Los Angeles County
Metropolitan Transportation Authority
Office of the Inspector General

Capital Project Construction Management Best Practices Study

Report No. 16-AUD-01

February 29, 2016

Metro

Los Angeles County
Metropolitan Transportation Authority

Metro

Office of the Inspector General
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Los Angeles, CA 90017

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February 29, 2016

Metro Board Members

Re: Report on Capital Project Construction Management Best Practices (16-AUD-01)

Dear Metro Board Members:

Currently, Metro is simultaneously overseeing an unprecedented number of projects; and there are multiple rail lines and other major projects under construction or about to start construction, and many more capital projects are in the planning phase. To ensure that these projects are effectively and efficiently managed, the Office of the Inspector General initiated a study to identify best practices for improving the management, oversight, and accountability of major construction projects. The overall objectives of the study are to:

- Determine major capital construction project management best practices;
- Determine how Metro might improve its practices to maximize completion of projects on schedule and within budget; and
- Determine how Metro might be more innovative, effective, efficient, safe, proactive in managing staff, schedules, costs, and relationships when performing capital project management and maximize use of state of the art technology.

We prepared a comprehensive RFP scope of work and hired Intueor Consulting which put together a team of construction, claims, process, and engineering experts who have experience in both construction and public transportation.

This report contains a number of recommendations and opportunities to improve procedures, policies, and processes in the following areas such as:

- Project planning and scope definition
- Project management
- Project delivery
- Utility relocation
- Staffing
- Change management
- Community involvement
- Partnering
- Procurement
- Oversight

The report was circulated to Metro management in late January. Management has only had a brief opportunity to review the report but provided a preliminary response (attached) stating: "Overall, the report provides a comprehensive set of recommendations that we plan to use as a catalyst for positive changes in the program management process and approaches in the future."

We will endeavor to have our consultant meet with management for a debriefing, and work with Metro construction management to evaluate and implement the best practice recommendations.

Sincerely,

Karen Gorman

Karen Gorman
Inspector General

cc: Board Deputies
Phillip Washington
Stephanie Wiggins
Richard Clarke
Bryan Pennington
Brian Boudreau
Calvin Hollis
Ivan Page
Charles Safer

Attached are the report and a CD that contains the following appendixes to the report:

Appendix A - Findings Workbook
Appendix B - Summary of Recommendations and Schedule of Proposed Actions
Appendix C - Documentation Inventory
Appendix D – Self Assessment Survey
Appendix E - Comparable Agency Benchmarks

Los Angeles County
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Metro

DATE: February 19, 2016

TO: Karen Gorman, Inspector General
Office of the Inspector General

FROM: Richard F. Clarke, Executive Director
Program Management
RF Clk

SUBJECT: Preliminary Report on Capital Projects

Program Management staff has reviewed the preliminary report on Capital Project Construction Management Best Practices. We generally agree with most of the findings and recommendations in the report. Overall, the report provides a comprehensive set of recommendations that we plan to use as a catalyst for positive changes in the program management processes and approaches in the future.

In the next few weeks, we will provide your office with specific responses to each of the 109 recommendations. I also plan to seek resources to assure that an action plan is developed and implemented.

I would like to thank you and your staff for the hard work on this effort. It will be very useful.

RFC:hs

Report on
Los Angeles County Metropolitan Transportation Authority
Capital Project Construction Management Best Practices Study

Prepared by: Intueor Consulting, Inc.
25 February 2016

Contents

I. Executive Summary

With the approval of Measure R in November, 2008, a projected $40B for transportation improvements throughout Los Angeles County will be implemented over the next thirty (30) years. Los Angeles County Metropolitan Transportation Authority (LACMTA), commonly referred to as Metro, currently has numerous major, complex projects under construction, in addition to many projects in the planning and design phases. Metro is an accomplished organization, with many exceptional initiatives and best practices incorporated into the organization and its operations.

However, Metro's past experience with managing transit project construction has been mixed. Identifying a need to improve its practices, the Metro Office of the Inspector General (OIG) developed a Statement of Work for a review to identify best practices for managing and overseeing capital construction projects. A Request for Proposal was sent to qualified consulting firms. Intueor Consulting, Inc. (Team Intueor) was selected to assist the OIG in a study project to assess the Metro organization's capital project management and project delivery capabilities, determine capital project management best practices, and provide recommendations for improving Metro's practices to maximize completion of projects on schedule and within budget.

Note: This report has been written based on the Metro organization and processes in place at the time of development (first half of 2015). Recent changes in Metro organizational structure, processes and procedures subsequent to the development of these specific findings and recommendations are not reflected in this report. Metro must assess this report, its findings and recommendations in light of these recent organizational changes.

A. Findings & Recommendations

The Findings and Recommendations identified in this executive summary are the highest priority for this study project. These high priority findings and other findings discussed in Chapter IV of this report address the objective areas of this study (refer to Chapter II, Introduction). The remainder of this report identifies and discusses other findings and recommendations. The high priority findings and recommendations listed in the executive summary are considered by the team to be of the **greatest influence on the probability of capital project success**.

This study incorporates findings from:

- Review and analysis of Metro's current processes and procedures in project management and project delivery
- Executive, management and staff interviews and discussions
- An on-line, anonymous, Self-Assessment Survey to understand Metro's project management maturity level (in accordance with the globally recognized standard for project management – the Project Management Institute's Project Management Body of Knowledge (PMBOK)

- Four (4) project workshops with each project team (Project Manager, Construction Manager, Contract Administrator, Project Controls Manager and support personnel) to capture best practices and lessons learned
- Comparable Agency questionnaires on their operations, processes and best practices

During the Self-Assessment Survey of Project Management Practice Maturity, Staff identified by the OIG and department Executives as representative of most of the major business functions performed by Metro, were asked to provide a self-assessment (on a scale of 1-5), of the maturity of specific project management disciplines and practices (e.g., Scope, Schedule, Cost, Quality, Risk Management, etc.). While the self-assessment provided by staff was fairly consistent across some departments, Team Intueor noted that the overall maturity for these departments were in the range of low-to-mid 3's, on a scale of 5, indicating the potential for considerable improvement. However, key supporting and/or stakeholder department maturity was significantly lower, indicating a lack of Metro-wide awareness of Project Management practices. Additional narrative feedback pointed to specific aspects that currently worked well within Metro, and those that could benefit from improvement.

The results of the self-assessment survey reveals that the departments directly responsible for delivery of the capital program consistently rank themselves at about 3.5 out of 5, indicating that they usually or almost always follow best practices. However, the departments less directly involved in program delivery have ranked the effectiveness of the program delivery at about 2 out of 5. Thus there is a gap between how the delivery units think they are doing and the perception of their stakeholders (refer to Figure 1 below).

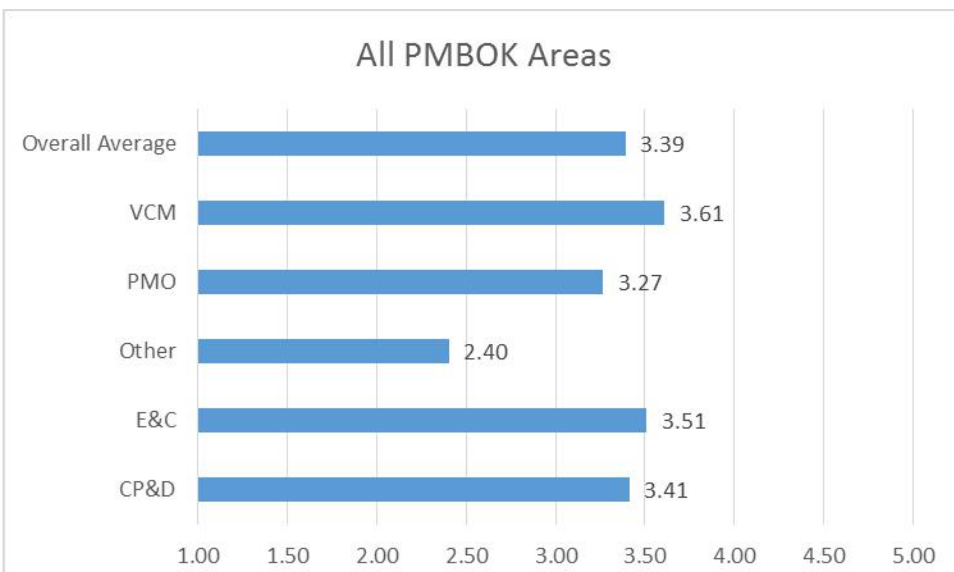

Figure 1: Self-Assessment Survey Summary

To achieve project excellence Metro needs to have a repeatable process consistently used by all project participants. Team Intueor's overarching recommendation is that Metro needs to better organize its procedures and processes around the FTA / FHWA oversight model. A base procedure setting forth minimum requirements for smaller projects should be established, with enhanced procedures mandated for larger projects. Project Managers should be involved from inception to final project closeout, and their compliance with the required procedures should be monitored. Initial and remedial training programs should be established. Upper management needs to let the project teams know that they are serious about best practices, and there should be consequences for non-compliance.

Team Intueor identified the following high priority findings and key recommendations that Metro should consider and further evaluate. A more thorough discussion of these and all other findings are provided in Chapter IV, Findings, Best Practices and Recommendations within this report. Also, Appendix B provides a summary of all the recommendations in the report and a separate schedule for tracking Metro's proposed implementation of the recommendations in this report. These findings are considered high priority in that addressing these issues through the recommended improvements listed will have the greatest influence on the probability of capital project success:

1. **Low bid contracting on major, complex projects is problematic**
   - Expand the use of best value techniques as frequently as possible
   - Carefully evaluate the future use of the Design-Build delivery method on a project by project basis

     - Establish intermediate milestones with liquidated damages for critical work.
     - Clearly define all project requirements.
     - Ensure project readiness for all Design-Build contracts utilizing FTA OP-54.

2. **There is no formal, established project delivery method selection process and criteria**
   - Assess, develop, implement, communicate and educate the organization on the detailed decision making process, criteria and elements of each project delivery method.

3. **Metro's Contract Administration process needs improvement**
   - Place a strong leader in charge of an agency wide change control group.
   - Establish a chain of command with clear roles and responsibilities of change control participants.
   - Establish procedures with timelines for resolution.
   - Increase training in change control and contract administration.
   - Consistently apply and proactively enforce the change control process.
   - Conduct regular audits.
   - Empower the Project Manager/Construction Manager with authority over the change order process, supported by co-located contract administrators.
   - Improve contractor compliance and Metro enforcement of the change management process.
   - Assess and enhance best practice models in change control.

4. **Obtaining approvals from City of Los Angeles and other cities can delay projects**
   - Establish a strategic, executive level partnering process.
   - Develop clear goals and objectives.
   - Secure a formal policy commitment.
   - Establish a management level partnering team to identify specific problems and issues and develop action plans for improvement.

- Develop and execute a new Master Cooperative Agreement with the City of Los Angeles, and any other cities in which Metro intends to construct a major project.

5. **Project Management methodology is not being utilized throughout the project lifecycle or throughout the Metro organization**
   - Formally adopt the Project Management Institute (PMI) and its Project Management Body of Knowledge (PMBOK) as the organizational standard for project management.
   - Develop an organization-wide Project Management Initiative, including a training and development program.
   - Develop and implement project management methodology throughout Metro.
   - Identify one (1) Project Manager responsible for the entire capital project lifecycle.
   - Empower the Project Manager with authority for decision making throughout the project lifecycle.
   - Realign and further develop the existing organizational structure for Program Management to establish a Strategic Program Management Office (PMO), reporting to the Chief Executive Officer (CEO) with dedicated staffing and resources to own the capital project delivery process, integrate project management throughout the organization, ensure compliance with processes and procedures, own the Metro Lessons Learned Program, assist all departments in project management development, and recommend continuous improvement to the CEO.

6. **Lessons Learned are not being programmatically captured**
   - Establish a formal, organization-wide Lessons Learned Program, managed by the Strategic PMO.
   - Establish a searchable, user friendly, Lessons Learned database to systematically capture, evaluate, analyze and incorporate into continuous organizational business operations, project management and project delivery improvements.

7. **Project Manager overall performance is wide ranging**
   - Develop and implement a Project Manager Performance Plan, detailing the specific skill set and competencies required of project managers, hiring strategy, training and development program and performance assessment metrics.

8. **Board of Directors oversight, reporting and approval concerns exist**
   - Closely adhere to Metro rules to enable staff accountability and keep the Board focused at the policy making level.
   - Assess if the Board of Directors can meet more frequently for items identified as critical to successful project delivery or delegate to a Board committee.
   - Consider delegating more authority to the Chief Executive Officer.
   - Reassess the Board review and approval process for more timely and efficient project changes.
   - Establish a team to assess Board requirements, other agencies and develop recommendations for improvement.

9. Up front planning of utility relocation issues is needed

- Dedicate staffing and resources to the Third Party Coordination Unit to effectively perform its functions.
- Revisit and expand master service agreements.
- Establish quarterly utility coordination meetings to programmatically discuss issues related to capital project delivery.
- Increase Metro investment in utility identification through more exploratory work during the early phases of project delivery.
- Expand the use of Advanced Utility Relocation (AUR) contracts.
- Consider allowing more time and cost contingency into capital project contracts for both utility identification and relocation.
- Apply for federal funding for AUR contracts.
- Create an initiative to "Re-engineer the Utility Relocation Process", developing and incorporating innovative strategies.
- Establish a Utility Relocation Technology Assessment Team to search, evaluate and implement state of the art technologies for subsurface utility identification.
- Establish a Utility Relocation Process Improvement Team to develop and implement a streamlined, creative utility relocation process.
- Establish a Legislative/Legal Improvement Team to assess and evaluate legislative and legal requirements for the utility relocation process.

10. Talent management concerns exist

- Staff augmentation contracts should be managed by individual functional departments.
- Expand the participation of the PM Academy.
- Further develop the PM curriculum to include interpersonal, technical and project management skills enhancement (this should be integrated with findings 5 and 7 above).
- Develop and implement a Staffing Analysis process with requirements for all departments that is used as the basis for all formal staffing requests.
- Develop a strategic plan for the use of consultants within the key departments of this study, incorporating the proposed pilot project mix of 70% Metro FTE/30% Consultant staff ratio.
- Assess the risk of the Quality Management function residing within the Engineering & Construction department.

B. Implementation Roadmap

Critical to the success of the above recommendations for improvement is an effective Implementation Roadmap that establishes a realistic schedule, considering needed resources to ensure that these broad impacting recommendations are strategically deployed, minimizing impact to staff, and capital project schedules. For the recommendations to be used successfully, Metro must thoroughly assess and analyze the recommendations within this report. In the development and implementation of a roadmap, Metro must consider:

- How these recommendations are interrelated, and must be integrated and closely coordinated with all impacted departments?

- What is the duration required to assess, develop and implement each recommendation for each finding?
- When each recommendation should start?
- What are the assumptions, constraints and resource requirements for each recommendation?
- What is the logical sequencing of these high priority findings and recommendations, considering all other findings and recommendations within this study report?

In addition, this Implementation Roadmap must consider the recent Metro organizational and process changes that have occurred since the start of this study project.

II. Introduction

In November 2008, Los Angeles County voters approved Measure R (½ cent sales tax), committing a projected $40 billion (35% to new rail and bus transit capital projects) for traffic relief and transportation upgrades throughout the county over 30 years. Measure R will help fund the construction of many new capital construction projects. With the 30/10 initiative to accelerate construction, Metro will be simultaneously overseeing an unprecedented number of projects. Currently, there are multiple rail lines and other major projects under construction or about to start construction, and many more capital projects are in the planning phase. In addition, Metro is considering another voter ballot initiative that would provide additional funds for construction.

Metro's past experience with managing transit project construction has been mixed. Some projects have been built on time and on budget while others have experienced difficulties due to various reasons. Given the significant number of transit related projects being built, it is essential that Metro learn from past successes and problems and develop industry best practices for moving forward to build these projects.

As part of utilizing best practices, the OIG has requested that Team Intueor consider the use of the Standards and Guidelines for Project Management for this study project. The Project Management Institute (PMI) has published guidelines for managing individual projects and defining project management related concepts. The Project Management Body of Knowledge (PMBOK) Guide contains the globally recognized standards and guidelines for the project management profession. These standards have evolved from the recognized best practices of project management practitioners. PMI also has published an extension to the PMBOK Guide that provides an overview of key attributes and best practices of project governance that apply to public sector organizations. Specific project management areas discussed in the PMBOK Guide and described within this study report are:

- Project Integration Management
- Project Scope Management
- Project Time Management
- Project Cost Management
- Project Quality Management
- Project Human Resources Management
- Project Communications Management
- Project Risk Management
- Project Procurement Management
- Project Stakeholder Management

Problem Statement

The purpose of this study was to identify best practices for improving the management and oversight of major capital construction projects. The overall objectives of the study were to:

- Determine major capital construction project management best practices.
- Determine how Metro might improve its practices to maximize completion of projects on schedule and within assigned budget.
- Determine how Metro might be more effective, efficient, safe, and proactive in managing staff, schedules, costs, and relationships when performing capital project management.

In addition, the overall study objectives were expanded in the Intueor contract to include Detail Objective Areas. The Detailed Objective Areas are the focus of all tasks in this study and are defined below:

1. General Readiness – Are projects ready in terms of staff, Memorandum of Understanding (MOU), project plans and procedures, plans for oversight, and clear schedules that identify consequences for schedule delays? Should a certain level of readiness be required prior to award of construction contract? How is readiness measured?

2. Utility Relocation – Are procedures and processes adequate for thorough detection of utility lines using latest technology, obtaining permits and approvals, and communication and transmission of information to third parties? Should Metro seek legislation to improve its ability to contract out utility relocations?

3. Communications – Are methods adequate for delivery of information and schedules, resolving impacts of obstacles, and coordination with contractors, third parties, and departments within Metro to ensure maximum cooperation and creative problem solving? Are roles, responsibilities, and accountability clear? Does Metro staff have the information, documents, and reports (such as monthly status reports) needed for oversight of transit construction projects? Are potential delays, budget impacts, and concerns promptly communicated and solutions or agreements documented?

4. Partnering – Are team working methods adequate to ensure maximum cooperation and creative problem solving? Are roles, responsibilities, and accountability clearly assigned? What are the best methods for partnering with contractors and clients such as Caltrans?

5. Problem Solving and Urgent Responsiveness – Are methods adequate for resolving disputes, problems, cost overruns, and delays to minimize overall project costs?

6. Safety – Are there adequate safety preventive measures and oversight procedures to avoid injuries and have swift response? Is an adequate process in place to identify red flags of safety concerns and security measures with law enforcement?

7. Staffing and Oversight – Is Metro's project delivery, project oversight, and related Metro departments adequately staffed, and have adequate resources to monitor and manage the progress of projects? Does the oversight function have adequate authority to address delays and cost risks? Is the mix of Metro staff to consultants appropriate to ensure efficiency, minimize commitment, and minimize costs? Is the staffing of Metro claims personnel adequate to analyze and resolve claims timely as events occur during the course of a project?

8. Policies and Procedures – Are Metro written procedures, software, and databases adequate for managing and overseeing capital construction projects including highway and rail projects, the claim process, and the resolution process for contractors and the public? Would resolving and closing out of claims with the contractor as they are received, or at certain milestones, versus resolving claims at the

end of the contract minimize potential litigation and costs? What are the key factors that need to be addressed to ensure success on current and future projects?

9. Project Delivery Methodology – Is Metro utilizing the best project delivery methodology for each type of capital project to minimize cost and reduce risk? For operational purposes, are terms/provisions in Metro construction contracts adequate to help ensure the project is completed free of problems?

A. Project Approach

The Study Team performed the following Tasks and associated activities in order to accomplish the project goals and objectives:

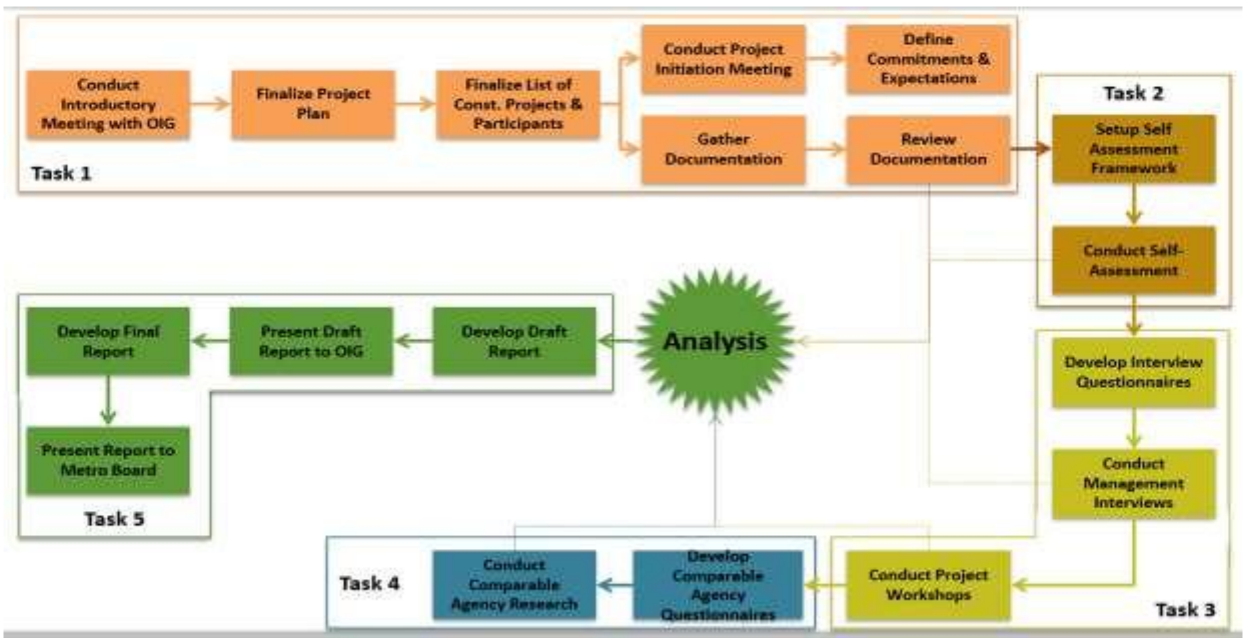

Figure 2: Project Tasks & Activities

a) Task 1: Project Initiation & Documentation Review

The purpose of this task was to effectively kickoff the project, and gather, review and analyze fundamental information pertaining to Metro's management and oversight of major capital construction projects, specifically focusing on Metro's objectives outlined in the RFP.

The project was initiated by requesting Metro policies and procedures, workflow charts, staffing plans (in house and consultant), organizational structure, safety statistics, changes and claims knowledge and capacity, contract documents and other data relevant to Metro's objectives (refer to Appendix B, Documentation Inventory, for a complete listing of Metro documentation assessed for this study project). This information was organized, reviewed and analyzed to identify Metro's strengths, weaknesses and areas for improvement. The results of this analysis, in integration with all other tasks for this study project, contributed to the development of the findings and recommendations within this report and are specifically discussed in Chapter IV, where appropriate. All findings are identified within Appendix A, Findings Workbook.

Armed with a greater knowledge of Metro, the Team Intueor participated in an Introductory meeting with OIG and Metro Executives to establish expectations and outcomes, and to identify appropriate participants and projects. Executive Interviews followed, to clearly understand the Metro organization, goals and objectives, operations, project management and project delivery processes and identify any areas for improvement. Based on the results of these meetings, the Study Team finalized the Project Plan. In addition, Team Intueor met with the former and current Metro CEO's to discuss study objectives.

Figure #2 above describes the general sequence of tasks and activities undertaken for this study (certain activities were performed in parallel and customized).

The project approach for this study focused on tasks and activities considering the following organizational and functional elements:

- The assessment of the current state of practice at Metro included project management over the entire project lifecycle, as opposed to just the construction phase.
- Team Intueor, in coordination with Metro, also identified specific construction projects that would have project workshops held to gather lessons learned.
- Information gathering and analysis activities of this study addressed the organizational structure* of Metro at the time of writing of this report and primarily focused on the following departments which are deemed critical to effective capital project delivery:
    - Engineering & Construction,
    - Program Management,
    - Vendor/Contract Management,
    - Countywide Planning & Development, and
    - Lesser focus on the departments such as Management Audit Services, Legal, Finance & Budget, Human Resources, Operations, Communications and Enterprise Risk & Safety.

*NOTE: Organizational and capital project delivery process changes have been implemented since the writing of this report and the findings and recommendations of this study must be assessed in light of those changes.

b) Task 2: Self-Assessment Survey

An on-line, anonymous, Self-Assessment survey was developed and implemented through discussions with OIG and Metro executives. The purpose of the survey was to assess the level of awareness and current use of standard project management practices within Metro and to further identify challenges and opportunities for improvement for staff with project management functions and PM support functions, such as executive management, planning, design, construction, procurement and project controls personnel (Refer to Appendix C, Self-Assessment Survey, for the framework and results of the Survey).

The survey was correlated to PMI standards and guidelines, based on the PMBOK knowledge areas and aligns with the primary and detail objective areas for the project. The survey was customized to Metro's terminology and processes based on the assessment of the Metro organization in Task 1 and additional discussions with Metro. In addition, the Survey questions consider the detailed objective areas across the project life cycle (Figure # 3 below provides a look at the format and structure of the survey).

The analysis of staff responses to the survey allowed the study team to evaluate the maturity of project management practices, and the consistency with which those practices are adopted at Metro. The survey analysis also determined that gaps exist between individual department assessments of project management practices.

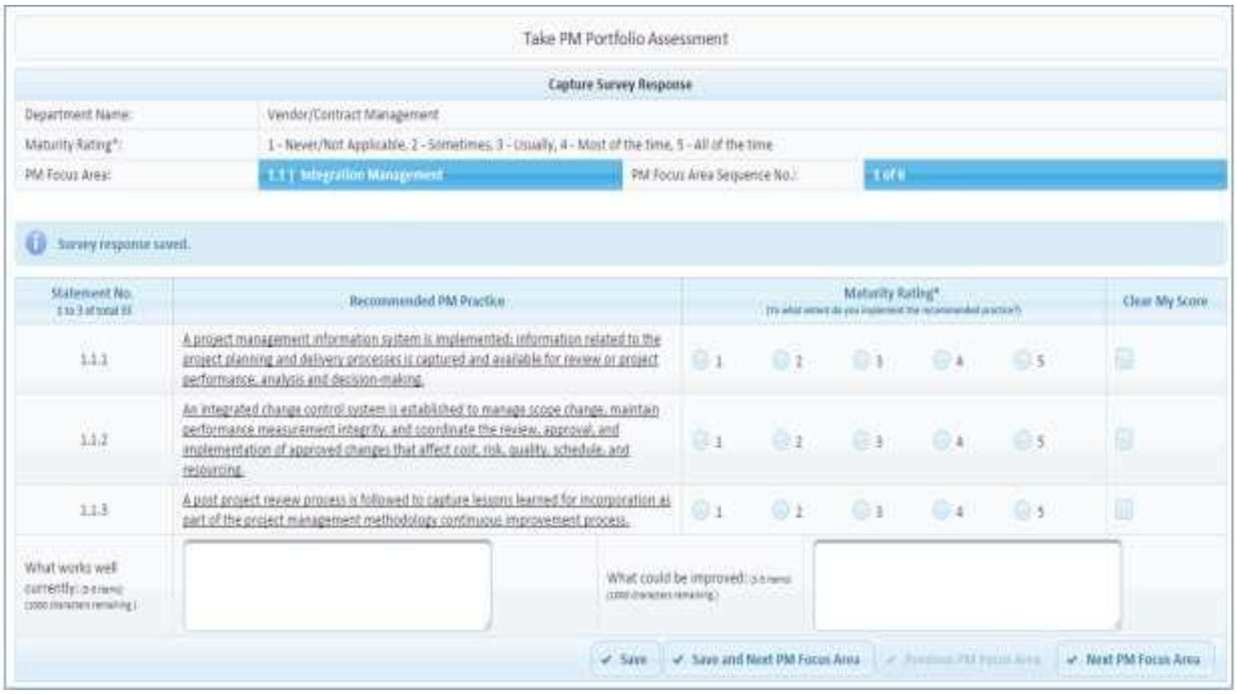

Figure 3: Self-Assessment Survey

c) Task 3: Staff Interviews and Project Workshops

Metro executive and management interviews were held along with four (4) project team workshops to capture lessons learned and identify how well business operations, project delivery and project management is functioning. This interactive approach identified capital construction project management best practices and areas for improving Metro practices and project delivery. In addition, the study team reached out to the Board of Directors for input and an interview was held with a Board Deputy (refer to the Study Team and Contributors list at the end of this report).

Based on discussions with OIG and Metro management and documentation review, the study team developed questionnaires for the executive and management interviews, and the Project Team Workshops. Information gathered from interviews included:

- Roles and responsibilities
- Reporting relationships
- Tasks performed on a day to day basis
- Business functions and processes that they support throughout the project lifecycle
- Other unit interactions

- Consultant and contractor interactions
- Information consumed, created or managed during job performance
- Tools and technologies utilized
- Challenges encountered
- Best practices and lessons learned

Analysis of the interviews and workshops further identified strengths and opportunities for improvement. Each interview was 1 to 2 hours in duration. A total of 33 Metro personnel were interviewed. The four (4) Project Workshops were each 2 to 3 hours in length. These interviews and workshops allowed Metro executives and management to participate in project delivery practice assessments and in making informed decisions on future solutions to improve capital construction project management. All interviews and workshops were conducted in a friendly, cordial and professional atmosphere, with strict confidentiality of all discussions stressed to all participants.

d) Task 4: Comparable Agency Research

The purpose of this task is to identify other comparable agencies' best practices that could be used in conjunction with Team Intueor's experience to develop targeted best practices to increase Metro's probability of project success. A list of comparable agencies was developed and approved by OIG based on specific criteria such as the size and scale of operations, capital program, transit modes, project delivery methods, etc. (Refer to Appendix E, Comparable Agency Benchmarks for information).

Team Intueor developed a questionnaire aligned with the 9 detail objective areas and PMBOK in order to solicit specific best practices information. Nine comparable agencies responded. This Questionnaire was sent to the agencies. Follow up communication was necessary to clarify and better understand responses. The results (Appendix E) are summarized in a matrix. The completed questionnaires are also included. The best practices gathered from this research are used throughout this report to formulate best practices and recommendations.

In addition to the benchmark data, the Study Team researched FTA, APTA and industry databases and layered in our broad collective experience with comparable agency best practices.

e) Task 5: Report Presentation

Utilizing all of the information gathered and analyzed, this Study Report was developed in a format acceptable to the OIG, describing the study and identifying findings, best practices and recommendations for improvement. The team will be available to make an in-person presentation to the Board concerning this report at a future Board meeting as directed.

III. LA Metro Landscape & Project Lifecycle

The Los Angeles County Metropolitan Transportation Authority (LACMTA), or Metro, is the largest public transit provider and the Regional Transportation Planning Agency for Los Angeles County, home to 10 million residents within 4,083 square miles. Metro is responsible for the continuous improvement of an efficient and effective transportation system for Los Angeles County. That responsibility is clearly shown in the exceptional initiatives and accomplishments that Metro is achieving, such as:

- The 30-10 Initiative and Measure R in accelerating key expansion projects
- Leading the transit industry in sustainability and environmental programs
- The fastest expanding bus fleet in the US
- Largest all clean-burning natural gas fleet in North America
- First agency to incorporate electric vehicle charging stations as part of the transit system
- First agency to apply flywheel technology to reduce energy use on trains
- Implementation of the 40 foot all electric, zero emission bus
- Creation of the Office of Extraordinary Innovation to develop and implement new ideas and innovative strategies

In FY16, Metro continues planning, design and construction of the largest public works program in America funded with voter approved Measure R, and prepares for a potential new ballot measure.

Metro has established clear Values and Core Business Goals for its organization and stakeholders.
Metro's **Values** are:

Safety: We commit to ensure that our employees, passengers and the general public's safety is always our first consideration.

Service Excellence: We commit to provide safe, clean, reliable, on-time, courteous service for our clients and customers.

Workforce Development: We commit to make Metro a learning organization that attracts, develops, motivates and retains a world class workforce.

Fiscal Responsibility: We commit to manage every tax payer and customer-generated dollar as if it were coming from our own pocket.

Innovation and Technology: We commit to actively participate in identifying best practices for continuous improvement.

Sustainability: We commit to reduce, re-use and recycle all internal resources and reduce greenhouse gas emissions.

Integrity: We commit to rely on the professional ethics and honesty of every Metro employee.

Teamwork: We commit to actively blend our individual talents to achieve world-class performance and service.

In addition, the **Core Business Goals** included in Metro's official mission statement are as follows:

1. Improve transit services
2. Deliver quality capital projects on-time and within budget
3. Exercise Fiscal responsibility
4. Provide leadership for the region's mobility agenda
5. Develop an effective & efficient workforce
6. Secure local, state and federal funding
7. Maintain open lines of communication
8. Enhance a safety-conscious culture with employees, contractors & customers
9. Sustain the environment with energy efficiency & reduce greenhouse gas emissions

The Findings, Best Practices and Recommendations for this study (discussed in Chapters I and IV of this report) reinforce the importance of the Values and Core Business Goals of the organization.

A. Metro Organization

The Metro organization structure is a functional organization, with vertical business units, or departments with specific functional assignments (Refer to the Metro Agency wide Organization Chart below). However, for improving capital project delivery, Metro utilizes a project matrix organization, with project teams formed. Functional departments assign personnel directly to a project, reporting to both the functional manager and the project manager.

For Major Projects, the organization utilizes a "tight matrix" structure, where the project team (Project Manager/Project Director, Construction Manager, Contract Administrator and Project Controls Manager) is co-located to the project to increase cooperation and communication with more effective delivery of work assignments thereby breaking down the functional vertical business units. This effective organizational structure is discussed in Chapter IV of this report.

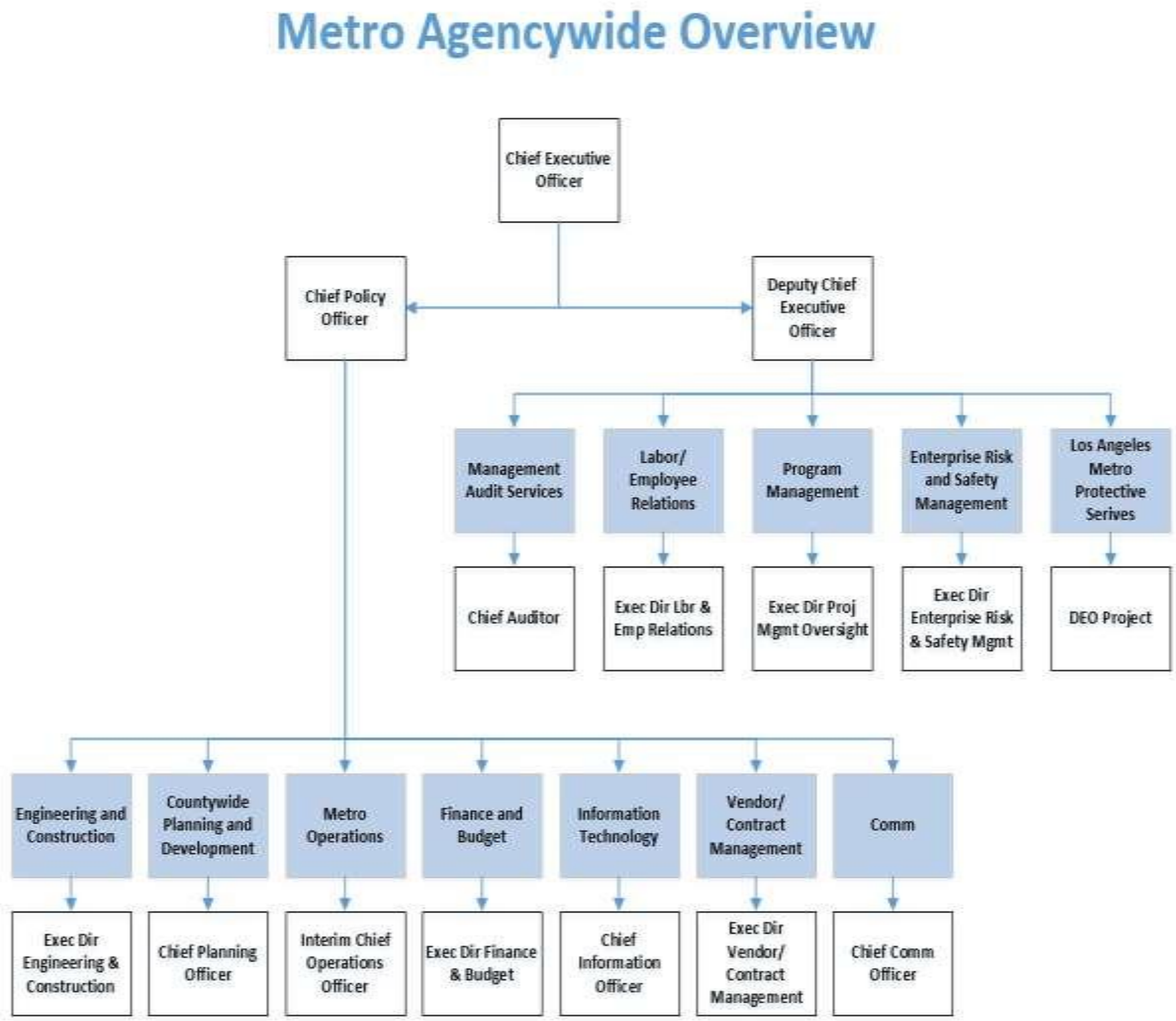

Figure 4: Metro Agency-wide Overview

B. Project Lifecycle

In order to clearly understand the Findings and Recommendations of the study report, an overview of the Project Lifecycle is provided. As a project is developed at Metro, the project proceeds through various stages or phases, depending on the specific type of project delivery (Design/Bid/Build or Design/Build). This process is described within various Metro policies and procedures, such as Policy DSGN0, which describes the development requirements for Major Transit Projects.

The major phases of capital project delivery are Planning, Design Development, Construction and Installation, Testing and Commissioning, and Operations and Maintenance. A depiction of the capital project delivery process is shown below:

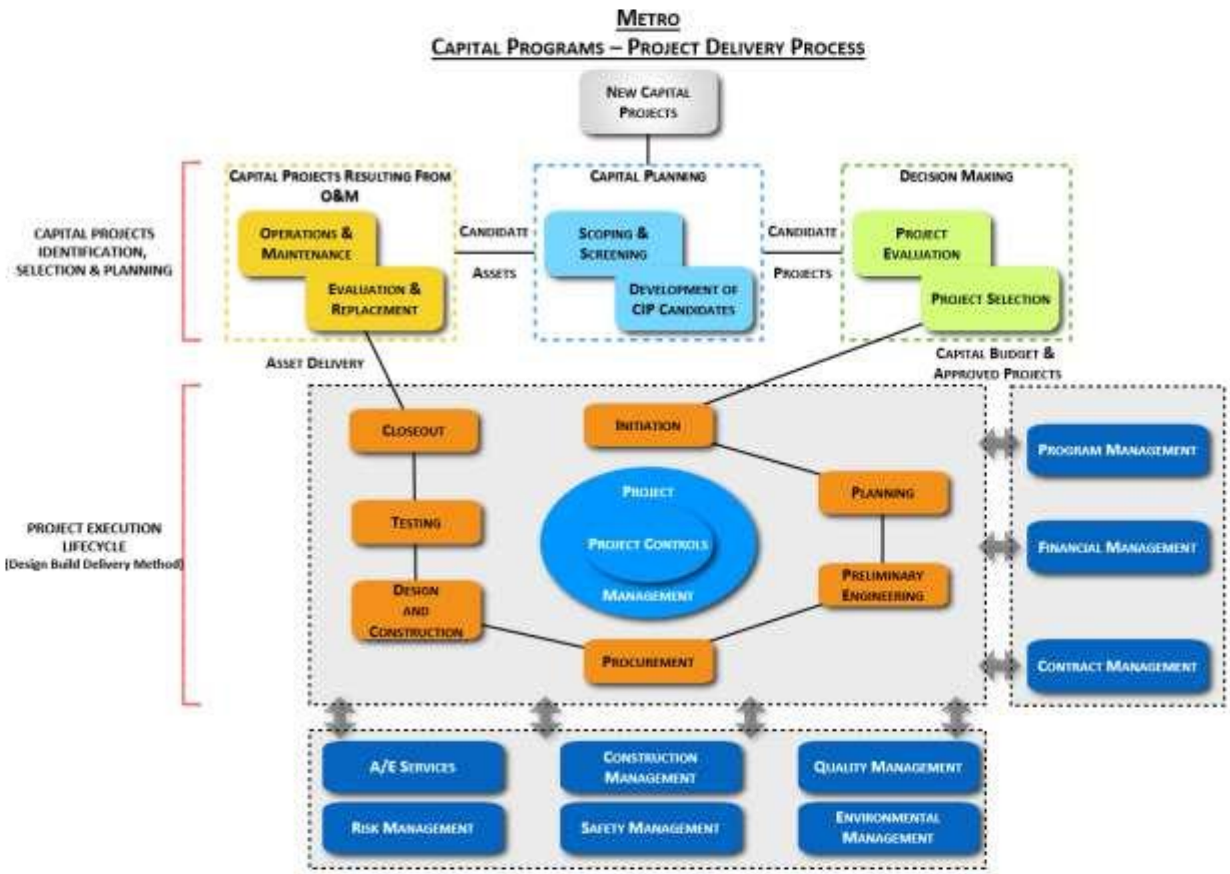

Figure 5: Capital Project Delivery Process

The initial phase of capital project delivery is the Planning Phase, managed by the department of Countywide Planning & Development. The major elements of the Planning Phase and critical activities are:

- Project initiation – Board authorization, project implementation document, project funding and agreement, kickoff meeting
- Alternatives analysis – detailed analysis of alternatives, stakeholder collaboration, selection of the preferred alternative
- Conceptual development – further development of the preferred alternative
- Environmental processes – environmental development, studies and drafting of an environmental document
- Project transfer to Engineering & Construction – preferred investment strategy developed, specific project contracts are determined, specific method of project delivery is determined

As the project progresses in development, the Design and Construction Phases have two pathways, depending on the delivery method selected (Design/Build or Design/Bid/Build) (refer to the project delivery process graphic below).

For the Design/Build Process, the major elements of the Design and Construction Phases and some key activities are described below:

- Preliminary Engineering – completion of the alignment plans and layout, development of the project design to a 30% level (project management up to environmental approval and funding is managed by Countywide Planning & Development department, then overall project managed is transferred to the Engineering & Construction department), third party and stakeholder coordination, approval of an environmental document, project schedule and estimate development, detailed design criteria, performance specifications, design and constructability review submittals and the development of the design, if necessary, to a level of detail appropriate for design/build solicitation and MTA approval.
- Bid/Proposal – development of the technical Request for Proposal (RFP) documents for the method of procurement (low bid, best value, competitive negotiations, sole source, etc.), response to Requests for Information (RFI), development of addenda, if necessary, technical evaluations of proposals, clarifications, selection and contract award.
- Design & Construction – project set up, preconstruction meeting, Notice to Proceed, schedule, advancement of the design as construction is progressing, progress payments, design and constructability review submittals, quality management, change management, final acceptance and closeout.
- Testing – project activation, test plan, systems integration testing, start up testing, final acceptance and turn over to Operations.

For the Design/Bid/Build delivery method, the major elements of the Design and Construction Phases and key activities are:

- Preliminary Engineering – development of the design to a 30% level (project management up to environmental approval and funding is managed by Countywide Planning & Development, then managed by Engineering & Construction), design and constructability reviews, Board approval.
- Final Design – development of the final design to interim (65%), Pre-Final (95%) and Final (100%) Review stages, design reviews, constructability reviews, and MTA approval to advertise.
- Bid/Proposal - development of the technical Request for Proposal (RFP) documents for the method of procurement (low bid, best value, competitive negotiations, sole source, etc.), response to Requests for Information (RFI), development of addenda, if necessary, technical evaluations of proposals, clarifications, selection and contract award.
- Construction - project set up, preconstruction meeting, Notice to Proceed, schedule, progress payments, constructability review submittals, quality management, change management, final acceptance and closeout.
- Testing - project activation, test plan, systems integration testing, start up testing, final acceptance and turn over to Operations.

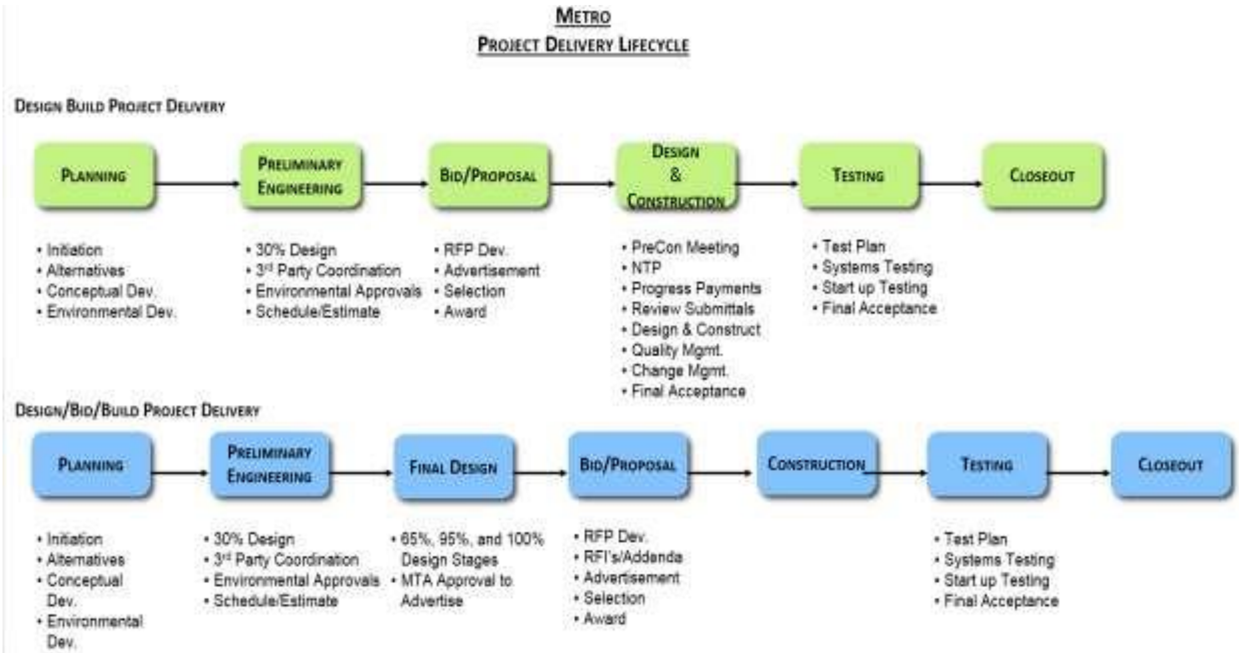

Figure 6: Project Delivery Lifecycle

IV. Findings, Best Practices and Recommendations

As a result of the study team review of all Metro documentation provided, executive and management interviews, the Self-Assessment survey responses, select project workshops and questionnaires obtained from comparable agencies as part of our Project Approach (described in Chapter II above), Team Intueor identified specific issues that the team considers of value to Metro, which are discussed within this report. Issues identified are separated into several categories.

First, in order to understand these issues in terms of the capital project lifecycle, we have grouped the issues into the following categories:

- Planning and Design Phase Issues
- Construction Phase Issues (including Operations and Maintenance)
- Overarching Issues (affect All Phases of capital project delivery)
- Support Process Issues (processes that support capital project management and delivery)

Secondly, Issues are further categorized by areas of specific issue, and which relate to the Detail Objective Areas of this study (described in Chapter II):

Planning and Design Phase Issues
- Scope Definition and Project Planning Issues (General Readiness objective area)

Construction Phase Issues
- Partnering Issues (Partnering objective area)
- Procurement Issues (Project Delivery Methodology objective area)
- Change Management Issues (Problem Solving objective area)

Overarching Issues (All Phases)
- Third Party Issues (General Readiness objective area)
- Project Team Issues (Staffing and Oversight objective area)
- Project Management Issues (Policies and Procedures objective area)
- Project Delivery Issues (Project Delivery Methodology objective area)
- Community Involvement Issues (General Readiness objective area)
- Board of Directors Issues (Staffing and Oversight objective area)
- Utility Relocation Issues (Utility Relocation objective area)

Support Process Issues
- Policy and Procedures Issues (Policies and Procedures objective area)
- Human Resource Issues (Staffing and Oversight objective area)
- System Issues (Communications objective area)

For each issue identified, a Finding discussion, an assessment of Best Practices related to the Finding, and the identification of any specific Recommendations for improvement are included. Recommendations describe what we recommend for improvement, but also suggest how Metro should develop and/or implement each Recommendation (please refer to the Implementation Roadmap section within Chapter I, Executive Summary, for the discussion of critical factors that Metro must consider when developing and implementing the recommendations within this report). In addition, some findings have been combined and are discussed as a group. For the complete listing of all Findings, its specific issue category, study objective area and PMBOK knowledge area, refer to Appendix A., Findings Workbook (includes findings cited in this report and other observations not included in this report).

A. Planning and Design Phase Issues

1. Scope Definition and Project Planning Issues (General Readiness objective area)

The Statement of Work in the RFP grouped several questions under the general readiness objective area. It asked:

a) Are project staff ready?
b) Are Memorandums of Understanding (MOU) in place?
c) Are project plans and procedures sufficient?
d) Are plans for oversight in place?
e) Are there clear schedules that identified consequences for schedule delays?
f) How readiness would be measured and should a certain level of readiness be required prior to award of a construction contract?

Each of these questions is addressed in this report. Team Intueor's investigation revealed that while some larger projects are ready to start, Metro management appears to think projects start before they are ready and staff think that Executive oversight is pushing projects to start before adequate project detail is complete. Thus both management and staff feel that projects start before they are fully ready.

a) Staff readiness could be enhanced on projects (Appendix A, Findings 31, 32, 36 and 81).

(1) Finding

Metro is a mature organization with many staff that have worked for the agency ten years or more. Also Metro has been engaged in its capital program for many years and has successfully completed many projects, large and small. Thus it has a pool of experienced staff that are indeed ready and able to start the next project. For newer staff, Metro has taken steps to help prepare staff to manage projects. There is a Project Management Academy established in July 2014 which is managed by the program management group. It offers a 2 day training and development class. There is also a mentoring and internship program. Team Intueor found processes and procedures that are grounded in best practices. Metro staff are also encouraged to attend and present at professional conferences.

However, when dealing with an organization as large and diverse as Metro it is impossible to make generalities that apply to all situations. While federally funded projects follow federal guidelines, the highway side of Metro does not follow the same procedures, get the same training, or use the same reporting tools as the rail side. The experienced rail staff are assigned to larger projects, while smaller projects get staff with mixed experience. One interviewee noted that PM performance and experience is wide ranging.

Team Intueor studied the PM Academy training slides and found them to be very high level, skimming the surface just enough to give a general understanding of the concepts without delving into the details enough to be meaningful. The procedures are not well organized and are not universally applied to the entire organization. They may not conform to federal oversight procedures, and there is little to no enforcement of the procedures nor are there consequences for non-compliance.

(2) Best Practice

The Federal Transit Administration (FTA) has published Oversight Procedures (OP) that include readiness reviews which describe what is needed to move a project to the next phase, as follows:

- 51 Readiness to Enter Engineering
- 52 Readiness to Execute Full Funding Grant Agreement (FFGA)
- 53 Readiness to Procure Construction Work
- 54 Readiness for Revenue Operations

These procedures are used by the FTA's Project Management Oversight Consultant (PMOC). As an example, the FTA checklist for OP-53 includes verification of the following:

- Readiness to Bid:
  - Plans & Specifications Complete
  - Construction Contract clearly defines the terms and conditions
  - Design QA Documentation
  - Construction Cost Estimate is consistent with plans and specifications
  - Construction Cost Estimate is based on contemporary cost information
  - General Conditions Cost Estimate reflects actual contract requirements and not an industry average factor

- Bid package Consistency:
  - Bid Package is consistent with environmental documents
  - Bid Package is consistent with project development and engineering phases
  - Bid Package is consistent with the Master Schedule
  - Master Schedule scope is consistent with the cost estimate
  - Project Schedule durations are coordinated with cost estimate
  - Cost Estimate does not exceed the project budget
  - Bid documents follow packaging guidelines

- Readiness to begin construction:
  - All third party agreements are in place and they have considered:
    - Design standards
    - Utility agreements
    - Agreement with other railroads; inclusion of enhancements; concurrent non-project activities, and timing of reviews, permits, land transfers, and funds transfers
    - Utility relocations are completed (advance utility relocation) or identified (potholing, ground penetrating radar, etc.) and added to the contractor's scope
  - Design consistent with Real Estate Acquisition & Management Plan (RAMP)
  - All required ROWs obtained or acquisition date called out in contract
  - Procurement Policies and Procedures are compliant with federal policies
  - Procurement Policies and Procedures ensure a fair bidding environment

- Procurement Policies and Procedures are able to efficiently resolve issues & disputes
- Project staffing plan is consistent with the PMP

(3) Recommendation

Recommendation 1. The FTA oversight procedures are a best practice that helps ensure projects are ready to move to the next phase. Metro should adopt these procedures and checklists for use on all projects regardless of size or complexity. Training should be provided for each procedure at a level of detail sufficient to facilitate understanding. Auditing of compliance and remedial training ensure consistent application.

Recommendation 2. To ensure a readiness approach, Metro should implement a formal Stage Gate process. Although Metro does perform detailed checks, and procedures establish specific requirements at the end of each phase of project development, a formal Stage Gate approval process will ensure that a project does not progress to the next stage of project development until it is ready. To ensure that the program/project is progressing satisfactorily as it is developed, control gates "Gateways" are incorporated into the delivery process. These gates represent a management event in the project life cycle sufficiently important to be defined and incorporated in the project schedule (represented as milestones). Control gates provide the opportunity for senior management to exercise their authority on the project's scope, pace and further advancement. They ensure that new activities are not pursued until the previously dependent activities are satisfactorily completed (refer to the Stage Gate graphic below).

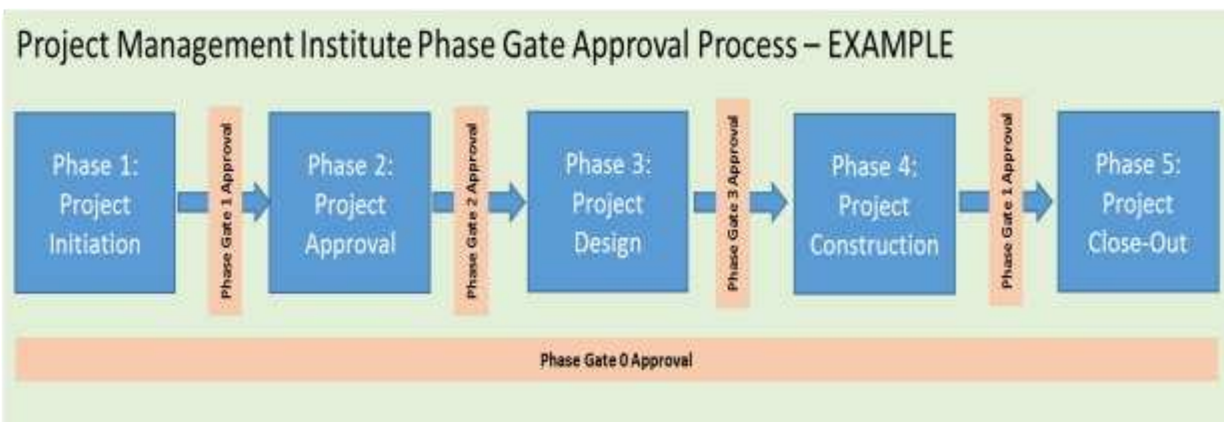

Figure 7: PMI Gateway Process

b) *Metro's Memorandum of Understanding process follows best practices, but is overwhelmed by the volume and pace of the capital program and is circumvented by use of the design-build delivery method (Appendix A, Findings 49, 93, 100, 101, 103 and 105).*

(1) Finding

Metro projects involve many external stakeholders that each have the potential to delay projects or cause cost overruns. A successful project engages these stakeholders from the conceptual stage and reaches an understanding regarding key issues. In addition to the citizens of the City of Los Angeles and neighboring communities, two of the most important categories of external stakeholders are the myriad of utility owners who have pipes and wires in the way of the alignment, and the various governmental entities who have a voice in the design of the project.

Metro recognizes the need to get a Memo of Understanding (MOU) in place and has full time dedicated Third Party Coordinators to manage this process. Third Party Coordinator interviews identified that Metro has existing master service MOUs applicable to all projects with almost all the utility firms. The Coordinators are in constant contact with the various stakeholders to ensure that they meet the obligations in the MOU in a timely fashion. However, despite following this best practice, third parties still frequently delay projects.

The reasons why there are still problems include the following:

- Several interviewees indicated that the Planning phase does not incorporate third party coordination.
- The sheer volume and pace of capital construction underway has overwhelmed the capacity of the coordinators. As a result not all MOUs are current.
- The volume and pace of the work exceeds the capacity of the third parties to meet their obligations under the MOUs, forcing them to prioritize requests. As a result, they frequently cannot meet their commitments.
- The design-build delivery methodology defers the identification of utility interferences to the construction phase and does not always leave enough time to schedule the utility relocations to support construction.
- The design-build delivery methodology puts detailed technical coordination with governmental entities during design and submittal review into the hands of individuals who do not understand the process or have prior relationships with the reviewers. It also defers the identification of government mandated scope changes to the construction phase when the cost of the change is much more expensive.
- The planned sequence of construction frequently changes as delays are encountered in the field, shifting the planned timing of the relocation to a period not envisioned in the MOU.
- The process of relocating utilities takes about two years. Projects often do not allow enough time for utility relocation.

(2) Best Practice

FTA Circular C 4220.1F provides contracting guidance for recipients of FTA assistance when using that assistance to finance its procurements (third party contracts). This document notes that the FTA reserves the right to deny Federal assistance if a recipient negligently to execute all required utility agreements in time to assure uninterrupted construction progress.

In addition, FTA Oversight Procedure 51-2 Readiness to Enter Engineering notes that “The framework and content of these <third party> agreements must conform to the needs of the project. Agreements should be negotiated and completed to the extent possible prior to start of Engineering Phase; where incomplete, a defined process for achieving completion is in place”.

(3) Recommendation

<u>Recommendation 3.</u> Metro should require staff and consultants to allow 2 years to get utilities identified and relocated and incorporate third-party coordination into their processes prior to the start

of Engineering. This duration should be customized on a project specific basis, based on project size and complexity. Metro should audit compliance with this requirement and use it as a factor in performance evaluations.

Recommendation 4. Metro's decision to accelerate the timeline for delivering its capital program has placed a significant burden on project stakeholders. The volume and pace of construction far exceeds the capacity of utility companies, government reviewers and other third parties to keep up. Metro should continue to develop and implement strategies to support third parties, such as providing financial assistance to utility companies and government entities in order to obtain the necessary resources to effectively support project delivery.

Recommendation 5. Metro should also carefully consider its delivery methodology decisions on a project-by-project basis. While design-build gives the appearance of starting earlier and shifting risk, it also shifts discovery of the need for MOUs to a more costly period and puts coordination and resolution of government mandated scope changes into the hands of an adverse party that has minimal interest in controlling costs (please refer to Procurement Issues, item a, and Project Delivery Issues, item b, for additional discussion regarding the design-build delivery method and selection process).

c) Design plans and specifications are not always ready for construction (Appendix A, Findings 11, 17, 31, 49, 53, 60, 84 and 105).

(1) Finding

Interviews and survey responses indicated frequent concerns about the quality of design. These concerns included the following:

- Project scope is not being effectively detailed before the design/build contract is awarded
- Design/Build contractors are not providing sustainability plans
- Contractors are not addressing operational requirements
- Environmental mitigation issues and changes are occurring in design/build contracts
- Projects are setting technology solution too early, causing later scope changes
- Utility relocation is not being addressed in the planning process

Participants in a project workshop for a problematic project stated that the job was rushed out the door to avoid losing funding. Similar statements from interviewees support this statement and indicates that this has occurred on multiple projects. For this project, there were inconsistencies in contract documents that took months to coordinate. Also several scope changes occurred because they all negotiations were not finished with stakeholders.

Metro has policies that cover design review of design-bid-build and design-build contracts. Since most of the concerns involved design-build contracts, the Team Intueor examined policy# DSGN1/D-B entitled Scope Definition Review and Acceptance for Design-Build Contracts. The goal of this policy is to "achieve cost effective Project Definition that improves construction, maintenance and operations, while at the same time achieving the required level of passenger safety, system reliability and service comfort."

The policy also establishes a Preliminary Engineering submittal review process that verifies that the Project Definition is consistent with the Project Management Plan, Project Implementation Plan, the

Environmental Impact Statement/Report, System-wide Design Criteria and Standards, MTA Directives, MTA-approved third party requirements and the Operations and Maintenance Plan. Review of the PE submittal is accomplished jointly by MTA Planning, CPM, Environmental and Operations. Thus there is a written procedure in place that if followed should avoid many of the concerns mentioned above. This policy only covers projects after they have been transferred from Planning to Engineering. Policies from the Countywide Planning department were not provided, that would allow us to determine whether their pre-Engineering efforts include addressing operational, environmental, utility relocation and sustainability effort.

On the question of sustainability, Metro has expressed a commitment to integrate sustainability into the agency's planning functions. It defined its goals in the Metro Ad-Hoc Sustainability Committee charter as fostering walkable and livable communities, minimizing greenhouse gas emissions and environmental impacts and providing leadership in sustainability within Los Angeles County without compromising its core mission of providing an efficient and effective transportation system. Metro's ongoing investment in its sustainability-related infrastructure continues a decade-long commitment. Since 2005, Metro has completed 37 projects, realizing nearly $2 million in yearly cost savings from the operation of these assets.

However, on February 27, 2014, the Metro Board of Directors approved a motion on sustainability-related infrastructure, operations and maintenance, which stated that there were gaps in the current sustainability approach; specifically for maintaining the current asset base to ensure the realization of projected cost-savings. It noted that "these gaps provide a very clear signal that continued maintenance deferment of sustainability-related infrastructure will reduce and eventually eliminate the unique benefits that arise from investments made by our agency in these assets." This therefore requires action to address different aspects of current and future sustainability investments and maintain them in a state of good repair.

In conclusion, while Metro has strong policies and procedures that if followed would result in plans and specifications that are ready for construction, in practice there still appears to be problems with design not being fully ready for construction.

(2) Best Practice

For federally funded projects, Metro is required to comply with FTA Oversight Procedures (OP). While not mandatory for non-federally-funded projects, the OPs set forth best practice standards. FTA OP-32A requires Metro to supply an operating plan to document how the Project Sponsor intends to fund and operate the proposed project and the existing transit system. The operating plan must document five years of historical data and present 20 years of projected system operating revenues and O&M costs to demonstrate the capability of the Project Sponsor to operate and maintain the proposed project while retaining existing levels of transit service. FTA OP-32B requires Metro to comply with NEPA requirements for preparation of an EIS, and in its Record of Decision (ROD) the FTA requires the scope of the project to include the committed mitigations to reduce the effects of identified environmental impacts. As noted above, FTA OP-20 states that Third-party Agreements should be negotiated and completed to the extent possible prior to start of the Engineering Phase. FTA OP-22 covers safety and security standards and provides a checklist to help ensure scope considers these important considerations.

A best practice to enhance the opportunity to get meaningful and ongoing input from operations is the San Francisco International Airport (SFIA)'s Stakeholder Engagement Program. This program establishes regular meetings between project teams and operations and provides for a SWAT-team like approach to issue resolution.

(3) Recommendation

Recommendation 6. Metro should use the PMI Gateway Process recommended in Planning and Design Issues, item a above, the SFIA Stakeholder Engagement Program and FTA oversight procedures to develop procedures and readiness checklists to verify that design documents represent a complete scope that includes all operational, environmental, security, safety and sustainability requirements. For scope completeness, Metro should include this because the problem is that agencies sometimes fail to include environmental requirements from the EIR / Mitigation Monitoring & Reporting Program (MMRP) in the DB design criteria or the DB scope, and thus this is a planning issue.

d) *State of Good Repair, Life Cycle Costs and Asset Management is not being effectively addressed within capital projects and the capital program (Appendix A, Findings 78 and 85).*

(1) Finding

Interviews indicated that the current goals and objectives of the organization are varied. Both need to prioritize operations and maintenance costs within the capital program. Both compete for funding. Metro needs to ensure that long term State of Good Repair costs are addressed sufficiently in the capital program (Billions of dollars in future costs are approaching). In addition, operation and maintenance costs are not being effectively assessed within project development.

(2) Best Practice

APTA SGR-TAM-RP-002-13, FTA Asset Management Guide and TCRP 157 – State of Good Repair provide excellent guidance for organizations on the development and implementation of an effective Asset Management Program.

(3) Recommendation

Recommendation 7. Establish an organizational commitment and obtain Board support for an effective Life Cycle Asset Management Program. The priority of the organization should be to develop a program that integrates operation & maintenance needs with Capital Improvement Program needs, considering MAP-21 requirements.

e) *Life of Project Budget is set at the beginning of the project lifecycle and is not reassessed (Appendix A, Finding 10).*

(1) Finding

Setting and strictly holding a Life of Project (LOP) Budget at the beginning of project development and not reassessing the budget at the end of project delivery stages is not an effective process. This process significantly increases the risk of cost changes to the project during project development. As project detail is developed throughout the project delivery lifecycle, costs will change. In addition, there is no standardization to this process (structure, cost assemblies, not reflecting potential inflation, etc.).

(2) Best Practice

The Project Management Institute's Project Management Body of Knowledge (PMBOK) Cost Management – Rolling Wave Planning and AACEI – Progressive Elaboration of Cost are effective guidance tools for establishing an LOP.

(3) Recommendation

Recommendation 8. Develop and implement a LOP budget with phased reassessments, utilizing the PMI Gateway process. Revise baseline management procedures to address Rolling Wave Planning.

f) Risk Management is not being implemented early enough in Capital Delivery (Appendix A, Findings 27 and 106).

(1) Finding

During the Planning phase of projects, the Countywide Planning & Development department performs the role of the project manager. It was discovered that this group does not conduct risk management identification analysis.

(2) Best Practice

DART and London Underground have detailed risk management processes, requiring risk registers developed and updated throughout the project lifecycle for all projects. In addition, SFPUC has implemented formal risk processes for the WSIP program. Risk registers are maintained and updated monthly throughout the duration of the project by construction managers supported by a central risk management group. SFPUC uses a risk assessment process to establish contingency on larger projects. In the assessment, a risk register is built that identifies, quantifies, and qualifies risks, and a mitigation plan is developed for each risk. Ideally, project participants and stakeholders are brought together to discuss possible risks that are common points of concern. Once all possible known risks are identified, a qualitative analysis is done to identify the risk probability (i.e., the likelihood that a specific risk will occur). This step is followed by a quantitative analysis that investigates the potential effect of a risk event on a project objective, such as time, cost, scope, or quality, and includes both negative effects for threats and positive effects for opportunities. In the next step of the process, members of the group develop a mitigation plan for each risk they can influence or control. All of this information is entered into either risk software or into an Excel spreadsheet to produce a project risk register. The list of risks is then prioritized by either running a risk analysis in probabilistic software or by simply assigning a risk value based on the qualitative and quantitative analysis. A contingency is then assigned to the contract based on this analysis.

Once the project goes into construction, this owner requires its CMs to submit an updated risk register every month with the monthly report. The risk register remains a live document throughout the project life cycle as the CM meets monthly with the WSIP risk management team to update the risk register. The program director receives a report each month of the top ten risks on the program to help direct his/her attention to areas of the program that could benefit from executive attention.

(3) Recommendation

Recommendation 9. Risk management should be an ingrained part of the culture of any organization from conception through closeout, and not just a facilitated workshop done on larger projects.

B. Construction Phase Issues

1. Partnering Issues (Partnering objective area) (Appendix A, Findings 12 and 50)

(1) Finding

Metro includes a Special Provision, SP-30 Partnering, in its construction contracts, which states "LACMTA encourages partnering among LACMTA, the Contractor, its Subcontractors, and other Third Party stakeholders ("Stakeholders.)" It also states that "The partnering process will be bilateral, and participation will be voluntary, but it is strongly encouraged by LACMTA." A third party facilitator is specified to conduct team building workshops, and participation of contractor and Metro management, key subcontractors, and third parties such as Caltrans and the City of Los Angeles are encouraged to attend. The SP also states "Follow-up workshops may be held periodically throughout the duration of the Project as agreed by the Contractor and LACMTA." Importantly, it establishes that "no claim or dispute settled or change approved through partnering shall be revived."

It appears when partnering is done on projects the cost can be substantial. The Regional Connector project had a $400,000 provisional sum amount in the schedule of values for partnering. It also appears that partnering is managed by a professional facilitation firm, Org-Metrics, that conducts the workshops and issues formal reports that include very detailed action items with responsible parties and due dates. In reviewing the partnering reports for the I-405 project there were separate partnering sessions at the executive and working level. The Executive Director and other key Metro staff participated in both of these workshops.

During interviews, participants noted that Metro's internal partnering sessions are working well to foster collaboration and problem solving for its stakeholders. Metro internal partners find the sessions helping to build trust, maintain sight of the big picture and solve problems collaboratively. However, there is room for improvement when it comes to adequate follow-up after the partnering sessions and ensuring that there is a coordinated, single response from the partnering sessions to project changes. Interviewees also noted that partnering sessions with contractors are not effective. Contractors do not share the owner's big picture view of a program, focusing on only their own requirements. On larger, hence longer projects, contractor staff often change losing continuity and institutional knowledge preventing them to participate effectively.

(2) Best Practice

The International Partnering Institute recommends the following best practices:

1. Have a neutral partnering facilitator, agreeable to all parties conduct the partnering sessions.
2. Have a "Partnering Charter" that includes jointly developed goals.
3. Have a periodic, joint evaluation process.
4. Have partnering sub-groups when the size/complexity of the project warrants breaking out into smaller teams.
5. Have a partnering follow-up plan to resolve possible issues at the lowest level possible.
6. Have a training plan to develop partnering skills.

In addition, San Francisco International Airport mandates regular partnering on its projects, and uses the same facilitation firm, Org-Metrics, to facilitate its workshops. Before follow-on sessions a scorecard is sent around to the participants to determine how well partnering has been going between meetings.

(3) Recommendation

Recommendation 10. Metro should consider making partnering mandatory on all projects. The partnering concept should become part of Metro's fabric of doing business. The level of partnering will vary based on the project size and complexity. Utilizing partnering on all projects will build experience within the organization.

Recommendation 11. Metro should establish a procedural standard so the quality of partnering is consistent across all projects. This can simply be a reference to partnering processes established by an organization like the International Partnering Institute. Metro does not need to develop its own procedures.

Recommendation 12. In order to improve contractor participation, Metro might want to consider using multi-tiered partnering where contractor executive staff participate in executive partnering sessions as a standard.

Recommendation 13. Additionally Metro may want to consider training prior to the partnering workshops that Metro staff and contractors attend together.

Recommendation 14. Enforcement of recommendations post-session can be improved by establishing a follow-up plan, mutually agreed upon by all stakeholders ahead of or during the partnering session. The follow-up plan would have steps to resolve issue at the required level in the organization. The pre-session scorecard survey used by San Francisco International Airport should also be considered. Procedural checklists and remedial trainings can become effective tools in further driving the successes of the partnering sessions. To the extent possible there should be some consequences if participants fail to follow the action plan, perhaps by imposing a greater share of the costs than the standard 50-50 split.

2. Procurement Issues (Project Delivery Methodology objective area)

a) Low bid contracting on major, complex projects is problematic (Appendix A, Findings 51, 76 and 107).

(1) Finding

In the public arena there is an industry-wide issue associated with using cost only to select contractors. Interviews indicated that:

- Unknown/inexperienced contractors are a recipe for disaster.
- Low bid contracting on major, complex projects is problematic.
- Best Value procurement process has been utilized on select projects.

It was noted that there is an increased use of the design-build methodology for larger projects. When questioned as to why, interviewees noted that D-B was selected because it would get construction started sooner and shift liability for design issues to the contractor. While some D-B projects like the Orange Line went well, others like the Crenshaw Connector have been challenging.

(2) Best Practice

A recent study by McGraw Hill indicates that architects, contractors and owners were actually more satisfied with Construction Manager (CM) at Risk or even Design-Bid-Build over the Design-Build method. The CM at Risk delivery method differs in that it involves a commitment by the CM to deliver the project within a Guaranteed Maximum Price. The chart below from this study summarizes the statistics.

Benefits Achieved by Owners Using Established Delivery Systems

Source: McGraw Hill Construction, 2014

	Benefits Achieved
Design-Bid-Build	• Cost: 67% on Budget; 27% Under Budget • Schedule: 67% on Time; 13% Ahead of Schedule • Satisfaction: 40% Very Satisfied
Design-Build	• Cost: 67% on Budget; 23% Under Budget • Schedule: 73% on Time; 20% Ahead of Schedule • Satisfaction: 37% Very Satisfied
CM-at-Risk	• Cost: 60% on Budget; 33% Under Budget • Schedule: 77% on Time; 7% Ahead of Schedule • Satisfaction: 60% Very Satisfied

[1]

Figure 8: Delivery Systems Comparison

Regarding best value procurements, Metro has been recognized by the FTA as one of the leaders in the use of best value contractor procurement process. At the thirtieth annual Capital Program Management Conference there was a presentation by the FTA and its Project Management Oversight Consultant (PMOC)[2] that discussed the use by Metro of Alternate Technical Concepts (ATC) on design-build contracts and considered it a best practice.

Under ATC at Metro, bidders are encouraged to propose alternate ways to build the project that could result in a lower cost. The alternate is proprietary to the bidder, unless the agency pays a stipend to a losing bidder for the right to use the ATC. The value the FTA saw in Metro's use of ATCs was the ability for Metro to have one-on-one confidential discussions regarding technical clarifications with the bidders in the RFP stage, the reduction in overly prescriptive design criteria, the shortening of the BAFO phase, and the screening out of unwanted concepts in the two-step process.

ATCs were successfully used on the Crenshaw project. Several ATCs were approved that optimized horizontal and vertical guideway alignments, raised a station designed to be underground to grade level, avoided the demolition of a former RR bridge, and allowed it to be used for new bridge false work.

However, FTA noted in this presentation that Metro's use of Alternate Proposals (APs) was less successful. On both the I-405 and the Westside Section 1 project no APs were submitted by bidders.

(3) Recommendation

<u>Recommendation 15.</u> LA Metro's future use of Design-Build should be carefully evaluated on a case by case basis. The value in DB comes from the potential time savings realized by overlapping design and

[1] Project Delivery Systems- How they Impact Efficiency and Profitability in the Buildings Sector, McGraw Hill 2014

[2] OP-30 Value Engineering and Constructability Review, Ray Tellis (FTA) and Mike Eidlin (KKCS), July 2015

construction, and the shifting of design error and omission risks to the design builder. Where projects have not gone well like Crenshaw and the I-405 some common themes emerge:

- The design half of the DB team did not effectively issue early design packages to support the planned construction schedule. One way to address this is to establish intermediate milestones with Liquidated Damages for critical work.
- The requirements were not clearly defined because of failure to get signed agreements that include scope and date commitments with community groups, third parties, utilities and permitting agencies.
- DB was selected because of a desire to get started on an accelerated basis. Unfortunately this seemed to shift discovery of problems to a phase of the project where the cost of resolution is much more expensive. Often delays push the end date later than it might have been had proper scoping and preparation been done.

Recommendation 16. It is recommended that LA Metro not enter into a DB contract until readiness is assured using the checklist in FTA OP-54. This will greatly reduce the risk of project failure.

3. Change Management Issues (Problem Solving objective area)

a) Construction delays are not being consistently addressed in a timely manner (Appendix A, Findings 24, 25, 30 and 99).

(1) Finding

It was noted during interviews that many projects do not analyze construction delays until the contract completion and Change Order delays in processing are occurring. During project workshops it was confirmed on more than one project that responsibility for delay-related change orders were not being addressed in the time frame required by the contract, and Metro staff were not enforcing the contract clauses. Vendor Contract Management (VCM) noted that contractors have not been willing to submit Time Impact Analysis (TIA) and that PMs have not been willing to enforce that requirement. It was also noted that PM’s do not want to go to the Board regarding delays.

Metro’s construction contract general condition 01 29 76 Cost/Schedule Integration System states that in order for a delay to be an “Excusable Delay”, the Contractor has to describe the event in a written notice within five (5) Days of the event and has to follow up the notice within thirty (30) Days with an “analysis of the impact of the claimed act or event causing the Delay upon the then-current Critical Path Schedule, identifying the affected activities, the actual impacts and the number of days delayed.” They also have to describe “proposals and measures taken to mitigate the claimed Delay, and the effects thereof.” The specification goes on to state that “if the Contractor does not submit a Notification of Delay and Time Impact Analysis for a specific Change Order/Modification or delay within the specified period of time, the Contractor shall be deemed to have irrevocably waived rights to additional time and cost.”

The same specification section requires the contractor to “submit a mitigation plan, if current progress reflects negative float of minus 30 calendar days or more for a Contract milestone activity in the current CPM Contract Schedule, regardless of which party is responsible for the delay”. The contractor has to “include a fragnet (stand-alone portion of the network) that show activities affected, date delay(s) or disruption(s) occurred or how productivity rates were impacted and unmitigated impacts to schedule caused by delay or disruption” and “a written narrative describing circumstances which caused delay or disruption and methodology used to determine extent of delay or disruption.”

An additional issue regarding delay resolution was observed – the timeliness of Metro's response to a time extension request or mitigation plan from a contractor. During executive interviews, it was noted that procedures are light on timelines that hold the contractors and Metro staff accountable. The Vendor/Contract Management department is developing those now as part of a construction Change Order initiative. In the past it was taking over a year to issue a change order. A review of Metro contract language did not find any stated timelines for Metro's response. Specification 01 29 76 states simply that "Metro will accept or reject each Time Impact Analysis. Upon approval, a copy of a Time Impact Analysis signed by Metro, will be returned to the Contractor for incorporation into the schedule", without any statement of when this has to be done. Metro procedure likewise does not address the timing of resolving contractor delays. Furthermore, the topic of when a delay analysis should be done was also not addressed in the PM Academy training done in January 2015. While some in Metro feel the timeliness of delay resolution is an endemic issue, there is no action being taken to correct the problem.

Regarding payment for delays, Metro's contract follows a best practice in contract general condition 01 29 76, section 29.5.5 by stating that "The actual number of days of Compensable Delay may be greater or lesser than the estimated quantity. Contractor will be paid Delay Compensation only for actual Compensable Delays, without respect to the estimated quantity." This clause avoids a common concern Owners who deal with delays on a contemporaneous basis have, that they will overpay their contractor for a forecast delay that never actually materializes.

A related finding is that Metro is establishing daily overhead rates for compensable delays through the bidding process, rather than through an accounting audit of the contractor's true out-of-pocket delay-related costs. Metro contract general condition 01 29 76, section 29.5.5 states that the "daily rate of Delay Compensation is the rate set forth in the Schedule of Quantities and Prices. The Total Contract Price adjustment shall only be at the specified Delay Compensation rate." Metro's Schedule of Quantities and Prices Form Schedule E – Delay Compensation states that "The items in Schedule E shall be included in Total Price Proposal for evaluation but shall not be part of the Total Contract Price."

(2) Best Practice

It is widely recognized in the industry that delays to contract completion should be addressed as they occur. The means of addressing delays is to perform a time impact analysis that allocates responsibility for delays between the owner and contractor, and use it to resolve the delays in a change order or mitigation plan. Without such an analysis it is difficult to require a contractor to make up lost time, and the value of the schedule as a planning and retrospective tool is compromised.

Boston's $14.5B Central Artery Tunnel program is an excellent example of successful resolution of delays. This massive project dealt with innumerable delay issues on over one hundred contracts with only one contract going to litigation. This successful track record is due in large part to the fact that the project addressed each delay as it arose, rather than waiting for the end of the contract. Experienced delay claims analysts were assigned full-time to the project so that responsibility for delays could be determined and decisions made based on that analysis. Creative solutions to unavoidable delays were able to be formulated, such as prioritization of just the portion of work needed by follow-on contractors with a time extension for the other scope; or shifting the delayed work to the follow-on contractor. Change orders granting time and delay damages were issued contemporaneously.

Among the owners who still prefer to wait until the end of the contract, the reason most often stated for doing so is that they do not want to overpay the contractor for delay damages that are forecast but may not actually occur. The San Francisco Public Utilities Commission (SFPUC) addressed this concern by issuing an Allowance Change Order that gave a time extension and created a pool of money calculated as the number of days of compensable delay (as determined by their independent Time Impact Analysis) multiplied by the agreed daily overhead rate. Then each month the contractor could bill for the delay actually encountered. It also provided the owner the opportunity to reduce the amount of compensable delays when the contractor has concurrent delays that arise after the Change Order is issued.

Many owners prefer to establish the daily rate for compensable delays from an audit, rather than the bid process. Where the bid item is not added to the selection process and thus is not part of the competitive process of establishing the daily rate, there is little incentive for a contractor to offer a reasonable price. Delay damages easily get into millions of dollars very quickly.

(3) Recommendation

Recommendation 17. Delays should be addressed as they occur, not at the end of a project. Metro's contract recognizes this by requiring timely action by the contractor when a delay occurs, but the same sense of urgency does not apply to Metro's response.

Recommendation 18. Metro should consider establishing timelines for agency response in its Resident Engineer's Manual, and should train users in the more stringent requirements. Procedural audits should focus on compliance with this new procedure until most project teams are following its requirements.

Recommendation 19. Metro should also consider establishing a contractor's daily overhead rate based on auditable records rather than a bid item that does not factor into the Contract Price. If it wishes to continue with a bid rate it should make that rate part of the contract price so there is an incentive for the contractor to be competitive.

b) Metro's Contract Administration process works well, but it needs to be expanded, explained and proactively enforced (Appendix A, Findings 15, 16 and 24).

(1) Finding

During interviews several participants at both executive and staff level noted that there was not a thorough staff understanding of legal concerns, issues and requirements for contracts and an inadequate understanding of contract administration by PM's, VCM staff and Program Management. It was also noted that there were compliance issues with PM's on change orders, TIA's, etc. Looking more statistically at the anecdotal interview comments, the overall score for the Change Control topic in the self-assessment survey (results shown below) is a 3.88 out of 5, or 78%. There were 14 participants out of 78 (18%) that scored Change Control a 2 or less.

Group	# Responses	Average Score
CP&D	8	3.00
E&C	28	3.86
PMO	31	4.03
VCM	11	4.18
Total	78	
Overall Average		3.88

Figure 9: Change Control Survey Responses

When asked in the survey "***what about change control could be improved***," the following self-assessment responses were reported. The actual written comments from Metro staff are in the sub-bullets, in quotes. Team Intueor has grouped the comments under major categories to summarize each group of comments. Words <in brackets> were added by Intueor for clarity:

- Construction change control needs knowledgeable leadership.
    - "While a system is established, there is no specific 'change control department' handling the specifics of such".
- Change Control responsibilities were combined with Document Control responsibilities to form Configuration Management and individuals cross-trained. However the expertise of "change control' has been lost. These areas require different technical skills. Staff involved in the change control process may not have received appropriate training.
    - "At times the Contract Administrator is unaware of Changes in the field. Managers often do not understand the process and the timeline related to Contract Change Work".
    - "In addition, the Scope of Work that is provided for the Change Work is unclear and that makes processing the Contract Modification difficult to Merit. This also results in a Metro Estimate that is not comparable to the Contractor's proposal".
    - "Sometimes required in contracts but there is no formal training to Planning staff on how to guide the development and administration of a PMP".
- Metro's change control processes and procedures are not consistently applied to all projects and departments.
    - "<Lack> Standard change control procedures across all capital projects".
    - "Not all projects/programs utilizing PC change control procedures".
    - "I don't think the smaller projects are using the CCB".
    - "Need <change control procedures> in Highway Program".
- Metro's change control processes and procedures are not proactively enforced across the enterprise.
    - "Getting the contractor to follow change management requirements from the GCs <could be improved>".
    - "Inconsistent, random, subjective enforcement of <change control> procedures".
    - "We recently found the project team for one project was using their own spreadsheet to track changes and it didn't match the CCO Log. This created a major cost risk as the spreadsheet had more changes than the CCO Log. CCO Log must be current for us to manage the project CMA and LOP Budget".

  - "The LPE team should be using the "Issues" module to track potential changes and not track them in the CN system".
- Metro's system of change control checks and balances slows down the construction change approval process.
  - "Purple Line Extension (PLE) uses a hard copy based system and the mail delivery slows things down, especially related to legal review".
  - "The Change Management review process needs to be less encumbered, and be decentralized".
  - "Change Order process can take 6 months. This causes real issues on the project level".

Presumably these comments come from the 18% of the participants who were dissatisfied with Metro's change control performance. The conclusion from this data is that while the scoring shows that overall change control appears to be effectively functioning, the comments indicate that the problem is a lack of consistency in application of the change control process.

(2) Best Practice

Metro itself has established a best practice set of checks and balances for contract administration, as noted below:

- A contractor's CO request is submitted directly to someone who is independent from the management of the project – Vendor Contract Management (VCM) Contract Administrator (CA).
- The CA and Project Manager determine if the submission has a fully defined scope.
- Program Management independently estimates the cost and time impact of the change.
- Metro's Legal department reviews it for merit.
- The VCM CA takes the lead in contractor negotiations.

While Metro's independent oversight minimizes the risk of fraud and overpayment to contractors, it delays the time it takes to process change orders (more than a year at times), and creates some confusion in roles and responsibilities.

SFPUC's Water System Improvement Program established a timely change order approval process that included an appropriate level of checks and balances. Key elements of this process follow:

- The consultant construction manager is given an average of 10% contingency for cost and time change orders, which could be spent at the discretion of the SFPUC General Manager. Consultant construction manager has to employ a professional Field Contract Administrator that possessed the following qualifications:
  - At least ten (10) years of recent experience in construction contract management on large and complex engineering/construction projects similar to the WSIP projects.
  - Experience in at least three (3) relevant, verifiable heavy civil/industrial type projects.
  - A baccalaureate degree from an accredited institution in Engineering, Construction Management, Business Administration or relevant discipline.
  - Fully knowledgeable in Construction Contract Requirements, Contract Change Conditions and Claims analysis and negotiations, Change Orders Cost Estimates, and Time Impact Analysis.
  - Experience in using Primavera P6 Scheduling software and Contract Manager/Expedition is highly desirable.

- All changes have to be authorized by an Agency Construction Manager (knowledgeable of the details), Project Manager, and the Director of Construction. Larger changes have to be authorized by the Program Director, Assistant General Manager and the General Manager.
- Replenishment of the 10% has to be authorized by the Commission. The package includes an explanation of how the contingency to date has been spent.
- An independent audit of change orders on every project regardless of size is done quarterly by a consultant Program Manager using the Contract Management Information System (CMIS).
- The City's internal audit group conducts periodic procedural compliance audits, both with its own staff and with consultant auditors.
- The consultant program manager uses the CMIS to track document turnaround times for change orders, submittals and RFIs. Monthly "High Alert" reports are used to identify the individuals responsible for bottlenecks. Phone calls are made by the SFPUC Director of Construction to the responsible individuals to resolve the endemic issues. All reviewers were held accountable.

As a result of this process, the program has a high percentage of successful projects that won numerous awards from various professional societies, and was frequently highlighted in Engineering News Record.

(3) Recommendation

<u>Recommendation 20.</u> A strong leader with construction change order experience should be put in charge of an agency wide change control group. A chain of command should be more clearly established, with roles and responsibilities of the various participants in the change control process described and communicated through training. Procedures should be developed that establish timelines for resolution.

<u>Recommendation 21.</u> The Contract Administrators in the Change Control group should be required to meet minimum qualifications. Sample minimum qualifications required by the SFPUC are provided above as a starting point. CAs should be experienced construction professionals with field experience in dealing with contractor changes. There should be a career path from Construction to Contract Administration.

<u>Recommendation 22.</u> There needs to be better training of the contract administration and change control process to all staff. The PM Academy is covering topics at a high level, while this subject needs its own full day or more of training. The Legal department should participate in the development and execution of this training.

<u>Recommendation 23.</u> Metro's change control processes and procedures should be consistently applied to all projects and departments. This would include the highway program and smaller projects. These processes and procedures should be proactively enforced across the enterprise.

<u>Recommendation 24.</u> An audit function should be established and regular audits should be conducted.

<u>Recommendation 25.</u> Metro should establish accountability for document turnaround times.

Recommendation 26. Metro should put the Project Manager/Construction Manager back in charge of the change order process, with support from co-located professional contract administrators from Vendor/Contract Management.

Recommendation 27. It is noted that for projects that use the PMIS Contract Management database, the aging of a change order is tracked. Team Intueor has not been provided information that identifies who is creating a bottleneck. All projects should use the central change management database in the PMIS; and the use of standalone spreadsheets to track changes should be barred.

Recommendation 28. Metro should improve the contractor's compliance with and Metro's enforcement of the change management requirements. To do so Metro management needs to verify that it wants to vigorously enforce the following language:

"Notify Metro within five calendar days of becoming aware of a delay and submit a Time Impact Analysis within ten calendar days after notification. If the Contractor does not submit a Notification of Delay and Time Impact Analysis for a specific Change Order/Modification or delay within the specified period of time, the Contractor shall be deemed to have irrevocably waived rights to additional time and cost."[3]

If in fact it intends to enforce this waiver language, which will certainly make contractors be timelier, Metro's top management needs to make a strong public announcement to contractors, consultants and staff to avoid any argument by contractors that Metro has waived its right to enforce its contract language by past failures to enforce it.

Recommendation 29. The currently specified timeframes should be revised to a more realistic timeframe, and exceptions to the hard durations be allowed for special circumstances. The ten calendar days after notice to submit a Time Impact Analysis is unrealistic. The notice is due at the start of a delay, but the TIA cannot be completed until the delay itself has ended or a reasonably accurate date can be forecast. Thus it is better to state *"Notify Metro within five calendar days of becoming aware of a delay and submit a Time Impact Analysis within ten calendar days after ~~notification~~ the delay has ended, can be reasonably forecast, or upon demand by the Engineer, whichever is earlier."*

The timely processing of vendor change orders is a key element of project success. While the current Change Management review process is a best practice in terms of checks and balances, it has resulted in change order turnaround times from 6 months to more than a year. Part of the problem is that there are several different Metro departments involved. The reliance on central groups remote from the field work to handle all contracts creates bottlenecks and inefficiencies. The more parties involved in the change management process the more the administrative cost of meetings, emails and the need to reach a consensus escalates. This way of dealing with change orders developed in reaction to earlier problems has since been resolved.

Recommendation 30. Use a model more like the SFPUC best practice described above, where the PM and CM are in charge of the change order process, with support from professional contract administrators that are empowered to disagree with the PM/CM if they are not following the contract. An enhancement to the SFPUC model Metro might consider is to have the Field Contract Administrators

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[3] Metro contract general condition 012976 3.09 Notification of Delay and Time Impact Analysis

that handle contractor change orders remain VCM employees, but deploy them to the field in a matrix organization. To handle the volume of changes during the accelerated $40B capital program, it is also recommended that VCM procure one or more on call Contract Administration firms to help them handle the volume. All consultant staff should meet the same qualifications and get the same training as Metro VCM staff.

These are cross cutting recommendations, impacting numerous processes. It should be noted that when implementing the recommendations for this issue, it is essential that these recommendations be closely coordinated and integrated, not only for this set of recommendations, but in consideration with all of the proposed recommendations within this report (refer to the Implementation Roadmap within the Executive Summary for additional discussion).

c) Change Order Tracking can be enhanced by consistent use of the PMIS and more vigorous cost forecasting (Appendix A, Findings 23 and 25).

(1) Finding

During interviews it was indicated that change orders are not being effectively tracked and reported by PM's. In the self-assessment survey it was noted that:

- The team should be using the "Issues" module to track potential changes and not track them in the CN system.
- CCO Log must be current for us to manage the project CMA and LOP Budget Cost reporting could be improved.

Review of documentation for the PMIS system was performed, specifically the user guides for CM13 Cost and Change Control User Guide and the output reports user guide, in order to see how project teams are instructed to track change orders.

Metro's use of CM13 (now upgraded to CM14) for change management is a best practice that would alleviate the concerns expressed above. The problem expressed by staff seems therefore to be one of consistency and/or enforcement. As noted elsewhere in this report, not all projects are required to use PMIS, but it is recommended that all projects should require PMIS use (see System Issues within this report).

In addition, the functions being performed at Metro were compared to a best practice implementation of the same software at SFPUC. Through this exercise, a possible enhancement in the way Metro does cost forecasting for construction contracts was identified. While Metro Procedure #PRCL05 Project Cost Reporting & Forecasting requires the CM and Metro functional groups to provide a Trend Notice that updates the cost forecast on a quarterly basis, this concept does not appear to have been picked up in the reporting systems.

The CM13 Cost and Change Control User Guide describes the use of CM13's trends module as follows "The Trends module in CM13 provides a unique way to populate any column on the cost worksheet and provide an audit trail on why the costs were entered. It also notes "Trends are commonly used for:

- Adding or deducting estimates to complete to make forecasts more accurate.
- Documenting the transfer of costs from one Cost Code to another (as in moving Change Authorization (contingency) from the Contingency cost Code to the specific Cost Code to cover change orders. "

Thus Metro does not seem to be using the trends module for cost forecasting. In fact, other than the comment in the first bullet above there is not a mention in the CM13 Cost and Change Control User Guide about cost forecasting. Furthermore, as shown in Figure 10 below (from the CM13 Cost and Change Management User Guide), Forecast At Completion is calculated as the sum of only the Original contract Amount + Approved Changes + Pending Changes. This forecast does not include change proposals that are being negotiated with the contractor, Change Notices, or Trends (often used for cost/schedule impacts that were discussed at progress meetings but were not yet submitted by the contractor).

LA Metropolitan Transportation Auth. — **Orange Line Extension - Construction**

Committed Cost Detail Report with Forecast
By Cost Code

Date: 11/29/2010

Project No: 800119 — **Page: 5 of 6**

Metro Cost Code Item	To	Contract No.	Line Number	Date	Original Amount	Approved Changes	Actuals To Date	Current Balance	Pending Changes	Forecast At Completion
3.3.04.01	**UTILITY RELOCATION**				**Element:** C SC		**Account:** 53101	**Cost Ctr:** 8510	**Task:** 3.3.04.01	
Change	BRUTOC00	C0943	00001	11/15/2010	$0	$0	$0	$0	$7,090	$7,090
		Subtotals:			**$3,130,000**	**$175,000**	**$939,321**	**$2,365,679**	**$349,232**	**$3,654,232**
3.3.06.01	**SYSTEMS**				**Element:** C S		**Account:** 53102	**Cost Ctr:** 8510	**Task:** 3.3.06.01	
Contract	BRUTOC00	C0943	13-01	2/24/2010	$4,687,000	$0	$0	$4,687,000	$0	$4,687,000
Proposal	BRUTOC00	C0943	00001	9/29/2010	$0	$0	$0	$0	$20,000	$20,000
		Subtotals:			**$4,687,000**	**$0**	**$0**	**$4,687,000**	**$20,000**	**$4,707,000**
3.4.001.1	**REAL ESTATE APPRAISALS**				**Element:** R		**Account:** 53102	**Cost Ctr:** 8510	**Task:** 3.4.001.1	
Contract	KEITHS00	0106510002	60	8/21/2009	$6,750	$0	$0	$6,750	$0	$6,750
		Subtotals:			**$6,750**	**$0**	**$0**	**$6,750**	**$0**	**$6,750**

Figure 10: Forecast at Completion

Further evidence of this lack of forecasting is provided in Figure 11 below (from the user guide), which shows a Cost Worksheet that has no Trends (Commitment Adjustments - Column I):

	A	B	C	D	E	F	G	H	I	J	K	L
1	Cost Code	Title	Projected Budget ($)	Original Commitment ($)	Approved Commitment ($)	Revised Commitment ($)	Pending Commitment ($)	Estimated Commitment Revisions ($)	Commitment Adjustments ($)	Projected Commitment ($)	Actuals Received ($)	Metro Task #
2	3.2.01.01-81.03	ENG & DES - DEV BID DOCS	2,000,000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.2.01.01
3	3.2.01.03-81.05	ENGINEERING & DESIGN - FINAL DSGN	0.00	417,486.00	0.00	417,486.00	0.00	2,200.00	0.00	419,686.00	0.00	3.2.01.03
4	3.2.02.01-83.00	CONSTR MANAGEMENT SUPPORT SERVIC	3,938,400.00	5,171,924.00	0.00	5,171,924.00	0.00	0.00	0.00	5,171,924.00	190,959.58	3.2.02.01
5	3.2.03.01-84.01	PROJECT MANAGEMENT ASSISTANCE	1,432,100.00	505,789.32	0.00	505,789.32	0.00	0.00	0.00	505,789.32	0.00	3.2.03.01
6	3.2.03.04-84.04	QUAL MGMNT LAB TEST SERVICES	358,000.00	72,165.00	0.00	72,165.00	0.00	0.00	0.00	72,165.00	0.00	3.2.03.04
7	3.2.03.05-84.05	COMM OUTREACH DURING CONSTR	358,000.00	43,000.00	0.00	43,000.00	0.00	0.00	0.00	43,000.00	0.00	3.2.03.05
8	3.2.03.08-84.08	MISC SPEC. SERVICES - PROF SERV	358,000.00	31,100.00	0.00	31,100.00	0.00	0.00	0.00	31,100.00	0.00	3.2.03.08
9	3.3.01.01-20.03	D-B STATIONS	0.00	10,300,000.00	0.00	10,300,000.00	0.00	0.00	0.00	10,300,000.00	0.00	3.3.01.01
10	3.3.01.04-40.01	D-B DESIGN GENERAL REQ	0.00	630,000.00	0.00	630,000.00	0.00	0.00	0.00	630,000.00	630,000.00	3.3.01.04
11	3.3.01.07-08.08	D-B LASSEN / RR OVERCROSSING	0.00	3,950,000.00	0.00	3,950,000.00	44,952.00	550,000.00	0.00	4,544,952.00	17,469.00	3.3.01.07
12	3.3.01.07-42.08	D-B LASSEN STREET IMPROVEMENT	0.00	360,000.00	0.00	360,000.00	0.00	0.00	0.00	360,000.00	0.00	3.3.01.07
13	3.3.01.09-42.13	D-B FIELD OFFICE	0.00	25,850.10	0.00	25,850.10	0.00	0.00	0.00	25,850.10	0.00	3.3.01.09
14	3.3.03.01-43.02	ENVIRONMENTAL MITIGATION	359,600.00	115,591.00	0.00	115,591.00	0.00	0.00	0.00	115,591.00	0.00	3.3.03.01
15	3.3.03.02-43.03	WASTE HANDLING SERVICES	599,300.00	20,000.00	0.00	20,000.00	0.00	0.00	0.00	20,000.00	0.00	3.3.03.02
16	3.3.04.01-42.10	D-B OPTION C - UNDERGROUND DWP POW	0.00	980,000.00	175,000.00	1,155,000.00	20,000.00	0.00	0.00	1,175,000.00	898,071.00	3.3.04.01
17	3.3.04.01-42.05	D-B UTILITIES / UTILITY RELOCATION	0.00	2,150,000.00	0.00	2,150,000.00	207,341.90	0.00	0.00	2,357,341.90	41,250.00	3.3.04.01
18	3.4.001.1-60.00	APPRAISALS & TITLE REPORTS	33,600.00	6,750.00	0.00	6,750.00	0.00	0.00	0.00	6,750.00	0.00	3.4.001.1
19	3.5.10.01-46.01	LA CITY DWP - WATER	119,900.00	162,575.71	0.00	162,575.71	0.00	0.00	0.00	162,575.71	0.00	3.5.10.01
20	3.5.10.02-46.02	LA CITY DWP - POWER	359,600.00	100,847.70	0.00	100,847.70	0.00	0.00	0.00	100,847.70	0.00	3.5.10.02
21	3.5.10.03-46.03	LA CITY DEPT OF TRANSP	1,613,000.00	1,176,253.06	0.00	1,176,253.06	0.00	0.00	0.00	1,176,253.06	0.00	3.5.10.03
22	3.5.10.04-46.04	LA CITY BUR OF ENG	958,900.00	484,275.00	0.00	484,275.00	0.00	0.00	0.00	484,275.00	0.00	3.5.10.04
23	3.5.10.05-46.05	LA CITY - BUR OF ST. LIGHTING	359,600.00	251,738.34	0.00	251,738.34	0.00	0.00	0.00	251,738.34	0.00	3.5.10.05
24	3.5.10.07-46.06	LA CITY POLICE DEPARTMENT - LAPD	119,900.00	30,000.00	0.00	30,000.00	0.00	0.00	0.00	30,000.00	0.00	3.5.10.07
25	3.5.10.09-46.08	LA CITY BUILDING & SAFETY	0.00	459.00	0.00	459.00	0.00	0.00	0.00	459.00	0.00	3.5.10.09
26	3.5.10.10-46.09	LA CITY BUR OF STREETS (LABSS)	239,700.00	130,000.00	0.00	130,000.00	0.00	0.00	0.00	130,000.00	0.00	3.5.10.10
27	3.5.10.15-46.10	LA CITY BUR OF CONTR ADM	668,900.00	200,000.00	0.00	200,000.00	0.00	0.00	0.00	200,000.00	0.00	3.5.10.15
28	3.5.10.16-46.11	MISCELLANEOUS 3RD PARTY WORK	239,700.00	25,179.00	0.00	25,179.00	0.00	0.00	0.00	25,179.00	2,186.90	3.5.10.16
29	3.5.30.01-46.13	PRIV UTIL - OTH UTIL REARRANGMNT	185,000.00	111,626.00	0.00	111,626.00	0.00	0.00	0.00	111,626.00	0.00	3.5.30.01
30	3.5.30.01-46.14	PRIVATE UTILITIES - QWEST	0.00	200,265.00	0.00	200,265.00	0.00	0.00	0.00	200,265.00	0.00	3.5.30.01
31	3.5.40.04-10.00	MASTER COOPERATIVE AGREEMENTS	350,000.00	805,805.00	0.00	805,805.00	0.00	0.00	0.00	805,805.00	0.00	3.5.40.04
32	3.5.60.02-46.17	STATE - DEPT OF TOXIC SUBS CONTROL	59,900.00	49,940.00	0.00	49,940.00	0.00	0.00	0.00	49,940.00	0.00	3.5.60.02
33	3.5.60.03-46.18	SCRWQB	59,900.00	404.00	0.00	404.00	0.00	0.00	0.00	404.00	0.00	3.5.60.03
34	3.6.10.01-47.02	STATION / LANDSCAPE ARTISTS - MISC	0.00	1,000.00	0.00	1,000.00	0.00	0.00	0.00	1,000.00	0.00	3.6.10.01
35	NOT COSTED	NOT COSTED	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NOT COSTE
36	**Log Totals:**		**14,771,000.00**	**28,509,022.23**	**175,000.00**	**28,684,022.23**	**272,293.90**	**552,200.00**	**0.00**	**29,508,516.13**	**1,779,936.48**	

Figure 11: Cost Worksheet with no Trends

(2) Best Practice

The SFPUC instituted best practices for construction change management on its $4.5B Water System Improvement Program (WSIP). SFPUC set up a cost reporting system for its WSIP program using the same Oracle Primavera Contract Management CM13 system. The system was used by all CM teams to track construction contract change orders, cost proposals, and trends even on smaller projects under $5M.

This system facilitated identification of potential cost overruns at the earliest possible time by requiring CMs' field contract administrators (FCA) to add an estimated cost into CM13's Trend module whenever the contractor mentioned an impact that affected cost or schedule. The trend serves as a "placeholder" in the cost system until the contractor eventually submits a cost proposal. The day a proposal comes in, the trend is closed in the contract management information system and the proposal entered as a potential change order.

Since contractors often take protracted time to submit proposals, this process gave management a heads up in advance regarding the forecast cost at completion due to changes. Using this data, SFPUC developed the following custom program-level report (Figure 12) to compare the cost forecast on active construction contracts to the available funding. Each contract has a green funding bar aligned with the actual/forecast cost either based on the data in the contract management information system or developed from the risk registers, as shown below:

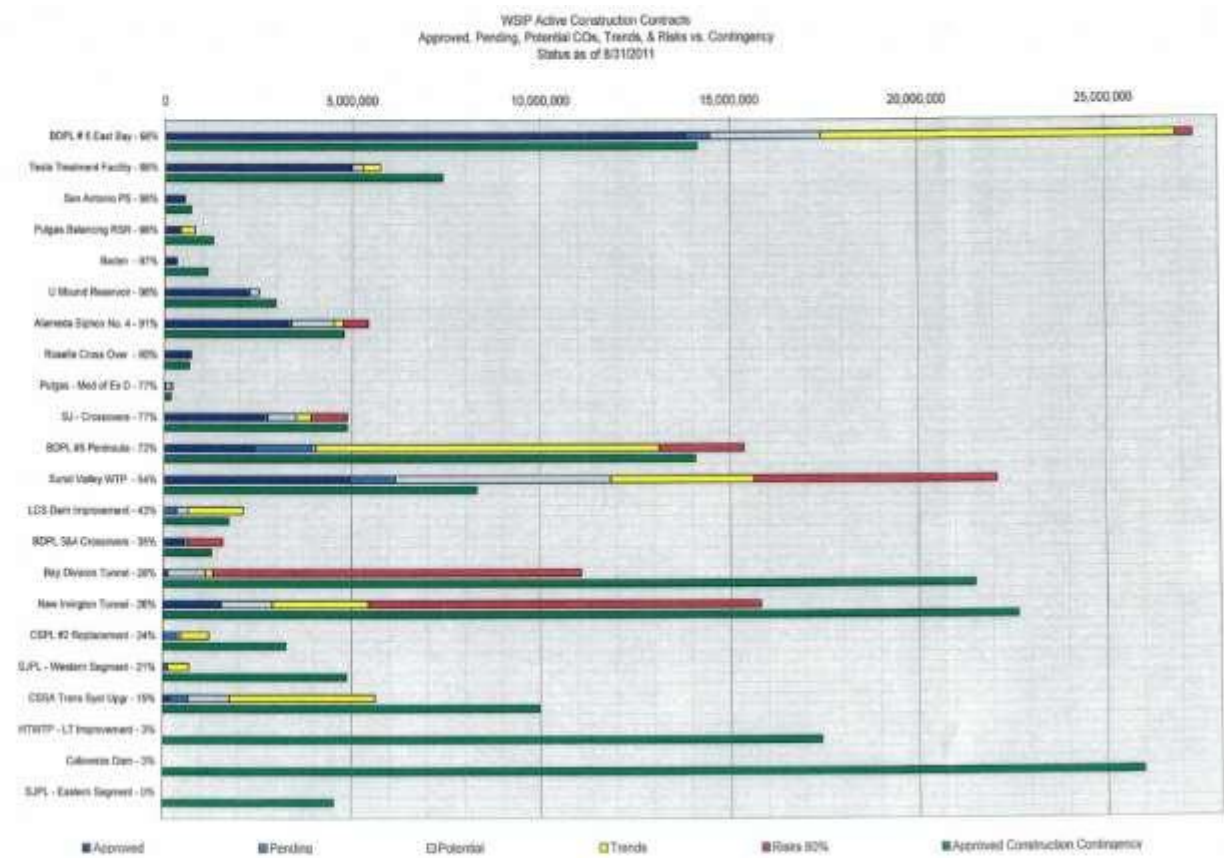


Figure 12: SFPUC Program-level Report

Each pair of horizontal bars represents a project. Darker colors in the top bar represent original contract value plus approved and pending changes. Light blue represents potential changes that are in negotiation with the contractor. Yellow represents cost impacts where the contractor has not yet submitted a proposal, and red represents the potential cost if a percentage of the risks occur.

The Peninsula and Water Treatment Plant (WTP) contracts in the middle of the chart are good examples of the benefit of this report. The Peninsula project is 72% complete. Without the yellow trend bar, it would seem as if this contract had no funding worries because the green available funding bar extends far beyond the two dark blue bands. However, with trending, the director can immediately identify that the contractor is sitting on a pile of proposals, which will drive the cost almost to the funding limit; and if the risks occur, the director will have to go to the Commission to request additional money. Knowing the problem many months in advance allows the director time to resolve the issues immediately while there still may be a chance to mitigate cost overruns.

On the 54% complete WTP project, the director can see that there is an immediate need for funding as there are many light blue proposals in negotiation that will exhaust the funding. Because of the yellow trending, the director also has a relatively good estimate of all proposals that have not yet been submitted, and can ask for enough money now to avoid the inefficiency and embarrassment of going back to the Commission multiple times to request additional funding for the same project. If the director really wants to play it safe, enough money to cover red potential risks can be requested. If challenged as to why so much money is being requested, the director can point to a rigorous forecasting system and use it to provide credible reasons for requesting the full funding.

(3) Recommendation

Recommendation 31. Metro should use the PMIS and its procedures on all projects, as already noted, to bring transparency to the change order process. This transparency can be enhanced by using the record of negotiation form in CM14 to document any variance between the Independent Cost Estimate and the negotiated amount.

Metro should also enhance its use of trends to provide timely cost forecasts, as was done by SFPUC in the best practice example. Metro might also consider developing a report like the funding comparison report described above.

d) Metro needs to address the underlying issues rather than increasing its project contingencies (Appendix A, Findings 4, 14 and 29).

(1) Finding

During interviews and in the self-assessment survey Metro staff stated:

- Project contingencies are minimal and often are exceeded.
- KPI's are currently well established for cost and schedule and managed in accordance with contingency policies for major projects.
- Some people manipulate the soft cost estimate downward causing overruns, including upper management. Projects often lack enough contingency at the start causing overruns.
- Contingency planning for delay, default, claims, is often ad hoc.
- Inadequate contingencies often plague projects from the start. Board considers change orders to be a failure instead of normal project thing. They don't know or understand project contingency even though it’s been explained to them.
- Risk Response strategies, action plans and contingency plans are going well.
- The project contingency is known by contractors, creating an expectation and incentive to submit frivolous change order requests.

Workshops and document reviews indicated that many projects had to go back for more funding even though the amount of funding they started with was generally at the high end of industry average percentages.

Metro contingency procedure PRCL12 requires the use of risk processes to establish contingency. It says throughout the procedure that risk should be used on each project. Risk procedure PRCL07 also appears to apply to all projects. However, the construction contract contingency was set at a standard 10%, indicating that a risk-based contingency may be reserved more for Mega projects in actual practice.

(2) Best Practice

The FTA has three Oversight Procedures (OP-40a, b & c) entitled Risk and Contingency Review. FTA notes in these procedures that “Professional risk management provides the basis for improving the reliability of project delivery.” The three different risk procedures address various levels of risk management depending on project characteristics. The lowest level only requires the PMOC to review the Sponsor’s risk efforts. The highest level requires full PMOC risk assessment, using the Beta Range

Factor Analysis. For FTA-funded projects, sponsors like Metro are expected to do a Risk and Contingency Management Plan, and have a risk register that is regularly updated. FTA expects sponsors to clearly identify cost and schedule contingencies; explain the process for tracking and managing current and minimum levels of contingency; and the policies for use and custody of contingencies. Metro procedure PRCL07 generally complies with these procedures, with the exception of the beta range factor analysis the PMOC does.

The FTA prefers that contracts have a 20% time contingency. Metro procedures reflect this preference.

Many agencies do not publish their contingency amounts. It should be noted that contingency is not intended to cover major scope increases in the project. Scope increases should be funded by alternate funding sources. The LAX/Crenshaw project has set up its project accounting to segregate major scope increases, although they still seem to be using the original project funding.

(3) Recommendation

Recommendation 32. Metro should consider revising its risk and contingency procedures to do scaled down versions of a risk analysis for smaller projects. A scaled down version could involve a 4 hour team meeting where a standard risk register is tweaked to project specifics, the risks are quantified, and mitigation plans developed.

Recommendation 33. Metro should enforce its procedures regarding using risk to set contingencies on all projects. Smaller projects often require more contingency on a percentage basis than larger ones. For example, contingency of only \$100K on a \$1M project with a large risk is often insufficient. Furthermore, the FTA has in the past refused to fund sponsors' cost overruns, so it is wise for Metro to show the highest contingency they will accept, but hold it in a Program reserve controlled by someone above the project team level.

Most importantly, and in response to the comments by staff, the issues causing the funding overrun need to be addressed, at least on the larger programs. The solution is not asking for more money up front, it is instead doing better planning before bidding. As noted elsewhere in this report, the design-build contracting method can shift resolution of large risks to a much more costly phase of the work when the contractor is mobilized. Its use should therefore be carefully evaluated.

Recommendation 34. If Metro is allowed by law to keep its contingency amounts hidden it should do so. However, if it cannot the simple solution is to send a strong clear message that frivolous claims will not be tolerated. There are strong false claims acts laws that can be used in extreme cases.

C. Overarching Issues (All Phases)

Overarching issues are those issues that can occur in any one or all phases of capital project delivery from Planning through Construction/Testing and Operations/Maintenance and can have an impact on capital project management and project delivery. Through our study interviews, survey, and project workshops, we identified overarching issues within specific categories of issues, specifically Third Party, Project Team, Project Management, Project Delivery, Community Involvement, Board of Director, and Utility Relocation Issues. These specific categories of issues are discussed below.

1. Third Party issues (General Readiness objective area)

A Third Party is an entity separate from Metro and includes state, county and local city governments; public and private utilities; railroads; and federal agencies. Third Party issues are common on capital projects and can occur throughout the project delivery lifecycle, from Planning through Operations and Maintenance, and can range from minor communications problems between Metro and a project stakeholder, to significant issues that can impact the project scope, schedule, budget and quality, such as utility relocations. Some Third Party issues Team Intueor has found involve problems associated with the resolution of review comments, inadequate information being provided by a Third Party, requests within a project that are outside the scope, delays in obtaining necessary Third Party approvals, inadequate Third Party resources being available to the project to meet the schedule and some general communication, coordination and collaboration problems that need to be improved in order to effectively deliver capital projects. Key issues which we have identified of value for Metro to consider are described below.

a) Obtaining City of Los Angeles approvals can delay projects (Appendix A, Finding 18)

(1) Finding

Interviews and project workshops indicate that there are numerous coordination, collaboration and communication issues with the City of Los Angeles (LA) on capital projects. It was emphasized repeatedly that the City of LA is not responsive to Metro requests, there are old and outdated Master Cooperative Agreements and Memorandums of Understanding (MOU) that need to be revisited, there is difficulty in obtaining timely City of LA approvals on projects, and there is inconsistencies in City of LA coordination processes between capital projects.

Interviewees also stressed the need to improve coordination and collaboration with the City of LA. The City of LA has established a Special Permitting Process (SPP), which adds a concurrent review of design and submittals. This is a problem because the City of LA Bureau of Engineering (BOE) does not apply the same standards as Metro, and BOE lacks sufficient reviewers to keep up with the volume of reviews from Metro projects and other projects in the City of LA. In the past, BOE deferred to Metro and did not require duplicate reviews. Metro offered to pay for seconded consultants to help the City do the reviews, but the City declined the help.

In looking at the City of LA perspective, city interviews have noted the need to improve Metro project manager performance, in both the technical and project management areas, project readiness is not always obtained on Metro projects, and smaller projects are being neglected with a focus on the mega projects. It was also noted that City of LA inclusion in project partnering is recommended, Metro should improve the integration of project teams (traffic, design, structural, etc.), quality improvement is needed with design-build submissions, and a better understanding and improvement of community involvement with city council officers is needed. Both Metro and the City of LA agree that high level partnering and discussions are needed to improve their relationship.

Although there has been some successes in collaboration with the City of LA on projects, many problems exist. Many city departments have no single point of contact. On some projects, there are too many reviewers (up to twenty (20)), delaying approvals of design, submittals, and other requests. It was discussed that the City of LA is not executing agreements up front on projects and appears unable to effectively manage the volume they are dealing with. Out of town contractors have problems dealing with the City of LA because they don't understand the process, requiring Metro to become the mediator. There is no clear City of LA policy on Metro capital project coordination and dispute resolution.

It was also noted that the City of LA has resource issues that impact projects, affecting project readiness, there are competing requirements between city reviewers on projects, and a special permit process that needs to be revisited. Staff level discussions, however, are not yielding acceptable results. These issues are a significant impediment to successful capital construction project management and need resolution.

(2) Best Practice

Third Parties are stakeholders in Metro's projects. PMI's PMBOK and the International Partnering Institute both provide excellent guidance on Stakeholder Management, Communications Management and Partnering. Best practices for effective stakeholder management includes treating stakeholders as partners, this is fundamental to success. In addition, clearly defined roles and responsibilities on each project must be identified. Stakeholders must be kept involved throughout the project lifecycle, with frequent communications and project updates, in addition to a transparency approach.

Another best practice from PMBOK is the development and implementation of a Stakeholder Management Plan and incorporation of that plan into the overall Project Management Plan (PMP). The stakeholder plan is a valuable tool to clearly understand the interrelationships, roles and responsibilities to better manage and control all project stakeholders. Also, up to date Master Cooperative Agreements, as defined in Metro policies THD1 (Agency/Utility Coordination) and THD2 (Cooperative Agreements) with key agencies further improves stakeholder management.

(3) Recommendation

Recommendation 35. Considering the numerous instances of City of LA communication, coordination and collaboration problems on capital projects as reported by Metro and the City of LA interviewees and project workshop teams, a strategic approach at the executive level needs to be developed and implemented. Higher level partnering meetings are recommended to develop clear goals and objectives and a formal policy commitment between Metro and the City. Higher level partnering can be extended to the management level team, managed by the Third Party Coordination unit or Program Management Office (PMO), if necessary, to clearly identify the specific problems and issues that are being encountered and develop and implement clear action plans for improvement. The strategic level partnering needs to address the entire project lifecycle and include plans for:

- Communications
- Staffing
- Scheduling and Readiness
- Technical Competency
- Coordination and review processes

It also has been noted by staff that there have been instances of success in partnering with the City of LA on several projects (Gold Line Eastside Extension and Purple Line, etc.). These valuable lessons learned have been captured by the project teams but have not been formally shared and need to be organizationally captured and incorporated into the strategic and management level plans (see Project Management Issues, item b).

Recommendation 36. In addition, a new, formal Master Cooperative Agreement with the City of LA needs to be developed and executed based on the results of both executive and management level partnering.

b) The Metro/Caltrans partnership needs improvement (Appendix A, Finding 89).

(1) Finding

Interviewees and project workshop input indicates that interaction with Caltrans on capital projects could be improved. They indicated that there are communication and coordination issues that exist between Metro and Caltrans on projects involving their joint collaboration. While there has been some success on certain projects, those lessons learned were not formally shared across Metro. A review indicates that there is a need for formal policies and procedures to be developed in order to improve and formalize the partnership.

The Metro message to Caltrans at the highest levels within the organization is not clear and concise. There needs to be a commitment to readiness, resources and the urgency required of Caltrans on capital projects. In addition, numerous issues exist on projects that require programmatic resolution, such as:

- Roles and responsibilities of the Metro/Caltrans project team
- Roles and responsibilities of the Metro project control group
- Quality Assurance Plan for highway projects, incorporating Caltrans Independent Quality Assurance (IQA) roles and responsibilities
- Metro review of Caltrans cost estimates is not occurring
- Metro contingency analysis for estimates is not occurring
- Process needs to be established for determining the method of project delivery on highway projects
- New and updated procedures need to be developed for highway projects for both design/build and design/bid/build delivery methods

(2) Best Practice

Effective interagency coordination is essential to success on Metro/Caltrans projects. PMI's PMBOK, the International Institute for Partnering, FTA and the Federal Highway Administration (FHWA) all provide substantial guidance on implementing effective teams, and improving communications and coordination. In addition, please refer to the similar best practice discussion within item a) above.

(3) Recommendation

Recommendation 37. In order to improve the Metro/Caltrans partnership, engage Caltrans in a strategic partnering initiative at the highest possible levels within both organizations. Clear vision, goals, and objectives need to be formally developed and agreed upon. Management level teams can further the executive level success by developing specific implementation plans for improvement, identifying issues and problems, establishing formal policy and procedures with clear roles and responsibilities. Critical to success is a joint sharing of information, best practices and lessons learned through a training and development partnership. Caltrans input should be captured during the design and procurement phases of projects. A continuous partnership can be established and led by the strategic Program Management Office (PMO), holding quarterly coordination meetings to discuss problems and issues at a programmatic level and implement action plans for continuous improvement.

c) *In general, Third Party coordination, communication and resource problems exist (Appendix A, Findings 47, 48, 49, 102 and 103).*

(1) Finding

The majority of Metro interviews, survey responses and project workshop discussions repeatedly emphasized the problems associated with working with third parties on capital projects. Communication and coordination problems exist between Metro and third parties, including utility companies, government organizations, railroads and federal agencies. In addition, findings indicate that most third party organizations have resource challenges that prohibit them from meeting the accelerated schedules and extensive requirements of Metro projects. Another issue expressed to the team is that third party utility relocation coordination is not beginning until the Preliminary Engineering phase.

(2) Best Practice

Effective stakeholder management is an investment in project delivery that cannot be ignored. The Return on Investment (ROI) far exceeds its burden of cost. The best practices of other comparable agencies need to be assessed by Metro in order to customize a process to address these challenges. San Francisco International Airport has established an effective Stakeholder Engagement Process which is effectively managing project goals and objectives. Also, London Underground (Transport for London) has established a detailed Stakeholder Engagement Plan, utilized for all projects, which includes a Communications Plan, establishes stakeholder needs and requirements and specific stakeholder engagement strategies and is included in their Project Execution Plan.

(3) Recommendation

<u>Recommendation 38.</u> Metro engagement with utility companies needs to begin in the Planning phase. Earlier initiation of the utility engineering and relocation process is an effective mechanism to improve project delivery and minimize project risk, as the utility relocation process is a long, and costly effort. The execution of the project utility agreement should occur in the Planning phase. Metro should update policies and procedures and educate/train staff on this improvement.

<u>Recommendation 39.</u> In order to further develop and improve the relationship between Metro and utility companies, the Third Party Coordination unit should establish Quarterly Coordination meetings with each utility company to clearly understand, at a programmatic level, the issues, problems and constraints that impact these organizations as it relates to Metro capital project delivery. These high level meetings are an opportunity for Metro and utility companies to discuss processes, procedures, and project requirements and develop strategies for improvement.

Quarterly Coordination meetings also allow Metro to share capital program schedules in advance and discuss Metro's specific needs for upcoming projects. This will allow utility companies an advance look at projects and enable them to better plan and prepare for work. These meetings also provide an opportunity for education and training, and the sharing of information, best practices and lessons learned between and within organizations. At a higher level, an industry utility engineering conference, sponsored by Metro, can also be a support mechanism for further improving the Metro partnership with utility companies.

This type of coordination meeting that is recommended with utility companies can also be developed similarly for select agencies and local governments on an as needed basis. It is recommended that for these coordination meetings, the strategic PMO manage these meetings for effective coordination and control.

d) Metro Master Agreements are outdated (Appendix A, Finding 100).

(1) Finding

Interviews and documentation review have indicated that Metro is currently utilizing Master Cooperative Agreements with utility companies that are over 10 years old. These agreements are critical elements of capital project delivery, and are used to establish the roles and responsibilities and procedures for the execution of work and the resolution of problems on Metro projects.

(2) Best Practice

Master Cooperative Agreements are an effective tool to improve the interaction, communication and coordination on capital projects. These agreements allow the organizations to come to a programmatic understanding of the relationship goals and objectives in managing and delivering capital projects.

Cooperative Agreements define the roles and responsibilities of both organizations as related to communications, reporting, submission review comment and approval, and quality management. These Cooperative Agreements are then utilized to frame the project specific requirements between the organizations, which are added as an addendum to the agreement. Metro Third Party Coordination Unit policies THD1, Agency/Utility Coordination and THD2, Cooperative Agreements, provide higher level guidance to staff on utility coordination. In addition, comparable agencies maintain new Master Agreements with agencies and utility companies and renew these agreements every couple of years.

(3) Recommendation

Recommendation 40. The Third Party Coordination Unit should assess all Master Agreements, develop the recommended Metro improvements to these agreements, as needed, and engage with utility companies to create new Master Agreements. These engagements can be accomplished through the quarterly coordination meetings suggested in item c above.

2. Project Team issues (Staffing and Oversight objective area)

Project team collaboration is an important element towards overall project success. Project team issues involve the Metro capital project team, which primarily includes the Project Manager (PM), Construction Manager (CM), Contract Administrator (CA), and Project Controls Manager (PCM), but can also include personnel from all Metro departments, as assigned to a specific project, such as Operations/Maintenance, Systems, Communications, Procurement, Legal Counsel, etc.

Project team issues occur within all phases of the project delivery lifecycle, from Planning to Operations/Maintenance. Team issues are wide ranging, such as issues associated with the team members and member personalities; general project coordination and communication issues; the review, comment and resolution of planning, design and construction deliverables (environmental document, plans, specifications, etc.); contract requirements and even changes to the construction contract (scope, schedule, cost and quality). The significant Project Team Issues affecting Metro capital projects are described below.

a) *Project team selection and maintenance is critical to project success (Appendix A, Findings 46 and 62).*

(1) Finding

Most interviews and project workshop discussions, and survey responses indicate that the assembly of a high performance team is currently not always possible at Metro. Also, a review of Metro documentation indicates that there is no formal process or procedure for establishing and maintaining an effective project team.

There are numerous factors that influence the selection of a project team, such as other projects competing for staff, staff availability, skill set, knowledge, specific experience requirements for the project and cost. It is critical that team members selected for a project clearly understand their roles and responsibilities and be able to work together collaboratively to effectively deliver the project. Most importantly, it is the Project Manager that must be an integral part of team selection, understanding the skills, experience and knowledge required of the team members and ultimately continuously developing and managing the team throughout the project lifecycle.

Currently, when a project is initiated in the Planning phase, a project manager is identified. However, an integrated, multi-disciplined team is not set. Interviews indicate that the team should be established in Planning, not when the project is transferred to Engineering & Construction.

(2) Best Practice

Just as important to selecting the Project Manager for a project is the selection of the project team. This is a critical element to project success. Team members must have the necessary skills (technical, interpersonal and conceptual) to accomplish the specific goals and objectives of the project. The benefits of effectively selecting, developing and managing a high performance team far outweigh the costs associated it.

Metro has incorporated some team best practices into its organization. Like many comparable agencies, Metro is a composite organization, which is a combination of a strong matrix organization, with functional departments and a Project/Program Management department, with a projectized organization for major projects, with team members under dual assignment to the functional departments, but also assigned with key team members co-located to the project site.

Team development guidance is provided within PMI's PMBOK, under Human Resource Management, which describes the organizational influences that affect the project team, its structure and membership. PMBOK also includes the inputs, tools and techniques, and outputs for the acquisition, development and management of high performance teams, from specific team selection criteria, training and development requirements to team performance assessments.

In addition, the Construction Industry Institute in report RS37-1, entitled "Team Building: Improving Project Performance", has researched the team building process and provides excellent recommendations, such as the use of a professional team building consultant in a “retreat” type meeting, regular team meetings throughout the project lifecycle that should include broad team participation and should be built into the Project Manager roles and responsibilities of the project. Participants in team building almost unanimously agree that this process is effective and would use it again on projects.

Establishing and maintaining an experienced, technically capable project team at the beginning of project development is vital to project success. The project team must be carefully selected, identifying team qualifications, experience and technical knowledge specific for the project.

(3) Recommendation

Recommendation 41. Metro, led by the strategic PMO, should develop a strategic plan for the selection, development and management of project teams. The PMO should form a development committee with members from Engineering & Construction, Program Management, Communications, Vendor/Contract Management, and Human Resources to layout the framework for this plan. Key activities should include the assessment of research and similar efforts from comparable agencies, the establishment of the vision, goals and objectives for the strategic plan.

This development committee should establish the policy and procedures for the selection and maintenance of a high performing team and identify the short and long term requirements for success of this plan, such as a skill set inventory, training and development needs, a mentoring/coaching process and human resource needs. Input from Project Managers, Contract Administrators, Project Controls staff and Construction Management personnel must be incorporated into the final plan. Upon executive management and Board approval, the developmental and implementation phases of this plan should be initiated, integrating this strategy with other organizational strategies.

b) *Major projects utilize an Integrated Project Management Office (IPMO) team structure at the beginning of project development (Appendix A, Finding 61) (see the project team selection Finding above).*

(1) Finding

In accordance with 49 CFR 633 and FTA requirements, Project and Construction Management Guidelines, major projects require the development and implementation of a Project Management Plan (PMP), an effective project management tool that defines the roles, responsibilities and interactions among project staff (refer to the project team selection issue above). Within the PMP, the organizational structure for the project and the team approach is identified. For major projects, Metro is utilizing an Integrated Project Management Office (IPMO) team structure, an excellent management structure for project execution and control (see Figure #13 below). There are many advantages to this structure, such as reduced management costs, improved Metro/consultant interactions, eliminating rework and improving overall quality. With the Metro/consultant team co-located within a single office environment, this fosters improved collaboration and communication.

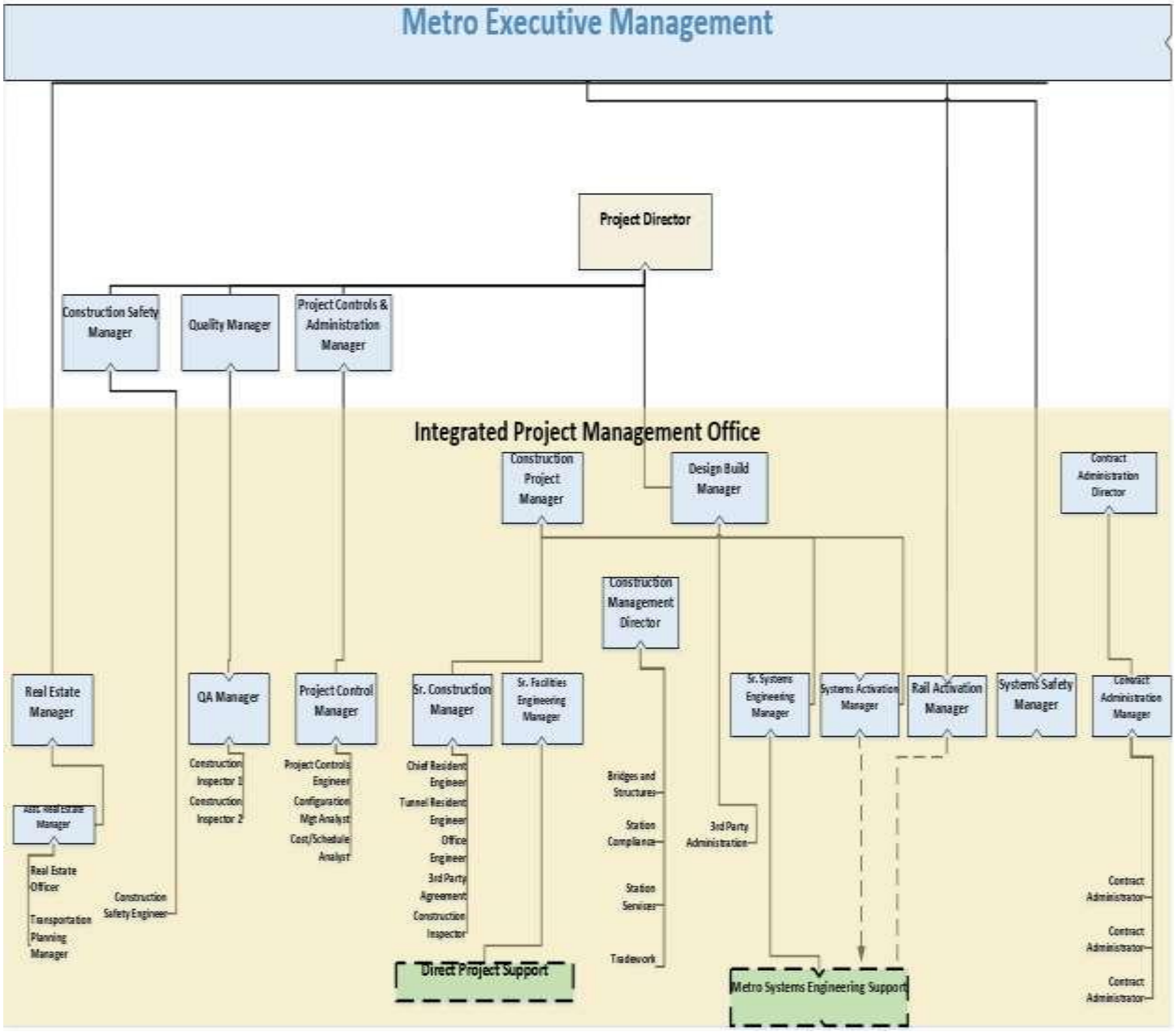


Figure 13: Integrated Project Management Office (IPMO)

(2) Best Practice

FTA requirements, comparable agency use and PMBOK guidance FTA requirements, comparable agency use and PMBOK guidance FTA Project and Construction Management Guidelines identifies the requirement for a PMP, in addition to FTA Circular 5010.1D, which describe the requirements for establishing the organizational structure and roles and responsibilities for the project. In addition, PMBOK provides additional guidance on a Project Governance Oversight function, and describes the structure, processes, decision models, and tools, utilized and described within the PMP for the project.

(3) Recommendation

<u>Recommendation 42.</u> Metro should assess, develop and implement an IPMO environment for all Metro capital projects (transit and highway). Although such a structure for some projects is not feasible as defined by some major projects, Metro should customize the team structure for projects based on scope and complexity.

Recommendation 43. Metro should require all projects to prepare and update a customized PMP. This tool, if effectively developed and used, can greatly improve the project management capabilities on a project. Metro policies and procedures should be revised to reflect these new requirements, and should include templates for PMP's and IPMO structures to assist project managers and project teams in development and implementation of these improvements. Organizational communication, education and training should also be developed and implemented.

c) *Upper management gets involved in project level decision making (Appendix A, Findings 34 and 35).*

(1) Finding

Not very long ago, a citizen was appointed to provide feedback on major projects. This individual got substantially involved in project management and governance. This subject matter expert, acting with the support of the Board, was able to motivate action and assist in overcoming project hurtles. However, it caused some confusion of roles, responsibilities and the chain of command. Upper Executive management involvement in interviews and project decision making is appropriate, but that involvement should only be when it is necessary for successful project delivery. If and when necessary, a decision escalation ladder is utilized for higher level decisions under specific controlled criteria. Executive leadership should be just that – providing Project Managers with overall project direction and support.

Interviews indicate that upper management is involved in day to day decision making. PMs and CMs have multiple status meetings with management. Functional managers are getting involved in project decisions instead of the designated team member from that functional unit. In addition, it has been noted by interviewees that contractors and project stakeholders are bypassing the Project Manager and the established chain of command on some projects and are reaching out to upper management for decisions. This practice is contrary to established project management best practice and should be avoided. Utilization of upper management should occur as necessary, but through the Project Manager.

(2) Best Practice

Upper management involvement in project decision making is appropriate, but that involvement should only be when it is necessary and specifically defined by the decision making procedures for successful project delivery. Day to day project decisions need to be delegated to the Project Manager, who utilizes the project team for expertise and support in decision making. The Project Manager must be empowered by the organization to make sound, timely decisions. If and when necessary, a decision escalation ladder is utilized for higher level decisions under specifically controlled criteria. Executive leadership should provide Project Managers with overall project leadership, direction and support.

All team members, especially the Project Manager, must be empowered and must take responsibility to make project day to day decisions. All team members must clearly understand their specific project roles and responsibilities.

Denver RTD has implemented a "Decentralized Project Management" best practice approach that empowers the project manager and team to make major project decisions and commitments, while keeping the Board informed with progress and issues (see the Collaborative Escalation Ladder below).

	Design and Construction Task Force Systems							
Level	**Row**	**Dry Utility**	**Drainage/Wet Utilities**	**Civil/Track**	**Structures**	**Stations Architectural Landscape**	**Fire-Life System Safety**	**Systems**
1 Task Force Co-Leads	Susan Altes (RTD) Terry Tyrrell (AECOM) Joshua Nitz (Kiewit) Joani Cravens Aurora	Utility Owner Reps Greg Jeppesen (RTD) Tom Fuentes (AECOM) Roger Weathers (Kiewit) Charlie Cooper Aurora	Greg Jeppesen Drainage Eng. TBD RTD Tom Fuentes (AECOM) Roger Weathers (Kiewit) Brad Richardson Aurora	Erik Haugen (RTD) Terry Tyrrell (AECOM) Martin Brown Nate Schanne (Track) Kiewit Brad Richardson Aurora Lead	Jack Vaughn (RTD) Steve Haynes (AECOM) Keith Spolar (Kiewit) Brad Richardson Aurora Lead	Susan Johnson (RTD) Steve Wilensky (AECOM) John Zegarski Les Nyland (Kiewit) John Fernandez Aurora	Bob Pitts (RTD) Suzanne Reese (IEI) Mike Monroe (Kiewit) Mike Dean Dirk Anderson Aurora Steve Buemer Asst. Fire Marshal Aurora	Altagracia Jager (RTD) Gordon MacDonald (HMM) Derrek Freeseman (Mass Elec) Al Fedderson Aurora
2 Mgr	**Design Issues** Paul Von Fay, RTD Danielle Smith, RTD Sonya Dupuis, Kiewit Robert Kennah, AECOM Brad Richardson, Aurora							
3 PM	**Project Management Team** Chuck Culig, RTD Roger Ryburn, Kiewit Rick Romig, AECOM Cindy Colip, Aurora							
4 Sr. Mgmt	**Senior Management Team** Pranaya Shrestha/Rick Clarke, RTD Roger Ryburn, Kiewit Dave Chambers/Nancy Freed, Aurora							
5 Exec	**Executive Team** Phil Washington, RTD Craig Briggs, Kiewit Skip Noe, Aurora							

Figure 14: Collaborative Escalation Ladder

(3) Recommendation

Recommendation 44. Establish governance model with delegated authority at a lower level. Board and Executives need to stay at policy level and delegate authority to project professionals.

Recommendation 45. Reduce the amount of internal management meetings with the project team. Train executives to use project controls tools to get status. Modify project reporting as necessary to provide executives with complete project status and issues. Establish and implement a workflow for management questions & responses to be formalized through the Project Controls group.

d) In general, project teams have review, communication and coordination issues (Appendix A, Findings 9, 16, 46, 64, 74, 80 and 81).

(1) Finding

Most interviews, all project workshop discussion and numerous survey response comments indicate that Metro capital project teams continue to have issues with coordination and communication, which are very important to successful project delivery. Team selection, development and management play a critical part in creating a high performing team and in limiting communication and coordination issues (see Project Team issues, item a) above).

Some of the concerns noted in interviews and survey responses that bear Metro consideration are:

- Project Managers are sometimes antagonistic to team members
- Review comments are not being effectively resolved
- PM's vary significantly in their communication effectiveness (see Project Management Issues category)
- Project Manager, Contract Administrator and Project Controls personnel need to have their roles and responsibilities more clearly defined
- Staffing changes during project development (in any phase) can significantly affect team communication and coordination
- Project status and reporting to the team needs to be improved
- More control is needed over consultants
- There is limited sharing of project information to team members

These concerns noted above are occurring for transit and highway projects, in all phases of project delivery and in all elements of delivery (procurement, design/construction reviews and submissions, stakeholder issue resolution, change orders, community involvement, etc.).

(2) Best Practice

Effective team communication and coordination is very important to successful project delivery. Team selection, development and management plays a critical part in creating a high performing team and in limiting communication and coordination issues (see Issue a) above).

In addition, effective Communications Management is critical to successful project delivery. PMBOK provides excellent guidance on a strong project team, managing stakeholders and communications (see the discussion in item a) above).

(3) Recommendation

Recommendation 46. Training and development for Project Managers and all team members is needed, with an emphasis on "soft skills". Assess and redefine, if necessary, the roles and responsibilities of the Project Manager, Contract Administrator and Project Control positions. Reassess the MTA organizational structure and develop clear roles and responsibilities for capital project delivery. Metro is currently developing a PM training and development program, which should be assessed to include these recommendations.

3. Project Management issues (Policies and Procedures objective area)

Per PMBOK, "Project Management is the application of knowledge, skills, tools and techniques to project activities to meet the project requirements". Project Management issues are not just about the Project Manager, these are issues related to the overall management of the project, and can involve issues relate to any and all team members and also issues surrounding the organizations specific project management methodology.

It should be noted that PMBOK categorizes project management into five (5) process groups (Initiating, Planning, Executing, Monitoring/Controlling, and Closing) and project management is further defined by ten (10) specific knowledge areas, as identified in Chapter II of this report. Project management issues can occur within any or all of the process groups and knowledge areas and can occur within any or all of the project delivery phases, from Planning through Operations/Maintenance. Project management issues can range from lack of or inconsistent use of project management processes, procedures, or tools and techniques to unclear or undefined roles and responsibilities. Our evaluation identified the following key issue areas with potential areas for improvement:

a) Project Management methodology is not being utilized throughout the project lifecycle or throughout the Metro organization (Appendix A, Finding 1).

(1) Finding

From our documentation review, interviews and survey responses, when a project is initiated and enters the Planning phase, a Project Manager is assigned from the Engineering & Construction department. However, the empowerment for project decision making and control is assigned to Countywide Planning & Development. In addition, the methodology of project management (processes, procedures, tools and techniques) is not being utilized or not being consistently applied on projects or throughout the project lifecycle (Planning through Operations).

(2) Best Practice

PMBOK is the globally recognized source for project management. Project Management is not just a process, but a philosophy. It is a critical and fundamental element of an organization, and if effectively implemented, can provide exceptional results in capital project delivery and in improving operations throughout the organization. As a best practice, project management should be established across all areas of an organization. In addition, the project management process and methodology cover the entire project lifecycle utilizing process groups, knowledge areas, policies and procedures, and tools and techniques to effectively manage and deliver capital projects.

Most of the comparable agencies assessed empower the project manager for project decision making and control from planning through closeout. Denver RTD utilizes a "Decentralized Project Management" approach, empowering the PM, with the assistance of the project team, to make most project decisions, with only significant decision made by upper management through a clearly defined decision ladder.

FTA Project and Construction Management Guidelines (July 2011) and the FTA Construction Project Management Handbook (2009) recognize the need for a "comprehensive lifecycle management approach" (Planning, Design, Construction and Operations) for all types of capital projects (major and small). This approach utilizes the full application of project management processes (procurement, risk, safety/security, communications, etc.) and utilizes Project Management Oversight (PMO) consultants to ensure compliance with these processes.

Project Management methodology can be utilized for all types of capital projects (transit and highway). The Federal Highway Administration (FHWA) "Large Project Management and Oversight" report to the Senate and House Subcommittees recognizes that "sound project management plans are a key in providing the framework for managing major projects and are critical to the success of any project". Project management methodology can also be used effectively to manage the numerous types of non-capital projects within the Metro organization, such as operations/maintenance, intelligent information (IT), procurement, human resource and Metro's administrative efforts.

(3) Recommendation

Recommendation 47. Metro should adopt the Project Management Institute (PMI) and its Project Management Body of Knowledge (PMBOK) as the organizational standard for project management. In addition, establish an organization commitment to develop and implement project management methodology throughout Metro, by incorporating project management goals, objectives, processes, procedures, tools and techniques in all departments of the organization in improving operations and capital project delivery.

Recommendation 48. Assign a Project Manager (PM) at project initiation and empower the PM with the authority for project decision making and control responsibilities throughout the entire project lifecycle.

Recommendation 49. Develop an organizational wide Project Management Initiative, including an organizational training and development program. Effectively implement this organizational change through clear identification of roles and responsibilities, executive direction, education, effective communication and strict enforcement and compliance of processes and procedures through the strategic PMO.

Recommendation 50. Establish the Strategic PMO with dedicated resources (established by short and long range PMO development plans). This requires Board of Directors and executive level commitment. Our evaluation (survey results, interviews, project workshops and comparable agency review) indicates that Metro is at an organizational maturity level for this initiative. It should be noted that Project Managers remain within the Engineering & Construction department.

The Strategic PMO should:

- report to the Chief Executive Officer (CEO).
- own the capital project delivery process (policies, procedures, tools, techniques, systems and training)
- own all organization wide project management methodology
- integrate project management between all Metro departments
- ensure compliance with capital project management and project delivery processes through mechanisms such as project reviews
- own the Metro Lessons Learned Program and historical database

- assist all departments with the development and deployment of project management methodologies and development tools to enhance department processes and functions for capital and non-capital projects
- develop and recommend to the CEO and Executive Director of Engineering and Construction continuous improvements to capital project management and project delivery and department project management development

These significant, high priority, recommendations should be assessed and closely integrated with all other recommendations within this report in order to ensure successful implementation (refer to the Implementation Roadmap section of the Executive Summary for additional discussion).

b) Lessons Learned are not being programmatically captured (Appendix A, Finding 26).

(1) Finding

All interviews, project workshops, survey responses and comments indicate that lessons learned are not being systematically captured on capital projects, with a subsequent formal analysis and resulting recommendation for improvement. Major projects at Metro under FTA oversight require lessons learned to be captured at project closeout, but interviewees indicate that this is not always performed.

Lessons learned have been captured under certain disciplines within specific departments, such as procurement (Vendor/Contract Management) and safety (Risk Management & Safety), but these are not programmatically shared throughout the organization. Lessons learned on capital projects may be identified during project development by project managers, team members and stakeholders, but are being lost and not incorporated into the processes, standards, contract documents, policies, procedures and without subsequent training and development for continuous improvement. In addition, there is no specific owner for lessons learned, and no historical database for access to and future reference of lessons learned. Safety, Legal, Communications, Accounting, Audit, Ethics, Inspector General, Operations and other departments may also have insights to contribute concerning lessons learned relative to capital projects.

(2) Best Practice

A vast amount of learning occurs on every project. The capturing and continuous improvement associated with lessons learned is a critical element for organizational and capital project delivery success. Improvements from lessons learned prevent an organization from repeating the same mistakes, but just as important, it allows the organization to take advantage of best practices and incorporate positive change into current and future projects. The value obtained from lessons learned is the ability of the organization to establish and sustain a culture of consistent project management improvement.

Some of the best practices in lessons learned are:

- reviewing previous project lessons learned at the beginning of a project (Planning)
- conducting lessons learned sessions throughout the project lifecycle
- utilizing a facilitator instead of the project manager for capturing lessons learned
- performing a root cause analysis to develop solutions to problems
- store lessons learned in a retrievable database that can be easily accessed and searched by the entire organization

FTA lessons learned requirements are stipulated in OP26, which provides the process and procedural steps for capturing lessons learned. Furthermore, the FTA posts lessons learned developed by its PMOCs on its website. In addition, the Project Management Institute has a wealth of research and reports on the development, implementation and maintenance of a lessons learned program for an organization.

(3) Recommendation

Recommendation 51. Establish a formal, organizational wide Lessons Learned Program under the management of the strategic PMO (see Recommendation 50 above). Establish a Lessons Learned database to systematically manage captured lessons learned in a searchable, user friendly environment. The responsibility of the PMO is to generate, maintain, evaluate, analyze and feedback into continuous improvement lessons learned.

A Lessons Learned program should be structured to allow capturing continuously throughout the life of a project, with a formal lessons learned meeting at the close of each phase of the project (Planning, Preliminary Engineering, Design, and Construction) for all types of project delivery (design/build, design/bid/build, etc.). In addition, Lessons Learned should be captured in all elements of a project (structural, utility, traffic, geotechnical, etc.) and in all knowledge areas of project management (scope, schedule, cost, quality, risk, etc.). Evaluate and incorporate, as deemed necessary, the best practices above into a lessons learned program.

c) *There is no specific department that is empowered with the authority to own and oversee the capital project delivery process, ensure compliance and assess and implement continuous improvement (Appendix A, Finding 77).*

(1) Finding

Examination of Metro documentation, executive management and staff interviews indicate that the capital project delivery lifecycle is managed by various departments:

- Countywide Planning & Development – Planning Phase
- Engineering & Construction – Preliminary Engineering, Design & Construction Phases
- Operations – Operations and Maintenance Phases

Each department above has its own policies and procedures related to project development. There is however, no integration of processes between owners, no organization wide capital project delivery training and development program other than a fundamentals PM Academy training and there are no enforcement mechanisms in place within these departments to ensure compliance of respective policies and procedures.

In addition, there is no ownership of the entire project delivery lifecycle to measure project performance and ensure the identification and assessment of all elements and aspects of the capital project delivery process to develop and implement continuous improvement of processes and procedures. Lessons Learned and best practices are not systematically captured and implemented (see item b and Recommendation 51 above). The capital project delivery process is not effectively communicated to the organization. Within the Program Management department there is a Program

Management Office (PMO) that plays a limited, but not a strategic role in capital project delivery oversight responsibility and reporting.

(2) Best Practice

One (1) owner within an organization should be empowered with the responsibility of the management of the entire capital project delivery process, from project initiation through closeout, commissioning and operations and maintenance. Responsibilities include:

- Partnership and collaboration with all areas of the organization related to capital project delivery
- Ownership of all policies, processes and procedures related to capital project delivery
- Coordination associated with development and implementation of continuous improvements
- Capital project delivery communications, training & development
- Performance measurement
- Management of lessons learned and best practices

(3) Recommendation

Recommendation 52. Develop and implement the best practice that one owner should be empowered with responsibility for the management of the entire capital delivery process. Assign ownership of capital project delivery to the strategic PMO. Provide the PMO with the necessary staffing and resources to accomplish this goal, including development of the necessary staff skills. Develop a strategic plan for the PMO (see item a, and Recommendation 50 above). Communicate and educate the entire organization.

d) Highway project management issues (Appendix A, Findings 7, 8, 32, 61, 64, 86, 87 and 88)

(1) Finding

While Metro is primarily a transit improvement authority, a significant portion of the capital program is dedicated to highway improvements (carpool lanes, freeway interchanges and, gap closures, etc.). Highway improvements are one of the critical elements to the overall success of the Los Angeles County infrastructure, and it is essential that highway project delivery be effectively staffed, resourced and managed.

Interview and survey responses indicate that highway projects are not receiving the organizational commitment that transit projects receive. Despite the large number of highway projects (about 15 projects where Metro hires a consultant, about 15 projects where Metro hires Caltrans, and more than 150 projects where Metro provides funding to cities and counties and provides an oversight role), the following issues have been identified:

- Limited transparency to the Board on highway projects.
- Policies and Procedures related to highway project delivery and project management need to be developed.
- Metro commitment of resources and support from other departments is lacking.
- Limited Metro expertise in highway design and construction – hiring consultants as an extension of staff is being considered.
- Highway Project Managers require project management training.
- Highway engineers require technical training and development.

- Organization wide education on highway functions is needed.
- Caltrans coordination needs improvement and there is limited sense of urgency at Caltrans (see Third Party Issues, item c).
- Concerns that the design/build delivery method is not being effectively utilized on most of the large highway projects (see Project Delivery Issues, item b).
- Detailed highway project schedules are needed.
- Metro staff are needed for project management and in-house quality assurance functions.

(2) Best Practice

PMBOK defines and recommends the utilization of project management methodology, tools and techniques for all projects, regardless of type, size and complexity. Also, the FHWA Office of Innovative Program Delivery provides guidance on best practices in highway project delivery. In addition, the National Cooperative Highway Research Program provides valuable best practices in NCHRP 20-68A (2009) “Best Practices in Project Delivery Management”.

(3) Recommendation

Incorporate the following improvements into highway project delivery and project management:

<u>Recommendation 53.</u> Incorporate the IPMO management structure into highway projects (see Project Team Issues, item c).

<u>Recommendation 54.</u> Improve the reporting process – project controls and highway management staff should develop specific reporting requirements and obtain executive approval.

<u>Recommendation 55.</u> Establish Metro Independent Cost Estimate and Contingency review.

<u>Recommendation 56.</u> Establish a detailed WBS for scheduling and budgeting.

<u>Recommendation 57.</u> Assess the most effective method of project delivery (see Project Delivery Issues, item b).

<u>Recommendation 58.</u> Assess the use of Advanced Utility Relocation (AUR) projects to support highway projects.

<u>Recommendation 59.</u> Provide staff training and education in project management and highway technical skills.

<u>Recommendation 60.</u> Develop a Quality Plan for highway projects, incorporating the Caltrans Independent Quality Assurance (IQA) process.

<u>Recommendation 61.</u> Improve configuration management and document control processes – reassess current processes and procedures, identify problems, issues and concerns and develop improved processes for executive approval.

e) Project Manager overall performance is wide ranging (Appendix A, Finding 81).

(1) Finding

At the heart of effective project management for capital project delivery projects is the Project Manager, fundamentally the most important role within the project team. The performance of the Project Manager is critical to the overall success of the project. It is the organization's responsibility to ensure that all staff are performing, and capable of performing, at the highest possible level, especially Project Managers.

Most Executive and management interviews, numerous survey responses and all project workshops have each reinforced the concern that there is a wide range in the performance of Project Managers on capital projects. Some of the issues with Project Manager overall performance were identified:

- Inconsistent application of Metro policies and procedures, specifically noting project schedules, cost estimates, time/impact analyses and contractor submittals as areas of Project Manager non-compliance
- Not utilizing the Program Management Information System (PMIS) to improve project management capability on all projects
- Limited project management training and development program – although a PM Academy has been established (July 2014), our review indicates this is a fundamentals type course and does not provide the detailed training curriculum needed for improving PM performance
- Experienced, high performing PM's are not formally mentoring and coaching other PM's
- Project Managers are not formally sharing information, knowledge, tools and techniques, best practices and lessons learned on both capital project management and capital project delivery
- Lack of empowerment to Project Managers to make timely decisions – this can be occurring for numerous reasons
    - Board approval cycle
    - Executive level decision making
    - Project Manager performance
    - Lack of PM trust
- No formal project management Center for Excellence to support and improve Project Managers
- Project Manager skill set inventory not developed to identify specific strengths and areas for improvement

(2) Best Practice

The skill set for a high performing Project Manager is extensive. PMBOK identifies the specific competencies required of Project Managers in order to effectively manage projects:

- Area specific skills (civil engineering, highways, transit, capital project delivery processes and procedures, etc.)
- General management principles
- Project management knowledge (processes, knowledge areas, tools, techniques, etc.)
- Performance capabilities – the ability of the PM to accomplish project goals and objectives using all skills
- Personal competencies (attitude, core personality characteristics, leadership, communication skills, etc.)

  PMBOK, within Appendix X3 provides detail into the interpersonal skills required of project managers. Comparable agencies have developed and implemented extensive project manager performance plans. Some agencies incorporate training and development needs into the PM's individual performance assessments, including requirements for mentoring and coaching fellow PM's. Agencies have developed skill set inventories for project managers, identifying strengths and areas for improvement in order to assist management in selecting the most appropriate PM for a project and in developing the organizations Training and Development Program.

(3) Recommendation

Recommendation 62. Develop a Project Manager Performance Plan, which should be part of Metro's overall Talent Management Program. A PMI White Paper, entitled, "Building High Performance Project Talent" (2013), provides recommendations to organizations on implementing or improving a project talent management program. Some of the keys to success in implementing a talent management program are:

- Executives must want to help staff succeed
- Look for signs of high performance – staff will pursue education, experience and credentials on their own
- Build a support structure that nurtures young talent
- Educate the organization on the value of project management

Recommendation 63. Establish performance metrics into Project Managers performance assessments, such as Schedule/Cost variance, change requests to the project scope, resource utilization, quality, and customer/stakeholder satisfaction. These metrics must be evaluated considering the project variability and risks when performing a PM performance assessment.

f) Project Managers are not reaching out to team members to provide consultant/contractor performance feedback support (Appendix A, Finding 80).

(1) Finding

When a Project Manager is performing a performance evaluation of a consultant or contractor, the overall performance of the consultant/contractor must be considered. The Project Manager may not be aware of all elements of the consultant/contractor performance. The PM must rely on feedback obtained from the project team members, and must consider performance in all aspects of the project.

To properly evaluate performance, team members must be utilized to provide their input or feedback as it relates to their specific area(s) of responsibility (contract administration, change management, design and construction quality, risk management, construction management, etc.).

Although Metro policies and procedures identify the need for this feedback mechanism, interviews and survey responses indicate that Project Managers are not reaching out to team members to obtain their input into the evaluation of consultants and contractors. This is critical to the proper evaluation of performance. It was noted that Vendor/Contract Management has a lessons learned database related to performance, but that this database of project specific information is not being formally shared.

(2) Best Practice

Project team extensive experience and an assessment of comparable agencies indicates that most organizations require the contracting officer or project manager to evaluate consultant and/or contractor performance at the completion of the contract and no less frequently then annually.

The contracting officer or PM is required to obtain evaluations from all functional elements in the performance management of the contract. These evaluations can come from team members, functional units, program management office, procurement, engineering and construction, and project stakeholders, as determined by the contract office/PM, such that all relevant performance information is obtained and utilized in preparing an evaluation.

(3) Recommendation

Recommendation 64. Require the Project Manager to evaluate contractor performance at least annually and at the completion of the contract. Executive management must emphasize the importance of thorough performance evaluations of consultants and contractors, utilizing the project teams for valuable insight into performance. The strategic PMO should be a mechanism for assuring compliance.

4. Project Delivery issues (Project Delivery Methodology objective area)

Project Delivery can be defined as the execution of those activities necessary to effectively develop and complete a project. Project Delivery issues for a Metro capital project cover any element of a project (traffic, electrical, systems, structural, procurement, community involvement, project management, etc.) and can occur from project initiation to project closeout within any or all phases of project development (Planning, Preliminary Engineering, Design, Construction and Testing). Project team review indicates that the project delivery process for capital projects at Metro is sound, with specific recommendations for improvement identified below.

a) Safety is paramount to the organization (Appendix A, Finding 52).

(1) Finding

Data reviews, project workshops, interviews, survey responses and agency assessments identify Metro as a national industry leader in addressing safety within its organization, capital projects and infrastructure. This is Metro's strongest element of project delivery. Staff at all levels of the organization clearly consider safety as their number one priority.

Safety is not being sacrificed on capital projects, and is effectively built into projects, addressed by project teams in construction, and communicated to the public and ridership. Although incidents can and will occur, Metro has an outstanding safety record on projects.

(2) Best Practice

Reviews, interviews, project workshops and survey responses clearly indicate that safety is the number one priority of Metro and the organization has established itself as a leader in safety management. Metro addresses all of the requirements of MAP-21 legislation with its Agency Safety Plan in addition to all FTA and FHWA specific requirements.

For capital projects, safety is considered in all phases of the project lifecycle, from the development of design standards, to purchasing, fabrication, and construction. Some of the Metro initiatives include the policy for a Zero-Accident Tolerance safety program, specific worksite safety requirements within the contract documents, the contractor requirement for a written Project Safety Program, the Community Relations Public Safety and Rail Safety and Education Programs and Metro's Safety Audit Program. Metro policies, procedures, communication, education and training are industry best practices.

(3) Recommendation

<u>Recommendation 65.</u> Assess whether additional safety training is needed.

<u>Recommendation 66.</u> Consider installing a safety "ticker" in the Metro lobby, to communicate the importance of safety to stakeholders and the organization to applaud the success of the safety program.

<u>Recommendation 67.</u> As part of the recommended upgrading of design criteria, standards and specifications for highway and transit projects (see Appendix A, Finding 75), these documents should be evaluated and developed, incorporating safety considerations.

b) There is no established project delivery method selection process and criteria (Appendix A, Finding 71).

(1) Finding

Key executive and management interviews, corroborated through our documentation review, has identified that no formal, written policy, process or procedures exist for the selection of the method(s) of capital project delivery (Design/Bid/Build, Design/Build, etc.). An examination of the delivery method being selected on projects has revealed that almost all projects are currently utilizing the Design/Build (D/B) method of project delivery. Without a formal decision making process and subsequent documentation, it is hard to determine if the D/B method is appropriate.

Although D/B may be appropriate for the large transit projects, it may be overused and not strategically planned for Metro's capital program. Also, other project delivery methods such as CMGC, CM @ risk, etc. should be evaluated for inclusions as methods of delivery. Most of the interviewees involved in capital program and project management have indicated that the D/B method of project delivery may not be appropriate for certain Metro projects, especially Regional Rail and the Capital Improvement Program projects. Lessons learned from past projects, per discussion with staff, indicates that the contractor/designer relationship with the D/B method has been problematic on smaller contracts. In addition, interviews and project workshops indicate that staff and the Board are in need of education on the various project delivery methods and the advantages and disadvantages of each method.

(2) Best Practice

FTA Project and Construction Management Guidelines (2011) provide guidance on the advantages and disadvantages, benefits and risks that must be considered when selecting the method of project delivery. In addition, FTA Project Management Oversight Procedure 32D, "Project Delivery Method Review", describes the review, analysis and recommendation procedures expected by FTA with regard to the selection of a project delivery method and plan for delivery, which a formal selection process should take into consideration.

CMAA, in "A Guide to Selecting the Best Project Delivery Method for Public Transit Projects" (2008), proposes a three (3) tier selection system to assist transit agencies in evaluating and selecting the most appropriate project delivery method. In addition, the Design Build Institute of America (DBIA), in "Design-Build Done Right", (2014), identifies best practices for owners in making project delivery decisions applicable to all types of projects and in "Choosing a Project Delivery Method" (2015) provides guidance and instruction on the methods, considerations and risks in selecting the project delivery method.

For highway projects, Michigan DOT's "Innovative Construction Contracting Guide" (2015) provides a selection matrix as a tool to help identify which delivery method may be most appropriate and Florida DOT's "Design Build Program Evaluation" (2004) identifies specific project selection guidelines after an assessment was made by Florida DOT after ten years of D/B project delivery.

(3) Recommendation

Recommendation 68. Assess, develop, implement, communicate and educate the organization on the detailed decision making process, specific selection criteria and the fundamental elements of each delivery method. As part of the development of a formal project delivery selection process, factors that need to be considered in the selection of a project delivery method should include:

- Readiness (all stakeholders)
- Funding
- Utility risk
- Market condition
- Systems
- Operational issues
- Personnel
- Project size
- Project type (transit, highway, other)
- Procurement type
- Environmental mitigation

c) Design Scheduling needs improvement (Appendix A, Finding 109).

(1) Finding

Most interviewees within the Engineering & Construction and Program Management departments indicate that design schedule development and management for projects is an area that could improve. Although major construction projects utilize the tools and techniques of scheduling (detailed project schedules, WBS, activities, resources, durations, dependencies, constraints, milestones, lags, etc.), design scheduling is being overlooked. A sense that design scheduling is being overlooked is substantiated in the fact that Program Management becomes responsible for the management of the schedule once the first construction contract is awarded. The schedule and budget get set at that time.

Metro has developed high level procedures for schedule management for transit project delivery, PRCL9, "Schedule Development and Control" and PRCL11, "Capital Program (CP) Projects" for smaller rail CP projects. The schedules stipulated in PRCL11 are developed at a level for identifying expected progress/cash flow and are updated quarterly until project completion.

There are great benefits derived from utilizing detailed schedules for improving the monitoring, analysis and control of capital projects. However, Metro is not requiring or enforcing the development of detailed project schedules from project initiation into the design phase.

(2) Best Practice

Most comparable agencies require the development of a detailed project schedule beginning at the initiation of a project (Planning). This CPM based schedule is approved, baselined and updated throughout the Planning phase. As the project development continues, a more detailed project schedule is developed, approved, baselined and controlled. As the project moves through each subsequent phase, increased schedule detail is provided throughout project development. This process is followed for all capital projects. Individual project schedules are customized for each project based on the scope, complexity and specific project requirements to meet project goals and objectives. Project schedules are analyzed and updated monthly.

PMI's PMBOK Schedule Management knowledge area describes the processes necessary to effectively develop, approve and manage/control the project schedule throughout the project lifecycle.

(3) Recommendation

Recommendation 69. Metro should develop and implement a scheduling section with Project Controls (similar to the Cost Estimating section currently in existence). This section should have dedicated resources to perform the roles and responsibilities of schedule management, as defined by PMBOK. Metro should develop and implement all scheduling methodology, tools and techniques and provide all necessary communication, education and training to establish and manage detailed project schedules throughout the project lifecycle.

d) Project closeouts are not occurring in a timely manner (Appendix A, Finding 110).

(1) Finding

Several Interviews have indicated that projects sometimes remain open for 2 to 3 years before being officially closed out. This length of time is problematic, as the Project Manager has moved on to another project. Although clearly stipulated in the project contract documents, this important project management process on the responsibility of the Project Manager for phase and overall project closeout has limited discussion in the documentation provided for review (Policies and Procedures and the PM Academy User Manual) and is not being enforced. This creates an unnecessary burden on staff to continue to report on these projects. Furthermore, if projects were efficiently closed out, the remaining unused funding and resource commitments could be used elsewhere.

(2) Best Practice

Project closeout allows the resources associated with the project (personnel, systems, and funding) to be formally released and the lessons learned from the project to be summarized and incorporated into the organizational assets.

PMBOK's Integration Management describes the elements for closing out each phase of a project and the eventual close out of the project. This ensures that all deliverables have been completed and accepted throughout the project lifecycle and lessons learned have been captured for analysis and organizational improvement.

(3) Recommendation

Recommendation 70. Every effort should be made to close out the project in a timely manner. The Project Manager has primary responsibility for project closeout, however, the project controls unit should be responsible for ensuring compliance from all departments. A checklist should be used to be sure all required documentation is submitted, and compliance audited to verify the quality and completeness of the documentation received.

5. Community Involvement issues (General Readiness objective area)

Community Involvement is the process to identify, plan, manage and control project stakeholders to effectively engage stakeholders in project decisions and execution. A broader term utilized by PMI's PMBOK is Stakeholder Management. Community involvement issues can involve all areas and elements of the project, from alignment and alternatives issues in the Planning phase to systems and aesthetic concerns during design and construction.

a) Community Outreach problems exist, the process is costly and the Metro roles and responsibilities for executing this process are not clearly defined (Appendix A, Findings 28, 63, 82 and 83).

(1) Finding

Several interviewees, including executives, noted that a substantial amount of Communications department personnel are assigned to projects, with some projects assigning five (5) Communications personnel. Included within this project assignment are consultants hired by Metro, at significant project cost. In addition, it was noted that the roles and responsibilities of personnel involved in community outreach have not been clearly defined. For example, project management staff at Metro (Countywide Planning & Development and Engineering & Construction departments) are performing public presentations, not Communications personnel.

Some additional issues were noted:

- Limited Communications department input is incorporated within the Project Management Plan (PMP) for the project. The PMP does not include a detailed Communications Plan. Our examination of several major project PMP's indicated a very limited, programmatic discussion of community involvement.
- Community involvement is not being seen as a critical element by the project team.
- An organizational public involvement plan is needed.
- Policies and procedures defining the community involvement process and project team roles and responsibilities are needed.
- Contractors are not being held accountable.
- Key stakeholders are sometimes not present at community meetings.
- Design/Build projects reduce the time available for community involvement, increasing risk and sometimes impacting project scope, schedule and cost during construction.

(2) Best Practice

Minnesota DOT's "Best Practices in Community Involvement" (2012) provides an examination of best practices from twenty (20) published reports from various organizations and researchers and also includes ten (10) case studies in community involvement.

(3) Recommendation

Recommendation 71. At an executive level, a strategic Public Involvement Action Plan should be developed.

Recommendation 72. A process improvement committee should be formed with membership from E&C, CP&D, Communications (including construction relations and public relations) to identify the problems, issues and risks surrounding the community involvement process and develop strategies and recommendations for improvement.

6. Board of Directors matters (Staffing and Oversight objective area)

Metro was created in 1993 when California State Law Assembly Bill 152 (AB152), the Los Angeles County Metropolitan Transportation Authority Reform Act of 1992, was enacted to merge the Los Angeles County Transportation Commission (LACTC) and the Southern California Rapid Transit District (SCRTD) into a single transportation agency. AB152 stipulates the establishment of a 14-member Board of Directors (one non-voting member) as the governing body of Metro.

California Pub. Util. Code, Sec. 130630 states that "the board provides counsel and direction to management and shall not be involved in the day to day affairs of MTA." Interviews and discussions with Metro executive and management staff, key Metro stakeholders, and specific project team members from selected major projects, has revealed almost unanimously that interviewees consider the Board of Director oversight, approval, and reporting requirements for capital projects are a significant part of the project management and could be improved. The specific matters related to the roles and functions of the Board of Directors are noted below.

a) Oversight, reporting and approval concerns exist (Appendix A, Findings 4, 6, 39 and 73)

(1) Finding

The Board of Directors is responsible for counseling and directing Metro staff in general and making policies. Discussions have indicated that although staff periodically make Board reports on the status of projects, sometimes there has been additional Board requests to Metro staff for information, review, meetings, emails, calls, presentations, and analysis. Departments indicate as many as 20 such written additional requests over the last 2 years, which are in addition to normal Board reporting. These requests require a substantial effort in the review, analysis, and preparation of additional reports with supporting documentation, such as project status reports related to specific ongoing design and construction activities, project scope of work details, reviews of design and construction work, additional engineering analysis and review, and technology assessments. It was noted that these requests, in certain instances, are impacting project staff resources, scope, schedules, and costs. Staff are concerned about the number of hours of staff time and the impact to project management processes, and expressed the need to streamline the process to provide regularly, periodic reporting and reduce supplemental reporting. If the regular Board reports need to have certain additional information to better meet the needs of the Board that should be communicated to staff.

Metro staff are concerned that the Board of Directors are increasingly involved in the day to day activities related to capital construction projects, which includes additional involvement of Board Deputies. This additional project oversight requires upper management to become more involved in project decision making, which is distracting to project management, and at times, displacing the empowerment, accountability, and authority for project decisions of the Project Manager, and in turn, impacting the fundamental best practice of effective project management.

Also, executive and management interviews and survey responses have indicated a lengthy Board approval process exists for specific project changes, with substantial lead times and requirements in providing information. Documentation review and interviews indicates that the full Board only meets once per month. Board reports by staff must be completed 4-5 weeks before the Board meeting; so writing of the report must commence 1-2 weeks before that, resulting in taking up to 6 weeks before proceeding on a matter. Depending on the significance of a project change, a quicker, timely review and approval by the Board may be necessary for these changes in order to avoid delays and/or increased costs to the project.

(2) Best Practice

Our research of comparable agencies found similar Board compositions and functions. The team researched the relative roles and responsibilities of the Board and Executive management for these comparable agencies. In all cases, the Board sets high level policy, selects the Executive, and does not get involved in the management of the agency. In some cases, the Board bylaws expressly direct them not to be involved in the day-to-day management, the same as Metro rules (Pub. Util. Code, Sec. 130630). The following quotes are from the published bylaws of the comparable agencies:

- <u>San Francisco International Airport</u>: “The <SFIA> Commission is prohibited by Charter from involving itself in the day-to-day operation of the airport. That function is vested in the Airport Director.”

- <u>Denver RTD</u>: “Through the responsibilities and authority delegated by the Board of Directors, the General Manager and the Senior Leadership Team implements and manages the agency in accordance with the direction that has been set by the Board.” *Section 1.2, Board Operating Principles*, RTD Board of Directors Governance Manual.

- <u>Denver RTD</u>: “Board members must avoid the proclivity of getting too detailed in day to day operations and try to stay focused at the policy making level.” (*Section 1.4, Board Operating Principles*, RTD Board of Directors Governance Manual).

- <u>Dallas Area Rapid Transit</u>: “The responsibility for the operation and control of the properties belonging to DART is vested in the Board of Directors (the "Board"). *[45 2.10 I].* The Board may exercise responsibility by appointing and prescribing compensation for a chief executive officer whom the Board may designate as an executive director or a general manager and <u>who shall administer the daily operations of DART and employ persons, firms, partnerships, or corporations deemed necessary by the Board for the conduct of the affairs of DART.</u>*” Article III, Section 1. General Powers,* DART Board By-Laws.

- <u>New York Metropolitan Transit Authority</u>: “The Presidents of the <NY> MTA’s constituent Agencies, pursuant to the direction of the Chairman/Chief Executive Officer, are primarily responsible for the general management and operations of such constituent Agencies.” *Functions of Senior Management,* Governance Guidelines. “An Executive Director, appointed by

> the <PANYNJ> Board of Commissioners, is responsible for managing the operation of the Port Authority in a manner consistent with the agency's policies, as established by the Board."

The best practices of comparable agencies are the delegation of authority to the CEO/General Manager and the overall policy level decision making remains with the Board of Directors. In addition, to assist the Board in its governing responsibility, San Francisco Municipal Transportation Agency (SFMTA) has implemented a Board process that includes a Policy and Governance Committee that serves as a sounding panel for the Executive Director and senior management.

Metro rules are consistent with other agencies and best practices; however, they sometimes may not adhere to these rules whether out of honest concerns or other reasons.

(3) Recommendation

Recommendation 73. Although Metro's rule is consistent with best practices, closer adherence to the rule would enable staff to be accountable and the Board to stay focused at the policy making level. Management needs to ascertain what better information and communication needs to occur so that the Board has confidence in the handling of construction projects so they won't feel the need to be involved in day-to-day operations.

Recommendation 74. On the issue of Board approvals necessary to expedite project delivery, a number of comparable agency Boards meet twice per month to limit delays on critical project requests. Metro should assess if the full Board can meet more frequently than once per month such as by telephone for items identified as critical to project delivery. If this is not practical for Metro, consider delegation of limited authority to a Board committee on construction that might meet more frequently as needed to expedite approvals, or membership of 7 to that committee to enable it to equal a quorum of the full Board for emergency items. The Port of Long Beach had an experienced construction attorney provide two briefings to its Board Members on typical construction change order topics that helped them to identify true "red flags" different from typical sources of change orders. The POLB Board also met twice a month most months in recognition of the large volume of decisions that were needed to be made quickly.

Recommendation 75. The Board of Directors should consider if there is any further delegation of authority that could be legally given to the Chief Executive Officer.

Recommendation 76. Reassess the Board review and approval process for project changes to allow timely and efficient decision making. We understand that the Board reporting process continues to be streamlined by online software; however, continual efforts need to occur to consider methods for decreasing the approval process time.

Recommendation 77. The Board of Directors should recognize and support a need for process improvement. This commitment should be visible in the establishment of a team to assess current process requirements, other authorities and comparable agencies, identify potential process improvement areas and risks, and develop recommendations for improvements to speed up approvals and minimize staff resources.

b) Increased Board understanding of Metro processes is needed (Appendix A, Finding 4)

(1) Finding

Interviewees have indicated that based on their discussions and interactions with the Board of Directors and Board Deputies through meetings, specific requests for information and analysis, and project change requests, the Board and its deputies may need to be provided better information to improve their understanding of Metro processes related to capital construction project management and project delivery. Some of the specific processes that Metro staff suggested the Board needs to be provided additional information are:

- Capital project delivery process – the phases, elements, key roles, and responsibilities of project delivery
- Project delivery methods – design/build, design/bid/build, P3 and other types of delivery, advantages and disadvantages and risks
- Project delivery method selection process – the process and criteria utilized to select the best method of project delivery
- Utility relocation process – technical aspects, process and procedures for planning, designing and constructing utility facilities, advance relocation contracts, issues, problems, and risks
- Project Management principles – cost, schedule, and scope management and their interrelationship in project management

(2) Best Practice

Information and transparency is an essential element of successful project management, and needs to be considered for all capital project stakeholders such as the Project Manager, project team, department functional units, management, executives and most importantly, the Board of Directors. Increased Board Directors' and Deputies' understanding of the process, problems, issues and complexities of capital project management and project delivery can improve the speed and effectiveness of their decision making. Providing this information via training programs, regularly scheduled meetings, and reports can alleviate special supplemental and impromptu contacts.

(3) Recommendation

<u>Recommendation 78.</u> Metro should develop and implement a Board presentation series to enhance the Board's understanding of important projects. Improving the Board's understanding of key Metro capital construction projects, management processes, and best practices can improve the effectiveness of Board decision making related to project change requests, improve the Board's understanding of the processes, problems, issues, and risks that executives, Project Managers, and Project Team Members are encountering that may affect delivering a successful capital project, and enhance communication with the Board.

7. Utility Relocation Issues (Utility Relocation objective area)

a) Relocation delays can be reduced by better up-front planning (Appendix A, Findings 13, 47, 48, 49, 93, 94, 95, 100, 101 and 103).

(1) Finding

As discussed throughout this study report, there are many issues that face Metro in effectively delivering projects, programs, and the Capital Program, but one area of capital project delivery that has a significant impact (cost and schedule) on Metro's success is the utility relocation process. A Purdue University cost savings study in 2000 (prepared for FHWA) concluded that for every $1.00 spent on subsurface utility identification, $4.62 of avoided costs (scope changes, additional excavation, redesign delays, change orders, etc.) are realized.

The ability to effectively and efficiently identify, analyze and relocate public and private utilities (gas, electric, sewer, water, cable, etc.) within or ahead of capital construction for both transit and highway projects is one of the most critical elements to Capital Program deployment and individual project success.

Many of the recommendations identified within other sections of this study report, such as recommendations for scope definition, change management, project management, project teams, human resources and systems, will have an improving impact on the effectiveness of the utility relocation process. Nevertheless, the utility relocation process itself needs to be thoroughly assessed, analyzed and re-engineered, within each and every element of the process, in order to truly achieve improvements that can have substantial long term benefits to Metro's capital project delivery.

One of the objectives of this study is to ascertain whether procedures and processes are adequate for thorough detection of utility lines using latest technology, obtaining permits and approvals, and communication and transmission of information to third parties. Some Metro projects have been delayed by utility issues due to unknown, abandoned utilities and unforeseen conditions. During interviews and in response to the self- assessment survey, Metro staff indicated that:

- Reassessment of the utility relocation process, issues, problems, and strategies for improvement is needed.
- There are communication and coordination issues with utility companies.
- Metro and utility company staffing is inadequate for projects.
- Poor quality of third party as-built drawings is a major problem on Metro projects. The lack of existing information on utilities affecting a project substantially increases project risk, with significant cost increases and schedule delays possible (see Third Party Issues).

Metro's experience is not unique. "Utility issues are widely recognized as one of the top reasons for delays in project development and delivery. Two critical factors contributing to inefficiencies in the management of utility issues are (a) the lack of accurate, complete information about utility facilities that might be in conflict with the project and (b) the resolution and overall management of those conflicts."[1]

In recognition of these issues, Metro issues advanced utility relocation contracts and has established a Third Party Coordination (TPC) group that is dedicated full time to third party coordination. This group currently has ten people that serve the entire enterprise. This staffing is adequate to cover the three major rail projects currently underway, but the construction workload will grow dramatically because of the accelerated capital plan. To keep up, TPC has requested four additional staff to cover the Westside

[1] http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_R15Cpilotreport.pdf

Purple Line Extension, and would also like to reorganize TPC with more engineering staff. With the recently announced plans to accelerate the Purple and Crenshaw/LAX Lines, more TPC staff is needed.

Currently, the TPC gets engaged at the start of Preliminary Engineering after the initial planning effort is completed. This does not give them enough time to better influence the outcome. Because it takes years to relocate utilities, they need to be involved as soon as the route (alternative) has been selected. Once engaged they should have their consultant pull the as built drawings, develop a conceptual utility topographical plan, determine conflicts between utility lines and new construction, and coordinate requirements, in writing, with the utility company. The TPC should also notify the contractor as to which utilities are not being re-located and thus will still be in the way, issue work orders, and coordinate the scope of work with the utility companies. The utility companies should get any required permits.

Some of the various reasons for delays concerning utility relocation issues are discussed below:

- <u>Quality of Relocation Drawings</u>. One cause of delay is the quality of the consultant's work in preparing the relocation drawings. The quality of these drawings is often driven by the poor quality of as-built drawings. While the TPC is trying to improve the quality of its consultants work, there is little time to do the field work required. Metro should verify consultant resources to support its ambitious capital program, and if insufficient, should procure more qualified consultants or hire qualified staff in-house to do the required field work. Metro also needs to allow sufficient budget and time for field work to be performed.

- <u>Relocation Work Outside of Master Service Agreements</u>. Most utility relocations at Metro are done by utility companies or municipalities under Master Service Agreements with Metro. One cause of delay is that many relocations are outside the scope of the Master Agreements, which require a separate Memorandum of Understanding (MOU) with the utilities. It takes about 6 months to complete a new MOU. Knowing which utilities are in the way during planning would allow the TPC time to get a supplemental MOU with the utilities earlier.

- <u>Utility Companies and City Understaffed</u>. Another cause of delay is that both the utility companies and the municipalities are understaffed to support all the work throughout the City and County of Los Angeles. The TPC recently developed a schedule showing all the upcoming Metro work and used it to point out to the City that they cannot keep up based on their current resources. Metro offered to give the City Metro-paid consultants working under City direction, but this offer was declined. The City has already started prioritizing which submittals they can do, and this is only going to get worse, as Westside and Regional Connector construction projects are just getting started. Additional options need to be explored and further negotiations need to take place to improve the anticipated workload delays for the City of Los Angeles.

- <u>Insufficient Time Planned for Utility Relocation</u>. During interviews, it was indicated that Metro does not build in enough time for the third party firms to do the utility relocation, considering the reality of their resource constraints. According to Metro staff, the schedule and cost estimate is always unrealistically too low (see Third Party Issues). More realistic timeframes need to be included and more contingency for utility relocations may need to be allotted in budgets in addition to efforts to reduce time and costs.

- Design-Build Delivery Method. Utility relocations become more difficult, and delays can result, when work is done under the design-build (D-B) delivery method. The fast track nature of D-B may not provide enough time to move the utilities in advance. Trying to shift the relocations to the design-builder creates its own set of problems. The utilities and municipalities want a full set of design drawings to work from. Also, the design-build contractors may not be meticulous in identification of existing utilities at the start of a contract. For example:
    - On the LAX/Crenshaw project, the contract required the design-build contractor to identify all utilities requiring relocation within the first 240 days of the contract so they can design around utilities where possible. The contractor has completed the design without complying with this contract provision, which increases the risk of delays and cost overruns due to utility conflicts during construction. Another important factor is that many of the contractors are from outside the Los Angeles area and do not have the relationships with Metro, the City and the utility companies needed to get things done in a timely manner. Strong relationships to accomplish good partnering are a significant factor that cannot easily be quantified or created in a short period. Much of the relationship must be prodded by the TCP group.
    - On the I-405 project Metro's approach was to place the relocation responsibility fully on the D-B contractor. According to Metro staff this was a problem, "creating the wrong impression and causing delays." Sometimes, political pressure to start before the project is ready in a technical, advanced research, or relationship way can occur.
    - On the Purple Line, the TPC started early with enough funding for early utility investigations.
    - On the Regional Connector, the TPC wants the D-B contractor to assume the responsibility for more advance utility relocation (AUR) work because it makes sense there. The bottom line seems to be that there is really no one best approach. Each project must frame its own approach to AUR based on a wide variety of factors, regardless of whether it is a design-build project. Whichever approach is selected, a strategic plan needs to be developed for accomplishing the utilities related objectives.

- Other Delay Issues. Other utility delay issues have occurred, such as the contractor discovering 50 feet underground storage tanks spilling contamination, delayed work for 6 months. On the Regional connector, Metro brought in the Advance Utility Contractor early, but there were still delays because the main subcontractor for the AUR went bankrupt. The AUR contractor also failed to coordinate with third parties and find solutions, instead relying on Metro to solve the issues.

Finally, there is cost risk. Interviews indicated that most of Metro's advance utility relocation projects are Metro funded. The FTA will generally pay the cost of utility relocations as part of the project cost, subject to their rules and procedures. Metro should seek federal funding for AUR projects.

(2) Best Practice

Advance utility relocation contracts are a best practice that has been utilized for decades. A member of our project study was the claims analyst on advance utility contracts in the late nineties on the $14.5 billion Central Artery Tunnel project in Boston (the “Big Dig”). Clearing utilities with a smaller contractor before bringing in the larger contractor with more expensive equipment and larger crews to do the main line work reduced the cost of construction delays, but it does not eliminate them. There will always be unknowns under the ground, especially in a large urban area.

Metro appears to rely on potholing and ground penetrating radar to locate utilities, buried pipes, tanks, manholes, cables, and other buried objects. Manholes, pull boxes, and other structures provide clues. Pot-holing helps also, but the entire alignment cannot be dug up just to prepare relocation drawings years in advance of construction. Electromagnetic utility locating, ground penetrating radar, and acoustic utility location are techniques that avoid mass excavation, but they each have their limitations. Soil type, soil density, environment accessibility and, crowding of surrounding utilities all influence the accuracy of these methods.

(3) Recommendation

<u>Recommendation 79.</u> Continue to expand the best practices of having a dedicated third party coordination group and use of advance utility relocation (AUR) contracts, master service agreements with utilities and other third parties, and advance identification.

<u>Recommendation 80.</u> The size of the TPC unit should be increased to keep up with increased construction workload. The master service agreements should be revisited and expanded to minimize the need for ad hoc MOUs (Recommendation 40). Metro should establish quarterly utility coordination meetings at a programmatic level to discuss issues related to capital project delivery (technical needs, resources, staffing, etc.) (Recommendation 39). This will help to identify problems and constraints and find solutions.

<u>Recommendation 81.</u> Metro should increase its investment in utility identification by doing more exploratory work during early phases of project delivery (planning, preliminary engineering).

<u>Recommendation 82.</u> Metro should communicate utility relocation risks to contractors and pass the risks on to the contractors, or accept the risk and allocate more contingency.

<u>Recommendation 83.</u> Metro should continue to utilize AUR contracts and Work Orders to get as much utility identification work completed as possible before the construction contract.

<u>Recommendation 84.</u> Metro should continue to enforce the contract requirement to complete utility engineering within 120-240 days and assign penalties for non-compliance. Contractors need to have

ability to conduct investigations (e.g. pot-holing every 30 feet). Metro should get all required permits in advance, if possible.

Recommendation 85. Metro needs to allow more time and cost contingency for both identification and relocation of utilities and other obstructions.

Recommendation 86. Metro should apply for FTA funding to help defray the cost of advance utility relocation.

Recommendation 87. Metro should create an initiative to "Re-engineer the utility relocation process." This effort could be led by the Office of Extraordinary Innovation or the Strategic PMO (Recommendation 50) with the Third Party Coordination Unit and include Metro's most experienced personnel from Engineering and Construction, Project Controls, and other departments as necessary. This initiative should be an organizational commitment at the highest levels to develop innovative strategies, from a global perspective, to incorporate the latest technological advancements (Recommendation 88), streamline the utility relocation process (Recommendation 89), and brainstorm, develop and implement effective legislative and legal strategies (Recommendation 90) and improvements to further enhance and accelerate the utility relocation process for effective capital project delivery. All improvements developed should be integrated and implemented through this initiative.

Recommendation 88. Under the Re-engineering Initiative discussed in Recommendation 87, establish a Utility Relocation Technology Assessment Team to globally search, partner with other organizations, authorities, agencies, and research the industry and academia to assess, analyze and develop better imaging technology and techniques for subsurface utility identification. Contractor, Metro, third party, and utility company methods and technologies should be investigated and evaluated.

The Technology Assessment Team should consider where specific technologies are most applicable to Metro projects (transit and highway), under what conditions, and incorporate those technologies into standard practice through development and implementation of policies, processes, procedures, training, communications, quality management, and enforcement as integrated by the Re-engineering Initiative.

Considerations should include:

a. Increased and deeper pothole testing utilizing the coring and reinstatement process, where applicable. All methods should be assessed, such as keyhole technology, water (hydro) and air vacuum excavation specifically customized for Metro projects.
b. Multi-Channel Ground Penetrating Radar (MCGPR)
c. Both active and passive systems of utility identification (active systems allow access to the utility at some point).
d. Induction utility locators (electromagnetic (EM) signaling)
e. Nuclear Magnetic Resonance (NMR) imaging
f. Infrared (IR) imaging
g. Geographical Information System (GIS)
h. Remote Sensing

i. Acoustic location methods
j. Non-destructive Air-Vacuum excavation
k. Radio Frequency (RF) methods
l. Digital 3D-BIM imaging and modeling technologies
m. Time Domain Electromagnetic Induction (TDEMI)
n. Exploratory test pit excavations
o. Electronic metal detectors
p. Magnetometry
q. Closed-circuit television (integrated with RF technology)
r. Active Millimeter Wave Scanning
s. Robotics technology (integrated with 3D methods) and camera drones with GPS. Robotics is an upcoming FHWA research project.
t. Laser rangefinders

The FTA and FHWA processes should be followed, using American Society of Civil Engineers (ASCE) standards (2003) for classifying the quality of utility data (quality levels A through D). On call, expert, subsurface utility engineering (SUE) contractors should also be considered. This assessment should also consider the latest SUE technologies and techniques from Transportation Research Board (TRB), FTA, FHWA and American Association of State Highway Transportation Officials. The TRB research program from the Second Strategic Highway Research Program (SHRP2), entitled, "Utility Investigation Technologies" (R01B) should be assessed, which provides implementation assistance to agencies in order to develop and implement SUE technologies.

SUE is most successful as a combination of a variety of geophysical technologies and techniques that obtain a complete and accurate assessment of underground utilities. Careful consideration must be given to soil type, terrain, and geophysical attributes to determine which technologies of a multi-sensor system are most effective.

<u>Recommendation 89.</u> Under the Re-engineering Initiative (Recommendation 87), establish a Utility Relocation Process Improvement Team. This team needs executive and organizational commitment and support to succeed in the development of innovative strategies, incorporating the latest technological advances (Recommendation 88), developing and implementing streamlined policies, processes and procedures, and incorporating creativity into the utility relocation process.

This team will look at every aspect of the process to identify risks and impacts in order to accelerate project delivery, reduce costs, enhance communication and coordination and improve resource management, education, training and quality throughout the entire project lifecycle.

The team should assess and analyze the utility relocation process considering various types of projects (transit and highway), in both scope and complexity, looking at regional locations and various stakeholders. The team should assess other agencies, authorities and utility companies, capturing valuable lessons learned and best practices. The utility relocation analysis should cover all ten (10) PMI PMBOK project management knowledge areas (scope, cost, time, quality, risk, communications, human resources, procurement, integration, and stakeholder management).

Some of the ideas and suggestions that the process improvement team should consider in their analysis and development of improvements are:

a. At what point in the project delivery process should the utility identification and relocation process begin (planning, preliminary engineering, etc.)? The study team recommends the initiation of the utility relocation process as early as possible in project development, since significant time is needed to complete this process (Recommendation 3). Consider utility relocation initiation when a preferred alternative has been selected in the planning phase.
b. Increase utility relocation time in project and master schedules. Larger time contingencies are needed (Recommendation 85).
c. Fully utilize PMIS for utility relocation contracts (scheduling, cost, change control, issues management, etc.). Refer to the System Issues recommendations.
d. Improve utility relocation cost estimating. Assess past projects and all third party agreements.
e. Reassess the quality management of utility relocations plans, drawings, specifications, quality standards, schedules, estimates, and reporting.
f. Develop and implement a risk management process into the utility relocation process as part of a further development of Recommendation 9.
g. Increase communications with all entities engaged in utility relocation to improve relationships, communications, reduce costs, and increase efficiency and effectiveness. Initiate utility communication and coordination at the earliest point in the project delivery lifecycle.
h. Improve community outreach within the utility relocation process. Construction Relations involvement should be initiated earlier in project delivery (planning or preliminary engineering). The design-build process does not allow sufficient time for community involvement. Also, interviewees noted that a disconnection exists between contractors and the community. Evaluate the need for more full time dedicated positions for community outreach.
i. Assess and develop contractor/owner/utility company partnerships.
j. Develop and implement a utility relocation summit event of all stakeholders and contractors, government agencies and consultants to discuss utility relocation successes, issues and problems, and create action plans for improvement. Regular follow up meetings may be required as an outgrowth of the summit.
k. Incorporate City of Los Angeles engineer(s) as part of the Metro team, assigned full time exclusively to Metro, working at Metro offices and/or field locations. Investigate Metro full or partial reimbursement of costs.
l. Improve design-build contractor, AUR contractor and utility company capabilities in utility relocation.
m. Assess and develop strategies for utility company resource issues.
n. Improve Metro personnel expertise in utility relocation. Consider dedication of a Utility Manager on large, complex projects (transit and highway) and include the responsibility within the project IPMO structure and project PMP. Enhance utility relocation training, education for Board directors, executives, management, and staff.
o. Hire utility subcontractors directly and proceed with utility work by Metro if utility companies are unable to meet the established schedule as stipulated in an MOU.
p. Create a utility relocation lessons learned knowledge database as a further development of Recommendation 51. Develop a best practices inventory and establish Key Performance Indicators (KPI) for utility relocation performance measurement.
q. Evaluate the use of best value bidding on AUR contracts. Make experience and sufficient available resources a key factor.

r. Assess and develop strategies for improving integration of AUR contracts with the subsequent construction contract.
s. Consider utility company integration meetings, bring several utilities together to integrate relocation schemes.
t. Develop, implement and enforce the requirement for PMP's on AUR contracts to more effectively manage these projects.
u. Consider Stage Gates specifically for the utility relocation process as a further development of Recommendation 2.
v. Include utility companies, the City of Los Angeles, other impacted cities, and AUR contractors in design-build partnering, as appropriate.

Recommendation 90. Under the Re-engineering Initiative (Recommendation 87), establish a Legislative/Legal Improvement Team to assess and evaluate existing legislation and legal requirements for the utility relocation process. The team should consider other authorities, agencies, and organizations. Brainstorm and develop strategies and action plans for improvement. Submit all recommendations with detailed plans to the Re-engineering Initiative Group for integration into the overall utility relocation improvements.

The Legislative/Legal team should consider and evaluate the following ideas and suggestions when developing recommendations for improvement:

a. Legislation to implement Metro's hiring of utility subcontractors as discussed in Recommendation 89, part O. This will authorize Metro to relocate utilities if a utility company is unable to meet project schedules.
b. Legislation for mandatory utility relocation plan and drawing standards and development, updating and revision requirements. Consider digital, online utility drawings with password access. This access can be given to other government agencies. Some cities, such as Chicago, have mapped the entire city using GIS driven drones and have a utilities group responsible for managing this process. One such group, the Chicago Office of Underground Coordination (OUC) is responsible for all requests regarding utility information and the review and approval of construction work in or adjacent to the public right of way.
   The OUC is also responsible for projects with deep excavations and penetrations, such as foundations (piles, caisson, etc.), earth retention systems or major pipe installations. The OUC works with permit officials to monitor and coordinate construction projects by public utilities in order to minimize disruption and maximize infrastructure benefits for Chicago taxpayers.

   Metro should consider partnering with the City and County of Los Angeles on the development and implementation of a large BIM base mapping system of utilities that can be made available to project teams. All capital projects would be required to use this mapping system for utility relocation design. In this situation, the city could become the owner and administrator of this one and only utility base mapping system, and all parties impacting the city infrastructure must utilize the system for design and as-built plans. The above scenario could be expanded to include all of Los Angeles County. Metro would be closely integrated into this process. Centralization responsibilities would include assistance in scheduling work to maximize efficiency and minimize cost.

c. Legislation to require utility company responsibility for all or partial utility relocation costs or delays to design and/or construct utilities that are impacted by Metro capital projects.
d. Legislation to require utility company responsibility for the identification of all utilities and updating drawings, and responsibility for all costs associated with improperly located utilities.
e. Evaluate increasing the liability for utility relocation errors and omissions for those entities that perform utility relocation services.
f. Analyze the potential for assigning more accurate schedule impact consequences for utility relocation errors. Higher liquidated damages can be established based on actual cost information from projects with utility delays. Metro should collect statistical data and information to critically analyze what is the real impact of utility relocation to capital projects.

D. Support Process Issues

Support Issues include areas needed to effectively develop and manage the staff (i.e. human resources), monitor and control project performance (project information systems), and produce quality project deliverables (i.e. policies and procedures). In this section these issues are discussed in 3 separate topics below.

1. Policy and Procedures Issues (Policies and Procedures objective area)

Policy and Procedure issues are those issues which include the development, maintenance, or enforcement of Standards, Policies, Procedures or other instructions that should be utilized by the project team in order to deliver quality project deliverables and achieve the overall expected results of the project.

a) Policies and Procedures for the Departments included in this study are not sufficiently detailed to support Metro's Capital Program (Appendix A, Findings 2, 3, 7, 8, 36, 40, 55, 57, 67, 75, 82 and 91).

(1) Finding

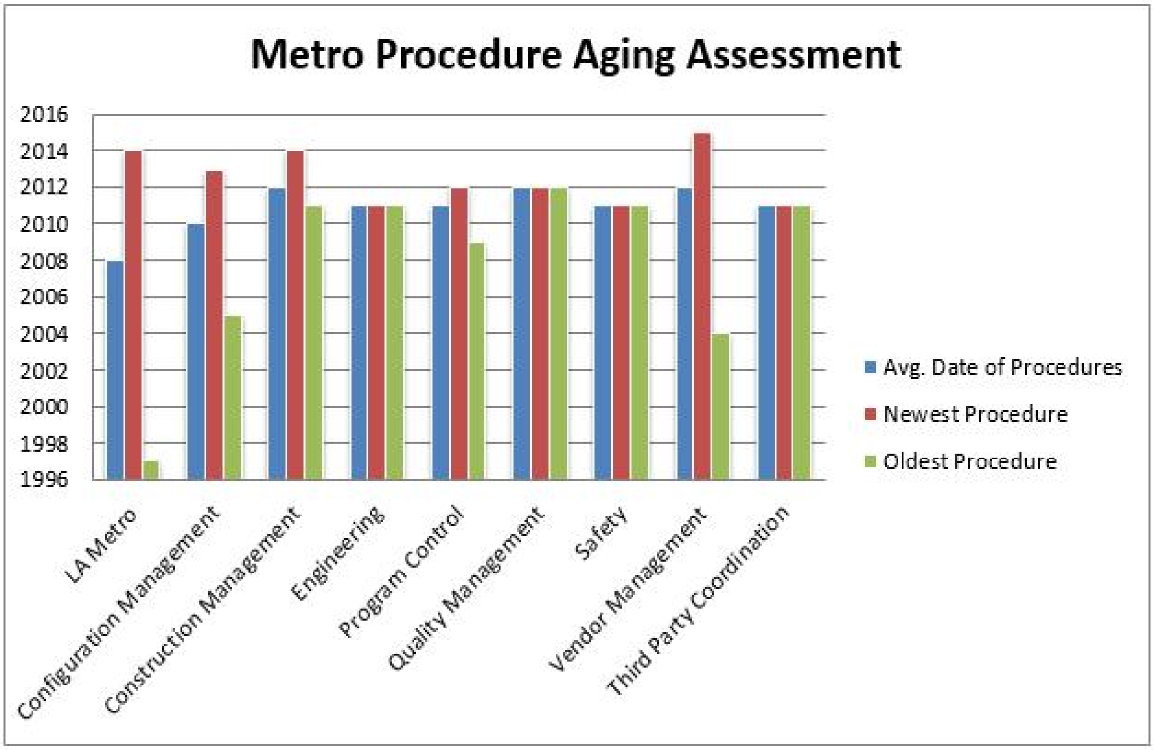
Documentation review and almost all interviews have indicated that Metro policies and procedures for managing capital projects require improvement. The specific type of improvements can be grouped into four (4) main categories:

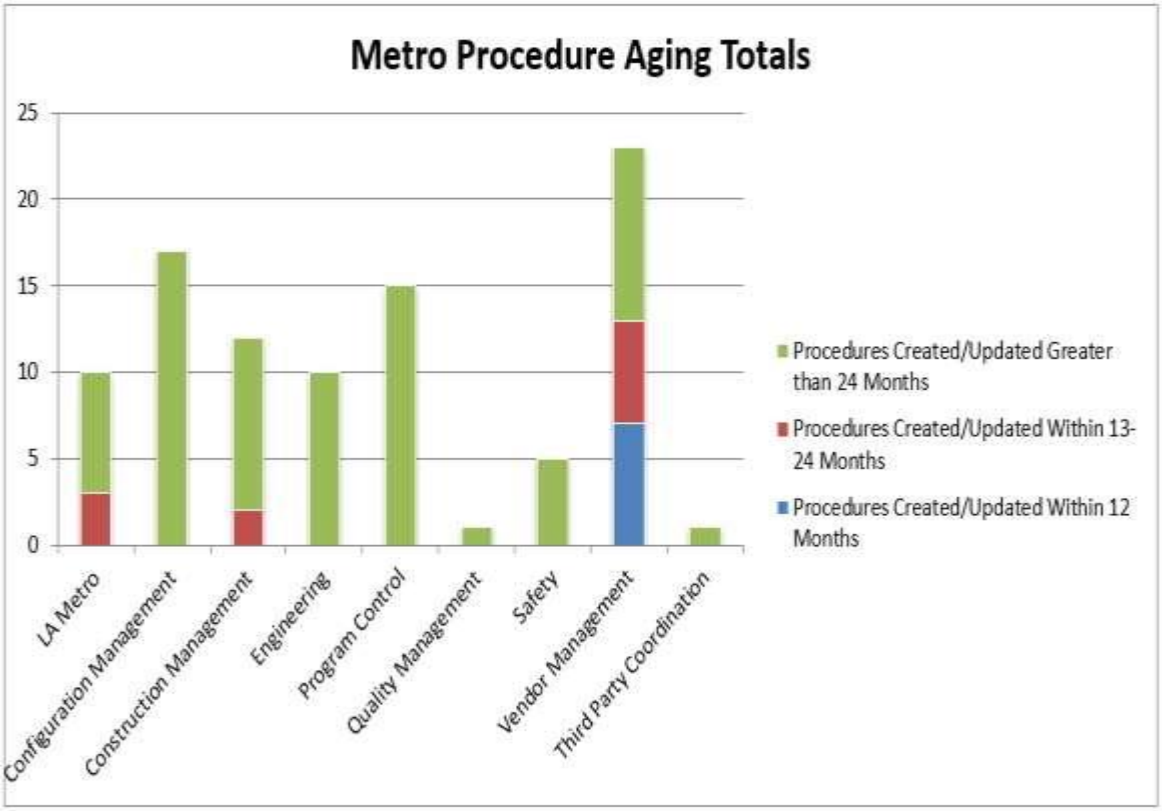
1. Departments which have no (or were unable to provide to us) documented policies and procedures:
    - High level organizational roles and responsibilities
    - Countywide Planning & Development
    - Program Management (Cost Estimating, has only a policy, but no procedures)
    - Engineering & Construction (Highway Programs)

    In some cases the lack of policies and procedures is due to staff availability: higher priority work has deferred development of this needed documentation.

2. Departments which have outdated policies and procedures:
    - Vendor/Contract Management
    - Engineering & Construction – including design criteria, performance requirements, general conditions, standards, standard drawings and specifications
    - Program Management
    - Communications

Most Policies and Procedures have not been updated for several years or longer (see Figures 15-16 below).





Figures 15 & 16: Procedure Aging Comparison

3. Procedures for which detailed instructions should be developed. For example, the PMO procedures (PRCL001-PRCL012) do not identify the systems and tools that should be used. For cost management, the PMIS should be identified, followed up with detailed end user instructions. What currently exists seems disconnected: procedures are disconnected from the PMIS user documentation, implying that the PMIS is not a required business system to be used for Capital Delivery.

   Engineering & Construction procedures are needed that define the procedures and differences between Design/Build and Design/Bid/Build methods of project delivery. In addition, detailed procedures are needed for project controls, project management, capital project delivery, and the construction resident engineer manual.

   Also, Operations, including Maintenance, is a key project team member and stakeholder in the development of a capital project. How operational elements are identified, evaluated and implemented into a project will have a significant impact on the Life Cycle costs and overall management of the asset. Operations is an affected stakeholder in project delivery, as they are the 'face' that the public sees when the asset is put into service. Currently, Operations involvement at project initiation in the Planning phase and continuation throughout project development is an excellent process to ensure that operational issues and concerns are addressed.

However, documentation review and interviews has indicated that the role and importance of addressing operational elements of a project are not formally described in planning, design and construction policies and procedures. The importance of addressing operations within a capital project must be a shared goal of the organization. Providing capital projects to constituents as quickly as possible may be implementing operational objectives. In addition, it is critical to enforce operational requirements with contractors.

4. Policies and Procedures need to be enforced to ensure compliance and need to include stronger enforcement language. Many of the policies lack Quality Compliance which would stipulate the means and methods of enforcement. Examples of non-compliance to policy and procedure as determined from our interviews is the limited use of risk management procedures on all capital projects and allowing some contractors to continue working without an approved construction schedule.

In all cases, without robust (i.e. scalable) and universally understood Policies and Procedures and effective compliance requirements, both staff and contractors are resorting to patchwork compliance, and inconsistent approaches and techniques. Reporting becomes time consuming. (For example, there is a policy for utilizing a standard WBS, but it is not enforced resulting in the inability to develop standard monthly status reports for the entire capital program. Rather PMO staff spend excessive hours on a monthly basis piecing information into a consolidated view of the program. This will be very critical in the near term as the size of the CP grows (both staff and vendors will be affected).

(2) Best Practice

PMI's PMBOK defines policies and procedures as organizational assets used by the organization to perform project work. Detailed and up to date policies and procedures are essential for an organization to be able to consistently initiate, plan, execute, monitor/control and close out capital projects. These policies and procedures need to:

- Define the most recent practices at Metro
- Incorporate best practices and lessons learned
- Provide a consistent approach in capital project delivery and project management
- Reflect the most recent organizational changes in roles and responsibilities
- Describe the differences in the methods of project delivery and the types of projects being delivered based on scope, complexity (transit, regional rail, capital improvement, highway, etc.)
- Include sufficient direction and detail to enable staff to effectively manage and deliver capital projects, describing the specific roles and responsibilities of the project manager, team members and project stakeholders

(3) Recommendation

Recommendation 91. Metro needs to begin an initiative to develop, update and detail policies and procedures organization wide, especially for capital project delivery and project management. Institute Quality Assurance into all Policies and Procedures. Institute a quarterly project review that includes measurement of compliance to Policies and Procedures. Utilize a Lessons Learned program to make the results of these reviews available to the wider capital program. Institute an annual review of Policies and Procedures to encourage continual process improvement. Ensure that policies and procedures are updated. The policies and procedures reviewed in this study for example have not been reviewed and updated in over 2 years, and the documented changes in the last two (2) years were only due to the renaming and reorganizing of department such as the movement of the PMO from Engineering and Construction, to its own Division.

Recommendation 92. Establish project metrics for compliance to Policies and Procedures.

Recommendation 93. Ensure that all policies and procedures are maintained in a Knowledge Management system that is accessible to all staff and affected vendors, suppliers, and consultants.

Recommendation 94. All individual departments should own their respective policies and procedures, but the strategic PMO ensures the consistency, compliance and integration of policies and procedures related to project management and capital project delivery.

Recommendation 95. A capital project delivery website should be developed that is owned by the PMO for establishing effective communication on capital project delivery.

Recommendation 96. Improve the end user documentation for the PMIS.

2. Human Resource Issues (Staffing and Oversight objective area)

Human Resources issues are those that are related to the acquisition, development and succession planning (commonly referred to as talent management) of Metro staff. These issues can affect all phases of capital project delivery from Planning through Construction/Testing and Operations/Maintenance and can have an impact on capital project management and project delivery. Through our study interviews, survey, and project workshops, we identified that these issues were commonly present across the key departments of this study, but may in fact be present across the organization as a whole. Due to the interrelationship of these issues they are discussed below.

a) Talent Management concerns (Appendix A, Findings 5, 20, 58, 59, 64, 68, 70, 74, 92 and 111)

(1) Finding

Most interviewees and survey feedback indicates that Metro is lacking formalized succession planning processes. This more than likely applies to all departments but is most significantly observed in the main departments included in this study.

In addition, Metro has no mechanism for performance/merit increases or step pay system. Staff compensation is frozen for an employee as long as the employee remains in the same position, except for cost of living increases, which have been limited and small in the last 8 years. This has resulted in the creation of supervisory positions with little or no management responsibilities as a means by which departments have attempted to provide salary increases to keep critical staff. Another observation is that staff have transferred into other departments for higher pay, even though they were not provided formal training to assume the duties of the new position.

Staff acquisition requests have likewise been frozen for an extended period of time, even when compelling, legitimate data supporting the staff increase was prepared and communicated. This resulted in a proliferation of professional service contracts for staff augmentation. Often the contract is not held by the appropriate functional department creating a convenient excuse to not comply with authority policies, procedures and tools. A case in point are project managers contracting for their own project controls staff, and this staff not complying with PMO policies and procedures, for example, the utilization of the PMIS. Interviews with OMB staff indicated that staffing requests are incomplete, lacking sufficient justification and information needed to approve the request. (See Systems and Tools Issues.)

The HR departmental data for the departments included in this study suggests that the problem has the potential to become significantly worse in the next few years. Below is data provided from HR information request in May 2015:

Figure 17: Metro Staffing Data

	FY14 Headcount	Eligible to Retire FY14	FY14 % Eligible to Retire	FY15 Headcount	Eligible to Retire FY15	FY15 % Eligible to Retire	Average Age FY14	Average Age FY15	Change in Average Age (FY14 to FY15)	Average Years of Service FY14	Average Years of Service FY15
CPD	175	58	33%	143	61	43%	43.6	46.1	2.5	9	10
E&C	159	50	31%	152	51	34%	48.3	51.7	3.4	8	7
PMO	40	17	43%	38	17	45%	48.9	50.6	1.7	10	11
VCM	126	64	51%	113	60	53%	51.0	53.3	2.4	14	15
Total	500	189	38%	446	189	42%	46.0	48.7	2.7	9	10

Changes greater than 1 suggest that staff is transferring into this Department. This is consistent with interviews and survey feedback-i.e., the lack of Salary Merit increases over the past years has resulted in staff moving into positions of higher salary. This also suggests that departmental training would be required. Feedback from surveys and interviews indicates that Departmental training is not being provided. Overall Conclusion: proficiency in key departments is being eroded.

These departments are at risk for losing valuable institutional knowledge. This observation was further bolstered by survey feedback and scores that generally indicated that there are no formal lessons learned processes. Without lessons learned (e.g. historical databases), significant knowledge transfer is not occurring. Note that this risk seems to have worsened from FY14 to FY15.

This represents a total loss of staff in these key departments of 54 personnel in one year. Given that the Capital Programs are increasing in size, complexity, and value over the next years, should this pattern continue it will place additional stress on the remaining staff, and/or result in more consultants/professional services, which is inconsistent with management direction (e.g., E&C is not renewing consultant contracts), and general 'work life' balance.

	Metro	Denver RTD	PANYNJ	BART	POLB	DART	SFIA	NYMTA	London Underground
CIP (in Dollars)	42 B	6 B	27 B	9.6 B	5 B	7 B	4.8 B	11.6 B	22 B
Capital Program Years	20 Years	14 Years	10 Years	9 Years	20 Years	20 Years	10 Years	4 Years	9 Years
Staff	446	100		514		83	150	1345	2155
Consultants	446	70		200		35	165	246	940
Prof Service Contract Value		500 M		323 M	421 M	168 M	340 M	560 M	4.4 B
Ratio Staff to Consultant (%)	50/50	60/40		70/30		68/32	48/52	85/15	70/30

Data Not Provided

Figure 18: Comparable Agency Staffing Comparison

Another talent management concern identified through interviews and discussions with staff is the staff to consultant ratio (indicated to be at a 50/50 ratio). As noted above, the management direction appears to be moving towards more Metro FTE's and a reduced consultant workforce. Board Report 2015-0955 (July 2015) states that the current mix of staff to consultants is 50/50. A proposed pilot project, utilizing the 4 Metro Mega projects and the Environmental Compliance Program, is suggesting a proposed mix of 70% Metro staff to 30% consultant. Converting 32 consultant positions to Metro staff saves $22 Million over 7 years, which will be converted into project contingency. This also promotes better succession planning and more committed, loyal staff. The study team feels this is an outstanding program recommendation. This pilot project approach for a 70/30 ratio goal is consistent with a comparison to comparable agencies (see Figure #18 above).

The overall Metro headcount compared to other agencies, considering their capital program size and years, seem low. This organizational level could be effective, however, there are other significant issues that Metro must address in order to make these staffing levels work, such as those issues identified in the Executive Summary and discussed in the Findings and Recommendations chapter of this report, such as resolving change management issues, capturing project lessons learned and resolving Board oversight concerns.

Another talent management concern is that there does not appear to be formal training curriculum in several key project delivery functions: Program and Project Management, Project Controls, and Quality Management. It should be noted however that a PM Academy was recently developed and delivered. This is an excellent first step towards the development of a project management curriculum, although staff discussions have indicated the content is at a very high level and of limited value. New hires and department transfers do not receive formal training. Anecdotally, one Department allows staff to attend professional conferences as a means for professional development and networking. Another department utilizes a 'mentoring' approach where the new hire is assigned to an existing staff member for a period of 1 to 3 years in which they learn the skills they are to perform.

(2) Best Practice

The following are organizational best practices:

- The organization has the mechanisms, systems, and processes in place that provide the organization with professional project managers and competent, committed project team members.
- The organization has a skills database which includes skills of individual staff members and this database is used to determine training requirements, and to select qualified individuals for staffing the projects.
- Project and Program Management is considered a key or critical skill within the Organization (e.g. LACMTA).
- Formal personnel development program has been developed and is maintained by a central organization.
- Personnel performance evaluation includes documented and measurable project delivery contributions.
- The organization funds the direct and indirect costs of training. Data is collected to determine training effectiveness, i.e., training activities are periodically reviewed.
- A documented process is in place for recognizing outstanding commitments or performance on a project. The Organization has established a linkage between performance and reward, i.e., the employee's contribution to project objectives and organizational strategic goals is assessed.
- Project Management is an established career path. Project Management Competency models are used.
- The Organization practices succession planning – BART and London Underground have established formal succession planning, which includes a Workforce Plan, a Resource Plan and incorporating succession planning requirements into individual performance evaluations.

(3) Recommendation

<u>Recommendation 97.</u> Staff augmentation contracts should be managed by the functional department to ensure compliance to relative policies and procedures. In the example described above, where the PMO is unable to adequately support project managers, the PMO should secure and manage the professional services contracts that augment the PMO staff.

<u>Recommendation 98.</u> Expand the participation of the PM Academy. Interviews and survey feedback indicated that project management training is needed to departments outside of the Engineering division. It is understood that an initiative is currently underway.

<u>Recommendation 99.</u> Further develop the PM Curriculum, PMI PMBOK (version 5) Identifies 11 Key Interpersonal skills that project managers must be able to effectively utilize in order to accomplish the project. These skills are in addition to their technical and conceptual skills, all of which are used in balanced measure. These key interpersonal skills must be developed, measured and supported. They include the following:

- Leadership
- Team building
- Motivation
- Communication
- Influencing

- Decision making
- Political and cultural awareness
- Negotiation
- Trust building
- Conflict Management
- Coaching

Recommendation 100. Develop formal curriculum for all levels of staff within the key departments included in this study.

Recommendation 101. Establish training programs and tie to HR development goals.

Recommendation 102. Develop and implement a detailed staffing analysis process with requirements (including staffing transition plan) for all departments. Use this as the basis for formal staff request to the OMB during annual budget process.

Recommendation 103. Develop a strategic plan for the use of consultants with the key departments included in this study.

Recommendation 104. Assess the qualitative risk of Quality Management organization, specifically to determine if it should continue to reside with the Engineering Division, or if a sufficient level of checks and balances to ensure autonomy could be instituted to create the necessary separation of duties and management influences.

Recommendation 105. Consider development of a step pay system that allows staff to move up in their salary range based on a combination of years in service, attendance and merit.

3. System issues (Communications objective area)

Robust information systems are the core of effective project communication, and are essential for timely decision making across all phases of program and project delivery.

a) Project Management Information System (PMIS) issues (Appendix A, Findings 19, 23, 33, 41, 42, 43, 44, 45, 54 and 57)

(1) Finding

Interviews, project workshops and survey feedback has indicated that PMIS is not being effectively utilized, controlled and enforced as the primary project management information system at Metro. Some of the concerns identified:

- Executive level reporting is inefficient
- PMIS is underutilized
- PMIS does not have organizational commitment or enforcement
- A standard WBS for scheduling is not being consistently utilized

As part of initial data gathering and documentation review, a technical review of PMIS was performed. This review identified the PMIS as a best practice. However, from subsequent review of monthly project reports, survey responses, comments and staff interviews, it was determined that very few projects are utilizing this system, key participants in project delivery are unaware of its existence, and there is no management mandate requiring its use: there are 5 projects and 10 associated contracts listed in the PMIS system:

Project Title	Current Project Phase	Contract #	Contract Name
Crenshaw Transit Corridor	Construction	C0943	Crenshaw Alignment D/B
		C0990	Crenshaw AUR
Orange Line Extension	Closeout	C0943	Orange Line Extension
Westside Section 1	Final Design	C1045	Westside Subway Section 1
Westside Section 2	Preliminary Engineering	C1034	Westside Exploratory Shaft
		C1048	WSE AUR La Brea Station
		C1055	WSE AUR Fairfax Station
		C1056	WSE AUR La Cienega Station
Regional Connector	Final Design	C0980	Regional Connector Alignment D/B
		C0981R	Regional Connector AUR

Figure 19: Contracts in PMIS

It was also observed that legacy systems are still in use, with no management plan in place to retire them. For example, many participants referred to the CCS (Change Control System) as the Contract Management system, yet Primavera Contract Management (CM14) has been deployed as a PMIS subcomponent and replacement to CCS, as depicted below:

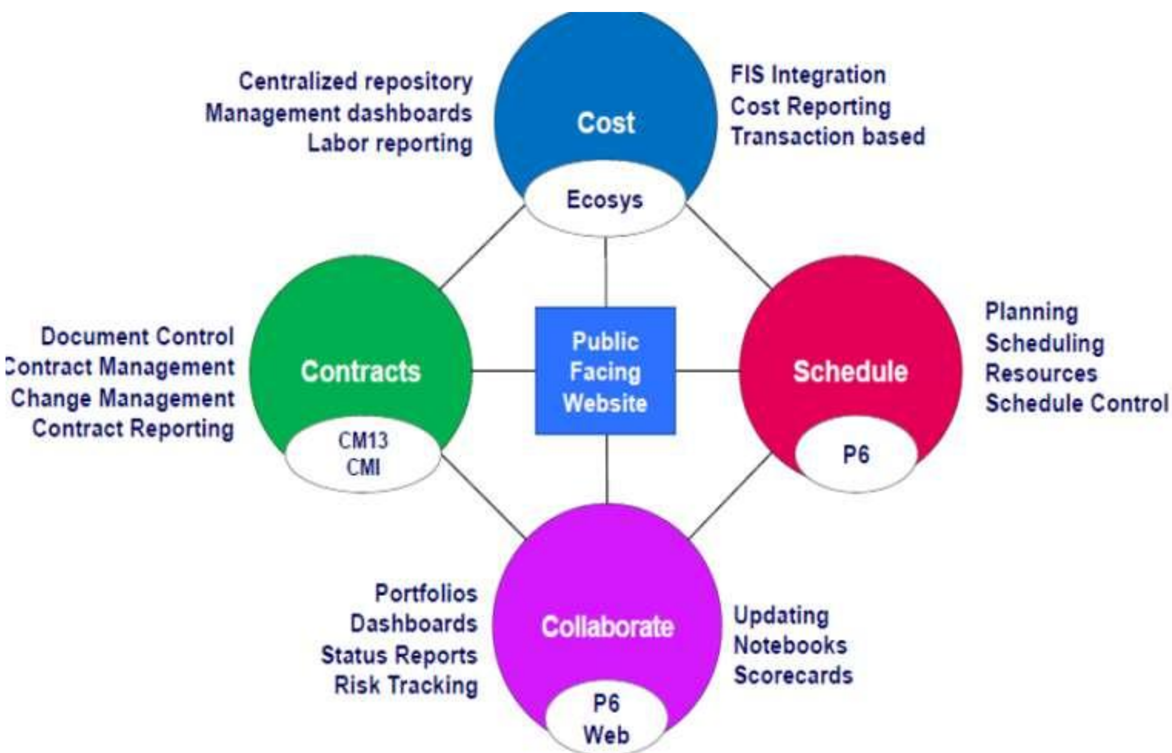


Figure 20: System Configuration

In order to correctly utilize the PMIS for Status Reporting for various levels of management need, common WBS structures should be used. Currently, this is not in place. The procedure (PRCL01) lacks description for the various levels within the WBS model:

Metro

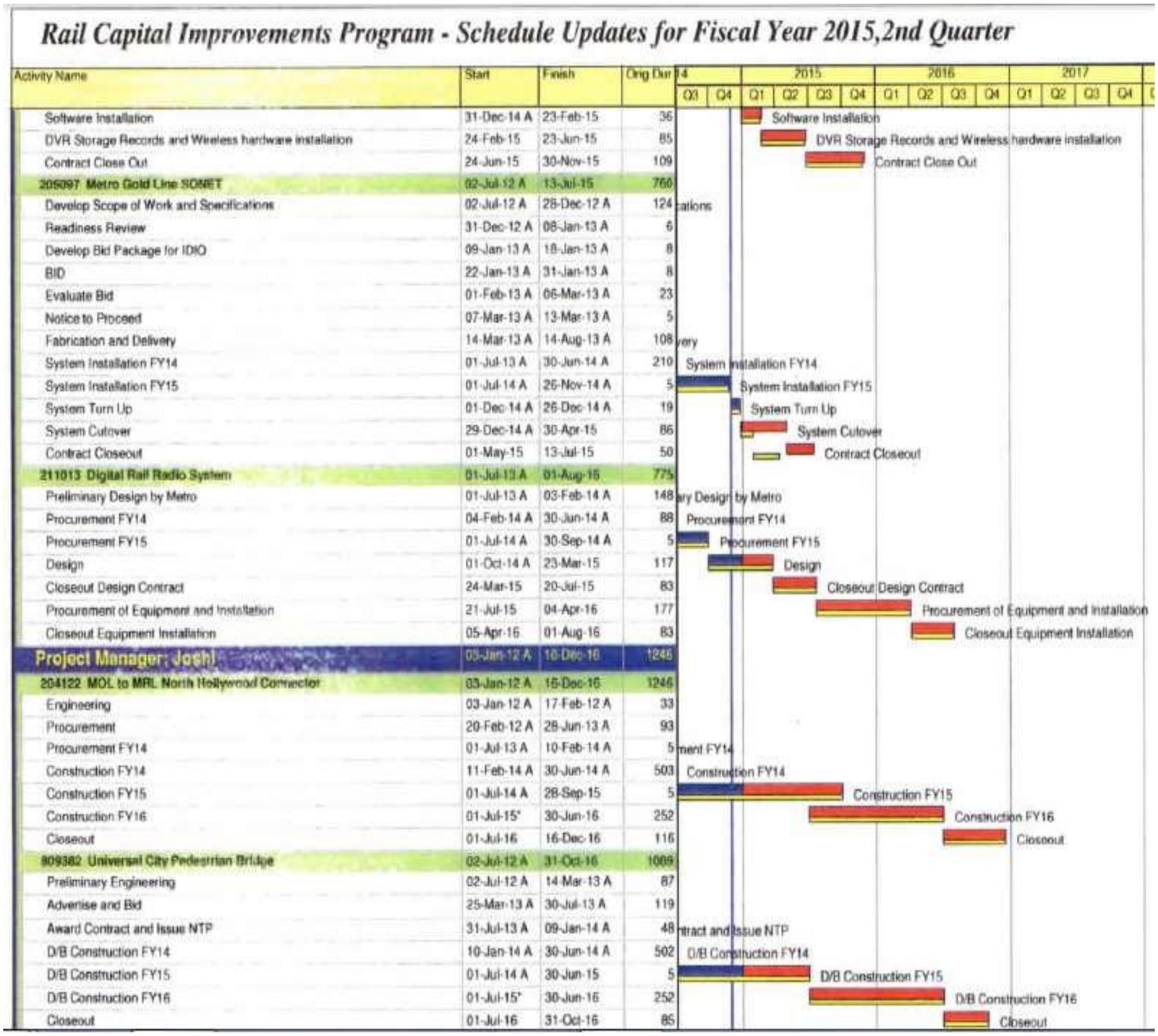
DEPARTMENTAL PROCEDURES	Procedure #: PRCL1
TRANSIT PROJECT DELIVERY DEPARTMENT	Revision: 6 Final
PROJECT CONTROL	Date: 08/01/11
WORK BREAKDOWN STRUCTURE	Page: 2 of 3

4.1 WBS Number For each project, a project specific WBS shall be developed in full conformance with the TPDD standard WBS model. The standard WBS model contains the following basic structure:

Project	Element	Line Item	Work Package
XXX	X	XX	XXXXX

Figure 21: Work Breakdown Structure

No WBS procedure exists for the Rail projects; however, the Metro Rail Capital Improvement Project Quarterly Status Report contains 47 projects, 33 of the projects do not use a WBS, while others use WBS structures that are dissimilar, making it difficult to roll up project status to a portfolio view. This was also identified in interviews and survey feedback. Below are extracts of the Monthly Report that were provided to the study team:



Rail Capital Improvements Program - Schedule Updates for Fiscal Year 2015,2nd Quarter

Activity Name	Start	Finish	Orig Dur
Software Installation	31-Dec-14 A	23-Feb-15	36
DVR Storage Records and Wireless hardware installation	24-Feb-15	23-Jun-15	85
Contract Close Out	24-Jun-15	30-Nov-15	109
205097 Metro Gold Line SONET	02-Jul-12 A	13-Jul-15	760
Develop Scope of Work and Specifications	02-Jul-12 A	28-Dec-12 A	124
Readiness Review	31-Dec-12 A	08-Jan-13 A	6
Develop Bid Package for IDIO	09-Jan-13 A	18-Jan-13 A	8
BID	22-Jan-13 A	31-Jan-13 A	8
Evaluate Bid	01-Feb-13 A	06-Mar-13 A	23
Notice to Proceed	07-Mar-13 A	13-Mar-13 A	5
Fabrication and Delivery	14-Mar-13 A	14-Aug-13 A	108
System Installation FY14	01-Jul-13 A	30-Jun-14 A	210
System Installation FY15	01-Jul-14 A	26-Nov-14 A	5
System Turn Up	01-Dec-14 A	26-Dec-14 A	19
System Cutover	29-Dec-14 A	30-Apr-15	86
Contract Closeout	01-May-15	13-Jul-15	50
211013 Digital Rail Radio System	01-Jul-13 A	01-Aug-16	775
Preliminary Design by Metro	01-Jul-13 A	03-Feb-14 A	148
Procurement FY14	04-Feb-14 A	30-Jun-14 A	88
Procurement FY15	01-Jul-14 A	30-Sep-14 A	5
Design	01-Oct-14 A	23-Mar-15	117
Closeout Design Contract	24-Mar-15	20-Jul-15	83
Procurement of Equipment and Installation	21-Jul-15	04-Apr-16	177
Closeout Equipment Installation	05-Apr-16	01-Aug-16	83
Project Manager: Joshi	03-Jan-12 A	16-Dec-16	1246
204122 MOL to MRL North Hollywood Connector	03-Jan-12 A	16-Dec-16	1246
Engineering	03-Jan-12 A	17-Feb-12 A	33
Procurement	20-Feb-12 A	28-Jun-13 A	93
Procurement FY14	01-Jul-13 A	10-Feb-14 A	5
Construction FY14	11-Feb-14 A	30-Jun-14 A	503
Construction FY15	01-Jul-14 A	28-Sep-15	5
Construction FY16	01-Jul-15*	30-Jun-16	252
Closeout	01-Jul-16	16-Dec-16	116
809382 Universal City Pedestrian Bridge	02-Jul-12 A	31-Oct-16	1089
Preliminary Engineering	02-Jul-12 A	14-Mar-13 A	87
Advertise and Bid	25-Mar-13 A	30-Jul-13 A	119
Award Contract and Issue NTP	31-Jul-13 A	09-Jan-14 A	48
D/B Construction FY14	10-Jan-14 A	30-Jun-14 A	502
D/B Construction FY15	01-Jul-14 A	30-Jun-15	5
D/B Construction FY16	01-Jul-15*	30-Jun-16	252
Closeout	01-Jul-16	31-Oct-16	85

Figure22: Projects with No WBS

For projects with a WBS, activities were not consistently associated to WBS elements. For example, in some projects, under the WBS element “Project Manager Activities” the environmental work was located, while in other projects, environmental activities were located within the WBS element “Environmental Activities”. Attempting to roll up cost or schedule data for this group of projects would not provide an accurate view.

205056 Metro Green Line Negative Grounding Devices	01-Jul-14 A	21-Sep-16
205056.5 Project Manager	30-Jan-15	13-Mar-15
Preliminary Environmental Studies	30-Jan-15	13-Mar-15
205056.4 Pre-Design	01-Jul-14 A	29-Dec-14 A
Finalize Scope of Work	01-Jul-14 A	03-Nov-14 A
Preliminary Design	03-Nov-14 A	29-Dec-14 A
Preliminary Estimate	03-Nov-14 A	29-Dec-14 A
205056.1 Design	31-Dec-14	22-Jun-15
90% Design Plans	31-Dec-14	27-Mar-15
Metro Review of 90% Plans	16-Mar-15	27-Mar-15
100% Design Plans, Estimate and Specs	30-Mar-15	22-Jun-15
Metro Review of Final Plans, Estimate and Specs	09-Jun-15	22-Jun-15
Finalize Plans, Estimate and Specs	16-Jun-15	22-Jun-15
205056.3 Construction	23-Jun-15	21-Sep-16
Delivery and Installation	23-Jun-15	14-Dec-15
Testing and Inspection	17-Sep-15	20-May-16
Closeout	23-May-16	21-Sep-16

Figure23: Environmental Activities within the PM WBS element

800113-FY15Q2 Expo Washington Siding	01-Jul-14 A	20-Mar-18	932
800113-FY15Q2.1 Pre-Design	01-Jul-14 A	18-Sep-14 A	55
Finalize Scope of Work	01-Jul-14 A	22-Jul-14 A	15
Preliminary Design	23-Jul-14 A	19-Aug-14 A	20
Preliminary Estimate	13-Aug-14 A	19-Aug-14 A	5
Develop Bid Package	20-Aug-14 A	18-Sep-14 A	20
800113-FY15Q2.8 Project Manager	01-Dec-14 A	24-Dec-15	269
Coordination with Metro Operations	01-Dec-14 A	09-Apr-15	90
Coordination with the City of Los Angeles	17-Aug-15	09-Nov-15	60
Coordination with 3rd Parties	17-Aug-15	24-Dec-15	90
800113-FY15Q2.2 Procurement for Design (D/B/B)	18-Sep-14 A	25-Mar-15	128
Readiness Review	18-Sep-14 A	24-Sep-14 A	5
Advertise Period	25-Sep-14 A	19-Nov-14 A	40
Bid Analysis	20-Nov-14 A	07-Jan-15	30
Award Contract	08-Jan-15	28-Jan-15	15
Submit Bond and Insurance prior to NTP	29-Jan-15	25-Feb-15	20
Issue NTP	26-Feb-15	25-Mar-15	20
800113-FY15Q2.3 Design	26-Mar-15	30-Mar-16	255
30% Design Plans	26-Mar-15	14-Aug-15	100
Engineering Survey	16-Apr-15	13-May-15	20
Metro Review of 30% Plans	20-Jul-15	14-Aug-15	20
60% Design Plans	17-Aug-15	24-Nov-15	70
Metro Review of 60% Plans	27-Oct-15	24-Nov-15	20
90% Design Plans	25-Nov-15	09-Feb-16	50
Metro Review of 90% Plans	27-Jan-16	09-Feb-16	10
100% Design Plans, Estimate and Specs	10-Feb-16	23-Mar-16	30
Metro Review of Final Plans, Estimate and Specs	10-Mar-16	23-Mar-16	10
Finalize Plans, Estimate and Specs	17-Mar-16	30-Mar-16	10
800113-FY15Q2.6 Environmental Activities	19-Jun-15	14-Aug-15	40
Preliminary Environmental Studies	19-Jun-15	14-Aug-15	40
800113-FY15Q2.4 Procurement for Construction (D/B/B)	31-Mar-16	03-Oct-16	130

Figure 24: Environmental Activities within an Environmental WBS element

With low PMIS utilization it is assumed that each department involved in project delivery uses their own means and methods to record and track project information. The use of multiple systems of record results in erroneous and or conflicting information as well as real and/or perceived issues of data quality. Further, it also requires the manual collection of information for reporting to Senior

Management and the Board. This is an inefficient utilization of staff labor: time spent gathering the data could better be spent analyzing and validating project and program performance.

(2) Best Practice

A project management information system includes all information related to the project planning and delivery processes. This information is captured and available for review or project performance, analysis and decision-making. The PMIS includes:

- Tools and techniques to gather, integrate, and disseminate the outputs from implementing the project management processes. For example, scope, schedule, cost, risk, quality, communications, procurement and change history.
- The Project Team (such as the IPMT) is trained to utilize the PMIS for managing projects effectively.
- The tool and the information within, is available to both individual Project Managers and their team (including consultants and contractors), stakeholders and sponsors, and, central groups such as Project Controls and Procurement.
- Executive, program and portfolio information is based on common Work Breakdown Structures.

(3) Recommendation

Recommendation 106. Metro should use PMIS for all capital projects, irrespective of type or size. This will require management direction and support.

Recommendation 107. The entire capital program should be incorporated into PMIS and Metro's reporting system.

Recommendation 108. Metro should reassess and implement revised executive level reporting requirements.

Recommendation 109. Additional training on the use of the PMIS, ideally role-based curriculum, should be developed. The existing PMIS documentation would be a good reference document to utilize for the development of this curriculum. Building upon the existing PMIS documentation, simple one page 'desk instructions' could be developed based on a job-task analyses of members of the IPMO.

V. Acronyms

AACEI	Association for the Advancement of Cost Engineering International
AB	Assembly Bill
A/E	Architecture and Engineering
AP	Alternate Proposal
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ATC	Alternate Technical Concepts
AUR	Advanced Utility Relocation
BAFO	Best and Final Offer
BART	Bay Area Rapid Transit
BIM	Building Information Modeling
BOE	Bureau of Engineering
CA	Contract Administrator
Caltrans	California Department of Transportation
CCB	Change Control Board
CCO	Contract Change Order
CCS	Change Control System
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CM	Construction Manager
CMA	Contract Modification Authority
CMAA	Construction Management Association of America
CMGC	Construction Manager General Contractor
CMIS	Contract Management Information System
CN	Change Notice
CO	Change Order
CP	Capital Program
CP&D	Countywide Planning and Development
CPM	Critical Path Method or Capital Program Management
DART	Dallas Area Rapid Transit
DB, D-B, or D/B	Design Build
DBIA	Design Build Institute of America
DOT	Department of Transportation
E&C	Engineering & Construction
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EM	Electromagnetic
FCA	Field Contract Administrators
FFGA	Full Funding Grant Agreement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration

FTE	Full Time Equivalent
GC	General Contractor
GIS	Geographical Information System
GPS	Global Positioning System
HR	Human Resources
IPI	International Partnering Institute
IPMO	Integrated Project Management Office
IPMT	Integrated Project Management Team
IQA	Independent Quality Assurance
IR	Infrared
IT	Intelligent Information
KPI	Key Performance Indicator
LA	Los Angeles
LACMTA	Los Angeles County Metropolitan Transportation Authority
LACTC	Los Angeles County Transportation Commission
LAX	Los Angeles International Airport
LD	Liquidated Damages
LOP	Life of Project
MAP	Moving Ahead for Progress
MCGPR	Multi-Channel Ground Penetrating Radar
MMRP	Mitigation Monitoring & Reporting Program
MOU	Memorandum of Understanding
MTA	Metropolitan Transportation Authority
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NMR	Nuclear Magnetic Resonance
NTP	Notice to Proceed
NYMTA	New York Metropolitan Transit Authority
O&M	Operations and Maintenance
OIG	Office of the Inspector General
OMB	Office of Management and Budget
OP	Oversight Procedures
OUC	Office of Underground Coordination
P3	Primavera Project Planner (software) or Public-Private Partnership
PANYNJ	Port Authority of New York and New Jersey
PC	Project Controls
PCM	Project Control Manager
PE	Preliminary Engineering
PLE	Purple Line Extension
PM	Project Management or Project Manager
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMIS	Project Management Information System
PMO	Program Management Office

PMOC	Project Management Oversight Consultant
PMP	Project Management Plan
POLB	Port of Long Beach
PUC	Public Utilities Commission
QA	Quality Assurance
RAMP	Real Estate Acquisition & Management Plan
RF	Radio Frequency
RFI	Request for Information
RFP	Request for Proposal
ROD	Record of Decision
ROI	Return on Investment
ROW	Right of Way
RR	Rail Road
RTD	Rapid Transit District
SCRTD	Southern California Rapid Transit District
SFIA	San Francisco International Airport
SFMTA	San Francisco Municipal Transportation Agency
SFPUC	San Francisco Public Utilities Commission
SP	Special Provision
SPP	Special Permitting Process
SUE	Subsurface Utility Engineering
SWAT	Special Weapons and Tactics
TCRP	Transit Cooperative Research Program
TDEMI	Time Domain Electromagnetic Induction
TIA	Time Impact Analysis
TPC	Third Party Coordination
TPDD	Transit Project Delivery Department
TRB	Transportation Research Board
VCM or V/C	Vendor/Contract Management
WBS	Work Breakdown Structure
WSIP	Water System Improvement Program
WTP	Water Treatment Plant

VI. Study Team and Contributors

Study Team

Steve Lavelle, Project Manager
Intueor Consulting, Inc.

Steve Lavelle is a highly skilled project management professional and a leader in conceiving, developing and executing projects and programs to drive revenues, increase growth, establish position in the competitive market, increase profits and shareholder value. Throughout his career he has earned great success, achieving exceptional results. The projects and programs that he has delivered span a variety of industries and disciplines, from major roadway, bridge and tunnel projects, commercial and residential buildings, parks and environmental mitigation to IT applications, process improvements and project and financial management programs. Steve has developed and implemented all aspects of an award winning Program Management Office (PMO), including organizational changes, operating documents, systems, human resources and all management controls. He has re-engineered the NJDOT Capital Project Delivery Process, significantly reducing the delivery time from problem statement to construction. This required the effective management and integration of over 20 multi-discipline teams. The new process results in significant efficiencies, increasing the volume of capital program delivery and minimizing project change while improving the state's infrastructure and economic outlook.

Leslie Schumacher
Intueor Consulting, Inc.

Leslie Schumacher has over 32 years of experience in all aspects of project controls and project management including process development, system architecture, system integration, personnel training and development, organizational assessments, and general project management consulting. Her project experience covers several industries, including engineering/construction, transportation, energy, software development, manufacturing, pharmaceutical, aerospace, defense and environmental remediation.

Bruce Stephan
PMA Consultants

Bruce Stephan is a nationally recognized licensed Civil Engineer, PMP and Attorney with over 35 years of experience on medium, large complex and mega engineering/ construction projects. He started his professional career as an Engineer in 1978 and has held progressively responsible positions in the design and construction of water, transportation and power infrastructure industries ever since. His distinguished career includes public service, general contracting and consulting nationally and internationally. As a Program Manager he has managed multiple projects as part of a larger program, and put systems, procedures and reporting tools in place to ensure consistency. As a Project Manager he has been responsible for projects from conception through closeout and warranty. As a Construction Manager he has led multi-consultant teams responsible for the full range of CM services. His award winning experience includes design-build, integrated project delivery, CM-GC and CM at Risk delivery methods, dispute resolution, complex change order negotiation, claims analysis, schedule management, technology solutions, and management consulting on public capital improvement programs. He is a frequent lecturer on topics designed to improve the way projects are delivered, and has consulted with numerous public agencies to implement industry best practices.

Sreeni Malireddy
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Sreeni Malireddy is the Co-founder and Managing Partner of Intueor, a technology and strategy consulting firm dedicated to serving the urban transit/transportation industry. He brings to Intueor a proven track record of large scale project development, delivery and management consulting experience. Over the last 24 years, Mr. Malireddy has helped clients: plan and execute large scale technology enabled transformation projects, including implementation and integration of packaged software such as PeopleSoft, SAP, Oracle and Primavera; he has helped clients with the development and implementation of business improvement strategies that enhanced business performance – areas of expertise include strategic planning, organizational analysis and redesign, procurement planning and business analysis (service model analysis, cost analysis, ROI analysis, audits and assessments). He also has extensive experience in transportation planning/economics, including major investment analysis/studies, travel demand software development and GIS applications. Over his tenure, he has demonstrated strong project management skills, with particular emphasis on scope planning and contract management.

Vijay Mididaddi
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Vijay Mididaddi is the Co-Founder and Managing Partner of Intueor, a technology and strategy consulting firm dedicated to serving the urban transit/transportation industry. Vijay is responsible for the overall operations of the firm including Client relationships, service delivery, and creation of strategic assets for Intueor. Over a 25 year career, Vijay has helped transform many a business through an innovative but structured approach while giving equal importance to all aspects of a business: people-process-technology. Experienced in a multitude of areas including Strategy, Engineering, Operations, Technology, Supply Chain, Economics, and Organization Design, he led transformation initiatives for a diverse set of Clients such as Metropolitan Atlanta Rapid Transit Authority, Region of Waterloo, and Port of Long Beach. Many of these projects combined strategy, engineering design, operations and technology that led towards a better value proposition to the client and their customers. Vijay acquired his Bachelors and Master’s Degrees in Transportation Engineering, and an MBA in Strategy, Technology and Finance from the Anderson School of Management, UCLA.

Ravi Nandivada
Intueor Consulting, Inc.

Ravi Nandivada is a seasoned consultant and technology professional with experience in providing technology solutions to private and public sector clients across the world. In his 18 years of experience, Ravi has led and overseen technology projects from concept to commissioning stages. Of the 18 years, he spent more than 15 years specializing in the public sector – working with Government Agencies in the United States, United Kingdom, Africa, Middle East and India. Ravi specializes in assisting clients discover opportunities and solutions to problems that ultimately result in their business success or growth. His areas of expertise include Project Management, Business Analysis, Business Process Improvement, Requirements

Definition, Business Architecture, Application Architecture, Data Conversion and Migration, Software Testing, Quality Assurance and Control, Independent Verification and Validation, Steady State Operations, and Enterprise Solutions. Ravi has experience providing these services to clients in Business Domains/Industries such as Retail, Banking, Government Accounting, General Administration, Unemployment Insurance, Taxation and Revenue, Criminal Justice, Corrections and Probation, and Education. Additionally, Ravi has held certifications in the areas of Software Quality Assurance, Software Engineering Processes, and Quality Standards such as ISO 9001, CMM, and Statistical Process Control.

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Appendix A

Findings Workbook

Report On
Los Angeles County Metropolitan Transportation Authority
Capital Project Construction Management Best Practices Study

Appendix A. Findings Workbook

Prepared by: Intueor Consulting, Inc.
25 February 2016

I. APPENDIX A. Findings Workbook

In order to effectively identify and manage each finding established though data collection, interviews, surveys, and project workshops, the study team assembled a workbook of all findings (corroborated and uncorroborated) that identifies for each finding:

- Project Delivery Lifecycle – what phase or phases the finding occurs within.
    - Planning and Design
    - Construction
    - Overarching (covers all phases)
    - Support Processes
- Major Finding Category – what category of issues does the finding occur within (these are the categories that findings are discussed in the study report)
    - Scope Definition and Planning
    - Partnering
    - Procurement
    - Change Management
    - Third Party
    - Project Team
    - Project Management
    - Project Delivery
    - Community Involvement
    - Board of Directors
    - Utility Relocation
    - Policy and Procedures
    - Human Resource
    - System
- Contract Objective Area – objective areas defined by Metro for this study project (see Chapter II) that each finding occurs within
    - General Readiness
    - Utility Relocation
    - Communications
    - Partnering
    - Problem Solving and Responsiveness
    - Safety
    - Staffing and Oversight
    - Policies and Procedures
    - Project Delivery Methodology
- PMBOK Knowledge Area – which knowledge area of project management does the finding fall within
    - Integration Management
    - Scope Management
    - Time Management

    - Cost Management
    - Quality Management
    - Human Resource Management
    - Communications Management
    - Risk Management
    - Procurement Management
    - Stakeholder Management
- SWOT (Strength, Weakness, Opportunity or Threat) – what the team considers the finding to be

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
1	Project Management methodology is not utilized throughout the project lifecycle or throughout the organization	All Phases	Project Management	Policies and Procedures	Human Resource Management	Weakness
2	High level procedures that define department functions and executive level roles and responsibilities are needed	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	ALL	Weakness
3	No detailed Project Controls procedures	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	ALL	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
4	Board understanding needs to be improved on utilities issues, capital project delivery processes and project successes	All Phases	Board of Directors Influence	Communications	Stakeholder Management	Threat
5	Nonexistent or limited succession planning	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	Threat
6	Board requirements for reports and meetings are extensive	All Phases	Board of Directors Influence	Staffing and Oversight	Human Resource Management	Weakness
7	No detailed Project Management procedures	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	ALL	Weakness
8	No detailed procedures for capital project delivery	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Integration Management	Threat

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
9	Organizational review, communication and coordination issues exist between departments during project delivery	All Phases	Communications	Staffing and Oversight	Communications Management	Threat
10	Life of Project budget is set at the beginning of the project life cycle and is not reassessed	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Cost Management	Weakness
11	Environmental mitigation issues and changes are occurring in design/build contracts	Planning	Project Delivery	General Readiness	Scope Management	Weakness
12	Contractors need to improve at partnering	Construction	Partnering	Partnering	Communications Management	Opportunity
13	Advance utility relocation projects are Metro funded	All Phases	Project Delivery	Utility Relocation	Cost Management	Opportunity

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
14	Project contingencies are minimal and often are exceeded	Construction	Project Delivery	General Readiness	Cost Management	Threat
15	Not a thorough staff understanding of legal concerns, issues and requirements for contracts	Supporting Processes	Human Resource	Communications	Human Resource Management	Weakness
16	inadequate understanding of contract administration by PM's, V/C staff and Program Management	Supporting Processes	Human Resource	Communications	Human Resource Management	Weakness
17	Projects are setting technology solution too early in the project life cycle and scope changes occur in design and construction	Planning	Project Delivery	General Readiness	Scope Management	Weakness
18	Obtaining City approvals can delay projects	All Phases	Project Delivery	General Readiness	Stakeholder Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
19	Executive level reporting needs improvement (necessary information is not being provided)	Systems/Tools	Communications	Communications	Communications Management	Weakness
20	Staffing requests to OMB do not include all necessary information	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	Weakness
21	Individual department Quality Management Plans are not being developed and utilized as part of a department's day to day operations	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Quality Management	Weakness
22	contract administrators are not included in partnering meetings	Construction	Project Delivery	Partnering	Human Resource Management	Threat
23	PMIS is utilized for Major Projects and a few additional projects	Systems/Tools	Systems	Communications	ALL	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
24	Compliance issues with PM's on change orders, TIA's, etc.	Construction	Project Management	Policies and Procedures	Integration Management	Threat
25	Change orders are not being effectively tracked and reported by PM's	Construction	Project Management	Policies and Procedures	Integration Management	Threat
26	Lessons learned are not being captured	All Phases	Project Management	Policies and Procedures	ALL	Weakness
27	No risk assessment with CP&D (Planning)	Supporting Processes	Project Management	Policies and Procedures	Risk Management	Weakness
28	Significant communication costs on projects	All Phases	Project Delivery	General Readiness	Communications Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
29	The project contingency is known by contractors, creating an expectation and incentive to submit frivolous change requests	Construction	Project Delivery	Policies and Procedures	Cost Management	Weakness
30	Many projects do not analyze construction delays until the contract completion	Construction	Project Delivery	Problem Solving and Urgent Responsiveness	Time Management	Weakness
31	Management and staff believe projects start before they are ready	Construction	Project Delivery	General Readiness	ALL	Threat
32	Highway projects are not managed the same as rail projects	All Phases	Project Delivery	Policies and Procedures	NONE	Weakness
33	Some projects are not inputting cost or schedule impacts into PMIS when known, preferring to wait until a change proposal is received	Systems/Tools	Systems	Policies and Procedures	Cost Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
34	PMs and CMs have multiple status meetings with management and other stakeholders	All Phases	Project Delivery	Staffing and Oversight	Communications Management	Weakness
35	Upper management get involved in project level decision making	All Phases	Project Management	Staffing and Oversight	NONE	Weakness
36	Metro procedures are not universally followed on all projects	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	ALL	Weakness
37	Previous trust issues resulted in potentially unreasonable procedural checks and balances	All Phases	Board of Directors Influence	Staffing and Oversight	Human Resource Management	Opportunity
38	Previous trust issues resulted in potentially unreasonable procedural checks and balances	All Phases	Board of Directors Influence	Staffing and Oversight	Human Resource Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
39	Waiting for Board approval can delay projects	All Phases	Board of Directors Influence	Staffing and Oversight	Scope Management	Weakness
40	RE Procedures Manual needs improvement	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	NONE	Weakness
41	There are multiple document control systems in use due to the PMIS being implemented only 2 years ago	Systems/Tools	Systems	Policies and Procedures	ALL	Weakness
42	Projects do not use a standard WBS	Systems/Tools	Development of Policies and Procedures	Policies and Procedures	Time Management	Weakness
43	Management has not enforced the use of the PMIS	Systems/Tools	Development of Policies and Procedures	Staffing and Oversight	Human Resource Management	Threat

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
44	MTA soft costs are not loaded into P/6, project level EVMS reporting is not possible	Supporting Processes	Development of Policies and Procedures	Staffing and Oversight	Cost Management	Threat
45	Compliance to use PMIS is not enforced by PMs.	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	
46	Project team selection and maintenance is critical to project success	All Phases	Project Management	Staffing and Oversight	Human Resource Management	Threat
47	Communication and coordination issues with utility companies	All Phases	Project Management	Utility Relocation	Communications Management	Weakness
48	Utility company staffing inadequate for projects	All Phases	Human Resource	Utility Relocation	Human Resource Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
49	Utility relocation is not being addressed in the planning process	Planning	Project Delivery	Utility Relocation	Scope Management	Weakness
50	Effective Partnering process	Construction	Project Delivery	Partnering	Communications Management	Strength
51	Unknown/inexperienced contractors are a high risk for project success	Construction	Project Management	Staffing and Oversight	Human Resource Management	Weakness
52	Safety is paramount to the organization	All Phases	Project Delivery	Safety	Integration Management	Strength
53	Contractors not addressing all operational requirements	Construction	Project Delivery	General Readiness	Scope Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
54	Utilization PMIS is very low	Supporting Processes	Systems	Communications	Integration Management	Weakness
55	Project Controls Policies and Procedures are needed	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	ALL	
56	Effective and scalable scheduling specifications are needed	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Time Management	Strength
57	PMIS Configuration and User Documentation is inadequate as end user manuals	Systems/Tools	Development of Policies and Procedures	Policies and Procedures	Multiple	Weakness
58	PM Curriculum for staff training and development is not adequate	Supporting Processes	Human Resource	Communications	ALL	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
59	Quality Management process is under the authority of Engineering & Construction	Supporting Processes	Human Resource	Staffing and Oversight	Quality Management	Threat
60	Metro has substantial sustainability program (water conservation, solar, CANG, electric vehicles)	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Scope Management	Strength
61	Major projects utilize an Integrated Project Management Office (IPO) structure	All Phases	Project Management	Staffing and Oversight	Human Resource Management	Strength
62	Project teams are established in Planning	All Phases	Project Management	Staffing and Oversight	Human Resource Management	Opportunity
63	Community Outreach process is costly and project roles and responsibilities are not clearly defined	All Phases	Project Delivery	General Readiness	Stakeholder Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
64	Project Management Training and Development Plans are needed within most departments	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	Opportunity
65	Procurement Mega Group has been established within Vendor/Contract Management	All Phases	Human Resource	Staffing and Oversight	Integration Management	Strength
66	Congestion Reduction Program is managed by Vendor/Contract Management	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	Threat
67	V/C policies and procedures are outdated	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Procurement Management	Weakness
68	Organizational structure and relationship between Project Managers and Contract Administrators is problematic	Construction	Project Management	Staffing and Oversight	Human Resource Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
69	PMO has established quarterly meetings with major project teams to identify issues, problems, concerns and establish action plans	All Phases	Project Management	Staffing and Oversight	Communications Management	Strength
70	Government experience is lacking at the executive level	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	Weakness
71	No established project delivery selection criteria and process for selecting the method of project delivery (Design/Bid/Build, Design/Build)	All Phases	Development of Policies and Procedures	Project Delivery Methodology	Integration Management	Weakness
72	Metro is limited in its method of project delivery	All Phases	Project Delivery	Project Delivery Methodology	Integration Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
73	Excessive Board oversight	All Phases	Board of Directors Influence	Staffing and Oversight	Human Resource Management	Weakness
74	Numerous staffing issues and concerns exist	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	Weakness
75	Design criteria, performance requirements, general conditions, standards, standard drawings, specifications are outdated	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Integration Management	Weakness
76	A Best Value procurement process has been utilized on select projects	Construction	Project Delivery	Policies and Procedures	Integration Management	Strength

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
77	There is no specific department that is empowered with the authority to own and oversee the project delivery process and ensure compliance and continuous improvement	All Phases	Project Management	Policies and Procedures	Integration Management	Weakness
78	State of Good Repair, and Asset Management is not being effectively addressed within capital projects and the capital program	Planning	Capital Programming	General Readiness	Integration Management	Weakness
79	Life Cycle Costs is not being utilized within capital projects and the capital program	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Cost Management	Weakness
80	Project Managers do not reach out to team members to provide feedback on contractor/consultant performance	All Phases	Project Management	Staffing and Oversight	Procurement Management	Opportunity

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
81	Project Manager performance, experience is wide ranging	All Phases	Human Resource	Policies and Procedures	Human Resource Management	Weakness
82	Communication policies and procedures are in need of improvement	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Integration Management	Weakness
83	Contractor is not being held accountable for communications issues	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Communications Management	Weakness
84	Design/Build contractors are not providing sustainability plans	Construction	Development of Policies and Procedures	Staffing and Oversight	Human Resource Management	Weakness
85	Operational concerns are not being addressed during alternatives analysis	Planning	Project Delivery	General Readiness	Communications Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
86	Metro staff do not have an adequate understanding of Metro highway projects	Supporting Processes	Human Resource	Communications	Human Resource Management	Weakness
87	Staff are lacking highway technical skills	Supporting Processes	Human Resource	Communications	Human Resource Management	Weakness
88	Highway policies and procedures are needed	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Integration Management	Weakness
89	Metro/Caltrans partnership needs improvement	All Phases	Partnering	General Readiness	Stakeholder Management	Weakness
90	Third party as-built plans are poor	All Phases	Project Delivery	General Readiness	Scope Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
91	Addressing operations (stakeholder role) within capital project policies and procedures is needed	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Stakeholder Management	Weakness
92	Certain staff working on capital projects are charging to overhead	Supporting Processes	Development of Policies and Procedures	Staffing and Oversight	Cost Management	Weakness
93	Reassessment of the utility relocation process, issues, problems and strategies for improvement is needed	All Phases	Project Delivery	Utility Relocation	Scope Management	Opportunity
94	Communications with authorities and third parties needs improvement	All Phases	Communications	General Readiness	Stakeholder Management	Opportunity
95	Metro/City of LA communication and collaboration problems exist	All Phases	Communications	General Readiness	Stakeholder Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
96	Partnering decisions are not being followed up.	Construction	Partnering	Partnering	Communications Management	Weakness
97	An executive team (V/C, E&C, PM) has been initiated to discuss, resolve problems	All Phases	Project Management	Staffing and Oversight	Communications Management	Strength
98	New Dispute Resolution Board process has been implemented	Construction	Partnering	Partnering	Stakeholder Management	Strength
99	Change Order delays in processing are occurring	Construction	Project Delivery	Problem Solving and Urgent Responsiveness	Integration Management	Weakness
100	Metro Master Agreements are outdated	All Phases	Development of Policies and Procedures	General Readiness	Procurement Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
101	Planning phase does not incorporate 3rd party coordination	Planning	Development of Policies and Procedures	Policies and Procedures	Stakeholder Management	Weakness
102	Third parties have major resource challenges	All Phases	Human Resource	General Readiness	Human Resource Management	Weakness
103	Metro/3rd party coordination needs improvement	All Phases	Project Management	General Readiness	Stakeholder Management	Opportunity
104	Independent Cost Estimates are prepared but no Basis of Estimate creating negotiating problems	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Cost Management	Weakness
105	Project scope is not being effectively detailed before the design/build contract is awarded	Planning	Project Delivery	General Readiness	Scope Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
106	Risk Management is not being utilized on all projects	Supporting Processes	Development of Policies and Procedures	Policies and Procedures	Risk Management	Weakness
107	Low bid contracting on major, complex projects is problematic	Construction	Project Delivery	Project Delivery Methodology	Procurement Management	Opportunity
108	Some contractors have been allowed to continue working without an approved schedule	Construction	Development of Policies and Procedures	Staffing and Oversight	Integration Management	Weakness
109	Design scheduling is being overlooked	All Phases	Project Delivery	Policies and Procedures	Time Management	Weakness
110	Project closeout are not occurring in a timely matter	All Phases	Project Delivery	Policies and Procedures	Integration Management	Weakness

No.	Finding	Project Delivery Lifecycle Phase	Issue Category	Contract Objective Area	PMI PMBOK Area	SWOT
111	Almost all design is being performed by consultants	Supporting Processes	Human Resource	Staffing and Oversight	Human Resource Management	Opportunity

Appendix B

Summary of Recommendations

And

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations

Report On
Los Angeles County Metropolitan Transportation Authority
Capital Project Construction Management Best Practices Study

Appendix B. Summary of Recommendations
and
Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations

Prepared by: Intueor Consulting, Inc.
25 February 2016

I. APPENDIX B. Summary of Recommendations

Issue	Category	No.	Recommendation
Staff Readiness could be enhanced on projects	Planning & Design	1.	Adopt FTA oversight procedures and checklists for all projects. Provide training and audit compliance.
	Planning & Design	2.	Implement a formal Stage Gate process
MOU process is overwhelmed	Planning & Design	3.	Allow two (2) years to identify and relocate utilities. Start third party coordination in Planning
	Planning & Design	4.	Develop and implement strategies to support third parties
	Planning & Design	5.	Consider project delivery methodology decision on a project by project basis
Design plans and specifications are not always ready for construction	Planning & Design	6.	Use gateway process, stakeholder engagement program and FTA oversight procedures
State of Good Repair, Life Cycle Costs and Asset Management is not being effectively addressed	Planning & Design	7.	Establish and obtain commitment for an effective Life Cycle Asset Management Program
Life of Project Budget is set at the beginning of the project lifecycle and is not reassessed	Planning & Design	8.	Develop and implement an LOP with phased reassessments
Risk Management is not being implemented early enough in Capital Delivery	Planning & Design	9.	Incorporate risk management into the culture of the organization from conception through closeout
Partnering Issues	Construction	10.	Consider making partnering mandatory on all projects
	Construction	11.	Establish a partnering procedural standard
	Construction	12.	Utilize a multi-tiered partnering
	Construction	13.	Train staff and contractors
	Construction	14.	Enforce a post partnering follow up plan
Low bid contracting on major, complex projects is problematic	Construction	15.	Carefully evaluate design build on a case by case basis
	Construction	16.	Assure readiness using FTA OP-54
Construction delays are not being consistently addressed	Construction	17.	Address delays as they occur
	Construction	18.	Establish timelines for agency response
	Construction	19.	Establish a contractor's daily overhead rate

Issue	Category	No.	Recommendation
Contract Administration needs to be expanded, explained and enforced	Construction	20.	Establish a change control group with a strong leader
	Construction	21.	Establish minimum requirements for Contract Administrators
	Construction	22.	Improve Contract Administration training
	Construction	23.	Consistently apply change control processes
	Construction	24.	Establish an audit function
	Construction	25.	Establish accountability for document turnaround times
	Construction	26.	Empower PM/CM in charge of the change control process
	Construction	27.	All project use PMIS contract management database
	Construction	28.	Improve contractor compliance and Metro enforcement
	Construction	29.	Establish realistic timeframes
	Construction	30.	Utilize best practice change control model
Change Order tracking can be enhanced	Construction	31.	Use PMIS on all projects, including CM14 record of negotiation form
Address underlying issues than increasing contingencies	Construction	32.	Revise risk and contingency procedures for all projects
	Construction	33.	Enforce procedures using risk to set contingencies for all projects
	Construction	34.	Hide contingency amounts or send a strong message
Obtaining City of LA and other city approvals can delay projects	Overarching	35.	Develop and implement strategic executive level partnering
	Overarching	36.	Execute new Master Cooperative Agreement
Metro/Caltrans partnership needs improvement	Overarching	37.	Develop and implement executive level partnering
Third Party coordination, communication and resource problems exist	Overarching	38.	Engage with utility companies in the Planning phase
	Overarching	39.	Establish quarterly coordination meetings
Master Agreements are outdated	Overarching	40.	Assess and execute new agreements
Project team selection and maintenance is critical to project success	Overarching	41.	Develop and implement strategic plan for project team management

Issue	Category	No.	Recommendation
Major projects utilize an Integrated Project Management Office (IPMO) team structure	Overarching	42.	Implement an IPMO environment for all projects
	Overarching	43.	Require all projects to utilize a Project Management Plan (PMP)
Upper management gets involved in project level decision making	Overarching	44.	Establish governance model with delegated authority
	Overarching	45.	Reduce the number of internal management meetings with project team
Project teams have review, communication and coordination issues	Overarching	46.	Establish soft skills training and development for all project team members
Project management methodology is not being utilized throughout the project lifecycle or throughout the organization	Overarching	47.	Adopt Project Management Institute (PMI) as the organizational standard for project management
	Overarching	48.	Assign a Project Manager at project initiation and empower with the authority for project decision making throughout the lifecycle
	Overarching	49.	Implement an organization-wide project management initiative
	Overarching	50.	Establish a Strategic Program Management Office (PMO)
Lessons Learned are not being programmatically captured	Overarching	51.	Establish formal, organization wide Lessons Learned Program
There is no specific department that is empowered with the authority to own and oversee capital project delivery processes	Overarching	52.	Assign ownership of capital project delivery to the Strategic PMO
Highway project management issues	Overarching	53.	Incorporate IPMO structure into highway projects
	Overarching	54.	Improve highway reporting process
	Overarching	55.	Establish Independent Cost Estimate and Contingency review
	Overarching	56.	Establish detailed Work Breakdown Structure (WBS) for scheduling and budgeting
	Overarching	57.	Assess the most effective method of project delivery
	Overarching	58.	Assess the use of Advanced Utility Relocation (AUR) projects to support highway projects

Issue	Category	No.	Recommendation
	Overarching	59.	Provide staff training and education in project management and highway technical skills
	Overarching	60.	Develop a Quality Plan for highway projects
	Overarching	61.	Improve configuration management and document control processes
Project Manager overall performance is wide ranging	Overarching	62.	Develop a Project Manager Performance Plan
	Overarching	63.	Develop Project Manager performance metrics into performance assessments
Project Managers not reaching out for team feedback on consultant/contractor performance	Overarching	64.	Establish enforcement and compliance mechanism into performance evaluations
Safety is paramount to the organization	Overarching	65.	Assess additional safety training
	Overarching	66.	Install safety “ticker” to applaud success
	Overarching	67.	Incorporate safety considerations into the updating of design criteria, standards and specifications
There is no formal established project delivery method selection process and criteria	Overarching	68.	Develop and implement a detailed decision making process on the selection of a project delivery method
Design scheduling needs improvement	Overarching	69.	Establish a scheduling section within Project Controls
Project closeouts are not occurring in a timely manner	Overarching	70.	Establish closeout compliance mechanisms
Community outreach problems exist	Overarching	71.	Develop strategic Public Involvement Action Plan
	Overarching	72.	Establish process improvement committee to develop recommendations for improvement
	Overarching	73.	Improve adherence to Metro rule (Pub. Util. Code, Sec. 130630)
Board of Director oversight, reporting and approval concerns	Overarching	74.	Assess increasing Board meeting frequency
	Overarching	75.	Delegate more authority to Chief Executive Officer (CEO)
	Overarching	76.	Reassess Board review and approval process
	Overarching	77.	The Board of Directors should recognize and support a need for process improvement.
Board education and understanding is needed	Overarching	78.	Develop and implement a Board education series

Issue	Category	No.	Recommendation
Utility relocation delays can be reduced by better up front planning	Overarching	79.	Expand AUR contracts, master service agreements and advance utility identification
	Overarching	80.	Increase Third Party Coordination Unit staffing level
	Overarching	81.	Increase investment in utility identification during planning and preliminary engineering
	Overarching	82.	Communicate utility risk to contractors
	Overarching	83.	Complete as much utility work in advance of construction contract
	Overarching	84.	Enforce Design Build requirements and penalties for non-compliance
	Overarching	85.	Allow more time and contingency for identification and relocation
	Overarching	86.	Apply for FTA funding for AUR contracts
	Overarching	87.	Re-engineer the Utility Relocation process
	Overarching	88.	Establish a Utility Relocation Technology Assessment Team:
	Overarching	88.a	Increased and deeper pothole testing utilizing the coring and reinstatement process, where applicable.
	Overarching	88.b	Multi-Channel Ground Penetrating Radar (MCGPR)
	Overarching	88.c	Both active and passive systems of utility identification.
	Overarching	88.d	Induction utility locators (electromagnetic (EM) signaling
	Overarching	88.e	Nuclear Magnetic Resonance (NMR) imaging
	Overarching	88.f	Infrared (IR) imaging
	Overarching	88.g	Geographical Information System (GIS)
	Overarching	88.h	Remote Sensing
	Overarching	88.i	Acoustic location methods
	Overarching	88.j	Non-destructive Air-Vacuum excavation
	Overarching	88.k	Radio Frequency (RF) methods
	Overarching	88.l	Digital 3D-BIM imaging and modeling technologies
	Overarching	88.m	Time Domain Electromagnetic Induction (TDEMI)
	Overarching	88.n	Exploratory test pit excavations
	Overarching	88.o	Electronic metal detectors
	Overarching	88.p	Magnetometry

Issue	Category	No.	Recommendation
	Overarching	88.q	Closed-circuit television (integrated with RF technology)
	Overarching	88.r	Active Millimeter Wave Scanning
	Overarching	88.s	Robotics technology (integrated with 3D methods) and camera drones with GPS.
	Overarching	88.t	Laser rangefinders
	Overarching	89.	Establish a Utility Relocation Process Improvement Team
	Overarching	89.a	Determine in the project delivery process (planning, preliminary engineering) where utility identification and relocation process begins.
	Overarching	89.b	Increase utility relocation time in project and master schedules.
	Overarching	89.c	Fully utilize PMIS for utility relocation contracts (scheduling, cost, change control, issues management, etc.).
	Overarching	89.d	Improve utility relocation cost estimating.
	Overarching	89.e	Reassess the quality management of utility relocations plans, drawings, specifications, quality standards, schedules, estimates, and reporting.
	Overarching	89.f	Develop and implement a risk management process into the utility relocation process.
	Overarching	89.g	Increase communications with all entities engaged in utility relocation to improve relationships, communications, reduce costs, and increase efficiency and effectiveness. Initiate utility communication and coordination at the earliest point in the project delivery lifecycle.
	Overarching	89.h	Improve community outreach within the utility relocation process.
	Overarching	89.i	Assess and develop contractor/owner/utility company partnerships.
	Overarching	89.j	Develop/implement a utility relocation summit event of all stakeholders, contractors, government agencies and consultants to discuss utility relocation successes, issues and problems, and create action plans for improvement.

Issue	Category	No.	Recommendation
	Overarching	89.k	Incorporate City of Los Angeles engineer(s) as part of the Metro team, assigned full time exclusively to Metro, working at Metro offices and/or field locations.
	Overarching	89.l	Improve design-build contractor, AUR contractor and utility company capabilities in utility relocation.
	Overarching	89.m	Assess and develop strategies for utility company resource issues.
	Overarching	89.n	Improve Metro personnel expertise in utility relocation.
	Overarching	89.o	Hire utility subcontractors directly and proceed with utility work by Metro if utility companies are unable to meet the established schedule as stipulated in an MOU.
	Overarching	89.p	Create a utility relocation lessons learned knowledge database
	Overarching	89.q	Evaluate the use of best value bidding on AUR contracts.
	Overarching	89.r	Assess and develop strategies for improving integration of AUR contracts with the subsequent construction contract.
	Overarching	89.s	Consider utility company integration meetings, bring several utilities together to integrate relocation schemes.
	Overarching	89.t	Develop, implement and enforce the requirement for PMP's on AUR contracts to more effectively manage these projects.
	Overarching	89.u	Consider Stage Gates specifically for the utility relocation process.
	Overarching	89.v	Include utility companies, the City of Los Angeles, other impacted cities, and AUR contractors in design-build partnering, as appropriate.
	Overarching	90.	Establish a Legislative/Legal Improvement Team
	Overarching	90.a	Legislation to implement Metro's hiring of utility subcontractors.

Issue	Category	No.	Recommendation
	Overarching	90.b	Legislation for mandatory utility relocation plan and drawing standards and development, updating and revision requirements.
	Overarching	90.c	Legislation to require utility company responsibility for all or partial utility relocation costs or delays to design and/or construct utilities that are impacted by Metro capital projects.
	Overarching	90.d	Legislation to require utility company responsibility for the identification of all utilities and updating drawings, and responsibility for all costs associated with improperly located utilities.
	Overarching	90.e	Evaluate increasing the liability for utility relocation errors and omissions for those entities that perform utility relocation services.
	Overarching	90.f	Analyze the potential for assigning more accurate schedule impact consequences for utility relocation errors.
Policies and Procedures are not sufficiently detailed	Support Process	91.	Establish, develop, update and detail policies and procedures organization wide
	Support Process	92.	Establish project metrics for compliance to policies and procedures
	Support Process	93.	Establish a Knowledge Management System to maintain and access all policies and procedures
	Support Process	94.	All departments own their policies and procedures, Strategic PMO ensures consistency, compliance and integration
	Support Process	95.	Establish a Capital Project Delivery website
	Support Process	96.	Improve end used documentation for PMIS
Talent Management concerns	Support Process	97.	Staff augmentation contracts managed by individual functional departments
	Support Process	98.	Expand participation of the PM Academy
	Support Process	99.	Further develop the PM curriculum
	Support Process	100.	Develop formal curriculum for all levels of staff

Issue	Category	No.	Recommendation
	Support Process	101.	Establish training programs and tie to HR development goals
	Support Process	102.	Develop and implement a detailed staffing analysis process for all departments
	Support Process	103.	Develop strategic plan for the use of consultants
	Support Process	104.	Assess the risk of Quality Management within the Engineering & Construction division
	Support Process	105.	Consider development of a step pay system
Project Management Information System (PMIS) issues	Support Process	106.	Utilize PMIS for all projects
	Support Process	107.	Incorporate entire capital program into PMIS and Metro’s reporting system
	Support Process	108.	Reassess and implement revised executive level reporting requirements
	Support Process	109.	Develop additional training on the use of PMIS

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Planning & Design	1	Adopt FTA oversight procedures and checklists for all projects. Provide training and audit compliance.				
Planning & Design	2	Implement a formal Stage Gate process				
Planning & Design	3	Allow two (2) years to identify and relocate utilities. Start third party coordination in Planning				
Planning & Design	4	Develop and implement strategies to support third parties				
Planning & Design	5	Consider project delivery methodology decision on a project by project basis				
Planning & Design	6	Use gateway process, stakeholder engagement program and FTA oversight procedures				
Planning & Design	7	Establish and obtain commitment for an effective Life Cycle Asset Management Program				
Planning & Design	8	Develop and implement an LOP with phased reassessments				
Planning & Design	9	Incorporate risk management into the culture of the organization from conception through closeout				
Construction	10	Consider making partnering mandatory on all projects				
Construction	11	Establish a partnering procedural standard				
Construction	12	Utilize a multi-tiered partnering				
Construction	13	Train staff and contractors				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Construction	14	Enforce a post partnering follow up plan				
Construction	15	Carefully evaluate design build on a case by case basis				
Construction	16	Assure readiness using FTA OP-54				
Construction	17	Address delays as they occur				
Construction	18	Establish timelines for agency response				
Construction	19	Establish a contractor's daily overhead rate				
Construction	20	Establish a change control group with a strong leader				
Construction	21	Establish minimum requirements for Contract Administrators				
Construction	22	Improve Contract Administration training				
Construction	23	Consistently apply change control processes				
Construction	24	Establish an audit function				
Construction	25	Establish accountability for document turnaround times				
Construction	26	Empower PM/CM in charge of the change control process				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Construction	27	All project use PMIS contract management database				
Construction	28	Improve contractor compliance and Metro enforcement				
Construction	29	Establish realistic timeframes				
Construction	30	Utilize best practice change control model				
Construction	31	Use PMIS on all projects, including CM14 record of negotiation form				
Construction	32	Revise risk and contingency procedures for all projects				
Construction	33	Enforce procedures using risk to set contingencies for all projects				
Construction	34	Hide contingency amounts or send a strong message				
Overarching	35	Develop and implement strategic executive level partnering				
Overarching	36	Execute new Master Cooperative Agreement				
Overarching	37	Develop and implement executive level partnering				
Overarching	38	Engage with utility companies in the Planning phase				
Overarching	39	Establish quarterly coordination meetings				
Overarching	40	Assess and execute new agreements				
Overarching	41	Develop and implement strategic plan for project team management				
Overarching	42	Implement an IPMO environment for all projects				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Overarching	43	Require all projects to utilize a Project Management Plan (PMP)				
Overarching	44	Establish governance model with delegated authority				
Overarching	45	Reduce the number of internal management meetings with project team				
Overarching	46	Establish soft skills training and development for all project team members				
Overarching	47	Adopt Project Management Institute (PMI) as the organizational standard for project management				
Overarching	48	Assign a Project Manager at project initiation and empower with the authority for project decision making throughout the lifecycle				
Overarching	49	Implement an organization-wide project management initiative				
Overarching	50	Establish a Strategic Program Management Office (PMO)				
Overarching	51	Establish formal, organization wide Lessons Learned Program				
Overarching	52	Assign ownership of capital project delivery to the Strategic PMO				
Overarching	53	Incorporate IPMO structure into highway projects				
Overarching	54	Improve highway reporting process				
Overarching	55	Establish Independent Cost Estimate and Contingency review				
Overarching	56	Establish detailed Work Breakdown Structure (WBS) for scheduling and budgeting				
Overarching	57	Assess the most effective method of project delivery				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Overarching	58	Assess the use of Advanced Utility Relocation (AUR) projects to support highway projects				
Overarching	59	Provide staff training and education in project management and highway technical skills				
Overarching	60	Develop a Quality Plan for highway projects				
Overarching	61	Improve configuration management and document control processes				
Overarching	62	Develop a Project Manager Performance Plan				
Overarching	63	Develop Project Manager performance metrics into performance assessments				
Overarching	64	Establish enforcement and compliance mechanism into contractor performance evaluations				
Overarching	65	Assess additional safety training				
Overarching	66	Install safety "ticker" to applaud success				
Overarching	67	Incorporate safety considerations into the updating of design criteria, standards and specifications				
Overarching	68	Develop and implement a detailed decision making process on the selection of a project delivery method				
Overarching	69	Establish a scheduling section within Project Controls				
Overarching	70	Establish closeout compliance mechanisms				
Overarching	71	Develop strategic Public Involvement Action Plan				
Overarching	72	Establish process improvement committee to develop recommendations for improvement				
Overarching	73	Improve adherence to Metro rule (Pub. Util. Code, Sec. 130630)				
Overarching	74	Assess increasing Board meeting frequency				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Overarching	75	Delegate more authority to Chief Executive Officer (CEO)				
Overarching	76	Reassess Board review and approval process				
Overarching	77	The Board of Directors should recognize and support a need for process improvement.				
Overarching	78	Develop and implement a Board education series				
Overarching	79	Expand AUR contracts, master service agreements and advance utility identification				
Overarching	80	Increase Third Party Coordination Unit staffing level				
Overarching	81	Increase investment in utility identification during planning and preliminary engineering				
Overarching	82	Communicate utility risk to contractors				
Overarching	83	Complete as much utility work in advance of construction contract				
Overarching	84	Enforce Design Build requirements and penalties for non-compliance				
Overarching	85	Allow more time and contingency for identification and relocation				
Overarching	86	Apply for FTA funding for AUR contracts				
Overarching	87	Re-engineer the Utility Relocation process				
Overarching	88	Establish a Utility Relocation Technology Assessment Team				
Overarching	88a	• Increased and deeper pothole testing utilizing the coring and reinstatement process, where applicable.				
Overarching	88b	• Multi-Channel Ground Penetrating Radar (MCGPR)				
Overarching	88c	• Both active and passive systems of utility identification.				
Overarching	88d	• Induction utility locators (electromagnetic (EM)				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
		signaling				
Overarching	88e	• Nuclear Magnetic Resonance (NMR) imaging				
Overarching	88f	• Infrared (IR) imaging				
Overarching	88g	• Geographical Information System (GIS)				
Overarching	88h	• Remote Sensing				
Overarching	88i	• Acoustic location methods				
Overarching	88j	• Non-destructive Air-Vacuum excavation				
Overarching	88k	• Radio Frequency (RF) methods				
Overarching	88l	• Digital 3D-BIM imaging and modeling technologies				
Overarching	88m	• Time Domain Electromagnetic Induction (TDEMI)				
Overarching	88n	• Exploratory test pit excavations				
Overarching	88o	• Electronic metal detectors				
Overarching	88p	• Magnetometry				
Overarching	88q	• Closed-circuit television (integrated with RF technology)				
Overarching	88r	• Active Millimeter Wave Scanning				
Overarching	88s	• Robotics technology (integrated with 3D methods) and camera drones with GPS.				
Overarching	88t	• Laser rangefinders				
Overarching	89	Establish a Utility Relocation Process Improvement Team				
Overarching	89a	• Determine in the project delivery process (planning, preliminary engineering) where utility identification and relocation process begins.				
Overarching	89b	• Increase utility relocation time in project and master schedules.				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Overarching	89c	• Fully utilize PMIS for utility relocation contracts (scheduling, cost, change control, issues management, etc.).				
Overarching	89d	• Improve utility relocation cost estimating.				
Overarching	89e	• Reassess the quality management of utility relocations plans, drawings, specifications, quality standards, schedules, estimates, and reporting.				
Overarching	89f	• Develop and implement a risk management process into the utility relocation process.				
Overarching	89g	• Increase communications with all entities engaged in utility relocation to improve relationships, communications, reduce costs, and increase efficiency and effectiveness. Initiate utility communication and coordination at the earliest point in the project delivery lifecycle.				
Overarching	89h	• Improve community outreach within the utility relocation process.				
Overarching	89i	• Assess and develop contractor/owner/utility company partnerships.				
Overarching	89j	• Develop and implement a utility relocation summit event of all stakeholders and contractors, government agencies and consultants to discuss utility relocation successes, issues and problems, and create action plans for improvement.				
Overarching	89k	• Incorporate City of Los Angeles engineer(s) as part of the Metro team, assigned full time exclusively to Metro, working at Metro offices and/or field locations.				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Overarching	89l	• Improve design-build contractor, AUR contractor and utility company capabilities in utility relocation.				
Overarching	89m	• Assess and develop strategies for utility company resource issues.				
Overarching	89n	• Improve Metro personnel expertise in utility relocation.				
Overarching	89o	• Hire utility subcontractors directly and proceed with utility work by Metro if utility companies are unable to meet the established schedule as stipulated in an MOU.				
Overarching	89p	• Create a utility relocation lessons learned knowledge database				
Overarching	89q	• Evaluate the use of best value bidding on AUR contracts.				
Overarching	89r	• Assess and develop strategies for improving integration of AUR contracts with the subsequent construction contract.				
Overarching	89s	• Consider utility company integration meetings, bring several utilities together to integrate relocation schemes.				
Overarching	89t	• Develop, implement and enforce the requirement for PMP's on AUR contracts to more effectively manage these projects.				
Overarching	89u	• Consider Stage Gates specifically for the utility relocation process.				
Overarching	89v	• Include utility companies, the City of Los Angeles, other impacted cities, and AUR contractors in design-build partnering, as appropriate.				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Overarching	90	Establish a Legislative/Legal Improvement Team				
Overarching	90a	• Legislation to implement Metro's hiring of utility subcontractors.				
Overarching	90b	• Legislation for mandatory utility relocation plan and drawing standards and development, updating and revision requirements.				
Overarching	90c	• Legislation to require utility company responsibility for all or partial utility relocation costs or delays to design and/or construct utilities that are impacted by Metro capital projects.				
Overarching	90d	• Legislation to require utility company responsibility for the identification of all utilities and updating drawings, and responsibility for all costs associated with improperly located utilities.				
Overarching	90e	• Evaluate increasing the liability for utility relocation errors and omissions for those entities that perform utility relocation services.				
Overarching	90f	• Analyze the potential for assigning more accurate schedule impact consequences for utility relocation errors.				
Support Process	91	Establish, develop, update and detail policies and procedures organization wide				
Support Process	92	Establish project metrics for compliance to policies and procedures				
Support Process	93	Establish a Knowledge Management System to maintain and access all policies and procedures				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Support Process	94	All departments own their policies and procedures, Strategic PMO ensures consistency, compliance and integration				
Support Process	95	Establish a Capital Project Delivery website				
Support Process	96	Improve end used documentation for PMIS				
Support Process	97	Staff augmentation contracts managed by individual functional departments				
Support Process	98	Expand participation of the PM Academy				
Support Process	99	Further develop the PM curriculum				
Support Process	100	Develop formal curriculum for all levels of staff				
Support Process	101	Establish training programs and tie to HR development goals				
Support Process	102	Develop and implement a detailed staffing analysis process for all departments				
Support Process	103	Develop strategic plan for the use of consultants				
Support Process	104	Assess the risk of Quality Management within the Engineering & Construction division				
Support Process	105	Consider development of a step pay system for staff.				
Support Process	106	Utilize PMIS for all projects				

Schedule for Tracking Metro's Proposed Actions to Implement the Recommendations
Capital Project Construction Management Best Practices

Issue Category	No.	Recommendations	Agree or Disagree	Assigned Staff	Proposed Action	Estimated Completion Date
Support Process	107	Incorporate entire capital program into PMIS and Metro's reporting system				
Support Process	108	Reassess and implement revised executive level reporting requirements				
Support Process	109	Develop additional training on the use of PMIS				

Appendix C

Documentation Inventory

Report On
Los Angeles County Metropolitan Transportation Authority
Capital Project Construction Management Best Practices Study

Appendix C. Documentation Inventory

Prepared by: Intueor Consulting, Inc.
25 February 2016

I. APPENDIX C. Documentation Inventory

The study team requested an enormous amount of organizational data and information to effectively understand Metro, its operations and capabilities. The following table summarizes the documentation received and analyzed in the study:

Department	Data/Information Requested
Human Resources	MTA Organization Chart (incl. ALL departments)
Human Resources	MTA staffing plans for vendor management, engineering, construction and project management
Human Resources	MTA position descriptions for vendor management, engineering, construction and project management
Human Resources	Organization Charts of target departments (with ALL employees)
Human Resources	Department Description (Roles & Responsibilities, etc.)
Human Resources	Training and Development programs (curricula, materials)
OIG	Metro Policies, Procedures, Instructions, Directives, etc.,
OIG	OIG Internal Audit Reports
OIG	Prior consultant related reports
Vendor Management	Consultant and Contractor procurement processes, procedures
Engineering & Construction	Engineering Standard Operating Procedures (SOPs), Manuals, Business Process Descriptions and Diagrams (i.e. Flow charts)
Engineering & Construction	Utility Relocation processes, procedures
Engineering & Construction	Construction Standard Operating Procedures (SOPs), Manuals, Business Process Descriptions and Diagrams (i.e. Flow charts)
Countywide Planning & Development	Short and Long Range Transportation Plans
Engineering & Construction (Transit Executive Office)	Project Delivery information (manual, supporting documentation)
Engineering & Construction (Transit Executive Office)	Project Management Standard Operating Procedures & Manuals and sample work products (i.e. processes and procedures for all nine PMBOK knowledge areas, sample reports, tools, templates). Note: These should include procedures/manuals/checklists/templates related to: partnering, DRB, dispute resolution ladder; risk management; project planning; scope definition and management including CO resolution; auditing of procedural compliance; oversight, etc.
Operations	Operations processes and procedures
Operations	Safety Manual and support documentation

Department	Data/Information Requested
Information Systems	List of IT Applications being used for Procurement, Engineering, Construction, and Project Delivery including System Descriptions for each of the following Project Management Construction Management Document Management Engineering/Design Production Software (e.g., CAD, AutoDesk, GIS, BIM, etc.) Vendor Management (e.g. supply chain/procurement) Enterprise/Transactional Software (e.g., ERP: accounting/financial, asset management, etc.) Records Management
All Functional Areas	Lessons learned and/or best practice databases or information
Engineering & Construction (Transit Executive Office)	Advance Utility Relocation contract information: 1). Scope of work for each contract 2). List of projects that have used this approach 3). % of change orders that these contract represent on those projects
Vendor Management	Construction Contract General and Special Conditions
Vendor Management	List of all Consultant Contracts with authorized budgets, spent to date, # of employees, contract term start-finish
Project Management Office	Procedures provided to outside Design and Construction Management consultants/contractors to define their work processes
Engineering & Construction	Any comparison of the cost /hr. for consultants versus MTA staff
Vendor Management	Sample contracts for each construction contract delivery method
Project Management Office	Statistical data related to change orders for the entire capital (Measure R) program; (e.g. Number of open change order, number of closed. Cost of each change order. Time to close Change order, Type of Change Order, Cost of Litigation, etc.)

Department	Data/Information Requested
Project Management Office	Projects Data for the 4 projects (El Monte Transit Center, Gold Line E Side Extension, Orange Line, I405 Sepulveda) 1). Change order logs, and 3-5 samples of Change Orders from each project 2). Correspondence logs, and access to correspondence files 3). Typical MOUs from each project (1-3 samples from each project) 4). Log of partnering sessions held, feedback surveys/scorecards, facilitator reports, and relevant supporting documentation 5). Document turnaround reports for construction contract submittals, and RFIs 6). Quality Assurance logs and sample QA Daily reports (from each project) 7). Warranty Logs for completed construction contracts 8). Dispute Resolution Board records
Project Management Office	Measure R Program Data: 1). Tabulated list of Projects with the following details for each project: Project Manager, Design Lead, Construction Manager, Project Description, Project Cost Estimate and Budget, Project Schedule (Baseline and Current), actual cost to date, forecast cost, forecasted completion date 2). Tabulated list of all change orders related to construction contracts, including contract name, contract value, amount at issue, settled amount, and cost of litigation. 3). Tabulated list of contracts performed under each delivery method 4). Any comparisons/statistical analysis of projects delivered under different contract delivery methods 5). Statistics on the time it takes to close out a contract from substantial completion to Final Board memo 6). Risk registers for projects in Measure R Program 7). FTA/FHWA Oversight Reports 8). Master Program Schedule
Vendor Management	APTA peer review of Metro CA Procedures
Vendor Management	Board report related to Construction COs Initiative
Vendor Management	Board Report related to construction change order turnaround time
Vendor Management	Board report and proposed bill related to CM/GC contracting methodology
Management Audit Services	I405 Audit Report related to Consultants not following Metro CA procedures

Department	Data/Information Requested
Vendor Management	Attachment A Procurement Summary
Management Audit Services	Performance Audits regarding Change Orders
Vendor Management	Instructions to Bidders
Vendor Management	Professional Services Proposal template
Vendor Management	Proposal scoring sheets/ Typical interview questions
Vendor Management	List of all professional service contracts showing vendor name, basic scope (design, CM, environmental, etc.), term of contract, # of renewals/amendments, contract dollar value, actual to date, whether on call or project specific, # of projects associated with the contracts.
Vendor Management	List of all construction contracts showing vendor name, basic scope (design, CM, environmental, etc.), term of contract, # of renewals/amendments, contract dollar value, actual to date, whether on call or project specific, # of projects associated with the contracts.
OIG	Charter for Board of Commissioners
Management Audit Services	Recent for performance audit reports related to Engineering and Construction, Program Management, Vendor/Contract Management, Communications, capital project delivery, construction management practices, etc.
Project Management Office	Scheduling practice documentation: policies, procedures, user manual desk instructions
Project Management Office	Cost Estimating Practice documentation: policies, procedures, user manual desk instructions
Project Management Office	PMIS System Description, Configuration, User Manuals, Desk Instructions

Appendix D

Self-Assessment Survey

Report On
Los Angeles County Metropolitan Transportation Authority
Capital Project Construction Management Best Practices Study

Appendix D. Self-Assessment Survey

Prepared by: Intueor Consulting, Inc.
25 February 2016

Contents

I. APPENDIX D. Self-Assessment Survey

As part of Task 2 of this study project, an on-line, anonymous self-assessment survey was performed to assess and understand the Metro organization (see Chapter II)

1. Introduction

The purpose of the survey was to assess the level of awareness and adoption of standard project management practices within LA Metro, and to identify adoption through staff's self-assessment of challenges and opportunities. As noted earlier, the focus of the Project Management Maturity Survey was the Management Processes at Metro (versus Production/Operational Processes). Team Intueor designed the online survey administered as a web based tool, for Metro Staff (primarily staff performing or supporting Project Management functions) to anonymously self-assess the Project Management Maturity within Metro.

Survey statements were based on process areas and practices suggested by the Project Management Institute (PMI), and tailored for Metro in consultation with the Project Executives. The overall survey included 67 statements spread across the following nine (9) Project Management Disciplines and Practices, and one (1) LA Metro-Specific Processes:

- Integration Management (9 statements)
- Scope Management (7 statements)
- Time/Schedule Management (5 statements)
- Cost Management (4 statements)
- Quality Management (7 statements)
- Human Resource Management (7 statements)
- Communications Management (6 statements)
- Risk Management (7 statements)
- Procurement Management (6 statements)
- LA Metro-Specific Processes (9 statements)

Based on consultation with the OIG Project Sponsor, and Executive Management, the following departments were invited to participate in the survey:

County-Wide Planning & Development (CPD)	All 67 Statements
Engineering & Construction (E&C)	All 67 Statements
Management Audit Services (MAS)	29 Statements
Program Management Oversight (PMO)	All 67 Statements
Vendor Contract Management (VCM)	33 Statements
Supporting & Stakeholders (Other): Communications County Counsel Enterprise Risk and Safety Management Finance and Budget Human Resources LA Metro Protective Services Operations	16 Statements

In response to each statement, staff was asked to provide:

- Self-assigned maturity rating on a scale of 1-5, the extent to which staff followed Project Management practices recommended by the PMI Standard. The survey asked participants to rate the maturity of these practices on a scale of 1-5, 1 = Never/Not Applicable, 2 = sometimes, 3 = usually, 4 = most of the times, 5 = all of the time
- (Optionally) Narrative feedback on (a) what works well within Metro and (b) what could be improved within Metro, both with respect to the specific practice in question
- (Optionally) Supporting documentation and sample project artifacts, to substantiate the maturity rating and/or the narrative feedback

Team Intueor utilized the maturity ratings to calculate:

- Average Maturity for each of the 9 PMI PM Disciplines, per participant and Department,
- Average Maturity for each of the 58 PMI PM Practices (statements) for the Metro and Department, and
- Average Maturity of LA Metro-Specific process statements.

Team Intueor analyzed the narrative feedback to identify patterns and trends with respect to staff's perception of project management practices and LA Metro-Specific processes within Metro.

On May 03, 2015 LA Metro OIG announced via email, the launch of the Project Management Maturity Survey along with an Intueor-provided URL and detailed instructions for responding to the survey. A total of 124 staff were invited to participate in the survey. The survey was closed on May 26, 2015. A total of 28 staff completed the survey, resulting in a completion rate of 22.6%. Due to this low response rate, team Intueor relaunched the survey on June 30, 2015. This survey was closed on July 11, 2015.
The following chart illustrates the overall survey completion by department:

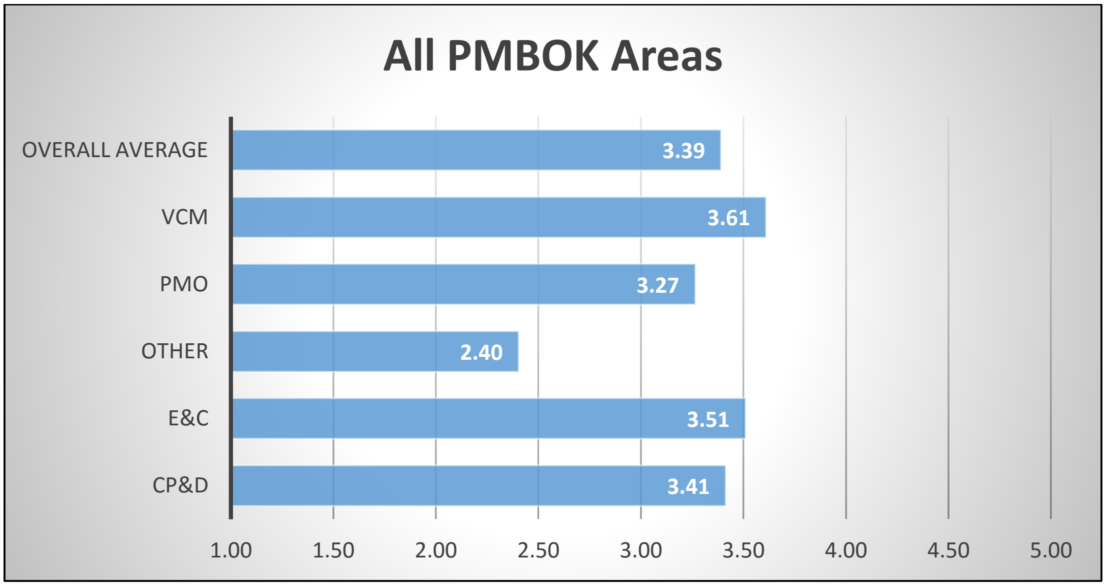
	Invited	Completed	Included in Data Sets for Analysis	Completion
CP&D	8*	8		
E&C	32	28		
MAS	1	0		
PMO	35	28		
Other	22	5		
VCM	19	12		
Total	117	81	79**	67.5%

*The original list of participants included 14 individuals in this department and for the relaunch was revised downwards at the request of CP&D Executive Management.

** A combined total of 81 staff substantially completed the survey. On closer examination, 79 of these participant scores and comments were included in the Data Sets for Analysis. 2 of the 81 participants were excluded from the Data Sets for Analysis due to the unusual scoring: In one case the participant categorically scored "5's" unconditionally, against all survey statements, without a narrative explanation or supporting documentation, and, completed the survey in 6 minutes. In the other case a repeating pattern of "1" and "5" was used throughout the entire survey – again, no narrative explanation or supporting documentation was provided, and, this participant completed the survey in 3 minutes.

In order to secure a large enough set of data points, while attempting to not skew the results because of incomplete responses, Intueor utilized responses from 79 participants as the "Data Sets for Analysis."

The chart below displays the overall PM Maturity rating by Department:



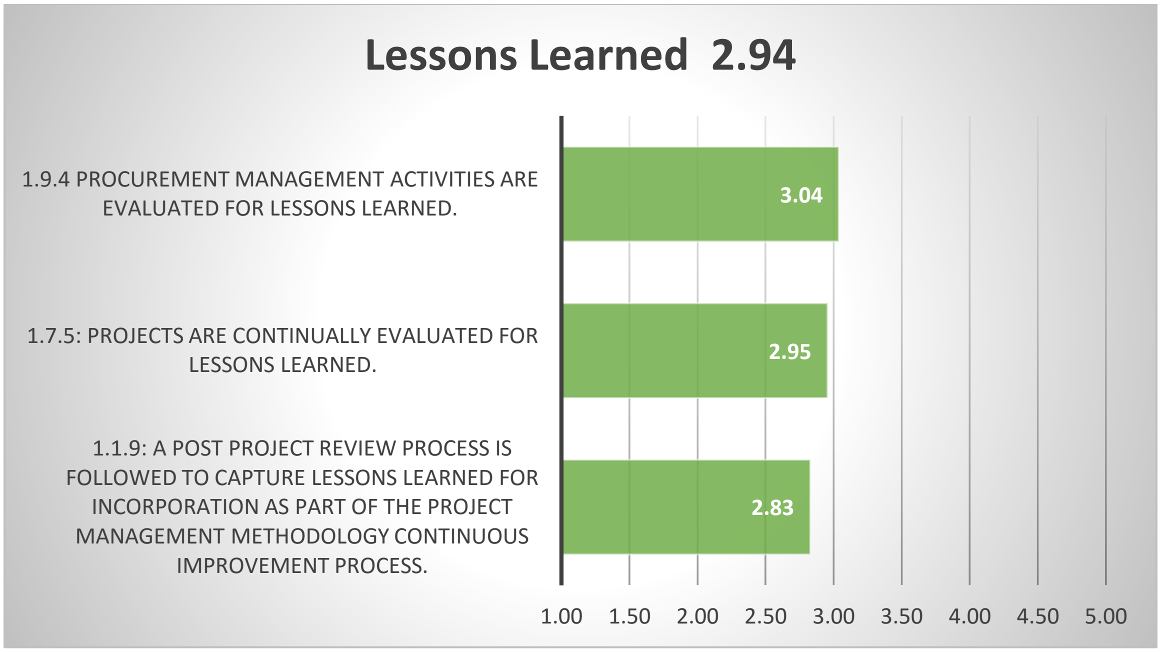
The following chart displays average maturity rating for each PM Discipline by Department:

	CP&D	E&C	PMO	VCM	Other
1.1 Integration Management	3.25	3.43	3.40	3.55	2.00
1.2 Scope Management	3.52	3.52	3.30	3.20	2.67
1.3 Time Management	3.58	3.96	3.48	3.65	3.50
1.4 Cost Management	4.03	3.83	3.91	4.20	3.13
1.5 Quality Management	3.35	3.53	3.19		2.00
1.6 Human Resource Management	3.07	3.30	3.06		1.50
1.7 Communications Management	3.40	3.68	3.13		
1.8 Risk Management	3.20	3.25	2.95		2.07
1.9 Procurement Management	3.73	3.40	3.25	3.67	2.30

The charts above indicate that the Average Maturity Rating calculated using 4 different data sets (CP&D, E&C, PMO, VCM) is very similar, indicating that self-assessments by staff in these departments is consistent. The average maturity ratings in each of the 9 Disciplines ranges between a lowest of 2.95 (Risk Management) and a highest of 4.2 (Cost Management), indicating these departments believe that most of the project management practices are followed "usually." The fifth data set (Other) is very dissimilar, with an overall Maturity Rating of 2.4, indicating that most PM practices are followed 'less than usually'.

Department staff assessed themselves relatively high on maturity with respect to Cost Management compared to Risk Management. In the context of a predominantly DB project delivery, this is common: more focus on contract management.

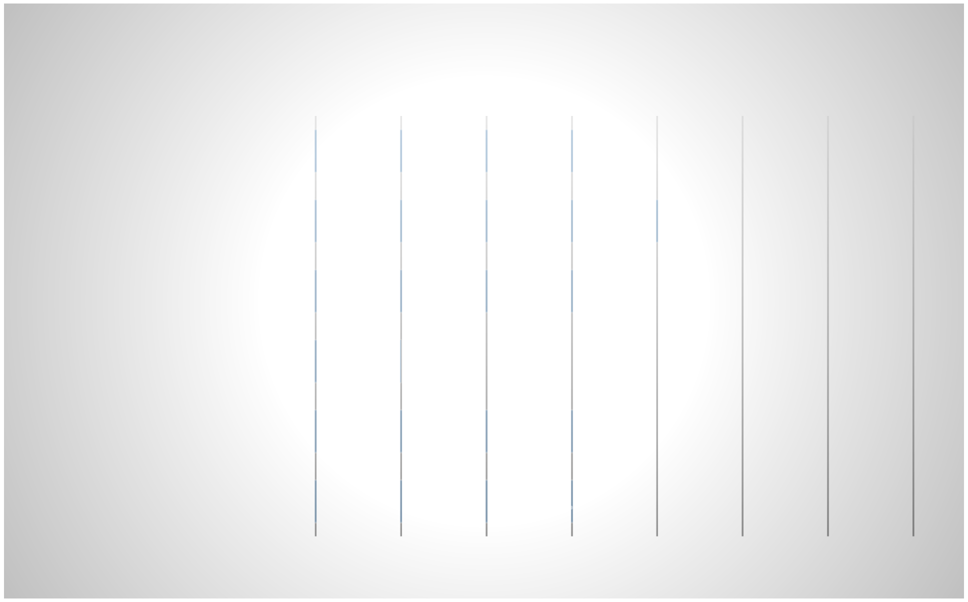
Further examination at the Knowledge Area level (Integration Management, Communications Management, and Procurement Management), the specific processes for implementing *best practices of formal lessons learned* are uniformly low, suggesting that past project experiences (both successes and failures) are not shared across the Organization. This lack of knowledge transfer culminates in repeating mistakes, increases staff effort, and does not avail continuous process improvements of the business processes utilized in good project delivery. (Note: The score for Procurement Management Lessons Learned score may be overstated – a lessons learned database exists but is not widely known/promulgated to those engaged with capital project delivery).



	What Works Well	What Could Be Improved
1.1.9 Integration Lessons Learned	I have not heard of this happening at Metro.	Provide training on the specifics of this practice.
1.7.5 Communications Lessons Learned		I do not hear about this happening on smaller projects.
1.9.4 Procurement Lessons Learned		Active participation from CA. Lessons learned database exists. Lessons learned summary prepared for each procurement.

In general, there is considerable scope for improvement across all Project Management disciplines. An average maturity rating of 4 or more indicates reasonable process consciousness and consistency.

1.1 Integration Management



Most Integration Management practices are followed usually:

Area of concern: Lessons Learned, and group of "Other" (represents supporting organizations such a Risk, OMB, and Strategic Operations) – suggests poor engagement of these departments during project delivery.

Departmental Details

	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.1.1 Project PMP	2	2	4	5	5	4	5	5	4
1.1.2 Project LifeCycle	4	2	5	5	5	4	4	5	4.25
1.1.3 Baseline KPIs	1	2	3	4	3	3	5	3	3
1.1.4 PM Methodology	1	2	2	5	4	3	4	5	3.25
1.1.5 PMIS	1	2	2	5	4	3	2	5	3
1.1.6 Change Control	2	2	2	4	3	4	2	5	3
1.1.7 Quantified Objectives	1	2	2	4	3	3	4	4	2.88
1.1.8 Performance Mgmt	1	2	2	5	3	4	2	5	3
1.1.9 Lessons Learned	2	2	1	5	3	5	1	4	2.88
Area Average	1.67	2	2.6	4.7	3.7	3.7	3.2	4.6	3.25

	Participant																												Dept
E&C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Avg
1.1.1 Project PMP	4	1	5	2	4	5	5	2	3	4	5	4	3	4	2	2	2	2	2	5	5	3	2	5	5	5	5	5	3.61
1.1.2 Project LifeCycle	2	1	5	2	3	5	5	4	4	4	5	5	3	4	2	2	2	1	4	5	5	4	2	5	5	5	5	5	3.71
1.1.3 Baseline KPIs	2	1	4	3	4	5	4	4	1	4	2	3	3	4	3	2	2	2	2	4	5	2	2	5	5	5	5	4	3.29
1.1.4 PM Methodology	4	1	4	3	3	4	4	2	1	3	4	4	3	4	4	4	2	1	2	5	5	2	2	5	5	5	3	4	3.32
1.1.5 PMIS	4	1	3	1	4	4	5	4	4	3	5	4	3	4	3	3	2	1	1	5	5	3	4	5	4	5	3	5	3.50
1.1.6 Change Control	4	1	3	1	5	5	5	4	2	4	5	4	4	5	4	5	4	2	3	5	5	3	3	4	5	5	4	4	3.86
1.1.7 Quantified Objectives	2	1	4	4	5	4	4	5	1	3	2	3	3	4	3	4	2	2	2	4	4	3	2	5	5	5	2	4	3.29
1.1.8 Performance Mgmt	4	1	4	3	4	4	3	3	4	3	2	3	3	4	2		3	1	2	4	4	3	3	5	5	5	2	5	3.30
1.1.9 Lessons Learned	2	1	4	1	2	5	4	4	1	4	2	3	3	4	3	2	2	1	2	5	4	3	1	4	2	5	5	5	3.00
Area Average	3.11	1	4	2.2	3.8	4.6	4.3	3.6	2.3	3.6	3.6	3.7	3.1	4.1	2.9	3	2.3	1.4	2.2	4.7	4.7	2.9	2.3	4.8	4.6	5	3.8	4.6	3.43

	Participant																														Dept
PMO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Avg
1.1.1 Project PMP		5	5	3	2	3		2	4	4	1	3	4	5	4	3	4	5	1	5	5	4	4	1	3	5	5	1	5	5	3.61
1.1.2 Project LifeCycle	2	5	5	2	3	2		2	3	4	1	1	1	5	5	3	5	5	1	5	5	5	5	1	3	5	5	1	5	5	3.45
1.1.3 Baseline KPIs	3	4	5	1	3	1		3	4	5	5	2	2	5	4	2	5	3	1	4	3	3	4	1	3	4	5	1	5	4	3.28
1.1.4 PM Methodology	2	4	5	1	2	2		3	4	5	2	1	3	5	3	4	5	5	1	4	4	3	4	1	3	5	4	1	5	5	3.31
1.1.5 PMIS	3	5	5	3	3	2		2	5	4	2	3	3	5	5	2	5	5	2	2	4	4	5	4	4	5	4	1	5	1	3.55
1.1.6 Change Control	4	5	5	2	4	3		2	4	4	4	5	2	5	2	4	5	5	2	5	4	5	5	5	5	5	5	1	5	5	4.03
1.1.7 Quantified Objectives	3	4	5	1	2	2		2	4	4	1	2	2	5	4	4	5	5	1	3	5	4	5	1	4	5	4	1	5	3	3.31
1.1.8 Performance Mgmt	2	4	5	1	2	2		2	3	4	5	4	2	5	3	3	5	5	1	4	5	3	4	1	4	5	5	1	5	4	3.41
1.1.9 Lessons Learned	2	4	5	1	2	2	3	2	4	2	3	1	2	5	4	2	4	4	1	1	1	2	3	1	2	5	5	1	5	2	2.70
Area Average	2.63	4.4	5	1.7	2.6	2.1	3	2.2	3.9	4	2.7	2.4	2.3	5	3.8	3	4.8	4.7	1.2	3.7	4	3.7	4.3	1.8	3.4	4.9	4.7	1	5	3.8	3.40

	Participant											Dept
VCM	1	2	3	4	5	6	7	8	9	10	11	Avg
1.1.5 PMIS	4	4	2	2	4	3	3	5	4	2	5	3.45
1.1.6 Change Control	4	4	4	3	5	3	4	5	4	5	5	4.18
1.1.9 Lessons Learned	2	4	3	3	4	3	4	5	2	1	2	3
Area Average	3.33	4	3	2.67	4.33	3	3.67	5	3.33	2.67	4	3.55

	Participant				
Other	2	3	4	5	Avg
1.1.9 Lessons Learned	2	2	2	2	2
Area Average	2	2	2	2	2

Potential Training Opportunity for some of this staff (a total of 29 were highlighted)

The variation of ratings from one participant to another (in the tabular charts above) indicates a high degree of inconsistency among staff with respect to either (a) the understanding of each of the disciplines and practices or (b) the adoption and following of these project management practices. The significantly lower scoring by the Other group (Maturity = "occurs only sometimes" suggests that supporting departments (e.g. Finance) and stakeholders (e.g. Operations) are not adequately engaged in project delivery.

Comments Provided by Participants.

Variation of What Works Well and What Could Be Improved indicates a high degree of inconsistency among staff. This inconsistency also suggests that individual scoring may be overly optimistic. Red arrows have been included where there are contradictory statements provided by participants.

Note: Singular Comments of "Yes" or "No" have been removed. Comments highlighted in yellow are areas of opportunity.

Topic	What Works Well	What Could be Improved
Project PMP (1.1.1.)	Most projects prepare a detailed PMP. Especially when it is FTA mandated. Template is good.	A standard PM template should be readily available for access to project teams to use.
	A PMP has been prepared & approved on projects which I have managed.	It would be helpful if templates existed that could be used by contractors on the PMP.
	PMP principles are applied all the time.	More information and training would be helpful. Currently there is no direction within the Engineering department on procedures.
	All projects seeking Federal New Starts prepare a PMP and it is reviewed by FTA.	Provide standard templates and training specifically on this practice.
	The PMP contains a detailed breadth of the overall plan of the project.	The PMP could be updated regularly to conform to the latest development of the project.
	For mega projects over $100 Million we are required to prepare a PMP.	PMP has been issued for the project as a whole and not developed for project by project, as far as I know. The content should be more specific and not just follow the level of detail prescribed in Metro Policies and Procedures. A PMP should also be developed to assist the contractor's in dealing with the Metro Process.
	Major transit projects and some capital projects develop a PMP. There is an organizational procedure for transit projects modelled after Federal Transit Administration procedures.	PMP templates would be wonderful.
	Project Management Plans are clear and logical.	PMP'S are only prepared for $100 Million and above projects. Not necessarily done on regional rail CP projects.
	Program Management controls PMP preparation.	

Topic	What Works Well	What Could be Improved
Project Lifecycles (1.1.2)	Principles of life cycles are applied all the time.	Provide guidelines and training on standard project life cycles.
	Life cycle management occurs primarily on major transit projects based upon FTA guiding principles for stage gates.	This is usually followed, but not formally. Performance not evaluated at each phase.
	All potentially Fed Funded Projects comply with FTA mandatory guidance.	Definition of life cycle phases for more project types and identification of stage gate criteria needed.
	Larger project receive this attention.	Depending on what phase or department a project is with, projects are set-up differently. PM needs to be involved throughout the entire Life Cycle.
	There are distinct phases on project but I do not understand "established". If these phases are referred to in scheduling documents, then yes.	Develop Gate for each Stage -Develop Gate Review Check list.
		Smaller projects and project managers have not been training in Project life cycles management.
		The project life cycles are defined but specific goals, measures, and monitoring should be performed that meet each cycle.
		They do not know what Standard Life Cycles are. Seriously.
Baseline KPIs (1.1.3)	Project Controls does all of these things. Especially good at setting up a bassline and making changes as necessary.	Does not set up KPIs.
	Project Controls data and the expertise are valuable PM tool.	Early input and consensus in the definition of project life cycle, key performance indicators and measurement, necessary controls to prevent and correct non-performance.
	KPI's are currently well established for cost and schedule and managed in accordance with contingency policies for major projects.	Better KPI tracking. Better procedures for other types of projects.
	Key performance indicators are established for quantifiable issues like cost and schedule. Some aspects of planning like community relations and mitigation require professional judgement and can only be measured (i.e. number of community relation meetings)	Have project specific KPI's along with agency wide KPI's.
	Process in place.	I am not aware of any KPI ever having been established on any project.
		Insufficient resources to service present and future projects at hand.
		KPI's are important at the project level, they should be formalized in the PMP and include formal adjustments when needed.

Topic	What Works Well	What Could be Improved
PM Methodology (1.1.4)	Metro does not have a department that provides these capabilities.	Provide training specific to this practice.
	PMO provides valuable input and validation on methodology.	The PMO (outputs) not reviewed by executives.
	We do have a PMO who does all of these things.	Currently insufficient resources to implement for Metro
	In principle, this is what we could do.	Need more definition of processes and procedures, and definition of roles and responsibilities for smaller projects, $30M.
	Defined processes and procedures, roles and responsibilities for major projects.	Recommended PM Practices used for FTA New Starts Projects should be considered for non-FTA Mega-Projects.
	For FTA New Starts Projects the Recommended PM Practices above are part of the FTA Oversight Procedures for Mega-Projects.	Consistency with the Project Management methodology.
	Majority of the team understands the basic concepts of Project Management. Regular communication and information sharing among the team members are helping implement these principles one step at a time.	I am unaware if there is such a group.
	Project management methodology is driven by engineering and construction department and not PMO.	No accountability for lack of systematic Project Management approach. PM's run projects based on their experience and knowledge base, not on a PM platform that is interchangeable.

Topic	What Works Well	What Could be Improved
PMIS (1.1.5)	Integration and dissemination of project information in a consistent manner is a very effective management tool.	Does not exist to my knowledge, at least not in the work that is administered in Countywide Planning & Development.
	Not aware of this system. Is this an official system or just methods from the PMO group?	PM Info System is slow = and not customizable.
	Excellent PMIS in place.	While the systems that are in place are good for management of projects, ensuring that sufficient senior staff with ability to properly implement the systems is important.
	system is in its infancy	No PMIS training has been provided or scheduled.
	PMIS applications are deployed and integrated to multiple systems. Standard reports are available in multiple applications. A change management process is in place for recommended enhancements.	Not currently in use by all departments/projects.
	Transit Project Delivery.	Buy in by project managers spotty. System is only summary. The infrastructure developed not being utilized as designed and not being utilized by smaller projects. Insufficient resources.
	We have recently implemented a PMIS.	Executive support is needed. Funding for enhancements as they are requested. There is no dedicated staffing for this function and it is desperately needed.
	Contract Cost System	PMIS for the Project Life Cycle?
	All projects in approx. last 10 years have had electronic management information systems with all deliverables, schedules and processes accessible to those authorized.	PMIS needs to be used by all departments. They are trying to expand and recently added Highway. Needs to be utilized by more departments such as Operations.
	Generally, there seems to be a good project management and project control system in place.	Financial Information System
		Yes, there is a PMIS. I am not aware if data gathered is evaluated.
		Practical and effective Project Management tools and databases are not in place which are essential for implementation of effective Project Management.
		Not applicable to small Capital projects.
		All contracts could be included in the PMIS system and not just those for selected projects. There are PMs that have developed their own paperwork that is different than the PMIS system to process changes.

Topic	What Works Well	What Could be Improved
Change Control (1.1.6)	Have not experienced this.	Getting the contractor to follow change management requirements from the GCs.
	Change control procedures.	Inconsistent, random, subjective enforcement of [change control] procedures.
	Change control system is in place for all Major Rail Capital projects and some Rail Capital Improvements projects.	Need in Highway Program.
	Process is well defined.	Not all projects/programs utilizing PC change control procedures. Don't think the smaller projects are using the CCB.
	Change control procedures are well defined and managed within transit project delivery.	Standard change control procedures across all capital projects.
	Change control log is in place without which we can't manage the projects.	We recently found the project team for one project was using their own spreadsheet to track changes and it didn't match the CCO Log. This created a major cost risk as the spreadsheet had more changes than the CCO Log. CCO Log must be current for us to manage the project CMA and LOP Budget.
	Cost estimating, risk analysis, schedule, resourcing, quality etc. including the qualifications of staff approved by FTA and PMOC reviewed.	While a system is established, there is no specific "change control department" handling the specifics of such. Change Control responsibilities were combined with Document Control responsibilities to form Configuration Management and individuals cross-trained. However the expertise of "change control' has been lost. It is my opinion these areas require different technical skills.
	Contract Cost System	Cost Reports.
	Weekly construction progress meetings that include time to discuss potential Contract Change Work or Separate Meetings to discuss Change Work on a weekly basis.	Yes, there is a change control system and Quality has limited involvement with it that provides for our input. But we are not ALWAYS involved in evaluating changes that MAY affect Quality. That decision is controlled by others.
	The integrated change control system is very effective.	The LPE team should be using the "Issues" module to track potential changes and not track them in the CN system. The system should incorporate an automated Stage Gate Review system, PLE uses a hard copy based system and the mail deliver slows things down, especially related to legal review. The Change Management review process needs to be less encumbered, and be decentralized.
		Change Order process can take 6 months. This causes real issues on the project level.
		Pre-construction input from Metro departments into procurement documents could be more thorough to minimize changes during

		construction.
		At times, the Contract Administrator is unaware of changes in the field. Project Managers often do not understand the process and the timeline related to Contract Change Work. In addition, the Scope of Work that is provided for the Change Work is unclear and that makes processing the Contract Modification difficult to Merit. This also results in a Metro Estimate that is not comparable to the Contractor's proposal.
		Sometimes required in contracts but no formal training to Planning staff on how to guide the development and administration of a PMP.

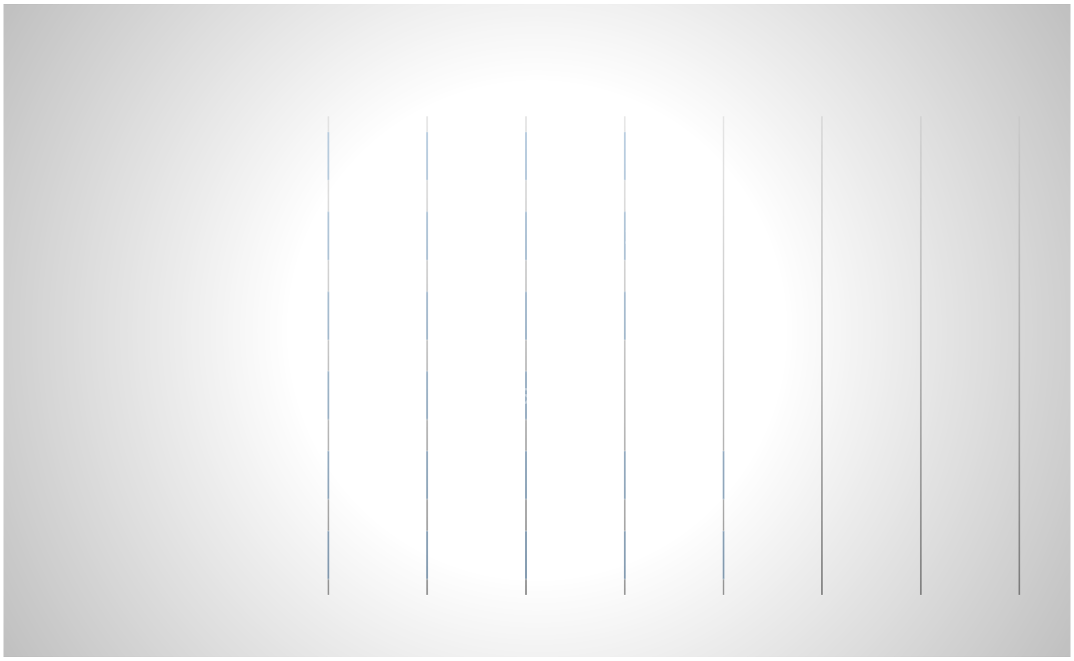
Topic	What Works Well	What Could be Improved
Quantified Objectives (1.1.7)	Integrated view of scope, schedule, cost and resources.	No formal metrics in place. Earned Value not used.
	Project Management Training has been implemented to assist the PM'S that are new.	Readily available best practices.
	Performance management is performed on design projects for major transit projects. Cost loaded schedules are utilized for major transit projects.	Engineering group for rail needs more CADD (Computer Aided Drafting and Design) resources which seems to be a bottleneck to finishing the design in timely manner and getting the procurement phase going.
	Transit Project Delivery.	Performance management methodology in general.
	Done Where appropriate.	Project Controls is not actively involved in all phases of a project. This is due to numerous reasons, staff limitations, departmental non-cooperation, etc.
	Concept sounds good.	Performance measurement is always performed but it cannot always be quantitative as in community relations or mitigation measures to maintain community cohesion.
		Unaware if any quantitative objectives have ever been established.
Performance Mgmt (1.1.8)	PMIS in place.	Not supported by in-house ITS group, but hosted by an outside consultant.
	PMIS Interfaces.	Share best practices.
	Project Management processes and information systems (PMIS) interface seamlessly with accounting, financial management, and procurement systems.	Buy in is still not there.
	Quarterly reviews by FTA and PMOC on site, introduction usually by CEO, PM reports verbally following up on written progress Reports. Very experienced (decades) Program Control Management, Senior Engineering Staff (both design and field construction). Some Planners with multi decade experience. As Built Drawings available for all prior technologies implemented HRT (heavy rail), LRT (light rail), BRT (bus rapid transit), with multiple examples for all rail project types built.	PMO is not involved in resource management at all.
	We are in the summary stages of PMIS to get other systems there must be a special push by management to ensure full integration.	The PMIS system is 'outsourced'. It does not reside internally. This is partly due to non-cooperation from the IT department. It's not a seamless integration but functional. It can be improved if PMIS were hosted internally and directly linked to other internal software.
		Performance reporting is minimal and casual.
		Understanding that it will take more time and money and manpower for development integration.

Topic	What Works Well	What Could be Improved
Lessons Learned (1.1.9)	I have not heard of this happening at Metro.	Provide training on the specifics of this practice.
	Project Controls works closely with PM during close-out.	Placing Project Controls person within office area of PMs.
	Some PMs do incorporate in their process lessons learned for future projects; specifically in regards to the closeout of data in compliance to funding agreements and audits. Recommendation to audit findings are implemented in order to comply with future projects.	The development of standard formal process for all projects that includes all the Project Controls to discuss the status, lessons learned, best practices, consistency in the management and reporting for all projects as much as possible, and find resolution to potential issues so that future projects can be delivered on time and budget.
	Projects get closed out eventually.	Needs to be done at conclusion of every single project.
	Sounds good in concept.	Overall sharing of lessons learned and project management enhancements.
	Lesson Learned reviews are mostly held with written material at project starts based on recent project experience. Some lessons learned are perhaps rightly held at a very high level.	PM at the close-out stage have left the project. The close-out is left to the construction manager/ engineer, contract admin to pick up the pieces. Generally the lessons learned process improvements have not been deciphered to be meaningful for the next projects lack of dedicated resources to do properly.
	The PMs do coordinate their project close-out to assess performance and variances to develop lessons learned. We have conducted follow-on lessons learned meetings on the major Measure R meetings to capture those things that went well or poorly to hone process improvements.	Staff limitations force PMs, Project Controls to move on to other projects so lessons learned and applied to new projects are somewhat ignored.
	Close-out process.	Perhaps an organized report (censored to avoid revealing data that could help bidders know Metro's financial positions) could be made available to starting project managers.
		A formal report from each major project that describes project performance and lessons learned should be issued. The report should include a list of recommendations for follow-on projects.
		Unaware of existence of such
		There doesn't seem to be formal post project review processes, maybe more informal.
		Lessons learned discussions.
		Rating for post project lessons learned - I have not participated in one of these because of short tenure with Metro. Rating provided is an assumption
		Post Project reviews are rarely done.
		Lessons Learned.

Topic	What Works Well	What Could be Improved
General	Art Program inclusion on corridor projects generally works well.	Project teams must be directed to follow the PMO policies and procedures for uniform management of Projects. Policies and procedures cannot be optional. The highway Department is guilty of this.
	All works well from a PM standpoint.	Sorry, but this level of Project Tracking is not utilized at my level. I am not aware of any KPI's or Quantitative Objectives being captured or communicated, nor is there any efforts to capture Lessons Learned on a post-Project completion basis.
	Being organized and on top of schedule and key milestones.	Signage inclusion on corridor projects Art and Signage inclusion on non-corridor projects
	Metro established Policy and Procedures. Following FTA's OP-40 guidelines. Experienced Project Directors/Managers.	Reduced political influences on projects. Provide realistic project budgets and schedules.
	My answers are bias because a limited number of resources can only do so much and can only allocate time to the high visibility projects/programs. So the summary data prepared is the best we could do.	Management at the DEO's position and above should be graded upon their ability to take the Metro project controls philosophy and ensure it is done consistently among their/ all Projects and Programs. Project controls and Program management involvement are not necessarily what the managers want to share. Training had started but the individuals that are/were running the projects would prefer to remain stealthy. There are programs that managers had been trained upon using the metro way but choose to do something different. Then you have higher positions than DEO that they claim were too busy to attend. Where is our upper management involvement since they report to a different department head?
	Not much.	Turnover from Engineering to Construction is nonexistent. Engineering Department currently runs construction projects. PE phase consistently turns over projects for construction that have fatal flaws or inherent design issues.
	PM teams that become familiar with each corridor project and the nuances of the communities being studied.	As PQM on nearly ALL major Metro projects to date, many focus areas of survey have never been within my scope of responsibility. I usually have no visibility of their effectiveness.
		Project Controls works with the Projects. Most of the project/programs have not been told to adopt the principles set forth in this practice. We try our best but lack the horsepower either through lack of authority and personnel to fulfill practice.

Disparate comments support conclusion that there is a lack of organizational-wide awareness of PM practices, resulting in a lack of standardization. Other comments suggest while there may be departmental awareness, there is no enforcement. Clear need and value to expand PM practice to all capital projects.

1.2 Scope Management



Recommendation/ Opportunity for Improvement:

Project Chartering,

More rigorous in engagement of the "Other" grouping which in many cases is the Stakeholder/Client. E.g. in a mature PBO, the OMB is the customer of staffing plans, and Operations is perceived as the customer.

	Participant								
CP&D	1	2	3	4	5	6	7	8	Dept. Avg
1.2.1 Project Selection	4	3	3	5	3	4	2	5	3.63
1.2.2 Project Charter	1	1	1	5	2	3	1	2	2
1.2.3 Scope Statement	2	3	5	5	5	5	5	5	4.38
1.2.4 Requirements Mgmt	1	3	4	5	5	5	4	5	4
1.2.5 Work Breakdown Structure	1	2	2	5	5	5	4	5	3.63
1.2.6 Acceptance Criteria	4	3	5	5	5	5	4	5	4.5
1.2.7 Best Practices	1	1	2	4	4	4	1	3	2.5
Area Average	2	2.29	3.14	4.86	4.14	4.43	3.00	4.29	3.52

	Participant																												Dept.
E&C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Avg
1.2.1 Project Selection	3	2	3	2	3		5	4	1	3	3	3	3	4	3	3	2	2	5	5	4	2	2	4	5	5	4	5	3.33
1.2.2 Project Charter	5	2	3	1	2		5	4	1	2	2	3	3	3	5	1	1	2	2	3	5	5	2	4	4	5	4	5	3.11
1.2.3 Scope Statement	5	3	4	2	3		5	4	1	3	5	5	3	4	3	3	4	3	5	5	5	5	2	4	4	5	5	5	3.89
1.2.4 Requirements Mgmt	5	2	3	1	2		5	4	4	5	4	4	3	4	3	2	2	3	5	5	4	2	2	5	5	5	2	5	3.56
1.2.5 Work Breakdown Structure	2	3	4	3	4		5	4	4	4	5	4	4	4	4	3	3	3	5	5	4	2	2	4	5	5	4	5	3.85
1.2.6 Acceptance Criteria	2	3	3	3	4		3	4	4	5	5	5	4	4	2	3		3	3	5	5	2	2	5	5	5	4	5	3.77
1.2.7 Best Practices	2	2	4	3	2	4	3	2	1	4	3	4	3	4	3	2	2	2	2	3	5	2	2	4	5	5	5	5	3.14
Area Average	3.43	2.43	3.43	2.14	2.86	4	4.43	3.71	2.29	3.71	3.86	4	3.29	3.86	3.29	2.43	2.33	2.57	3.86	4.43	4.57	2.86	2	4.29	4.71	5	4	5	3.52

	Participant																														Dept.
PMO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Avg
1.2.1 Project Selection	3	4	4	1	2	2		3	4	4	2	3	2	5	4	4	3	4	1	5	5	3	5	1	4	4	4	1	5	3	3.28
1.2.2 Project Charter	3	4	5	2	3	2			3	1	2	1	2	5	3	3	1	3	1	5	5	4	5	1	2	1	3	1	5	3	2.82
1.2.3 Scope Statement	3	4	5	1	3	2			3	1	2	2	2	5	4	4	5	4	1	5	5	5	4	5	4	5	5	1	5	5	3.57
1.2.4 Requirements Mgmt	3	5	5	3	5	2			4	3	5	3	2	5	4	2	5	4	1	4	4	3	3	1	4	4	5	1	5	5	3.57
1.2.5 Work Breakdown Structure	2	4	5	1	1	2			4	5	1	2	2	5	5	5	4	5	1	4	4	4	5	1	4	4	5	1	5	5	3.43
1.2.6 Acceptance Criteria	2	5	5	3	1	2			4	4	2	2	2	5	4	3	4		1	4	5	4	4	1	4	4	5	1	5	5	3.37
1.2.7 Best Practices	2	4	5	2	2	2	3		4	3	4	1	2	5	3	4	4	5	1	4	5	3	2	1	4	3	5	1	5	1	3.10
Area Average	2.57	4.29	4.86	1.86	2.43	2	3	3	3.71	3	2.57	2	2	5	3.86	3.57	3.71	4.17	1	4.43	4.71	3.71	4.00	1.57	3.71	3.57	4.57	1	5	3.86	3.30

	Participant											Dept.
VCM	1	2	3	4	5	6	7	8	9	10	11	Avg
1.2.1 Project Selection	2	4	1	2	4	5	4	5	4	3	3	3.4
1.2.2 Project Charter	2	1	1	1	3	5	2	1	2	2	2	2
1.2.3 Scope Statement	2	2	2	2	4	5	5	4	5	5	5	3.7
1.2.4 Requirements Mgmt	2	4	2	3	4	4	3	5	4	5	5	3.7
1.2.5 Work Breakdown Structure	3	4	2	2		5	5	4	4	1	2	3.2
1.2.6 Acceptance Criteria	3	4	2	2	4	5	5	4		1	5	3.5
1.2.7 Best Practices	1	3	1		3	3	4	4	3	5	2	2.9
Area Average	2.1	3.1	1.6	2	3.7	4.6	4	3.9	3.7	3.1	3.4	3.2

	Participant
Other	3
1.2.1 Project Selection	2
1.2.2 Project Charter	4
1.2.3 Scope Statement	2
1.2.4 Requirements Mgmt	2
1.2.5 Work Breakdown Structure	2
1.2.6 Acceptance Criteria	4
Area Average	2.67

Note: only one person in this group responded to these statements.

Potential Training Opportunity for some of this staff (a total of 21 were highlighted)

Comments Provided by Participants: Note: Singular Comments of “Yes” or “No” have been removed. Red arrows have been included where there are contradictory statements provided by participants

Topic	What Works Well	What Could Be Improved
Project Selection (1.2.1)	1. Strong communication and sharing of information within department allows PM to build upon prior scopes, procurement definitions. 2. Efforts to share upcoming procurement scopes within Countywide Planning & Development to identify area of impact, overlap, conflict, opportunity.	1. Dialogue with Procurement Contract Administrator and review and refinement of scope should begin earlier in the process once inputted in CIMS.
	Principles are always applied.	Formal process
	We fill out the Capital Budget Workbooks for every Fiscal Year.	The Scope and LOP have to be defined with little to no engineering, especially because OMB will not fund conceptual engineering without a full Capital project, including cost. The LOP is then locked-in forever, or requires Board approval and accusations of incompetence. Make initial LOP budgetary only, subject to change.
	Good need based project identification from internal departments and development through E&C and PM.	Difficult to find funding for all projects that are proposed. No real procedure in place for defining project scope, who leads, who supports, definition of roles and responsibilities for deliverables.
	Projects are not only selected to a portfolio, major projects are voter approved in the local funding process (Prop. A, C, Measure R).	
	OMB manages project selection. Resources are not assigned based upon project priorities.	PMO involvement in project prioritization.
	The scopes of work and specifications for major Measure R projects follow an integrated approach that aligns with the agency's objectives.	It is my opinion that Operations is not always attentive to changes or value engineering decisions. Operations needs to be more attentive to project requirements before the solicitation is released. Operations seems to be attentive after the contract is awarded or the project is near completion.
Project Charter (1.2.2)	Not clear what is meant by "Project Charter". PM is typically responsible for documenting objectives, consistent with Board direction. Authority/responsibility is not fully defined, however.	Guidelines to formally prepare Project Charters.
	Not aware of this.	Procedure to change these is unclear.
	OMB requires this.	Template project charters with defined responsibility hierarchies.
	Principles of Project Charters.	A project charter for major projects should be developed and widely distributed to define roles and responsibilities for all integrated staff.
	Generally works well.	I am not familiar with a Project Charter.
	I have not seen a project charter. It is possible that such a document is kept internal to integrated project staff.	Other than what is contained in the PMP I am unaware of such a charter.

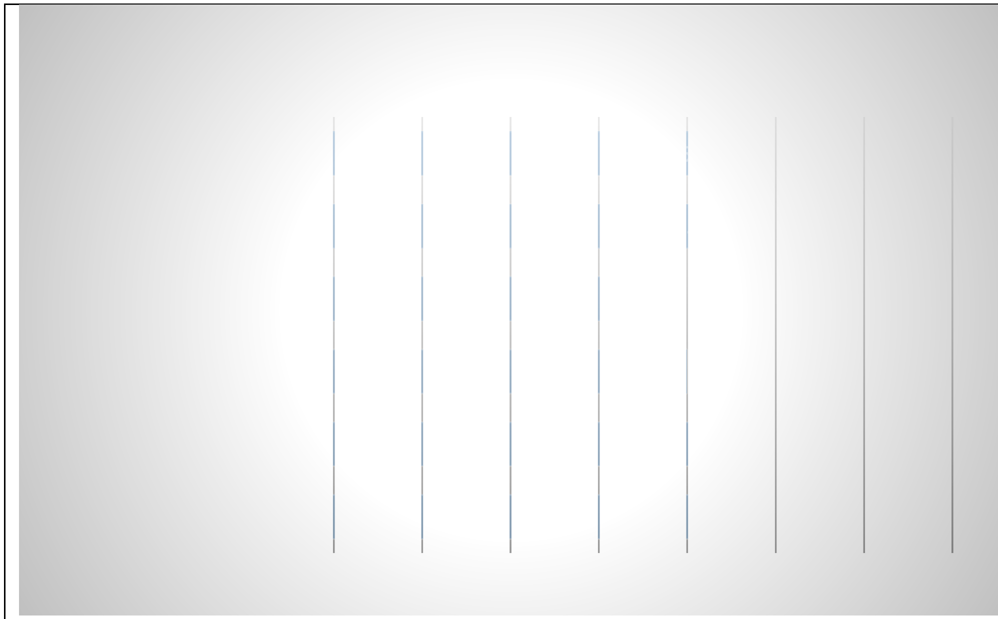
Topic	What Works Well	What Could Be Improved
Scope Statement (1.2.3)	Not aware of formal procedures.	Scope guidelines do not exist to my knowledge and I have not seen trainings to that effect. PM usually develops ad-hoc inconsistent with other PMs, building on past examples. Each Contract Administrator in Procurement has different expectations with respect to scope structure and detail.
	Scope Statement, input, management, and concurrence.	Formal process and templates
	Formal procedures may be available to PM's but I'm not aware of it.	Many PMs are maintenance managers with little training, due to lack of staff. Scope for project charter has to be written with little to no engineering (see PM 11).
	OMB utilizes budget books.	Need formal procedures.
	There is a new PM academy that includes formal training for PMs to understand their role and the role of those that support their projects. It defines all of the steps necessary to plan, execute and complete a successful project. Only time will tell if this academy is improving PM performance.	Process needs work.
	Art Program scopes within broader corridor project scopes are detailed by Art Program staff.	Other than what is contained in the PMP I am unaware of such a scope statement.
	FTA rates Metro as a mature organization in transit planning and construction. We have key people who have done this for 30 plus years (rail planning, rail engineering, and rail program control). We have done numerous mega projects and learned. Recent rail projects done be experienced teams (Red Line MOS-3, Eastside Gold Line) have come in on budget and schedule. Training new staff as inevitably the veterans retire is important.	Review of draft proposed scopes to ensure art program inclusion and impacts. Signage impact inclusion in draft scopes prior to Executive approval.
		I believe PMs need to perform early acquisition planning of their projects. There isn't always enough information given to Procurement early in the process to develop acquisition support and source selection strategies.
Requirements Mgmt (1.2.4)	Not aware of formal procedures.	Formal process and consistent application.
	Principles of scope management.	Stakeholders need to be more engaged.
	Not aware of this.	No change control process for CIPs, prior to release for bid. Exacerbated by "locking in" of LOPs too early.
	Board reports drive cost changes.	Board report processes are generally well defined.
	Managing project to requirements is challenging with an uncooperative contractor.	Yes, projects are managed to the requirements contained in the contract documents.
	I believe that scope management is taking place and the clients are informed.	Sponsors being informed versus being engaged are two different matters. Operations needs to be better engaged to avoid scope of work creep.

Topic	What Works Well	What Could Be Improved
Work Breakdown Structure (1.2.5)	This is true for all Major Capital Rail projects.	WBS are often a part of deliverables in scope or third party but planning staff is not trained develop or administer.
	Principles of WBS.	The Highway Program does not use a standard WBS. Project Controls has been working on this for 2 years, but OMB has been blocking it. This is a major roadblock to standardizing reporting for Measure R!
	Done by the project control person	WBS development and review throughout lifecycle
	Transit Project delivery projects in PE/Construction Phase.	No formal WBS. Little to no training. For many PMs, this is a second job after being maintenance manager.
	Yes there is a template form to create WBS that includes an approval process and periodic review.	Organizational guidelines. Organizational guidelines. Organizational guidelines. Every team tries to invent its own WBS, making practices inconsistent with others or previous. This makes it very difficult to analyze historical data for the same types of projects. It also makes it impossible to perform Enterprise Portfolio reporting.
	A WBS is part of every major project to align the project schedule to measure earned value and project performance.	No detailed descriptions of WBS exist nor standards for portfolio reporting or any uniformity. This is a critical item needed to standardize the cost breakdown structure at WBS level. Every project is left to do it at their whim without standards. Complete mess!
	The WBS is set up to accommodate multiple deliverables breakout.	The organization and its departments are unable to standardize or agree on any structure. Given the fact there various functions of the agency, there should still be some kind of structure.
	Work Breakdown Structure?	
Acceptance Criteria (1.2.6)	Basis for effective and agreed management methods.	Consistent enforcement.
	Specifications define, not PMP.	The Highway Program does not use a standard WBS. Project Controls has been working on this for 2 years, but OMB has been blocking it. This is a major roadblock to standardizing reporting for Measure R!
	Not applicable to current processes.	Need more construction inspectors due to high number of projects
	Yes, I agree with that statement.	WBS is used to establish scope baseline.
		Not really.
		Templates, recommendations and augmentation desired.
		Yes, but not with documented Quality input as far as I know.
		I'm not sure if small CIPs have the same level of evaluation detail, but they should.

Topic	What Works Well	What could Be Improved
Best Practices (1.2.7)	Project Controls participation.	Make available all the project WBS and how well they performed categorized by type of projects.
	Project performance data is not regularly tied to metrics.	The practice is NOT consistent across projects/departments. This can be improved: A project controls group (PCG) periodically reviews project performance with respect to scope management. Quantitative measurements/metrics are defined, and implemented. WBS Templates are periodically reviewed and revised. Historical Data on Scope Management is collected from projects and used to drive continuous improvements.
	Yes, this is performed on the major projects.	Historical and lessons learned sharing needs work.
	In a cutting edge technology like ours, it is a struggle to achieve acceptance for innovation. Modular CADD and BIM (building information modeling) station design to reduce cost is institutionalized in some project teams and rejected at substantial cost by others. Some innovations (like off street stations to avoid utility relocation) are Tunnel Advisory Panel recommended and pursued by some Planning Project Managers but not accepted universally by all departments willingly. Work is in progress to provide Metro with full internal Bottoms Up Costing capability now requiring consultant performance. It is labor costs based on time cards that are being compiled. Material costs are extensively documented. All Planning staff should attend FTA sponsored NEPA and Risk Analysis Training. NEPA training should be repeated whenever rules changes.	I am unaware if "best practices" are defined, considered or utilized.

Topic	What Works Well	What Could Be Improved
General	Generally, scope management is by contract requirements. Again my tenure is short and I cannot speak for all current or past projects.	I have worked on individual rail projects so I cannot attest to portfolios in other sectors.
	Having a clear Scope of Work.	PMO is not optional for any department. Enforcement is from the top down.
	Project level review and vetting of scope changes are in place.	Sorry, another facet of Project work that by-passes my position. I have never seen a Project Charter, or the cultivation of Best Practices/Lessons Learned. If these items are captured, they are not communicated to others.
	SOW are developed, sometimes based on other successful and similar projects thereby carrying over best practices.	Demands of a PM varies with complexity of each project. This is difficult to measure when trying to standardize performance.
	The Project Management Workshop is helpful with ensuring that processes are consistent Agency-wide.	Many of the general requirements differ from project to project and are not well coordinated from contract-GR-SP-Technical sections. Some provisions are not imposed, like liquidated damages. A group review of the goals, charter, etc. should be held and periodically revisited - formally.
	The two last FTA New Starts Projects - 1) Metro Red Line Segment 3 North Hollywood and 2) Metro Gold Line Eastside Extension Project were completed on-time and within budget utilizing the Recommended PM Practices. The Westside Purple Line Extension Projects are following FTA New Starts Requirements.	Project Controls should be more involved on EVERY project in regards to Scope Management, budget and task numbers.
	There isn't a formal process to verify/manage/develop Scope of Work.	Consistency among Project Management.

1.3 Schedule Management



Actual Participant Scores by Department:

NOTE: Yellow Highlights below suggest Training Opportunities

	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.3.1 Baseline Schedule	1	3	2	5	4	4	5	5	3.63
1.3.2 Schedule Mgmt	3	3	4	5	4	5	4	5	4.13
1.3.3 Monitoring & Controlling	3	3	4	5	4	5	2	4	3.75
1.3.4 Advanced Techniques	1	3	1	5	3	4	2	4	2.88
1.3.5 Best Practices	2	3	4	5	4	4	2	4	3.50
Area Average	2	3	3	5	3.8	4.4	3	4.4	3.58

	Participant																												Dept.
E&C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Avg
1.3.1 Baseline Schedule	4	2	4	3	4	5	5	4	4	5	5	5	4	5	4	4	4	5	5	5	5	5	4	5	5	5	5	5	4.5
1.3.2 Schedule Mgmt	4	4	3	5	4	5	5	5	1	5	4	4	3	5	3	4	3	4	4	5	5	2	2	5	5	5	5	5	4.1
1.3.3 Monitoring & Controlling	5	2	3	5	3	5	5	5	4	4	5	5	4	5	1	4	4	4	4	5	5	3	4	5	5	5	5	5	4.3
1.3.4 Advanced Techniques	5	1	3	5	4	5	5	5	1	4	4	4	3	5	1	3	1	2	3	3	4	2	1	5	5	5	5	4	3.5
1.3.5 Best Practices	4	1	3	4	2	5	5	4	1	3	4	4	3	5	3	2	1	3	5	3	4		1	5	5	5	4	5	3.5
Area Average	4.4	2	3.2	4.4	3.4	5	5	4.6	2.2	4.2	4.4	4.4	3.4	5	2.4	3.4	2.6	3.6	4.2	4.2	4.6	3	2.4	5	5	5	4.8	4.8	4

	Participant																														Dept.
PMO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Avg
1.3.1 Baseline Schedule	3	5	5	5	4	2	1	3	5	5	5	4	2	5	5	5	5	5	2	5	5	5	5	1	4	5	5	1	5	1	3.93
1.3.2 Schedule Mgmt	4	5	5	5	4	2	1	3	5	5	3	2	2	1	5	2	4	5	2		3	5	3	1	5	4	4	1	5	3	3.41
1.3.3 Monitoring & Controlling	2	5	5	5	4	3	1	2	5	5	3	4	2	1	5	3	5	5	2	5	4	5	4	1	5	4	5	1	5	3	3.63
1.3.4 Advanced Techniques	2	5	4	4	2	2	1	2	5	5	4	3	2	1	3	4	3	5	1	4	1	5	3	1	4	4	4	1	5	4	3.13
1.3.5 Best Practices	2	4	5	4	2	2	1	3	5	3	3	3	2	5	3	2	1	4	1	4	4	5	3	5	4	4	5	1	5	3	3.27
Area Average	2.6	4.8	4.8	4.6	3.2	2.2	1	2.6	5	4.6	3.6	3.2	2	2.6	4.2	3.2	3.6	4.8	1.6	4.5	3.4	5	3.6	1.8	4.4	4.2	4.6	1	5	2.8	3.48

	Participant											Dept.
VCM	1	2	3	4	5	6	7	8	9	10	11	Avg
1.3.1 Baseline Schedule	3	3	3	3	4	5	5	5	4	5	3	3.91
1.3.2 Schedule Mgmt	3	4	2	4	3	5	4	5	3	5	3	3.73
1.3.3 Monitoring & Controlling	4	3	4	4	4	5	4	5	4	5	3	4.09
1.3.4 Advanced Techniques	2	3	3	2	3	5	3	4	3	5	3	3.27
1.3.5 Best Practices	2	3	2	3	3	5	3	4	3	5	3	3.27
Area Average	2.8	3.2	2.8	3.2	3.4	5	3.8	4.6	3.4	5	3	3.65

	Participant		Dept.
Other	2	4	Avg
1.3.1 Baseline Schedule	5	2	3.5
Area Average	5	2	3.5

Potential Training Opportunity for some of this staff (a total of 17 were highlighted)

Note: Singular Comments of “Yes” or “No” have been removed. Comments highlighted in yellow are areas of opportunity. Red arrows have been included where there is contradictory statements provided by participants.

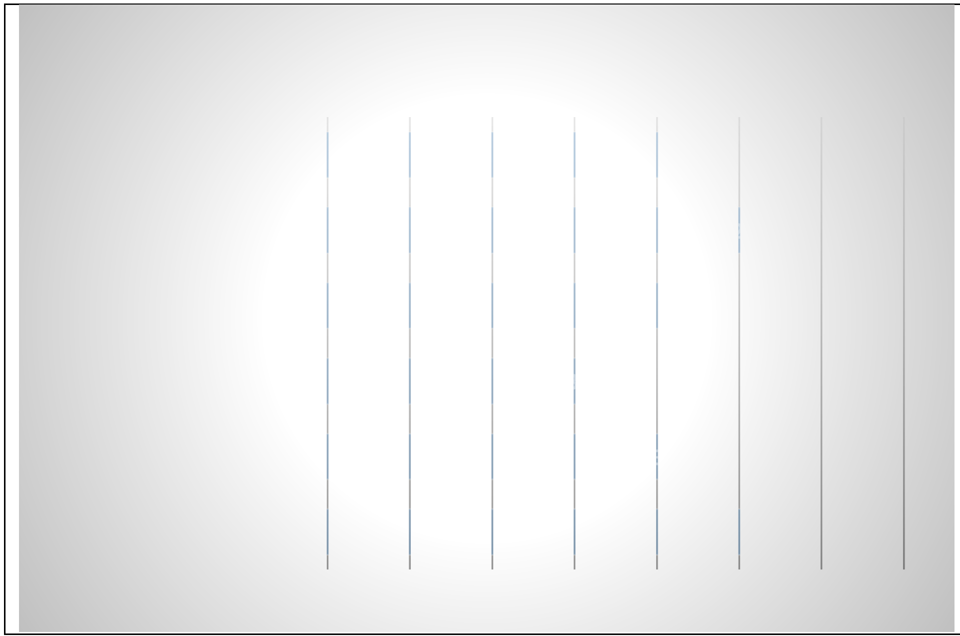
Topic	What Works Well	What Could Be Improved
Baseline Schedule (1.3.1)	WBS and resource estimates to develop baseline schedule.	Scheduled prepared for Countywide Planning & Development work that I administer do not use formal WBS.
	This is done all of the time for Major Rail Capital projects.	Inconsistent enforcement.
	N/A in my line of work.	Not done for the Highway program.
	For larger projects works well.	The PMs should have training on the development and purpose of a WBS to better assist them in the management of their project cost and reporting. Many PMs use a standard WBS that consist of tasks with multiple levels that are not always applicable to the project or required and never used.
	Done for all construction projects.	$100 million and below have insufficient resources to fully implement process.
	Well defined schedules that are phase based and resource dependent exist for major projects.	Need more scheduling resources to provide support to more projects.
	When Metro applies the contractual method for schedule development and monthly status, the critical path and all impacts are easily discerned.	Additional resources required to assure success of this PM practice.
		Requiring a schedule for every capital project at a high level.
		If the contractor does not provide monthly status or does not submit a schedule that is acceptable, Metro must raise this issue to the level of a default.
		Yes, but it is frequently dynamic and not always kept up to date at any given time.
Schedule Mgmt (1.3.2)	N/A in my line of work.	A standardized process would be helpful. Currently the PM's have different approaches and given the complex nature of Metro projects it can be challenging to some stakeholders.
	For larger project practice works	Smaller projects schedules are summarized. Generally contractor produces own working schedule
	Always have a kickoff meeting with contractor.	Nothing.
		Not that I am aware of.
	Almost all major projects have kickoff meetings.	Could standardize for all capital projects.

Topic	What Works Well	What Could Be Improved
Monitoring & Controlling (1.3.3)	Baseline schedule.	PM training for schedule control should be formalized.
	N/A in my line of work.	Enforcement of all the requirements in the baseline schedule and subsequent updates.
	Process described is how it should be done.	Insufficient resources in program management departments cannot be as proactive as described above. Programs want minimal amount of exposure to their programs projects, i.e. highways, CP Regional rail, and Operations.
	Always done.	Need more resources to attend weekly meetings in field.
	Transit project delivery.	Additional project control resources for Highway, Regional Rail and Capital departments to satisfy/deliver the "good PM practice".
	Major capital projects most times include detailed CPM scheduling specifications for schedule management, change management etc.	There is no agency requirement to ensure that all capital projects of a certain size manage with CPM schedules so it is left to a department by department basis with limited results.
	When monthly status updates are provided Metro understands the critical path and can manage it.	Unfortunately this did not happen on the I-405 project and it led to a dispute over delay and which party is responsible.
	Schedule is only controlled most of the time, things like the performance of other agencies controlling utility relocation cannot be controlled, they must be allowed for and adjusted to over time.	Yes, it is monitored but Quality is intentionally not to have involvement with either cost or schedule.
Advanced Techniques (1.3.4)	Critical part analysis.	Advanced techniques not used for types of professional services managed in Countywide Planning & Development.
	N/A in my line of work.	Provide training on specific of this practice.
	Practice deployed on Major Rail projects presently.	Insufficiently resourced to be consistent.
	CPM required on all projects.	Need more Metro staff due to large number of projects.
	Yes CPM analysis is performed on projects where CPM schedule specs are included.	There is no agency threshold for CPM schedules or requirement for CPM schedules on all capital projects above a threshold.
		I am unaware of "advanced techniques" or their use.
		Did not happen on I-405.

Topic	What Works Well	What Could Be Improved
Best Practices (1.3.5)	N/A in my line of work.	Highways, CP, Regional Rail have insufficient resources to do the tasks as stated. Highways has not implemented configuration management to their projects which aborts proper schedule/cost management. Insufficient resources and a choice by highway leadership not to conform to procedures.
	Presently deployed on Major rail projects	Need more staff to do this type of work
	Do not have sufficient staff for such documentation.	
	Schedules are generally managed against baseline plans and variances to baseline are explained for major projects.	Sharing of lessons learned is an area for improvement. Overall project management for program management benefit and lessons learned is not readily shared.
		Not on I-405.
		Not that I am aware of but reference my response on item 1.3.3.
		Most of schedule adherence is heavily impacted by technological risk accepted. Very simple projects with well-tried technology make their schedule comfortably (i.e. Foothill Extension of the Goldline). Very complex projects in areas of vast uncharted utilities (Red Line Subway Segment MOS-1 in Downtown Los Angeles) are more likely to experience delays from uncharted utilities etc. Neither are bad or poorly managed projects. The public needs to be informed when complex projects are undertaken. But truly enormous delays (see Seattle Bertha TBM) can be avoided (as they have been here) by avoiding truly unproven technologies.

Topic	What Works Well	What Could Be Improved
General	All of the basic pieces are in place and used for time management.	I'm not sure that PMIS is being utilized.
	Experienced, well-qualified Metro Project Controls staff are assigned to the Westside Purple Line Extension Projects.	Overall support for schedule management is not always enforced from the top down
	It works well to have a very good management and time management plan to keep things on track and on schedule.	Schedules are affected by complexity of project. Would need to monitor schedule performance while taking into consideration technical and political demands of each project.
	Metro reviewing and monitoring of schedule.	While Time Management is a worthwhile pursuit, most Metro Contractors are unaware of the close coordination that MTA requires, nor the impacts in dealing with City of LA Departments, various utilities, and LA Dept. of Transportation. All of these involvements weigh heavily on any thought of Time Management on a Project.
	Project schedules are prepared, but not necessarily by Program Management.	A greater appreciation and use of managing time tools needs to be encourage.
	Some effective advanced time management techniques are used such as on-line project tools, resource loading.	I am not sure what would be considered advanced techniques for time management.
	The major construction project implement these PM Practices effectively.	Contractor providing an accurate and timely schedule.
	The oversight process is good including the tools and staffing.	Adequate resources Project Management engineering resources to execute project. Resources need to be well trained and capable to execute.
		Need in-house training on different advanced time management techniques and how they are used.
		Contractors historically are reluctant to commit to a schedule at the onset of a project as they only committed limited resources to this topic during the bid phase. Perhaps the procurement process could improve on this commitment from the contractors as it will result in a better implementation phase.

1.4 Cost Management



	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.4.1 Cost Baseline	4	3	4	5	5	5	5	5	4.50
1.4.2 Cost Mgmt	1	3	4	5	5	4	4	5	3.88
1.4.3 Monitoring & Controlling	3	3	4	5	5	5	4	2	3.88
1.4.4 Best Practices	3	3	4	5	5	5	2	4	3.88
Area Average	2.75	3	4	5	5	4.75	3.75	4	4.03

	Participant																												Dept.
E&C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Avg
1.4.1 Cost Baseline	4	1	4	1	3	5	5	4	1	4	5	5	4	5	2	4	4	3	5	5	5	4	4	5	5	5	1	5	3.86
1.4.2 Cost Mgmt	4	1	4	3	2	5	4	4	4	4	5	5	4	5	1	4	4	3	5	4	5	4	4	5	5	5	1	5	3.89
1.4.3 Monitoring & Controlling	3	2	4	3	4	5	5	5	4	3	5	5	4	5	1	3	3	3	5	4	5	4	4	5	5	5	1	5	3.93
1.4.4 Best Practices	4	2	4	5	3	4	5	4	1	4	4	4	3	5	1	3	1	2	5	4	5	4	4	5	5	5	1	5	3.64
Area Average	3.75	1.50	4	3	3	4.75	4.75	4.25	2.50	3.75	4.75	4.75	3.75	5	1.25	3.50	3	2.75	5	4.25	5	4	4	5	5	5	1	5	3.83

	Participant																														Dept.
PMO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Avg
1.4.1 Cost Baseline	3	4	5	3	2	2	5	4	4	5	5	3	2	1	5	4	5	5	2	5	5	5	5	4	4	5	5	5	5	5	4.07
1.4.2 Cost Mgmt	3	4	5	4	3	1	5	2	5	5	3	2	2	1	5	3	5	5	2	5	5	5	5	4	5	3	5	5	5	5	3.90
1.4.3 Monitoring & Controlling	2	5	5	5	3	2	4	2	5	5	4	3	2	1	5	3	5	5	1	5	5	5	4	4	5	3	5	5	5	5	3.93
1.4.4 Best Practices	2	4	4	3	3	3	4	2	4	5	4	3	2	1	5	4	4	5	1	5	5	4	4	4	4	3	5	5	5	5	3.73
Area Average	2.5	4.25	4.75	3.75	2.75	2	4.5	2.5	4.5	5	4	2.75	2	1	5	3.5	4.75	5	1.5	5	5	4.75	4.5	4	4.5	3.5	5	5	5	5	3.91

	Participant											Dept.
VCM	1	2	3	4	5	6	7	8	9	10	11	Avg
1.4.1 Cost Baseline	4	4	3	5	5	5	5	5	5	5	3	4.45
1.4.2 Cost Mgmt	3	4	2	5	5	5	5	5	5	5	3	4.27
1.4.3 Monitoring & Controlling	4	4	3	5	5	5	4	5	4	5	3	4.27
1.4.4 Best Practices	3	4	2	4	4	5	3	5	4	5	3	3.82
Area Average	3.5	4	2.5	4.75	4.75	5	4.25	5	4.5	5	3	4.2

	Participant		
Other	2	4	Avg
1.4.1 Cost Baseline	4	2	3
1.4.2 Cost Mgmt	3	2	2.5
1.4.3 Monitoring & Controlling	5	3	4
1.4.4 Best Practices	4	2	3
Area Average	4	2.25	3.13

Potential Training Opportunity for some of this staff (a total of 14 were highlighted)

Comments Provided by Participants: Note: Singular Comments of “Yes” or “No” have been removed. Red arrows have been included where there are contradictory statements provided by participants

Topic	What Works Well	What Could Be Improved
Cost Baseline (1.4.1)	Estimating group does all of this.	WBS is not always used for professional services procured by Countywide Planning and Development.
	Not aware of this. Have not closed out a project yet.	WBS is not standard nor is an organizational standard set up. Standard cost and financial training is lacking.
	Project Budget prepared/issued based on cost estimation.	consistent organization-wide process
	Identifying scope, common list of cost categories, project WBS is used as framework for cost estimation. Generally cash flow prepared by the cost engineers.	To ensure that the estimates are at least achievable better work package detail would be helpful. Not enough technical staff to support preparation of more detailed work packages. Holding PM’s more accountable for their projects.
	Project budgets are resource based.	The Standard Project WBS isn't consistent across departments of the organization. I don't believe Budget Transfer logs are kept or documented when such transfers occur.
	Metro has a mature Program Control Department with lots of experience. Sometimes project managers in other departments reject standard modular CADD and BIM (building information modeling) designs and costs go way up. Program Control is not responsible for that. Sometimes new untried contracting methods are tried and do not work. Again that is not a fault of the Program Control people. We have and can refine modular station designs and proven techniques. If we use Modular, standard, CADD and BIM developed stations, costs of complex projects will be controlled.	Training definitely could help. No standard WBS is used for each portfolio. Each project creates its own. Nightmare for agency cost rollup. Enterprise requirements needed for portfolio reporting.
	Estimating provides clear and relevant independent estimates.	I have always assumed cost estimates are prepared but have never been involved with them.
	Independent estimates check and balance approach to bidding and changes.	Cost estimates are rarely accurate. Some budgets are set by Engineering Executives based on what will be approved by the Board, not the cost of the project.
		Accuracy of independent estimates to ensure proper funding is provided to projects (ensure construction bids are close to engineering estimate). This could be related to industry conditions and other factors.
		At times, cost estimates are provided with no market support or other evidence to support them. There is a corporate philosophy that estimators are supposed to find the lowest possible number to insert into an estimate, rather than a figure that is reasonable. This makes it difficult to reconcile with contractor's figures, since the contractors are generally establishing market prices.

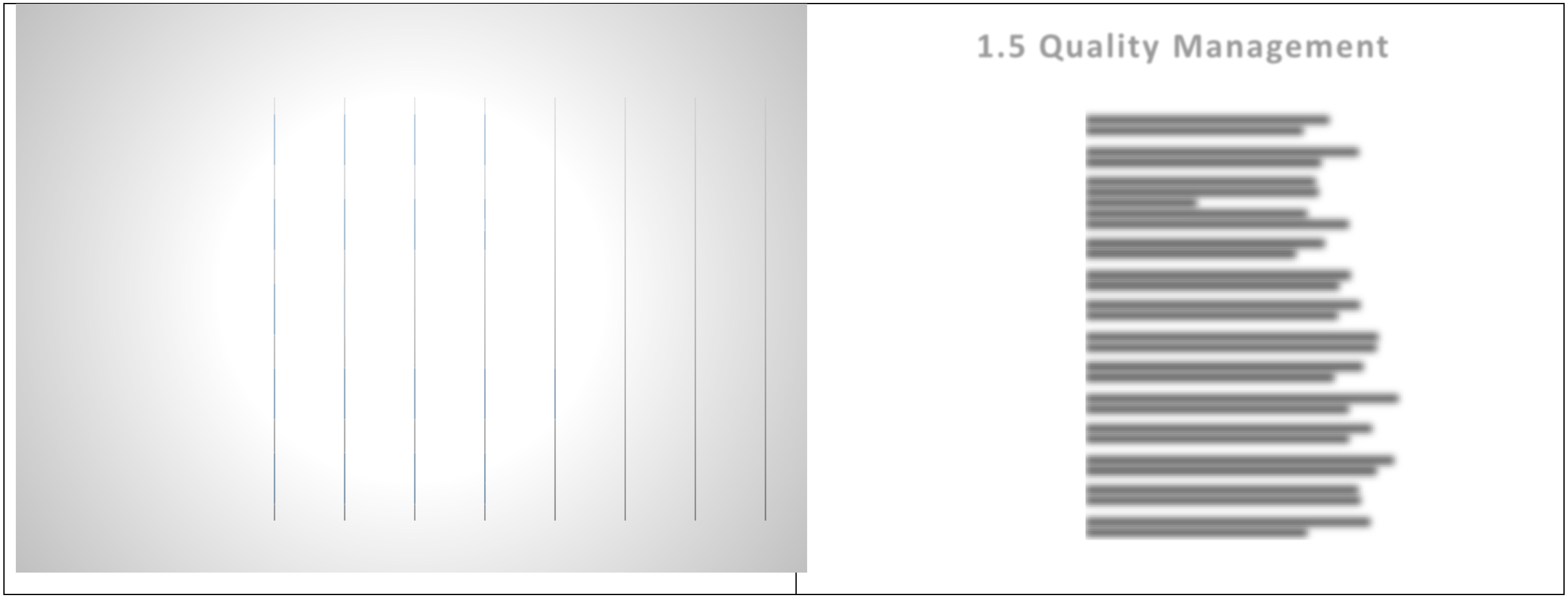
Topic	What Works Well	What Could Be Improved
Cost Mgmt (1.4.2)	Parametric models used as appropriate. Historical data and activity durations are used in support of the estimating process.	Most of practices mentioned have not been used in the projects that my departments has been involved in. Training of Project team members in Cost Management is not practiced but is needed very badly.
	Principles of cost management.	Provide training on specifics of this practice.
	Organizational cost management procedures followed. Cost forecast and trend process performed.	Training offered but project Managers are too busy to attend, then we wonder why things are not consistent. Organization Policies and procedures are not being used consistently. Resource plans as requested on a fiscal year basis by OMB are presented to OMB and disregard resource needs. It is very difficult to do life cycle cost analysis when you do not have the needed resources to the interim steps necessary. Most focus is on the Major Rail Projects. Look for consistency with the other groups within the engineering construction division. The executive Management for major groups have not taken the organizational policies and procedures training. They come from other organizations but never fully get their heads around the Metro way. We have had to resign to the fact that if OMB says no to resources that we can only provide minimal effort. This is true for my group engineering and construction and the whole organization.
		Project team members receive training in financial standards and procedures
		Financial Training for standards and procedures are lacking. Availability to information is a hindrance to departmental reporting and processes. Collaboration amongst departments are required in the agency.
		Cost Performance is monitored always. Very Carefully. But it is not always controlled, especially where a contracting method selected by another agency proves unsuccessful.
		Training program needed. Each project reports independently without consistent format. Requirements for compliance with enterprise reporting would help.

Topic	What Works Well	What Could Be Improved
Monitoring & Controlling (1.4.3)	This is done for Rail (major and improvements projects).	Not applied organization-wide.
	When set up the process as described works fine.	Highways wants to do things itself not per process not per procedure minimizing accountability and transparency. Certain persons in OMB which I have worked with for the last 3 years plus establishing a WBS for highways has fought us at every junction. The WBS is the backbone of Project Management set up and control of projects. Highways group have 400 plus projects of which PC could only focus on the Measure R project setup the rest remain without proper WBS. Again, no resources.
	We have implemented PMIS and Ecosys automated cost reporting.	Some project control staff lack skills to automate their reports.
	It works well in Construction for specific types of projects. The practice is not consistent and depends on the type of project i.e. capital project, highway project, etc.	Enterprise-wide Project Management Information System (PMIS). It does not support 'all' stakeholders and other departments are not involved or setup. For example, the Highway and Regional Rail departments are not using the Configuration Mgmt. module of PMIS which is responsible for Cost Control.
	Project financial processes identified and followed for major transit projects. Change management process enforced.	Enterprise work breakdown structure must be defined and enforced. Requirements to contribute budget and cost forecast within PMIS needed so offline proliferation of spreadsheets is mitigated. Reporting standards needed beyond transit.
	There are current systems in place.	I believe it is, but do not have involvement.
	Monthly invoicing process is clear and well monitored.	Cost control at level 1 and 2 are adequate but the use of provisional sums is less than adequate for controlling costs. The field staff needs to issue clean and complete scopes of work for pricing.
		There are current systems in place that are not being utilized. Methodologies and procedures vary from project team to project team.

Topic	What Works Well	What Could Be Improved
Best Practices (1.4.4)	Close out process.	Earned Value management is not used.
	Monthly cost tracking reports are developed by Project Control.	Provide training on this specific practice.
	Costs tracked per each project specific WBS and reconciled. Transit project costs translated to FTA standard cost categories. Historical project costs captured in estimating database.	This type of practices are not filtered down to departments that support projects such as Engineering. It would be helpful if all stakeholders are engaged in type of practices.
	Actual costing and reconciling works well if set up properly. Procedures call for tracking against budget of original estimates. Changes to budget would go through a rigorous process of scrutiny previous to going to Board for approval.	Increase resources to standardize the rest of the engineering and construction department. I call it METROLIZING. MAINTAINING THOSE RESOURCES to support the projects and attempt to adhere to Project control/management procedures
	Earned Value deployed on Construction projects under construction.	Some people are still using Excel spreadsheets instead of latest Ecosys automated software.
		Cost Estimation. Earned value for Design contracts. The following could be improved for specific departments (i.e. Highway, Regional Rail): "Actual costs are tracked and reconciled with the original estimated costs".
		Lessons learned not readily shared. EVM not utilized. Many cost staff not trained in earned value management methodology.
		There are current systems in place that are not being utilized. Methodologies and procedures vary from project team to project team. There is no standardization for reporting or performing tasks. There is no group cohesiveness. There is a high level of uncertainty and insecurity which causes conflict amongst the teams. There are high levels of resistance from the various teams in regards to adhering the PMO's standards. The systems can be simplified.
		In my experience, history is not used to standardize cost estimates, and market data is not always relied upon.
		I am unaware if best practices exist or are fostered.
		Again, not sure if Best Practices are captured, and used for a Lessons Learned or for an improvement to operating practices on future Projects. The subject is not communicated to Project staff.

Topic	What Works Well	What Could Be Improved
General	Budget Control and Estimating are performing well within all guidelines and procedures.	Not all projects follow the policies and procedures. The attempt is made to follow these procedures but enforcement must be provided from top Management down to lower management. And there must be follow-up by top management.
	Cost management procedures and protocols are more defined on large projects.	Estimating doesn't have the appropriate staff to handle the amount of work they are receiving. Project Managers are providing unclear Scope of Work and that makes it very difficult for Estimating to deliver an end product that is efficient and accurate.
	Program Management Policies and procedures are explicit.	Need more definition requirements and roles and responsibilities on smaller projects.
	Standardized report.	Tying costing to schedule
	The major construction projects implement these Practices well because of the systems that support the project control and contract change management functions.	A consistent understanding, training and responsibility of what the role of cost engineer is.
	You must have good cost estimates and budget oversight.	Individual should be trained on system such as FIS; therefore, individual does not have to rely on the other party.
		Nothing in this area. It is a must.

1.5 Quality Management



	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.5.1 Quality Policy/Plan	1	3	1	4	2	4	5	4	3.00
1.5.2 Audits/Inspections	2	3	1	5	4	4	5	5	3.63
1.5.3 Quality Mgmt	1	3	1	4	4	4	5	5	3.38
1.5.4 Monitoring & Controlling	1	3	3	4	4	4	5	5	3.63
1.5.5 Continuous Improvement	1	3	3	4	4	4	4		3.29
1.5.6 Customer Focus	1	3	4	4	5	3	3	4	3.38
1.5.7 Best Practices	1	3	3	4	4	3	3	4	3.13
Area Average	1.14	3.00	2.29	4.14	3.86	3.71	4.29	4.50	3.35

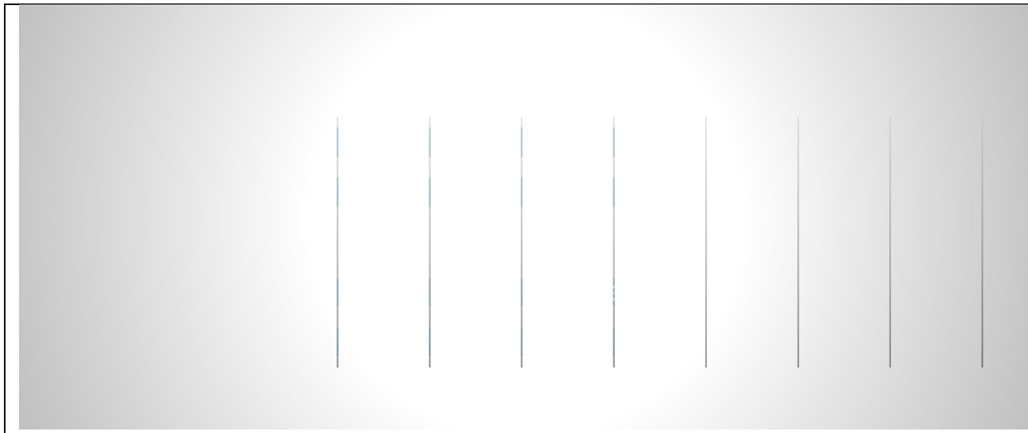
	Participant																												Dept.
E&C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Avg
1.5.1 Quality Policy/Plan	4	2	4	1	2	4	4	4	2	4	5	5	2	4	2	4	1	5	3	5	5	3	2	5	5	5	3	5	3.57
1.5.2 Audits/Inspections	4	4	4	2	4	4	5	5	2	5	5	5	4	5	2	3	2	2	2	5	5	3	2	5	4	4	4	5	3.79
1.5.3 Quality Mgmt	4	3	4	1	3	3	4	5	2	5	4	5	5	5	2	4	2	4	2	5	4	3	4	5	5	5	4	5	3.82
1.5.4 Monitoring & Controlling	4	1	4	1	4	4	4	4	2	5	4	4	3	5	1	4	2	3	2	5	5	3	4	5	5	4	5	5	3.64
1.5.5 Continuous Improvement	4	2	4	1	4	3	4	5	2	3	3	4	3	4	1	3	1	3	2	4	4	3	4	5	5	5	5	4	3.39
1.5.6 Customer Focus	2	3	4	1	2	3	4	5	2	4	3	3	4	4	3	2	1	2	2	3	3	3	2	4	4	3	5	3	3.00
1.5.7 Best Practices	4	4	4	3	2	2	4	4	2	4	3	4	3	5	2	3	1	4	2	3	4	3	4	5	5	4	5	4	3.46
Area Average	3.71	2.71	4.00	1.43	3.00	3.29	4.14	4.57	2.00	4.29	3.86	4.29	3.43	4.57	1.86	3.29	1.43	3.29	2.14	4.29	4.29	3.00	3.14	4.86	4.71	4.29	4.43	4.43	3.53

	Participant																														Dept.
PMO	1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Avg.
1.5.1 Quality Policy/Plan	2	4	5	1	4	2	3	4	4	3	2	1	1	3	5	5	4	1	5	5	5	4	1	4	4	5	5	5	4	3.48
1.5.2 Audits/Inspections	3	5	4	1	3	1	4	4	4	3	4	1	1	3	3	4	4	1	5	5	5	4	1	4	4	4	4	5	4	3.38
1.5.3 Quality Mgmt	3	5	5	1	3	2	1	4	4	1	3	1	1	3	4	5	5	1	5	4	5	3	1	4	3	5	4	5	3	3.24
1.5.4 Monitoring & Controlling	3	4	5	1	3	2	1	4	4	4	1	2	1	3	3	5	5	1	5	5	4	3	4	4	4	5	1	5	3	3.28
1.5.5 Continuous Improvement	3	4	5	1	2	2	1	4	2	1	3	1	1	3	4	4	5	1	4	4	4	4	1	4	3	4	1	5	3	2.90
1.5.6 Customer Focus	3	4	5	3	1	2	5	4	2	2	2	1	1	3	4	1	4	1	4	5	3	4	4	3	3	5	1	5	5	3.10
1.5.7 Best Practices	3	4	4	1	2	2	5	4	2	1	3	1	5	3	4	1	4	1	4	4	3	4	1	3	3	5	1	5	3	2.97
Area Average	2.86	4.29	4.71	1.29	2.57	1.86	2.86	4.00	3.14	2.14	2.57	1.14	1.57	3.00	3.86	3.57	4.43	1.00	4.57	4.57	4.14	3.71	1.86	3.71	3.43	4.71	2.43	5.00	3.57	3.19

Comments Provided by Participants: Red arrows have been included where there is contradictory statements provided by participants

Topic	What Works Well	What Could Be Improved
Quality Policy/Plan (1.5.1)	Not aware of the processes.	Consistent application.
	Project Workbook and Quality Assurance Plan.	Every project does not have a "Project Workbook and Quality Assurance Plan."
	Organizational quality policies managed.	
Audits/Inspections (1.5.2)	Quality Management Procedures.	Consistent application and enforcement
	Well established quality department with staff embedded in projects.	Need more construction inspectors
		Do not utilize enterprise applications for quality management.
Quality Mgmt (1.5.3)	Not aware of this.	Consistent application and enforcement.
	Quality Management Procedures	Need more staff training in Quality Management.
	No knowledge, not included in my work scope.	Department does not utilize enterprise applications for quality management.
	Quality department regularly embeds quality staff for major capital projects.	
Monitoring & Controlling (1.5.4)	Not aware of this.	Inconsistent enforcement.
	Principles of this practice.	Enterprise department metrics in lieu of project only.
	No knowledge, not included in my work scope.	
	Quality reports regularly included in monthly project status reports.	
Continuous Improvement (1.5.5)	Not aware of this.	Inconsistent enforcement.
	Variety of tools and techniques are employed to measure and monitor quality of project delivery.	Stakeholders need to be engaged actively.
	No knowledge, not included in my work scope.	Quality improvement initiatives.
	Project quality control managed quantitatively.	
Customer Focus (1.5.6)	Not aware of this.	Inconsistent enforcement.
	MTA has established quality as core goal.	Depends upon the project provider. Sometimes, the project delivery org is not well-connected to the customer and is not directly accountable to the customer.
Best Practices (1.5.7)	Principles of this practice.	No formal and well defined lessons learned or corrective measures and procedures are in place.
	Quality performs well project by project and consistent with best practices.	Consistent application and enforcement. Enterprise lessons learned sharing.

1.6 Human Resource Management



	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.6.1 Staffing Plan	3	2	2	5	4	3	5	5	3.63
1.6.2 Team Building	3	2	1	5	3	3	2	4	2.88
1.6.3 HR Mgmt	2	2	1	5	3	3	2	3	2.63
1.6.4 Team & Individual Development	3	2	1	5	3	4	2	3	2.88
1.6.5 Collaboration	3	2	2	5		4	2	5	3.29
1.6.6 PM Competencies	2	2	2	5	5	4	4	4	3.50
1.6.7 Mentoring	2	2	1	5	4	4	2	2	2.75
Area Average	2.57	2.00	1.43	5.00	3.67	3.57	2.71	3.71	3.07

	Participant																												Dept.
E&C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Avg
1.6.1 Staffing Plan	3	2	2	5	4	5	5	3	2	5	5	5	4	3	2	4	2	2	4	5	5	4	2	5	4	4	2	5	3.68
1.6.2 Team Building	3	2	3	5	4	5	4	4	4	3	3	2	3	3	4	4	1	2	5	4	4	1	4	5	4	5	2	5	3.50
1.6.3 HR Mgmt	3	2	3	2	4	3	5	4	2	3	3	2	3	3	3	4	1	2	5	4	3	2	4	5	4	4	2	5	3.21
1.6.4 Team & Individual Development	3	1	2	2	2	5	5	4	1	4	2	2	3	3	4	4	1	2	5	4	4	2	3	5	4	3	2	4	3.07
1.6.5 Collaboration	3	2	3	3	3	5	5	4	4	4	5	2	3	3	3	3	2	2	5	5	5	2	3	5	5	5	2	5	3.61
1.6.6 PM Competencies	2	1	3	2	2	3	5	4	1	4	4	4	4	5	3	5	1	2	5	5	5	1	3	5	5	4	2	5	3.39
1.6.7 Mentoring	1	1	1	2	2	3	3	2	1	4	2	2	3	3	3	5	1	1	5	4	4	1	3	5	4	4	1	3	2.64
Area Average	2.57	1.57	2.43	3.00	3.00	4.14	4.57	3.57	2.14	3.86	3.43	2.71	3.29	3.29	3.14	4.14	1.29	1.86	4.86	4.43	4.29	1.86	3.14	5.00	4.29	4.14	1.86	4.57	3.30

	Participant																														Dept.
PMO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Avg
1.6.1 Staffing Plan	3	4	5	3	2	2	5	3	4	4	2	2	2	5	5	2	5	5	2	5	5	4	4	1	3	3	4	4	5	5	3.60
1.6.2 Team Building	3	4	5	4	2	1	5	3	4	4	3	2	1	5	3	3	2	3	1	3	5	3	5	4	2	2	4	4	5	4	3.30
1.6.3 HR Mgmt	3	4	5	1	2	2	5	3	4	3	1	2	1	5	3	3	2	4	1	3	2	1	5	1	3	2	4	1	5	1	2.73
1.6.4 Team & Individual Development	3	4	5	2	2	2	3	2	3	3	1	2	1	5	2	1	3	3	1	3	2	1	4	5	3	2	4	1	5	4	2.73
1.6.5 Collaboration	3	4	5	4	2	2	5	2	3	3	3	2	1	5	2	4	4	4	1	3	3	2	4	4	4	3	4	1	5	3	3.17
1.6.6 PM Competencies	1	4	5	3	2	2	1	2	4	5	3	1	1	5	3	3	5	4	1	5	5	3	4	4	4	2	5	1	5	5	3.27
1.6.7 Mentoring	1	4	5	2	1	2	5	2	2	4	2	1	1	5	3	2	4	3	1	1	1	2	2	5	3	2	2	1	5	4	2.60
Area Average	2.43	4.00	5.00	2.71	1.86	1.86	4.14	2.43	3.43	3.71	2.14	1.71	1.14	5.00	3.00	2.57	3.57	3.71	1.14	3.29	3.29	2.29	4.00	3.43	3.14	2.29	3.86	1.86	5.00	3.71	3.06

Potential Training Opportunity for some of this staff (a total of 25 were highlighted)

Red arrows have been included where there is contradictory statements provided by participants

Topic	What Works Well	What Could Be Improved
Staffing Plan (1.6.1)	Principles of this practice.	Limited resources. Unbalanced workforce.
	Generally works well for Light and heavy rail projects.	This is true for Major projects but needs to be implemented for CIP projects.
	Done for large projects.	Consistent processes for all other projects and program.
	Project roles and responsibilities are established.	Caltrans, our partner on some projects, does not utilize staffing plans. They leave everyone on the project until it is closed out.
	The project organizational chart will identify all roles for the project.	Resources to satisfy "Project roles and responsibilities."
	Staffing plans are developed for all projects.	OMB may thwart staff needed for the project based upon their insular budget review and not based upon criticality of project needs and then further consultant staff budgets may be restricted that thwart project success.
	Staff plans for corridor projects but not other capital improvement projects. Staff resources to support Art Program integration are generally included in corridor projects. Staff resources for Signage are (sometimes) in corridor projects, however no authorization to fill the positions is provided so work cannot be completed.	Many projects are approved which impact departments and /or require support that is not included in LOP or project plans. Staff resources are not included in non-corridor projects. We have to resort to contracts to both manage and coordinate the work program as no FTE positions are authorized to fill.
	I am unaware of the creation of a staffing plan and have no input though I believe they exist.	It is hard to do a real thorough staffing plan as staff is usually very limited due to budget constraints.
	Project staffing plans are prepared and updated routinely.	Roles are not established clearly. There is no OBS. There is no training. Team members are acquired in a nontraditional non-conforming process. The selection process needs to be legitimized.

Topic	What Works Well	What Could Be Improved
Team Building (1.6.2)	Project team.	Reduce the number of supporting staff and levels of management in line with what worked for MRL, MOL, and PGLEE.
	All the points seems to work well except.	Training in team development. Team development is not planned or budgeted.
	A team based approach is followed on some projects.	The Project Team is assembled in one or more Project offices, and they must communicate with the Prime Contractor and the Gateway Office Staff - generally at other locations. The Team consists of seasoned personnel, with a smattering of newly-hired interns/college grads. Team Building is not a huge priority, but it would be fun to have the occasional "Ugly Sweater Contest" or "Tropical Shift Friday," but everyone needs to participate for the Team to benefit in the stress relief. Some Projects have Safety-type awards/giveaways on a Quarterly basis, other Projects have nothing. Some Projects have pot-luck gatherings, others do not. Some Projects have All-Hands meetings to discuss anything of interest, others do not. It all depends upon the PM Team.
	Having a good team assembled to work on the project utilizing each and everyone's strengths.	We need more Metro employees in this office, and need Metro employees to head all departments.
	Yes, they are conducted but seem to be entirely casual, not advanced, or overall planned that I am aware of.	Should allow more than just management to attend team building activities.
	Project team building is sometimes implemented on major projects.	Agency could benefit from teaming on all capital projects as well as teaming at an organizational level from silo to silo.
HR Mgmt (1.6.3)	Key individuals on the project team are identified as critical to project performance and Succession Planning.	There is no formal project risk management for HR for periodic review of HR management activities.
	All points seems to be working.	Limited selection pool.
	HR management procedures exist and generally are antiquated.	WHAT SUCCESSION PLAN?
		Not that I am aware of.
		Agency is quite poor in succession planning. New staff not hired until after staff retire. Extreme loss of talent as a result. OMB has a choke hold on adding any positions regardless of their criticality.

Topic	What Works Well	What Could Be Improved
Team & Individual Development (1.6.4)	Organization-wide procedures for individual/personnel development.	procedures for individual/personnel development relating to design and construction
	Collection of data for training effectiveness. Organizational funds costs of training. Organizational wide procedures exist.	PMP does not describe activities aimed at individual development. What linkage between performance and reward. The sustainers get the recognition and the achievers get the shaft. Program management was elevated in the last reorganization. The consultants recognized that the depth and breadth of talent was in our group to assist in the implementation of Metro processes within the organization. What PC got was more worthless recognition by our executive where he received all the credit, but nothing for his team. Let me say this, no secession plan will yield a decimated Program Management team in the near future. No resources added for FY16, reducing our reach to Metro.
		Team development and mentoring is dependent on each PM's style and approach. It is not always consistent from project to project or even from one department to another.
		I acknowledge that budgets are tight and much has to be built and operated. Our mission is critical to this County. But training is vital and I believe that metro is large enough that we could host annual CEQA and NEPA training at least until all planning staff have had it, in a cost effective manner. NEPA training should be best quality taught by FTA approved providers.
	In no formal way that I am aware of.	Team awards not available. Individuals are not encouraged for personnel development. No minimum standards for training levels identified. No requirement for training hours per year or evaluation thereof. No pay for performance.
	Individual Performance Plan is an HR document for staff below manager.	

Topic	What Works Well	What Could Be Improved
Collaboration (1.6.5)	Project team.	Executives and upper management interference without involving the PM.
	Generally good.	This is not the standard practice within Highways. Program control is not necessarily a team member. Highways would rather act as a separate entity. Again limited resources to be effective.
	Most major projects operate in IPMO format that promotes teamwork.	Generally leadership, team-training and partnering training could be improved.
	Yes, there is much discussion of a team approach.	Department does not have a team based approach such as monthly or quarterly staff meetings.
	Good team work regardless of whether Metro or consultant staff.	Teams are not effective. Team leaders and departments are inexperienced and not management oriented. The project team leaders may be efficient
PM Competencies (1.6.6)	Project team measures itself against performance expectations	Establish guidelines for PM career path, competency model and proficiency charts. Consistent/fair application to all PMs.
	No knowledge, not included in my work scope.	There is no "established career path."
	Attempting to train Project Managers.	Insufficient project controls resources to assist project managers. Insufficient project managers to meet the present and future work.
	Employees below the level of manager receive review and development plans.	Employee contribution to objectives and strategic goals not assessed, no employee development plans above supervisor. Career path progression analysis and assessment is lacking. Employees that obtain professional certification are not recognized within the agency.
	I've never heard ANY function mentioned as a "Core Competency."	No goals have been established. There is no career path available at this time. The organizational structure is not set up to accommodate growth. There is no development plan especially when dealing with a complacent agency where everyone feels their job security is threatened with the addition of a team member. It has been the same set of managers for the past 15+ years with no mobility. The agency is very immature and not structured for program management.

Topic	What Works Well	What Could Be Improved
Mentoring (1.6.7)	Principles of a mentoring program.	There is no formal mentoring program in place.
	Mentoring program worked excellent for me. I have a top notch Entry Level Trainee Program (ELTP) which we trained to do Project Control.	Provide training on this practice.
	We have some entry level training positions.	Having available direct positions once the ELTP fulfills the two year requirement. We lost a great candidate because OMB has this no growth concept. Need to look deep into present policy. Concept of ELTP vs Succession is not working.
	At least Metro has an entry level trainee program.	Formalized mentoring program is needed.
	Not that I am aware of.	A mentoring program.
		This is a hypocritical segment. There is no mentoring, especially when managers feel there livelihood is threatened and are resistant to change or updating the collective intelligence of the group and or team. Skills, capabilities, competencies are below industry standards. If there was a mentoring program, those being mentored will most likely be suspect to resistance, as they have demonstrated.
		It might be helpful if a structured mentoring program was established.
		Limited development, mentoring used to promote individuals career path or promotions. The department does not have a plan or at least what could be shared with the rest of the groups.
		Mentoring might be good, but would have to be fairly distributed. High quality uniform training is probably more crucial.
		Unfortunately there is no such thing as a mentoring program at Metro. Critically there is no measurement to gauge the success of the Entry Level Trainee Program. Sadly a large number of entry level staff leave as OMB does not grant entry level positions in the budget process. OMB should be tied to metrics to manage the ELTP program and ensure that positions are added to the budget to retain staff. More is required to ensure age, minority and gender diversity of staff across departments. Where are the metrics?

Topic	What Works Well	What Could Be Improved
General	Directors are incredibly busy, but generally very caring about their teams. Most staff just need more training including organized presentations for beginners on how to read engineering drawings and especially risk reduction. FTA has risk analysis classes which are important albeit very technical.	1. Staffing is dictated by budget, not by necessity. 2. Mentoring/career growth is mostly nonexistent. 3. Most of the time team members do not report directly to the PM, so there is a disconnect between action and accountability.
		At an organizational level, the Engineering and Construction Department has silos and functional support is not provided because the Engineering staff are not as competent and/or lack the expertise as Metro's consultants.
		Department needs to promote within rather than hire outsider. A lot of staff have been in the same position for more than 5 years.
		More training and guidance is needed. Manpower availability is limited to provide these activities.
		We need more Metro employees in this office, and need Metro employees to head all departments.
		Ensure continuity of staff throughout project to ensure project history is not lost (minimize attrition of key staff).
		Interproject coordination is not very evident
		Larger projects consume resources leaving inadequate staffing for smaller and capital projects. Estimating and scheduling for smaller projects especially.

1.7 Communications Management

	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.7.1 Communications Plan	2	3	2	4	4	4	4	2	3.13
1.7.2 Status Reporting	3	3	2	5	4	5	5	5	4.00
1.7.3 Communication Mgmt	2	3	2	4	4	4	5	5	3.63
1.7.4 Monitoring & Controlling	1	3	2	5	4	5	5	4	3.63
1.7.5 Lessons Learned	2	3	1	4	4	4	3	4	3.13
1.7.6 Best Practices	1	3	2	4	4	3	3	3	2.88
Area Average	1.83	3.00	1.83	4.33	4.00	4.17	4.17	3.83	3.40

	Participant																												Dept.
E&C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Avg
1.7.1 Communications Plan	3	2	3	3	4	5	5	4	1	4	4	5	3	3	4	3	3	3	3	5	5	3	1	5	4	4	4	4	3.57
1.7.2 Status Reporting	4	2	4	5	4	5	5	4	3	4	5	5	4	5	1	3	4	3	5	5	5	3	2	4	5	5	4	5	4.04
1.7.3 Communication Mgmt	3	3	4	5	4	5	5	4	1	3	4	5	4	4	3	3	3	3	5	4	4	3	2	5	4	5	5	5	3.86
1.7.4 Monitoring & Controlling	3	2	4	1	4	5	5	4	3	3	4	5	3	4	2		2	3	5	5	5	3	4	5	5	5	5	5	3.85
1.7.5 Lessons Learned	2	4	4	1	2	5	5	4	1	4	2	2	3	4	3	2	1	2	4	3	5	2	2	5	4	5	5	5	3.25
1.7.6 Best Practices	3	2	3	5	4	4	4	4	1	4	2	4	3	3	4	3	1	3	5	3	5	3	2	5	4	5	4	5	3.50
Area Average	3.00	2.50	3.67	3.33	3.67	4.83	4.83	4.00	1.67	3.67	3.50	4.33	3.33	3.83	2.83	2.80	2.33	2.83	4.50	4.17	4.83	2.83	2.17	4.83	4.33	4.83	4.50	4.83	3.68

	Participant																														Dept.
PMO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Avg
1.7.1 Communications Plan	4	5	4	1	3	2	5	2	3	3	1	3	3	1	2	4	2	3	1	5	5	4	5	1	3	3	3	1	5	4	3.03
1.7.2 Status Reporting	2	4	5	4	3	2	1	2	4	5	3	3	3	5	5	4	5	5	1	5	5	4	5	1	4	3	3	1	5	3	3.50
1.7.3 Communication Mgmt	3	4	5	2	3	2	5	4	4	4	3	3	3	1	3	4	2	3	1	4	2	3	4	4	4	3	3	1	5	3	3.17
1.7.4 Monitoring & Controlling	2	4	5	1	3	2	4	2	4	4	2	3	3	5	3	4	5	5	1	4	4	3	4	4	4	4	5	1	5	4	3.47
1.7.5 Lessons Learned	4	4	5	1	2	2	1	4	3	2	3	2	2	3	3	2	3	3	1	2	1	3	3	1	3	3	4	1	5	3	2.63
1.7.6 Best Practices	3	4	4	1	3	2	5	3	3	3	3	2	2	5	3	4	1	3	1	3	4	2	3	4	3	3	4	1	5	3	3.00
Area Average	3.00	4.17	4.67	1.67	2.83	2.00	3.50	2.83	3.50	3.50	2.50	2.67	2.67	3.33	3.17	3.67	3.00	3.67	1.00	3.83	3.50	3.17	4.00	2.50	3.50	3.17	3.67	1.00	5.00	3.33	3.13

Potential Training Opportunity for some of this staff (a total of 17 were highlighted)

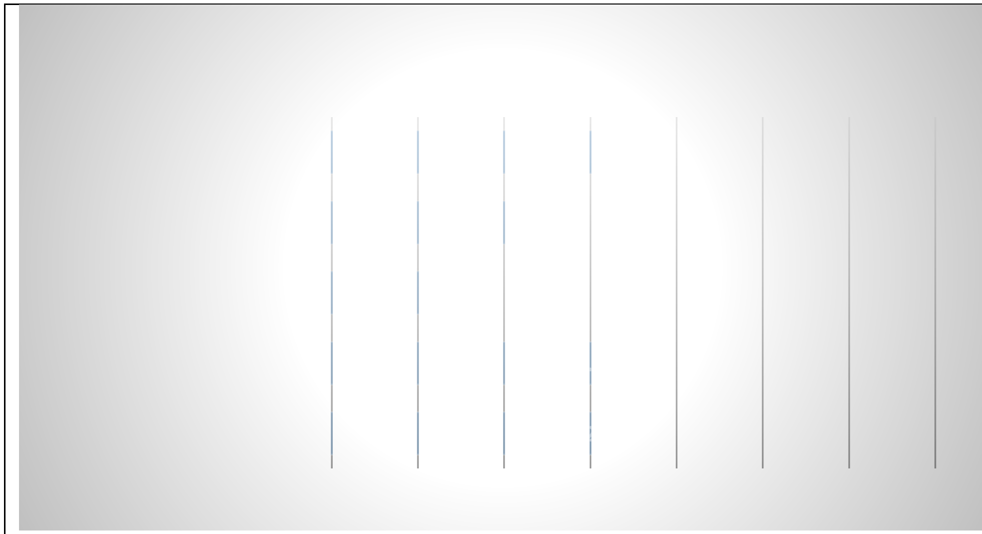
Red arrows have been included where there is contradictory statements provided by participants

Topic	What Works Well	What Could be Improved
Communications Planning (1.7.1)	I am unaware of any "Communication Plan."	The Communication Plan for the Westside Purple Line Projects is tied to the monthly and quarterly FTA monitoring meetings and reports. However, the numerous changes to top personnel in the Metro Communications Department create confusion in the communication ladder between Construction Relations, Community Relations, Government Affairs and Media Relations.
		The communication plan is important and should be shared in some way to all.
Status Reporting (1.7.2)	Project status reports.	Early input from management.
	No knowledge, not included in my work scope.	Highways, regional rail, etc., assist but not necessarily involved with progress reporting, schedule or budget issues. Since they have not adopted systems available most information becomes translucent.
	A standard project progress report is available for the larger projects.	For other departments: "Project status reporting procedures are established and followed." There are none!
	We produce a monthly project status report for all projects.	Monthly or Quarterly Project Status Reports are prepared, and copies are sent around for personal review. No efforts to capture Lessons Learned or Best Practices or needed changes to baseline MTA specifications/guiding documents.
	Transit project delivery, PE/Construction phases.	Project status reports are prepared monthly but no project "review" that I have ever been asked to attend.
	Major transit project status meetings held monthly with management and FTA PMOC.	Project reviews occurring on an ongoing basis but could be formal on an occasional basis.
	Communications and project monitoring for safety, budget and schedule are established on all Metro projects.	
	Project information is documented and distributed in reports and presentations on a regular basis and covers Board, Metro management, and project staff. Regularly scheduled staff meetings and meeting with contractor staff keeps open lines of communications to minimize unforeseen conditions.	
	Project status reports are well written and timely.	

Topic	What Works Well	What Could Be Improved
Communication Mgmt (1.7.3)	I do not have enough knowledge about this area to answer.	Communication outside of the protocol.
	Communication Procedures and Protocols.	Communication Skills training for key team members.
	Practice in play on larger projects.	Communication by executives or upper management outside of the communication protocol and without involving PM.
	Project records very organized and available for access. Project announcements regularly delivered.	Communicate process.
	I do not have enough knowledge about this area to answer.	Sponsors don't always participate actively.
	This is dependent on a good outreach coordinator.	
	Communication responsibilities assigned to a project team member.	
	Not aware of this formal process.	
	Sponsor is identified for each project.	
	There is no communications management performed.	
	The communications department assigns dedicated staff to major projects.	
Monitoring & Controlling (1.7.4)	I do not have enough knowledge about this area to answer.	Training on this practice.
	Not aware of this plan.	Other groups, Highways have yet to adopt progress review performance reporting earned value forecasting and obviously trending. Tries to remain opaque. Not interested with anyone looking over their shoulder. Need more resources to be more effective technical/ PC.
	Communications Management Plan.	EVM not utilized. Performance reporting training not available.
	Practice in play on larger projects.	I believe it is but have little or no input to it.
	Not all aspects of project performance can be controlled. For example other agencies have legal review rights over utility relocation drawings. Delays in reviews are absolutely routine. Other agencies and utilities are not motivated to adhere to schedule and have an adversarial role on budged. Where utilities must be relocated an exact prior estimate of either cost or schedule is unlikely.	Where possible, design projects in ways that allow Metro control of cost and schedule. Projects on Metro ROW and with ROW stations are much more controllable than projects with massive utility relocation. If Metro would use standardized station designs with pre developed BIM material estimates prior to bidding and access to constructed prior examples, cost could go way down.
	Trending program is in place.	
	Trend analysis process is utilized.	

Topic	What Works Well	What Could Be Improved
Lessons Learned (1.7.5)	Have not closed a project yet.	I do not hear about this happening on smaller projects.
	I have seen Lessons Learned on the Major Rail projects.	Support from functional groups.
	Project Close out plan.	Ask highways for a close out plan and if they are using cm14 (contract manager software version) to its full extent, using metro systems.
	No knowledge, not included in my work scope.	Lessons learned not readily shared.
	Practice in play for most projects except highways.	I am unaware of any formal or proceduralized "Lessons Learned" program.
	Project closeout performed and lessons learned captured.	Lessons learned is always paramount in conversation but regarding documentation does not get fully there.
		Currently working to identify lessons learned on all projects and apply in the future. Need to follow up and continue to develop this practice.
Best Practices (1.7.6)	I do not have enough knowledge about this area to answer.	Guidelines on objectives used to measure effectiveness of communications plan.
	Open communication	Clearly defined objectives that are measurable might be the challenge.
	Practice in play for Metro the Organization.	Unaware of any "best practices" in project communications management.
	Communications well structured.	
General	Works for Art Program on corridor projects	Most of these items occur on the larger projects. Smaller projects do not have the manpower or budgets to support this level of effort.
	You do need to have good communication between the various team members and the consultant team. It is critical in keeping the project on track and headed in the correct direction at all times.	We have a slight failure to communicate on this project.
	A good communications group with depth of knowledge while handling the public.	Not effective for Art and Signage on non-corridor projects
		Communications does not always follow the established channels
		I think that it is pretty much a given that you need to have constant communication on your projects.

1.8 Risk Management



	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.8.1 Risk Mgmt Plan	1	3	1	5	4	4	5	4	3.38
1.8.2 Risk Identification	1	3	1	5	4	3	5		3.14
1.8.3 Risk Response	1	3	1	4	4	3	5	5	3.25
1.8.4 Risk Mgmt	1	3	2	4	4	3	5	5	3.38
1.8.5 Risk Implications	1	3	1	4	4	3	4	4	3.00
1.8.6 Risk Communications	1	3	1	5	4	3	4	4	3.13
1.8.7 Best Practices	1	3	2	5	4	3	3	4	3.13
Area Average	1.00	3.00	1.29	4.57	4.00	3.14	4.43	4.33	3.20

	Participant		Dept.
Other	1	5	Avg
1.8.1 Risk Mgmt Plan	2	1	1.5
1.8.2 Risk Identification	4	3	3.5
1.8.3 Risk Response	3	2	2.5
1.8.4 Risk Mgmt	3	2	2.5
1.8.5 Risk Implications	1	2	1.5
1.8.6 Risk Communications	1	2	1.5
1.8.7 Best Practices	1	2	1.5
Area Average	2.14	2.00	2.07

E&C	Participant 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Dept. Avg
1.8.1 Risk Mgmt Plan	4	3	4	4	3	5	5	5	2	4	5	3	3	4	1	2	2	1	4	3	3	3	2	5	5	5	1	5	3.43
1.8.2 Risk Identification	4	2	4	5	3	5	5	5	1	4	5	3	3	4	1	3	1	1	5	3	5	3	2	5	5	5	1	5	3.50
1.8.3 Risk Response	4	2	4	5	3	5	5	5	1	4	5	3	3	4	2	3	1	1	5	4	5	2	2	5	5	5	1	5	3.54
1.8.4 Risk Mgmt	4	2	4	5	3	5	5	4	1	2	5	3	3	4	2	3	2	1	5	3	4	2	2	5	3	5	1	5	3.32
1.8.5 Risk Implications	4	2	4	2	3	4	5	4	1	3	5	3	3	4	2	2	1	1	5	3	4	2	2	5	3	5	1	4	3.11
1.8.6 Risk Communications	4	2	4	1	2	4	5	3	1	2	4	3	3	4	1	2	1	1	5	3	3	3	2	5	3	5	1	4	2.89
1.8.7 Best Practices	3	2	4	2	2	4	4	3	1	2	4	3	3	5	1	2	1	1	5	3	4	3	2	5	3	5	1	5	2.96
Area Average	3.86	2.14	4.00	3.43	2.71	4.57	4.86	4.14	1.14	3.00	4.71	3.00	3.00	4.14	1.43	2.43	1.29	1.00	4.86	3.14	4.00	2.57	2.00	5.00	3.86	5.00	1.00	4.71	3.25

PMO	Participant 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Dept. Avg
1.8.1 Risk Mgmt Plan	2	4	5	1	2	2	1	2	4	4	3	4	2	1	5	3	4	5	1	4	5	4	4	1	3	3	5	5	5	3	3.23
1.8.2 Risk Identification	2	4	5	1	2	3	1	3	4	4	1	3	2	1	5	3	5	5	1	3	4	4	3	1	4	3	5	5	5	4	3.20
1.8.3 Risk Response	2	4	5	1	2	3	1	2	4	4	2	3	2	1	5	5	5	5	1	3	3	3	3	1	3	3	5	5	5	4	3.17
1.8.4 Risk Mgmt	2	4	5	1	2	2	1	2	3	4	1	3	1	1	4	3	4	5	1	5	4	4	3	1	4	2	5	5	5	3	3.00
1.8.5 Risk Implications	2	4	5	1	2	2	1	2	3	3	1	3	1	1	4	3	4	5	1	3	3	4	3	1	3	3	5	1	5	3	2.73
1.8.6 Risk Communications	2	2	5	1	2	2	1	2	4	3	2	3	2	1	3	3	4	4	1	2	3	3	3	1	3	3	5	1	5	4	2.67
1.8.7 Best Practices	2	4	4	1	2	2	1	2	4	3	3	3	1	1	4	4	1	4	1	3	2	3	3	1	3	3	5	1	5	3	2.63
Area Average	2.00	3.71	4.86	1.00	2.00	2.29	1.00	2.14	3.71	3.57	1.86	3.14	1.57	1.00	4.29	3.43	3.86	4.71	1.00	3.29	3.43	3.57	3.14	1.00	3.29	2.86	5.00	3.29	5.00	3.43	2.95

Potential Training Opportunity for some of this staff (a total of 25 were highlighted)

Comments Red arrows have been included where there is contradictory statements provided by participants

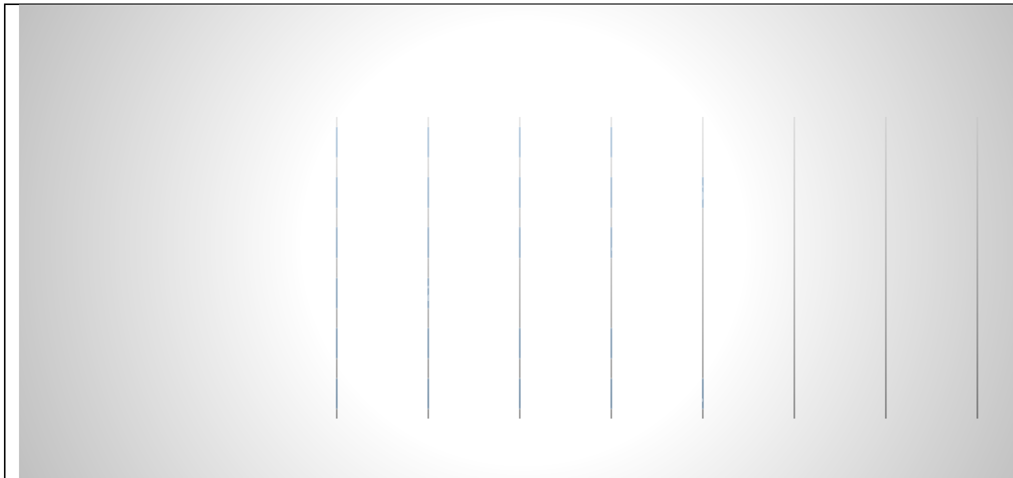
Topic	What Works Well	What Could Be Improved
Risk Mgmt Plan (1.8.1)	This is done on the Major Rail Capital projects.	Can be improved for Rail Capital Improvements and Highway projects.
	Risk Management Approach.	It would be helpful if there was a risk management standard and template for a plan.
	Risks associated with construction method and project completion of well understood.	This practice is typically done only for major projects. It should be practiced on medium to small CIP projects.
	N/A No knowledge, not included in my work scope.	Training on specifics of this practice.
	All FTA funded projects have elaborate Risk Analysis and Risk Management Plans, reviewed during preparation by the PMOC and subject of numerous on site FTA/PMOC visits. Outside risk analyses are usually mandatory (rightly) for mega projects. Small local projects undoubtedly use simpler projects. But my 30 plus years has been primarily focused on the largest mega projects (over one billion dollars) Metro has done.	Am not aware of formal risk management plans for projects <$30M.
	A good Risk Management Plan is essential. However, there are some very small projects that may not require one to be performed.	No Enterprise Wide Risk Evaluation of projects including Risk to the public, and risks of individual project during operation. Risks associated with the failure to do the project are often not done.
	This practice is in force on large projects.	This practice is not necessarily being used on smaller projects.
	We do RISK REGISTERS.	Some people manipulate the soft cost estimate downward causing overruns including upper management projects often lack enough contingency at the start causing overruns.
	Larger projects require risk management plans.	
	Major transit projects most times have detailed risk assessment process per FTA guidelines.	

Topic	What Works Well	What Could Be Improved
Risk Identification (1.8.2)	Complete a high-level risk assessment at the start of each project, and throughout the life of the project.	Early input and consensus from all the stakeholders.
	This assessment works well for risks associated ONLY with project delivery.	This practice typically done only for Major projects. It should be practiced on medium to small CIP projects.
	N/A. No knowledge, not included in my work scope.	Generally by this point, the project scope and breadth is well identified. This type of risk assessments should be done far earlier, even before the project is completed. Post-construction risks not considered. The no-build option risks are not considered.
	For larger projects in play.	Not quite sure that Stakeholders participate in this exercise.
	Risk registers are done.	Inadequate contingencies often plague projects from the start. Board considers change orders to be a failure instead of normal project thing. They don't know or understand project contingency even though it has been explained to them
	Risk Registry is done for all major projects.	New risks adding and mitigated risk removal could be smoother, but this is not a huge issue.
	Risk register is done early and maintained.	Consistent policy for all capital projects above a threshold level.
	Risk assessments performed on major transit projects.	
Risk Response (1.8.3)	Risk Response strategies, action plans and contingency plans.	Input and consensus from stakeholders.
	The insurance and contractual risk transfer elements related to bodily injury and property damage are in place.	This practice typically done only for Major projects. It should be practiced on medium to small CIP projects.
	N/A; No knowledge, not included in my work scope.	Contingency planning for delay, default, claims, is often ad hoc.
	Practice in play on larger projects.	Should be a requirement for all capital projects. Will need resources to assist.
	Works well for major transit projects.	More uniform approach for wider selection of projects.
Risk Mgmt (1.8.4)	Principles of this practice.	Formal training on Risk Management.
	Risk register exists but only for project delivery risks.	More consistent approach for portfolios outside of transit.
	N/A. No knowledge, not included in my work scope.	Formal training in Risk Management not provided. Risk Mgt. not included in review of project risks.
	Practice in play.	Not quite sure if review is accomplished regularly.
	Fostering risk management concept.	
	Risk Management is a requirement for FTA New Starts Projects, that includes all of the above Recommended PM Practices.	
	Works well for major transit projects.	

Topic	What Works Well	What Could Be Improved
Risk Implications (1.8.5)	Principles of this practice.	Training.
	N/A. No knowledge, not included in my work scope.	Cannot assess because our Department not included in any of these activities.
	Practice in play on larger projects.	I do not believe Risk Management issues are incorporated into PMIS.
	Sophisticated risk tools/models applied for major transit projects and managed offline in spreadsheets.	Risks not yet part of PMIS although already architected. Need requirement to enforce compliance by project managers. Response audits not performed.
		There is no Risk Relevant Software.
Risk Communications (1.8.6)	Principles of this practice.	PCG coordination.
	N/A. No knowledge, not included in my work scope.	This practice typically done only for Major projects. Should be practiced on medium to small CIP projects.
	Practice in play on larger projects.	Cannot comment. Not included in these processes.
	Works well for major transit projects.	Stakeholders?
		More universal approach across wider array of projects.
Best Practices (1.8.7)	Principles of this practice.	Earned Value management not used.
	N/A. No knowledge, not included in my work scope.	Provide training on the specifics of this practice.
	Practice in play on larger projects.	This practice is typically done only for Major projects. Should be practiced on medium to small CIP projects.
	Project control procedures exist.	Risk Management not included in any of these processes.
		I have not verified as to all points described are followed.
		Additional Resources. Comment is applicable to ALL 1.8: Risk Management is not being performed for the life-cycle of a project. Earned value is not deployed across all phases of a project and is not used in other departments i.e. capital, highway, regional rail, etc.
		Risk management templates needed. EVM (earned value management) not utilized. Historical data not shared as part of lessons learned analysis.
		Limited resources make it difficult to do the follow up required by best practices. Smaller projects appear to not have documented up front risks making it difficult to track and keep projects on time.

Topic	What Works Well	What Could Be Improved
General	The risk identification, monitoring, and mitigation process is dynamic and ongoing. Individuals from different parts of the project contribute to ensure a holistic view of possible risks.	Again, these activities are practiced on the larger projects, the smaller projects do not have the manpower and budget to get to this level of effort.
	Risk management is in place and used during the planning stages of the project.	Not aware of the Risk Management involvement, no communication about the process or the group involved.
		Not familiar with the Risk Assessment process of the projects. Metro CM provides risk evaluation during the constructability review process. However, Metro Engineering does not always request a constructability review.
		On all major projects for which I have managed Quality: Green Line, Red Line, Pasadena Blue Line, MGLEE, I-405 and CLAX I have never been aware of a Risk Management plan or the components that would be contained in such. I feel Quality ought to be an integral component considered.
		More sharing of contractor perceived risks with Metro to factor this consideration into Metro risk mitigation - contractor's option.
		These answers refer to Metro Mega Projects, usually conducted with Federal Funds. Simple small, routine projects, i.e. painting a small building, may not have or need such involved procedures. Most senior planners and engineers take FTA approved Risk Analysis training and attend many meetings on this with FTA/PMOC. What can be improved is always sending junior staff to FTA approved training and even more meetings with peer agencies on their experiences.
		I would recommend nothing.
		My opinion is Risk is one of the triad elements of good project management and should be practiced with the same intensity as scheduling and cost control. We should be evaluating the items of risk in planning during the construction process and adjusting as we proceed. The contractors should be included in the process.

1.9 Procurement Management



	Participant								Dept.
CP&D	1	2	3	4	5	6	7	8	Avg
1.9.1 Procurement Plan	2	3	5	5	5	2	5	5	4.00
1.9.2 Contract Administration	4	4	3	4	5	5	4	5	4.25
1.9.3 Contractor Performance	3	2	2	5	5	4	5	5	3.88
1.9.4 Lessons Learned	2	3	2	4	5	3	2	5	3.25
1.9.5 Project Partnering	2	2	1	5	5	4	5	4	3.50
1.9.6 Best Practices	2	3	2	5	5	3	3	5	3.50
Area Average	2.50	2.83	2.50	4.67	5.00	3.50	4.00	4.83	3.73

	Participant			Dept.
Other	2	4	5	Avg
1.9.2 Contract Administration			4	4.00
1.9.3 Contractor Performance	5	3		4.00
1.9.4 Lessons Learned	1	2		1.50
1.9.5 Project Partnering	1	3	2	2.00
1.9.6 Best Practices	1	1		1.00
Area Average	2.00	2.25	3.00	2.30

E&C	Participant 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Dept. Avg
1.9.1 Procurement Plan	3	3	4	1	3	5	5	4	1	2	5	2	3	4	2	2	2	4	5	1	4	4	2	4	5	5	1	5	3.25
1.9.2 Contract Administration	3	4	4	5	4	5	5	4	5	4	5	3	4	5	2	5	2	4	5	5	5	4	4	5	5	5	1	5	4.18
1.9.3 Contractor Performance	3	2	4	1	3	5	5	4	1	3	2	4	3	4	3	3	3	4	5	4	5	4	2	4	4	4	1	5	3.39
1.9.4 Lessons Learned	3	4	4	1	3	5	5	4	1	3	2	2	3	4	3	3	2	3	5	2	4	3	2	5	4	4	1	5	3.21
1.9.5 Project Partnering	3	2	2	1	4	1	5	3	4	3	4	4	3	4	4	3	1	3	5	3	5	1	2	5	5	5	1	5	3.25
1.9.6 Best Practices	3	2	4	1	3	3	5	3	1		3	3	3	5	3	2	1	3	5	3	4	4	2	5	4	3	1	5	3.11
Area Average	3.00	2.83	3.67	1.67	3.33	4.00	5.00	3.67	2.17	3.00	3.50	3.00	3.17	4.33	2.83	3.00	1.83	3.50	5.00	3.00	4.50	3.33	2.33	4.67	4.50	4.33	1.00	5.00	3.40

PMO	Participant 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	Dept. Avg
1.9.1 Procurement Plan	4	4	5	2	3	2	1	4	4	4	4	4	4	1	4	2	4	3	2	4	4	1	4	1	4	4	5	1	5	2	3.20
1.9.2 Contract Administration	4	4	5	1	5	2	5	4	4	5	4	4	4	1	5	2	5	3	2	4	4	2	4	1	4	5	5	5	5	5	3.77
1.9.3 Contractor Performance	4	4	5	2	2	2	5	2	4	4	3	3	3	1	3	2	4	3	1	4	4	2	3	1	4	4	4	1	5	4	3.10
1.9.4 Lessons Learned	4	4	5	1	2	2	1	3	4	4	4	2	3	1	2	2	1	3	1	3	4	1	3	1	4	4	5	1	5	1	2.70
1.9.5 Project Partnering	4	3	4	1	3	2	5	4	4	3	5	2	3	5	2	4	4	4	1	5	4	2	3	1	4	2	5	5	5	4	3.43
1.9.6 Best Practices	4	4	4	2	2	2	5	3	3	3	4	2	3	5	1	3	1	3	1	4	4		4	1	4	4	5	5	5	4	3.28
Area Average	4.00	3.83	4.67	1.50	2.83	2.00	3.67	3.33	3.83	3.83	4.00	2.83	3.33	2.33	2.83	2.50	3.17	3.17	1.33	4.00	4.00	1.60	3.50	1.00	4.00	3.83	4.83	3.00	5.00	3.33	3.25

VCM	Participant 1	2	3	4	5	6	7	8	9	10	11	Dept. Avg
1.9.1 Procurement Plan	4	4	4	5	4	4	5	5	2	5	5	4.27
1.9.2 Contract Administration	4	4	4	5	5	5	5	5	4	5	3	4.45
1.9.3 Contractor Performance	4	4	2	5	4	3	4	4	2	4	3	3.55
1.9.4 Lessons Learned	5	4	1	5	4	3	3	5	3	4	3	3.64
1.9.5 Project Partnering	2	1	2	2	4	4	3	4	3	4	3	2.91
1.9.6 Best Practices	2	2	2	1	4	3	3	5	5	5	3	3.18
Area Average	3.50	3.17	2.50	3.83	4.17	3.67	3.83	4.67	3.17	4.50	3.33	3.67

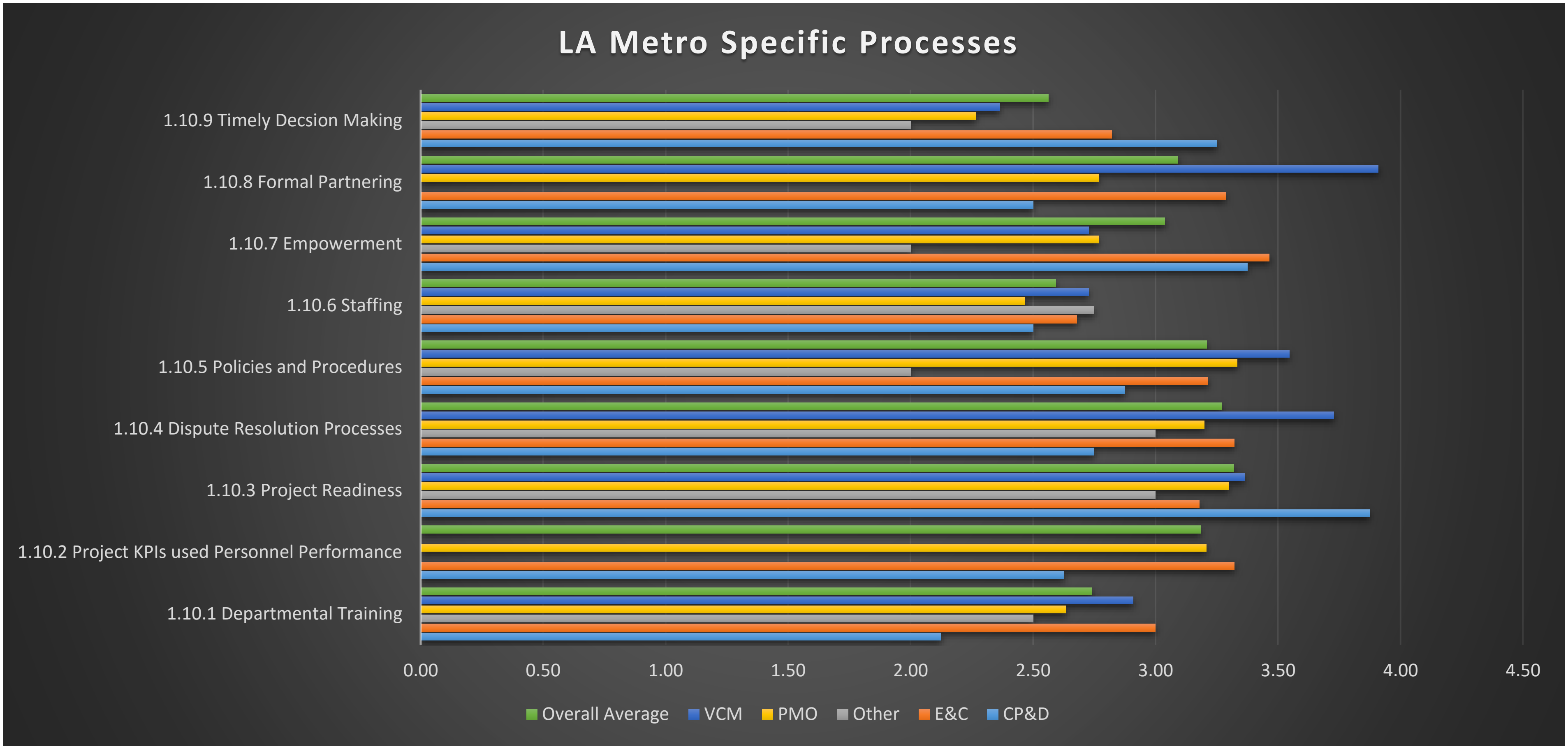
Topic	What Works Well	What Could Be Improved
Procurement Plan (1.9.1)	I do not have enough knowledge about this area to answer.	Experienced staff to provide input. Do not allow decisions based on input from inexperienced staff or staff that does not have an overall understanding.
	Risk assessment conducted on procurements. Contract types evaluated/assessed for application.	Insufficient procurement managers to execute smaller projects on time. Again, you cannot expect to take on double or triple the work without providing resources. Problem going back at least 5 years.
	N/A. No knowledge, not included in my job description.	Need more procurement staff
	Process appears to be satisfactory.	I am unaware of a procurement plan on projects, though I would assume someone within Contract Administration prepares such
	Formal procedures payments tied to earned value.	
	Very sophisticated process for major procurements.	
Contract Administration (1.9.2)	I do not have enough knowledge about this area to answer.	Consistent enforcement of contract requirements.
	Progress status updating.	It would be helpful if there was a different contract for architectural and engineering work vs. contractors.
	Contract Administration has always been an integral part of each project that I have been associated with.	Ensure follow through with competent managers.
	Practice in place.	Enhancements for professional service contracts.
	Schedule specifications are part of all contracts.	
	Very structured approach for major procurements.	
Contractor Performance (1.9.3)	I do not have enough knowledge about this area to answer.	Consistent enforcement of this practice. Records are prepared and maintained from supplier performance reviews. A contract closeout process that records the evaluation of supplier performance in meeting their contact requirements is documented.
	I am unaware of any supplier or subcontractor performance monitoring though nearly all Metro projects are now Design Build so this would be the responsibility of the Design-Builder.	1.9.3 and 1.9.4 Use modular standard, previously tested designs for stations and track work. Have complete records of bottoms up costs including both materials and labor based on earlier projects available at project onset. Review prior designs and require written justification for changes giving special management attention to those promising cost reduction at low risk. Use AREMA or other industry standard track work solutions unless innovation is overwhelming necessary. Standardization increases safety and decreases life cycle cost.
	Formal Procedures.	Not that confident that the close-out process is being adhered to.
	Process in place.	Supplier performance review and lessons learned documentation.
	Needs works.	The agency lacks in the practice of documenting poor performance. Project Managers must identify breaches early to effect improved performance and to assess past performance for new awards.
	These processes are in place.	

Topic	What Works Well	What Could Be Improved
Lessons Learned (1.9.4)	I do not have enough knowledge about this area to answer.	Active participation from CA. Lessons learned database exists. Lessons learned summary prepared for each procurement.
	Formal procedure exists to facilitate project close-out	Responsibility for who is required pushing the clos-out not clear.
	N/A; No knowledge, not included in my job description.	No lessons learned summary.
	There is a defined process in place.	Lessons learned process improvements and addition of enterprise available database.
	I am unaware of any formal, proceduralized Lessons Learned program at Metro.	1.9.3 and 1.9.4 Use modular standard, previously tested designs for stations and track work. Have complete records of bottoms up costs including both materials and labor based on earlier projects available at project onset. Review prior designs and require written justification for changes giving special management attention to those promising cost reduction at low risk. Use AREMA or other industry standard track work solutions unless innovation is overwhelming necessary. Standardization increases safety and decreases life cycle cost.
	Project Closeout checklist exists.	Lessons learned documentation needs to be distributed widely so that past performance assessments can to completed.
	Needs work.	
Project Partnering (1.9.5)	I do not have enough knowledge about this area to answer.	Consistent enforcement Partnering agreements.
	Signed Partnering agreements.	Not all projects are in PMIs.
	Process to be in place.	Partnering should be applied to all capital contracts above a threshold.
	Major transit projects have partnering agreements.	Yes, partnering is practiced on major Metro projects though dedication to this entirely at the whim of the Project Director and effective based on the competency of the facilitator hired.
	I am not aware of subcontractors having access to PMIS.	Have not experienced much formal partnering on large or small projects.
Best Practices (1.9.6)	I do not have enough knowledge about this area to answer.	Strategic alliance not in place.
	Principles of this practice.	Provide easy access to data and training on this practice.
	Not totally versed on detailed internal process.	Not sure if there is a Knowledge Management system to review.
	We must go with low bidder by law.	I am only aware of this occurring on the largest capital projects.
	Needs work.	
	I am unaware of best practices in procurement management.	
	Metro does partner with the AGC to assess mutual strategic goals for the agency and private industry. Assessment of estimates and contract methods are reviewed and analyzed by all parties.	

Topic	What Work Well	What Could Be Improved
General	A procurement plan is essential but I think most people at Metro recognize that. It is pretty much a given.	Coordination with Design Builders procuring artwork fabrication and installation services.
	All procurements start with a well thought out procurement plan. The agency has implemented an Integrated Project Management Office on major construction projects. This model should be implemented on critical system contracts. Supplier and subcontractor performance if effectively monitored on major construction projects.	Again, lack of manpower, oversight, budget and the overall willingness to accomplish these activities is lacking.
	Contract Administrators work well with Project staff.	Contract Administration deals with issues that are way beyond my typical involvement on a Project. They are the "iron fist in a velvet glove."
	For buy America items, audits are being performed to ensure the contractor is ensuring compliance. A good concept but only time will tell if completely effective in ensuring compliance by contractor. Procurement and contract administration processes are generally good.	Desk instructions for those who are coming in new to the department. Proper training and sharing of knowledge is difficult to come by due to work load and inconsistencies in procedures.
	For large projects, a Project Controls Manager is assigned to the project. This provides expertise and consistency for budget and schedule throughout the life of project.	Numerous changes in the MTA Procurement Department have created inefficiencies and disputes regarding interpretation and application of various MTA Procurement Policies and Procedures.
	I do not know too much about the performance aspects. I do know that contract administration has an active role in the project.	Sometimes the Procurements can take a little too long due to a shortage in personnel.
	Largest projects retain best resources to continue on next project a major plus.	The planning and program department is very weak in partnering with the procurement department and needs to improve its project management skill set.
	These answers are based on Metros Mega Projects (over 1 billion dollars) and other rail projects that were still large even though not over one billion dollars.	Partnering not established early enough on Project.
		Procurement plan is partly the responsibility of the contractor. The proactive planning of the contractor, including timely involvement of their subcontractor(s) impacts timeliness of procurement for long lead and other items. Buy America components of projects are a risk caused by the contractor's traditional method of procurement which includes bidding to different vendors. If some vendors determined to be non-compliant there could be impact to the project even though it is the contractor's responsibility to ensure compliance.

		Conformed documents verification for accuracy prior to issuance to contractor as part of the contract. Sufficient senior procurement staff needed.
		Significant issues with procurement doing things in a timely way.
		Contract and other provisions should be implemented or removed.
		We have attempted to get early involvement from our procurement and work with the project team for an easier transition to the procurement cycle. Today procurement could not tell you weeks in advance who the agent will be since they have the same issue in Program Management no people.

1.10 LA Metro Specific Processes



	Participant																															Dept.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg
CP&D Average	1.89	2.67	1.78	4.33	3.78	3.11	2.56	2.89																								2.88
1.10.1 Departmental Training	1	3	1	3	3	4	1	1																								2.13
1.10.2 Project KPIs used Personnel Performance	2	3	1	5	3	3	3	1																								2.63
1.10.3 Project Readiness	3	3	4	5	5	3	3	5																								3.88
1.10.4 Dispute Resolution Processes	1	3	1	5	4	3	1	4																								2.75
1.10.5 Policies and Procedures	1	3	1	5	4	4	3	2																								2.88
1.10.6 Staffing	1	2	2	2	3	4	2	4																								2.50
1.10.7 Empowerment	4	3	1	4	5	4	2	4																								3.38
1.10.8 Formal Partnering	1	2	3	5	2	1	4	2																								2.50
1.10.9 Timely Decision Making	3	2	2	5	5	2	4	3																								3.25
E&C Average	3.11	2.00	3.00	1.67	3.00	4.89	4.44	3.44	1.44	2.78	2.00	2.89	3.11	3.78	3.44	3.67	1.11	2.33	4.00	3.33	3.89	1.67	2.00	4.11	4.22	4.56	3.56	4.56				3.14
1.10.1 Departmental Training	4	2	4	2	4	5	4	4	1	2	1	2	3	4	3	5	1	2	3	3	3	1	2	4	4	4	2	5				3.00
1.10.2 Project KPIs used Personnel Performance	4	4	3	4	3	5	5	3	1	2	2	3	3	4	3	4	1	2	4	5	3	1	2	4	5	5	5	3				3.32
1.10.3 Project Readiness	3	2	3	3	3	4	4	4	1	3	2	3	3	4	3	3	1	2	5	5	4	2	2	4	4	5	2	5				3.18
1.10.4 Dispute Resolution Processes	3	1	2	1	2	5	5	4	4	3	2	2	4	4	4	4	1	3	5	3	4	2	2	4	5	5	4	5				3.32
1.10.5 Policies and Procedures	3	2	4	1	3	5	4	4	1	2	2	4	3	4	3	5	1	2	3	2	4	3	2	5	4	4	5	5				3.21
1.10.6 Staffing	4	1	2	1	2	5	5	4	1	2	2	3	3	3	3	4	1	2	3	2	4	1	2	3	3	4	2	3				2.68
1.10.7 Empowerment	3	3	4	1	3	5	4	4	1	4	2	4	3	3	4	4	1	3	5	4	5	2	2	5	5	5	3	5				3.46
1.10.8 Formal Partnering	3	2	2	1	4	5	5	2	2	4	3	3	3	4	4	2	2	3	5	3	4	1	2	5	4	5	4	5				3.29
1.10.9 Timely Decision Making	1	1	3	1	3	5	4	2	1	3	2	2	3	4	4	2	1	2	3	3	4	2	2	3	4	4	5	5				2.82
PMO Average	3.67	4.00	4.33	2.00	2.22	1.11	2.67	3.44	2.67	3.33	3.78	2.00	2.44	2.67	2.11	2.33	3.22	2.78	1.00	2.78	2.00	2.78	2.56	2.11	2.89		3.11	4.33	3.33	4.78	3.89	2.88
1.10.1 Departmental Training	3	4	4	2	1	1	2	3	4	4	4	1	3	5	3	1	2	3	1	1	1	1	2	5	2		2	3	1	5	5	2.63
1.10.2 Project KPIs used Personnel Performance	5	5	4	3	2	1	5	3	1	4	5	2	3	5	2	3	3	3	1	1		5	3	1	2		2	4	5	5	5	3.21
1.10.3 Project Readiness	4	4	5	3	2	1	5	3	3	4	4	3	2	1	2	2	4	3	1	5	4	4	3	1	4		4	5	4	5	4	3.30
1.10.4 Dispute Resolution Processes	4	4	5	3	3	1	1	4	3	3	5	3	3	1	3	2	3	3	1	4	1	2	3	4	3		4	5	5	5	5	3.20
1.10.5 Policies and Procedures	4	5	4	1	3	1	2	4	3	3	2	3	2	5	2	4	4	2	1	3	3	5	2	4	4		4	5	5	5	5	3.33
1.10.6 Staffing	3	4	5	2	2	2	2	4	2	2	3	1	2	2	1	1	4	2	1	4	2	2	2	1	2		4	4	4	3	1	2.47
1.10.7 Empowerment	4	4	4	1	2	1	4	4	2	4	4	2	3	1	2	2	4	3	1	2	1	2	3	1	3		3	4	4	5	3	2.77
1.10.8 Formal Partnering	5	4	4	2	2	1	1	3	3	3	4	1	3	3	2	4	4	3	1	3	2	2	2	1	3		2	5	1	5	4	2.77
1.10.9 Timely Decision Making	1	2	4	1	3	1	2	3	3	3	3	2	1	1	2	2	1	3	1	2	2	2	3	1	3		3	4	1	5	3	2.27

VCM Average	2.75	3.75	2.88	2.75	3.63	2.88	3.00	3.88	3.63	3.75	1.88																					3.16
1.10.1 Departmental Training	3	3	2	2	4	2	4	4	2	5	1																					2.91
1.10.3 Project Readiness	3	4	3	3	4	3	3	4	4	5	1																					3.36
1.10.4 Dispute Resolution Processes	4	5	4	4	4	3	3	4	4	4	2																					3.73
1.10.5 Policies and Procedures	2	4	4	2	3	3	4	4	5	5	3																					3.55
1.10.6 Staffing	3	4	2	3	3	3	1	3	4	3	1																					2.73
1.10.7 Empowerment	3	4	2	3	3	3	3	4	2	2	1																					2.73
1.10.8 Formal Partnering	2	3	4	3	5	3	3	5	5	5	5																					3.91
1.10.9 Timely Decision Making	2	3	2	2	3	3	3	3	3	1	1																					2.36
Other Average		2.40	2.20	2.40	2.40																											2.35
1.10.1 Departmental Training		4	2	2	2																											2.50
1.10.3 Project Readiness					3																											3.00
1.10.4 Dispute Resolution Processes					3																											3.00
1.10.5 Policies and Procedures		1	2	3	2																											2.00
1.10.6 Staffing		4	2	3	2																											2.75
1.10.7 Empowerment		1	3	2																												2.00
1.10.9 Timely Decision Making		2	2	2																												2.00
Overall Average	2.86	3.00	2.90	2.65	3.05	3.00	3.17	3.40	2.54	3.27	2.58	2.44	2.78	3.22	2.78	3.00	2.17	2.56	2.50	3.06	3.00	2.22	2.28	3.11	3.56	4.56	3.33	4.44	3.33	4.78	3.89	2.99

Comments

Topic	What Works Well	What Could Be Improved
Departmental Training (1.10.1)	PMO started a Project Management Academy, which addresses capital project delivery.	Not in Countywide Planning & Development.
	Principles of this practice.	Need more training and development that are department specific.
	A training Academy that requires all PMs to attend has been established and implemented to assist in the deliverance of Metro project.	Maybe we do develop some more specific department training and development plans. Those seem to be lacking.
	PM training class in progress.	Not all departments have attended the training yet.
	Plans clear but not necessarily shared with the rest of the team members.	Specific trainings.
	There is PM and CA training that is now being applied. The PM academy is a good first step.	My department does not have a specific training/development plan for the staff. Just found out that each person has $1,000 available to spend on training for the FY.
	Training in place for PMIS systems.	Rarely. Many PMs are maintenance managers and this is not their primary line of business.
	I don't believe that we have too much department specific training and development plans as each group does very different projects. You would need to do some general Project Management training.	While there are good policies and systems, the increase in Capital Projects has increased Metro staffing. This has created a need for training and mentoring to ensure compliance with policies and effectiveness in implementation of systems.
		Communications across multiple silos. Focusing as a team on task at hand.
		Need more training for ELTP's.
		No departmental training plans.
		There is no department-specific training or development plan in Quality Management.

Topic	What Works Well	What Could Be Improved
Personnel Performance (1.10.2)	There is considerable variation between team performance on cost and schedule adherence. For example one team has twice engineered very large projects on time and on budget. Not all projects turn out as well. Admiral Rickover said that an agency working on the cutting edge of technology must strive to be continually improving. That certainly applies to Metro.	IPP process lacks rigor and commitment, and while tied to agency wide "Budget Themes," do not always clearly correspond to department goals.
	Goals and objectives.	PM control on achieving these goals and objectives.
	With my team it is a must. That comes with good communication going outside of my team things get convoluted with different set of goals.	I have been writing Metro Performance Evaluations for 24 years and do not recall ever including KPI's into an employee's evaluation.
	KPI's sometimes included but not acted on by management.	Focused direction with the authority to replace sustainers.
		Documented expectations must be identified. Repercussions for non-compliance required.
Project Readiness (1.10.3)	Principles of this practice.	Enforce project readiness.
	This concepts as a goal works well.	Extraneous circumstances beyond project cannot be anticipated.
	Project stage gate reviews are held regularly and very disciplined for major transit projects.	I have little involvement in project award other than to participate in the review of bidder's proposals during the procurement process. PQM has little involvement in the writing of project-specific requirements before being assigned to a project.
		Process more relaxed for other capital projects.
Dispute Resolution Process (1.10.4)	I do not have enough knowledge about this area to answer.	Not applicable in Countywide Planning & Development.
	A formal dispute resolution ladder.	Consistent enforcement of a formal dispute resolution ladder.
	N/A. No knowledge, not included in my job description.	Has not worked in Metro's favor generally.
	It is set up for projects.	Agency wide partnering mentality needed to avoid disputes needed where possible and practical.
	Quality has little involvement in the dispute resolution process though I am aware only one exists.	Dispute Review Board was late in being implemented to update requirements for all projects.
	Yes. The new Construction Change Order process defines the timeline.	
	Disputes resolution contractually identified with established timelines.	

Topic	What Works Well	What Could Be Improved
Policies and Procedures (1.10.5)	There are well established policies and procedures.	Not applicable in Countywide Planning & Development.
	I do not have enough knowledge about this area to answer.	Consistent use of IPD.
	Integrated Project Delivery (IPD) techniques for design build projects.	Should be done more often.
	I have never reviewed a policy/procedure for capital project delivery.	Ad-hoc only. No formal process.
	Policies and procedures are more than adequate here at Metro.	IPD strategies for all major capital projects.
	There are good policies and systems.	With unlimited time and unlimited money this concept would be great.
	Concept great. As time goes on and changes or problems arise team tend to move to their employer's position.	
	IPD strategies utilized for major transit projects.	

Topic	What Works Well	What Could Be Improved
Staffing (1.10.6)	Staffing plans are developed.	Staff is spread too thin.
	Detailed staffing plans with project transition plans.	Adequate staffing is an issue every year. OMB does not approve enough Metro FTEs for successful project delivery.
	Resources are inadequate for providing Metro estimating services for small (<$30M) and capital program projects.	Inconsistent input or support from executives and upper management on appropriate staffing/transition plans.
	This is what we strive for.	Staffing planning almost non-existent as it relates to CIP projects. Individual staff is sometimes allocated at 150% to 200%.
	Metro staffing is of high quality.	Shortage of CADD, Engineering and CM Resources
	Staffing plans are regularly prepared.	I can only speak to Quality and staffing levels are unacceptably low, borderline ineffective in truly monitoring DB activities. This was documented on I-405 MASD audits and nothing was done in response.
		Rarely. Projects are mainly staffed with personnel whose primary job is something else.
		Staffing is inadequate due to imbalances because the squeakiest wheel receives the most grease. Additional staff are thrown at problems, as opposed to assessing whether upper management is providing proper direction to existing staff.
		At times not having the right resources to fill the positions. Due to OMB thinking they are running the projects from the side lines and limited technical experience is not warranted.
		More design and CM staff are needed to execute Measure R
		Metro needs more Metro people.
		Transition plans....not really in play due to limited resources spread too thin.
		The right staff for the job is important. Growth in Capital Projects has left Metro shorthanded in some areas.
		Staffing requests are thwarted by OMB and unilaterally impact successful project delivery.

Topic	What Works Well	What Could Be improved
Empowerment (1.10.7)	I do not have enough knowledge about this area to answer.	Involvement by executives or upper management which undermines PM authority or compliance
	PM authority and compliance in vendor performance assessments.	Seems to be working the way it was designed.
	Processes are well defined.	Some vendors have political connections with Board members that impact leader decision making process.
	Management empowered to make decisions.	Is true for the major capital projects, ***but it is a PM decision to implement*** on the smaller capital projects.
		I do not agree with this statement. Quality HAS been "gone around" when; with Construction management agreement, we recommended Stop Work Orders and were discouraged from issuing such.
		The Board is sometimes overly involved in the day to day management of projects. This undermines the PMs authority.
Formal Partnering (1.10.8)	Sometimes other methods than partnering are used and they may give equal results. For example, a strict and demanding approach is needed early and can be relaxed a little as the contract proceeds.	Not applicable in Countywide Planning & Development.
	I do not have enough knowledge about this area to answer.	Consistent application or enforcement and support from upper management in line with the agreed process.
	Formal partnering process that is consistently applied by both parties and supported by upper management.	Only for Major projects. A formal program would help with small to medium CIP projects.
	Yes, a formal partnering program exists but appears to be based on the Project Director's level of belief and dedication to such a program and its success is largely based on the facilitator hired to conduct sessions.	Dispute resolution processes are effective only if all parties are committed to resolving in a fair and equitable manner.
	N/A. No knowledge, not included in my job description.	When problems start to occur the partner concept dwindles different motives than the contractor has, like making their fee versus the changes that are the document specifications, etc.
	Formal partnering for the larger projects is a must.	Partnering Sessions at the beginning and middle of Construction projects are very useful to reinforce the team spirit and help resolve issues in an efficient manner.
	Partnering included for major transit projects.	Periodic health checks could be better managed. Some vendors do a better job. Partnering requirement needed on all capital projects. The $100M Division 13 project had no partnering requirement.

Timely Decision Making (1.10.9)	Quick response teams to expedite decisions.	Executives should provide a memo on the agreement on the quick response teams.
	Agree with statement but not aware of any formal protocols. This happens effectively based on level of experience of project department members with counterparts in other departments.	This does not happen. Response times between departments is generally very slow. Silos need to be removed.
	Practice in play on larger projects.	Case in point: Engineering are excluded from PLE project involvement.
	Change control boards established for design criteria changes that affect multiple departments.	Seems to work relatively smooth.
	There is good response time to most critical issues. Especially when there is an integrated project office.	"Quick response teams". I have not seen this term or group used/identified at Metro.
		Expand concept to areas beyond design criteria.
		Not all projects have integrated project management offices.

Topic	What Works Well	What Could Be Improved
General		Communications. Accountability.
		Each project is managed under unique circumstances, as project managers, procurement CA's, etc. All have 'their way' of handling things. There is little consistency. There is very little systematic management being practiced. If one team member is replaced, the entire team has to learn the new team member's way of operating. Additionally, support from upper management is inconsistent at best. Power struggles to control projects and gain importance within the organization seem to take up most of the time that would be wisely spent on forming a team. Metro needs more leaders and less managers/executives.
		Most of these Items apply to larger projects, the smaller projects ($100 million and below) do not get this type of attention. Some departments like Highways are ignoring standard operating procedures by claiming that they do not apply. This is not correct, PMO oversight is provided just for that reason, to keep things above board and open. Without proper oversight and enforcement from upper management, things end up becoming nothing more than organized chaos.
		The Engineering and Construction Department has had only one all-hands meeting per year and less than 6 direct report staff meetings. There is no regular forum to convey or solicit feedback on the Mission, Vision, Goals and Objectives for the Department. Disputes within the Department are not resolved because there is no regularly held common forum to discuss issues.
		The informal organization dictates how and who influences the outcome on projects regardless of the systems and processes put in place. Effective executive leadership must establish and support the formal organization.
		Defining projects to reduce risk, knowing all the details of a project based on experience. If rail project planners and engineers can visit actual construction sites and see the labor required for various activities cost control will benefit. Watching the installation of soldier pile and lagging at a building basement or subway site will reveal how much labor is needed and how much progress made. Watching rail installation and overhead electrification being installed will help when designing and costing light rail, etc.
		Ensure that the executive management have sufficient Project controls training and understanding of the transitioning tasks that have to be processed in order to make transitions from engineering to procurement less painful. Developmental training for what? There are no incentives, recognition and or rewards for the ones that make it happen. We have consultants making almost double the salary while we continue to burn ourselves out.
		Consensus from various internal departments and resolution is not adequate. Interdepartmental collaboration needs work.
		Consensus from various departments are sometimes difficult to obtain. Some items should have been addressed pre-bid. Other items are preferences. Changes have taken place in some departments to allow proper escalation of issues for resolution in a timely manner. Non-project Metro staff interaction with contractor needs to be improved. Discussions beyond requirement of contract can create confusion if perceived to be direction from Metro by the contractor.

Appendix E

Comparable Agency Benchmarks

Report On
Los Angeles County Metropolitan Transportation Authority
Capital Project Construction Management Best Practices Study

Appendix E. Comparable Agency Benchmarks

Prepared by: Intueor Consulting, Inc.
25 February 2016

Contents

I. APPENDIX E Comparable Agency Benchmarks

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
Cap Plan $	$9,608,321,447	7,074,193,486	6,000,000,000	21,800,000,000	$11,600,000,000	$27Billion	$5 Billion total current budget of active projects, of which $2.5 Billion is forecasted over the next 10 years	$4.8b over the next 10 years.
Cap Plan Years	FY2015-FY2024	20	14	2014/15 to 2023/24	2010 - 2014	10-years	Approximately 20 years, including a 10 year forecast	10 year planning cycle which is updated each year.
# Projects	843 discrete projects within nine program areas; many program activities involve multiple projects	282	10	There are 8 major programmes, each comprising a number of projects. The Plan (attached) explains the programmes in summary detail. See page #242	Approximately 740	Over 500 projects	Approximately 80 projects	Approximately 220, with a range of budgets. See attached project report.
# Pro Srv Contracts	843 discrete projects within nine program areas; many program activities involve multiple projects	GPC vi -10 (CA), OCAE-17(CA), CPS-45 (ca), GPCv-1, General Engineering Consultant 3-1, Enviornmental Response -1, Positive Train Control Consultant - 1.	15		Approximately 100 professional service contracts		100 current active contracts	5 CM/GC with an A&E component and PM Support Services component, approximately 20 Design-Build contracts which includes design services and PM Support Services, and approximately 6 other professional services contracts. See attached project list.
$ Pro Srv Contracts	Unknown for FY2015-FY2025; FY2012 through third quarter FY2015 – $323,752,135	12,000,000.00, OCAE - $35,259,799.00, CPS - $37,100,000.00, GPC v - $27,500,000.00, General Engineering Consultant iii - $53,235,977.00, Environmental Response - $3,250,000.00, Positive Train Control Consultant- 4,386,248.00	500,000,000	Assuming you mean project management / engineering, etc. then about 15-20% of the plan cost in b above.	Since January 2010 to date: approximately $560 Million		$421,428,530	Approximately $340m budgeted, $40m awarded

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
FTE Staff	514	83	100	2155	1,345			Approximately 150 architects and engineers, construction services staff, inspectors, code compliance reviews, maintenance staff, etc.
FTE Consultants	200	30	70	940	246	As needed		Estimate = \$340m/\$200hr/40 hrs./week/52 weeks = 165 yearly FTE for each year of the capital program
Succession Plan BP	The District defines succession planning as a process for identifying and developing employees with the potential of providing them an opportunity to obtain advanced level positions within the District. See page #40	NA	NA	The processes used for succession planning are attached. See page #244			Maintain a consistent ratio of entry-level, mid-level, and management positions. Training and mentoring staff so staff is prepared for next level and we are able to promote from within if possible	Design & Construction tries to promote from within and we try to give junior staff opportunities to manage contracts with increasing complexity. Much of our project management staff were promoted from our Architecture and Engineering sections. Additionally we have created a Design & Construction Leadership Committee which has been looking at succession planning issues.
Stakeholder BP	See programs provided above for best practice examples of partnerships with external partners and stakeholders. To address succession with internal stakeholders Human Resources works with District department managers to obtain important information needed on forecasting of	CIPMP Project PMP	Get Stakeholder engaged early in the program	The TfL Pathway has a module covering Stakeholder management. Stakeholder engagement with external parties - local authorities, lobby groups, etc. is coordinated from the corporate centre (Stakeholder Communications). See page #246 - 260			Proactively engage communication with stakeholders, develop a communication plan, obtain agreement on and commitment to the project scope with stakeholders, obtain required permits and appropriate environmental approvals, perform outreach to the community and other stakeholders as needed, conduct regular meetings with stakeholders.	We have a very structured and thorough stakeholder engagement process that gathers input from stakeholders throughout each phase of our project delivery. The Stakeholder Engagement Process (SEP) is defined in our Delivery Exceptional Projects document (see attached).

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
	needs for critical positions. We also work with them to develop programs, like the Utility Worker to TVET program identified above, to address future workforce challenges.							
% on time	85%	95%	100%	LU measures milestone delivery – for 2014/15 94.3% of milestones were delivered on time compared to a target of 90%.	78%		Not benchmarking this measure at this time. N/A	We develop the project schedules working collaboratively with the contractors, designers, and stakeholders. It is rare that a project exceeds the mutually agreed schedule without a specific reason for a change (scope addition, etc.).
% on budget	100%	99.9%	100%	98.1% in 2014/15	78%	Within 11% of original contingency	Not benchmarking this measure at this time. N/A	We develop the project budgets and contingencies working collaboratively with the contractors, designers, and stakeholders. It is rare that a project exceeds the mutually agreed budget and contingency without a specific reason for a budget or contingency change (scope addition, etc.).
PM cradle to Grave	Projects are delivered from the same Executive Office within the District. As a project builds, that project is handed off to Design PM for Construction and Deliverable. Lead changes, but team stays intact.	Yes	Yes	The attached Handbooks set out the requirements in more detail. Also attached is the Project Execution Plan See page #261 - 365	At NYC Transit, our Project Managers (PM) are responsible for the Planning, Design, Construction, and Testing/Acceptance of Capital Projects. They are not responsible for the Maintenance, Operation, of said projects. Upon substantial completion, the	Yes	Cradle to grave responsibility is transitioning. The PMs within Program Management Division will have defined cradle to grave responsibility in the new project delivery model established in the Bureau Reorganization that we are undergoing.	Yes

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
					responsibility of the project is returned to our Operating Departments			
Complete Scope BP	We recently reorganized to ensure cradle to grave delivery. We assign a team up front to a project that has planning, design, and construction management skill sets, so that each discipline is engaged early on in the process. The end user is included early on in process.	Full communication on all levels, holding meeting to fully discuss the scope of work. Involvement of all affected parties regardless of the size or their own involvement. Full discussion and disclosure and dissemination of meeting minutes with everyone's roles and responsibility. Use of ball in court to get everyone participating in the process.	Start early and have everyone involved	The attached documents from Pathway cover the high-level requirements and specific requirements for an LU Project Requirements document. Key to note is that signatures must include the Sponsor, the Project / Programme, Operators, Maintenance, Health & Safety, i.e. the full stakeholder chain. The principle is to get widespread agreement on the what and the how. See page #366		Project Initiation Request Form has been established, PIRF was developed to ensure agreement on project scope prior to start. Gate Review process also support scoping and verification	Best practices used are defined in the Project Delivery Manual	We have established a Programming Phase, which occurs before design starts, and allows the entire project team (Airport staff, Designers, Contractors, and all stakeholders) to jointly develop the project program. This program becomes the Basis of Design. See Delivery Exceptional Projects document (attached).
Study Cost BP	The project number is assigned during the planning phase, which allows us to track cradle to grave costs. The project number can be tracked by different activities.	Once a project is approved to move forward an account code and baseline budget is established. Everyone will charge accordingly to the budget code as required.	Project budget starts at the MIS stage of a project and refine it as the project moves forward	Each project is allocated a unique identifier that is used throughout the approvals process. The initial authority will cover any early studies or planning and be increased as the project moves through to implementation.	NYC Transit incorporates to support the proposed system into the Master Plan	Separate charge code for each stage of project development		All staff members charge to a project number, and we split out these costs based on the schedule of the project.
Board Govern $	See table		See table	The TfL project authority levels are as set out in the attached document. The project authority paper template is also attached. Please also refer to the Governance Handbook attached	See Table		See Table	See Table

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
				before these questions. See page #383				
Full Fund BP	N/A		Board commits only at the award of construction contract	The authority requested will include a risk allowance for such matters. Additionally, there are tolerances on estimates based on the project stages that progressively reduce as the project passes through from feasibility to final design and tender. The Board is free to authorize to the level it feels comfortable with. If it commits full authority, the project / programme will have to undertake normal assurance activity which is reported and any funding request above initial authority will have to return to the Board. Generally speaking, the major projects / programmes proceeding to the Board for authority (>£25m) do not receive full authority at a preliminary design phase.	Capital Planning and Budget and Sponsor and Managing Departments are responsible for the adoption and completeness of the Master Plan process to a high level of confidence. However in terms of delivering a 5 year capital program it is impractical to have all projects in PE prior to the Board's approval.	Board Approval Process – Planning Authorization, Project Authorization, Contract Authorization	While there may be situations that could necessitate such a request for full funding at such an early stage (i.e. emergency projects and small projects – those short in duration and/or with lower budgets).Typically this is not practiced, and no special criteria have been established.	Projects are not fully funded before preliminary design. Projects are funded progressively throughout the life cycle of the project. It is the job of the Airport Project Manager or Contract Manager to request incremental funding
Construction CO %	Generally 10%	D-10% depending on contract risks	The Board authorizes the Project Budget and the Project team does not have to go back to the Board for any change	There is not a specific contingency. Contingency allowances are not used. There is a risk assessment from which a risk allowance is derived.	NYCT budgets the majority of the capital projects with a 5% contingency and authorizes its Program Areas to spend within these limits without	6-8% for Extra Work	At the time of Conditional Award of a construction contract, the Board approves project budgets which include contingency (generally approximately 10% of	The Airport Commission authorizes up to 10% contingency for construction change orders with the initial authorization to proceed with construction. Typically,

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
			orders if the overall Project budget in not impacted	This risk allowance is managed as set in the attached Pathway Handbook. See page #391	requiring Board approval.		the construction value) based on project specific Risk Assessments performed. Board authorizes signing authority for Change Orders up to an accumulated $200,000. Once this limit is reached, staff may request refreshing the $200,000 signing authority.	the teams request 7.5% of the direct cost of construction in contingency. In the event that change orders beyond the contingency are required, additional approvals are required by the Airport Commission.
Consr Cntgcy Owner	Group Manager	As outlined in Change Management Plan and within authorized personnel, fiscal authority or Board Approved	Project team		Procurement rules govern the use of project contingency as part of capital contracts	For Construction Contracts, Construction Management Division (CMD)/ Engineering Department oversees Extra work allowance within each contract and contract change approval process for use, as long as the project is within the authorized Total Project Cost (TPC)	Program Managers control the project/program contingency and Construction Managers control the construction contingency. Program Managers approve changes (increase/decrease) to construction contingency, which is subject to the Board's approval.	The project manager controls the contingency, although there are executive level sign offs required for single or cumulative changes, depending on the amount.

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
Get more Cntgcy	Notify Board in Writing. The Board rule is 5.2-4(a) (2), which states: The General Manager shall notify the Board one week prior to the issuance of any change order that is anticipated to result in expenditures aggregating more than 10% of the contract price." In practice what we do, as in the example shown here, is list all expected upcoming change orders, so that we do not have to return to the Board each time. See page #42	Go back to the Board	Need to go back to the Board if the overall Project budget is impacted	See 4 above, if a need for extra funding arises supplementary authority must be sought at the appropriate level for the revised value of the project.	Changes to project budgets are required to follow a Budget Modification process with different levels of approval based on the amount of capital money being requested.	For Construction contracts, If additional cost to complete the project is more than previously authorized TPC, the project is presented to the board for re-authorization	If additional contingency is required which results in an increase to the approved program or project budget, Board approval is required.	Airport Commission approval, which includes justification for change as well as cost, schedule and project impacts.
Board Oversight	In general, they are a policy Board. For bigger projects, staff provides semi-annual briefings and memos as appropriate		Project team provides the Board regular Project update	The Rail & Underground Board does not generally meet or communicate with project teams outside board meetings. However, all projects in LU are overseen by the relevant Programme Board and these require R&U Board presence to be quorate.	The Board routinely approves the Capital Program Status reports, their Construction Oversight Consultant issues monthly reports based on complex projects, budget procedures as well as information on major scope budget and schedule changes.	They are not involved in the management of projects.	The Board of Harbor Commissioners is constituted as an oversight body and meet twice a month. They do not manage projects, but they are required to approve a number of items related to the projects, such as: scope; budgets; authorizations for spending; professional service contracts and amendments; construction contract bid and award; construction change	The Airport Commission puts a great deal of responsibility on the project team to appropriately manage the project. Design & Construction management typically only go to the Commission for the required approvals at regular Commission Meetings. However, the Commission is updated on the progress of the large capital projects and other important issues

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							orders over $200k; substantial completion; and final acceptance. The Board does not typically communicate directly with the project team outside of Board meetings, except as necessary in relation to Board action items.	via special presentations during Commission Meetings, of calendar memos, and story board presentations at Commission Meetings.
Scope Creep BP	Develop and agree to process ahead of time (develop project management plan). Inform users they have a specific point in time to provide scope; immediately escalate the issue to ensure project schedule	Hold weekly meetings to keep a tab on the progress made. Monitor designer activities and reports for abnormalities and deviation from scope of work. Require designer to only take direction from the assigned manager on the project.	Manage expectation of stakeholders	Please see the Pathway Change Request Guidance Note attached to question 9.	Through the use of software requirement tracking tools, such as IBM DOORs, NYC Transit is able to document and trace design requirements throughout a project's life cycle. The use of requirement management tools, as well as diligent scope review by our Program Management staff scope creep is kept to a minimum while allowing design changes to be thoroughly evaluated with regards to schedule and budget.	Project Delivery Performance system (PDPS) is used to prepare engineering proposals defines scope, delivery schedule and cost. If the project scope, budget, or schedule changes the Lead Engineer, with the assistance of the discipline Task Leads, will revised schedule, and budget in the PDPS system for approval by the PM. For changes later in the design process a supplemental request proposal can be prepared in lieu of reissuing the entire proposal.	Scope of the work developed by the project team is usually prepared with a design proposal which is broken down with WBS which is also tied to the project schedule. When there are any changes to the project scope, those are addressed with revised proposal and schedule so they can be tracked	As part of the Delivery Exceptional Projects, stakeholders are engaged early in the project development process. They participate in the program development process and sign-off on their components of the projects in the programming phase, so the projects are more fully developed before they move into the design stage. Stakeholders are also kept involved during the design phase and are part of the decision making process when difficult program or design choices need to made by the project team. This helps limit scope creep.
Design Review BP	Establish rigorous schedule for design review; we have our own technical review team; insist they are timely in their comments. We also hold meetings for users to make sure all comments have been addressed	We have established a design review process that identifies roles, responsibilities, process, and schedule. We typically send the plans aut to selected group of professionals within the agency and require review	Use the industry as a resource	Please see Guide G1237 Design Reviews See page #413			Port of Long Beach (POLB) has Quality Management System Manual (QMS) to follow. QMS requires the design teams to prepare Design Quality Management Plan (DQMP) which identify checkers and Quality Control Manager for the projects. Typically design packages are	Design drawings will soon be routed to reviewers through our Project Management System, Primavera Unifier. For actual design review we will be using Blubeam to graphically capture design review comments and responses. This will allow all reviewers to

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		comments within a defined time frame. Comments are entered into our design review file sharing database for disposition by designers and Agency Project Manager assigned to the project. Any approved comments will be included in the next design submittal to the Agency.					submitted at 15%, 50%, 100%, and final for interdivision reviews. Prior to submitting for interdivision review, it is required to have internal quality reviews.	see other reviser comments and allow for coordination and reconciliation of comments.
Design Quality BP	Ensure we have a separate review team (separate from design effort); mandatory constructability reviews	Review by Project Manager and evaluation of reviewer comments during design review process. We also do design certification to assure that all DART Design Criteria manual requirements are included in the design.	Have a process in place the manages and independent review and quality checks	The Pathway philosophy is that quality is 'built-in' to the methodology. Therefore, key documents, such as Requirements, Design, Design Reviews, etc., all require the presence and signature of relevant and authorized personnel. This, it is believe, should allow quality because professional and accredited staff should do their jobs. Quality is not a parallel function acting in a checking capacity	NYC Transit's Engineering Services Division within our Department of Capital Program Management is responsible for the quality of our capital project designs. Through the use of BIM on typical construction projects, NYCT designers are able to identify interferences and coordinate with our different engineering disciplines; thereby mitigating design issues and delays. Also, each design discipline has a set of Design Guidelines to ensure standardization and quality. NYC Transit Engineering established their own set of PMP/PMGs to assist in the design and management of projects.		Typically Engineering Design Division is responsible for quality control and quality of the design packages. Project Management Office under Program Management Division is responsible for Quality Assurance (QA). POLB also implemented Risk Assessment Process which requires the project team to go through risk assessment workshops throughout the project. The Port also has instituted, as needed, third party independent review of project design documents	We have an in-house QA/QC staff member whose job it is to provide a quality review of designs performed by our in-house design teams. For projects designed by external teams, we rely on the project management support services teams to provide quality reviews. We also review design documents closely with the stakeholders.
Claim Avoid BP	We attempt to address issues as soon as they arise.		Start the any Project with the mindset that you will not have	The successful techniques used by TfL are firstly a procurement	NYCT CCO guidelines require the contractor to address their claim to the Program Officer	Try to resolve disputes as soon as they occur rather than have them	Implementation of strategies to develop good contract documents, including:	Part of Delivering Exceptional Projects and the Structured Collaborative Process is

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	Partnering helps to avoid claims, too.		claims and make sure all team members buy into that mindset!	strategy based upon the NEC3 Contract. This is a collaborative suite of contracts that encourages client and contractor to work together thus addressing potential claim situations early. The other technique is extensive use of partnerships and frameworks. These are long term relationships with our suppliers which encourage working together	(PMO) as an intermediate step before formally submitting a claim to the chief engineer. The only claims that make it to the chief are those claims that were unable to be resolved in the PMO and which require the Chief Engineer to adjudicate.	linger and build into a larger dispute	subsurface investigations, Quality Management System, project risk assessments, peer reviews, constructability reviews, etc. Implementation of strategies during the Construction Phase, including: partnering, pre-activity meetings, full-time inspection, QA material testing, thorough and accurate daily reports, job photos, thorough documentation, and proactive issue resolution.	project partnering. Project partnering starts in the programming phase for executive staff and project stakeholders, and starts with the design-build teams as soon as we bring them onboard. We have found through partnering, the early identification of problems/issues, and open and honest communication amongst all project team members and stakeholders, that we have been able to avoid claims and litigation. See attached Delivering Exceptional Projects document.
Time Ext timing	We try to get them as they happen, but that is not always practical.		As they occur	The NEC3 contract requires contractors to give notice immediately they become aware (Early Warning Notice). This approach avoids the wait until close-out syndrome	NYC Transit Contract Specification Section 2.04 requires the contactor to submit their request for Extension of Time (EOT) within ten days of its occurrence otherwise EOT will not be entertained	Yes, the contract language requires them to submit as they happen. Although we do recognize if a contractor waits until the end to submit it. We typically will not deny based on untimely submission of claim, as long as the request is legitimate.	They are required to submit as they happen, but it is extremely difficult to implement. It is often mutually agreed upon to defer time analysis, with alternate language added to the Change Order to indicate the CO represents full accord and satisfaction as to the Direct Costs, and time and time-related overhead is deferred.	Contract issues that require time extensions are identified as early as possible resolved and added to the contract as appropriate if easily accommodated. Contract time extensions that cannot be easily accommodated or have other project/stakeholder impacts may have to be resolved through the partnering process.
Claims BPs	Adhere to contract principles; bring in third party experts; break down into manageable pieces		NO CLAIMS!!!			See 14 above. Also, for disputed items of work, keep Time and Material records.	Partnering – resolve at lowest level with the individuals most familiar with the issue. Include escalation ladders as part of partnering so contractor and owner	See previous answers.

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							know who to contact if it is not resolved.	
Dispute Resolution BP	Partnering; Mediation or Dispute Resolution Board	See page #63	Set up a DRB and escalation ladder for all issues			Our contracts state that claims that cannot be settled within the supervisory ladder can go to the Chief Engineer for final, binding, resolution. This has been challenged in court and upheld. We have had less than 5 Chief Engineer's decisions in the last 30 years.	Partnering escalation and mediation.	See answer to Question #15.
Utility Identification BP	BART's best practices to identify utilities include, but are not limited to the following: See page #45	See page #64	Use an experienced staff and do lot of pothollings	The documents attached to Question 19 cover identification of utilities in the way of construction	NYC Transit conducts non-destructive field surveys using electronic metal detector/utility locator and Ground Penetrating Radar (GPR) equipment; we also perform air/vacuum excavation followed by exploratory test pit excavation.	Surveys performed during Preliminary &Final Design Phase. Surveys performed during Preliminary &Final Design Phase. One-Call system in place before digging. Our in-house surveyors also verify prior to construction. Contracts require hand digging over utilities.	Maintain record of utilities in GIS system, research as-built drawings, perform utility site investigations.	Except for a portion of a natural gas distribution line (owned by Pacific Gas and Electric), the aircraft fueling system (third party operator), and legacy portions of AT&T's telecommunications cabling, all other utility infrastructure on the airport campus is owned, maintained, and operated by the airport. This allows us much greater flexibility incorporating utility relocations into our projects. When have had to relocate the natural gas distribution line, it has taken considerable planning and process with PG&E
Utility Relocation BP	BART's best practices to relocate utilities include but are not limited to the following: See page #46	See page #65	Work with the utilities early in the Project	The attached documents cover utility relocation. See page #420	NYC Transit starts coordination and communication with the specific utility owners/operators as early as possible during the design phase of the utility relocation. We conduct all required	Pre-Bid: Work with the utility companies to finalize utility agreements & review utility relocation plans. Coordinate w/ upcoming projects in the same area.	Meet with utility agencies well in advance of anticipated development to discuss options to accommodate the project. Options may include: defining requirements for the contractor to protect	The Airport has invested considerably into the underground infrastructure to reduce many of the unknowns. Understanding the utilities in the design phase of projects lends itself to better utility

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					property acquisition and/or property management including clearing and improvement for ROW as a priority item. We arrange frequent joint meetings with utility owners as the project's design progresses to get their input on relocation issues and to make certain that they coordinate the proposed relocation designs with their maintenance team for any prioritization requirements.		utilities in place and not disturb operation; coordinating a schedule for the utility agency to move their utilities out of the way; or requiring the contractor to relocate or abandon the utilities in question.	designs and bid pricing. Moreover, Airport planning documents are typically referenced in utility relocation projects to develop utility corridors for future construction.
AUR Experience	Instead of issuing advance utility contracts, the Warm Springs Extension (WSX) team worked with the utility company directly in advance of utility relocation to mitigate risk. See page #47	Only issue advance utility contracts if (1) your design is 100% complete, (2) you are confident that there are not going to be design changes,(3) you are confident that you know all of the utility conflicts, and {4) your federal partner has agreed to the execution of advance utility relocation contracts between the agency and the utility companies.	This works very well to get the utilities out of the way	Generally, utility diversions would proceed the main works and arrangements will be made with the Utility companies to facilitate them and any diversions / final re-locations or reinstatements required to meet work stages.		More beneficial, improves the need for coordination between the utility contract and Port Authority contract performing Roadways project as an example. Port Authority contractor able construct without utility relocation delays	POLB has long term utility agreements in place with utility companies that establish assignment of responsibilities and define who pays for specific costs. With these in place, POLB can issue advanced Directives to relocate utilities prior to construction as needed. This approach works well.	Generally utility relocation is an early activity in a larger project, although sometimes it is carved out as a predecessor contract. The direction taken is usually dependent on project scope and schedule considerations
Utility Partnering	We have generally good experience with utility companies on their relocation. The key to this success is to have a mutual and timely understanding of the utility company	See page #66	Works very well		NYC Transit conducts multiple meetings with utility companies well in advance to discuss the projects and their support/assistance required for their resource planning. We invite utility company personnel to pre-	Experience has been positive in having utility companies perform relocation work advance of our project needs.	In an effort to get timely relocations of utilities, POLB also conducts joint quarterly meetings with utility agencies to discuss future planned work. As a result of this practice, Long Beach Gas & Oil looked	When working with the PG&E to relocate their infrastructure, it takes a lot of discussion and planning early in the programming phase to ensure the scope of their work is clearly defined, the design schedule and

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	and the project's need, and come up with an agreement with a reasonable schedule that works for both parties. Once the agreement is reached, we work closely with the utility company to ensure timely relocation, which may include constant and continuous communications.				construction meetings and request utility company personnel involvement as deemed appropriate, during the construction phase of the project.		at the Port's long term development and decided to proactively move a large volume of their lines and equipment out of the way.	deliverables are established. In some instances the Airport has taken on the design responsibility for PG&E utility relocations under their oversight. Also the means of construction agreed to, i.e. will PG&E self-construct or can the Airport's contractor construct under PG&E oversight.
Utility Relo Challenges						See page #1,223	See Table	Encountering unknowns during excavation
Utility Resource Issues	The potential risk of resource constraints can be mitigated if ample time is given to utility companies for the relocation. Hence, early determination of the conflict and early notification to the utility company is crucial to prevent resource constraints.		Work may have to be done by the RTD's contractor			Pre-construction Utility relocation agreements. Try to perform as much of work with our own forces or our contractors, Try to leave minimal work/approvals for them.	POLB practices providing as much advanced notice as possible and working with the utility agencies to identify challenges then incorporating their requirements and constraints into the plan and schedule. When unexpected utility resource constraints impact work during construction, POLB works with the agencies to define alternate approaches or solutions to minimize impacts (both cost and schedule) to the contract and to the other stakeholders involved.	Historically, the Airport has competitively bid components of the installation work that otherwise would be performed by the utility company. This approach allows the Airport to reduce the schedule risk of integrating utility companies into a project schedule and proves to be more cost effective.
Asset Commissioning	On board assets during the life of construction	See page #67	Operation Dept. should be part of the Project Team and OPS rep should be	See page #427				

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			housed with the Project team					
Identify Cap Plan Needs	Capital Improvement Program (CIP) along with asset management register	DART Maintenance provides the information for Scope of work, and the cost to do the work. DARTs Rail Program Development (RPD) department, can provide Cost Estimates and a Project Manager (PM) to develop Baseline Schedules. PM's work with DART Procurement to put RPD's Solicitation packages together. It has to be an approved project in the Capital Financial Plan.	work with ops early in the project	This is done through the process for developing the Line, Asset & Network Plans		Condition assessments by Line Department or Quality Assurance Division/Engineering Department	In 2016 we are initiating the first phase of an asset management program to include a facilities condition In 2016 we are initiating the first phase of an asset management program to include a facilities condition baseline and incorporating into the computerized maintenance management program and/or 10-year CIP plan.	
Condition Assessment	Condition assessment varies widely based upon data available. In a few areas, we have detailed failure data from our Maximo system and our operations delay database that informs asset condition. In most areas, our Maximo implementation is not yet advanced enough for detailed, reliable data, so asset condition is made subjectively by subject matter experts, often for small pools of assets, not for individual assets.	DART Maintenance departments can also approach DART Rail Program Development (RPD) with condition assessments and special project needs. RPD provides technical input to DART Maintenance and DART Procurement for project scope and statements of work ensuring that each project is compliant with DART design standard specifications, that Safety and Security Compliance is met or maintained	NA	The requirements are set out in Standard S1042 – Asset Condition Reporting and associated guide G042, attached. The requirements in the standard are set out in the first 15 pages, the remainder of the document (c335 pages) is the LU Asset Condition Certificate (the output of the standard). See page #451 - 844		Cyclical inspections by Quality Assurance Division/Engineering Department; Pavement Management Program; Status Reports	See question #25	The airport's preventative maintenance program that produces and tracks maintenance work orders is one tool to perform equipment condition assessment. The GIS database that tracks campus wide infrastructure systems can also be used to do system based condition assessment. In-house engineering and maintenance staff working closely to monitor system performance is a third.

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Cap Plan Prioritization	Prepare the scope, schedule, budget, and submit to the capital budget department for prioritization; final decisions are handled by the executive team.		Start with the MIS	This is set out in the Governance document attached before these questions			As part of the annual budget process, the Engineering Bureau provides a 10-year projection of the forecasted capital outlay expected for all active and anticipated projects that constitute the Capital Improvement Program. This forecast gets incorporated into an over-all cash-flow projection for approval by Executive Management and the Board of Harbor Commissioners. As new projects get identified each year, they are also approved by Management and the Board.	The airport has established a Capital Plan Review Committee (CPRC) to review and rank capital plan projects proposed for inclusion on the capital plan. The CPRC reviews the project against a set of established criteria. Contracts ranking above a minimum threshold are recommended in total to senior staff for approval.
Work Orders	Currently Work Orders are issued for Preventive Maintenance and Corrective Maintenance. Some rehabilitation work is captured via Corrective Maintenance work orders; however, the work orders are not an integral part of our capital rehabilitation programs as of yet. As our program matures, the plan is to utilize them to track the work, capture asset baseline data, serve as prioritized work authorizations for capital work, update	See page #69	Work order is negotiated between contractor and project team and are issued if it is within the Board authorized amount	We understand works orders in the capital projects context to refer to Method Statements. These cover works on site and have to be in line with health and safety legislation.		Port Authority uses established Work Order type of contracts to perform some of the maintenance type of work at the facility. Developed work order documents are issued to the contractor to commence work through CMD/Engineering Department.	Both internal and external customers contact the Maintenance Division (via electronic or telephony) and a work request is established. These requests are reviewed and appropriately assigned to the correct maintenance section manager. The manager establishes a priority to the request and creates a work order which is included on a 12-day planning schedule for the crew(s) to act upon. Emergencies and high-priority requests are handled on a case-by-case basis.	The Maintenance Division has a preventative maintenance program that produces and tracks work orders

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	conditions and risk assessments, etc.							
Asset Mgmt. BPs	Our asset management process and tool set can't be well described in a couple of sentences. Here is a copy of our Strategic Asset Management Plan which contains most of the information related to this question.	DARTs Maintenance and Technical Services Division utilize the Design Review, and Change Control Board (CCB) processes for planning and design development involving Capital Projects over $250,000.00 or for other special projects thot require design services.	We have a asset management team	See page #845 – 1,078	See page #1,210	Various tools, processes and procedures are used eg. IBM Maximo is used for Road Devices Management System to catalogue, manage and maintain Traffic assets, and pilot program for Aviation- EWR Airfield Lighting; PATH is using AssetWorks	See question #25	The airport does not have a formalized Asset management program, various departments track the assets under their care with a variety of tools.
Enterprise Schedule	▪ Enterprise schedule software (Provide software name) Primavera ▪ Integrated Master Schedule (all projects in capital plan in one schedule file) ▪ Cost Forecasting (Please describe method & tools) Excel spreadsheet		▪ Enterprise schedule software ▪ Cost-Loaded Schedules	See page #1,079	▪ Integrated Master Schedule (all projects in capital plan by Program Area) ▪ Earned Value Management System (Please describe) Primavera 6 (P6) Software ▪ Off-the-shelf Cost Estimating software (MS Excel and Oracle P6 Software)			See page #1,255
Integ Master Schedule						Construction Management Division/Engineering Department Schedulers review and analyze contractor's schedules		
Central Contractor DB				Done at Programme level – Acumen Fuse is available for this.				
Cost Load Schedules				This is dependent upon the type of contract. Some, mainly contacts for power works, have earned value milestones which are linked to payments.				

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Schedule Reviews	RE receives schedule and has a staff scheduler; schedule is updated once a month; work is verified.		We have an experienced scheduler assigned to each project.				For most projects we require Primavera P6, and use a consultant scheduler to review the baseline, monthly updates, and Time Impact Analysis. Each consultant can chose the type of software they use to analyze/review schedule, such as using Claim Digger. The Construction Manager is responsible for reviewing the schedule for logical sequence and scope that matches the contract requirements. The Port is in the process of hiring in-house schedulers and centralizing construction schedule reviews.	Most projects hold weekly meetings to review schedules (amount other things). Our project managers and management consultants are constantly aware of the project's schedule. When we put in place the integrated master schedule, we'll be able to review dependencies and overlaps between multiple projects.
Prog Payment-Schedule	N/A		Part of every contract				Not currently integrated.	We are developing our procedures.
Lessons Learned	Database of lessons learned are developed within each program, and shared with the team as well as other groups throughout the District. Lessons learned are not published, but database is available upon request		Annual and after completion of every project	See page #1,083	See page #1,211			We are developing our procedures.
PM Procedures	BART RE Manual; BART Procurement Manual; Engineering Project Management guide under development. A copy of the RE Manual is attached.		Every project has a PMP	See page #1,104		Documentation of current process and procedures is on going	Project Delivery Manual, Draft Project Controls Practice Guide, Quality Management System Manual, Risk Assessment Manual, Design Standards,	SFO has developed a contract process and procedures manual for contract management. In addition, we developed a construction management manual

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							Construction Management Division Procedures Manual, Engineering Design Division Procedures Manual, Guidelines for Professional Consulting Services, and Directives. Not all of these documents have been updated to reflect the on-going Bureau Reorganization adjusted roles, responsibilities and procedures.	for use under our FAA mandated runway safety area program that completed last summer. That manual is being modified to become a generic construction management manual. Both of these manuals are living documents that will be or are updated to reflect legislative changes, process and procedure changes, or new best management practices.
Audit of Compliance	Procurement department and Office of Civil Rights department ensures consistency in contract award and administration. Project Management seminars establishes processes and procedures. The Project Manager and General Manager ensure the RE Manual is enforced.	See page #70	Training	This is done via the Gate Review process and Integrated Assurance Reviews as set out in the attached documents		PMO holds responsibility to verify integrity of cost/schedule data and oversee controls security; PMO Project Controls Specialists maintaining schedules in concert with project managers; update and monitor Agency's Capita Plan & Operating Program; and perform schedule and cost analysis	Project Delivery Manual, Draft Project Controls Practice Guide, Quality Management System Manual, Risk Assessment Manual, Design Standards, Construction Management Division Procedures Manual, Engineering Design Division Procedures Manual, Guidelines for Professional Consulting Services, and Directives. Not all of these documents have been updated to reflect the on-going Bureau Reorganization adjusted roles, responsibilities and procedures.	Each project team is expected to develop a Project Management Plan using the Policies and Procedures as a starting point. We hold regular training on the various processes and procedures that are regularly used by project teams. Finally, our Accounting department holds regular Internal desk reviews which identify any discrepancies, and we work with project teams to revise processes as necessary and ensure other projects are aware of any changes.
Staffing Plan		Yes	Yes	Yes		Yes (PDPS provides engineering budget and staffing plan for each project; Annual PM Workload & FTE analysis)	Yes	On the large D-B capital projects there is a staffing plan for the program management support service (PMSS) consultant that is brought on in the programming phase and that remains on

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								the project until construction close out. There is not a formal staffing plan developed for the design build team that is reviewed or followed by the airport
Personnel Development			See page #196	See page #1,146				
Formal Training		Yes	Yes, leadership academy	Yes		Yes	Yes	Yes
Training Frequency		Varies depending on the subject/program	Regular basis	Essentially training is attended as is agreed necessary to develop competence. See page #1,143		Annually and more frequently when needed	Various formal training sessions are provided and vary depending on the subject and audience. Department goal is 40 hours per year.	Training on process, procedures, and new systems/system changes, and controls are held as required. Training for specialized areas are coordinated by staff and managers. Specialized training is dependent on the individual, their project assignments, and their career goals. Additionally, the Airport's Equal Employment Office regularly offers training for staff on safety, customer service, etc.
Curriculum		Leadership DART-SMU Cox Executive Education; Light Heavy Rail Safety Training; Workplace Diversity; Ethics & Conflict of Interest; Human Trafficking; Workplace Violence; Sexual Harassment; Reasonal Suspicion				Project Management, leadership skills and technical skill and operations and maintenance training	Varies depending on the need (ranges from technical to interpersonal)	See above
Who Trained		Everyone receives designated training	All RTD position have the opportunity for training	Anyone can attend the introductory courses, attendance is otherwise based on applicability to		Project Management, leadership skills and technical skill and operations and maintenance training	Various training is provided for all position titles.	Any staff member that wishes to attend the training, or when specifically identified by a manager

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				the job holders role. For example, Advance Project Manager training is reserved for staff holding senior positions				
Train Consultants		Yes, Light and Heavy Rail Safety Training	Yes	Consultants and non-permanent labour are expected to be experts in their field. However, LU specific training is provided, for example PRINCE 2 no, but LU specific health & safety requirements or Pathway training, yes.		It depends- only PA specific process & procedures training	No	Yes - They can be if the training is on airport specific process, procedures, and new systems/system changes, and controls.
Training Admin		Departments for departmental training, EEO, Legal, Light Rail Safety Training-Director Construction Safety & Certification, Heavy Rail Training-TrackSense, Inc.	RTD	HR Shared Service Centre takes the course bookings while PMO owns the course content and manages the schedule of courses		The programs are administered by internal Talent Management staff as well as consultants and vendors depending on the type of training.	Human Resources or other Specialty teams (i.e. Cal State Long Beach, PMI, CMAA, ASCE, Academy Leadership, etc.)	There is no assigned program administrator, however, trainings are often held by our contracts group, process & controls group, and our legal team.
PMO	Yes	Yes, Project specific Decision -PMO used for design build - Irving	No	Yes	Yes	Yes	Yes	Yes
PMO Functions	PM, PC, Quality, Safety			Project Controls	PM & Project Safety	See page #1,224	Project Quality Assurance Program / Project Risk Assessment Lessons Learned	PM, PC, Quality, Safety
Contracting Strategy	DB, DBOM >$20M		Design build, PPP, Design-bid-build, CMGC, unsolicited proposal, best value selection	The contracting approach will depend upon the project delivery model adopted. The attached document sets out the approach to determining the delivery model to be adopted. This is		See page #1,225	Design-Bid-Build, D-B, PPP,	Design-Bid-Build, D-B, Construction Manager/General Contractor

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				usually determined at programme level and applied to the projects in the programme				
Why DB	Innovation and reduced owner's risk; schedule	Time	Cost and schedule	Covered in the Delivery Models Handbook attached to question 46		Complete project faster and reduce risk	Funding needs (the State's Design-Build Demonstration Program provided additional funding for the bridge) and schedule conservation (this methodology accelerated project delivery).	The D-B approach has allowed the airport more flexibility in implementing large capital projects. The way the program has been structured it has also enabled us to have greater stakeholder engagement throughout the project so the airport ends up with a project greater user and operator satisfaction.
Why PPP	N/A	Under Consideration.	Federal pilot program	London Underground had in place three 30-year PPP contracts for renewal and maintenance of the network. Effectively these were a requirement of the then UK Government to secure the long-term stable investment required in the network. Two of the contracts were brought in-house when the contractor went into administration as it could not fulfil the contract within the agreed contract sum and the other was bought-out and brought in-house as that was seen as a more cost effective way of doing the work.		Limited available funding; leverage private partner expertise	In partnership with the City for the new Civic Center, this methodology enabled navigating through financial challenges and building public acceptance.	The airport has not used the PPP model.

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
Alt Contract improve Success	Has depended on the type of project and the level of 3rd party involvement. Successful with parking garages.	Yes, Early Delivery, Change Management, Quality.	Yes cost and schedule along with risk transfer	Direct control of project management has been seen as more effective than the arrangements under the PPP contracts both in terms of cost and timely delivery. A benchmarking exercise currently underway with other metros has shown that they mostly control large projects directly, not least because of the loss of knowledge if the project management is outsourced.		Yes. Projects moved faster; less change orders	. Yes, both financially and in delivery schedule. Building cooperative relationships with the Stakeholders and consultant/ contracting teams for the alternative delivery projects.	The methodology itself makes some difference, however the biggest factor in project success is the collaborative nature of the approach to programming, design, and construction and addressing the needs all of the stakeholders including in-house staff and management, designers, contractors, and construction manager team.
CO Authority	Shown in RE manual (see attached).	Change Control Board (CCB) -- for time or significant cost changes, matter must be presented to Change Control Board comprised of representatives from many DART departments, functions and disciplines. CCB must vote to approve a significant change prior to implementation and many times prior to final negotiations with contractors. CCB action is required prior to any changes that must go to Board of Directors for approval. This has been a very effective	Change control board-Project Manager-Sr. Manager, Assistant General Manager-General Manager	Please see Change Control Form			The Chief Executive authority to issue change orders for up to $200k in cumulative change (either additive or deductive). Once the cumulative amount is reached, staff seeks approval from the Board for the next change order, ratification of the previous change orders, and refreshes the Chief Executive's change order authority.	

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
		coordination and oversight tool, allowing transparent actions related to procurement and management of construction contracts.						
Contract Mgmt. BPs	Use of BART RE manual and Construction Management (CM) software. Specifications standardized by incorporating BART Facilities Standards (BFS)	See page #71	Board gives the GM Project Authority for the entire Project budget!	Contract management processes are covered in the Commercial and Procurement Handbook attached before these questions and in the attached documents See page #1,147		Resident Engineer in Construction Management Division/Engineering Department manage all construction contracts on behalf of the Chief Engineer and communication protocol of one point of contact w/contractor is clearly established	. Best practices used for construction contract management are generally addressed in the Construction Management Division Procedures Manual. Best practices used for professional services contract management are in the Guidelines for Professional Consulting Services, Contracting Procedures Manual, and other guidance documents depending on the type of services being provided.	We have a team of contract management staff which assist in contract procurement, certification, payment administration, and other areas. We also use an enterprise database system which allows for centralized contract data and reporting
Doc Mgmt. Software	Fusion	See page #72	Aconex	See page #1,152 – 1,194		LiveLink, SharePoint	Primavera Unifier for some project management and all construction management documents during the project lifecycle, Bentley ProjectWise for CAD drawings, and EMC EDRMS for record archiving.	We use a range of document management systems, including OpenText eDocs, Primavera Unifier, Sharepoint, and our internal file share system through Windows explorer.
All Projects	Yes	The systems, tools, and document management procedures are used for all projects.	Yes	Livelink is recommended for all projects		Yes, for most projects	Yes	While many of the large Capital projects use OpenText eDocs and many of the internal projects use our internal file share system, our document management approach is not consistent for all

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
								projects within the Division.
Construct Doc Mgmt. Tool	CM Software	Primavera Contract Manager and the network drives are used by the Construction Management staff during construction.	No	Sometimes in order to share documents with the supplier.		Yes, Mainly Primavera Contract Management, E-Builder for some specific Projects	No	The Airport is trying to work with our teams to ensure that they use the Airport's systems, but often contractor's use their own systems and deliver documents to the Airport at closeout.
Doc Mgmt. Integration	Not Currently	Primavera Contract Manager is linked to the network drives. Documents stored on the network drives (in accordance with the file plan), are attached/linked in Contract Manager. Remaining document management systems are independent.	NA	Custom basis depending on the systems		Manually	NA	See answer above
Meeting Action Items	Yes. CM Software enables this function	Construction meeting minutes are documented utilizing Primavera Contract Manager. Business/action items are input and tracked with a status. Items with an open status are tracked until completion. Once items are closed, they remain on the meeting minutes for one meeting after the closure (to document the closure). Minutes are stored, in Contract Manager, by meeting and date with all open/closed items	Yes	Customized at project level		For some projects, at the discretion of the Resident Engineer	Yes (Primavera Unifier)	Not at the moment, but we are considering using our Project Management System Primavera Unifier, to manage meeting minutes and action items.

	BART	DART	Denver RTD	London Underground	NYMTA	PANYNJ	POLB	SFIA
Other BPs	Emphasis on continuous improvement.		People, transparency, stakeholder engaged, communication, teamwork!	A key element of Pathway and all of the other management system elements covered above is the statement that success is primarily driven by the skills of the professional staff. The management system provides tools, allows and encourages collaboration, and is an aid to the correct behaviors. However, processes do not, of themselves, guarantee success. They can only create the environment for effective delivery.		General Agency oversight of projects (Monitor & Control)	Experienced and competent in-house staff that know the project goals, stakeholders, the unique business challenges, the Port complex, ability to work with other Port groups to get things done quickly, and know history of Port and challenges of the site. In addition, competent consultant support, good team communications, a team that anticipates potential issues early on during project planning/design and accounts for them in the contract documents.	

LA County MTA (LACMTA)'s objective for this study is to position itself to deliver quality capital projects on time and within budget as we build a significant, long range portfolio. This questionnaire is designed to gather any best practices BART has developed to address the challenges of delivering a complex portfolio of projects.

Guidelines:

- If a question is not applicable, please type in NA.
- Where tables are provided for your input, please feel free to re-format information or share existing attachments if that better reflects your response to the question(s).
- Please share attachments, where possible, which –
  - Elaborate your responses in this questionnaire AND/OR
  - Provide LACMTA additional insights, tips and guidance in building on its strengths but also in identifying our areas of improvements and proactively implement a robust project delivery and capital forecasting framework.
- Attachments can be shared by embedding files in this section or by attaching them to your transmitting email.

LACMTA is most appreciative of your time and efforts.

A. BART Information *(This section gathers info about your agency)*

1. BART Contact *(please fill in your contact information below)*

Contact Information	Description
Agency	San Francisco Bay Area Rapid Transit District (BART)
Contact person	Ms. Grace Crunican
Title	General Manager
Phone Number	(510)464-6060
Email	gcrunic@bart.gov

2. BART Capital Plan Overview (*Please provide BART information below)*

a. What is your primary business line? **Heavy rail transit**

b. What is the total dollar value of agency Capital Plan **$9,608,321,447**

c. How many years does the capital plan above span? **FY2015-FY2024**

d. How many projects are in the capital plan? **843 discrete projects within nine program areas; many program activities involve multiple projects**

e. # of professional services contracts for the capital plan? **Unknown for FY2015-FY2025; FY2012 through third quarter FY2015 – 36 professional services contracts for capital program**

f. What is the total dollar value of professional contracts? **Unknown for FY2015-FY2025; FY2012 through third quarter FY2015 – $323,752,135**

g. Please fill in the table below:

Staff Type involved in capital program only	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff	**514**	25%
Consultants	**200**	
Independent Contractors		
Total		100%

h. Please share any succession planning best practices you may be using to deal with an aging workforce. **The District defines succession planning as a process for identifying and developing employees with the potential of providing them an opportunity to obtain advanced level positions within the District. Our goal is to increase the availability of experienced and capable employees that are prepared to assume these roles as they become available in the future. To do this the District conducted analysis on workforce trends, incorporating projected retirements, new service needs, as well as emerging technology trends, to forecast what the workforce needs will be over the next five to ten years. As a result of the analysis the District is finalizing a Workforce Plan that provides a guide in addressing these needs. In line with that plan the District developed training**

programs to focus on two areas, critical technical positions and management level positions. We established a number of training programs that focus on critical technical positions in the areas of Elevator/ Escalator workers, Transit Vehicle Electronic Technicians and Electricians. A brief summary of the programs are provided. <u>Utility Worker to Transit Vehicle Electronic Technician Upgrade Program:</u> The District, in partnership with SEIU, developed a Utility Worker to Transit Vehicle Electronic Technician (TVET) Upgrade Program. The program defines the pathway for Utility Workers to become TVETs. It includes formal education obtained in an Electronic Technician certification in an accredited community college and "on the job" (OJT) training provided by the Rolling Shop and Stock Department. <u>Elevator/Escalator Apprenticeship Program:</u> In January 2014 the US Department of labor (DOL) officially approved the Transportation Learning Center's proposed Transit Elevator/Escalator Apprenticeship Program. The program allows the District to provide internal and external applicants the ability to gain the technical and on the job training needed to become journey workers through an organized and properly supervised training program. The approved program is designed to be forty eight months and includes an attainment of 6399 hours. <u>Transit Career Ladders Training Program:</u> In January 2015 the District submitted an application to the Federal Transportation Agency for a grant to fund a Transit Career Ladders Training (TCLT) Program. The program, established for Transit Vehicle Electricians, Electricians, and Train Control Electronic Technicians, was designed to meet the growing needs of the transit workforce by providing training access for traditionally under-represented individuals with the goal of developing streamlined pathways into transportation employment. This will be done by establishing partnerships with such agencies as the local Workforce Investment Boards (WIB) and Bay Area Community Colleges. The model creates a direct line of communication and feedback between the educational institutions and the District with the goal of creating new avenues previously not available to external and internal applicants. If funded the TCLT program is expected to last twenty three (23) months from outreach to completion and certification of the technical training classes. It will consist of four cohorts identified at the four SF Bay Area local colleges of 25 students each in electronics and electrical technical training classes. The other succession plan area focus for the District is building up our employees' skills and competencies to transition into supervisory and management positions. The District updated its Performance Evaluation process by incorporating a succession plan dimension for each professional and management employee. In coordination with the performance management tool the District developed training programs for: Employees who are in technical/clerical positions and aspire to be team leaders Employees who are new supervisors and/or would like to be supervisors Existing supervisor and managers Managers who aspire to become our future leaders The training programs provided range from District provided supervisory trainings to established programs from educational institutions such as the Mineta Institute at San Jose State University.

i. Please share any stakeholder management best practices you may be using. **See programs provided above for best practice examples of partnerships with external partners and stakeholders. To address succession with internal stakeholders Human Resources works with District department managers to obtain important information needed on forecasting of needs for critical positions. We also work with them to develop programs, like the Utility Worker to TVET program identified above, to address future workforce challenges.**

j. What percentage of completed capital projects finished on time? **85%**

k. What percentage of completed capital projects finished within the original contingency budget? **100%**

B. Questionnaire *(This section gathers best practices in each project phase)*

B.1 Planning

B.1.1 Project Manager's Role

1. Please share information regarding your Project Manager's role in the table below:

Does PM have Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes/No			
YES & NO	Design & Construction	Projects are delivered from the same Executive Office within the District. As a project builds, that project is handed off to Design PM for Construction and Deliverable. Lead changes, but team stays in tact.	

2. Describe any best practices used to develop a complete project scope and verify it with the end user. **We recently reorganized to ensure cradle to grave delivery. We assign a team up front to a project that has planning, design, and construction management skill sets, so that each discipline is engaged early on in the process. The end user is included early on in process.**

3. Describe any best practices used to capture early studies and planning costs to a project charge number. **The project number is assigned during the planning phase, which allows us to track cradle to grave costs. The project number can be tracked by different activities.**

B.1.2 Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below. Change the phase name to correspond to your terminology

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used
Annual Capital Planning	Board	N/A	N/A	Fiscal year budget; Strategic Plan; Capital Improvement

				Plan
Conceptualization/ Study	Assistant General Manager	N/A	N/A	Consistent with Boards approved annual capital planning
Project Planning	Chief Development Officer	N/A	N/A	Fiscal year budget; Strategic Plan; Capital Improvement Plan
Preliminary Design	Group Manager	N/A	N/A	Fiscal year budget; Strategic Plan; Capital Improvement Plan
Final Design (CDs)	Group Manager	N/A	N/A	Fiscal year budget; Strategic Plan; Capital Improvement Plan
Bid & Award	Group Manager	N/A	N/A	Fiscal year budget; Strategic Plan; Capital Improvement Plan
Construction	Group Manager	N/A	N/A	Fiscal year budget; Strategic Plan; Capital Improvement Plan
Closeout	Group Manager	N/A	N/A	Fiscal year budget; Strategic Plan; Capital Improvement Plan

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project? **N/A**

6. What % contingency does the Board authorize for construction change orders? **Generally 10% of construction**
7. Who controls the contingency? **Group Manager**
8. What does the Board require the BART to do in order to get additional contingency? **Notify the Board in writing**

9. Please provide a representative attachment, if possible, of the workflow and content required to obtain original and additional funding from the Board will be very helpful. **The Board rule is 5.2-4(a)(2), which states: The General Manager shall notify the Board one week prior to the issuance of any change order that is anticipated to result in expenditures aggregating more than 10% of the contract price." In practice what we do, as in the example shown here, is list all expected upcoming change orders, so that we do not have to return to the Board each time.**

10. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings? **In general, they are a policy Board. For bigger projects, staff provides semi-annual briefings and memos as appropriate**

B.2 Design

11. Please describe any best practice tools and processes that BART uses to control scope creep throughout the project lifecycle. **Develop and agree to process ahead of time (develop project management plan). Inform users they have a specific point in time to provide scope; immediately escalate the issue to ensure project schedule.**
12. Please describe any best practices you use for design reviews. **Establish rigorous schedule for design review; we have our own technical review team; insist they are timely in their comments. We also hold meetings for users to make sure all comments have been addressed.**
13. Please describe any best practice tools and processes that BART uses to improve the quality of design. What department/group is responsible for ensuring quality of design? **Ensure we have a separate review team (separate from design effort); mandatory constructability reviews**

B.3 Construction

B.3.1 Construction Claims Management

14. Please describe any successful techniques you use to avoid claims **We attempt to address issues as soon as they arise. Partnering helps to avoid claims, too.**
15. Do you require contractors to submit time extension requests as they happen during construction or do you wait until close-out? **We try to get them as they happen, but that is not always practical.**
16. Please describe any best practices you use to timely resolve claims. **Adhere to contract principles; bring in third party experts; break down into manageable pieces.**
17. Please describe any best practices you use for dispute resolution of unresolved claims (DRB/arbitration/ litigation)? **Partnering; Mediation or Dispute Resolution Board**

B.3.2 Utility Relocation

18. Please describe any best practices BART use to identify utilities in the way of construction

BART's best practices to identify utilities include, but are not limited to the following:

a. **Survey the area to identify locations of utilities and types of utility.**
b. **Contact the utility owner and request for as built plans.**
c. **Interview location authorities (City and County) for information.**

d. **Incorporate information received from utility owners, create utility composite plans (including plans and profiles) of all existing utilities in the project area.**
e. **Conduct field verification of the existing utilities from the composite plan and identify locations where we have conflicts.**
f. **Pothole locations where we believe there are conflicts for confirmation.**

19. Please describe any best practices you use to relocate utilities Click here to enter text.

BART's best practices to relocate utilities include but are not limited to the following:

a. **Once conflicts are identified, we meet with utility owners to discuss the conflict, and ways to resolve the conflict, which can be a utility relocation, or can be a redesign to avoid the conflict.**
b. **We request for proof of utility owner's right to be in the street, easement, license area, etc. This information helps us determine who is responsible for relocation cost.**
c. **We create a Utility Impact Report for preliminary engineering which mainly describes the work scope, location of the conflict, and party responsible for the cost of relocation.**
d. **Notice of Owner which describes the conflict, and BART's intention, and the party responsible for the work, is sent to utility owner as part of the Right Of Way Certification process.**

20. If you issue advance utility contracts please discuss your experience with this mitigation approach.

Instead of issuing advance utility contracts, the Warm Springs Extension (WSX) team worked with the utility company directly in advance of utility relocation to mitigate risk.

a. **We met with utility companies to reach an agreement for the work.**
b. **Under the agreement, the utility owner and BART agree on a reimbursement amount, if applicable, and a timeframe in which the relocation work has to be completed by.**
c. **The advance utility relocation was done to mitigate the risk on schedule impact, so not all utility relocations are done in advance.**
d. **Those utility relocations done in advance were completed successfully and eliminated the potential risk on the project schedule.**

21. Please discuss your experience partnering with utility companies to get timely relocations by their forces. **We have generally good experience with utility companies on their relocation. The key to this success is to have a mutual and timely understanding of the utility company and the project's need, and come up with an agreement with a reasonable schedule that works for both parties. Once the agreement is reached, we work closely with the utility company to ensure timely relocation, which may include constant and continuous communications.**

22. Please share your experience with Utility Relocation challenges in the table below.

Challenge Description	Impact on Capital Projects (High/Medium/Low)		BART Response to Mitigate Impacts	Additional Comments
	Cost	**Schedule**		
Develop Agreement	High	High	Collaborate with Utility Company	
Timely Completion	High	High	Monitor Progress Closely	
Betterment	High	Low	Resolve in an Agreement	
Financial Responsibility	High	Low	Research and Fact Finding	

23. How does the BART resolve resource constraints that exist for a utility company? **The potential risk of resource constraints can be mitigated if ample time is given to utility companies for the relocation. Hence, early determination of the conflict and early notification to the utility company is crucial to prevent resource constraints.**

B.4 Operations/Maintenance

23. Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations. **On board assets during the life of construction.**

24. Please discuss how you identify maintenance and capital improvement needs. **Capital Improvement Program (CIP) along with asset management register**

25. Please discuss how you do condition assessment. **Condition assessment varies widely based upon data available. In a few areas, we have detailed failure data from our Maximo system and our operations delay database that informs asset condition. In most areas, our Maximo implementation is not yet advanced enough for detailed, reliable data, so asset condition is made subjectively by subject matter experts, often for small pools of assets, not for individual assets.**

26. Please discuss how you get the projects in the capital plan. **Prepare the scope, schedule, budget, and submit to the capital budget department for prioritization; final decisions are handled by the executive team.**

27. Please discuss how you issue work orders. **Currently Work Orders are issued for Preventive Maintenance and Corrective Maintenance. Some rehabilitation work is captured via Corrective Maintenance work orders; however, the work orders are not an integral part of our capital rehabilitation programs as of yet. As our program matures, the plan is to utilize them to track the work, capture asset baseline data, serve as prioritized work authorizations for capital work, update conditions and risk assessments, etc.**

28. Please describe any other best practice tools, processes and procedures the BART uses for Asset Management.

B.5 Supporting Processes

B.5.1 Scheduling

29. Please check the box next to each best practice tools the BART uses for Cost/Schedule management?
   ☒ Enterprise schedule software (Provide software name) Primavera
   ☒ Integrated Master Schedule (all projects in capital plan in one schedule file)
   ☐ Contractors' Schedule Updates in one central schedule database
   ☐ Cost-Loaded Schedules
   ☒ Cost Forecasting (Please describe method & tools) Excel spreadsheet
   ☐ Earned Value Management System (Please describe) Click here to enter text.
   ☐ Off-the-shelf software (Please provide software name) Click here to enter text.
   ☐ Project Risk Management program (Please describe method & tools in the table below)

Project Size	Risk Registers	Type of Risk Analysis	Monte-Carlo Based Contingencies	Approved Project Budget or Capital Plan Includes Risk-based Contingencies
Above $XX	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Between $XX and $YY	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Below $ZZ	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Please edit/add thresholds as appropriate				

30. Please describe the process you follow to review contractor's schedules. **Resident Engineer receives schedule and has a staff scheduler; schedule is updated once a month; work is verified.**

31. Please describe any best practices you may follow to integrate progress payments with cost-loaded schedules. **N/A**

32. Please describe any Lessons Learned program the BART has, noting how lessons are (1) collected (2) published and (3) retrieved as needed: **Database of lessons learned are developed within each program, and shared with the team as well as other groups throughout the District. Lessons learned are not published, but database is available upon request.**

33. Please describe (and if possible provide a copy of) any written project management and controls procedures.

34. Describe how BART ensures all participants are following the procedures**. Procurement department and Office of Civil Rights department ensures consistency in contract award and administration. Project Management seminars establishes processes and procedures. The Project Manager and General Manager ensure the RE Manual is enforced.**

B.5.2 Human Resource Management

35. Is a Staffing Plan created and followed for every project?
   ☐ **Yes**

☐ **No**

36. Check the box next to any organization-wide HR Management procedures that BART has implemented for individual/personnel development:
    - ☐ Succession planning
    - ☐ Training responsibilities are assigned to named individual(s).
    - ☐ Training activities periodically reviewed.
    - ☐ Budgets/funds direct and indirect costs of training.
    - ☐ Data is collected to determine training effectiveness.
    - ☐ A documented process is in place for recognizing outstanding performance on projects
    - ☐ Linkage has been established between performance and reward.
    - ☐ Project Management is an established career path
    - ☐ A competency model is used that includes proficiency assessments.
    - ☐ Established goals for improving project management capabilities.
    - ☐ Employees have personal development plans.
    - ☐ Training on team development exists
    - ☐ Project Team development is planned and budgeted
    - ☐ The effectiveness of the various HR programs are periodically reviewed.
    - ☐ Key individuals on the project team are identified as critical to project performance
    - ☐ Employee's contribution to organizational strategic goals and objectives are assessed
    - ☐ A mentoring program is in use that provides timely feedback
    - ☐ The effectiveness of mentoring is periodically reviewed.
37. Does BART have any formal training programs?

☐ **Yes**

☐ **No**

If Yes:

38. What is the frequency of training? Click here to enter text.
39. What curriculum is taught? Click here to enter text.
40. What position titles are given training? Click here to enter text.
41. Are consultants also trained? Click here to enter text.
42. Who administers the program? Click here to enter text.

B.5.3 Project Delivery Organization

43. Does BART have a Project or Program Management Office (PMO)?

☒ **Yes**

☐ **No**

44. If Yes, please share the information in the table below –

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	**Yes**			
Project	**Yes**			

Controls				
Project Quality	**Yes**			
Project Safety	**Yes**			
Please edit/add functions as appropriate				

B.5.4 Contract Management

45. What contracting strategies does the BART use for its capital projects? Please use the table below.

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build	**Yes**	**Any size**	**Minimize ambiguity**	**schedule**
Design/ Build (D-B)	**Yes**	➢ **$20M**	**Innovation and reduced owner's risk; schedule**	**Reduced control over design; 3rd party coordination**
Public Private Partnership (PPP)	**N/A**			
Others (Please Add)	**Yes, Design Build Operate Maintain**	**>$20M**	**Innovation and reduced owner's risk; schedule; increased construction quality**	**Reduced control over design; more complex contracting environment**

46. If the BART has used D-B, what conditions guided the BART to consider it? **Potential for reduced cost and improved schedule adherence**
47. If the BART has used PPP, what conditions caused the BART to pursue such a model? **N/A**
48. Did the use of alternative contracting methodologies improve project success? If yes, please describe what aspect of that methodology made a difference. **Has depended on the type of project and the level of 3rd party involvement. Successful with parking garages.**
49. Please share the BART's change order approval authority via an attachment showing the signature authority and approval thresholds?
50. Please describe any best practices you follow related to contract management or communications. **Use of BART RE manual and Construction Management (CM) software. Specifications standardized by incorporating BART Facilities Standards (BFS)**

B.5.5 Document Management

51. What document management system do you use? **Fusion**

52. Is it used for all projects? **Yes**
53. Is a different tool used during construction? **Yes, CM software**
54. If yes how do you integrate the two systems? **Not currently done**
55. Are construction progress meeting minutes maintained in a database that tracks action items to completion? **Yes, CM software enables this functionality**

C. Catchall Question

56. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (ie- contract language, procedure, workflow, etc.) Emphasis on continuous improvement.

<u>End of Questionnaire</u>

Bart Succession Plan

Our goal is to increase the availability of experienced and capable employees that are prepared to assume these roles as they become available in the future. To do this the District conducted analysis on workforce trends, incorporating projected retirements, new service needs, as well as emerging technology trends, to forecast what the workforce needs will be over the next five to ten years. As a result of the analysis the District is finalizing a Workforce Plan that provides a guide in addressing these needs. In line with that plan the District developed training programs to focus on two areas, critical technical positions and management level positions. We established a number of training programs that focus on critical technical positions in the areas of Elevator/ Escalator workers, Transit Vehicle Electronic Technicians and Electricians.

A brief summary of the programs are provided. Utility Worker to Transit Vehicle Electronic Technician Upgrade Program: The District, in partnership with SEIU, developed a Utility Worker to Transit Vehicle Electronic Technician (TVET) Upgrade Program. The program defines the pathway for Utility Workers to become TVETs. It includes formal education obtained in an Electronic Technician certification in an accredited community college and “on the job” (OJT) training provided by the Rolling Shop and Stock Department.

Elevator/Escalator Apprenticeship Program: In January 2014 the US Department of labor (DOL) officially approved the Transportation Learning Center’s proposed Transit Elevator/Escalator Apprenticeship Program. The program allows the District to provide internal and external applicants the ability to gain the technical and on the job training needed to become journey workers through an organized and properly supervised training program. The approved program is designed to be forty eight months and includes an attainment of 6399 hours.

Transit Career Ladders Training Program: In January 2015 the District submitted an application to the Federal Transportation Agency for a grant to fund a Transit Career Ladders Training (TCLT) Program. The program, established for Transit Vehicle Electricians, Electricians, and Train Control Electronic Technicians, was designed to meet the growing needs of the transit workforce by providing training access for traditionally under-represented individuals with the goal of developing streamlined pathways into transportation employment. This will be done by establishing partnerships with such agencies as the local Workforce Investment Boards (WIB) and Bay Area Community Colleges. The model creates a direct line of communication and feedback between the educational institutions and the District with the goal of creating new avenues previously not available to external and internal applicants. If funded the TCLT program is expected to last twenty three (23) months from outreach to completion and certification of the technical training classes. It will consist of four cohorts identified at the four SF Bay Area local colleges of 25 students each in electronics and electrical technical training classes.

The other succession plan area focus for the District is building up our employees’ skills and competencies to transition into supervisory and management positions. The District updated its

Performance Evaluation process by incorporating a succession plan dimension for each professional and management employee. In coordination with the performance management tool the District developed training programs for: Employees who are in technical/clerical positions and aspire to be team leaders Employees who are new supervisors and/or would like to be supervisors Existing supervisor and managers Managers who aspire to become our future leaders The training programs provided range from District provided supervisory trainings to established programs from educational institutions such as the Mineta Institute at San Jose State University

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

MEMORANDUM

TO: Board of Directors **DATE:** May 9, 2012

FROM: General Manager

SUBJECT: **Change Orders to Contract No. 15PD-110**
Added Cost for Maintenance Stairways per California Building Code

This is to notify you, pursuant to Board Rule 5-2.4 (Change Orders), that I intend to authorize Change Orders to Contract No. 15PD-110, Earthquake Safety Program Aerial Structures – C Line with William P. Young, in excess of 10% of the original Contract Price of $10,606,641.10. To date, the District has issued ninety-nine (99) Change Orders in the amount of $1,050,893.38, or 9.91% of the original Contract Price. The forecast of prospective Change Orders is an additional $537,000 or 5.06%. Below is a description of the Change Order costs expected to be undertaken. These Change Orders are necessary for completion of the Contract. Subsection (a) of Board Rule 5-2.4 (Change Orders), provides that the General Manager shall notify the Board one week prior to the issuance of any Change Order that is anticipated to result in expenditures aggregating more than ten percent of the Contract Price.

Change Order No. 32 - Estimated Cost: $145,000

This Change Order will provide for replacement of maintenance stairways affected by the retrofit work to be compliant with the California Building Code. The original staircase was not compliant with any modern code. The Contract Documents identified the stairways to be replaced to meet OSHA worker safety requirements. However, BART's maintenance department stated that the staircase would be unacceptable to BART unless it was constructed to the higher requirements of the California Building Code. To ensure safe access to work areas for BART workers, the ESP agreed to reconstruct the maintenance stairways in accordance with the California Building Code standards. Upgrading the stairs to meet current California Building Code requirements will be an additional cost.

Change Notice No. 93 - Estimated Cost: $27,000

There was an existing combined irrigation and electrical service cabinet shown in the Contract Documents to be relocated after retrofit construction at Pier 250 on Las Juntas Way in Walnut Creek. The Contract Documents erroneously assumed the existing electrical service (electrical meter) could be reused. However, PG&E has now required the electrical service cabinet to be upgraded prior to reconnecting electrical service because it did not comply with current PG&E standards, particularly in regard to providing a separate PG&E meter box. The upgraded facilities necessary to correct the design error will be an additional cost.

<u>Change Notice No. 106 - Estimated Cost: $10,000</u>

Additional top mat rebar in the footing overlay is necessary due to variation in location of fiber optic utilities at Pier 124 on Oak Hill Road in Lafayette.

<u>Change Notice No. 114 - Estimated Cost: $145,000</u>

During the installation and testing of the micropiles in Lafayette, the Engineer determined that the micropile subcontractor has to increase the micropile design length and post-grout the micropiles in order to achieve the design capacity required by the Designer. This is an additional cost due to the differing site condition.

<u>Change Notice No. 115 - Estimated Cost: $20,000</u>

Portions of sidewalks, curbs and gutters were required to be replaced in the City of Lafayette at the completion of the retrofit work. The Contract Documents assumed that the existing sidewalk conformed to City requirements, but upon removal it was learned that the existing sidewalk sections did not contain aggregate base (AB) under the portland cement concrete as required by the City. As a result, the existing subgrade has to be removed and replaced with AB in order to comply with the current City standards.

<u>Change Notice No. 116 - Estimated Cost: $10,000</u>

During construction, it was discovered that rainwater draining over new footing overlays caused erosion of decomposed granite pathway adjacent to the footings. To minimize erosion of the newly-installed decomposed granite, the Contractor must install drain rock, surrounded by an edger. This work was not included in the Contract Documents.

<u>Change Notice No. 117 and Change Notice No. 121 - Estimated Cost: $50,000</u>

During retrofit construction, an unidentified irrigation well pump system was discovered to be supplying the existing irrigation lines on Mesa Street in Concord. The City of Concord has requested that the existing pump well system be restored to supply the new irrigation system. This additional scope of work will be an additional cost.

<u>Change Notice No. 120 - Estimated Cost: $40,000</u>

During footing retrofit construction, unidentified existing pea gravel backfill was encountered. The project design does not include any activity that uses pea gravel; and hauling and storage of this material for possible future use would be more costly than offhaul and disposal. A portion of the material was utilized as backfill by mixing it with other soil on site. The remainder had to be disposed of at an additional cost to the contractor.

<u>Contingency - Estimated Cost: $90,000</u>

Closing out the project is anticipated to result in additional costs to perform restoration and repair of items beyond the Contractor's control. These items may result in additional compensation to the Contractor.

Negotiated Change Orders may be executed seven days after this notice has been forwarded to the Board.

Funding for the above-referenced changes are included in the total project budget for the Earthquake Safety Program.

Negotiations to resolve final cost and time issues related to these changes are proceeding. No individual Change Order forecasted above is expected to exceed the $200,000.00 authority delegated to the General Manager by Board Rule 5-2.4(b).

All Change Orders will be approved as to form by the Office of the General Counsel prior to execution.

Grace Crunican

Cc: Board Appointed Officers
Deputy General Manager
Executive Staff

BART Utility Identification BP

- Survey the area to identify locations of utilities and types of utility.
- Contact the utility owner and request for as built plans.
- Interview location authorities (City and County) for information.
- Incorporate information received from utility owners, create utility composite plans (including plans and profiles) of all existing utilities in the project area.
- Conduct field verification of the existing utilities from the composite plan and identify locations where we have conflicts.

Pothole locations where we believe there are conflicts for confirmation.

BART Utility Relocation BP

A. Once conflicts are identified, we meet with utility owners to discuss the conflict, and ways to resolve the conflict, which can be a utility relocation, or can be a redesign to avoid the conflict.
B. We request for proof of utility owner's right to be in the street, easement, license area, etc. This information helps us determine who is responsible for relocation cost.
C. We create a Utility Impact Report for preliminary engineering which mainly describes the work scope, location of the conflict, and party responsible for the cost of relocation.
D. Notice of Owner which describes the conflict, and BART's intention, and the party responsible for the work, is sent to utility owner as part of the Right Of Way Certification process.

BART AUR Experience

A. We met with utility companies to reach an agreement for the work.
B. Under the agreement, the utility owner and BART agree on a reimbursement amount, if applicable, and a timeframe in which the relocation work has to be completed by.
C. The advance utility relocation was done to mitigate the risk on schedule impact, so not all utility relocations are done in advance.
D. Those utility relocations done in advance were completed successfully and eliminated the potential risk on the project schedule

Metro **Comparable Agency Research**

A. DART Information *(This section gathers info about your agency)*

1. DART Contact *(please fill in your contact information below)*

Contact Information	Description
Agency	Dallas Area Rapid Transit (DART)
Contact person	Timothy H. McKay, P.E.
Title	Executive Vice President
Phone Number	214-749-2926
Email	tmckay@dart.org

2. DART Capital Plan Overview (*Please provide DART information below)*

a. What is your primary business line? ***Build, establish and operate a safe, efficient and effective transportation system that, within the 13 DART member cities, provides mobility, improves the quality of life, and stimulates economic development through the implementation of the DART service plan as adopted by the voters on August 13, 1983, and as amended from time to time.***

b. What is the total dollar value of agency Capital Plan ***$7,074,193,486***

c. How many years does the capital plan above span? ***20 years***

d. How many projects are in the capital plan? ***282***

e. # of professional services contracts for the capital plan? ***GPC vi – 10 (CA), OCAE – 17 (CA), CPS-45 (ca), GPCv – 1, General Engineering Consultant III-1, Environmental Response – 1, Positive Train Control Consultant – 1.***

f. What is the total dollar value of professional contracts? ***GPC vi- $12,000,000.00, OCAE - $35,259,799.00, CPS - $37,100,000.00, GPC v - $27,500,000.00, General Engineering Consultant iii - $53,235,977.00, Environmental Response - $3,250,000.00, Positive Train Control Consultant – 4,386,248.00***

g. Please fill in the table below:

Staff Type involved in capital program only	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff	*83*	
Consultants	*30*	
Independent Contractors	*5*	
Total	*108*	*100%*

h. Please share any succession planning best practices you may be using to deal with an aging workforce ***N/A***

i. Please share any stakeholder management best practices you may be using ***CIPMP Project PMP***

Metro

Comparable Agency Research

j. What percentage of completed capital projects finished on time? ***95.0%***

k. What percentage of completed capital projects finished within the original contingency budget? ***99.9%***

B. Questionnaire *(This section gathers best practices in each project phase)*

B.1 Planning

B.1.1 Project Manager's Role

1. Please share information regarding your Project Manager's role in the table below:

Does PM have Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes		***Project Manager is fully engaged with every aspect of the project. They are able to recognize risks and mitigate them quickly as they are developed. They have insight as to the end users requirements as well as dealing with all authorities having jurisdiction to mange issues.***	***Reliance on one person can lead to issues should he move on. Also he will be the contact for that project on all issues after the job is turned over to the end user.***

2. Describe any best practices used to develop a complete project scope and verify it with the end user ***Full communication on all levels, holding meeting to fully discuss the scope of work. Involvement of all affected parties regardless of the size or their own involvement. Full discussion and disclosure and dissemination of meeting minutes with everyone's roles and responsibility. Use of ball in court to get everyone participating in the process.***

3. Describe any best practices used to capture early studies and planning costs to a project charge number ***Once a project is approved to move forward an account code and baseline budget is established. Everyone will charge accordingly to the budget code as required.***

B.1.2 Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below. Change the phase name to correspond to your terminology: ***Please see the attached Power Point***

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used

Metro Comparable Agency Research

Annual Capital Planning				
Conceptualization/ Study				
Project Planning				
Preliminary Design				
Final Design (CDs)				
Bid & Award				
Construction				
Closeout				

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project? ***Please see attached PowerPoint***
6. What % contingency does the Board authorize for construction change orders? ***0-10% depending on contract risks***
7. Who controls the contingency? ***As outlined in Change Management Plan and within authorized personnel, fiscal authority or Board Approved***
8. What does the Board require the DART to do in order to get additional contingency? ***Go Back to the Board***
9. Please provide a representative attachment, if possible, of the workflow and content required to obtain original and additional funding from the Board will be very helpful. ***Please see the attached Power Point***
10. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings? ***Our Board is very involved, committees are developed to hear presentations and go over any concerns they may have. The Board meets twice a month.***

B.2 Design

11. Please describe any best practice tools and processes that your DART uses to control scope creep throughout the project lifecycle. ***Hold weekly meetings to keep a tab on the progress made. Monitor designer activities and reports for abnormalities and deviation from scope of work. Require designer to only take direction from the assigned manager on the project.***
12. Please describe any best practices you use for design reviews: ***We have establish a design review process that identifies roles, responsibilities, process, and schedule. We typically send the plans out to selected group of professionals within the agency and require review comments within a defined time frame. Comments are entered into our design review file sharing database for disposition by designers and Agency Project Manager assigned to the project. Any approved comments will be included in the next design submittal to the Agency.***
13. Please describe any best practice tools and processes that your DART uses to improve the quality of design. What department/group is responsible for ensuring quality of design? ***Review by Project Manager and evaluation of reviewer comments during design review process. We***

also do design certification to assure that all DART Design Criteria manual requirements are included in the design.

B.3 Construction

B.3.1 Construction Claims Management

14. Please describe any successful techniques you use to avoid claims ***Write clear contracts, with risk allocation clearly identified. Cross-discipline/cross-departmental team work together in creating contracts. Continue good communication and working relationships with the project team – contractors and owners design, construction, management Use Partnering, Disputes Review Board, and escalation ladder of issues/disputes to higher levels of management, to keep communication open and identify issues before they become disputes. Have recently utilized Cooperation Agreement and collaborative methods to commit to all parties involved in project working closely as a team. Have included Designer, Contractor and Owner, and City or other significant stakeholders if possible. Have included sharing of potential cost and time savings incentives. Team work including construction/government contracts lawyer embedded in the capital projects as resource for procurement and design/construction groups to try to prevent litigation by maintaining proper records, creating and equitable contract language and correspondence during contract, providing legal input on contract interpretation, negotiation preparation, and encouraging use of alternative dispute resolution (ADR) tools.***

15. Do you require contractors to submit time extension requests as they happen during construction or do you wait until close-out? ***DART focus is on resolving issues in construction as they arise, and try not to wait until end of contract. Contemporaneous evaluation and resolution is preferred to avoid re-writing history and manipulating data for claims. Contract clauses and specifications support this approach, as do weekly meetings, partnering and ADR tools included in the Contract. Examples of clauses requiring Contractor to submit cost and time proposals timely include: Exhibit F General Provisions clauses entitled Changes, Equitable Adjustment, Time Extension, as well as Schedule Specification requirements for time extension requests.***

16.Please describe any best practices you use to timely resolve claims ***Hold regular meetings with key player participants weekly at construction site. In addition to site construction management teams, representatives from end user, safety, quality, engineering, design, environmental, real estate, systems integration, schedule management and all relevant disciplines involved continuously throughout the project. S Claims Team for larger claims or those that could require extensive analysis and possibly experts. Team comprised of representatives of Procurement, Design/Construction, technical support, and legal. DART has brought experts for engineering or schedule review and analysis of issues prior to negotiations and prior to litigation. DART has also used collaborative agreements between DART and contractor to share information and potentially share one independent expert to provide an opinion to all parties to help resolve an issue. Provide training on claims avoidance/management/resolution for construction management and procurement team members. Training regarding DRB process and uses to both contractor and owner teams on the contract. Use DRB, Partnering, Disputes Resolution Escalation Process, other tools as needed.***

17.Please describe any best practices you use for dispute resolution of unresolved claims (DRB/arbitration/ litigation)? ***DART utilizes Dispute Review Boards (DRB) on many of its larger Construction Contracts, under the DRB Foundation model. DART prefers that engineers sit on the 3-member panel, and that the panel have experience with government contracts for heavy construction, and preferably rail or light rail linear projects. DRB meets regularly at the construction site during the project and the parties are required to present not only the status of the project, but also any issues each party believes may become a problem or dispute. By having regular contact with the project and*** *reports of potential issues, the DRB acts to help avoid disputes. The DRB is also available a hearing panel to make non-binding written determinations on disputes brought by the parties (no lawyers). While DRB findings are not binding, they serve as an independent view from experienced and respected panel of engineers. Have written a contract clause, Dispute Resolution Escalation Process (DREP) that can be included in construction contracts. This is an escalation ladder to higher management to attempt to resolve disputed issues between the contractor and owner. The DREP clause requires that this process be used prior to entering into the formal administrative Contract Disputes Process. DART's administrative Contract Disputes Resolution Process is similar to the U.S. government construction contracts' Boards of Contract Appeals process. The contractor may ask for a Contracting Officer Final Decision on any outstanding disputed issue. Contracting Officer Final Decision is to be an independent look at the issue, since the Contracting Officer is at least one level up from the procurement official overseeing the contract at the field level. The Disputes Clause allows for the contractor to appeal the C.O. Final Decision to an independent Administrative Judge hired by the DART Board of Directors. DART has a pool of Judges from the Armed Services Board of Contract Appeals that are well versed in heavy construction and government contract law. Many of DART's standard clauses are similar to the federal clauses in the Federal Acquisition Regulations (FAR), and DART states in the contract that if there is no Texas law applicable to an issue, Federal government contract law will be used for guidance. The contractor gets a fair hearing in a process very much like litigation, and the process is generally quicker than going to the courts. The Judge's Decision may be appealed to court if either party believes that there is an error in matters of law, but is dispositive as to findings of fact. There have been very few appeals to court, since a knowledgeable sitting or retired judge hears the case and writes the decisions.*

B.3.2 Utility Relocation

18. Please describe any best practices you use to identify utilities in the way of construction

    DART's experience has been that money spent during planning and design save the project money and preserves construction schedules.

    - ***Use three dimensional Subsurface Utility Engineering (SUE), including verifying utilizes in the field***
    - ***Reimburse the utility companies for a designated representative from their company to work with your planning design and construction teams. These individuals can help the agency teams.***
        - ***Locate and identify the utilities that are in conflict.***
        - ***Be available to suggest ways to mitigate any conflicts and help establish a realistic project budget and project schedule.***
        - ***As the design changes, the utility companies will immediately be aware of the changes and be able to help identify new conflicts and adjustments required to the project's budget and/or schedule.***
    - ***Hire a full time professional utility coordinator that works with you planning, design and construction teams as well as with the utility companies' representatives (If possible, this should be the same person or persons during planning, design and construction.***

19. Please describe any best practices you use to relocate utilities 1. ***In your solicitation, do not indicate that all utilities will be relocated prior to notice to proceed for construction activities. 2. Know the federal requirements when using federal funds. 3. Work with the regional office of your federal***

funding partner to make sure that your processes meet the federal requirement. 4. Make sure to include the required federal clauses in any relocation agreements between the agency and the utility company. 5. Reimburse the utility companies for a designated representative from their company to work with your planning, design and construction teams. These individuals can help the agency teams. Understand the utility company requirements, the phases of their relocation work, the long lead time items and establish a realistic utility relocation budget and construction schedule. As the design changes or a field condition change, the utility companies will immediately be aware of the changes and be able help identify new conflicts. Be available to suggest ways to mitigate any new conflicts and help identify additional cost to the project budget and schedule. Hire a full time professional utility coordinator that works with your planning, design and construction teams, as well as with the utility companies' representatives, (If possible, this should be the same person or persons during planning design and construction. Establish a protocol with the utility companies for (1) authorization of overtime when required (2) if utility crews have to be pulled off the job site due to emergency situations such as tornadoes, hurricanes, ice storms, etc., and (3) how to mitigate delays. Whenever possible, design the project in such a way that it does not require utility relocations for major items such as utility vaults, major transmission lines, large major pipelines, etc... When possible, make the construction contractor responsible for all utility relocations. This allows the construction contractor to control the construction schedule. Consult with the utility companies to see if they agency's contractor can perform some or all of the work, such as design and construction for their relocation. Structure your weekly design and construction meetings to include the agency's utility coordinator and the representatives from the utility companies. Reserve a specific time in the meetings to discuss utility relocations and utility conflicts. Have regular meetings in the field with the agency's utility coordinator, utility representatives, project managers and construction supervisor to verify materials and activities in the field. Follow the protocols established during the planning phase.

20. If you issue advance utility contracts please discuss your experience with this mitigation approach. *Only issue advance utility contracts if (1) your design is 100% complete, (2) you are confident that there are not going to be design changes, (3) you are confident that you know all of the utility conflicts, and (4) your federal partner has agreed to the execution of advance utility relocation contracts between the agency and the utility companies.*

21. Please discuss your experience partnering with utility companies to get timely relocations by their forces. *Include the utility companies in the planning and design phases to establish a positive working relationship and create an understanding of each party's schedule constraints. In your weekly construction meetings, review the proposed construction schedule for the next four-to-six weeks and compare it to the schedule and progress of the relocation by the utility company. Work with all parties to make adjustments at that time if a conflict appears to be evident. Recognize that, in emergency situations such as tornadoes, hurricanes, ice storms, etc..., the utility company crews may be pulled off your project to get services back up and operating in other parts of the country. Have a mitigation plan in place and have money in the budget to pay for necessary mitigation. A mitigation plan may include, but is not limited to (1) paying the utility company for overtime labor, (2) paying the utility company's costs to expedite delivery of materials, and (3) obtaining permission for the agency's contractor to perform the utility relocation engineering and construction work on behalf of the utility company.*

22. Please share your experience with Utility Relocation challenges in the table below. Click here to enter text.

Challenge Description	Impact on Capital Projects	DART Response to Mitigate Impacts	Additional Comments

	(High/Medium/Low)			
	Cost	Schedule		
Redesign of Project	*High*	*High*	*Utilities had to be relocated multiple times*	
Utility crews had to be pulled off the project work weather related outages due to hurricanes, tornadoes, etc.	*High*	*High*	*Schedule delays, increased Project Cost*	
Change in field conditions (other utilities were found to be in conflict with new location for the relocated utility or location of existing utilities were not in the location as shown on the construction plans)	*High*	*High*	*Schedule delays, increased Project Cost*	

23. How does the DART resolve resource constraints that exist for a utility company? ***Resource constraints that exist for utility companies should be identified during the planning and design phase. Reimburse the utility companies for a designated representative from their company to work with your planning design and construction teams. Hire a full time professional utility coordinator that works with your planning, design and construction teams as well as with the utility companies' representative (If possible, this should be the same person or persons during planning, design and construction).***

B.4 Operations/Maintenance

24.Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations ***At DART, all trains, facilities, systems and operational processes are designed, constructed and implemented in a manner that promotes the safety and security of persons and property. The design, construction testing, and start-up of all Rail Transportation Project Systems comply with applicable safety and security laws, regulations, requirements and railroad industry practices. DART's Rail Program Development (RPD) department fulfils the primary role in accomplishing this task. Each individual and organization within DART's Rail Program Development department is responsible for hazard and vulnerability management, for applying the processes that are designed to ensure safety and security, and for maintaining established safety and security standards, consistent with their position and organizational function. System modifications undergo a Design Review process. Design Review meetings involves managers from Safety, Operations and Maintenance. Items in the Design Review and Change Control processes can be assigned to responsible parties. Reviewers are notified immediately of any changes to an item and DART personnel, not design or construction contractors, must appropriately disposition every item. If there is a dispute or concerns about an issue, DART convenes a meeting comprised of the aforementioned*** *decisions. Through a cooperative team effort and the systemic application of safety and security principles, Rail Transportation Systems are designed, constructed, tested, and placed into service in a safe and secure manner. Integrated Testing and verification of a transit system is the final major activity to take place before System Safety and Security Certification of the Construction occurs and revenue service begins. Integrated Testing also ensures that the project elements operate/function as intended. Previous start-up experience within DART has shown that the most effective way to manage this major coordination effort is by having a single organization, independent from the designer and the contractor, in place and tasked with this responsibility during the start-up period. DARTS System Integration Group (SIG) is responsible for all integrated testing activities. The SIG provides the strategic link necessary for the extensive coordination and cooperation needed during the start-up phase. The SIG directs all activities during the integrated testing process before revenue service begins. Prior to the construction. The SIG reviews all systems design submittals at each level of their design development and provides formal comments where applicable. The SIG maintains close coordination with the Quality & Safety Design 7 Construction in RPD, the Transportation Department, the Operation and Maintenance departments, the DART Police Department; and the Rail Safety Section within the Risk Management Division. In addition to performing the detailed tasks related to the start-up, the SIG provides the additional staff, and other resources, that are only required during the start-up period. DART also temporarily assigns personnel from its Rail Operations and Maintenance departments to aid in the Integration and Start up process under SIG authority, during the Start up phase. Integrated Testing is also a key part of the Safety and Security Certification (SSC) process, as it ensures the effective interface of all of the project elements and that these project elements comply with established safety and security performance requirements. DARTs utilizes its Integrated Test Plan (ITP) to accomplish its system integration needs. The ITP is based on the implementation of policies and the evolution of test procedures that have taken place during previous DART Integrated Testing efforts for the Phases II and Phase III of the LRT Build-Outs, Dallas Streetcar for the City of Dallas, and the Urban Circulator for the Heritage Trolley M-Line of the McKinney Avenue Transit Authority (MATA). The ITP is reviewed annually and is subject to change to meet the needs of each individual Rail Transportation Projects. Adherence to the ITP provides DART with the assurance that all Rail Transit System elements and personnel are able to function together as an integrated unit. Compliance is achieved using verification, validation, and testing. Additional tests are developed and added as needed. The ITP defines the tests that are to be conducted to verify performance at appropriate levels of the system hierarchy. For each project the ITP is based on a specifically developed list of integrated tests crafted to fulfill the various testing and validation efforts peculiar to each project. When the Contractors begin to submit their contractually required test plans, procedures, and testing schedules to the Authority, these plans are reviewed by RPD/SIG personnel for compliance with DARTs design criteria and project standard specifications.*

DART utilizes a detailed SSC program with RPD being responsible for the SSC of the rail transportation systems. Although managed as separate programs, the Safety and Security Certification Plan (SSCP) and the ITP complement and reinforce each other by coordination of the various safety and security related tests and Readiness Drills. In the past DART has used project-specific SSCPs. DART is now working toward a single procedure or manual to serve as a basis for all certifiable Rail Transportation Capital improvements projects. Projects are certified at both the design and construction stages. DART requires designers and builders to submit a safety and security certification checklist in their proposals for review and approval by the Safety and Security Certification Review Team (SSCRT). Additionally, DART includes in its project scope for major capital projects a requirement that contractors hire a system safety manager. The SSCRT includes upper management-level personnel from Safety, Rail Program Development, Systems Engineering and Integration, Facilities Engineering, and Construction. In addition, DART coordinates

these activities through its Start up Team (SUT). The SUT consists of representatives from the various departments/divisions affected by the start-up, and serves as an informational forum for each representative. At the completion of integrated testing, the SIG and SUT support the SSCRT. They provide the data necessary to certify that the projects meet DART's established safety and security goals, and operational performance requirements. The SUT supports the transition of the Project from the SIG to the DART Operations. The SSCRT determines whether to recommend an element for System Safety and Security Certification. Detailed Certifiable Items Lists (CILs) accompany each certifiable project. The Director of System Safety and Certification is primarily responsible for CILs, with in-house contractor support (SIG). The Director proactively participates in the design process, enabling an efficient transition between design and construction and helping ensure that safety considerations undergird the entire process. DART verifies construction safety requirements through field inspections, test records, and integrated test results. Upon receiving and reviewing the SSCRT's recommendation for approval, the Executive Vice President – Growth/Regional Development will sign a Certificate of Compliance. After signing the Certificate of Compliance, DART RPD/SIG will transfer the system to DART Operations for the Pre-revenue training prior to beginning full revenue service operations.

25. Please discuss how you identify maintenance and capital improvement needs. ***DART Maintenance provides the information for Scope of work, and the cost to do the work. DARTs Rail Program Development (RPD) department, can provide Cost Estimates and a Project Manager (PM) to develop Baseline Schedules. PM's work with DART Procurement to put RPD's Solicitation packages together. It has to be an approved project in the Capital Financial Plan.***

26. Please discuss how you do condition assessment ***DART Maintenance provides the information, the Scope of work, and the cost to do the work. DART Maintenance departments can also approach DART Rail Program Development (RPD) with condition assessments and special project needs. RPD provides technical input to DART Maintenance and DART Procurement for project scope and statements of work ensuring that each project is compliant with DART design standard specifications, that Safety and Security Compliance is met or maintained.***
27. Please discuss how you get the projects in the capital plan ***RPD is involved in the design and design review processes and ensures that each Capital improvement projects are compliant with DART design standard specifications and that Safety and Security Compliance is met or maintained. New projects are brought to the DART Board each year during the Budget Process for inclusion in the next year's financial plan. Typically it follows this pattern. An Asset Condition Study is performed and a Management Report generated. A Finance and Departmental analysis of the Asset Condition then is evaluated against the reserves in the financial plan. If the project budget and financial plans are approved the project is funded and moves forward.***
28. Please discuss how you issue work orders. ***RPD provides technical input to DART Procurement for project scope and statements of work ensuring that each project is compliant with DART design standard specifications and that Safety and Security Compliance is met or maintained. The DART Procurement Department is responsible for the development and management of all agency purchasing and contracts. The Director of Contracts oversees managers who are responsible for capital projects, including major operations and maintenance services, as well as construction, architecture, and engineering. Procurement staff follows a standard process for developing a procurement, which starts with a meeting with the requesting Department to develop a Statement of Work. Procurement ensures that standard clauses are included in all contracts. A contract will typically include requirements to adhere to: Special Provisions, which are project specific General Provisions, which are more general to DART Quality Program, DART Safety & Security Program. The***

Metro Comparable Agency Research

Special Provisions include specific requirements for coordinating with light rail operations and adhering to all DART rail operating rules, environmental requirements, and safety and security requirements.

29. Please describe any other best practice tools, processes and procedures the DART uses for Asset Management. ***DARTs Maintenance and Technical Services Division utilize the Design Review, and Change Control Board (CCB) processes for planning and design development involving Capital Projects over $250,000.00 or for other special projects that require design services.***

B.5 Supporting Processes

B.5.1 Scheduling

30. Please check the box next to each best practice tools the DART uses for Cost/Schedule management?

Yes Enterprise schedule software (Provide software name) ***Oracle 8.4 Primavera Project Manager***

Yes Integrated Master Schedule (all projects in capital plan in one schedule file) ***All projects reside in a single database on a single server.***

Yes Contractors' Schedule Updates in one central schedule database – ***Contractor schedules are received monthly and stored in the same database with the Program Schedule.***

Yes Cost-Loaded Schedules –***Some contracts require cost and resource loaded schedules from the contractor.***

Yes Cost Forecasting (Please describe method & tools) - ***Cost forecasting is reflected in a cost-loaded schedule as the value remaining or forecasted beyond the status date. Embedded within each activity in the Contractor's Schedule Activities by Type of Direct Cost (Labor, Materials, Equipment, Other Expense) for each activity.***

Yes Earned Value Management System (Please describe***) Oracle Primavera (P6) contains an earned value functionality to allow reporting earned value metrics from cost-loaded, progressed schedules. Also, if the contract does not require cost-loaded progressed schedules – schedule performance can be measured against the schedule baseline and then cost metrics are developed off of the unit price based contract bid pay items and then the earned value calculation is made.***

Yes Off-the-shelf software (Please provide software name) ***XER Schedule ToolKit or Schedule Analyzer is used to analyze schedule health, integrity, and variances.***

Yes Project Risk Management program (Please describe method & tools in the table below) ***During the initial project initiation DART starts to creates an understanding of the financial/schedule risk of each requested capital project. A risk management matrix (Risk Register) is created for the capital projects or programs in Excel. Risk is managed and actions reported throughout the duration of each project. The Risk Register is updated monthly to track and report actions/mitigations and due dates to mitigate or close issues. Each Project Manager is responsible for timely managing risk issues related to their projects. Project contingencies are developed for each assigned risk including a contingency for unknown risks.***

Project Size	Risk Registers	Type of Risk Analysis	Monte-Carlo Based Contingencies	Approved Project Budget or Capital Plan Includes Risk-based Contingencies
Above *$50M*	***Yes***	***Cost &***	***Yes***	***Both***

		Schedule		
Between *$49.99 M* and *$5M*	*Yes*	*Cost & Schedule*	*No*	*Both*
Below *$5M*	*Some*	*Cost & Schedule*	*No*	*Both*
Please edit/add thresholds as appropriate				

31. Please describe the process you follow to review contractor's schedules. ***Each Contractor's schedule is analyzed by using XER Schedule Tool/Schedule Analyzer to check for changes from one monthly submittal to the next. The software checks for missing logic, calendar changes, variance to the previous baseline, out-of sequence statusing, new activities added, activities deleted and resource requirement or changes. In Oracle Primavera Project Manager (P6) a Critical Path and Longest Path analysis is performed along with verifying status updates.***

32. Please describe any best practices you may follow to integrate progress payments with cost-loaded schedules - ***Some contracts require the contractor to bill monthly progress billings off of the monthly progressed schedule. The contractor's monthly progress is updated based on progress achieved, (labor, materials, equipment, other), using stored-period- of-performance for prior monthly updates. The monthly invoice value is exported from the P6 Monthly Progress Schedule into Excel format. The monthly values are uploaded via Excel function "V-Lookup" into an EXCEL SS coding template by schedule activity. The monthly billing is coded and then electronically uploaded into DART's Lawson Accounting System.***

33. Please describe any Lessons Learned program the DART has, noting how lessons are (1) collected (2) published and (3) retrieved as needed: Please describe (and if possible provide a copy of) any written project management and controls procedures. ***DART has a custom Lessons Learned Program. The program is web-based, and is hosted on DART's intranet. The stages of a lesson include: collection, screening, analysis, Lessons Learned Board Review Progress, Implementation, Follow-up Evaluation, and Distribution. The Lessons Learned Program manual provides the program objectives, requirements, and process. In addition, a requirement to submit Lessons Learned is included within contracts. Lessons are submitted monthly with the pay application. The contractor conducts a Lessons Learned Workshop to review the lessons identified throughout the duration of the project. A Lessons Learned Deliverable is also provided. (Reference: Lessons Learned Program Manual / Exhibit H Scope of Work – Lessons Learned)***

34. Please describe (and if possible provide a copy of) any written project management and controls procedures: ***Please review the Attached CD***

35. Describe how the DART ensures all participants are following the procedures. ***Schedule baselines and monthly schedule updates are required submittals by contract. The Resident Construction Management Staff reviews the required submittals and narratives and dispositions the update as follows: Approved, Approved as noted, Approved as noted (correct and re-submit), disapproved. The Resident Construction Management staff also reviews and recommends the monthly payment amount based on the progressed schedule detailed invoice and field documented progress. If the contractor is not compliant with the contractual obligations, the Resident Construction Manager/COR works with the Contracting Officer to***

bring the contractor issues into compliance. If not, the contract has remedies available to overcome any issue.

B.5.2 Human Resource Management

36. Is a Staffing Plan created and followed for every project?

    Yes

37. Check the box next to any organization-wide HR Management procedures that the DART has implemented for individual/personnel development:

Yes	Succession planning – ***Maintenance Department Only***
Yes	Training responsibilities are assigned to named individual(s).
Yes	Training activities periodically reviewed.
Yes	Budgets/funds direct and indirect costs of training.
Yes	Data is collected to determine training effectiveness.
Yes	Linkage has been established between performance and reward.
Yes	Project Management is an established career path
Yes	A competency model is used that includes proficiency assessments.
Yes	Established goals for improving project management capabilities.
Yes	Employees have personal development plans.
Yes	Training on team development exists
Yes	Project Team development is planned and budgeted
Yes	The effectiveness of the various HR programs are periodically reviewed.
Yes	Key individuals on the project team are identified as critical to project performance
Yes	Employee's contribution to organizational strategic goals and objectives are assessed
Yes	A mentoring program is in use that provides timely feedback

38. Does your DART have any formal training programs?

    Yes

If Yes:

39. What is the frequency of training? ***Varies depending on the subject/program***

40. What curriculum is taught? ***Leadership DART – SMU Cox Executive Education; Light Heavy Rail Safety Training; Workplace Diversity; Ethics & Conflict of Interest; Human Trafficking; Workplace Violence; Sexual Harassment; Reasonal Suspicion***

41. What position titles are given training? ***Everyone receives designated training***

42. Are consultants also trained? ***Yes, Light and Heavy Rail Safety Training***

43. Who administers the program? ***Departments for departmental training, EEO, Legal, Light Rail Safety Training-Director Construction Safety & Certification, Heavy Rail Training-TrackSense, Inc.***

B.5.3 Project Delivery Organization

44. Does the DART have a Project or Program Management Office (PMO)?

    Yes ***Project specific Decision – PMO used for design build - Irving***

45. If Yes, please share the information in the table below –

Metro **Comparable Agency Research**

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	*Yes*		*Immediate on Issue*	*Engagement Resolution*
Project Controls	*No*	*Headquarters*		*N/A*
Project Quality	*Yes*		*Immediate on Issue*	*Engagement*
Project Safety	*No*	*Headquarters*		*N/A*
Please edit/add functions as appropriate				

B.5.4 Contract Management

46. What contracting strategies does the DART use for its capital projects? Please use the table below.

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build	*N/A*	*N/A*	*AEC Involvement*	*Change Management*
Design/ Build (D-B)	*N/A*	*N/A*	*See Question 49*	
Public Private Partnership (PPP)	*Funding not identified*	*N/a*	*Under Consideration*	
Others (Please Add)				

47. If the DART has used D-B, what conditions guided the DART to consider it? ***Time***
48. If the DART has used PPP, what conditions caused the DART to pursue such a model? ***Under Consideration.***
49. Did the use of alternative contracting methodologies improve project success? If yes, please describe what aspect of that methodology made a difference. ***Yes, Early Delivery, Change Management, Quality.***
50. Please share the DART's change order approval authority via an attachment showing the signature authority and approval thresholds? ***Change Control Board (CCB)-- for time or significant cost changes, matter must be presented to Change Control Board comprised of representatives from many DART departments, functions and disciplines. CCB must vote to approve a significant change prior to implementation and many times prior to final negotiations with contractors. CCB action is required prior to any changes that must go to Board of Directors for approval. This has been a very effective coordination and oversight tool, allowing transparent actions related to procurement and management of construction contracts.***

51. Please describe any best practices you follow related to contract management or communications: ***Review and approval of baseline budget and schedule. Receive recurring update from project team overseeing project implementation and incurred cost, forecasted cost to establish estimate at complation, variation with budget and schedule; and work closely with business analyst and project control coordinator to monitor independent reports and charges recorded against the project. Regarding procedures in our department for contract management. Procurement requisition requires authorized personnel to cite project code. DART Contracting Officer designates Contracting Officer Representative with responsibility o certify invoice and accept work. DART AVP Program Delivery or Department Heed/EVP designates DART staff to serve in the roles of project manager and invoice reviewer in the invoice workflow process. Invoices are reviewed by DART staff serving in above name positions in accordance with DART Admin Policy.***

B.5.5 Document Management

52. What document management system do you use? ***DART utilizes various document management systems. Systems utilized, by the department, include the following: <u>ORACLE Imaging and Processing, Network Drives, and Google Drive</u> The department file room controls, tracks and distributes department correspondence. This includes correspondence created or received by department staff, consultants and construction field personnel. The goal is to provide a central control point for department correspondence and provide direction for the filing and archival of documents at the construction site. ORACLE Imaging and Processing was utilized by the file room for department correspondence. Currently, it is used for research, historical, and retrieval purposes. At this time correspondence is logged, scanned to the appropriate network drive, OCRd, and distributed via email/Google Drive. (Reference: Rail Program Development File Room Procedures) <u>Primavera Contract Manager and Network Drives</u> Primavera Contract Manager is utilized for the construction management files. Files consist of correspondence, contract modifications, shop drawings, submittals, administrative records, quality records, meeting minutes, contract drawings, and specifications. Documents are logged and/or generated in Primavera Contract Manager, scanned, and filed in accordance with the file plan. (Reference: Resident Construction Manager's Manual, Project Owner's Manual, and Rail Program Development File Room Procedures) ImageSite is the document repository system utilized by the Engineering Document Control group. Documents and drawings are indexed (to create a CSV file), stored on the appropriate network drive, and uploaded to ImageSite for users. Examples of documents uploaded to ImageSite include: design review packages, conformed contracts, contract changes, as-built drawings, as-built specifications, geotechnical reports, etc. (Reference: Document Control Procedures) FileNet is the agency document management software. The department utilizes FileNet for archive box information. Records archived are done in accordance with the established procedures. Information from the archive forms/sheets is uploaded into FileNet for search and retrieval. (Reference: Resident Construction Manager's Manual, Project Owner's Manual, Rail Program Development File Room Procedures)***

53. Is it used for all projects? ***The systems, tools, and document management procedures are used for all projects.***

54. Is a different tool used during construction? ***Primavera Contract Manager and the network drives are used by the Construction Management staff during construction.***

55\. If yes how do you integrate the two systems? ***Primavera Contract Manager is linked to the network drives. Documents stored on the network drives (in accordance with the file plan),***

are attached/linked in Contract Manager. Remaining document management systems are independent.

56. Are construction progress meeting minutes maintained in a database that tracks action items to completion? ***Construction meeting minutes are documented utilizing Primavera Contract Manager. Business/action items are input and tracked with a status. Items with an open status are tracked until completion. Once items are closed, they remain on the meeting minutes for one meeting after the closure (to document the closure). Minutes are stored, in Contract Manager, by meeting and date with all open/closed items***

C. Catchall Question

57. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (ie- contract language, procedure, workflow, etc.) Click here to enter text.

<u>End of Questionnaire</u>

DART Dispute Resolution Best Practice

DART utilizes Dispute Review Boards (DRB) on many of its larger Construction Contracts, under the DRB Foundation model. DART prefers that engineers sit on the 3- member panel, and that the panel have experience with government contracts for heavy construction, and preferably rail or light rail linear projects. DRB meets regularly at the construction site during the project and the parties are required to present not only the status of the project, but also any issues each party believes may become a problem or dispute. By having regular contact with the project and reports of potential issues, the DRB acts to help avoid disputes. The DRB is also available a hearing panel to make non-binding written determinations on disputes brought by the parties (no lawyers). While DRB findings are not binding, they serve as an independent view from experienced and respected panel of engineers. Have written a contract clause, Dispute Resolution Escalation Process (DREP) that can be included in construction contracts.

This is an escalation ladder to higher management to attempt to resolve disputed issues between the contractor and owner. The DREP clause requires that this process be used prior to entering into the formal administrative Contract Disputes Process. DART's administrative Contract Disputes Resolution Process is similar to the U.S. government construction contracts' Boards of Contract Appeals process. The contractor may ask for a Contracting Officer Final Decision on any outstanding disputed issue. Contracting Officer Final Decision is to be an independent look at the issue, since the Contracting Officer is at least one level up from the procurement official overseeing the contract at the field level. The Disputes Clause allows for the contractor to appeal the C.O. Final Decision to an independent Administrative Judge hired by the DART Board of Directors. DART has a pool of Judges from the Armed Services Board of Contract Appeals that are well versed in heavy construction and government contract law. Many of DART's standard clauses are similar to the federal clauses in the Federal Acquisition Regulations (FAR), and DART states in the contract that if there is no Texas law applicable to an issue, Federal government contract law will be used for guidance. The contractor gets a fair hearing in a process very much like litigation, and the process is generally quicker than going to the courts. The Judge's Decision may be appealed to court if either party believes that there is an error in matters of law, but is dispositive as to findings of fact. There have been very few appeals to court, since a knowledgeable sitting or retired judge hears the case and writes the decisions.

DART Utility Identification Best Practice

DART's experience has been that money spent during planning and design save the project money and preserves construction schedules.

- Use three dimensional Subsurface Utility Engineering {SUE}, including verifying utilizes in the field

- Reimburse the utility companies for a designated representative from their company to work with your planning design and construction teams. These individuals can help the agency teams.

    - Locate and identify the utilities that are in conflict.
    - Be available to suggest ways to mitigate any conflicts and help establish a realistic project budget and project schedule.
    - As the design changes, the utility companies will immediately be aware of the changes and be able to help identify new conflicts and adjustments required to the project's budget and/or schedule.

- Hire full time professional utility coordinator that works with you planning, design and construction teams as well as with the utility companies' representatives {If possible, this should be the same person or persons during planning, design and construction.

DART Utility Relocation Best Practice

1. In your solicitation, do not indicate that all utilities will be relocated prior to notice to proceed for construction activities.
2. Know the federal requirements when using federal funds.
3. Work with the regional office of your federal funding partner to make sure that your processes meet the federal requirement.
4. Make sure to include the required federal clauses in any relocation agreements between the agency and the utility company.
5. Reimburse the utility companies for a designated representative from their company to work with your planning, design and construction teams. These individuals can help the agency teams. Understand the utility company requirements, the phases of their relocation work, the long lead time items and establish a realistic utility relocation budget and construction schedule.

As the design changes or a field condition change, the utility companies will immediately be aware of the changes and be able help identify new conflicts. Be available to suggest ways to mitigate any new conflicts and help identify additional cost to the project budget and schedule. Hire a full time professional utility coordinator that works with your planning, design and construction teams, as well as with the utility companies' representatives,(If possible, this should be the same person or persons during planning design and construction. Establish a protocol with the utility companies for (1) authorization of overtime when required (2) if utility crews have to be pulled off the job site due to emergency situations such as tornadoes, hurricanes, ice storms, etc., and {3) how to mitigate delays. Whenever possible, design the project in such a way that it does not require utility relocations for major items such as utility vaults, major transmission lines, large major pipelines, etc. When possible, make the construction contractor responsible for all utility relocations. This allows the construction contractor to control the construction schedule. Consult with the utility companies to see if they agency's contractor can perform some or all of the work, such as design and construction for their relocation. Structure your weekly design and construction meetings to include the agency's utility coordinator and the representatives from the utility companies. Reserve a specific time in the meetings to discuss utility relocations and utility conflicts. Have regular meetings in the field with the agency’s utility coordinator, utility representatives, project managers and construction supervisor to verify materials and activities in the field. Follow the protocols established during the planning phase.

DART Utility Partnering Best Practice

Include the utility companies in the planning and design phases to establish a positive working relationship and create an understanding of each party's schedule constraints. In your weekly construction meetings, review the proposed construction schedule for the next four-to-six weeks and compare it to the schedule and progress of the relocation by the utility company. Work with all parties to make adjustments at that time if a conflict appears to be evident. Recognize that, in emergency situations such as tornadoes, hurricanes, ice storms, etc..., the utility company crews may be pulled off your project to get services back up and operating in other parts of the country. Have a mitigation plan in place and have money in the budget to pay for necessary mitigation. A mitigation plan may include, but is not limited to (1) paying the utility company for overtime labor, (2) paying the utility company's costs to expedite delivery of materials, and {3) obtaining permission for the agency's contractor to perform the utility relocation engineering and construction work on behalf of the utility company.

DART Asset Commissioning Best Practice

At DART, all trains, facilities, systems and operational processes are designed, constructed and implemented in a manner that promotes the safety and security of persons and property. The design, construction testing, and start-up of all Rail Transportation Project Systems comply with applicable safety and security laws, regulations, requirements and railroad industry practices. DART's Rail Program Development (RPD) department fulfils the primary role in accomplishing this task. Each individual and organization within DART's Rail Program Development department is responsible for hazard and vulnerability management, for applying the processes that are designed to ensure safety and security, and for maintaining established safety and security standards, consistent with their position and organizational function. System modifications undergo a Design Review process. Design Review meetings involves managers from Safety, Operations and Maintenance. Items in the Design Review and Change Control processes can be assigned to responsible parties. Reviewers are notified immediately of any changes to an item and DART personnel, not design or construction contractors, must appropriately disposition every item. If there is a dispute or concerns about an issue, DART convenes a meeting comprised of the aforementioned Metro Comparable Agency Research decisions. Through a cooperative team effort and the systemic application of safety and security principles, Rail Transportation Systems are designed, constructed, tested, and placed into service in a safe and secure manner.

Integrated Testing and verification of a transit system is the final major activity to take place before System Safety and Security Certification of the Construction occurs and revenue service begins. Integrated Testing also ensures that the project elements operate/function as intended. Previous start-up experience within DART has shown that the most effective way to manage this major coordination effort is by having a single organization, independent from the designer and the contractor, in place and tasked with this responsibility during the start-up period. DARTS System Integration Group (SIG} is responsible for all integrated testing activities. The SIG provides the strategic link necessary for the extensive coordination and cooperation needed during the start-up phase. The SIG directs all activities during the integrated testing process before revenue service begins. Prior to the construction. The SIG reviews all systems design submittals at each level of their design development and provides formal comments where applicable. The SIG maintains close coordination with the Quality & Safety Design 7 Construction in RPD, the Transportation Department, the Operation and Maintenance departments, the DART Police Department; and the Rail Safety Section within the Risk Management Division.

In addition to performing the detailed tasks related to the start-up, the SIG provides the additional staff and other resources, that are only required during the start-up period. DART also temporarily assigns personnel from its Rail Operations and Maintenance departments to aid in the Integration and Start up process under SIG authority, during the start-up phase. Integrated Testing is also a key part of the Safety and Security Certification (SSC} process, as it ensures the effective interface of all of the project elements and that these project elements comply with established safety and security performance requirements. DARTs utilizes its Integrated Test Plan {ITP} to accomplish its system integration needs. The ITP is based on the implementation of policies and the evolution of test procedures that have taken place during previous DART Integrated Testing efforts for the Phases II and Phase Ill of the LRT Build-Outs, Dallas Streetcar for the City of Dallas, and the Urban Circulator for the Heritage Trolley M-Line of the McKinney Avenue Transit Authority (MATA). The ITP is reviewed annually and is subject to change to meet the needs of each individual Rail

Transportation Projects. Adherence to the ITP provides DART with the assurance that all Rail Transit System elements and personnel ore able to function together as on integrated unit. Compliance is achieved using verification, validation, and testing. Additional tests are developed and added as needed. The ITP defines the tests that are to be conducted to verify performance at appropriate levels of the system hierarchy. For each project the ITP is based on a specifically developed list of integrated tests crafted to fulfill the various testing and validation efforts peculiar to each project. When the Contractors begin to submit their contractually required test plans, procedures, and testing schedules to the Authority, these plans ore reviewed by RPD/SIG personnel for compliance with DARTs design criteria and project standard specifications.

DART utilizes a detailed SSE program with RPD being responsible for the SSE of the rail transportation systems. Although managed as separate programs, the Safety and Security Certification PIan (SSCP) and the ITP complement and reinforce each other by coordination of the various safety and security related tests and Readiness Drills. In the past DART has used project- specific SSCPs. DART is now working toward a single procedure or manual to serve as a basis for all certifiable Rail Transportation Capital Improvement projects. Projects ore certified at both the design and construction stages. DART requires designers and builders to submit a safety and security certification checklist in their proposals for review and approval by the Safety and Security Certification Review Team (SSCRT). Additionally, DART includes in its project scope for major capital projects a requirement that contractors hire a system safety manager. The SSCRT includes upper management-level personnel from Safety, Rail Program Development, Systems Engineering and Integration, Facilities Engineering, and Construction. In addition, DART coordinates these activities through its start-up Team (SUT). The SUT consists of representatives from the various departments/divisions affected by the start-up, and serves as an informational forum for each representative. At the completion of integrated testing, the SIG and SUT support the SSCRT. They provide the data necessary to certify that the projects meet DART's established safety and security goals, and operational performance requirements. The SUT supports the transition of the Project from the SIG to the DART Operations. The SSCRT determines whether to recommend an element for System Safety and Security Certification. Detailed Certifiable Items Lists (CILs) accompany each certifiable project. The Director of System Safety and Certification is primarily responsible for CILs, with in-house contractor support (SIG). The Director proactively participates in the design process, enabling an efficient transition between design and construction and helping ensure that safety considerations undergird the entire process. DART verifies construction safety requirements through field inspections, test records, and integrated test results. Upon receiving and reviewing the SSCRT's recommendation for approval, the Executive Vice President - Growth/Regional Development will sign a Certificate of Compliance. After signing the Certificate of Compliance, DART RPD/SIG will transfer the system to DART Operations for the Pre-revenue training prior to beginning full revenue service operations.

DART Work Orders

RPD provides technical input to DART Procurement for project scope and statements of work ensuring that each project is compliant with DART design standard specifications and that Safety and Security Compliance is met or maintained. The DART Procurement Department is responsible for the development and management of all agency purchasing and contracts. The Director of Contracts oversees managers who are responsible for capital projects, including major operations and maintenance services, as well as construction, architecture, and engineering. Procurement staff follows a standard process for developing a procurement, which starts with a meeting with the requesting Department to develop a Statement of Work. Procurement ensures that standard clauses are included in all contracts. A contract will typically include requirements to adhere to: Special Provisions, which are project specific General Provisions, which are more general to DART Quality Program, DART Safety & Security Program. The Special Provisions include specific requirements for coordinating with light rail operations and adhering to all DART rail operating rules, environmental requirements, and safety and security requirements.

DART Audit Compliance

Schedule baselines and monthly schedule updates are required submittals by contract. The Resident Construction Management Staff reviews the required submittals and narratives and dispositions the update as follows: Approved, Approved as noted, Approved as noted (correct and re-submit), disapproved. The Resident Construction Management staff also reviews and recommends the monthly payment amount based on the progressed schedule detailed invoice and field documented progress. If the contractor is not compliant with the contractual obligations, the Resident Construction Manager/COR works with the Contracting Officer bringing the contractor issues into compliance. If not, the contract has remedies available to overcome any issue.

DART Contract Management BP

Review and approval of baseline budget and schedule. Receive recurring update from project team overseeing project implementation and incurred cost, forecasted cost to establish estimate at completion, variation with budget and schedule; and work closely with business analyst and project control coordinator to monitor independent reports and charges recorded against the project. Regarding procedures in our department for contract management. Procurement requisition requires authorized personnel to cite project code. DART Contracting Officer designates Contracting Officer Representative with responsibility to certify invoice and accept work. DART AVP Program Delivery or Department Heed/EVP designates DART staff to sit in the roles of project manager and invoice reviewer in the invoice workflow process. Invoices are reviewed by DART staff sitting in above named positions in accordance with DART Admin Policy.

DART Document Management Software

ORACLE Imaging and Processing, Network Drives, and Google Drive. The department file room controls, tracks and distributes department correspondence. This includes correspondence created or received by department staff, consultants and construction field personnel. The goal is to provide a central control point for department correspondence and provide direction for the filing and archival of documents at the construction site. ORACLE Imaging and Processing was utilized by the file room for department correspondence. Currently, it is used for research, historical, and retrieval purposes. At this time correspondence is logged, scanned to the appropriate network drive, OCRd, and distributed via email/Google Drive. (Reference: Rail Program Development File Room Procedures) Primavera Contract Manager and Network Drives Primavera Contract Manager is utilized for the construction management files. Files consist of correspondence, contract modifications, shop drawings, submittals, administrative records, quality records, meeting minutes, contract drawings, and specifications. Documents are logged and/or generated in Primavera Contract ·Manager, scanned, and filed in accordance with the file plan. (Reference: Resident Construction Manager's Manual, Project Owner's Manual, and Rail Program Development File Room Procedures) lmageSite is the document repository system utilized by the Engineering Document Control group. Documents and drawings are indexed (to create a CSV file), stored on the appropriate network drive, and uploaded to lmageSite for users. Examples of documents uploaded to lmageSite include: design review packages, conformed contracts, contract changes, as-built drawings, as-built specifications, geotechnical reports, etc. (Reference: Document Control Procedures) FileNet is the agency document management software. The department utilizes FileNet for archive box information. Records archived are done in accordance with the established procedures. Information from the archive forms/sheets is uploaded into FileNet for search and retrieval. (Reference: Resident Construction Manager's Manual, Project Owner's Manual, Rail Program Development File Room Procedures)

LA County MTA (LACMTA)'s objective for this study is to position itself to deliver quality capital projects on time and within budget as we build a significant, long range portfolio. This questionnaire is designed to gather any best practices you have developed to address the challenges of delivering a complex portfolio of projects.

Guidelines:

- If a question is not applicable, please type in NA.
- Where tables are provided for your input, please feel free to re-format information or share existing attachments if that better reflects your response to the question(s).
- Please share attachments, where possible, which –
  - Elaborate your responses in this questionnaire AND/OR
  - Provide LACMTA additional insights, tips and guidance in building on its strengths but also in identifying our areas of improvements and proactively implement a robust project delivery and capital forecasting framework.
- Attachments can be shared by embedding files in this section or by attaching them to your transmitting email.

LACMTA is most appreciative of your time and efforts.

A. Denver RTD Information *(This section gathers info about your agency)*

1. Denver RTD Contact *(please fill in your contact information below)*

Contact Information	Description
Agency	Denver RTD
Contact person	Pranaya Shrestha
Title	Sr. Manager, Program Management
Phone Number	(303) 299-2461
Email	Pranaya.Shrestha@rtd-Denver.com

2. Denver RTD Capital Plan Overview (*Please provide Denver RTD information below)*

a. What is your primary business line? Transit Agency

b. What is the total dollar value of agency Capital Plan 6 Billion

c. How many years does the capital plan above span? 14

d. How many projects are in the capital plan? 10

e. # of professional services contracts for the capital plan? 15

f. What is the total dollar value of professional contracts? 500 Million

g. Please fill in the table below:

Staff Type involved in capital program only	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff	100	100
Consultants	70	
Independent Contractors		
Total	170	100%

h. Please share any succession planning best practices you may be using to deal with an aging workforce NA

i. Please share any stakeholder management best practices you may be using Get Stakeholder engaged early in the program

j. What percentage of completed capital projects finished on time? 100

k. What percentage of completed capital projects finished within the original contingency budget? 100

B. Questionnaire *(This section gathers best practices in each project phase)*

B.1 Planning

B.1.1 Project Manager's Role

1. Please share information regarding your Project Manager's role in the table below:

Does PM have Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes/No			
yes		Consistency	none

2. Describe any best practices used to develop a complete project scope and verify it with the end user start early and have everyone involved
3. Describe any best practices used to capture early studies and planning costs to a project charge number project budget starts at the MIS stage of a project and refine it as the project moves forward

B.1.2 Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below. Change the phase name to correspond to your terminology

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used
Annual Capital Planning	Board	Project Limit		
Conceptualization/ Study	Board	Project Limit		
Project Planning	Board	Project Limit		
Preliminary Design	Board	Project Limit		
Final Design (CDs)	Board	Project Limit		
Bid & Award	Board	Project Limit		
Construction	Board	Project Limit		
Closeout				

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project? Board commits only at the award of construction contract

6. What % contingency does the Board authorize for construction change orders? The Board authorizes the Project Budget and the Project team does not have to go back to the Board for any change orders if the overall Project budget in not impacted
7. Who controls the contingency? Project team
8. What does the Board require the Denver RTD to do in order to get additional contingency? Need to go back to the Board if the overall Project budget is impacted
9. Please provide a representative attachment, if possible, of the workflow and content required to obtain original and additional funding from the Board will be very helpful. Click here to enter text.
10. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings? Project team provides the Board regular Project update

B.2 Design

11. Please describe any best practice tools and processes that your Denver RTD uses to control scope creep throughout the project lifecycle. Manage expectation of stakeholders
12. Please describe any best practices you use for design reviews. Use the industry as a resource
13. Please describe any best practice tools and processes that your Denver RTD uses to improve the quality of design. What department/group is responsible for ensuring quality of design? Have a process in place the manages and independent review and quality checks

B.3 Construction

B.3.1 Construction Claims Management

14. Please describe any successful techniques you use to avoid claims Start the any Project with the mindset that you will not have claims and make sure all team members buy into that mindset!
15. Do you require contractors to submit time extension requests as they happen during construction or do you wait until close-out? As they occur
16. Please describe any best practices you use to timely resolve claims NO CLAIMS!!!
17. Please describe any best practices you use for dispute resolution of unresolved claims (DRB/arbitration/ litigation)? Set up a DRB and escalation ladder for all issues

B.3.2 Utility Relocation

18. Please describe any best practices you use to identify utilities in the way of construction

Use a experienced staff and do lot of pothollings

19. Please describe any best practices you use to relocate utilities Work with the utilities early in the Project

20. If you issue advance utility contracts please discuss your experience with this mitigation approach. This works very well to get the utilities out of the way
21. Please discuss your experience partnering with utility companies to get timely relocations by their forces. Works very well

22. Please share your experience with Utility Relocation challenges in the table below. Click here to enter text.

Challenge Description	Impact on Capital Projects (High/Medium/Low)		Denver RTD Response to Mitigate Impacts	Additional Comments
	Cost	Schedule		

23. How does the Denver RTD resolve resource constraints that exist for a utility company? Work may have to be done by the RTD's contractor

B.4 Operations/Maintenance

24. Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations Operation Dept. should be part of the Project Team and OPS rep should be housed with the Project team
25. Please discuss how you identify maintenance and capital improvement needs work with ops early in the project
26. Please discuss how you do condition assessment na
27. Please discuss how you get the projects in the capital plan Start with the MIS
28. Please discuss how you issue work orders. Work order is negotiated between contractor and project team and are issued if it is within the Board authorized amount
29. Please describe any other best practice tools, processes and procedures the Denver RTD uses for Asset Management. We have a asset management team

B.5 Supporting Processes

B.5.1 Scheduling

30. Please check the box next to each best practice tools the Denver RTD uses for Cost/Schedule management?

☒ Enterprise schedule software (Provide software name) Click here to enter text.
☐ Integrated Master Schedule (all projects in capital plan in one schedule file)
☐ Contractors' Schedule Updates in one central schedule database
☒ Cost-Loaded Schedules
☐ Cost Forecasting (Please describe method & tools) Click here to enter text.
☐ Earned Value Management System (Please describe) Click here to enter text.
☐ Off-the-shelf software (Please provide software name) Click here to enter text.
☐ Project Risk Management program (Please describe method & tools in the table below)

Project Size	Risk Registers	Type of Risk Analysis	Monte-Carlo Based Contingencies	Approved Project Budget or Capital Plan Includes Risk-based Contingencies
Above $XX	Yes/No	Cost/Schedule	Yes/No	Project/Capital/Both/None

		/Both		
Between $XX and $YY	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Below $ZZ	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Please edit/add thresholds as appropriate				

31. Please describe the process you follow to review contractor's schedules. We have an experienced scheduler assigned to each project.

32. Please describe any best practices you may follow to integrate progress payments with cost-loaded schedules part of every contract

33. Please describe any Lessons Learned program the Denver RTD has, noting how lessons are (1) collected (2) published and (3) retrieved as needed: annual and after completion of every project

34. Please describe (and if possible provide a copy of) any written project management and controls procedures. Every project has a PMP

35. Describe how the Denver RTD ensures all participants are following the procedures. training

B.5.2 Human Resource Management

36. Is a Staffing Plan created and followed for every project?
    ☒ **Yes**
    ☐ **No**

37. Check the box next to any organization-wide HR Management procedures that the Denver RTD has implemented for individual/personnel development:
    - ☒ Succession planning
    - ☒ Training responsibilities are assigned to named individual(s).
    - ☒ Training activities periodically reviewed.
    - ☐ Budgets/funds direct and indirect costs of training.
    - ☒ Data is collected to determine training effectiveness.
    - ☒ A documented process is in place for recognizing outstanding performance on projects
    - ☐ Linkage has been established between performance and reward.
    - ☒ Project Management is an established career path
    - ☐ A competency model is used that includes proficiency assessments.
    - ☒ Established goals for improving project management capabilities.
    - ☒ Employees have personal development plans.
    - ☒ Training on team development exists
    - ☒ Project Team development is planned and budgeted
    - ☐ The effectiveness of the various HR programs are periodically reviewed.
    - ☐ Key individuals on the project team are identified as critical to project performance
    - ☒ Employee's contribution to organizational strategic goals and objectives are assessed
    - ☒ A mentoring program is in use that provides timely feedback
    - ☒ The effectiveness of mentoring is periodically reviewed.

38. Does your Denver RTD have any formal training programs? Yes leadership academy

39.

☒ **Yes**

☐ **No**

If Yes:

40. What is the frequency of training? Regular basis
41. What curriculum is taught? Click here to enter text.
42. What position titles are given training? All RTD position have the opportunity for training
43. Are consultants also trained? YES
44. Who administers the program? RTD

B.5.3 Project Delivery Organization

45. Does the Denver RTD have a Project or Program Management Office (PMO)?

☐ **Yes**

☒ **No**

46. If Yes, please share the information in the table below –

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	Yes/No			
Project Controls	Yes/No			
Project Quality	Yes/No			
Project Safety	Yes/No			
Please edit/add functions as appropriate				

B.5.4 Contract Management

47. What contracting strategies does the Denver RTD use for its capital projects? Please use the table below. RTD has used successfully used Design build, PPP, Design-bid-build, CMGC, unsolicited proposal, best value selection

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build				
Design/ Build (D-B)				
Public Private Partnership (PPP)				
Others (Please Add)				

48. If the Denver RTD has used D-B, what conditions guided the Denver RTD to consider it? Cost and schedule
49. If the Denver RTD has used PPP, what conditions caused the Denver RTD to pursue such a model? Federal pilot program
50. Did the use of alternative contracting methodologies improve project success? If yes, please describe what aspect of that methodology made a difference. Yes cost and schedule along with risk transfer
51. Please share the Denver RTD's change order approval authority via an attachment showing the signature authority and approval thresholds? Change control board-Project Manager-Sr. Manager, Assistant General Manager- General Manager
52. Please describe any best practices you follow related to contract management or communications. Board gives the GM Project Authority for the entire Project budget!

B.5.5 Document Management

53. What document management system do you use? Aconex
54. Is it used for all projects? Yes
55. Is a different tool used during construction? No
56. If yes how do you integrate the two systems? NA
57. Are construction progress meeting minutes maintained in a database that tracks action items to completion? Yes

C. Catchall Question

58. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (ie- contract language, procedure, workflow, etc.) People, transparency, stakeholder engaged, communication, teamwork!

End of Questionnaire

A knowledge-sharing report to help RTD find better ways to serve the public.

Best Practices

Table of Contents

Executive Summary

Partnering

Processes

Workforce

Internal Communication

Technology


RTD
Thanks for riding RTD
Keep this ticket as proof of payment.
For Light Rail: No validation required.
For Bus: Hand to Operator.

Executive Summary

From the General Manager

I am proud to present the first RTD Best Practices report. We at RTD recognize that our most important initiatives, projects and processes happen because of the efforts of individual employees who set out to make our organization better and provide safer, cleaner, more reliable, courteous, accessible and cost effective service for the citizens of the District. The best practices contained in this report highlight their efforts, and show how they have made RTD a regional and national leader in the transportation industry.

RTD has worked hard to create an organizational culture that encourages employees to come up with new solutions to complicated challenges. RTD's leaders have encouraged employees to take risks, they have taken responsibility for failures, and they have ensured that staff members receive the credit when a project goes well. Creating a culture of risk-taking in a large, mature organization is no small feat: organizations are quick to point fingers when a project goes badly, but that culture of blame stifles innovation. At RTD, we have tried to overcome the tendency to look for an individual to blame when something goes wrong, accepting that mistakes are a necessary part of big projects. It is only by learning from our mistakes that we can become an outstanding organization.

The best practices on partnering show that RTD innovates not only by reflecting on our own successes and failures, but by looking to the outside as well. In order to be a leader in the transportation industry, we must continually be aware of changing conditions in the industry, the transit marketplace, and the region we serve. We have looked to partners for solutions repeatedly, involving the private sector in a first-in-the-U.S. public transit DBFOM public-private partnership (P3), working with local educational institutions to create a groundbreaking workforce development program, and partnering with municipalities to finance an award-winning transit hub in downtown Denver.

As highlighted in the Multi-Agency Exchange (MAX) Program best practice, RTD has a tradition of sharing best practices and lessons learned with our peers. I believe that knowledge sharing is a key to improving transit nationwide. Only by reflecting on and sharing both our successes and the lessons we have learned can we move forward as an industry. It is my hope that our peers in the transit industry and beyond can learn from these best practices and implement similar programs in their home agencies where appropriate.

In the long-term, I hope this document will be the start of a new tool for sharing best practices across the transit industry, not just at RTD. We intend to expand this collection into a searchable, Wikipedia-style compendium of best practices. If many agencies participate, we will be able to learn from each other and inspire the next generation of transit professionals to make the industry better.

I am confident as I execute my transition from RTD that I leave the organization in good hands and all existing programs are fundamentally sound and moving in the right direction. This report and these best practices are a wonderful example of the entrepreneurial culture that we have created here at RTD, where people are always seeking continuous improvement and where failure is never an option.

Sincerely,

Phillip A. Washington

April, 2015

Purpose of the Best Practice Initiative

With the impending retirement of the baby boom generation, the transit industry must find pathways for critical practitioners to pass their knowledge, experience and strategies to the next generation of transit professionals. In order to address that challenge, RTD has collected internal knowledge to develop this compendium of RTD best practices for employees and managers of RTD, both now and in the future. It is our hope that this report will encourage collaboration and communication across the agency, allowing individuals from every department insights into their colleagues' most significant accomplishments. This effort to identify and promote best practices across the organization is intended to bolster successful strategies at RTD and encourage new thinking to overcome challenges: employees will be able to draw from best practices from other departments to address issues in their own work groups.

Peer transit agencies across the nation and world have expressed a great deal of interest in RTD's successes and lessons in project delivery, finance, security, workforce development and operations. RTD has developed this compilation of best practices to share with our peers as well as internally so our experience can inform not only our agency's next generation, but also the next generation of transportation professionals across the industry.

Findings

The best practices included in this report highlight RTD's strengths, while areas with fewer best practices bring to light opportunities that the organization can build on in future years. The many best practices related to partnering, processes, and workforce development reveal that RTD has fostered a culture of innovation, particularly with respect to external-facing initiatives, process improvements, and managing an evolving workforce of contractors and in-house staff. RTD truly is a regional and national leader in each of these areas. At the same time, RTD has made gradual progress in breaking down antiquated silos and improving collaboration and communication across departments and work groups.

Aside from a few important examples of projects done right, RTD continues to struggle to find the right way to incorporate technology into the agency's operations. Using technology to improve the customer experience and increase efficiencies will be an important challenge in the coming years: the RTD Board has selected technology projects – particularly ensuring that RTD has a technology infrastructure that we can build on and disseminating real-time information – as one of five key goals for the agency in 2015.

Methodology

The Best Practices program began with senior managers and leadership but also incorporates feedback from mid-level managers and practitioners to capture successes and opportunities at every level of the organization. During the first phase in collection, RTD's planning/policy analysis staff used a facilitated approach to establish the scope of the effort and direct the development of best practices. Policy analysis staff worked with each department's leadership to identify focus groups that participated in brainstorming sessions. Through discussion and directed questions, the facilitators and participants developed a high-level list of best practices within each Department. In a follow-up session with Assistant General Managers and Senior Managers, each practice was assigned one or more appropriate subject-matter experts. Policy analysis staff then conducted in-depth interviews with these subject-matter experts and background research to inform each short, Wikipedia-style description of each practice, which appear below.

Organization of this Report

RTD's best practices are grouped into the following key categories, which are ordered in this report from the agency's greatest strengths to areas with opportunity for improvement:

- Partnering
- Process Improvement
- Workforce Development/Managing Contractors
- Internal Communication
- Using Technology as a Tool

Tabs highlighting each theme are provided at the edge of each page for easy navigation through the report.

Within each theme, best practices are ordered roughly following the order of the strategic budget plan prioritization system: safety-related initiatives appear first, followed by initiatives that led to financial savings or innovations, initiatives that increase reliability, etc. In addition, best practices that affect all of RTD or a large portion of the agency generally appear before those that affect a smaller segment of the organization.

A clickable table of contents provides easy access to introductory material, the first page of each theme, and individual best practices. Each discussion also includes clickable links to email subject-matter experts for more information.

How to Use this Report

The Best Practices report is intended for a general audience and requires no special knowledge of the transit industry. Links to more specialized resources and contact information for subject matter experts appear at the end of each best practice and may be relevant to more technical audiences.

RTD Board Members, External Stakeholders and Citizens of the District

The executive summary, executive introductory letter, and descriptions of each theme are likely to be of particular interest to these readers. Consider perusing the table of contents for best practices relevant to your area(s) of interest.

Managers & Executives of RTD

Best practices are categorized into themes with RTD's managers and executives in mind: each of the themes may be of interest to managers who are trying to solve a particular, related problem. Managers may be able to identify practices from other divisions or departments that could inform strategies within their own departments. To that end, managers may want to read all of the best practices within an entire theme at once. The clickable table of contents also provides access to specific best practices that may be of interest to RTD management.

Peer Agencies

Like RTD managers, employees of peer transit agencies may want to explore one theme deeply depending on areas of opportunity at their own organization.

New Employees

New employees who would like a general overview of RTD's strengths and an introduction to who does what may want to explore this report. New employees may want to pay special attention to the names and contact information of subject matter experts included at the end of each best practice. Those subject matter experts may be potential collaborators on new projects.

Partnering

RTD's reputation as a forward-thinking transit agency is largely due to innovative partnerships forged over years. RTD has repeatedly leveraged resources from the private sector, exchanged knowledge with other government agencies, and fostered relationships with universities and non-profits to develop mutually beneficial projects. In many cases, those projects would never have gotten off the ground if the agency had worked alone.

Many of RTD's most exemplary projects and accomplishments have involved creative and intensive work with partners outside of the agency. From the transit industry's first public-private partnership to an historic transit hub made possible by working with local municipalities, RTD has looked outside for innovative solutions. RTD has addressed challenges as complex as workforce development and leadership training with an eye to the outside.

As the following collection of best practices indicates, RTD has been able to build these partnerships in part due to a long tradition of outreach to the private sector and transparency with the public and key stakeholders. Included in these best practices are frank discussions about finding the balance between internal interests and the desires of those stakeholders and partners. The following examples offer blueprints for transit agencies that want to build relationships with outside entities and leverage partnerships for the public good.

EAGLE Public-Private Partnership

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Goal

Accelerate construction of a large portion of the FasTracks rapid transit expansion.

Background

Beginning in 2007, declining sales and use tax revenues as a result of the Great Recession combined with worldwide demand for construction materials placed the financing of RTD's ambitious 140-mile FasTracks rapid transit expansion at risk.

At the same time, the Federal Transit Administration (FTA) initiated a Public-Private Partnership (P3) pilot program called Penta-P, which sought to explore how transit properties could partner with the private sector to reduce the burden on the Federal government and find new sources to finance and build transit projects. FTA included incentives in their New Starts Major Capital Investments funding program for transit properties willing to participate in Penta-P. In order to speed the delivery of the FasTracks program, RTD packaged two of its planned commuter rail corridors (the East Corridor and the Gold Line) and the necessary commuter rail maintenance facility into the East And Gold Line Enterprise (EAGLE P3) and applied to have the project be part of Penta-P. The application was accepted by FTA in 2007.

With acceptance into the Penta-P program, RTD moved quickly with development of the Eagle P3 Project. At the time, and to this day, few transit projects in the U.S. have used P3 for construction and none had included private financing. RTD had previously experimented with CDOT on the highly successful T-REX rail and road expansion project using a Design-Build (DB) approach. That method realized significant savings and also allowed RTD to complete the project ahead of schedule. Encouraged by this success, RTD was open to exploring new ways to get FasTracks completed.

Best Practice

The Eagle Project adds another layer of complexity not seen before in the delivery of transit projects in the U.S., adding a financing component to the contract (concession agreement) for a period of 34 years. Under this contract, RTD engaged Denver Transit Partners (DTP) to design, build, finance, operate, and maintain (DBFOM) the EAGLE project. Through the concession agreement, RTD retains ownership of all assets at all times, sets fares and fare policies, and keeps all project revenues. RTD will make payments to the private sector "concessionaire" based upon whether the service is accessible and on-time for the contract-defined periods and schedule (availability payments). RTD contributions to the project include costs related to the acquisition of right of way, construction payments and service availability payments which will be made to the concessionaire over the 29-year operating term of the concession. The total cost of the Federal Full Funding Grant Agreement for the Eagle project is $2,043.1 million structured with a variety of local, federal and private grants, loans and equity:

- FTA New Starts Full Funding Grant Agreement – $1.03 billion, awarded 8/2011
- Private Activity Bonds – $396.1 million
- TIFIA loan – $280.0 million
- Other federal grants – $57 million
- RTD sales tax revenue – $128.1 million
- Revenue bond proceeds – $56.8 million
- Local/CDOT/other contributions – $40.3 million
- Equity – $54.3 million

By pursuing the Eagle P3, RTD was able to leverage federal grants as well as private equity and debt to address the financial shortfalls in the FasTracks financing plan and build the commuter rail projects years ahead of schedule. In addition, the DBFOM agreement spreads the cost of the project over a longer time period via the availability payment model, enabling RTD to avoid potential funding bottlenecks in the future.

Flexibility

Through the Eagle procurement, RTD offered flexibility and used competition between bid teams to drive down construction and operating costs on the proposals. To maximize flexibility, RTD did not mandate specific solutions through design specifications. Instead, the agency required that proposers meet performance and availability of service standards. This decision allowed bidders freedom to propose cost savings and innovative solutions while still focused on delivering the transportation infrastructure in the FasTracks plan.

RTD recognized that if the agency shared design or engineering innovations suggested by one private sector proposer with other proposers, there was no incentive for a team to offer innovations – they might view it as giving away competitive advantages. To alleviate this concern, RTD developed a confidential Alternative Technical Concept (ATC) process, allowing proposers to suggest changes to specific design and construction requirements confident that the information would not be shared with other proposers. Through the ATC process, RTD got a better, lower-cost design. Additionally, RTD informed proposers in the ATC agreement that RTD would retain ownership of all concepts from successful and unsuccessful proposers - meaning a great design or construction innovation from a proposer who was not selected could still be implemented by the winning proposer without incurring design costs.

Risk Transfer

Engaging the private sector through a DBFOM contract enables RTD to transfer financing risk, construction risk and operating risk to the private concessionaire. The structure of the agreement includes incentives for the concessionaire to adhere to the budget or the concessionaire loses money.

The DBFOM approach maximizes contractor innovation and participation as well. Over the 34-year contract featuring private financing, the concessionaire team has a long-term commitment to the project. That commitment means the concessionaire has every incentive to build a quality project that will be cost effective to operate and maintain.

Risk transfer is not only in one direction, however. The private sector concessionaire agrees to build the quality product because they will operate and maintain it for the long term of the contract. RTD takes on increased up-front costs (legal and advisory fees, etc.) and increased financing costs because private sector financing requires a higher return than RTD’s traditional tax-exempt financing. RTD also hands over significant control of the day-to-day construction of the project.

RTD endeavored to address the reduction in project control by structuring the concession agreement to define how the service would be operated and included availability payment incentives to encourage the concessionaire to meet or exceed the requirements and assigning penalties to the concessionaire (in the form of reduced availability payments) for unsatisfactory performance.

RTD, as a public sector transportation provider, also spent considerable effort to ensure that the contract is properly worded to retain a high degree of control over crucial elements such as safety and training, operational standards, fares, and other items to ensure the private contractor provides transportation that meets the agency’s standards and expectations, and provides seamless service to the public.

Results

In an age of uncertain infrastructure funding, the EAGLE P3 project has become a transit-industry best practice. The Federal government and peer agencies often seek out RTD for counsel on the development and procurement of public-private partnerships. In 2011, RTD conducted a Lessons Learned exercise on the DBFOM procurement to be open about the three-year development process and share the elements that worked well and also those that might be done better next time. RTD officials often note that public-private partnerships are not a cure-all for infrastructure project finance but an option to be considered early. Some projects will lend themselves to a P3 structure while others should be pursued through more traditional methods.

In October 2014, RTD and DTP were faced with an example of the risk transfer from the public agency to the private sector partner. An inspection of the already constructed Jersey Cutoff bridge near 43rd Avenue and Fox Street indicated it would not last the planned 60 years. Due to its future 29 years of operating and maintenance of the structure, DTP elected to demolish and reconstruct the span to ensure it met the 60-year life and also re-inspect all the bridges in the project. The private concessionaire (DTP) will bear all of the costs for demolition and reconstruction.

The EAGLE P3 project is scheduled to open in 2016, years ahead of schedule if not for participation in the Penta-P program and leveraging private sector resources through the DBFOM contract. Substantially due to the use of Alternative Technical Concepts that allowed the private sector to innovate, RTD saved over $300 million from its internal estimate and locked in that price through the concession agreement.

Resources

Testimony of Phillip A. Washington Before the Panel on Public-Private Partnerships of the House Committee on Transportation and Infrastructure. 5 March 2014

EAGLE P3 Concession Agreement

Eagle P3 Project Procurement Lessons Learned 2011

All Aboard! Implementing Transit Rail Public-Private Partnerships in the United States: Hudson-Bergen Light Rail (New Jersey, USA) and EAGLE P3 Commuter Rail (Colorado, USA), Gudgel and Wang

Departments

Capital Programs

Communications

General Counsel

Materials Management (Executive Office)

Planning

Contact(s)

- Richard Clarke, Assistant General Manager, Capital Programs
- Pauletta Tonilas, Sr. Manager, Public Relations and Public Information
- Marla Lien, General Counsel
- Brian Iacono, Senior Manager, Materials Management
- William Van Meter, Assistant General Manager, Planning

Denver Union Station Financing

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Goal

Partner with local governments to rehabilitate historic Denver Union Station and construct a multimodal transportation hub.

Background

In 2001, RTD purchased the Denver Union Station site including the historic station and surrounding 19.5 acres with assistance from the City and County of Denver (CCD), the Colorado Department of Transportation (CDOT) and the Denver Regional Council of Governments (DRCOG). RTD paid $49.75 million while DRCOG pledged $20 million in federal air quality traffic mitigation funds and CCD $10 million.

RTD and its partners envisioned the station as a multimodal transportation hub where light rail, commuter rail, Amtrak, buses, taxis, shuttles, bikes and pedestrians would all converge and the surrounding land could be redeveloped. The master planning process began in 2002 and continued for three years. The process featured substantial public and stakeholder involvement, including 125 public meetings and a 96-member Advisory Committee. In the early planning for the transportation elements of the project it became clear that the project would cost hundreds of millions of dollars.

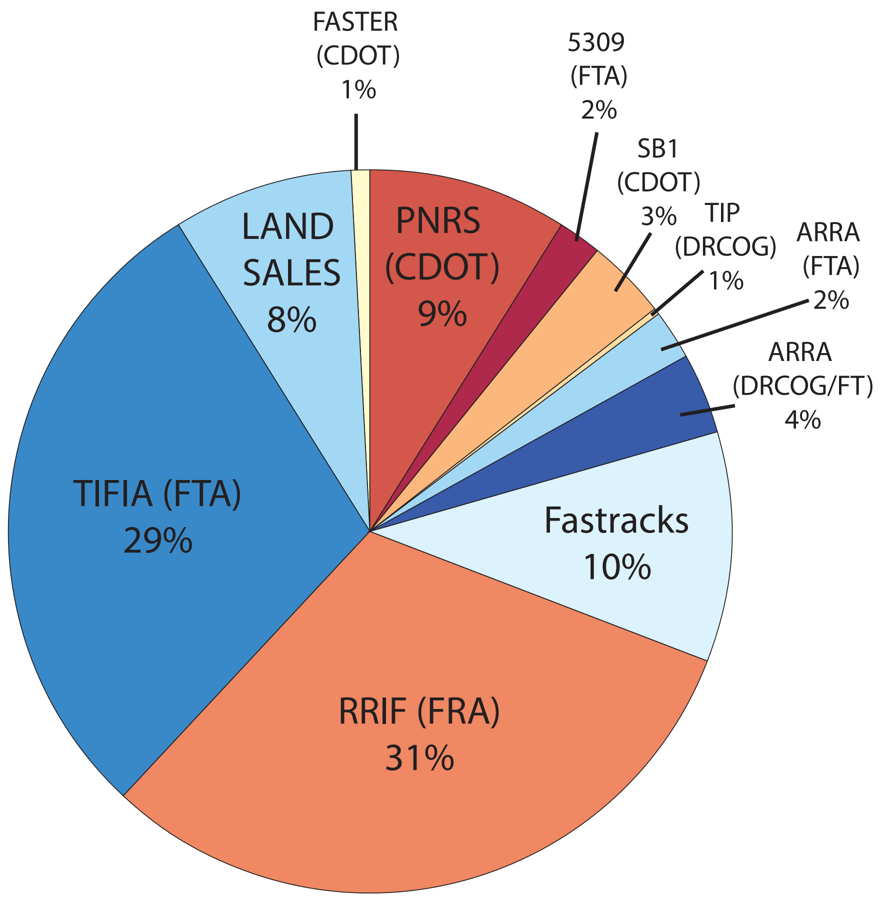
Best Practice

As the costs for the construction of the facilities approached $500 million, RTD and its partners recognized that they would need to develop a financial package of grants, loans and other sources to pay for the project. RTD's FasTracks sales and use tax receipts would not be enough to repay that amount of debt. Moreover, the scope of the project based on stakeholder input was beyond the scope authorized for RTD's use of FasTracks funds. The City and County of Denver offered to help repay the loans through the creation of a Tax-Increment Financing (TIF) district covering the 40-acre area. TIF is a method cities and counties can use to help finance projects by capturing the new (or incremental) taxes that are created when a property is redeveloped and property values increase. CCD created the Downtown Denver Authority as a special district to collect those taxes. The development around the station area would be crucial to repayment. In addition the Denver Union Station Metropolitan District was formed and a mill levy assessed for capital costs and maintenances of the portion of the development immediately around the historic station.

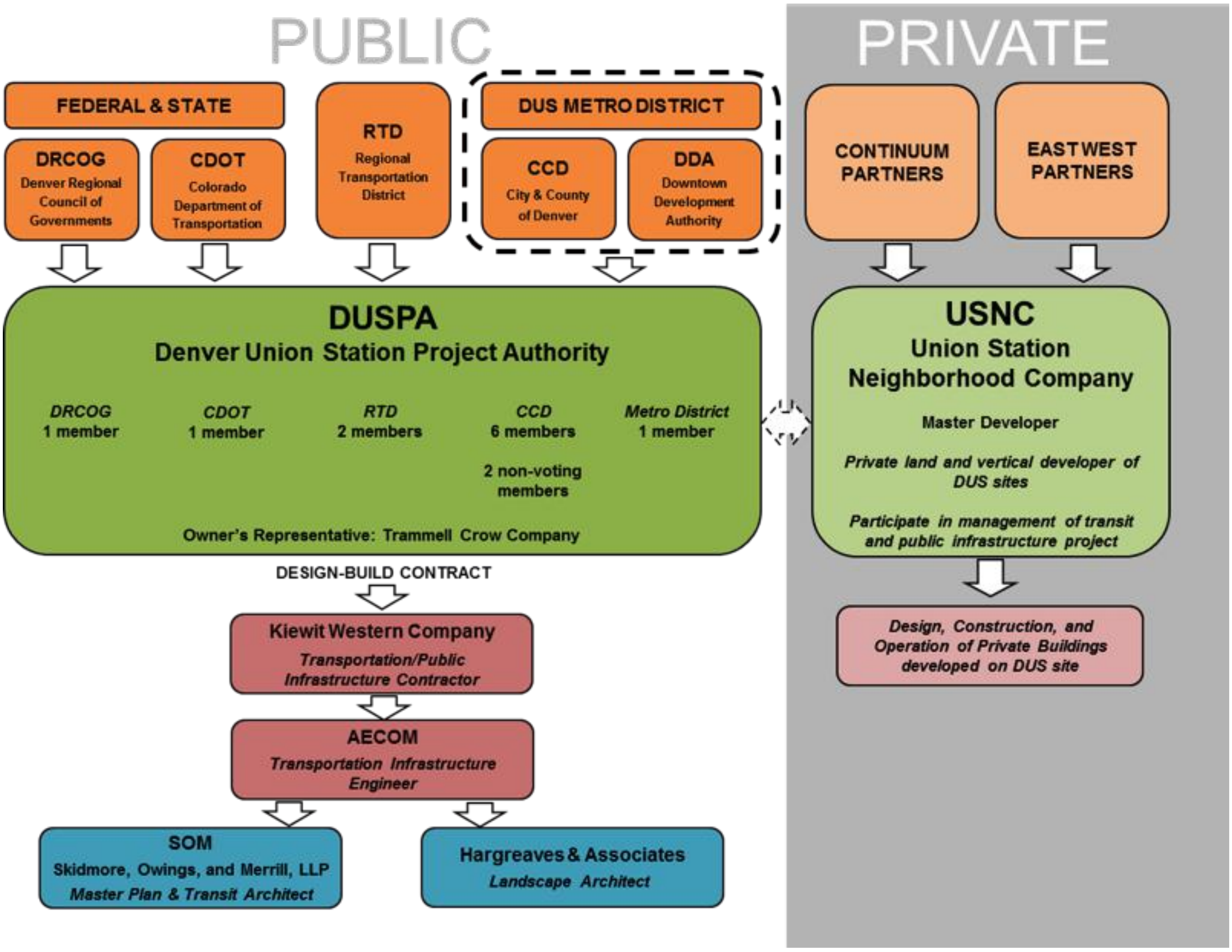
The partners also determined traditional tax-exempt bond financing would not be economically feasible. A different, low-interest financing structure would be required. RTD worked with the U.S. Department of Transportation to develop loans through two of their infrastructure financing tools that offer below-market interest rates to transit agencies. RTD worked with the Federal Highway Administration (FHWA) to secure a $145.6 million Transportation Infrastructure Finance and Innovation Act (TIFIA) loan and, simultaneously, a $155 million loan from the under-utilized Federal Railroad Administration (FRA) Railroad Rehabilitation and Improvement Finance (RRIF) program. It was the first time that a TIFIA and RRIF loan had been used for the same project and also the first RRIF loan for a transit project. CCD also agreed to pay the difference, or "backstop," the RRIF loan if either the FasTracks receipts or the TIF revenues came up short.

In the end, RTD and its partners at City and County of Denver were able to combine these revenue streams with grants from the FHWA and Federal Transit Administration (FTA) and the sale of the lands surrounding the station to leverage the two loans to fund the $484 million project:

Ongoing Revenue Sources		
Source	**Description**	**Amount**
RTD	Annual payment	$12.6 million/year
Denver	Limited Interest Backstop	Up to $9.3 million/year
Downtown Development Authority	Tax-increment revenue (property and sales) from 40-acre area; Metro District covenant to levy 30 mills	Grows to $33 million/year by 2024
Development Sources		
Source	**Description**	**Amount**
USDOT/FHWA	TIFIA Loan	Up to $145,600,000
USDOT/FRA	RRIF Loan	Up to $155,000,000
FHWA	Federal Projects of Regional & National Significance Funds	$40 million upfront
FTA	Federal Funds (5309 and ARRA)	$42,000,000
RTD	Proceeds from sale of land to private developer	$38 million during construction period
CDOT	State Senate Bill 1 funds	$16.8 million upfront



This complex financing structure required the creation of the Denver Union Station Project Authority (DUSPA), a non-profit corporation organized to manage, finance and implement the Denver Union Station Project. All four partner agencies participate in the governance of DUSPA through board membership with the private partner:



Results

The Denver Union Station project was completed in 2014 with the Bus Concourse opening in May and the newly renovated station opening in July. RTD buses and Amtrak currently operate out of the facilities with commuter rail scheduled to begin operation in 2016.

The TIF financing arrangement has been tremendously successful – with more than $1 billion in development of the land around the station already completed or underway, revenues from this source are outpacing projections by 8 to 10 years or more.

Resources

Denver Union Station Lessons Learned 2015

Departments

General Counsel

Planning

Contact(s)

- Marla Lien, General Counsel
- William Van Meter, Assistant General Manager, Planning
- Bill Sirois, Senior Manager, Transit-Oriented Communities

Goal

Prepare participants to compete for future opportunities and share knowledge and strengthen contacts between RTD and peer agencies.

Background

In the past, transit employees both at RTD and at other agencies had limited opportunities to learn about the industry. In addition, ensuring that agencies exchange information at all levels – not just at the executive level – has been a challenge in the industry. Leadership programs at RTD and in the industry as a whole were especially limited for represented employees. By the early 2010s, RTD was simultaneously seeking ways to encourage professional development and foster leadership training for employees and share innovative ideas throughout the industry.

Best Practice

In 2012, RTD along with Dallas Area Rapid Transit (DART) and the Los Angeles County Metropolitan Transportation Authority (LA MTA) established the Multi-Agency Exchange (MAX) program, a collaborative, long-term, structured leadership development and learning exchange program. In 2014, the Metropolitan Atlanta Rapid Transit Authority (MARTA) joined the program. In order to gain the support of all three of the original agencies in the program, RTD's General Manager along with the General Managers of DART and LA MTA worked together to launch the program. RTD education, training and development staff followed up with one-on-one meetings both with internal stakeholders at RTD and leadership at DART and LA MTA. Early on, one agency that was a potential MAX participant agency expressed concern over losing staff to other agencies, and decided not to join the program for that reason. For the most part, however, the attitude towards the program was highly supportive. RTD volunteered to host the first MAX event.

One of the first challenges of the MAX program was setting up the logistics of the program: creating a scope, budgeting, determining how candidates would be selected, and recruiting a diverse candidate body were all key elements that needed to come together quickly on an ambitious launch schedule. In the interest of saving time, RTD training staff decided that Assistant General Managers (AGMs) should select candidates for MAX in the first year of the program. In the next two years, however, MAX candidates were required to be graduates of RTD's Leadership Academy program. Connecting the Leadership Academy to the MAX program laid the foundation for a highly developed strategic leadership development program with additional components.

The MAX program addresses best practices in both operation and support functions, and participants receive a broad overview of how an entire transit agency functions. In addition, MAX participants identify best practices to bring back to their home agencies, which allows for innovative ideas to percolate through all of the participating agencies.

In 2015, for the first time, MAX featured 90-minute break-out sessions, which allowed participants to explore an area in depth. For example, a break-out session on light rail operator training reviewed RTD's train operator recertification process and plans for a new light rail training simulation system. Other break-out sessions focused on safety and security and human capital. Using break-out sessions in conjunction with common experiences for all participants preserved the MAX program's benefit of allowing participants to see all aspects of a transit operation while encouraging deeper exploration of their interests.

In upcoming years, RTD will increasingly integrate MAX with other leadership development programs: the Leadership Academy; Departmental Leadership Training; Mentoring Program; and Expanded Training Programs. Together, these programs constitute RTD's Strategic Leadership Development Program. In addition, RTD's education, training and development department intends to create a regular issue-specific conference for MAX alums. The conference will focus on hot issues in the industry, such as state of good repair or innovative financing for transit projects.

Results

MAX has helped prepare future transit leaders to manage critical challenges in the transit industry and to ensure continuity in meeting current and future public transit needs. At RTD, 18 employees have successfully completed the MAX program so far, after 3 years. Three MAX participants have been accepted into Leadership APTA, and six RTD participants were promoted after completing the program.

MAX has sparked innovative ideas from the participants, who have learned and championed implementation of new projects in their home agencies. For example, Bob Grado, RTD's Transit Police Commander, entered the MAX program with a series of questions to ask counterparts at other agencies. One of his goals for RTD had been to obtain a smartphone app that would allow transit riders to report incidents to transit security easily, anonymously and inconspicuously. Grado had researched transit security apps and found that they typically cost approximately $400,000. Through the connections he made in the MAX program, Grado learned that LA MTA had obtained a transit security app at a comparatively affordable price through one of their part-time security officers who also owned a company that develops apps. In addition, the company was willing to provide the app at an attractive price (under $90,000) to RTD. As a result, Grado was able to purchase and implement the app within a few months, and RTD is now receiving information from passengers through the Transit Watch app.

Resources

2014 MAX Annual Report

Departments

Human Resources (Finance & Administration)

Contact(s)

- Cherie Sprague, Senior Human Resources Executive
- George Kuzirian, Manager, Education Training & Development
- Richard Petty, Senior Education Training & Development Specialist
- Bob Grado, Transit Police Commander

Goal

Create opportunities for metro Denver residents to attain and retain living wage careers in the transit and construction industries.

Background

In 2008 and 2009, even as Colorado slowly recovered from the Great Recession, RTD staff recognized that RTD and the transportation industry as a whole would soon face a labor shortage. In particular, FasTracks projects would require a large number of skilled and semi-skilled construction workers. Impending retirements in the transportation industry and a shortage of local workers who had the skills to build a major rail project like FasTracks concerned both RTD and consultants such as Denver Transit Partners (DTP), the contractor for RTD's Eagle commuter rail project. At the same time, the scale of the FasTracks program provided an opportunity to help people in local communities find employment and directly benefit from the construction and operation of new transit capital projects and other public transportation activities.

In 2010, RTD's new General Manager prioritized workforce development at RTD. In response, RTD developed a new program called the DRWI (Denver Regional Workforce Initiative) with two goals:

- Increase access to high-quality transportation jobs in underserved Denver-area neighborhoods, especially those affected by FasTracks construction
- Ensure that RTD and partner employers have access to skilled labor for construction projects, operations and maintenance

Along with Civil Rights staff, RTD's General Manager reached out to contacts in the Denver-area community, beginning with the Community College of Denver (CCD). CCD administrators were enthusiastic about developing training programs for prospective transportation-industry workers. RTD also reached out to other potential employers such as DTP as well as nonprofits in workforce development such as the Denver Urban League.

At the same time, RTD staff built support with labor unions and staffing agencies, both of which offered alternative pathways to careers in transportation. RTD reached out to all local labor unions, and coordinated with unions to ensure that new transportation workers would have access to the benefits of union membership. RTD successfully involved unions by actively reaching out and building individual relationships. RTD also involved staffing agencies as partners through a similar outreach effort.

In order to get the new program off the ground, RTD staff and partners targeted specific neighborhood networks. Denver's Park Hill was an early focus due to the socioeconomic profile of the neighborhood. In particular, Park Hill residents, as a whole, had low educational attainment and faced high unemployment, poverty, foreclosure, and crime rates. The neighborhood was also adjacent to the East Line, a commuter rail line that was soon to enter the construction phase and would provide ample job opportunities. RTD staff reached out to specific individuals and nonprofits in the Park Hill area that were already training residents. For example, the Bo Matthews Center for Excellence, a nonprofit located near Park Hill, was already training veterans for jobs in construction. Soon, those neighborhood leaders and nonprofits spread the word about the new RTD workforce development program to others in the community. Around the same time, RTD organized an event in Park Hill called the Denver Regional Workforce Initiative Community Call to Action where community leaders and workforce development professionals committed to supporting the new program.

Best Practice

RTD sees its capital construction projects as unique opportunities to prepare community residents for successful employment and ensure short-term job opportunities are transformed into long-term career pathways. As RTD and partners have moved forward with the WIN program, they have focused on five key goals: focusing on employer needs, building career pathways for participants, collaborating to broaden the impact of the program, emphasizing retention support, and inspiring positive community development.

In the three years since its founding, WIN has rapidly expanded its network of partner general contractors and small businesses. In order to expand the program, RTD staff has continued to network with potential partners. At the same time, partners who have had positive experiences with the WIN program have encouraged other potential partners to join WIN.

After successfully piloting WIN with its Eagle P3 project, RTD established a policy that inserts employment and training goals for local residents into the contract for each construction project. Building on the success of construction projects, RTD has also added WIN goals to other types of projects, such as an FTA-mandated before-and-after study of FasTracks lines.

By connecting education and skills development programs with integrated support services and on-the-job coaching, WIN bridges the gap between the skills individuals already have and the skills they need to succeed in careers. Services include career guidance, job training, career development coaching, and supportive services that enable metro residents to secure, retain and advance in transportation and construction jobs that pay a living wage. Employer services include recruitment and pre-screening, customized training, community outreach, and enhanced retention through on-going career coaching.

Results

In 2012, President Obama recognized RTD as a Transportation Innovators Champion of Change for the WIN program.

As of 2014, the WIN network includes 56 partners, both training organizations and employers, as well as labor union partners. WIN has signed memorandum of understanding (MOUs) with all of those partners. WIN enrolls 90 to 120 individuals annually, and the program has placed over 80% of participants, with an average starting wage of $16.25 per hour.

In the wake of RTD's success with WIN, other transportation agencies across the country are now creating their own WIN programs. In June, Boston's transit agency, the Massachusetts Bay Transportation Authority (MBTA) and the Massachusetts Department of Transportation launched its own workforce development program modeled on RTD's WIN program: MassWIN.

Resources

WIN Program FTA Close-Out Report

MassWIN

Departments

Civil Rights (Executive Office)

Contacts

- Martell Dyles, Manager, WIN Program

Goal

Encourage private sector innovation to benefit RTD projects.

Background

During and after the Great Recession, RTD was struggling to find funding to construct remaining FasTracks lines through traditional strategies. In addition, RTD was seeking innovative solutions to operations and technology challenges. In 2011, inspired by the Chicago Transit Authority (CTA)'s deal with Apple, which revitalized a Chicago El station, RTD's General Manager suggested a two-pronged effort to encourage private companies to provide solutions. The agency would simultaneously develop an unsolicited proposal policy and host a forum to educate private companies about RTD's challenges and opportunities and attract their interest. While RTD had a brief unsolicited proposal policy on the books, no proposals had ever come in under that policy, and the policy was not detailed or explicit about what types of proposals RTD would accept. Some RTD staff were skeptical about the feasibility of a forum and successful unsolicited proposal process, but once the planning process got underway, staff across many departments became increasingly involved and supportive of the effort.

Best Practice

Unsolicited Proposal Policy

To ensure that the agency would receive high-quality proposals and determine the best way to review them, representatives from RTD's Materials Management Division, Finance Department, Capital Programs Department and Legal Department worked together to develop an unsolicited proposal policy, along with advising from private sector consultants.

The policy specifically outlined the types of proposals that RTD would accept. RTD staff were careful to incorporate Federal Transit Administration (FTA) unsolicited proposal regulations into the policy, which has paid dividends for the agency and helped ensure that the policy would stand up to an FTA audit. The unsolicited proposal policy explicitly outlines the types of proposals that RTD will consider. RTD's policy includes specific language from FTA's Circular 4220.1F: Third Party Contracting Guidance. For example, according to FTA, an unsolicited proposal is:

1. Innovative and unique,
2. Independently originated and developed by the offeror,
3. Prepared without the recipient's supervision, endorsement, direction, or direct involvement,
4. Sufficiently detailed that its benefits in support of the recipient's mission and responsibilities are apparent,
5. Not an advance proposal for property or services that a recipient could acquire through competitive methods, and
6. Not an offer responding to a recipient's previously published expression of need or request for proposals. (FTA Circular 4220.1F: Third Party Contracting Guidance, p. 11,)

According to RTD's policy, an unsolicited proposal "must have the following qualities":

1.2.1 Innovative and unique;

1.2.2 Independently originated and developed by the proposer;

1.2.3 Prepared without RTD's supervision, endorsement, direction, or direct involvement; and

1.2.4 Sufficiently detailed that its benefits in support of RTD's mission and responsibilities are apparent.

An Unsolicited Proposal is distinguishable from a project which is already part of RTD's long-term budget planning process if it uses innovative and unique solutions to offer added value, such as enhanced financing options or materially advancing delivery dates. RTD does not consider sales tax bonds and certificates of participation are not unique and innovative financing tools. Following federal guidelines, RTD's unsolicited proposal policy also specifically excludes proposals regarding real property. (RTD Procurement Standards Manual VI-4: Unsolicited Proposals Policy)

RTD's unsolicited proposal policy is consistent across all projects and programs, whether or not they include federal funding sources. Making the policy consistent makes accounting easier and helps protect RTD in case of an audit. Adding this explicit language about the types of proposals that would be of interest to the agency was also intended to help reduce staff time spent reviewing irrelevant proposals.

In addition, RTD does not move immediately from a proposal to a contract. Rather, once RTD staff (including both procurement and subject matter experts) have reviewed a proposal, they decide whether to pursue the concept through a traditional RFP process or reject the proposal outright. If staff chooses to release an RFP, the original proposal must be formalized and resubmitted to meet the requirements of the competitive RFP process. At that point, other companies have an opportunity to compete.

Transformation through Transportation (T3) Industry Forum

In order to attract attention from private companies, RTD hosted an event in September 2011 to share information and solicit feedback from industry: the Transformation Through Transportation (T3) Industry Forum. At the T3 forum, staff explained to invitees from industry how to create competitive unsolicited proposals and avoid wasting staff time with unsolicited proposals that are irrelevant or unfeasible. The forum provided an opportunity for industry leaders to meet RTD decision-makers face-to-face and receive information about the agency's situation. The T3 took place at the Denver Athletic Club, a private club and venue in Downtown Denver, and lunch was provided for invitees. There was also ample time for mingling at a reception at the end of the day.

The intention of the T3 forum was to foster innovation by sharing the kind of information that would spark ideas from the private sector. The assumption was that the private sector would be able to leverage their knowledge of RTD to submit effective proposals for building out FasTracks as well as benefit the base system. The T3 program began with a series of introductory presentations from the Chairman of the RTD Board of Directors, Denver's Mayor, the President of Denver's Chamber of Commerce, and RTD's General Manager. But the day's centerpiece was a series of presentations from RTD staff, who described the organization's financial situation and operations and construction challenges. Staff made sure to share as much as possible about the organization's difficulties in order to give the attendees clear direction on the kinds of proposals that would be most beneficial, and most likely to be accepted. Staff also specified what they did not want to see in proposals (for example, proposals for RTD's typical needs, such as diesel fuel).

RTD reached out to private sector companies across many different industries, rather than focusing on construction or traditional transit contractors. For example, the tech industry was heavily targeted in marketing materials for the T3. The event itself was intended to ensure that the private sector would both understand the types of proposals that RTD was interested in receiving and show that the agency was eager to work with private companies.

Results

RTD has accepted two unsolicited proposals for rail lines in the FasTracks system: the I-225 Rail Line and the North Metro Rail Line. In both cases, teams submitted proposals to accelerate construction of the lines within RTD's available financial capacity. In addition, receiving the proposals was an important political tool for RTD. Before the proposals were received, the staff and Board had not determined which FasTracks rail lines to build next. Once RTD received the proposal for I-225, staff and board members had a powerful argument for building that line next. When the proposal for North Metro came in, staff and board determined that would be the next line to be built based on the offer.

The built-in RFP process has ensured both FTA compliance and a good deal for RTD. In both the case of I-225 and North Metro, the teams submitted confidential unsolicited proposals that were deemed to have technical merit. In both cases, the proposals that RTD selected through the ensuing RFP process were more advantageous to RTD than the original unsolicited proposals.

In addition, the policy has become an industry procurement best practice because it simultaneously provides an opportunity for private sector innovation while ensuring that RTD complies with FTA policies. FTA has referred other transit agencies to RTD's unsolicited proposal policy. Some agencies that have unsolicited proposal policies that did not pass FTA audits have requested copies of the RTD policy at FTA's direction.

As of December 2014, RTD had rejected 28 of 30 unsolicited proposals that did not meet the requirements of the policy or for lack of feasibility, however. While the policy outlines the specific types of proposals that RTD might pursue, many companies have submitted proposals that do not meet those requirements. In many cases, the proposals have not been innovative or RTD staff has already considered the opportunities being proposed and either rejected the idea or released a typical Request for Proposals (RFP).

Resources

Unsolicited Proposal Policy

Procurement Standards Manual (including Unsolicited Proposal Policy)

Departments

Capital Programs

Communications

Finance (Finance & Administration)

Materials Management (Executive Office)

Contact(s)

- Richard Clarke, Assistant General Manager, Capital Programs
- Susan Cohen, Manager, FasTracks Program Control
- Pauletta Tonilas, Sr. Manager, Public Relations and Public Information
- Brian Iacono, Senior Manager, Materials Management

Goal

Implement transit-oriented developments (TOD) on a small scale to identify the ideal role for RTD in development projects before undertaking a more ambitious TOD program.

Background

Transit-oriented developments (TODs) feature walkable spaces and a mix of uses located close to (and ideally within a half-mile of) a transit station or hub. As early as 1974, RTD was investigating “joint development,” that is, working with developers, municipal governments and other partners to ensure that compact, transit-centered development occurs near rail stations when the market supports those types of projects. The proposals in those early investigations never came to fruition, however.

In the late 1990s, the City of Englewood spearheaded the Denver metro area’s first TOD, Englewood City Center, a redevelopment of the declining Cinderella City shopping mall into a mixed-use, walkable urban center. The development featured government offices and public services, a park, retail, and housing, as well as an integrated bus and rail station. A number of transit-oriented projects near light rail stations along the Southwest and Southeast lines followed Englewood City Center, but RTD provided little support for TOD projects at that time. While the T-Rex (Southeast corridor) project was underway, RTD hired a transit-oriented development staffer who focused on marketing TOD to the metro area, but RTD still did not take an active role in development. At the time, RTD’s primary interest in TOD was as a potential source of revenue.

In 2005, after FasTracks passed, and after a brief period when RTD had no internal staff focused on TOD, the agency brought on a Manager of Transit-Oriented Development to determine how RTD could encourage TOD projects that met the needs of the agency as well as developers. The manager created a TOD policy, which the Board adopted in 2006, to help guide future projects and define the agency’s role within the development process.

Best Practice

In 2010, the Transit-Oriented Development group added staff in economic policy and began focusing on partnering with developers. At the same time, with the encouragement of a new General Manager, the department began to think more broadly about how RTD could help facilitate TOD. Stakeholders, the public, and the Board also encouraged RTD to become increasingly involved in TOD. With assistance from a consultant, the division created a strategic plan for TOD in 2010. The strategic plan incorporated the six Federal livability goals that the Department of Transportation (DOT), Department of Housing and Urban Development (HUD), and the Environmental Protection Agency (EPA) announced in 2009. The six principles are: provide more transportation choices; promote equitable, affordable housing; enhance economic competitiveness; support existing communities; coordinate and leverage federal policies and investment; and value communities and neighborhoods.

With the TOD strategic plan, RTD began moving toward a new model for TOD that would evaluate joint development opportunities based on community creation and leveraging the six livability principles, rather than focusing primarily on RTD financial return. In addition, RTD aimed to take a more proactive role in the process, partnering with developers and municipalities to create communities that were emphatically transit-oriented.

To test the principles in the strategic plan in a real-world application, the TOD division launched the TOD pilot program in 2010. Establishing the pilot program allowed the division to hire the staff to move TOD forward at RTD. The pilot program included four projects, which were chosen with an eye toward their potential for success and supportive partnership opportunities:

» Alameda Station

» Olde Town Arvada

» Federal Center

» 26th / 29th & Welton Street

For the pilot program, the TOD division intentionally chose a variety of types of projects that featured different kinds of challenges and opportunities. The first two projects to move forward were the Alameda Station project, an urban, mixed-use community in central Denver, and the Olde Town Arvada project, in a relatively denser, suburban area. In both cases, the local municipalities supported the projects and assisted in moving them forward.

Because property ownership is RTD's key negotiating tool in a project, the TOD department has found that they can influence a project's design more effectively when they retain ownership of the land until a developer has agreed to a plan that aligns with TOD principles. In the case of the Alameda project, RTD was careful to retain ownership of their property until the developer agreed to a plan that worked for them.

RTD's new TOD staff, added as the pilot project got underway, acted as internal champions and a point of contact with whom partners could coordinate development. Over the course of the pilot program, the staff has found that partnering to create transit-oriented development works best when there are both internal point people at RTD and point people at the developer, municipality, or other interested organizations. At Alameda Station, for example, the developer identified a point person to coordinate with RTD's TOD manager. Those two individuals developed a positive working relationship, and were able to address minor issues and keep the project moving forward.

Areas of Opportunity

At times, given that the TOD pilot program is relatively new, it has been difficult to ensure that RTD staff based in other departments are aware of the TOD program and refer prospective partners to TOD staff. Establishing authority and influence through a standardized TOD process within RTD has been a significant challenge because promising projects sometimes do not move forward if individuals who are not as interested in TOD take the lead.

It has also been important to identify partners with a strong interest in a project who are also in a position to move the project forward. Federal Center, for example, has been a more challenging project: the Federal Government has been a willing partner, but the pace of progress on that development has been slow, in part due to federal processes.

Managing the expectations of partners and other internal and external stakeholders is essential to completing a successful project. Some external partners, notably municipalities, have had unrealistic expectations about the potential of transit-oriented development projects to succeed in places where the market does not support a high level of investment. RTD has managed this issue by gently encouraging municipalities to focus on station areas where the private sector is willing to make an investment.

Results

The Alameda Station project has been the first of the TOD pilot projects to move forward, with construction beginning in Spring 2014. The project will incorporate a mixed-use development with both residential and commercial spaces around the Alameda light rail station on the Central Line. While the developer did not emphasize the light rail station in initial plans for the project, RTD was able to negotiate a more favorable, truly transit-oriented plan through the TOD pilot program.

Of the three remaining pilot projects, the Olde Town Arvada development is closest to a launch. A supportive municipal government and good relationships with the Capital Programs Department, and Eagle P3 team have kept the project on schedule.

Resources

TOD Strategic Plan, TOD Policy, and a description of the pilot program

Partnership for Sustainable Communities and the Six Livability Principles

Departments

Planning

Contacts

- Bill Sirois, Senior Manager, Transit-Oriented Communities
- Kate Iverson, Manager, Transit-Oriented Development
- Patrick McLaughlin, Transit-Oriented Development Associate

Goal

Educate employees, investors, stakeholders and the public about RTD's financial status.

Background

RTD has become increasingly transparent with financial information in recent years. The agency has always been subject to the Colorado Open Records Act (CORA), which requires that RTD share documents with the public upon request, and potential investors can request a Banker's Book with financial information. As the 2008-2009 Recession affected sales tax receipts, public interest in FasTracks financing increased. Public scrutiny and a Chief Financial Officer (CFO) who supported transparency led the agency to share more financial information with the public before receiving specific requests. In addition, the CFO was inspired by other transit agencies to make financial information as easily available as possible.

Best Practice

Budget Book

RTD publishes an annual Budget Book outlining agency finances for the upcoming year. The Budget Book is available to the public on RTD's website. The Government Finance Officers Association (GFOA), a major industry association, has awarded RTD their Distinguished Budget Presentation Award for thirty years in a row. The GFOA assigns anonymous, independent reviewers to assess government budget books, and sets criteria for industry budget documents. According to the GFOA, the Budget Book should be a:

- Policy Document
- Operations Guide
- Financial Plan
- Communications Device

Over time, the Budget Department has added information to the Budget Book, including an overview of the agency's mission, with annual accomplishments and goals for the upcoming year tied to mission statement elements. Departmental goals and accomplishments also appear in the Budget Book, as well as a description of RTD's governance. Most recently, the department improved the Budget Book by streamlining it and making it more user-friendly. As part of that process, they added more charts and graphs to make the information more accessible and easy to understand. The GFOA reviewers praised the narrative overview in the 2014 edition.

The Budget Book serves as both an external and internal document. External audiences include bondholders and citizens and taxpayers of the District. Internally, the Budget Department shares the Budget Book with each Assistant General Manager (AGM), the General Manager, and the Board of Directors. The Budget Book is also a useful reference for staff throughout the year.

Comprehensive Annual Financial Report

RTD releases a Comprehensive Annual Financial Report (CAFR) that summarizes the organization's financial situation for the upcoming year. The CAFR is the public sector equivalent to a public company's 10-K report, and is required by the State of Colorado. Investors refer to the CAFR to determine whether RTD is using resources responsibly. In addition, producing the CAFR supports RTD's bond ratings.

Culture of Transparency

Public interest in FasTracks corridor financing has led the Finance Department to literally open the books to the public. Before receiving an unsolicited proposal from a contractor at an unusually low rate in 2013, RTD had determined that it would be impossible to finance the North Metro rail corridor for many years to come. Many meetings were held with stakeholders from the North Metro region after they asked to review RTD's financial situation, and the Finance Department opened the books to them. After studying RTD's finances, the North Metro stakeholders agreed with RTD that financing that rail line would be impossible in the near-term. After a private company submitted an unsolicited proposal to build the North Metro rail line in 2013, RTD involved the North Metro stakeholders in the request for proposal (RFP) process to designate a contractor to build that line.

Future Plans

In the future, RTD will combine the annual Budget Book with a long-term financial plan. This will provide readers with information on a one-year appropriated basis along with a long-term outlook. The long-term plan will inform potential investors, private companies that wish to submit unsolicited proposals, and the public about RTD's plans. Producing this document annually will also streamline investor requests for information. Currently, the Finance Department must produce and distribute "Banker's Books" five to six times per year upon request, but a long-term financial document would meet these requirements more comprehensively. In addition, the document will be useful for internal staff in Planning and Capital Programs to determine which planned projects are feasible.

In addition, the Finance Department and Information Technology are working to make financial information easily accessible internally using Oracle Business Intelligence software. Once that program is fully implemented, AGMs and other key staff will be able to monitor department finances with user-friendly dashboards that will summarize real-time budget information.

Area of Opportunity

Gaining support for increasing financial transparency at an agency that had been less transparent in the past has been challenging at times. A supportive Board, General Manager and Senior Leadership Team as well as a CFO focused on increasing transparency were essential to opening RTD's culture and sharing as much information as possible. Still, RTD is not as transparent as some transit agencies: for example, many agencies share salary records, and some share all transaction records online. Determining the ideal amount of relevant, useful information to share without causing information overload is a continuing challenge. In addition, providing timely, accurate and relevant information also requires agency resources, and balancing those needs with the appropriate resource levels can be difficult.

Results

Aside from enabling RTD to meet legal requirements, the culture of financial transparency has increased interest from investors and improved relations with stakeholders. In addition, making as much information as possible freely available on the website has saved staff time by streamlining internal and external requests for information. The Budget Book and the CAFR have become essential reference documents not only for those seeking financial information about RTD but for anyone seeking a broad overview of the state of the agency.

Resources

RTD Adopted Budget 2014 ("Budget Book"):

RTD Comprehensive Annual Financial Report 2013

Government Finance Officers Association (GFOA) Distinguished Budget Presentation

Departments

Finance (Finance & Administration)

Contacts

- Douglas MacLeod, Controller
- Jannette Scarpino, Manager, Budget & Financial Analysis

Goal

Save money, finish projects on time, establish an integrated and seamless team and ensure that RTD is in a strong negotiating position by working collaboratively with contractors and other government organizations.

Background

Since at least the T-Rex (Southeast Corridor) project, RTD has worked to partner effectively with both municipalities and contractors. During the Southwest Corridor project, RTD established a reputation in the industry as an agency that would be flexible with contractors while still representing the interests of District citizens. That attitude first paid off during the Central Platte Valley (CPV) project: RTD planned the CPV quickly and made a number of changes, which required significant changes up to the final design. In response to RTD's approach to contractors, the CPV contractors were flexible with RTD, working through issues rather than charging a large amount for change orders.

During the T-Rex project, RTD worked with the City and County of Denver, the Colorado Department of Transportation (CDOT), and Federal agencies to deliver the first of its kind light rail and road expansion project ahead of schedule and under budget on November 17, 2006. RTD learned that the T-Rex project could only be successful if they worked with CDOT because each agency had a strong stake in the project. With the success of these relationships, RTD formalized the process by embedding representatives from both CDOT and the City and County of Denver in the FasTracks Planning and Capital Programs offices.

Best Practice

RTD's Capital Programs Department has intentionally created a culture that encourages partnering with other government agencies and contractors. There are at least three key components of this culture: decentralized decision-making, fostering personal relationships between RTD staff and contractors, and developing a positive working relationship with Procurement.

RTD's senior leadership pushes down decision-making to staff at lower levels, which gives that staff the flexibility to negotiate directly with contractors and municipalities rather than elevating issues. This approach enables staff to solve problems early, before RTD, contractors, or government partners incur significant costs. In part because of the agency's decentralized approach, RTD staff at all levels are able to develop positive working relationships with contractors. Those relationships are essential when a project is running behind or RTD requires work that was not scoped in the original contract.

In addition, the Capital Programs Department has worked to build a trusting relationship with the Procurement division. Over time, Capital Programs staff have proven that they can be trusted to act in RTD's best interests. This trusting relationship allows for some flexibility for Capital Programs as they negotiate contracts.

Results

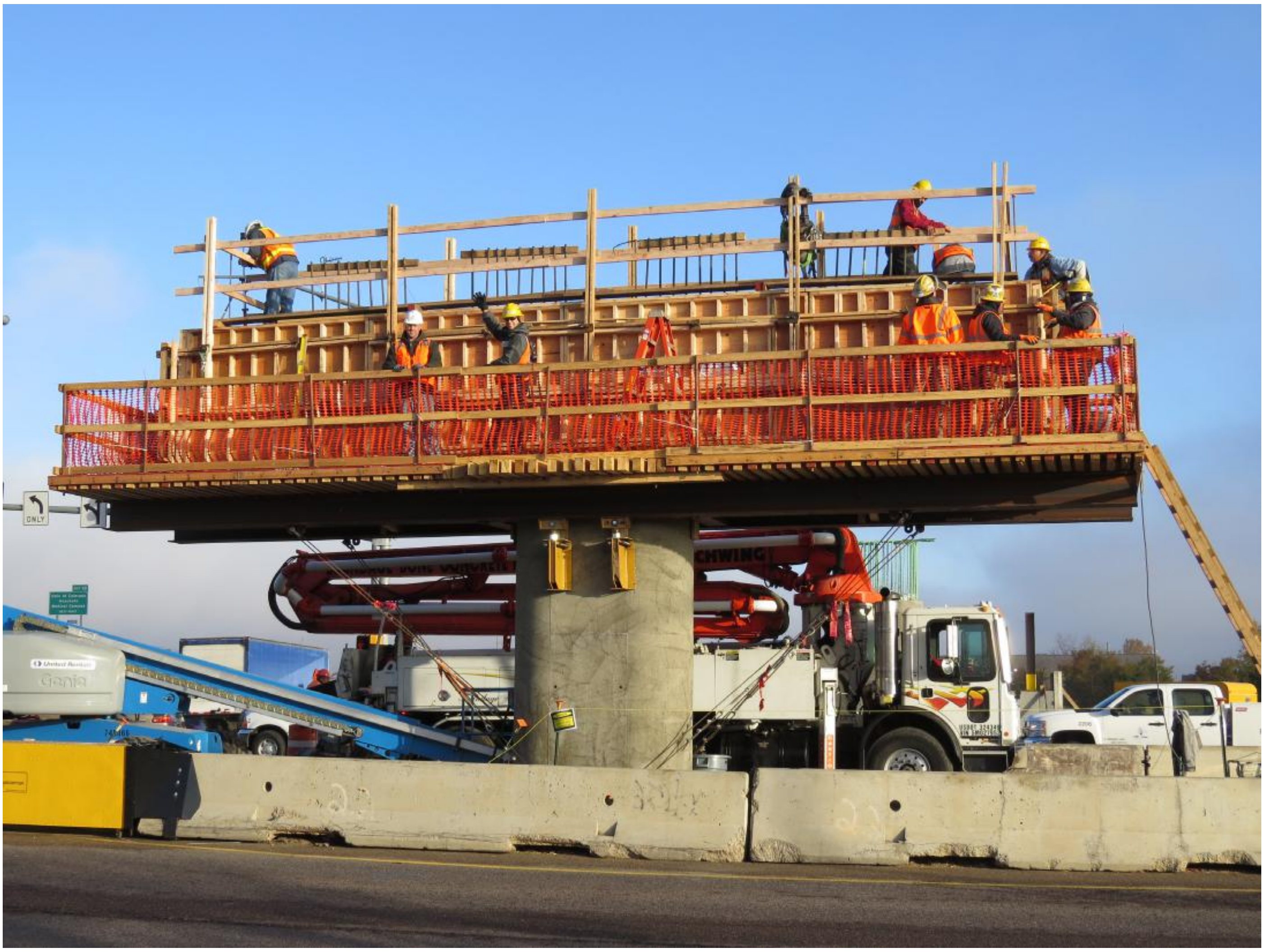
Because RTD is known as a preferred client, the agency receives more bids at better prices than they otherwise might. In addition, contractors will occasionally take on unscoped work, which has allowed RTD to finish projects on time: just as RTD is flexible with contractors, contractors are flexible with RTD. At the same time, RTD's tendency to work well with local governments has allowed the agency to finish complex projects relatively quickly. Although the agency occasionally escalates a situation or has an issue with a contractor, the benefits of partnering have far outweighed the risks. Partnering well with both contractors and other agencies has been a major component in RTD's success building FasTracks in a difficult economic and political climate.

Departments

Capital Programs

Contacts

- Pranaya Shrestha, Sr. Manager, Program Management
- Frank Buczkowski, Sr. Manager, Systems Engineering & Construction



Subcontractor Performance Self-Insured Program

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Goal

Increase the participation of small and disadvantaged business enterprise (SBE/DBE) subcontractors in RTD construction projects and save money for the district by eliminating bonding as an obstacle.

Background

In meeting with minority and disadvantaged businesses during the development of the FasTracks program, RTD was advised by small business groups that bonding requirements were an impediment for potential SBE and DBE subcontractors. Colorado law requires penal bonds (payment and performance bonds) for prime contractors on large public works programs.. In practice, contractors typically pass on bonding requirements to subcontractors. Federal DBE regulations require that agencies receiving federal funds assist DBEs in overcoming limitations including inability to obtain bonding. RTD had created owner-controlled and self-insured programs for liability risks on construction projects in the past and could build on those models for a program addressing bonding. The program began with the West Line and has been implemented for the I-225 corridor.

Best Practice

RTD creates a self-insured loss fund ("Program Fund") that covers claims that could have been made against subcontractors' sureties if they had obtained a bond, allowing SBEs, DBEs, and other subcontractors to perform work for RTD even if they cannot qualify for bonds. All subcontractors with contracts below a certain dollar threshold must participate in the program: if only high-risk subcontractors were included, the program would be unaffordable. RTD evaluates subcontractors as to the financial and technical qualifications prior to admitting them to the program and monitors their performance. RTD does not collect premiums. Instead, RTD works with an insurance broker to determine the amount that each subcontractor would have paid for bonds plus overhead and profit, and deposits that amount in the Program Fund. RTD requires the prime contractor to require all subcontractors with contracts below the established dollar threshold to participate in the program and to limit claims against subcontractors to the amount in the Program Fund.

Results

The program began in 2008 with West Line rail construction. During that project, there were 37 subcontractors in the program, and 23 were DBEs. Thirteen were new subcontractors to RTD, and nine had never qualified for a bond. Eight contractors did not qualify. RTD saved an estimated $243,681 compared to construction bonds (not including program development and monitoring). There were no claims.

Resources

Marla Lien Presentation to APTA "RTD's Subcontractor Performance Self-Insured Program"

Departments

General Counsel

Contact(s)

- Marla Lien, General Counsel
- Robert Medina, Risk Manager

Goal

Objectively track and measure how the region changes as RTD plans, constructs and opens FasTracks.

Background

The 2004 FasTracks Plan outlined three key goals for the rail expansion program:

» Provide improved transportation choices and options to the citizens of the district

» Increase transit mode share during peak travel times

» Establish a proactive plan that balances transit needs with future regional growth

When a transit agency such as RTD constructs a rail line using Federal funds through Full Funding Grant Agreements (FFGA), the Federal Transit Administration (FTA) requires a "Before and After Study" comparing the project scope, transit ridership, service levels and costs at the time the project is proposed, just before opening, and after the project has been open for two years. In 2004, after FasTracks passed with the goals outlined above, Planning Department leadership decided to conduct a more extensive study that would expand on the FTA's "Before and After Study" concept. The Quality of Life study was the result. Unlike Before and After studies, the Quality of Life study has a broad focus, examining general indicators of changing mobility, transit mode share, and growth patterns across RTD's region.

Best Practice

The Quality of Life study is a long-term effort that aims to objectively measure changes happening within RTD's region as FasTracks is constructed. Changes are tracked and analyzed at three geographic levels: regionally, corridor, and station-level. RTD produces a short, annual Quality of Life report (high-level measures report) each year, as well as a comprehensive report every three years (detailed report). The reports are divided into three sections based on the three FasTracks Plan goals (above).

Each section includes measures that track changes in relevant indicators of growth, transit mode share, and transportation choices. For example, "taxable retail sales" is one high-level measure within the section on regional growth. One measure of increasing transit mode share at peak times is annual transit boardings per capita. Percentages of regional destinations served by high-frequency transit are measured in order to help show how transit offers transportation choices.

Initially, in early 2006, RTD's Planning Department worked with a multi-disciplinary team of consultants and RTD internal staff to create a baseline report identifying all of the measures that the study would track over time as FasTracks was constructed. Over time, measures have changed somewhat as sponsoring organizations discontinue data collection in some areas and new data sources become available. Ensuring consistency over time has been one of the challenges of the project.

With strong support for the Quality of Life program from the beginning, RTD staffed the program and funded consultant support at appropriate levels. Initially, the Planning Department relied heavily on consultants. Once the measures were established, RTD was able to cut back on consultant support. Currently, with the Quality of Life program in its eighth year, one internal project manager at .3 to .5 FTE and a small consultant team are adequate to run the program. Aside from the project manager, the study requires a graphic designer and a data analyst, both of whom work through consultants on an ongoing FasTracks contract.

QUALITY OF LIFE MEASURES SUMMARY

High Level Measures **Bolded** Below

Goal	Objective	Measure Area	Measure
Goal: **Establish a Proactive Plan** That balances transit needs with future regional growth	1 MEET Future Transportation NEEDS	Population Growth	Population (R, C)
			Urban Land Consumption (R)
			Urban Residential Density (R)
			Population Density (C)
		Job Growth & Employment	Annual Change in Employment (R)
			Directly Supported Jobs (R)
			Indirect Job Creation (R)
			Unemployment Rate (R)
			Employment (S)
		Housing Growth	Housing Starts (R)
	2 PROVIDE Opportunity for Development NEAR TRANSIT	Economic Activity	RTD Sales Tax Revenue (R)
			Taxable Retail Sales (R)
			Fuel Cost (R)
			New Development (S)
		Property Value	Apartment Rent (R, S)
			Housing Affordability Index (R, C, S)
			Transportation Cost (R, S)
			Commercial Lease Rates (S)
			Property Values (S)
Goal: **Increase Transit** Mode share at peak times	3 ENVIRONMENTAL Sustainability	Sustainable Design	**Sustainable Project Features & Actions (R)**
		Air Quality	Vehicular Emissions (R)
			Number of Air Quality Exceedences (R)
		Energy Consumption	Transportation Energy Consumption per Capita (R)
			Excess Fuel Consumed Due to Congestion (R)
			Fuel Saved Due to New Transit Trips (R)
	4 Transit Usage	Peak Transit Mode Share	Mode Share (R, S)
		Ridership	Transit Boardings (R, S)
			Annual Transit Boardings per Capita (R)
			Passenger Demographics (R)
			New Transit Riders (R)
	5 TRAVEL Safety & Security	Accidents	Safety Benefit (R)
		Crime	Crime Rate on RTD Property (R)
			Security Resource Inventory (R)
		Passenger Perception	**Safety Perception (R)**
	6 CUSTOMER Satisfaction	Passenger Satisfaction	**Overall Service Rating (R)**
Goal: **Improve Transportation** Choices & options	7 SYSTEM Mobility	Vehicle Miles Traveled	Transit VMT Impact (R)
			Vehicle Ownership (R,C,S)
		Congestion	Extent of Congestion (R)
			Duration of Congestion (C)
		User Cost Savings	Motorist Congestion Cost Savings (R)
			Transit Riders Cost Savings (R)
		Travel Times	**Corridor Travel Times (C)**
			Travel Time Variability (C)
		Traffic Volumes	Peak Period Freeway Volumes (C)
			Peak Period Arterial Volumes on Parallel Streets (C)
	8 PROVIDE TRAVEL Choices & Accessibility	Transit Service	Miles of Rapid Transit Facilities (R)
			Revenue Hours of ADA Service (R)
			Transit Revenue Hours (R)
		Transit Access	Access Mode (R)
		Auto Access	**Park-n-Ride Capacity & Utilization (S)**
			Park-n-Ride License Plate Survey (S)
		Bike Access	Bicycle Parking Inventory (R)
			Bike-on-Bus Usage (R)
			Station Bicycle Access (S)
		Pedestrian Access	Population within Walking Distance (S)
			Employment within Walking Distance (S)
			Station Pedestrian Access (S)
		Household Access	Population Served by High-Frequency Transit (R)
		Job Access	Employment Served by High-Frequency Transit (R)
		Destination Access	**Regional Destinations** Served By **High-Frequency Transit (R)**
		Land Use	Transit Supportive Zoning Changes (S)

(R) Regional Measure (C) Corridor Measure (S) Station Area Measure

Results

As with any major study, it is important to set appropriate expectations for results for the Quality of Life Study. The study is intended to be informative, but RTD does not necessarily make changes to FasTracks based on the results of the study. In addition, the Quality of Life Study is intended to measure district-wide changes, but there is no way to determine whether those changes are due to FasTracks or other causes – that is, it is possible to establish correlation with FasTracks, but not causation. In addition, because only one rail line has been completed so far, it may be years before FasTracks affects the region in a meaningful way.

RTD has shared the Quality of Life Study with the FTA, which has shown interest as they've worked to develop and revise measures that track transit development that can apply to transit agencies across the country. The study has also been popular with the RTD Board of Directors: Directors have appreciated the opportunity to see how the region has changed since the passage of FasTracks.

Resources

2013 High Level Measures Report

2012 High Level Measures Report

2011 High Level Measures Report

2010 Detailed Report

Departments

Planning

Contacts

- Genevieve Hutchison, Senior Transportation Planner

Goal

Involve stakeholders in RTD projects while ensuring that projects finish on time and on budget.

Background

RTD worked with many of the stakeholders (generally defined as governmental entities) that have been involved with FasTracks on the T-Rex project, which allowed the agency to establish relationships and lay the groundwork for inter-governmental agreements (IGAs) and arrangements that would become essential to FasTracks. In 2004, RTD gained metro-area-wide support for FasTracks, with municipalities across the district committing to work with RTD to accomplish mutual goals.

Best Practice/Area of Opportunity

In practice, working with stakeholders has varied depending on the specific circumstances of each project. Projects with a large number of stakeholders, who sometimes come into conflict, are generally more complicated than projects with just one or two major stakeholders.

Project managers have found that working out as many issues as possible in the planning phase is critical to maintaining good relations with stakeholders and ensuring that a project progresses later on. When those issues are not settled early in the process, sometimes RTD appears to be changing course later on, as stakeholders assume that RTD's determination to delay an issue was actually a concession or a promise.

In the most effective cases, RTD works with the municipality to define their respective roles early in the process. An essential part of the process is determining how a stakeholder will categorize RTD. In the best cases, RTD is categorized as a government entity, but many municipalities consider RTD a developer at the outset. When a municipality or county defines RTD as a developer, they often aim to receive as much money and as many concessions from RTD as possible. It is a continual challenge to convince municipalities that RTD is government, and that the entities can work together toward the same goal of serving the public. In addition, determining what kind of code will apply to RTD is critical: in one case, a municipality tried to apply standard building code to rail platforms, for example, which frustrated both parties and slowed the project.

Adding stipulations to the inter-governmental agreement (IGA) that lay out each entity's roles and responsibilities and funding arrangements has helped reduce misunderstandings down the road. In the case of the I-225 project, RTD funds a position for the City of Aurora to manage permits, review requests, and coordinate with RTD and with stakeholders at the City of Aurora as the process moves along. Funding that position was an upfront expense, but it has led to a smoother process working with that municipality as the project has progressed.

Internal conflicts about goals can also delay a project, particularly when RTD plans a Transit-Oriented Development (TOD) project along a rail line. At times, the goal of the project manager to move a project forward comes into conflict with the goal of the TOD group to leverage RTD's strength to ensure that developments along rail lines are truly transit-oriented and benefit RTD. Separating the TOD process from the rail line can allow the line to be constructed faster. From the TOD perspective, however, separating the two projects can reduce RTD's interest and leverage in TOD project negotiations and put RTD at risk for working on TOD projects that don't benefit the agency.

Partnering

Resources

Inter-Governmental Agreements (IGAs) are available to staff in Aconex

Departments

Capital Programs

Contacts

- Charles Culig, Project Manager, Engineering
- Pranaya Shrestha, Senior Manager, Program Management
- Greg Straight, Project Manager, Engineering-Facilities
- Ashland Vaughn, Project Manager, Engineering

Processes

Large, mature organizations like RTD risk slipping into habits based on stagnant cultures rather than strategic decisions. RTD has encouraged employees throughout the organization to rethink the way old processes work to improve efficiency and achieve the agency's mission. Employees have fought stagnation and identified and implemented new, innovative ways of approaching problems.

The following best practices highlight process improvements that have increased safety, lowered costs, and improved the quality of RTD's services and construction. From a new reporting method that has reduced bus accidents to an asset management system has led to better, data-driven decision-making, to a budgeting process that refocuses financial decision-making on core strategies, the following best practices highlight areas where RTD has taken opportunities to innovate. The best practices in this section outline strategies for transit agencies that are seeking ways to improve processes and implement mission- and data-driven decision-making.

Goal

Increase safety in bus operations.

Background

In 2010, RTD had three fatal bus accidents within one week, with four fatalities. That incident brought press attention to the agency and inspired a major safety campaign and long-term measures to reduce accidents.

Best Practice

The Safety, Security and Facilities and Bus Operations Departments worked together to implement initiatives to improve safety in Bus Operations and reduce accidents for the long-term.

Tracking and Performance Measures

Safety and Bus Operations worked together to develop a formal reporting process and perform analyses of accidents. The safety compliance officer for bus operations began collecting accident records from Dispatch, street supervisor reports, and reports that bus operators fill out after an accident occurs. The safety officer compiles data from the reports in an Access database and uses Excel to analyze the data, track trends over time, and produce regular reports for Senior Leadership.

In 2011, using this method, the safety officer identified an increase in right-turn accidents. Safety and Bus Operations worked together to conduct a safety campaign on that topic:

» Bus Operations tied red ribbons to mirrors to remind operators to check them
» Internal newsletters featured articles on right-turn accidents
» Training included a module on right turns in an annual refresher course

Training Improvements

Bus Operations instituted an annual refresher training program for all operators. The one-day program includes both industry standard defensive driving courses and training on specific issues based on accident trends identified by the Safety Officer. In addition, Bus Operations identified operators with significant histories of accidents and safety issues for re-training.

Regular Safety Meetings

Bus Operations and Safety conduct monthly safety meetings at each division. A cross-functional team attends the meetings. Both represented personnel selected by the Union (ATU) and supervisors attend. Attendees include:

- Two bus operators from each operating division
- Mechanics
- Service and cleaning staff
- Sign shop staff
- Treasury staff
- Supervisors
- Trainers
- Safety compliance officer
- Managers
- Assistant managers

More recently, Bus Operations has implemented a drive-along program, with street supervisors driving along with each operator at least once per year.

Area of Opportunity

Initiatives are underway to improve safety in Bus Maintenance, but are less advanced than in the Bus Transportation Division. Currently, Safety and Bus Maintenance are working together to develop an accident investigation process for that division. The safety officer has recently developed forms for accident investigations for mechanics. An agency-wide employee survey conducted in January 2015 revealed that safety is a larger issue in Bus Maintenance than in Bus Transportation. Although the majority of bus maintenance employees (66%) responded favorably to safety questions overall, and a slight majority (53%) felt that Safety is RTD's top priority, those numbers fell far below the average for the agency overall.

Results

In 2012, RTD reduced preventable accidents by 32% compared to 2011. Although accidents have ticked up recently due to a change in FTA reporting standards, RTD has established a safety culture among operators. The 2015 Employee Survey revealed that Safety is RTD's strongest area, with 78% of all employees responding favorably to safety questions. In Bus Transportation, 76% of employees responded that Safety is RTD's top priority on the employee survey.

Departments

Bus Operations

Safety, Security & Facilities

Contact(s)

- Bruce Abel, Assistant General Manager, Bus Operations
- Alice Osner, General Superintendent, Transportation
- Martha Bembry, Safety Compliance Officer

Project Funding Prioritization

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Goal

Establish a systematic process to select projects for funding in the Strategic Budget Plan (SBP).

Background

Each year, RTD develops a fiscally-constrained Strategic Budget Plan (SBP) outlining projected service levels, associated operating costs, and capital and expense projects for the next six years. Projects are evaluated based on their relative costs and benefits to the public and must operate within the constraints of the forecasted budget. The first year of the SBP capital and operating program serves as the basis for the preparation of the annual budget.

Historically, the Budget division of the Finance and Administration Department convened meetings of Assistant General Managers (AGMs) and senior staff to select projects for inclusion in the six-year SBP. These selections relied heavily on narrative arguments rather than established objective selection criteria. Projects were submitted in Word or Excel documents, making the process exceptionally labor intensive for both project sponsors and the Budget division.

Best Practice

In 2013, the Budget division began exploring methods to make project selection more rigorous and automate the project submission process. The Information Technology (IT) Division already had in use the cloud-based Innotas program for IT project prioritization and management. IT suggested that this platform might be adapted to the SBP project process to help streamline and prioritize the project selection process. The Budget division worked with IT and a development group (including Innotas super-users) to develop a process for project entry and to establish criteria based on RTD's mission statement elements for ranking the desirability of each project. In consultation with the Senior Leadership Team (SLT), the development team established weights for each ranking criterion and then trained budget analysts, request submitters and AGMs on the automated process before rolling it out. The incremental training and SLT periodic briefings were critical in establishing buy-in for this new process.

The Process

Each project sponsor is required to provide the following information on a request:

- Project description
- Project justification
- Project activities
- Capital costs
- Operating and maintenance costs
- Cost savings
- Expected project outputs
- Staffing requirements

Requesters must also rate (1-10) how the project enables RTD to address the following areas derived from RTD's mission statement:

- Accessibility
- Cleanliness
- Cost-effectiveness
- Courtesy
- Meets future needs
- Reliability
- Safety

Sponsors also rate the business unit benefits and risk of no action for each project.

In this way, each project request (311 total requests submitted in 2014 for the 2015-2020 SBP) is scored by the project sponsor, the appropriate AGM and, critically, a five-person investment review panel convened to score all project requests. The investment review panel is selected and approved by the Senior Leadership Team every year. Panel members have the option to recuse themselves from projects within their own departments.

After all three parties score the requests, the total of the scores for each project are averaged to obtain a final score. The Budget Department ranks all project requests by final score and compares these scores to prioritize projects in a more objective fashion than in the past. In 2014, there were still more requests than funds available in the SBP. When this occurs, Budget meets with each AGM and staff to trim down his or her list before convening a senior staff meeting to determine a final list of projects for the SBP. In 2014, AGMs remarked that the new process helped them consider projects within their own departments objectively and offered a useful baseline when discussing the projects in the Senior staff meeting.

Budget recognizes that there will always be some sustaining and necessary projects that do not score well by these criteria, for example, road repair or art maintenance. The project selection team must remain vigilant to ensure that sustaining projects continue to be funded. When a project does not score well, the sponsor must explain why it fell into the sustaining category. If they cannot, the project is deferred or removed from the SBP.

Area of Opportunity

The Budget Division plans to take an incremental approach to the project priority process, building on early successes and continually seeking areas to improve. In 2015, Budget plans to explore ways to incorporate data from the Asset Management group into decision-making while also considering how projects deferred in the SBP should best be handled. Additionally, as the process becomes more mature, the department may seek a specialized, more user-friendly software package that can deliver more robust reporting.

Results

In its first year, the project priority process added much-needed objectivity to RTD's annual strategic budget planning. While the number and costs of the requests still outstripped the available budget, the Budget Division and senior staff were able to use the project scores as a valuable input into their final decision-making.

In addition to making the annual SBP project selection process more objective, the Innotas tool has given Budget a cloud-based database that will include all SBP project requests. Budget's use of Innotas significantly improved reporting and saved time organizing requests from all departments. In future years, requesters will be able to simply update the database with any new information, saving time for all parties.

Resources

[RTD Strategic Budget Planning] (SBP) Request Procedure 2014

Departments

Finance (Finance & Administration)

Contact(s)

- Jannette Scarpino, Manager, Budget and Financial Analysis
- Todd Nikkel, Senior Budget Analyst

Goal

Leverage data for investment decision-making and improve reliability, safety, cost management and customer service across the agency.

Background

The Federal Transit Administration (FTA) and the U.S. transit industry have been working to improve the understanding and practice of transit asset management. Since the passage of MAP-21 in 2012, transit agencies have been required by national policy to establish asset management and state of good repair programs. Under MAP-21, the Federal Government requires transit agencies to prepare a Transit Asset Management Plan (TAMP). This plan provides a framework for managing assets both individually and as a portfolio of assets that comprise an integrated system.

Even before MAP-21 went into effect, RTD decided to develop an asset management system. In addition, the Safety, Security and Facilities (SSF) Department had been struggling to get funding and support for projects. The senior manager of property management developed the concept of an asset management program. An initial goal was to come up with a risk assessment tool for projects. When the FTA began to emphasize asset management in 2010, RTD made the program a priority. In 2010, the RTD Board of Directors made the creation of an asset management program with a state of good repair component a strategic goal for 2011.

Best Practice

The SSF department started a pilot program in 2011 and hired two FTEs to support the program initially. The newly-formed asset management group conducted an extensive investigation of asset management at other transit agencies, both in the U.S. and internationally, and in the aviation industry.

The asset management group also began investigating software options. With assistance from the Information Technology (IT) Division, they learned that RTD had already purchased Oracle's Business Intelligence software (Oracle Business Intelligence Enterprise Edition or OBIEE). Asset management determined that this software would suit their needs. While IT had already purchased the software, they had not yet implemented it in any department. The IT department's involvement was limited to the initial suggestion to use the Oracle software. The asset management group decided to build the software in-house because they wanted to understand the system, customize it if the agency's needs changed, and be able to fix it if they had problems. They discovered that RTD had the talent to implement the project in-house.

The asset management division created a pilot and selected bus maintenance due to that division's long history of collecting data. Initially, asset management uncovered a number of challenges in identifying performance measures and condition measures. Defining an asset also required a substantial investment of time and resources. They also learned that the data that RTD had been collecting was not clean. Since the pilot, the asset management department has taken an iterative approach to the program's development, constantly adjusting and revising processes they use as the need arises.

In 2014, RTD created a Transit Asset Management Plan (TAMP) for the agency based on FTA regulations. The asset management plan is intended to share lessons learned from those with hands-on experience with each type of asset with other transit agencies. The purpose of the plan is to position RTD to transition from a "fix when fail" maintenance culture to a "predict and prevent" approach that will reduce costs and improve safety and reliability. The plan includes examples and practices that RTD can apply and provides guidance for the District to improve awareness of asset management. The plan will be integrated into agency-wide strategic planning and policy initiatives. The TAMP will be updated periodically.

Change management has been a critical success factor for the asset management program. In particular, building trust with maintenance departments and other internal stakeholders has been essential. The Asset Management and State of Good Repair group has found that hiring from within is the most effective way to ensure that they have good relationships with other areas of the agency. In 2014, Asset Management conducted a survey of maintenance employees to determine how well key stakeholders understood the asset management program and how much they valued it. The survey uncovered a continued lack of understanding of asset management. The asset management group began work on a communications campaign to address the issue and will survey the same maintenance divisions again in 2015 to determine whether the increased outreach is effective.

Results

Asset Management and State of Good Repair (SGR) are in compliance with the 2010 RTD Board strategic goal and MAP-21. The asset management program has also produced dashboards to allow Senior Leadership access to up-to-date data about performance, condition and age-based asset scores and measures. SGR inspectors fully implemented condition assessments for bus, light rail vehicles, park-n-rides, light rail stations, and operating facilities in 2014, and intend to build on that experience to make progress in implementing facilities, rail infrastructure, IT, security, and support vehicles asset management. Asset Management has also identified potential cost savings. For example, the group analyzed data to determine which light rail vehicle heating, ventilation and air-conditioning (HVAC) unit is the most cost effective for future purchases. The Asset Management ivision has also assisted many RTD departments with projects to improve processes, organize and update data in Maximus, and identify potential cost savings.

Resources

FHWA - MAP-21 Website

FTA Research: Asset Management Guide. October 2012

RTD TAMP

Departments

Safety, Security & Facilities

Contact(s)

- Jim Sutton, Manager, Asset Management
- Lou Cripps, Asset Management System Administrator
- Luke Westlund, State of Good Repair Supervisor
- Charles Austin, State of Good Repair Supervisor

Rail Activation Process (West Rail Line)

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Goal

Ensure capital projects are completed on-time and on-budget and ready for revenue service on opening day.

Background

RTD has developed a thorough activation and testing program that brings input from all departments together more than a year prior to corridor opening to identify and resolve potential issues with operation. The activation process is critical to identifying the needs of every department during construction so the contractor can address issues before RTD takes possession and begins revenue service.

On the West Rail Activation, the team followed a detailed Integrated test plan for crossings, overhead contact system (OCS), signals and communications systems with specified test descriptions, resources identified and criteria for success. Contractors played a supporting role and were required to address any issues identified during integrated testing. Key areas of impact and cooperation include:

- Safety certification program
- Completing all integrated testing
- Completing all construction activities
- Coordinating operations staffing and budget
- Performing an operations and safety readiness review

The activation project manager held weekly meetings with representatives from relevant departments and divisions to monitor progress and schedule track access for the following week. If requests were not made at those meetings, they were only granted in emergencies. RTD Rail Operations has continued the weekly meetings within their department to integrate the maintenance and operation of the entire system.

Best Practice

Preliminary planning for activation involves many moving parts. It is helpful to have an opening day target and work backward from that date at least two years in advance initially focusing on high-level milestones rather than the detailed deliverables. Without the activation process setting the milestones, people may find it hard to focus on the necessary tasks during construction. With this skeletal outline, the project manager works with department heads to determine the right representatives and, then, works with those representatives to identify the fundamental details the contractor will need to address to accomplish each milestone.

Strong leadership is also crucial to establish the importance of activation early. The West Rail Line project manager and the Assistant General Manager (AGM) for Rail Operations both had prior experience with rail activations and identified the appropriate staff that should be involved while emphasizing the value of the exercise at the beginning.

Early in the west rail activation process weekly meetings only required attendance by representatives who had deliverables to discuss. The project manager determined that requiring attendance from the whole team helped identify issues earlier and also created a more dynamic problem-solving environment. Additionally, the early inclusion of a liaison from Rail Operations helped identify issues early and maintained a focus on constructing everything needed to operate revenue service.

Processes

Results

The West Rail corridor opened within budget and ahead of schedule on April 26, 2013. The integrated testing of the 22 at-grade crossings (in a Colorado winter) was completed by internal staff in the two months allotted in the schedule. After completion of integrated testing, the project was turned over to Rail Operations, allowing them almost two months for pre-revenue testing, which included training, certification of train operators, emergency drills and simulated service.

The Capital Programs' Program Management Lessons Learned report notes that Rail Operations provided excellent support to Capital Programs throughout the project, and particularly during the integrated testing period when resources such as trains, train operators/supervisors, and wayside maintenance personnel were needed on site to complete the integrated testing procedures.

Also, through the Activation process the AGM of Rail Operations and AGM of Capital Programs recognized the benefits of installing a senior rail operations manager working on the project in a major role from the beginning to weigh in on the many decisions that affect rail operations during construction. Rail and Capital Programs have instituted this practice on subsequent construction corridors, embedding a senior manager from the rail operations department in the project team funded through the FasTracks program.

Resources

West Rail Line Program Management Lessons Learned Report

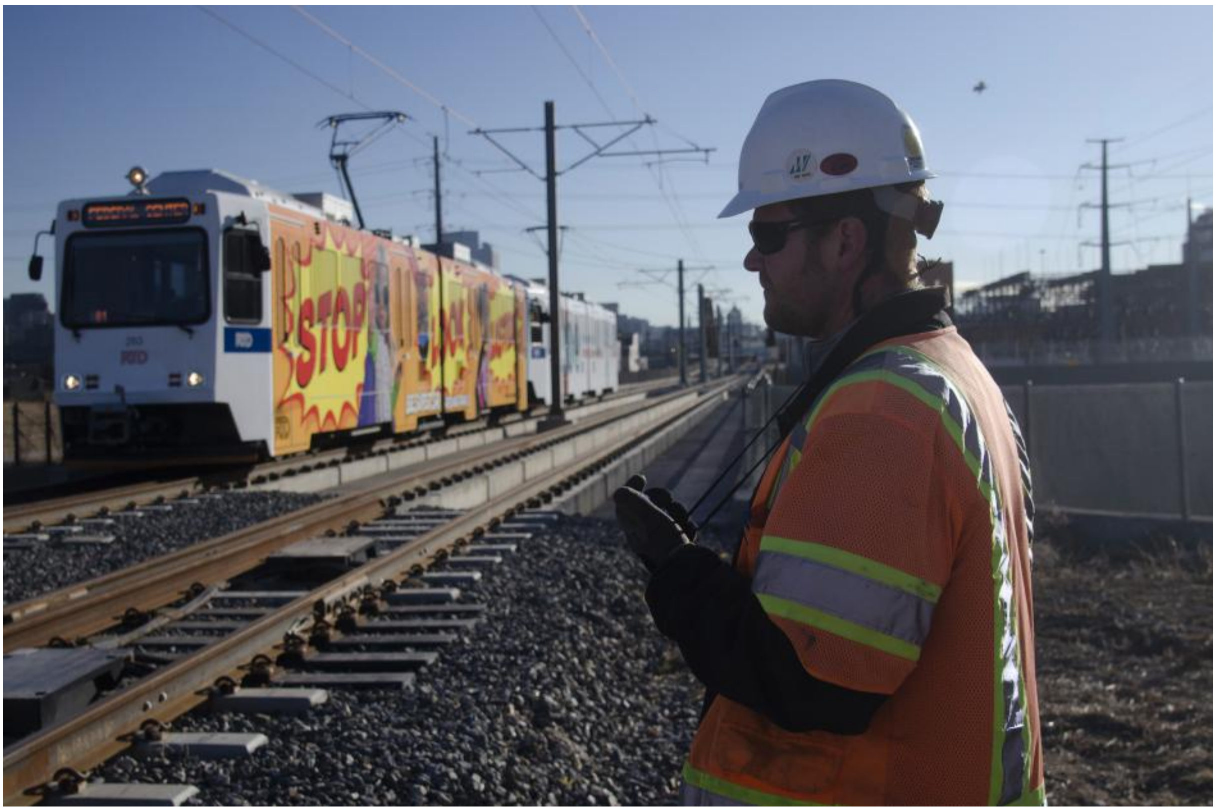
Departments

Capital Programs

Rail Operations

Contact(s)

- Mark Baudermann, Project Manager, Systems Integration & Project Activation



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Goal

Provide safe, efficient, seamless rail service during special events.

Background

When RTD opened the Metro Area Connector (MAC) line in 1994, the agency eliminated a large number of bus trips and struggled to manage the crowds from the Parade of Lights. Rail Operations learned from that initial negative experience and began planning and allocating resources for special events more effectively.

Best Practice

During a special event such as a Broncos game, New Year's Eve, the Parade of Lights, convention center events such as the Great American Beer Fest, and Rockies games, Rail Operations successfully ramps up service for extra riders. A number of factors contribute to Rail Operations' ability to manage major events with large crowds:

1. The system, especially stations at Decatur/Federal, Sports Authority Field, and Pepsi Center, is built to accommodate crowds during events. Those station plans include gates for fare enforcement, large, open areas, and easy access to event centers. Planning for special events when constructing the stations helps operations run smoothly.
2. Rail Operations "stacks" trains (lines them up at locations where they can reach event stations easily) before events are expected to conclude, saving time when the event lets out and the crowds arrive at the stations.
3. Rail Operations uses a standard template for service planning for major events, which saves time and allows them to provide sign-up information to staff as early as possible.
4. Rail Operations ensures that extra staff sign up for extra shifts before events. Certain events, such as New Year's Day, require all hands on deck.
5. Rail Operations stations mechanics, service and cleaning employees, and security and other employees to handle crowd control at key points along the route to the stadium or other event location in case issues arise. Having mechanics and other employees already deployed prevents delays.

Results

After a typical Broncos game, RTD moves 10,000 people by light rail out of the stations serving the stadium in 75 minutes. Even during significant events such as major concerts (U2, Kenny Chesney), the Democratic National Convention, the West Rail opening, and Broncos' playoff games, RTD has successfully managed especially large crowds of light rail riders. To date, RTD has not had serious incidents or problems during special events. The longest delay at a Broncos game has been just 20 minutes.

While ridership on the W rail line has come in under expectations overall, ridership during special events has exceeded expectations.

Peer transit agencies have requested assistance from RTD when planning stations near event centers and when planning for major events.

Departments

Rail Operations

Contact(s)

- Rocky Whalen, Lead Light Rail Controller

Fiscal Sustainability Task Force

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Goal

Examine RTD revenues, expenses and controls and recommend ways to improve the fiscal sustainability of the organization.

Background

In 2011, faced with declining revenues due to the financial crisis, RTD convened a task force of internal and external experts to ensure fiscal sustainability by exploring opportunities for operating efficiencies and revenue enhancements. The task force recognized that there would be no "silver bullet" solution and, instead, developed a combination of policies and strategies that could help achieve fiscal sustainability. As the task force convened, a financial shortfall brought on by the Great Recession had dramatically reduced sales tax receipts, forcing the agency to cover the gap with set aside reserves. In 2012, the shortfall was projected to be $35 million. Despite these challenges, the task force was committed to focus not simply on near-term challenges but also consider longer-term solutions.

Best Practice

The task force brought together 21 professionals with legal, financial, transit operations, and planning expertise from inside and outside the agency for 11 meetings over eight months. All participants were given extensive background information about the financial challenges transit agencies faced nationally, as well as RTD-specific fiscal concerns. The participants brainstormed revenue enhancement and expense reduction strategies. RTD staff then evaluated top-rated solutions in greater depth and developed recommendations for RTD Board approval. Those recommendations were:

Policy Changes

- » Adopt a Fund Balance Policy to provide working capital to smooth the volatility in tax receipts and to respond to extreme events
- » Institute a Capital Replacement annual set-aside to fund replacement of rolling stock and avoid debt service charges
- » Apply a conservative approach to Sales Tax Projections to remove volatility in budgeting

Revenue Enhancement

- » Pursue legislative action to make RTD's sales tax base consistent with that of the state
- » Continue to collaborate with CDOT as they develop tolling and managed lanes in the region
- » Use three-way partnerships (RTD, local governments, developers) to establish regional and local tax districts to place an additional, modest mill levy on property close to light rail stations
- » Self-collect sales tax
- » Improve fare recovery ratio by either reducing service or increasing fares
- » Charge for parking
- » Sell "sponsorships" or naming rights of facilities

Expense Reduction

- » Conduct a comprehensive energy audit and use innovative technology to enhance efficiency
- » Optimize service efficiency: examine benefits of serving the District broadly throughout versus focusing on serving the most riders
- » Examine the delivery methods for paratransit
- » Partnerships-privatization: may include privatizing routes, administrative functions like cash handling, and operational functions such as parking lot maintenance

Results

Early Successes

Taking the recommendations of the Task Force, RTD has contracted with the University of Colorado Leeds School of Business to provide quarterly sales and use tax projections for the short, medium and long term. The outside experts use sophisticated modeling techniques and analytical evaluation to add credibility and remove volatility from projections and increase RTD's confidence in forecasts for a source that accounts for approximately two thirds of RTD's revenue.

RTD also took a hard look at bus and rail service levels to optimize service efficiency. In January 2012, a reduction in bus and rail service hours of approximately 8% took effect. RTD watched ridership and savings carefully. The service changes have resulted in $8 million annual savings with no significant change in ridership.

Informed by the Task Force, RTD explored the possibility to enact legislation to establish tax exemption parity with the state of Colorado. The Task Force found that RTD might realize tax collection benefits if the state legislature brought the RTD tax on par with state sales tax in which the state occasionally adjusts exemptions to address economic cycles. At the time, RTD was statutorily prohibited from collecting tax on many items on which the state collected sales tax, e.g., soda and snack food. To bring RTD into parity, the state enacted legislation effective January 1, 2014 to bring RTD's sales and use tax base in line with that of the state of Colorado. This exemption parity legislation will simplify the filing requirements for taxpayers while establishing a uniform tax base, which may increase funding for RTD during economic downturns.

RTD also established a fund balance policy with a goal to maintain three months of operating expenses that may be used during economic downturns. The balance is kept in three accounts: a Board-Appropriated Fund, a Capital Replacement Fund and an Unrestricted Fund. The funds will be replenished during economic expansions and provide a cushion during sales and use tax downturns to avoid service disruptions.

The results of a completed energy audit encouraged RTD to implement cost-saving measures such as low energy lighting and solar power but also take a measured approach in more large-scale projects due to the prohibitive cost of initial investments for such efforts.

Ongoing Implementation of Recommendations

The primary benefits identified by the Task Force for self-collection of sales taxes lay in ensuring 100% compliance with tax filing requirements and providing analytical information not currently available from the Colorado Department of Revenue (DOR). RTD has modified this goal to perform tax compliance reviews and contracted a private firm to provide additional compliance review resources to the DOR. Contracted reviews intended to ensure 100% compliance with statutory sales and use tax regulations within the District are currently underway.

RTD has also engaged a private firm specializing in naming rights and advertisements to generate additional revenues for RTD from its extensive property holdings. The private firm is analyzing opportunities and will be seeking solicitations following RTD Board approval.

RTD regularly evaluates opportunities for partnerships and privatizations. RTD entered a leasing arrangement for its Denver Union Station historic building featuring a 110-room hotel and several retail and commercial enterprises. RTD will share in revenues above a certain threshold while transferring the financial responsibility for operations, maintenance and capital replacement to the lessee. RTD continues to seek additional partnerships and privatizations when such arrangements are mutually beneficial.

Resources

2011 Fiscal Sustainability Task Force Report

Departments

Finance (Finance & Administration)

Contact(s)

- Douglas MacLeod, Controller

Annual Program Evaluation (APE)

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Goal

Reaffirm Fastracks' total estimated cost (estimate-at-complete) forecast, and ensure that RTD does not commit to projects that the agency cannot afford to fund.

Background

The Annual Program Evaluation initially was designed in response to the future construction cost uncertainty and Great Recession's effect on the sales tax receipts that endangered the FasTracks expansion. It has evolved into an internal annual planning document and tool for Capital Programs.

The FasTracks Plan in 2004 estimated that the entire FasTracks program could be delivered for $4.7 billion in capital costs with $3.3 billion in finance costs through 2048 and $1.5 billion in operating costs through 2025. In 2007, in response to resolutions passed by the Denver Regional Council of Governments (DRCOG) and the RTD Board of Directors, RTD staff initiated a process known as the Annual Program Evaluation (APE) to analyze the revenue, scope, and cost assumptions for FasTracks, such as material, labor, equipment, and inflation. During the first APE, RTD discovered that the estimates used for the original FasTracks Plan when incorporating new alignments for the corridors, negotiations with the railroads, the number of right-of-way (ROW) acquisitions, extraordinary inflation in material prices, and existing conditions associated with utilities, drainage and environmental requirements had increased the cost to deliver FasTracks dramatically.

Best Practice

To ensure that RTD has a flexible plan to deliver FasTracks within the range of likely outcomes, RTD has implemented a combination of refinements to develop alternate sources of forecasts and examine a wider range of outcomes. The APE allows RTD to:

» Provide a range (best-case and worst-case cash flows) of potential sales and use tax collections, rather than an exact figure, for longer-term projections, and perform sensitivity analyses within the range.

» Investigate additional alternative sources for long-term economic projections and sales tax forecasts.

» Educate stakeholders and the public on RTD's sales and use tax forecasting methodologies, and the differences between short-term (3-4 years) and long-term (15+ years) forecasts.

» Emphasize more clearly that long-term growth projections are averages, rather than exact forecasts of annual growth rates.

Recent APEs feature input from the Cost Escalation Task Force (DRCOG, CDOT, RTD, and other member agencies). This group analyzes and discusses cost trends, both locally and nationally. Additionally, a local economist was retained to focus on local industry cost trends while the chief economist from the Associated General Contractors of America (AGC) provides valuable input on national cost trends and economic factors that could potentially affect the FasTracks program. RTD has also used the input of local economists to aid in sales tax revenue projection and ensure that update actual and estimated (forecast) program costs and revenues can be used for management decisions on how to deliver the remainder of the program. The APE gives RTD a more accurate budget forecast to allocate required funds for the upcoming financial year.

Results

The 2007 APE yielded a revised Estimate-at-Complete (EAC - a projection of total cost at completion) in Year of Expenditure (YOE) dollars of $6.1 billion. The subsequent APEs of 2008 through 2012 continued to vary in concert with the volatile economic trends, and became more stable each successive year, as projects commenced construction with committed contract values and ROW purchase prices.

In the years (APEs) leading up to 2012 elections, RTD's staff and board assumed that a ballot initiative for increased sales tax revenues would be necessary in 2012 to cover the gap between the total program EAC and current realistic projections of all FasTracks funding sources. This assumption was carefully considered against public appetite (measured with public surveys/opinion polls) and it was determined that such a tax initiative had less than the minimum required likelihood of success. Therefore, RTD chose to change the APE strategy from 2012 forward, to only focus on forecasting Estimate-at-Complete for projects that had committed funding per the RTD Board-adopted FasTracks financial plan.

Resources

2004 FasTracks Plan

2009 Lessons Learned Report

2012 Lessons Learned Report

Departments

Capital Programs

Contact(s)

- Susan Cohen, Manager, FasTracks Program Controls
- Sean VonFeldt, Manager, FasTracks Project Controls

Internal Quality Audits

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Goal

Determine the effectiveness of FasTracks management plans and procedures, identify gaps, and promote continuous improvement.

Background

In 2004, prior to FasTracks, RTD and the Colorado Department of Transportation (CDOT) jointly applied for the Colorado Performance Excellence Award (now known as the Rocky Mountain Performance Excellence Award). One of the opportunities for improvement identified in the Feedback Report was for RTD and CDOT to implement a process to systematically measure their own performance. Around that same time, RTD received feedback from the Federal Transit Administration's (FTA) Project Management Oversight Consultant, Urban Engineers, that RTD should implement internal audits for the West Corridor Environmental Impact Statement (EIS) project. Given the feedback from both of these sources, RTD determined that a robust internal quality audit program would be implemented during FasTracks.

Best Practice

Currently, RTD conducts internal quality audits through a sub-consultant to the Quality Management Consultant (QMC), who maintains organizational independence from all other aspects of the FasTracks program and is professionally certified in the practice of quality audits. All internal quality audits are conducted in accordance with an approved quality procedure that is based on the international standard ISO 19011, "Guidelines for Quality and/or Environmental Management Systems Auditing." The internal quality audit program includes the following elements:

» Annual schedule, reviewed with senior management and revised as needed

» Audit scoping meeting between the auditor, QMC Program Manager, and Director of Quality Assurance

» Written audit plan

» Formal audit notice to the auditees

» Opening and Closing meetings

» Formal audit report

» Improvement actions (when needed) and surveillance to follow-up on improvement actions

Results

Since 2006, RTD has conducted 45 internal quality audits at the FasTracks program and project level. These audits have identified 23 improvement actions, which have led to continuous improvement in RTD's Capital Programs project management approaches.

Resources

2013 Lessons Learned Report

Departments

Capital Programs

Contact(s)

- Kevin Diviness, Director of Quality Assurance

Decentralized Project Management

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Goal

Increase flexibility when dealing with projects, including when projects require changes mid-stream, in order to keep costs low and finish projects on schedule.

Background

In 2001, RTD and the Colorado Department of Transportation (CDOT) began construction of the Transportation Expansion (T-REX) Project – a $1.67 billion highway expansion and light rail project. The complexity of the road, bridge and transit project and the use of a design-build delivery method meant delay in decision-making might affect the partner organization and increase the contract cost. Prior to T-REX, RTD maintained control over project-level construction decisions at the executive or Board of Directors level. Driven by the necessity of nimble decision-making in that large partnership, RTD began a process of decentralizing project management that has continued with significant success as RTD oversees FasTracks' multiple construction corridors. Balancing program-level obligations with the need for nimble decision-making at the project level has helped Capital Programs maintain project schedules and budgets to deliver FasTracks projects in a timely manner.

Best Practice

The decentralized approach begins at the policy level with the RTD Board of Directors. For major corridors, the RTD Board has given the General Manager authority to enter into contracts, purchase orders, blanket purchase orders, work orders, and agreements up to the total budget for the project. The General Manager in turn delegates this authority to the Assistant General Manager (AGM) of Capital Programs, who has further decentralized decision-making for the FasTracks program, pushing decision-making authority to the lowest appropriate level. This has empowered the project staff to make major decisions and commitments, commensurate with the intense pace of the projects. The Board is updated on a regular basis so that they remain engaged in the progress and issues of the project.

RTD decentralizes decision-making under the belief that those closest to the problem are best able to understand the issue, and should be able to make a quicker, better-informed decision than those at the program level. Staffing project offices with the right people to effectively do the work and make expeditious decisions is critical to the FasTracks approach to decentralized management. As part of the project management plan, Capital Programs develops ladders of escalation for each area of the project, pairing leads from RTD, the contractor and applicable local officials at the task force co-leads, manager, project manager, senior management and executive levels (see example below). When counterparts at any level cannot agree on a path forward the issue is automatically escalated to the next level. Program-level guidance is always available to provide assistance as necessary, and the exact personnel involved in the escalation may vary depending on the issue.

The project management plan gives the project manager authority over critical aspects of the project, including responsibility for delivering the project on time and on budget, responsibility over all staff allocated to the project, and project support functions such as quality assurance, operations, and safety. Program managers outside of the project team participate in project-level reviews of budget, schedule, quality and other aspects of the project. This approach allows senior management to focus on critical program-level issues.

The FasTracks program management and each project management plan are designed to ensure adequate, competent resources are provided at the project level. Project-level personnel are encouraged to seek advice when their decisions affect other projects, or when they are not able to come to a satisfactory solution at the project level.

Example: I-225 Project Collaborative Escalation Ladder **(June 2014)** *abbreviated*

	Design and Construction Task Force Teams							
Level	**ROW**	**Dry Utility**	**Drainage/Wet Utilities**	**Civil/Track**	**Structures**	**Stations Architectural Landscape**	**Fire-Life System Safety**	**Systems**
1 **Task Force Co-Leads**	Susan Altes (RTD) Terry Tyrrell (AECOM) Joshua Nitz (Kiewit) Joani Cravens Aurora	Utility Owner Reps Greg Jeppesen (RTD) Tom Fuentes (AECOM) Roger Weathers (Kiewit) Charlie Cooper Aurora	Greg Jeppesen Drainage Eng. TBD RTD Tom Fuentes (AECOM) Roger Weathers (Kiewit) Brad Richardson Aurora	Erik Haugen (RTD) Terry Tyrrell (AECOM) Martin Brown Nate Schanne (Track) Kiewit Brad Richardson Aurora Lead	Jack Vaughn (RTD) Steve Haynes (AECOM) Keith Spolar (Kiewit) Brad Richardson Aurora	Susan Johnson (RTD) Steve Wilensky (AECOM) John Zegarski Les Nyland (Kiewit) John Fernandez Aurora	Bob Pitts (RTD) Suzanne Reese(IEI) Mike Monroe (Kiewit) Mike Dean Dirk Anderson Aurora Steve Buemer Asst. Fire Marshall Aurora	Altagracia Jager (RTD) Gordon MacDonald (HMM) Derrek Freeseman (Mass Elec) Al Fedderson Aurora
2 **Mgr**	<u>**Design Issues**</u> Paul Von Fay, RTD Danielle Smith, RTD Sonya Dupuis, Kiewit Robert Kennah, AECOM Brad Richardson, Aurora							
3 **PM**	<u>**Project Management Team**</u> Chuck Culig, RTD Roger Ryburn, Kiewit Rick Romig, AECOM Cindy Colip, Aurora							
4 **Sr. Mgmt**	<u>**Senior Management Team**</u> Pranaya Shrestha/Rick Clarke, RTD Roger Ryburn, Kiewit Dave Chambers/Nancy Freed, Aurora							
5 **Exec**	<u>**Executive Team**</u> Phil Washington, RTD Craig Briggs, Kiewit Skip Noe, Aurora							

FasTracks maintains program-level oversight through regular internal audits and senior management reviews of project budget, schedule, quality, engineering standards, etc. The RTD Board assigns full contractual and schedule authority to the General Manager. The General Manager delegates this authority to the AGM of Capital Programs, who then sets approval and authority levels for the project manager. The levels are high enough to limit opportunities for micro-management by the program office, but sufficiently low so that the senior manager of program management and AGM of Capital Programs are involved in all major changes.

Results

RTD has historically completed each of its corridor construction projects on time and within budget, in part due to the decentralized approach, which allows project teams to address most issues. Only significant issues are escalated to upper management, including the General Manager, which allows them to focus on the big picture.

Resources

2009 Lessons Learned Report

2010 FasTracks Program Management Plan

2013 Lessons Learned Report (Internal Only)

2007 T-REX Lessons Learned Report (Internal Only)

Departments

Capital Programs

Contact(s)

- Richard Clarke, Assistant General Manager of Capital Programs

IT Project Management Processes

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Goal

Implement system-wide information technology (IT) project management processes to prioritize strategically, increase efficiency, and improve responsiveness to the business units.

Background

In 2013, an internal audit of Information Technology products identified gaps in consistent project management processes. The audit revealed that a key system had data integrity issues and had not been implemented properly.

After the audit, IT codified a project flow that incorporated FTA System Engineering guidelines and Project Management Institute (PMI) standards based on the Project Management Body of Knowledge (PMBOK). A workflow outlined responsibilities for IT, project managers, business analysts, and the project sponsors within the business units. Since that time, IT has been working to improve project prioritization and implement that process.

Best Practice

The project management process consists of five key elements:

1. Initiation: The project sponsor in the business unit determines that they need a project, identifies the applicable executive sponsor (an Assistant General Manager, or AGM), and enters a project request into The Pulse (Innotas portfolio and project management system). Ideally, there should be only one executive project sponsor. The Pulse is the same system used for budgeting at RTD, so business owners are familiar with the process and software. IT works with the business unit to understand project activities and identify the desired outcomes and business requirements. IT and the business unit focus on desired outcomes rather than a particular software solution at this point in the process. IT and the business owner work together to outline the project's goals, or "desired future state," and describe the current state.

2. Plan: IT works with the business unit to develop a project charter. The project charter delineates responsibilities, lists the project customer(s) and sponsor(s) and the project manager, describes the purpose of the project, and outlines roles and responsibilities of any contractors, including a checklist if necessary.

3. Execute: The IT Program Management Office (PMO) works in concert with all stakeholders as they design and build the solution, create an operations plan, and plan implementation and training. Working with the business units, IT business analysts develop and refine requirements and deliverables as the project advances through the execution phase.

4. Control and Monitor: IT and PMO conduct testing including quality assurance testing and user testing and update the operations plan as needed. At the end of this phase, the system is ready for implementation.

5. Close: IT and PMO implement the system and conduct a post-implementation review to ensure that the system meets the needs of the business unit. Ideally, IT conducts a lessons learned exercise at the end of the process to improve future outcomes.

Throughout the process, IT and the IT PMO make data available to the business units through dashboards available via The Pulse. A link to the dashboards is provided in the email signature of members of the PMO group. Individuals throughout the organization can see the number of hours spent on each IT project via that link.

Results

The IT department has phased in the implementation of the project management processes. In practice, IT found that the process would work best if business analysts worked within the PMO. Since December 2014, three business analysts have been re-assigned from other parts of IT to project management, and one more business analyst will be hired in spring 2015. Business analysts will work with owners from the business unit to ensure that IT is meeting customer needs.

IT is also currently working to prioritize projects effectively. The IT division conducted a charrette in 2014 to determine a vision and mission statement, which has helped set priorities for the entire division. The division works with the IT governance board, which consists of every AGM, the senior manager of civil rights and the senior manager of materials management, to determine which projects should be priorities. The IT department's technical architecture governance (TAG), which consists of operational managers in the IT department, also reviews projects to identify priorities and assure the projects are consistent with RTD's technology roadmap. Current priorities include providing real-time information, SmartCard, and critical maintenance and system refreshes.

Resources

IT Project Management Office

IT Project Status Dashboards in The Pulse

FTA Transit Research & Technology: Application Instructions And Program Management Guidelines

Project Management Institute: Project Management Body of Knowledge IEEE Guide to the PMBOK

Example RTD Project website

Departments

Information Technology (Finance & Administration)

Contact(s)

- George Hovey, Manager, Program Management Office

Health Plan Overhaul

Back to Table of Contents

Goal

Optimize the financial resources of RTD and maintain a competitive benefit package for RTD employees.

Background

In 2009, RTD faced considerable financial challenges with sales tax revenues reduced by the Great Recession and the costs to construct FasTracks escalating. To save money and maintain the existing workforce, the District implemented a salary freeze for all salaried RTD employees. RTD's Human Resources (HR) Benefit Team recognized that increases for health insurance benefits were becoming a significant drag on the financial resources of the agency: costs had increased 10% or more each year for several years consecutively. To preserve the earning power of employees, the HR Benefit Team explored multiple options on how to preserve current benefits and minimize the cost impact to RTD.

In 2010, Human Resources conducted an analysis and audit of all benefits plans: PPO, HMO, and High-Deductible HMO Health Plans, Heath Savings Accounts (HSA), Flexible Spending Accounts, Life and Vision Insurance. The analysis determined that RTD had not encouraged competition by going out to bid for its plan providers in many years. Additionally, benefits management lacked any plan documentation and functionally made decisions about approvals or denials of coverage on a case by case basis, resulting in arbitrary and sometimes contradictory decisions, a potential compliance concern. The analysis also determined that RTD's share for benefits costs were significantly higher than standard industry practice.

Best Practice

To control costs, RTD created a self-funded program for health and dental plan offerings for salaried employees that provides employees access to networks but requires higher employee contributions for services – ideal for people who rarely need health care. RTD maintains stop-loss insurance to isolate its own exposure in this plan. New plan designs were also implemented, providing a consumer-driven full insurance health plan for RTD salaried employees where enrollees experience a set premium regardless of the number or amount of claims. Human Resources also implemented an hourly contract agreement with a health and welfare broker rather than provider, rather than a lump sum as had historically been the case.

The most significant barrier to changing benefits was simple resistance to change among RTD employees. The plans had not changed for an extended time and the company-provided cost share was generous compared to industry practices. In the first year of the overhaul, Human Resources elected not to change cost sharing since the salary freeze was still in effect. It was decided that changing plans and requiring a higher contribution from employees would be too drastic a change. The changes were rolled out first to plan and, later, to cost sharing.

Results

The new plans enable RTD to track and project actual costs versus expected costs and adjust the self-funded plan design as employee claims change. Through the use of an hourly rate for the broker, RTD has saved at least $50,000 annually. Cigna was selected as the health insurance Third Party Administrator (TPA), and the savings to RTD over five years is in excess of $10 million. Delta Dental was selected as the TPA for dental insurance offerings, and the savings to RTD is in excess of $500,000. The health plan offerings for RTD salaried employees have been enhanced, and the employee cost-sharing has not increased since 2008.

Resources

Employee Benefits (The Hub)

Department

Human Resources (Finance & Administration)

Contact(s)

- Sylvia Francis, Manager, Total Rewards
- Cherie Sprague, Senior Human Resources Executive

457(b) Plan

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Goal

Optimize the investments of RTD employees in order to save money.

Background

In 2012, as part of due diligence, RTD's Total Rewards Manager determined that the agency had never conducted a competitive analysis or request for proposals (RFP) for vendors of the organization's 457 plan in the plan's 20-year history. She realized that RTD and the Human Resources Division had a fiduciary responsibility to have a competitive RFP for administration. Human Resources conducted an analysis of the fees charged by the two 457 Third Party Plan Administrators and the asset charges assessed within the investment portfolios of each of the vendors, Hartford and Valic. In comparing these fees and asset charges to the typical market fees and assets, the Human Resources Division discovered that RTD employees were incurring excessive costs, diluting the overall return on their 457 contributions. The agency also lacked an established investment committee to provide independent oversight of the investment fund portfolio offered to employees. The Human Resources Division initiated a competitive bid process for administration of the 457(b) Retirement Plan and for a third party investment advisor.

Best Practice

The RTD Total Rewards Manager routinely conducts an annual audit of the 457 Plan. The asset fees and charges assessed are closely analyzed to ensure reasonable asset charges are assessed based on aggregate contributions, according to contract provisions. Each quarter, the Investment Committee evaluates the portfolio of funds offered to RTD employees and ensures there is an appropriate mix of funds. RTD hired Lockton to conduct the RFP for the 457(b) Plan. Lockton was selected to provide quarterly analysis of the Investment Funds to the RTD Investment Committee.

Results

The change in vendors resulted in an increased value in employee accounts, and significantly reduced the costs in asset charges and administrative fees, saving RTD employees more than $300,000 annually. RTD also established an Investment Committee to review the investment portfolio quarterly to insure employees are offered reasonable investment offerings, reasonable fees, and reporting compliance.

Resources

Human Resources on the Hub

Departments

Human Resources (Finance & Administration)

Contact(s)

- Sylvia Francis, Manager, Total Rewards
- Cherie Sprague, Senior Human Resources Executive

Quarterly Quality Management Reviews

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Goal

To assess the status and adequacy of RTD's Quality Management Oversight (QMO) program and identify improvement actions when necessary.

Background

The FasTracks QMO program is registered to the international standard ISO 9001:2008, "Quality Management Systems Requirements," which requires management reviews. The standard states that:

"Top management shall review the organization's quality management system, at planned intervals, to ensure its continuing suitability, adequacy, and effectiveness. This review shall include assessing opportunities for improvement and the need for changes to the quality management system, including the quality policy and quality objectives. Records from management review shall be maintained." (ISO 9001:2008, Clause 5.6.1)

The standard also describes specific review inputs such as results of audits, customer feedback and status of preventive and corrective actions. It also describes specific review outputs resulting from the review, including decisions and actions related to improvement of the effectiveness of the quality management system and its processes, improvement of the product, and resource needs.

Best Practice

The RTD FasTracks team has performed quarterly quality management reviews since December 2005 at the FasTracks or program level. During these reviews, senior managers review inputs such as the design review, construction verification inspection, materials testing, and audit results; improvement actions; training needs; and other information, based on the goals for the quality oversight program. This promoted discussion and decisions to improve the QMO program, improve work product outcomes, and improve resource needs for the QMO program.

In 2010, one of those discussions led to a management decision to conduct separate project-level quarterly quality management reviews for the West Rail Line, Denver Union Station (DUS), and Eagle projects. The FasTracks program-level quarterly reviews have continued but are more focused on program-wide QMO activities and smaller projects.

Results

Since 2005, there have been quality management reviews resulting in a wide range of program improvements, and a heightened level of confidence for senior management in the quality program results. Since 2010, there have been an additional 37 quality reviews at the project level. The project level quarterly quality management reviews have resulted in many benefits to the projects, including a greater awareness and engagement by participants, better understanding of the objectives and processes for quality management oversight, identification of specific improvements to project quality issues, enhanced discipline in performing QMO activities, and enhanced leadership commitment to implementing and improving the QMO program. Conducting management reviews on a quarterly basis at the project level to review the results of oversight activities and enable decisions to be made has improved the effectiveness of the oversight program.

Resources

2013 Lessons Learned Report

Departments

Capital Programs

Contact(s)

Kevin Diviness, Director of Quality Assurance

Processes

Initial Operator Training

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Goal

Ensure that new bus operators are thoroughly prepared for the job.

Background

RTD provides extensive initial training programs for bus operators. When there is enough staff, training lasts eight weeks; currently, as the agency is short on staff, training lasts seven weeks.

Best Practice

RTD provides seven weeks of paid training for new operators. New operators begin driving a bus on their first day in training. They gradually spend more time behind the wheel and with customers over the course of the seven-week training program. Classroom training is alternated with driving to provide a mix of theoretical and hands-on experiences each day. Each instructor takes two new operators on the bus for driving experience so they get extensive individual attention from instructors. Training for the CDL exam and the exam itself are included in the program. RTD administers the CDL exam onsite and has eight certified CDL instructors on staff. In addition to the CDL, training covers the Trailblazer (RTD's guide to routes and policies for bus operators), fares, customer service, and map reading.

Extensive Americans with Disabilities Act (ADA) training is included in the program. In one of the later modules, new operators work with disabled passengers through the Craig Hospital, King Adult Day Enrichment Program, as well as a visit to the Atlantis independent living facility and a presentation from their staff. In addition, RTD gives an overview of the different disabilities that an operator may encounter in service. The training also outlines the history of the ADA and RTD's leadership in providing accessible transportation. In ensuring compliance with the ADA, an ADA presentation is given outlining RTD policy. RTD's training department also collaborates with different groups, representing the disabled community, such as the Colorado Cross-Disability Coalition (CCDC) and the Denver Regional Mobility Access Council (DRMAC) to address barriers that affect riders with disabilities that use fixed-route service. The RTD training department has also reached out to senior centers, high schools and individuals with disabilities, in conjunction with VIA travel training, to teach them how to ride fixed-route bus service. Operators learn to assist passengers with disabilities and brush up on customer service skills, while riders learn how to become comfortable alighting and de-boarding the bus.

There are three types of instructors at RTD: "Revenue Instructors" drive regular bus routes as well as train new operators in the classroom and on their routes. "Non-revenue instructors" train operators in the classroom and may also drive their regular routes. "Full-time instructors" are assigned only to the training department and do not drive a bus route. All instructors must work as bus operators for at least one year before moving into training.

Results

RTD's training programs have been lauded by operators in multiple employee surveys. In an operator survey in 2011, operators rated initial training programs highly. In a 2015 employee survey, operators rated training more highly than any other category on the survey except for safety.

Departments

Bus Operations

Contact(s)

- Alice Osner, General Superintendent, Transportation
- Daniel Seifert, Assistant Manager, Transportation Operating Division

Workforce

Choosing whether to outsource responsibilities or hire staff is a challenge for many organizations. Over the past few years, RTD has re-evaluated those options for many functions across the agency. RTD has found that either option – or a combination – can be effective depending on the circumstances. Contracting services has been cost-effective in some cases, but the agency has found ways to save money and increase quality by bringing services in-house in other cases.

The following best practices discuss the advantages of contracting or moving responsibilities in-house, the ways RTD has made the decision whether or not to outsource a service, and the types of investments that must be made in each case. From working with large bus companies to contract out essential services to ensuring the highest quality in drug and alcohol testing by using in-house staff to outsourcing para-transit services to increase accessibility, these best practices show that RTD is dedicated to finding the combination of in-house staff and contractor relationships that will optimize cost-effectiveness and quality. These best practices can offer templates for RTD departments and other transit agencies that are grappling with similar considerations.

Goal

Provide seamless rubber-tire service to customers while ensuring RTD receives the best possible value from contractors and that contractor performance is consistent with RTD's own standards.

Background

The Colorado State Legislature passed a bill in 1989 requiring RTD to contract out at least 20% of fixed-route services. Later, the legislature raised the bar to 35%, and then to 50% of all rubber-tire service (including fixed routes, paratransit, and call-n-rides). More recently, the state legislature significantly modified the requirement: RTD is no longer required to contract out any services, and cannot contract more than 58% of rubber-tire services. After the legislature began requiring RTD to contract out services, the agency began hiring staff to monitor and oversee contracted services.

Up until the mid-2000s, RTD and the contractors ran uneven service, and there was strong distrust of contractors among RTD employees, both operators and management. In the late 1990s, RTD hired a contractor based on a low bid that had to be terminated within 30 days because their service was so poor.

Best Practice

Since the early 2000s, RTD has implemented a series of policies that have improved both contractor performance and the relationship between the agency and the contractors.

First, RTD lobbied for legislation that would allow the agency to choose contractors based on the quality of service rather than price alone. That policy change has meant that RTD has the power to select contractors who will offer service comparable to the agency's own. In addition, it opened the door for requiring contractors to meet ambitious performance standards (Key Performance Indicators or KPIs).

Second, RTD established a senior manager position to oversee all contracted rubber tire services, including fixed-route, paratransit, and call-n-ride services. The first person to have that position, who later became Assistant General Manager of Bus Operations, had a background with transit contractors, and began implementing changes that would allow RTD to hold contractors to a higher standard.

Third, Bus Operations began to emphasize open communications between RTD and contractors. For example, contracted services and bus operations began holding regularly meetings between contracted services management and trainers and RTD management and trainers. Currently, they hold four different regular meetings to review performance statistics, share knowledge and updated policies and procedures, and ensure that all parties are consistent in their approach to maintenance, training and operations. Managers from the contractors are also invited to RTD Bus Operations managers' meetings. RTD has found that when representatives from the contractors are in the room during meetings, RTD management shows a better attitude toward contractors.

Finally, RTD began holding contractors to the same standards as in-house operations. RTD uses identical KPIs for contractors and the agency. Contracted Services has worked to ensure that contractors are reporting consistent numbers, so that anyone from either organization can open tracking software such as Maximus and see the same data. Ensuring that contractors' numbers are consistent and accurate has reduced the amount of criticism of contractors from RTD, and contributed to changing the culture.

Contractors have been receptive to the KPIs, because it provides them with consistent direction and standards and they understand how RTD is judging their performance. In addition, contracted services staff report that contractors appreciate being held to the same standard as the agency, because they felt that being held to a lower standard made them seem less competent.

RTD has also tried to be a good partner to contractors. For example, in the past, RTD required contractors to purchase their own buses, but contracts would only last for five years. Today, RTD purchases buses and leases them to contractors, and ensures that contractors receive a similar fleet to RTD (that is, buses of roughly the same make and age). RTD also solicits feedback from contractors before releasing a request for proposals (RFP) for buses.

Coincidentally, RTD's two major contractors, TransDev and FirstTransit, have recently unionized with the same union that represents RTD employees (Amalgamated Transit Union, ATU). Unionization has contributed to an improved relationship between RTD and contractors because union leadership now sees contracted services as part of their own organization rather than outsiders. Although the contractors are unionized, the collective bargaining agreements (CBAs) still allow for more flexibility than RTD's CBA.

RTD also regularly monitors contractors to ensure that performance is up to agency standards. RTD reviews training records and hiring records and conducts pull-out checks and undercover ride checks of contracted services.

Results

Although RTD is no longer required by law to contract out services, the agency continues the practice because of the value they receive from private contractors. For example, contractors are able to provide affordable service due to efficient practices in employment (due in part to a relatively flexible CBA and flexibility in scheduling) and maintenance. Because RTD carefully tracks the performance of contractors, the agency can be sure that their standards are acceptable and that customers experience seamless service. For example, RTD requires certain types of maintenance while recommending other maintenance to contractors, but contractors and RTD have similar numbers of miles between road calls (a KPI). While contractors pay their operators a lower hourly rate than RTD, some operators prefer contractors because they attain seniority faster, have more flexibility in scheduling, and work with a smaller operation.

At times, RTD adopts best practices from contractors. For example, one contractor began adding event recorders to buses, and RTD saw the value and eventually adopted the practice for in-house operations. Because RTD's two major contractors, FirstTransit and TransDev, are major international companies with extensive experience in transit, their staff has often worked in many different cities across the industry, and can contribute helpful suggestions to RTD's in-house operation.

Currently, the Contracted Services Division is developing their own policies and procedures manual, which they will share both in-house and with contractors. They are also in the process of creating desk manuals for each employee to provide for knowledge transfer in case of retirements and ensure that new employees have guidance in their jobs.

Resources

Regional Transportation District Act, Colo. Rev. Stat. § 32-9-119.5 (August 31, 2012)

Department

Bus Operations

Contact(s)

- Bruce Abel, Assistant General Manager, Bus Operations
- Carolyn Conover, Senior Manager, Contracted Services

Goal

Provide employees with the knowledge and skills needed to succeed in their current position and develop supervision, management, and leadership skills.

Background

There are currently seven individual Learning Paths ranging from entry into the transit industry up to executive leadership training. Each Learning Path includes a series of required classes which are offered in-house to all RTD employees. In addition, Learning Paths include a series of external individual courses and leadership certificate programs as well as established transit-oriented learning programs. RTD employees can pay for external individual courses and seek tuition reimbursement through the represented employees' Education Development Plan (EDP) or the Professional Development Program (PDP) for salaried employees. Depending on the availability of funds, the District may reimburse an employee up to $2,000 per calendar year for pre-approved course work, seminars, or other development activities that will improve their work skills, increase their knowledge, and enhance their future contributions to the District.

Best Practice

Core Classes

While other transit agencies typically purchase off-the-shelf training materials, RTD has on-staff instructional designers who create courses specifically designed to address RTD's needs. RTD designed the Crucial Conversations and Crucial Accountability courses to help employees develop tools to handle difficult and important conversations as well as to prepare participants for high-stakes situations with proven techniques. Core classes also include a full-day District Tour, Ethics for Public Transit, Generations, which addresses generational barriers and the strategies to overcome them, and a Terrorist Activity Recognition course designed to provide the skills and knowledge to enable employees to know how to identify and report pre-attack terrorist activity. All salaried employees are required to complete the core courses within two years of hire. Represented employees are only required to take the Terrorist Activity Recognition course but may enroll in any additional course.

Leadership Training

RTD has a multi-layered approach to training the next generation of leaders in the organization. Supervisors and managers have additional training requirements including Core Skills for Managers and Supervisors, Basic Labor Relations, and Transit Coach, which explores the options for improving business coaching. The training also includes a class entitled Meet the Challenge that focuses on regulatory issues in the areas of the drug and alcohol policy, employment law, equal employment opportunity (EEO), and workplace violence. As managers move up the organizational ladder additional courses in performance management and appraisal and presentation skills are required.

RTD has also developed a robust leadership program that gives employees the opportunity to participate in a year-long internal Leadership Academy, learn best practices from peer agencies through the Multi-Agency Exchange Program (MAX), and, later, serve as a mentor to a Leadership Academy participant.

Candidates for senior and executive leadership are encouraged to participate in the Eno Leadership Development Conference, Eno Foundation Transit Executive Seminar, Leadership APTA (offered by the American Public Transportaton Association) and the Women's Transportation Seminar (WTS) Leadership Development Program.

Results

To date, 79 employees have been accepted into RTD's Leadership Academy. Thus far, 14 individuals have been promoted into leadership positions that have more responsibilities than their prior positions required. One current participant has been selected for the Eno Foundation Transit Executive Seminar later this year.

In the third year of the MAX Program, 18 employees have successfully completed the program, and an additional eight employees are scheduled to complete this year's program in October. Three of the participants have been accepted into Leadership APTA: one has graduated, one is currently participating, and one will begin the program in January 2015.

Below is a detailed description of each of the Learning Paths:

Intern Development

- Crucial Conversations
- District Tour
- Terrorist Activity: Recognition and Development
- The Effective Job Search: From Resume to Interview

Employee Development (All salaried employees)

- Crucial Conversations (two years to complete)
- District Tour (six months to complete)
- Ethics for Public Transit (two years to complete)
- Generations: Finding Common Ground (two years to complete)
- Crucial Accountability (two years to complete)
- Terrorist Activity: Recognition & Reaction (one year to complete)

Mid-Level Leadership (Supervision)

- Crucial Conversations (two years to complete)
- District Tour (six months to complete)
- Ethics for Public Transit (two years to complete)
- Generations: Finding Common Ground (two years to complete)
- Crucial Accountability (two years to complete)
- Terrorist Activity: Recognition & Reaction (one year to complete)
- Meet the Challenge (one year to complete)
- Core Skills for Managers for Managers and Supervisors (one year to complete)
- Transit Coach (two years to complete)

Mid-Level Leadership (Management)

- Crucial Conversations (two years to complete)
- District Tour (six months to complete)
- Ethics for Public Transit (two years to complete)
- Generations: Finding Common Ground (two years to complete)
- Crucial Accountability (two years to complete)
- Terrorist Activity: Recognition & Reaction (one year to complete)
- Meet the Challenge (one year to complete)
- Core Skills for Managers for Managers and Supervisors (one year to complete)

- Transit Coach (two years to complete)
- Performance Management and Appraisal Workshop (one year to complete)
- Presentation Skills (one year to complete)

Labor Relations

(Managers and supervisors who work with represented employees)

- Basic Employee and Labor Relations for Managers and Supervisors (two years to complete)

Senior Leadership Knowledge Exchange

- Crucial Conversations (two years to complete)
- District Tour (six months to complete)
- Ethics for Public Transit (two years to complete)
- Generations: Finding Common Ground (two years to complete)
- Crucial Accountability (two years to complete)
- Terrorist Activity: Recognition & Reaction (one year to complete)
- Meet the Challenge (one year to complete)
- Core Skills for Managers and Supervisors (one year to complete)
- Transit Coach (two years to complete)
- Performance Management and Appraisal Workshop (one year to complete)
- Presentation Skills (one year to complete)
- Basic Employee and Labor Relations for Managers and Supervisors (two years to complete)

Executive

Completion of the following programs

- RTD Leadership Academy
- Multi-Agency Exchange Program (MAX)
- Serve as a mentor for a Leadership Academy participant

Completion of one of the following external Leadership Programs

- Eno Leadership Development Conference
- Eno Foundation Transit Executive Seminar
- Leadership APTA
- WTS Leadership Development Program

Departments

Human Resources (Finance and Administration Department)

Contact(s)

- George Kuzirian, Manager, Education, Training & Development,
- Richard Petty, Senior Education, Training & Development Specialist
- Cherie Sprague, Senior Human Resources Executive

In-House Drug and Alcohol Testing

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Goal

Fully comply with RTD policy and U.S. Department of Transportation (DOT)and Federal Transit Administration (FTA) regulations and consistently apply prescribed procedures while saving money for the District.

Background

FTA regulations require RTD to perform drug and alcohol testing for all RTD employees, volunteers, and contractors. With more than 2,200 safety-sensitive employees, maintaining a drug and alcohol-free workplace is essential for passenger and worker safety. RTD historically used external firms to perform drug and alcohol testing. In late 2012, an RTD audit of these contractors revealed none achieving 100% compliance due to lack of training and high turnover of collectors in the contracted clinics. Additionally, the audit identified 14 deficiencies in the review of Breath-Alcohol and Urine Collection Testing.

Program compliance requires the consistent use of certain criteria and skills. FTA does not recognize anything short of 100% compliance in all areas of program administration and breath alcohol testing procedures. If an agency does not achieve 100% compliance, they have 90 days to correct the deficiency. If the deficiency is not corrected, the agency may lose FTA funding. Urine collection procedures are the weakest link in the entire process. Overall compliance depends on those initial two elements. RTD's Substance Abuse/Office Services division predicted that contractors would significantly increase prices in the upcoming contract bid. These predictions were confirmed when an industry Request for Information (RFI) in 2013 revealed a best price of $160,000 to maintain the same level of service. Substance Abuse/Office Services adjusted the scope of the services to RTD experience (80% Division employees and 1,200 tests per year) and estimated that the true cost would be over $300,000 to actually implement at RTD with external testing contractors. Initially, RTD leadership wished to avoid adding additional staff, but evaluating the high cost convinced them to try another approach.

Best Practice

Substance Abuse/Office Services proposed that RTD bring the testing in-house. The team purchased its own testing equipment and supplies for $12,000 and hired two part-time testers for $30,000 each. Prior to hiring and training part-time testers, existing staff established the compliance and testing procedures and performed all tests. These early months required significant additional duties but enabled Substance Abuse/Office Services staff to hone their procedures through a train-the-trainer approach and ensure continuous education and implementation of best practices. These refined processes and procedures improved the consistency of results.

RTD has seen immediate results from in-house testing, including the ability to set exact procedures and ensure consistent application of the program. Consistency ensures staff treats every employee equally and without bias. Substance Abuse/Office Services staff has found that consistency, fairness, and the increased investment in human capital sends a message that RTD's goal of safety, including a drug- and alcohol-free workplace, is real, present, and here to stay.

Results

Most importantly, in-house control brought RTD to 100% compliance. In a recent FTA Drug and Compliance Office Review, RTD received FTA's first-ever deficiency-free collection site assessment. In addition, In-House Drug and Alcohol Testing has saved $250,000 over the anticipated cost to achieve full compliance with an external contractor in its first year of operation.

Additionally, Substance Abuse/Office Services staff implemented the use of 3D tamper-resistant stickers in testing to reduce the chances of fraudulent tests. The 3D stickers are produced by NovaVision, Inc., which does custom 3D strips that show "VOID" throughout the part of the strip that has been removed. They are used to show tampering with resources such as water or soap in restrooms during the testing.

RTD's successful in-house drug and alcohol testing program may soon spread to other companies and transit agencies. Encouraged by the early success of the program, Substance Abuse/Office Services staff may expand in-house testing to the contracted services partners in bus operations. The private contractors experience the same compliance and testing issues that RTD once did and could benefit from RTD's expertise to come into compliance. The Transit Safety Institute has been impressed by the program, and has requested that RTD develop materials to train peer agencies to stand up their own in-house testing facilities to emulate RTD's success.

Resources

Procedures for Transportation Workplace Drug and Alcohol Testing Programs

(49CFR Part 40)

RTD Drug and Alcohol Policy

Department

Human Resources (Finance and Administration Department)

Contact(s)

- Edin Memic, Manager, Substance Abuse/Office Services
- Travis Bussey, Supervisor, Substance Abuse/Office Services
- Cherie Sprague, Senior Human Resources Executive

Security System (Internal/Contractor Hybrid)

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Goal

Ensure RTD maintains safe, cost-effective service through a mix of RTD Transit Police staff and contracted security officers and an off-duty police officer program.

Background

Maintaining safety and security at transit facilities is a concern across the nation. Many transit agencies hire their own police force (some numbering into the hundreds), while others entrust all safety and security responsibility to private security firms.

In May 2004, the Colorado General Assembly granted RTD authority to operate its own police force. Rather than investing only in RTD police staff, the Transit Police Division has developed a hybrid approach with six RTD Police Officers and 20 additional RTD Division staff, contracted security officers and an off-duty police officer program. Peace Officer authority also improved collaboration with the many police departments across the District – enabling Transit Police to speak with city and county police on the same level.

Best Practice

RTD Transit Police see tremendous benefits in the way the division has developed since being granted authority as Colorado Peace Officers in 2004. As the Transit Police Division has grown with RTD rail expansions and adapted to the greater threat terrorism represents to transit facilities across the world, the hybrid approach has grown with it. The division's 26 employees and six police officers oversee safety and security in the District in collaboration with 140 contract security officers and augment their operations with 430 off-duty police officers from jurisdictions within the District. Currently, officers may only patrol within their own jurisdiction.

Results

The off-duty police officer program, in particular, has produced many beneficial results. Using part-time police officers improves Transit Police flexibility – the program uses city and county police officers at no more than 20 hours per week to patrol light rail, buses and transfer centers both in uniform and plain clothes. The collaboration with local police forces has also improved Transit Police relations with those police forces and improved local police understanding of the particular challenges related to safety and security at transit facilities.

Resources

Colorado Revised Statute 16-2.5-146 (see Public Transit Police Officers p. 27)

Department

Safety, Security & Facilities

Contact(s)

- John Tarbert, Transit Police Chief
- John Perry, Transit Police Commander, Field Operations

Workforce

Goal

Improve financial control and quality of planning by maintaining control over modeling and simulation.

Background

During the 1980s, the Denver Regional Council of Governments (DRCOG), the Denver-area Metropolitan Planning Organization (MPO), performed all transportation modeling for the Denver metropolitan region. RTD disagreed with DRCOG's results and methodology regarding mode split (the choices travelers make between transit and automobile modes). RTD hired a consultant to investigate the demographic characteristics of existing riders so the agency could build a mode choice model that more accurately estimated the number of transit trips based on rider characteristics. This mode choice model was incorporated into the DRCOG travel model and its structure remains in use in DRCOG's trip-based travel model, "Compass."

Because travel demand and micro-simulation modeling are such specialized skills, many transit agencies contract out all modeling or use the local MPO model results. In those situations, any analysis requiring simulation or demand modeling either must go back out to bid for consultant support or rely on MPO staff and time. RTD has developed an in-house technical service department with skills in macro – and micro-scale modeling. This arrangement maintains institutional memory and historical model simulations, speeding up analysis, saving time and increasing cost efficiency.

Best Practice

While still contracting with consultants for some technical services, RTD Planning Technical Services staff manages operations-related short- and long-term technical studies for the development and refinement of bus and rail operations and cost models. Staff also provide direction on technical and complex functions with the travel model and coordinates with other RTD divisions and DRCOG in coding, calibration, and administration of operations and maintenance statistics and cost models.

RTD Planning Technical Services staff use TransCAD for macro-scale integrated travel modeling of all motorized modes of transportation including car, HOV, truck, bus, and rail movements. The results of these models feed into the long-range planning for capital projects with information such as forecast ridership at the system, corridor, route, and station levels. Planning Technical Services staff also uses VISSIM micro-scale simulations to perform analysis and test scenarios to improve bus and rail operations including station locations, signal priority, and preemption. TransCAD and VISSIM both are industry-standard software packages that allow for sharing of model inputs and outputs among RTD, DRCOG, consultants, and other parties.

Results

Maintaining the ability within RTD to build and apply micro- and macro-level models from start to finish has reduced costs and enabled Technical Services to deliver timely analysis. During the scope and value engineering exercise on the West Rail Line, Capital Programs and Rail Operations wanted to determine if the planned double-track alignment on the whole corridor could be reduced to single track and still maintain 15-minute frequency. The cost to construct double-track on the entire alignment threatened the entire project. Using both micro-simulation and macro-travel modeling, staff determined that RTD could operate the service with the reduction to single- track west of the Federal Center station. West Rail may not have begun construction without this change.

In-house staff also creates real flexibility in forecasting and simulation. Staff has modeled the operations on the Design-Build contract for the I-225 light rail construction. Through their analysis, an operational concern was identified early. With the early information, Capital Programs and Rail Operations staff could address the issue by adding a pocket track and purchasing additional vehicles, avoiding problems in delivering service.

Department

Planning

Contact(s)

- Brian Welch, Senior Manager, Planning Technical Services
- Lee Cryer, Project Manager II, Planning
- Lacy Bell, Project Manager, Planning

In-House Bus Design and Refurbishing

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Goal

Improve bus reliability, safety, drive-ability and adaptability to local environment by designing technical solutions into new bus procurement and refurbishing existing buses.

Background

New buses are usually purchased using standard technical specifications developed by the American Public Transportation Association (APTA). The standard specifications are generic and designed to serve the needs of a variety of different transit agencies. Many of the features required in the standard specifications are not suitable for the local environment or a particular operational requirement. In past practice, RTD had used these standard specifications, with minor modifications, in an attempt to fit the buses better to the operating environment at RTD. In the late 1990s, the Bus Maintenance division recognized that it could expand the customization effort to improve bus performance in its environment, and address known operating issues using the expertise, knowledge and experience of in-house personnel. To bring this experience to bear, RTD Bus Maintenance encouraged the in-house design team to add their proposed solutions into the requirements for new bus procurements. Historically, RTD senior management has relied on Bus Maintenance's record of success in keeping road call mileage in its fleet and service hours on the Mall Shuttle low, enabling the division the freedom to seek innovative solutions.

Best Practice

Many transit agencies perform bus refurbishment on a fixed-interval basis. This type of effort requires a large pool of labor – meaning transit agencies must either hire more people or use outside contractors to perform the job. As equipment has improved and manufacturing processes have made great strides in quality, general bus refurbishments are no longer necessary or cost effective. Rather than handcuffing staff to a fixed interval, RTD better uses its resources by performing targeted refurbishment on identified issues to address specific needs with a smaller, dedicated staff. Through these processes staff has identified parts that require replacement earlier than the manufacturer recommends and others that can last far longer – saving time and money and avoiding service calls.

RTD's equipment engineering and technical services section handles design of the technical solutions that go into the technical specifications of new buses. The engineering team reviews the operational and reliability problems with existing bus fleets and implements solutions through researching and testing better products, implementing advanced technologies and, in many cases, simplifying the existing design to allow easier operation and fewer chances for defects. The engineering team also draws on the expertise and experience of repair mechanics and bus operators to identify issues and suggest improvements. For example, before issuing a new bus procurement engineering and technical services assembles a team including an expert trainer, engineer, quality control, mechanics, operators and service personnel to discuss issues with the existing fleet that might be solved through technical or design changes.

RTD has implemented bus refurbishments only to address specific issues. RTD uses various bus history data and indicators to decide which sub-fleets require attention and what types of refurbishments are necessary. For example, after review of duty cycle history, parts usage, break down and maintenance data, and availability of replacement parts, RTD identified the mall shuttle buses as in need of critical maintenance and implemented a half-life refurbishment to improve reliability and availability for service.

Results

By leveraging the expertise and experience of in-house personnel – who live with the issues and could provide the solutions in a more expedient manner than vendors – RTD's in-house bus design and replacement has improved bus reliability while reducing costs. RTD uses Maximus asset management software to track operator calls and the nature of the issue. The software provides engineering and technical services with data to identify trends and problem areas. Since beginning the in-house design and replacement effort, RTD has improved bus reliability significantly. The RTD fleet roadcall mileage has increased from 7,500 miles per roadcall to today's 26,000 miles per roadcall.

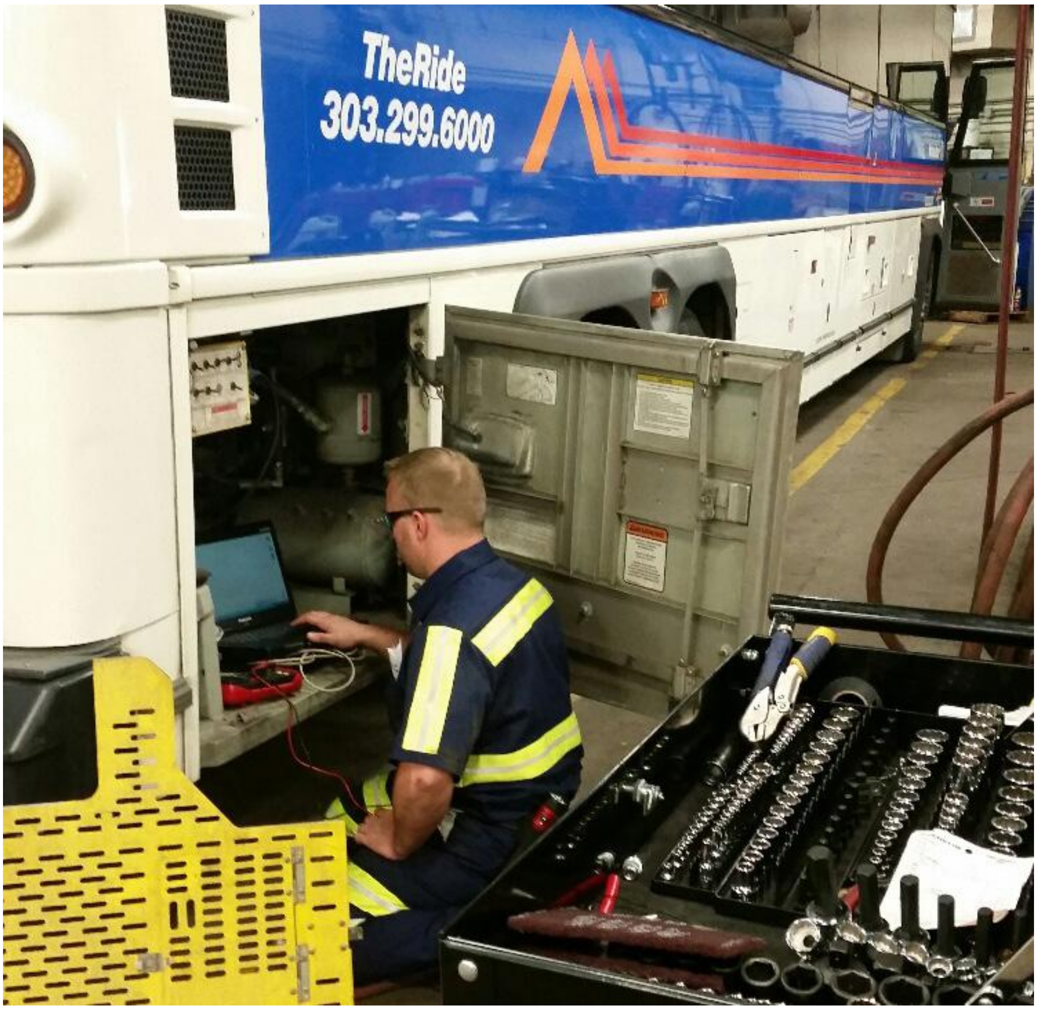
RTD uses Maximus data, in-house labor and engineering expertise to perform targeted bus refurbishments enabling the agency to address bus problem areas cost-effectively without increasing in-house labor. The half-life refurbishment has extended the Mall Shuttle's useful life to 14 years old as of 2014, exceeding the standard 12-year lifespan.

Department

Bus Operations

Contact(s)

- Lou Ha, Manager, Technical Services, Bus Operations
- Steve Gieske, Assistant General Superintendent, Maintenance



Access-A-Cab Augmenting Paratransit Delivery

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Goal

Provide flexible and cost-effective service to persons with disabilities.

Background

RTD provides Access-a-Ride local bus transportation in the Denver metro area for people who (1) are unable to get to and from a bus stop or on and off a lift-equipped bus by themselves or (2) have a cognitive disability that prohibits understanding how to complete bus trips. Qualified riders can schedule a trip within Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson counties in Colorado, as long as the starting point and destination are within three quarters of a mile of RTD's local fixed-route transit system. Access-a-Ride is available during the same days and hours as local bus service and includes door-to-door service with driver assistance. Riders may also establish subscriptions for regular trips to the same destination. RTD contracts with Easter Seals of Colorado to certify each passenger's eligibility for the program. The cost per rider to provide Access-a-Ride service averages $51.50.

Best Practice

In 1993, RTD began a pilot Access-a-Cab program as a way to provide flexibility and address a spate of denials to users of the Access-a-Ride service. The Access-a-Cab pilot began with an agreement with three local taxi companies to provide subsidized taxi service to eligible paratransit riders. One of the participating taxi companies was offered an opportunity to use recently retired RTD paratransit vehicles to improve the program for riders using mobility devices such as wheelchairs. The taxi companies were initially paid with vouchers on a per-mile payment structure.

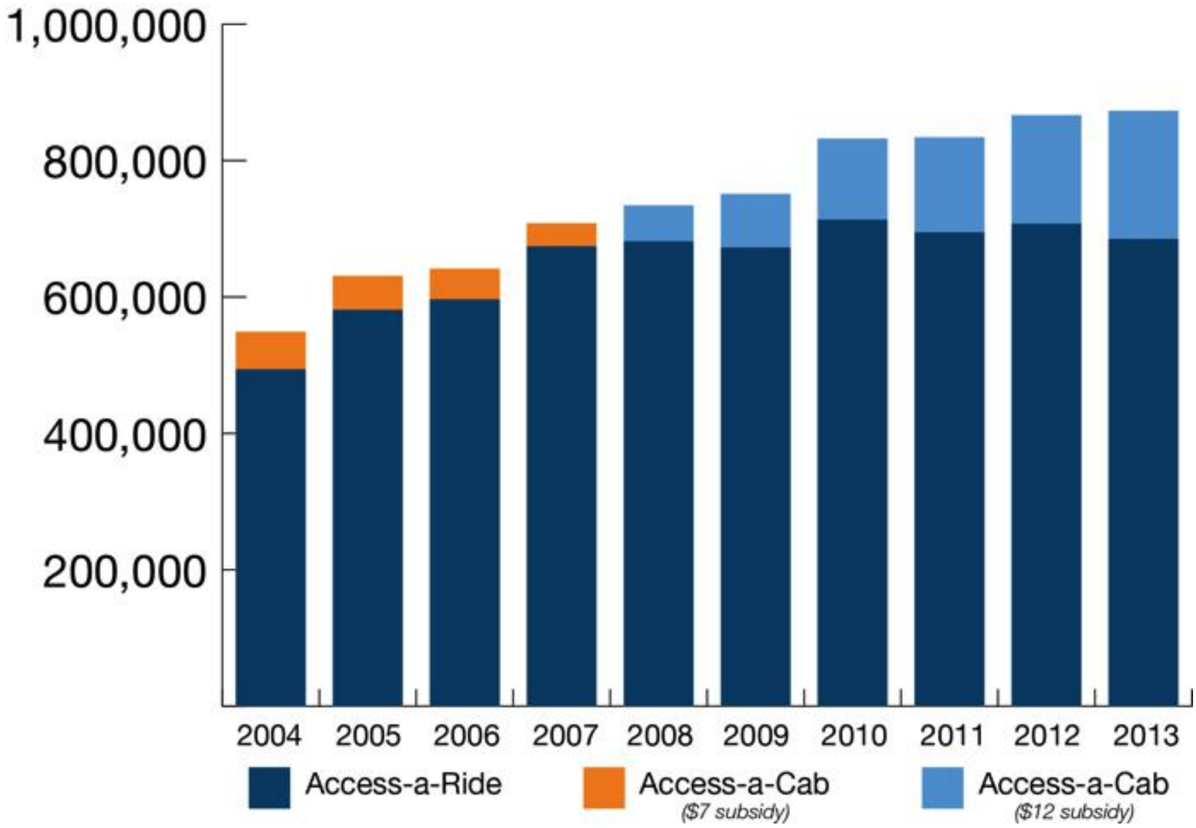
The pilot experienced initial success and its budget was increased to meet demand. Initial audits of passenger-tracked and taxi-tracked vouchers revealed instances of overcharging. Therefore, RTD instituted a flat subsidy for Access-a-Cab providers. Under the new arrangement the passenger was responsible for the first $2.00 in cab fare, RTD subsidized the next $7.00 in fare and the passenger was responsible for any amount above $9.00 for the trip. To address rapid growth in rider requests and encourage taxi providers to offer more rides, RTD adjusted the Access-a-Cab subsidy from $7.00 to $12.00 in 2008.

The Access-a-Cab service has proven to be very popular and given RTD flexibility in the service it provides to Access-a-Ride certified users. In contrast to Access-a-Ride, which requires at least 24-hours' notice to schedule a trip, clients can schedule same-day trips with pre-certified local cab companies. The $12 subsidy on Access-a-Cab rides also represents a significant savings over Access-a-Ride costs per rider. Riders are provided a choice between the additional cost and flexibility of Access-a-Cab and traditional Access-a-Ride services.

Results

In the 20 years of the program, certified user scheduled trips have increased significantly – making it harder for RTD to meet the customer service requests. Between 2004 and 2007, ridership grew from 493,948 to 674,419 (37%) significantly straining RTD's resources.

Graph: Access-a-Ride and Access-a-Cab Ridership 2004-2013



This change enabled RTD to serve ever more riders while maintaining the level of more costly Access-a-Ride effectively constant. Currently, Access-a-Cab ridership delivers 500 trips per day and has grown to represent more than 20% of total program ridership – Access-a-Cab now provides nearly four times as many rides as it did ten years ago. Delivering 187,884 Access-a-Cab rides in 2013 saved an estimated $7.4M over the cost of providing those rides through traditional Access-a-Ride services.

Resources

Bruce Abel 2011 APTA Presentation

Department

Bus Operations

Contact(s)

- Bruce Abel, Assistant General Manager, Bus Operations
- Larry Buter, Manager, Paratransit Services

Goal

Increase mobility in the region by coordinating vanpools rather than operating low ridership routes.

Background

Providing service in the most cost-effective manner is a struggle for transit agencies across the nation. Vanpooling is a transportation option that links geographically-clustered commuters and employees and provides a van driven and maintained by one of the vanpool participants. Typically, the vans carry from six to twelve riders and are provided by the vanpool program. Vanpools are organized on a break-even, cost sharing, fare basis but often prove difficult to organize because many commuters are uncomfortable driving larger vans and smaller vans do not accommodate enough people to amortize the purchase cost.

In 2001, RTD worked with the DRCOG RideArrangers vanpool program to overcome its limited participation due to perceived high fares and insufficient funding for van acquisition. In order to help overcome these barriers, RTD and DRCOG entered into a partnership in April of 2001 to expand vanpool service in the Denver metropolitan area. Since RTD support for the vanpool program began in late 2001, the number of vans in the RideArrangers service grew from 11 to 107.

Best Practice

RTD financial support helps underwrite the vanpool pricing structure to make vanpool fares more competitive. RTD subsidizes vanpool fares above the appropriate monthly pass rate for the length of the vanpool commute for each participant (Local $79, Express $140, Regional $176). RTD subsidies allow DRCOG to reduce fares for participants and purchase more driver-friendly minivans. DRCOG also uses RTD subsidies to provide incentives to attract and retain vanpool drivers.

Vanpool subsidies have been a worthwhile investment for RTD: the resulting increase in vanpool usage has enabled RTD and its partners to provide mobility to citizens of the District in a cost-effective manner. Adding vanpool routes reduces the calls for RTD to operate additional service – much of it likely to serve only a handful of riders. In a few instances, RTD has even eliminated a route that was better served by a vanpool.

Results

In 2009, DRCOG chose VPSI Inc. to operate the vanpool program. Currently the vanpools carry an average of 5.8 riders per van and the fleet is at 80% capacity.

DRCOG vanpool performance through the 3rd Quarter in 2013 resulted in an RTD subsidy per passenger trip of approximately $2.21. For comparison, the subsidy per passenger for RTD fixed route service in 2012 ranged from an average of $2.85 subsidy per passenger for central business district local routes to an average of $6.66 subsidy per passenger for suburban local service and an average of $5.23 subsidy per passenger for regional service.

Department

Bus Operations

Contact(s)

- Brian Matthews, Manager, Special Services

Owner's Verification Testing (OVT)

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Goal

Verify the validity of contractor quality assurance (QA) practices in a best-value procurement, including all required materials testing.

Background

Owners can conduct all acceptance testing. While this approach can work for smaller, confined construction footprints, it introduces risks to RTD including:

- Late report submittals
- Failed material reported as passing
- Passing material reported as failed
- Incorrectly reported materials expose RTD to contractor claims
- Loss of certification
- Technician tardiness
- Cost of testing goes over budget

During the T-REX project, RTD and the Colorado Department of Transportation (CDOT) employed an Owner's Verification Testing (OVT) approach that sought to validate contractor test results through independent testing of approximately 10% of the testing the design-builder performed. Because the testing was completely independent, differences in test methods, dates, times, and locations introduced variation between the contractor and RTD/CDOT data sets. Over time, this resulted in significant differences. Although the database allowed RTD and CDOT to verify that construction material was of sufficient quality, the verification testing process itself was inconclusive.

Best Practice

At the beginning of FasTracks, the Quality Management Committee chose to require acceptance testing by the contractor's QA team, with OVT by RTD. Unlike the T-REX approach, RTD chose to conduct split sampling between the contractor's QA testers and RTD's OVT testers. In this approach, both testers, while still operating independently, tested the same sample of material, at the same time. All results were entered into a database to compare one-for-one split sample tests. Contractor test results differences that fell within a pre-defined tolerance were considered valid. Where significant differences were observed the matter was investigated and material retested if necessary. Split sampling was conducted on approximately 5% of contractor QA tests for West Rail Line and subsequent projects.

While split sampling alone provided RTD with adequate confidence in the test results, RTD chose to supplement verification testing with process audits of the contractor's QA test methods, equipment, personnel qualifications, number of tests versus material quantities, and disposition of failed tests. Process audits led to direct improvements in contractor QA testing programs, giving RTD further confidence in the contractor's methods.

Results

A split sampling approach to owner's verification testing, coupled with a robust process audit schedule, is an effective method to verify contractor QA test results.

Split sampled OVT:

- » Minimizes variation from differing material test samples
- » Enables direct comparison of test results
- » Allows for a lower level of OVT testing (more cost-effective)
- » Allows for investigation of specific results (improving contractor QA/OVT test methods)

With a proper materials testing verification approach, RTD places management responsibility for large, best-value, contracts with the contractor spreading out risk while still employing an effective verification program.

Resources

2013 RTD FasTracks Lessons Learned Report

Department

Capital Programs

Contact(s)

- Kevin Diviness, Director of Quality Assurance


NOT
OFFICIAL
TIME
CONGRATULATIONS
East Metro Division

Internal Communication

Like many large organizations, RTD has struggled with internal silos: departments focused inward that are not in the habit of collaborating. Silos can prevent efficient operations and even lead to safety problems or other major issues if decision-making happens without input from key players in different areas of an organization.

While RTD continues to struggle with collaboration and communication between work groups – an issue highlighted in a recent agency-wide employee survey – the organization has worked proactively to create a collaborative culture. The following best practices highlight silo-busting projects across the organization, from a cross-departmental committee that oversees safety and security issues to a tool that increases communication between front-line employees and other departments. These successful projects can be used as models as RTD moves forward with efforts to increase communication.

Goal

Oversee safety and security policy and implementation for the district.

Background

The Executive Safety and Security Committee (ESSC) has its roots in the safety committee established to oversee the original Metro Area Connector (MAC) light rail line in the early 1990s. At the time that committee was established, having a safety committee was an industry best practice but not yet required by regulation. The original MAC committee focused on safety certification and review. Since that time, the committee has gradually grown in scope and membership to encompass safety issues related to bus operations (in the late 1990s), security (in the early 2000s), and, most recently, asset management. The FTA now requires an interdisciplinary committee of this type to oversee many safety issues.

While the ESSC is now well-regarded around RTD, this was not always the case. Having a champion within the organization was an essential part of establishing and developing the ESSC. The Assistant General Manager (AGM) of Safety, Security and Facilities, championed the committee before federal regulations made it essential and invited different departments to participate, gradually building the committee's membership and reputation. Acceptance has grown as new individuals have joined RTD and saw the ESSC as an established part of doing business at the agency.

Best Practice

The Executive Safety and Security Committee (ESSC) includes members from across the district: at least one representative from each department is invited to serve on the committee. The most active members are from Safety, Security, Rail Operations, Capital Programs, Risk Management, and Bus Operations, but Finance and Communications also participate regularly. Individuals at many levels of management are invited to the meetings to comment, present, and observe, but only AGMs can vote. Much of the committee's business, including voting, occurs over email.

The committee meets once per month and the meetings follow a set agenda beginning with bus operations and ending with corridor updates. Meetings run for no more than an hour. In the meetings and over email, the committee is updated on accident trends, facilities issues, transit security statistics, rail modifications and design criteria variances, changes to standard operating procedures, accident investigations, hazard management and state safety oversight. Because the committee is interdisciplinary, the meetings focus on broad issues rather than details, which helps keep all attendees engaged.

The ESSC is a mature committee that is well-regarded throughout the agency and people from many different departments regularly refer issues to the ESSC. In addition, certain issues must go to the ESSC: federal regulations require that representatives from many parts of the organization review certain issues. For example, Capital Programs can handle minor variances in their department, but a level IV variance must go to the ESSC for a vote because it could create safety issues that only someone from operations or safety would be able to identify. RTD had already developed the ESSC before many of those federal regulations went into place, and having an established committee to handle those types of reviews has served the agency well.

The ESSC must come to a consensus on voting issues and each member has the option to block consensus. The consensus and consensus blocking model has been a key part of the committee's success. For example, Capital Programs might request a change to a component of a rail line that will save money. Rail Operations will be the primary department affected by the change. Other members of the committee – for example, Bus Operations, Safety, Security and Facilities, and Finance – might approve of the change or have no opinion, meaning the change could go through under majority rule. But, under consensus blocking, should the Rail Operations department oppose the change that participant may block the decision and force the committee to explore other solutions. In the history of the ESSC, there have only been a handful of cases when the committee could not come to a consensus. In the rare cases when the ESSC cannot reach consensus, the General Manager makes the final decision.

Results

The ESSC puts RTD ahead of the industry in inter-departmental collaboration around safety issues. Other transit agencies often fail to involve all of their internal stakeholders in safety decisions, and establishing an ESSC can be a step toward achieving that input.

In addition, the ESSC has been flexible enough to address new regulations. Recently, FTA began requiring interdisciplinary oversight for state of good repair issues. For example, if an asset is in service outside of certain specifications, an interdisciplinary committee can approve its use under certain circumstances. Because RTD already has the ESSC in place, the agency has simply added asset management to the roster rather than having to establish a new committee for that purpose.

The ESSC has been so successful for RTD that the Eagle P3 project also has an ESSC with the concessionaire.

In peer reviews, RTD staff have recommended that other transit agencies establish similar committees to meet regulatory requirements and improve safety at their organizations.

Departments

Safety, Security & Facilities

Contacts

- David Genova, Assistant General Manager, Safety, Security & Facilities

Inter-Departmental Relationship Building

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Goal

Facilitate communication and collaboration between the general counsel's office and other RTD departments and minimize legal costs for the agency.

Background

RTD has had in-house counsel since at least 1974, shortly after the agency was founded. At various times in RTD's history, the agency has considered out-sourcing some or all legal work. In 1996, RTD hired a productivity consultant to assess the legal department. The consultant investigated outsourcing some department functions, but determined that RTD should continue to have in-house attorneys and that the department had the right amount of staff. RTD does outsource legal work in certain specialized areas, including eminent domain and bankruptcy cases and bond and tax matters.

The General Counsel's Office has developed and maintained strong relationships with clients even as RTD has grown with the FasTracks expansion. When FasTracks passed, the General Counsel's Office added two project attorneys specializing, in part, in real estate, who are paid out of the FasTracks budget. Those attorneys, along with the rest of the legal staff, have worked closely with the Capital Programs Department.

Best Practice

The RTD attorneys work to develop relationships with clients across the agency. The success of these relationships depends on a combination of personal interaction and the following policies:

» Having in-house legal services rather than contracting with outside firms saves time and money: RTD lawyers already understand the agency and the industry before they receive a call from the client.

» Financial policies help to ensure that attorneys and clients communicate early and often. While some agencies charge departments for internal legal services, RTD allows all departments free access to the legal team. This policy encourages clients to call on attorneys in order to solve their problems early and it prevents departments from competing for attorneys' time. Even departments with relatively small budgets can take advantage of legal services.

» Recently, RTD has stressed the single, agency-wide mission. This emphasis on common goals helps show clients that attorneys are their allies, and, as a result, clients are more likely to contact attorneys early.

» Some departments include a non-lawyer who is an expert in specific legal matters. This model works well because attorneys have a point person with whom they communicate frequently. For example, the Capital Programs Department includes a real estate specialist who acts as a liaison between the attorneys and the engineers and handles minor issues.

» The General Counsel's Office encourages attorneys to add to their expertise through continuing legal education. While the RTD attorneys work closely with departments, they are co-located at Blake Street in order to improve cross training.

In addition to following these standard policies, some individuals in the counsel's office have taken steps to develop positive relationships with their clients:

- Responding quickly to client requests
- Providing multiple options for clients
- Introducing clients to the attorney who can best help them with their request

Area of Opportunity

The informal nature of attorney-client relationships can cause pressure when a client calls the same attorney for all of their needs. Currently, the General Counsel's Office does not have a standardized method for distributing work. Designing a consistent system for assigning work could help newer attorneys build relationships with potential clients and reduce the workload for attorneys who have been with the department longer and are regularly sought after by their clients. In the long term, a more formalized system could improve interdepartmental relationships as attorneys can continue to respond quickly to client requests. The risk is that attorneys who are highly specialized are subject to the ebbs and flows of their particular areas of practice which can also be unpredictable and make for an imbalanced work load.

Results

Clients who have a good working relationship with an attorney are more likely to contact them early when an issue arises, which can prevent problems.

Hiring in-house attorneys also saves money for the agency. For example, RTD recently had to outsource legal work for an out-of-state bankruptcy case for $70,000, considerably more than the cost of similar projects that are handled in house.

Resources

Contact information for RTD attorneys and their specializations are listed on The Hub

Information on common legal issues such as CORA requests, records retention and use of facilities are outlined in management directives available on The Hub

Departments

General Counsel

Contact(s)

- Marla Lien, General Counsel
- Rolf Asphaug, Deputy General Counsel

Goal

Obtain grant funding for projects throughout the agency.

Background

In 2013, the RTD Board created a 2014 General Manager goal to pursue innovative, priority-based FasTracks and Strategic Budget Plan Funding. The General Manager's annual goals set the tone for the work of the agency for the year. At the same time, after a temporary increase in discretionary grant opportunities from the Federal stimulus in 2009-10, Federal transportation and construction grant opportunities decreased significantly. These circumstances motivated RTD to take a proactive, targeted approach in seeking grants.

Until 2012, most members of the Planning Department wrote grants, but there was no systematic process to identify opportunities or collaborate with project sponsors. Generally, the Assistant General Manager (AGM) of Planning or a senior manager would assign a grant to an individual, who would then write the grant and turn it in for review at the end of the process. Often, the grant writer had to make substantial changes after the review, which was time-consuming and inefficient. In addition, due to Federal sequestration in 2013 formerly available discretionary grant opportunities were eliminated or reduced. The Planning Department created the Grants Taskforce (or Grants Team) to pursue grant opportunities systematically, encourage collaboration during the grant seeking and writing process, and work proactively to discover non-traditional sources of grant funding.

Best Practice

The grants taskforce is based in the Planning Department because planners typically have both the writing and research skills and the technical knowledge required to write a successful grant application. Because planners are involved in the early stages of projects, often before they are funded, they frequently know more about the technical details of the project than anyone else in the agency. At the same time, planners are trained in writing, data visualization, and stakeholder involvement – skills necessary for a professional grant application.

The grants taskforce meets monthly to discuss grant opportunities, identify lead authors to write upcoming grants, and share information about related projects throughout the district. All official members of the taskforce attend regularly, while other members of the Department attend when the taskforce requires their input. When many members of the Planning Department contribute to a grant – which is often the case – they share information on their progress regularly, preventing duplicative work.

After identifying potential grant opportunities, members of the taskforce contact AGMs and senior managers who might have relevant projects. In addition, they consult individuals throughout RTD who might have projects that meet the requirements of the grants. The taskforce members inform both upper-level and mid-level management of grant opportunities. In the past, they found that the agency missed out on possible opportunities because the grants team had not informed all potential internal stakeholders, and information did not always trickle down from upper management to practitioners. The grants team has developed close working relationships with project managers in Capital Programs who frequently oversee relevant projects. When writing a grant, the taskforce members leading the effort will frequently check in with the project managers or other sponsors. Sponsors also provide essential materials and information during the grant-writing process. In general, project managers and sponsors are enthusiastic about grant opportunities, and they have readily provided required information and resources to the grants team. A management directive has also been approved detailing the Grants Task Force Process for Preparation of Competitive Grants.

Communication and collaboration can be more challenging after a grant is awarded. In past years, the Planning Department turned over the grant to the sponsoring department after award. In some cases, the turnover has produced confusion, as planners who worked on the grant are asked to approve financial documents and perform other tasks that should fall under the purview of the sponsor. A management directive outlining the Establishment of Grant Administration Responsibilities Post-Award is currently under review.

Results

Since it was established in 2013, the grants taskforce has formed relationships with potential grant recipients across the agency. Increasingly, individuals throughout the organization recognize the taskforce as the people to come to for assistance with grant opportunities. This has allowed them to learn of opportunities beyond traditional Federal and State sources for transportation and construction. Even as opportunities have dwindled, in both number and funding, the grants team has continued their strong record of successful grant awards.

Resources

Management Directive: Process for Preparation of Competitive Grants

Department

Planning

Contacts

- John Elias, Senior Policy Analyst & District Historian
- Ryan Mulligan, Eagle Risk Assessment

Operator Information Page/Bulletin Board

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Goal

Improve constructive communication among operators (including contractors), Bus Operations, Customer Care, Service Planning and Development, and other RTD departments in order to increase efficiency and reliability across the system.

Background

In the mid-2000s, RTD's service planners, customer care department and operators were not communicating regularly. This meant service planners were not aware of important issues when developing new schedules and Telephone Information Center (TIC) operators could not adequately inform the public about detours and other service changes. At the same time, bus and light rail operators did not have a way to access schedules and other important information in order to prepare for their days before arriving at work, and they had no simple way to provide feedback on routes and schedules. Some operators felt that their ideas and opinions were not valued by the agency.

In 2008, when the operator information site and bulletin board debuted, RTD's intranet site was only available at RTD facilities. The agency had identified a need for better information sharing, but had not yet identified SharePoint as a solution. In early 2012, RTD released a new, SharePoint-based intranet site, "The Hub." Gradually, departments have added content to The Hub and it is now accessible at home. Bus operators required a separate website so they could access information 24/7. Therefore, the operator site stands alone outside of The Hub. RTD is planning to revise the current site to link it to SharePoint and The Hub more directly.

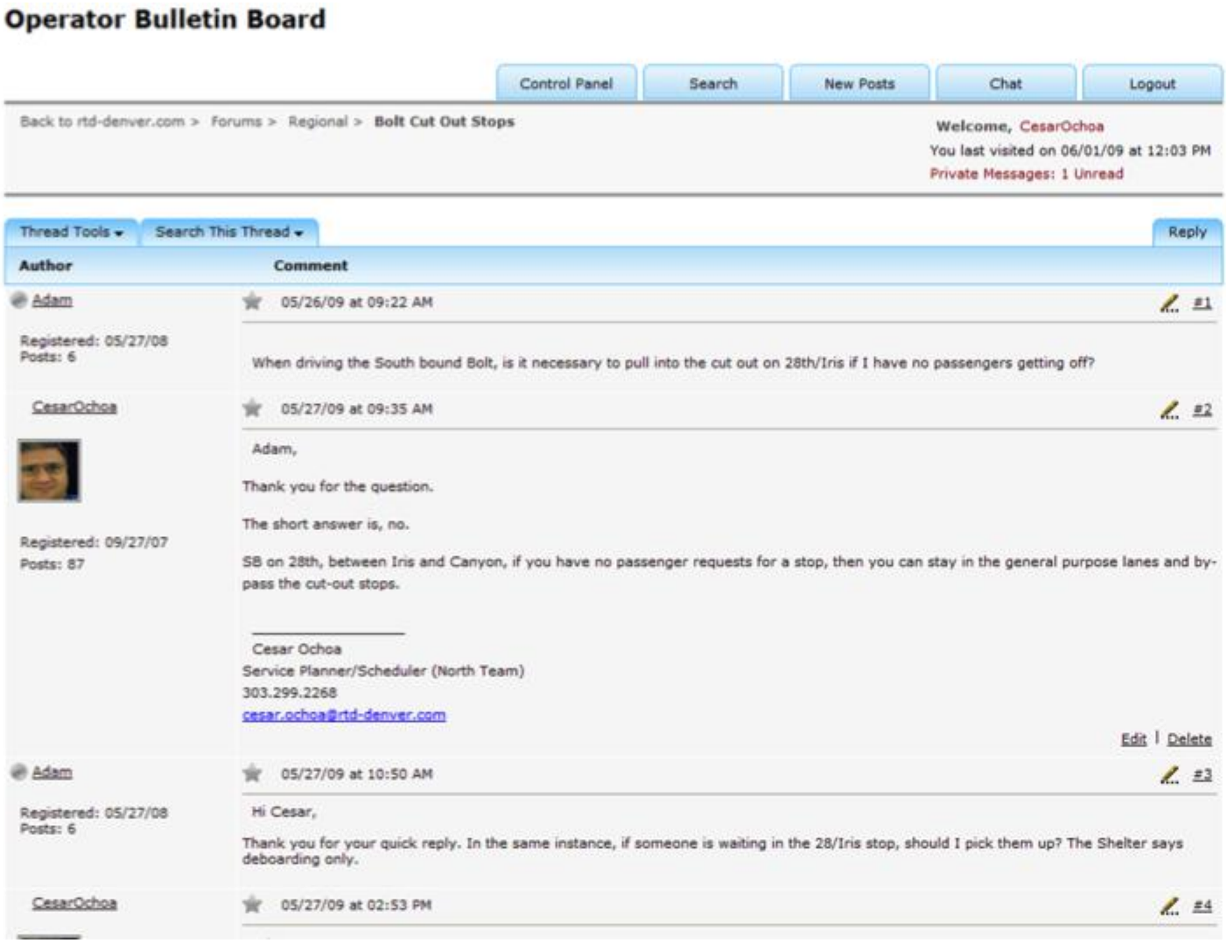
Best Practice

The Operator Information Page provides access to the entire Trailblazer, run sheets, train cards, bulletins, rider alerts, and other information that bus and train operators need on a regular basis. Operators have access to the site from home (using a log-in) and at kiosks located in all of the RTD and contractor facilities. Any RTD employee and bus operator contractors can access the site directly using a log-in. The Customer Care Division can access the Information Page via a shortcut on their desktops. The site was designed to be easy-to-use, even for those without extensive experience with computers.

In addition to receiving information from other parts of their departments, operators can post suggestions and ideas on the Operator Bulletin Board. The Bulletin Board is accessible through the Operator Information Page. Rather than building a bulletin board from scratch, a service planner discovered an outside software service, Website Toolbox, that costs $150 per year and is easy to operate. Website Toolbox staff has been responsive and helpful.

Any operator with a log-in can post suggestions, ideas, feedback, or other information to the bulletin board. Service planners, street supervisors, Dispatch, the Sign Shop, and other department managers check the board regularly and respond or forward information to other departments.

The Operator Bulletin Board Interface:



Areas of Opportunity

The Operator Information Page and Bulletin Board is outgrowing its original format. The Information Page is maintained by information technology (IT) staff, and IT is looking into ways to make the page more interactive and 'real-time,' rather than having only static uploads available. A lone service planner has managed the Information Page and the Bulletin Board on a voluntary basis since its inception, but the site is now large enough to require dedicated staff time. Transferring ownership of the project to a new staff member may jeopardize the trust operators have built in the current system, however.

In addition, creating a process for responding to requests that are relevant to other departments would make the bulletin board more useful. Making other departments aware of the importance of checking the bulletin board is also essential.

Operators currently access the page on their own time because the collective bargaining agreement (CBA) does not encourage operators to access information outside of typical working hours. Adjusting the next CBA to pay operators to access the site could improve communication.

Improving connections to documents important for operators through The Hub and SharePoint could also enhance the Operator Information Page.

Results

Currently, the Operator Bulletin Board has 950 members, primarily operators. Typically, the Operator Bulletin Board receives 3,000 views per month, though it has received as many as 5,000 views per month during major events such as the West Rail Line Opening.

Feedback from the Bulletin Board has led bus operations to fix schedules and running times, address issues with the automatic stop announcement system, adjust runs, correct the Trailblazer, and informed other key changes, which has increased efficiency and reliability throughout the District.

Resources

Operator Bulletin Board

Department

Bus Operations

Contact(s)

- Nataly Erving, Senior Service Planner / Scheduler

Goal

Provide optimal technology solutions based on a solid understanding of user needs.

Background

In the past, the Information Technology (IT) Department typically chose a software solution before consulting with the business units (users) to determine their needs. This appears to have been the case with the Oracle Business Intelligence software package, for example: IT selected software that did not fully meet the needs of users. Recently, IT has begun to delay selecting or developing a product in favor of communicating early and often with the business units until they fully understand what the users need.

In addition, the IT department primarily purchased commercial off-the-shelf (COTS) products in the past. Now, the department is careful to determine user needs before deciding whether to purchase COTS software or develop a product in-house, which is often more cost-effective and appropriate for user needs.

Best Practice

Before the IT department chooses software, the requesting department must submit a service request or project request via The Pulse (Innotas) or via the service request form on The Hub (RTD's Intranet). IT is working to develop relationships with AGMs and managers to ensure that they are aware of these tools and submit requests appropriately. Next, the IT department identifies a project manager for each request based on expertise. In most cases, someone in the department has an understanding of the possible technology solutions, but often the IT professionals do not understand the business needs well. The project manager then speaks with the representatives from the business units to determine how they will be using the software.

In cases when the business unit's processes are well established but flexible, this strategy works particularly well. The new Strategic Budget Plan (SBP) process has been a good example: IT conducted a needs assessment with the Finance Division, and they determined that Innotas, the same cloud-based service that IT uses for project requests, could meet their needs for the SBP process. Then the IT and Finance Divisions worked together to customize Innotas and tweak the SBP process based on that tool.

Recently, IT has implemented the needs assessment process as they fully implement SharePoint. Because SharePoint is a tool for collaboration, the IT department convened small focus groups with members representing all parts of the agency to learn how RTD users collaborate. In the next phase, IT professionals will create a preliminary implementation plan, and then they will consult with user groups again to ensure that they are on the right track with SharePoint.

Areas of Opportunity

Ideally, each business unit would identify one or two product owners for each project to make decisions about what is needed and interact with IT. Currently, many projects have no product owners or champions on the business side. This means that IT sometimes has to make decisions that are functional rather than technical in nature. When IT makes functional decisions, software often does not meet user needs, which can slow down the development process, raise expenses, and force users to work with sub-par products.

With more resources, IT would add more business analyst positions within their division. Business analysts would act as liaisons between developers and the business units, and the needs assessment would be a key part of their roles.

Results

The needs assessment process has worked particularly well with departments that interact with IT frequently. IT has developed a positive working relationship with Bus Operations, which has served both parties well during development and implementation of the Transportation Information Exchange System (TIES) used for operator and vehicle assignments and reporting. TIES replaced an unsupported legacy program. IT chose to create software to replace the legacy program rather than purchase COTS software because the business process in question was unique to RTD. They worked with Bus Operations directly and have continued to interact with the department through a TIES working group. The TIES software has met the needs of the users in Bus Operations.

Resources

The Pulse/Innotas (project requests)

IT Service Manager (service requests)

Department

Information Technology (Finance & Administration)

Contact(s)

- Kim Heldman, Senior Manager, Information Technology
- Rahul Sood, Manager, Software Architecture & Development

Goal

Improve responsiveness to business units and streamline software development and implementation.

Background

Over a six-month period in 2012, the Software Architecture and Development Group implemented an agile approach to software development to increase efficiency and ensure they were meeting the needs of the business units (users).

Before that time, the department used a "waterfall" approach to software development. The waterfall approach began with a long process to determine business requirements and obtain sign-offs from the business units, followed by an extended (3-month-to-one-year) development period and, finally, delivery of a product. There was little communication with the business units.

The waterfall process was slow and frequently ineffective, and the business units' needs would often change before a product was complete. In addition, substantial staff time was devoted to unnecessary documentation of the development process rather than producing software.

Best Practice

The agile approach emphasizes communication, collaboration, and flexibility. Before the entire project begins, developers work with the business unit to determine their needs and priorities and break the requirements into small pieces of work called "user stories." The user stories become part of a "product backlog," a to-do list for the developers.

Next, software developers are split into small project teams (called a "scrum") of 4-5 people that work on a segment of a project for a short period (called a "sprint"). The business unit selects top priorities (user stories) from the product backlog. The developers work on those priorities in the first project sprint, which lasts 2 to 4 weeks. At the beginning of the sprint, the development team (scrum) holds a planning meeting where each member chooses the user stories that they will own during the sprint.

At this point, the RTD implementation of agile diverges from the industry ideal. In an authentic agile environment, a product owner representing the business unit would attend the meeting at the beginning of the sprint. This rarely happens at RTD because the business units do not assign product owners. Instead, many people from each business unit are involved in the development process, while no single person has the authority to make a final determination about priorities. Because it is impractical to invite a large number of people from the business unit to the IT department meetings, IT holds a separate meeting with the business unit at the beginning of the sprint.

Members of the scrum work for the duration of the sprint to accomplish each priority, and it is important that the priorities do not change during this phase. In order to ensure that the team members can work without interruption, a "scrum master" oversees the sprint. The scrum master is similar to a traditional project manager, but it is a far more flexible position, and anyone on the team can be a scrum master. The team meets each day to discuss roadblocks and ensure that everyone is moving forward. The daily meetings are always short because everyone is required to stand.

At the end of the sprint, team members share results with each other. A product owner from the business unit is also invited to this meeting in an ideal agile environment. At RTD, because there is no product owner, a representative from the development team meets separately with the business unit to present the work. Next, a member of the development team consults with the business unit to identify the next set of priorities for the project. The process then begins again with another sprint.

At RTD, the process continues until the product vision and charter are fulfilled. There is no set scope statement. Instead, constant collaboration and communication with the business unit allow the developers to accomplish as much work as possible and ensure that the product is relevant.

Areas of Opportunity

Two important elements of the agile process are missing at RTD. First, the business units do not assign an owner or take responsibility for the product ownership for each product. This means that IT often acts as a mediator between different staff members or divisions with different expectations for a product. The problem with this approach is twofold. First, IT makes functional decisions that should reside with the business unit, and inviting a large number of individuals from the business unit to planning sessions is impractical, so the business units' involvement is more limited than it would be in an authentic agile environment. This leads to the same miscommunication and inefficiency that IT implemented agile to resolve. Secondly, IT does not have the resources (time and staff) to incorporate a retrospective into each sprint. In an ideal agile environment, the team would reflect on each sprint to identify strengths and gaps. Instead, the developers go through a lessons learned process only on the project level. Again, this means the process is less efficient than it might be in a pure agile environment.

Results

IT reports that the business units have been very receptive to the new agile approach because they are able to provide more input into the process than in the past. In addition, this approach has saved money and time because the software is more likely to meet the needs of the business unit than software developed using the waterfall approach.

Department

Information Technology (Finance & Administration)

Contacts

- Rahul Sood, Manager, Software Architecture and Development

Goal

Inform RTD staff and board members about various topic areas and promote consistent messaging across the agency.

Background

The FasTracks Public Information (PI) Division developed a Key Messages Manual in 2006 to provide the FasTracks team, board members, and other key agency staff with information and key messages on various topic areas so they would be able to answer questions about important issues. Up until that time, many staff and board members were not able to explain technical issues consistently and without slipping into jargon. In some cases, they did not understand technical topics that were important to the agency. There was no obvious place for them to go to quickly learn about an issue or learn how to explain it in a consistent, straightforward manner.

The Key Messages Manual was originally a controlled document within FasTracks available only in hard copy. The managers of FasTracks signed off on the document and the PI team distributed it to board members, FasTracks staff, and key staff throughout the agency. Eventually, the PI team collaborated with the Public Relations (PR) Division to expand the document into a general RTD Key Messages Manual. It is now available to the entire agency electronically through The Hub intranet and staff can print the manual from the link if they prefer to have a hard copy for easy reference.

Best Practice

Each year, the PI/PR Division revise the Key Messages Manual by working closely with subject matter experts throughout the agency. In many cases, they know the subject matter experts, but if they are not familiar with the best internal person to work with on a specific topic area they ask an AGM to recommend an expert. Members of the communications staff write the first draft of the key messages that are most relevant to their specialization. Next, they send the drafts to the subject matter experts to review and revise as necessary. Finally, the Senior Manager of Public Relations reviews the entire document prior to distribution. The PI team updates the Key Messages Manual annually and determines which messages are still relevant, which ones should be revised and what additional key messages should be created on new topic areas.

Throughout the year, the PI/PR Division develops and distributes key message sheets on topic areas as new issues emerge or change. At the end of the year, they roll all of the new sheets from the previous year into the Key Messages Manual and aim to distribute the manual to the agency at large in January. The document is a tool for all RTD personnel, who are ambassadors for the agency and could be in a position to provide information and field questions about RTD issues and initiatives at any time.

The PI/PR Division also complements the Key Messages Manual with communications and media training for board members, the senior leadership team and project managers. In addition, a weekly internal email called Friday Facts is an offshoot of the Key Messages Manual that came about because board members requested more up-to-date information and talking points on important and current issues.

Results

The manual is essentially a quality control tool for messaging related to FasTracks and, now, RTD as a whole. The Key Messages Manual, along with the additional work in media training by the PI/PR team, helped the agency stay on point through the economic difficulties of the recession and gain public support for the agency's innovative initiatives like the Eagle Public-Private Partnership (P3).

The Key Messages Manual helps board members and staff discuss topics and issues that could be technical or controversial, such as public-private partnerships, environmental planning, property acquisition, or funding. Board members and staff often use the Key Messages Manual when preparing for interviews, telephone town halls, public meetings or meetings with constituents. In addition, the PI/PR team refers to the Key Messages Manual and repurposes the information to efficiently write newsletters, articles and other informational materials.

Resources

Key Messages Manual is available on The Hub

Department

Communications

Contacts

- Pauletta Tonilas, Senior Manager, Public Relations & Public Information

Goal

Ensure consistency, quality, and equity in environmental planning across all FasTracks corridors.

Background

With the passage of FasTracks, RTD planned to build multiple rail corridors simultaneously for the first time. Before FasTracks passed, RTD had no guidelines or standards to ensure that environmental planning was consistent across corridors. To ensure consistency, the Planning Department created the NEPA Volume I manual – a set of guidelines for the environmental process to distribute to consultants – in 2006.

Best Practice

The RTD board requires that the agency follow a consistent process across all corridors, including corridors that receive federal funding and those that do not. When a corridor does receive federal funding, RTD must complete an environmental impact statement (EIS). For corridors funded through other sources, RTD completes an Environmental Evaluation or EE (which is not a NEPA term but a term created by RTD) that is equivalent to a federal NEPA process. By ensuring consistency across corridors, environmental reviews improve efficiency and result in a higher quality of environmental protection and predictability for corridor stakeholders. Maintaining consistency also ensures the process is equitable across the district and all corridors, ensuring compliance with Title VI regulations.

The NEPA Manuals provide guidelines and standards for the FasTracks environmental planning process. NEPA Volume I ensures that RTD takes a standardized approach to the EIS, and EE processes. NEPA Volume II outlines programmatic agreements with regulatory agencies and guides overall program environmental policy through the life of FasTracks. NEPA Volume III guides environmental work through design and construction. The three manuals have different users: Volumes I and II primarily focus on the early phases of a project, and consultants use them when preparing NEPA documents to ensure they meet RTD's specifications. RTD staff involved in environmental mitigation tracking, design and construction are the primary users of NEPA Volume III.

The FasTracks Environmental Resource Group (FERG) updates the NEPA manuals regularly and distributes "FERG alerts" to key staff when regulations change. In addition, a member of the FERG is embedded with each project so that RTD can quickly address environmental review issues as they arise. This structure allows FERG members to quickly identify and address inconsistencies across corridors. For example, currently consultants manage tree trimming differently in each corridor, so the FERG is creating a white paper on the topic to distribute to staff and consultants. Because very little design is completed upfront in design-build projects, FERG is especially involved late in the process: 30% of design must be completed for an EIS. FERG must work closely with Capital Programs as they build each corridor.

Capital Programs recognizes the value of the FERG group and the NEPA manuals because they make the environmental process more efficient and prevent problems with regulators. In addition, the Federal Government will not distribute funds to a project that does not follow environmental regulations correctly. Because the FERG group engineering comply with regulations, the FERG has been able to overcome any inter-departmental or disciplinary divides between planning and engineering. Capital Programs recognizes that the EIS process is part of doing business and consults the FERG members regularly. Even after the EIS process is over, RTD must conduct clearances (re-evaluations, categorical exclusions, and a supplemental EIS for major changes), and track mitigation commitments so the FERG works with Capital Programs continuously through the construction process.

Area of Opportunity

In the past, a planner was the project manager during the early phases of a project, while an engineer who would later become project manager worked on the project as a design manager/deputy project manager. . The engineer would take over as project manager during the final design and construction phases, while the planner stayed on the team to provide institutional memory and assist with planning and political situations that might arise late in the project. In practice, staff turnover has caused this system to break down, and planners have not had long-term involvement in projects. This is problematic when engineers make changes that could affect the environmental process or lead to other issues and do not inform planners early. In addition, the transition can be complicated because planners traditionally manage the politics of a project at the beginning and engineers, who may have less training in community and stakeholder involvement, must take over later on. Still, the process has worked effectively when staff members stay through the life of a project.

Results

A number of agencies have referred to RTD's NEPA manuals as they create their own processes for environmental review. Notably, CDOT used RTD's manuals as a basis for creating their own, similar documents.

Resources

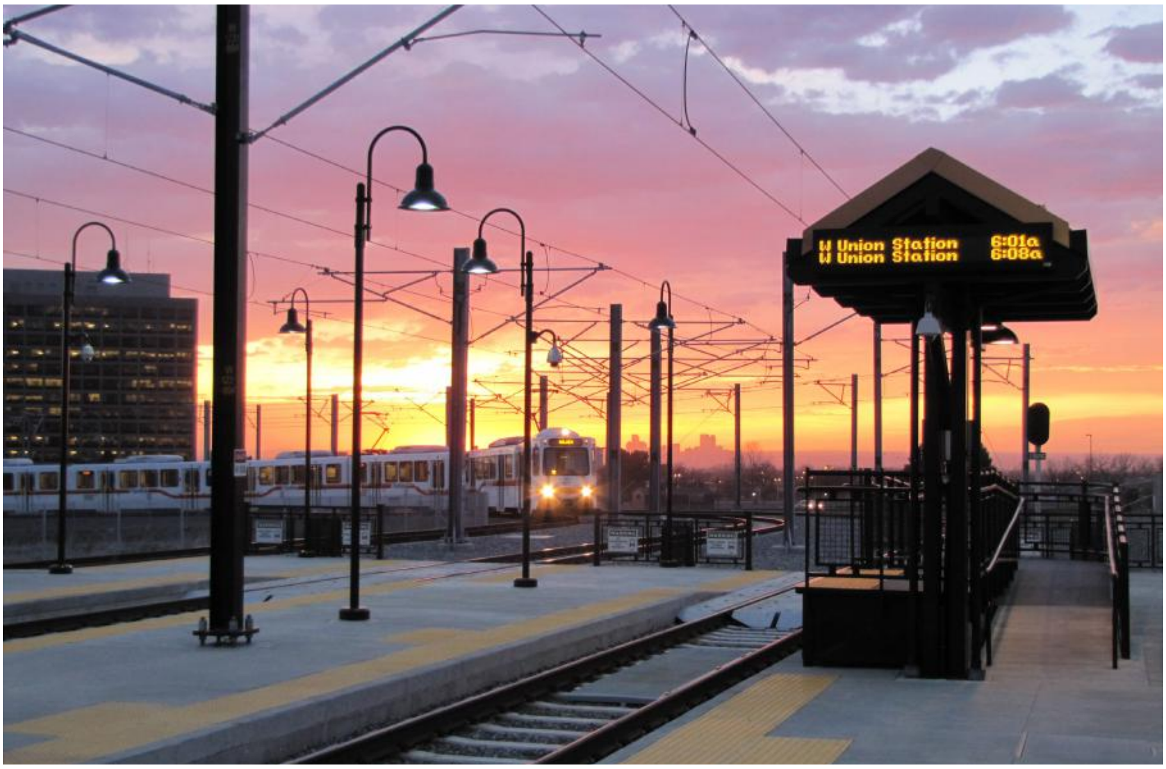
Manuals are stored on the X: Drive (Internal Only)

Department

Planning

Contact(s)

- Liz Telford, Manager, Corridor Planning (Environmental)



Technology

RTD has increasingly begun to recognize the importance of technology in all areas of the operation. As the agency has expanded without adding staff, the importance of using technology to "do more with less" is more evident than ever. At the same time, providing information is becoming increasingly essential to RTD's mission: for example, providing information to customers can increase reliability, and using technology to share information across the district can increase safety. As one employee put it, "we are becoming an information company."

While RTD continues to add technological advances, the agency has accomplished major technology projects that lay the groundwork for future innovation: the CAD/AVL project featured here is the primary example. Finding opportunities to use technology in other areas, such as Title VI reporting, is an ongoing project for many parts of the agency.

The best practices below should inspire smaller transit agencies that are just beginning to make the transition to transit's information age.

CAD/AVL Implementation

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Goal

Select and implement a Computer-Aided Dispatch/Automatic Vehicle Location (CAD/AVL) system for Bus Operations to increase reliability and safety of bus service.

Background

In the mid-1990s, RTD implemented a new state of the art CAD/AVL and radio system. By the mid-2000s, RTD's Motorola 450 MHz three-tower radio and Trapeze dispatch systems were antiquated and crashed frequently, leaving dispatchers and street supervisors with few options for contacting bus operators. Occasionally, Dispatch was forced to operate for days at time with only voice communication to buses. In other cases, the system would report that buses were driving in non-specific or even non-existent locations, such as the intersection of Interstate 25 and Interstate 25. When that previous system was implemented, there was turnover in project managers and few users were consulted during the testing, roll-out or troubleshooting phases. The system was already becoming antiquated within five years of implementation.

In 2003, the Federal Communications Commission (FCC) announced that they would narrow-band the radio system that RTD was using as part of the problematic earlier system. This gave RTD a regulatory deadline of December 31, 2012 to switch to a new radio system. As the project to create a new radio system began, the agency recognized that this was an opportunity to capitalize on new technology and replace the entire antiquated system.

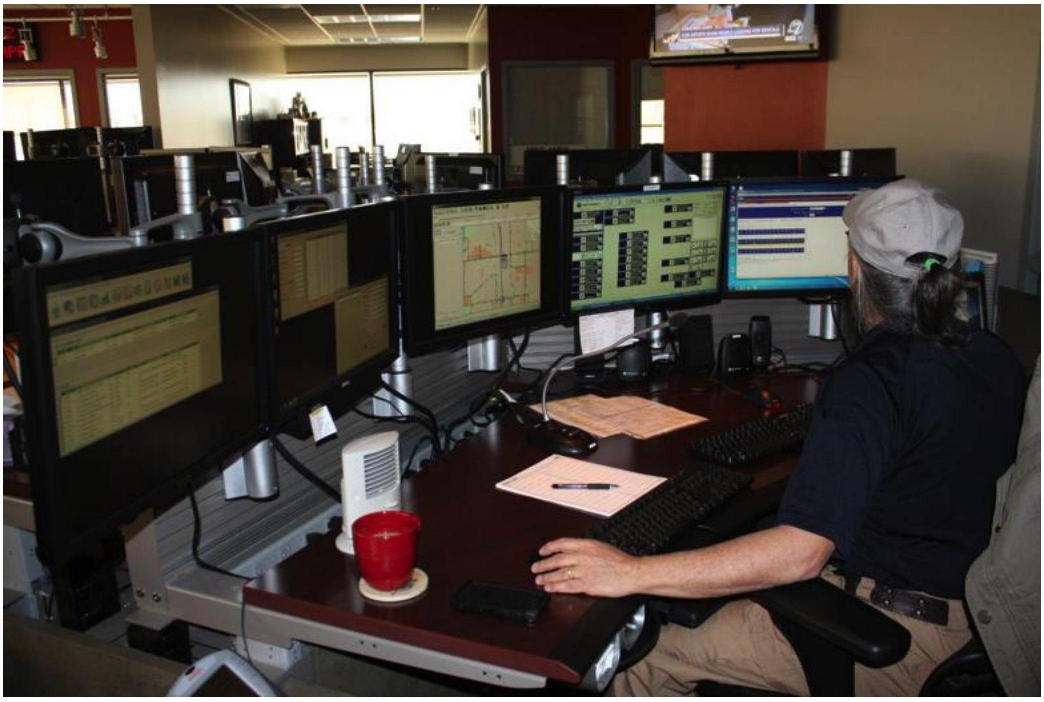
Best Practice

The Bus Operations Department and Information Technology (IT) division worked together on the CAD/AVL project from the beginning. Early on, Bus Ops and IT defined their responsibilities related to the project, with IT acting as the technical lead and Bus Operations acting as the business lead.

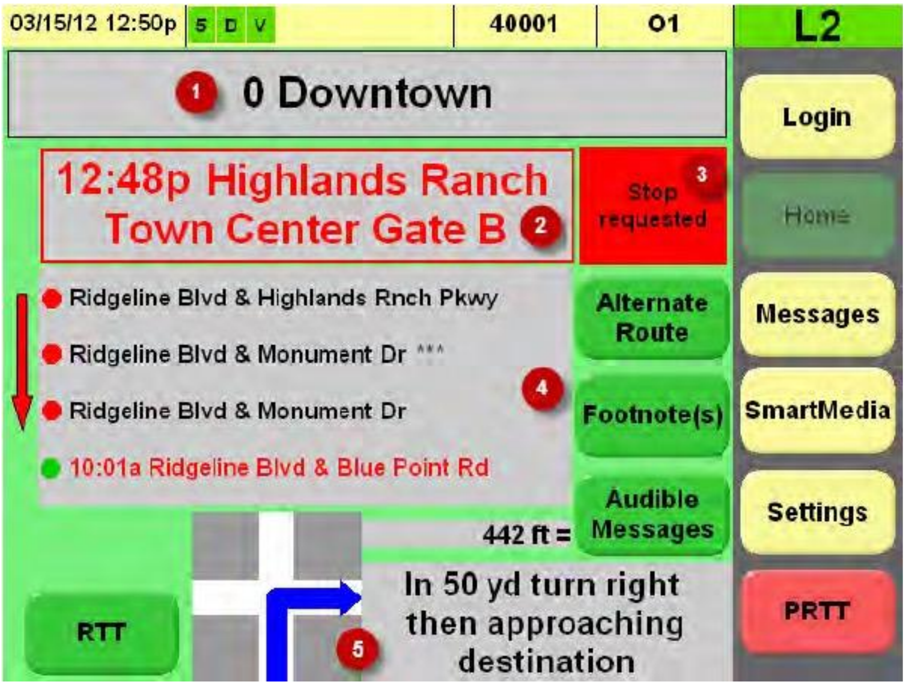
When it became clear that the CAD/AVL project would be a more significant undertaking than a simple radio upgrade, the IT project manager took the lead and brought on a consultant, Booz Allen Hamilton, to help plan the project. IT was able to hire the consultant quickly because they already had an ongoing work order with Booz Allen Hamilton, avoiding any delays that could have been caused by a long procurement process. Booz Allen Hamilton recommended that RTD hire an owner's representative to be a project consultant, conduct a peer review, and act as a liaison between the project vendor and RTD. The owner's representative would also advocate for RTD's interests and take on other short-term tasks during the project roll-out.

RTD considered proposals from multiple owner's representatives (including Booz Allen Hamilton), and selected IBI Group. IBI conducted a thorough peer review, including examinations of Baltimore, Portland, and Atlanta's experiences, producing insider intelligence on potential CAD/AVL vendors. With that knowledge, RTD staff was able to make an informed choice about who to select. Shortly thereafter, RTD staff also visited transit agencies that had recently implemented CAD/AVL in Everett and Seattle WA and Vancouver, BC. IT project management staff feel that having an owner's representative has been a key component of the successful CAD/AVL implementation.

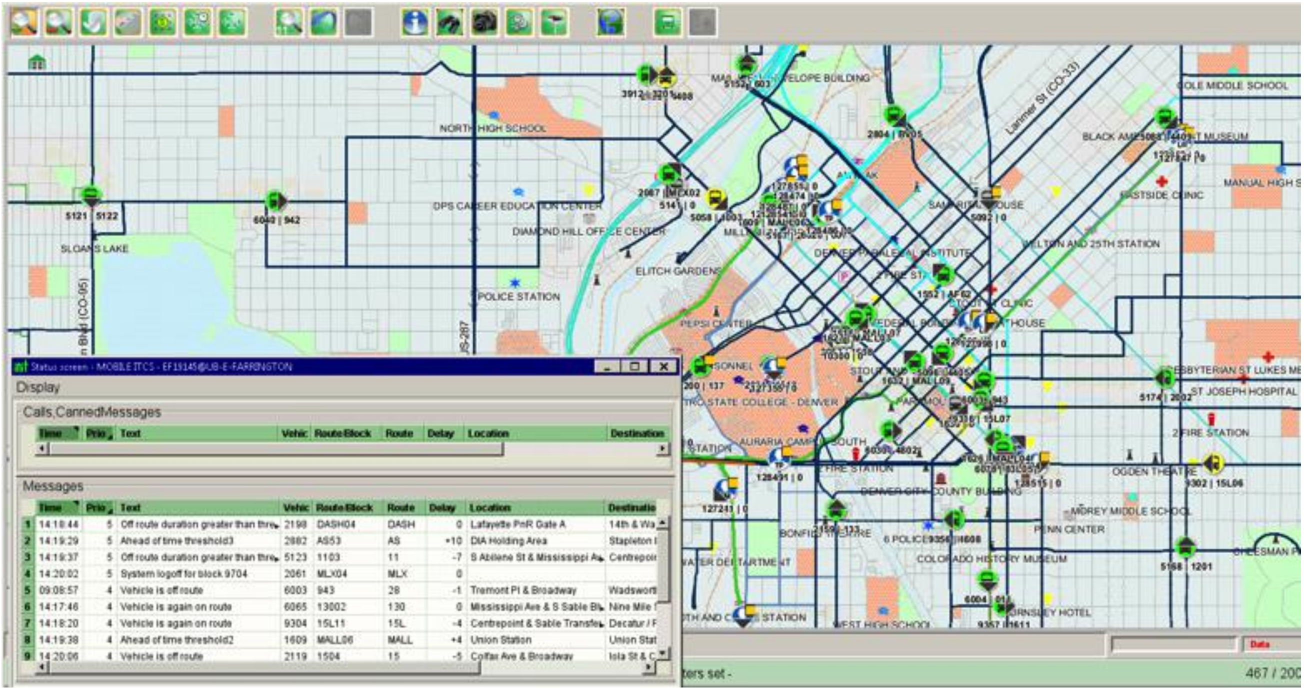
Informed by the owner's representative's findings, IT and Bus Operations worked together to create a request for proposal (RFP) for a CAD/AVL vendor. They selected Innovations in Transportation, Inc. (INIT) after a rigorous review of proposals and contacting other transit agencies that had worked with the company. Their knowledge of INIT helped RTD staff create a contract that accounted for some of the vendor's drawbacks. For example, other agencies had informed RTD that INIT's documentation and project management were not as good as needed, so the IT department requested that INIT improve documentation and project management. The owner's representative has consistently worked with INIT to ensure that their documentation is useful for RTD.



Throughout the project, but especially in the implementation phase, the project managers ensured that end users in Bus Operations would be able to help select features and test the system. Representatives from Dispatch and Street Supervision sit on an ongoing Change Management Board, which has the authority to make decisions and troubleshoot issues as they arise. In addition, dispatchers and street supervisors have unofficial point people within their division who work directly with IT. IT has also assigned the Program Manager as a key contact within their own division to work with Dispatch and Street Supervision. Identifying point people who can understand both the operations and the technology side has helped with troubleshooting as issues and challenges arise.



IT and Bus Operations decided to roll out the CAD/AVL project in phases in order to work out issues before deploying the new system across the entire district. The project roll-out began with a "mini-fleet" in Boulder. While this first test phase showed that the system essentially worked, the schedule forced RTD to allow the rest of the fleet to be installed before passing all of the requirements of mini-fleet. These additional issues remained unresolved during the full system roll-out. In retrospect, managers would have included some contractor buses as well as more street supervisors in that first, test "mini-fleet." Because all of the fleet was installed before the "mini-fleet" phase was complete, IT and Bus Operations gradually implemented CAD/AVL through the rest of the system as the vendor installed the new equipment in all of the buses. In the meantime, Dispatch successfully operated two systems at once for approximately 14 months, while some buses still used the old system and others had been upgraded.



While the project implementation was underway, Dispatch modified their workspace, added five new workstations, and added staff in order to handle the new system. The dispatchers, who would eventually be using both the new system and the space, were heavily involved in this process. Receiving the resources to adapt the division to the new system was an important component of successful CAD/AVL implementation.

Training was also a key component of CAD/AVL success. The vendor conducted the initial training. Bus Operations trained dispatchers, street supervisors and operators and then re-trained them as necessary. For dispatchers and street supervisors, they used a "train the trainer" approach, designating super users who would learn about the system from the inside out and then train their colleagues. Operators have a user-friendly interface and require less training than street supervisors and dispatchers, but they are introduced to the system in initial operator training and then have the option to use it extensively or very little, depending on their preferences. There are training bus-in-a-box units at the Divisions for the operators to use. In addition, the training division within Bus Operations developed a video for training operators.

Throughout the process of implementation, IT and Bus Operations have provided regular updates to the Board of Directors. The Board has been supportive of the project throughout and allocated enough resources to keep the process moving without significant delays. The public has been informed of the project through the board updates, but CAD/AVL is primarily an internal-facing project so far.

Results

The CAD / AVL system was a major, seven-year project costing approximately $51M. The CAD / AVL implementation has been RTD's largest non-FasTracks project in the past decade. Like any significant project, CAD / AVL has had occasional issues and delays. Due to having an owner's representative on board, using the knowledge from the peer review, good communication channels and clear delineations of authority between IT and Bus Operations, and significant user involvement in the selection and modification of the technology, the system has performed well so far and issues that have arisen have been resolved rapidly.

So far, CAD / AVL has significantly increased both the safety and reliability of the bus system. For example, with the real-time data that now moves between Dispatch and operators, dispatchers can immediately see if a bus is running late and send a back-up out to improve reliability. Dispatchers and street supervisors also know the exact locations of accidents in real-time, meaning they can arrive at the scene and send a new bus more quickly than they could in the past. Because communications systems have improved, operators can immediately inform Dispatch or Security of incidents on buses, improving response times and passenger safety. Telephone information center (TIC) operators also have access to real-time data on bus delays, so customers who call TIC can find out when a late bus will arrive or where their bus will pick up during a temporary detour.

The next phase of the CAD / AVL project will be the provision of real-time data directly to customers through a General Transit Feed Specification (GTFS-Real Time) feed. Creating the feed requires RTD's IT department to structure the information from the CAD / AVL system and other systems into one, simple data feed so that RTD and software developers can use the data to provide trip updates (delays, cancellations, changed routes), service alerts (stop moved, unforeseen events affecting a station, route or the entire network), and vehicle positions (information about the vehicles including location and congestion level). Provision of an open data format for schedules and associated geographic information enables private-sector developers to create apps for smart phones so customers can see where their bus is in real-time and predict its arrival at their stop. In addition, consolidating and distributing the data collected through the CAD / AVL system, such as on-time performance information and passenger counts, will allow RTD to analyze bus on-time performance, identify ongoing issues with problem routes, and improve service planning.

Resources

CAD / AVL Project Management Site

Board Reports

Departments:

- Bus Operations
- Information Technology (Finance & Administration)

Contacts

- George Hovey, Manager, Program Management Office
- Eric Farrington, IT Program Manager
- Mike Gil, Deputy Assistant General Manager, Bus Operations
- Gina Callahan, General Superintendent of Street Operations
- Vaughn Townsend, Street Supervisor
- Daniel Lamorie, Dispatcher

GIS for Title VI Compliance

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Goal

Use maps to show that RTD is in compliance with Title VI of the Civil Rights Act of 1964, which prohibits discrimination on the grounds of race, color and national origin.

Background

RTD must submit a Service and Fare Equity Analysis (Title VI Analysis) to the Federal Transit Administration (FTA) after significant service changes, defined by the FTA as "a 25% addition or reduction in the service hours of any route that would remain in effect for twelve (12) or more months." The Title VI Analysis must show that the service change does not have a disparate impact on low-income and minority populations as well as populations with limited English proficiency (LEP), meaning it cannot affect those populations 10% more than their non-low-income, non-minority, or English-speaking counterparts in the district. If an agency is found to be in violation of Title VI, that agency may lose its federal funding.

In 2006, RTD included Geographic Information Systems (GIS) maps in the Title VI report for the Southeast Corridor light rail opening to help demonstrate that the service addition did not have a disparate impact on protected groups. FTA responded favorably to the maps, and RTD has included maps in every Title VI report since that time.

Best Practice

RTD service planners determined that they could use GIS as a tool to help tell a story about how the agency serves the district equitably. RTD Title VI Analyses now include detailed maps drawn from census data to show how route changes will affect minority and non-minority as well as low-income and non-low-income riders within the district. Maps and aerial photos created in GIS show the density of residents by income level, race and ethnicity and LEP status with routes overlaid.

Exhibit A: Arvada

For example, the aerial photo of Arvada above shows a low-density region with a low percentage of minority residents and a low level of service provision. Using this visual, RTD can quickly communicate the low need for service in this area and justify the level of service provided.

Exhibit B: Northeast Park Hill

By contrast, the Northeast Park Hill neighborhood, above, is another low-density area due to a mix of single-family and industrial uses. That neighborhood has a far higher percentage of minority residents and a higher level of service provision than the selected area in Arvada.

In a recent Title VI Analysis, RTD showed both maps side-by-side to show how the agency determines the level of service to provide across the district, and to demonstrate that the agency equitably serves district residents.

Results

FTA was impressed with the GIS maps and illustrations that RTD provided in the Southeast Corridor Service and Equity Analysis. FTA now recommends maps in all Title VI reporting nationwide.

Resources

Zachary Van Gemert, "GIS for Title VI Compliance," GIS in Transit Conference, 2013

Departments

Bus Operations

Planning

Contact(s)

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- Jessie Carter, Manager, Service Planning and Scheduling
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Denver RTD Personnel Development

- Succession planning
- Training responsibilities are assigned to named individual(s).
- Training activities periodically reviewed.
- Data is collected to determine training effectiveness.
- A documented process is in place for recognizing outstanding performance on projects
- Project Management is an established career path
- Established goals for improving project management capabilities Employees have personal development plans.
- Training on team development exists
- Project Team development is planned and budgeted
- Employee’s contribution to organizational strategic goals and objectives are assessed
- A mentoring program is in use that provides timely feedback
- The effectiveness of mentoring is periodically reviewed.

RTD FASTRACKS

FasTracks 2009 Lessons Learned Report

Regional Transportation District

Regional Transportation District

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RTD

September 15, 2009

Every successful organization learns from the past and improves for the future. When I assumed the duties of RTD Interim General Manager, one of my first directives to staff was to develop a Lessons Learned document to analyze the first five years of the FasTracks program. The idea is to gain direct knowledge from our experiences and use it as a guide in moving forward toward program completion.

In this initial document, we focus on nine primary areas including: Planning/Environmental Studies, Cost Estimating, Revenue Forecasting, Railroad Rights-of-Way, Property Acquisition, Management, Processes/Procedures, Project Delivery and Communications. Our team intends to implement an ongoing Lessons Learned process to capture and update these ongoing experiences throughout the program. We plan to publish this document on an annual basis to reflect upon the previous year's practices.

While my intent is to use this document to ensure our continuous improvement in implementing the FasTracks investment, we welcome other agencies and even our federal partners to learn from our experiences as well.

Finally, this document is an agency-initiated undertaking to be honest and open about what has gone well and should be repeated, and also identify things that we would and will do differently. However, we know there will likely be some who criticize the District. We choose to be forward looking in our approach, and be very clear and transparent in our continued implementation of this great project. Our program objectives remain the same:

- Complete the FasTracks investment initiative
- Help create huge, community-wide economic benefits
- Provide a quality program and develop a world class transit system
- Ensure public and transit system safety
- Minimize impacts during construction
- Provide timely, accurate, clear, consistent information to the public
- Create jobs and opportunities for individuals and small businesses

We look forward to working hard and smart with the RTD Board and our stakeholders to complete the long-term investment called FasTracks.

Phillip A. Washington

Phillip A. Washington
Interim General Manager

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Executive Summary

Every major program has something to learn from its experiences. The FasTracks program is currently one of the most ambitious transit expansion efforts in the nation. The Regional Transportation District (RTD) has built four light rail projects on time and on budget and has drawn upon the many lessons learned on each of those individual projects to develop the long-range FasTracks program. A program of this magnitude is a unique venture that is positioned to benefit not only from the lessons of the past, but also to present a whole new slate of experiences that emerge from its trailblazing nature.

Nearly five years into the implementation of FasTracks, RTD has taken a look back at what's gone well from the start and what we will do differently given what we know now as the program moves forward. These insights come together as the first FasTracks Lessons Learned Report. The report is presented as nine main categories that break down into a number of lessons within each topic area. The key lessons we've learned are summarized below.

- **Planning/Environmental Studies –** We've learned to appropriately staff projects from day one with experienced planning and engineering project managers and support personnel; to allot three to five years in the schedule for future planning/environmental studies; and that many third-party requested changes in plans or requirements require significant analysis that can delay studies.

- **Cost Estimating –** We've learned that it's beneficial to provide a program-wide contingency to cover uncertainty and unknown issues rather than relying only on individual corridor contingencies; to maintain a 30% cost contingency until design reaches 30%; and to advance engineering to identify risks and the costs associated with them, ensuring the FasTracks plan is shovel-ready before requesting any additional tax increase to construct the projects.

- **Revenue Forecasting –** We've learned that it is more prudent to provide a range (best-case and worst-case cash flows) of potential sales and use tax collections, rather than an exact figure, for longer-term projections; the importance of educating stakeholders and the public on RTD's forecasting methodologies; and it should be emphasized more clearly that long-term growth projections are averages, rather than exact forecasts of annual growth rates.

- **Railroad Right-of-Way –** We've learned that when establishing a budget for purchasing railroad right-of-way, the actual cost should include a larger corridor enhancement factor to be more on the conservative side; that there should be a greater emphasis on minimizing impacts to railroad operations to help contain the cost of relocation or enhancement; and to allow sufficient time to negotiate to accommodate the railroads' approval process by their various departments.

- **Property Acquisition** – We've learned that more direct coordination among internal disciplines is essential to provide consistent communication with potentially impacted property owners as design progresses, always stressing that the acquisition of property takes place following the completion of the formal environmental process; and that designers providing certified rights-of-way plans as early as feasible is key to completing property acquisitions in a timely manner prior to construction.

- **Management** – We've learned that staffing resources must be at a sufficient level to adequately address the demands of the program; that the "matrix" organization works well as long as each corridor project has an adequate core group of personnel who are fully dedicated to that corridor; and that it's essential to assign full responsibility and final decision-making authority on program implementation to the FasTracks Program Manager, in conjunction with the General Manager and Board of Directors..

- **Policies/Procedures** – We've learned that we must focus progress reporting and issue resolution on critical schedule milestones; that integration of FasTracks-specific control systems with overall RTD processes and systems is critical; and that adequate business processes and internal controls need to be in place before entering into joint construction agreements for projects.

- **Project Delivery** – We've learned that design-build, design-build-operate-maintain and design-build-finance-operate-maintain delivery methods bring a significant private sector component into the management of these projects, which maximizes contractor innovation and participation; and that negotiated contract prices are extremely challenging to implement and should be avoided in the future.

- **Communications** – We've learned that it is important to clearly define an overarching Public Information and Public Involvement Program as early in a program as possible; that it is essential to communicate the stakeholder participation process and how involvement opportunities narrow as a project becomes more defined; and that the level of internal communication must accommodate the size and de-centralized nature of a multi-project program.

Lessons Learned

Lessons Learned are general statements that describe good practices or innovative approaches that are shared to promote repeat application. They may also be descriptions of challenges or areas for improvement that are shared to provide continuous improvement.

Effective organizations use past experience as a guide to improve future performance. A program as large and complex as FasTracks is especially prone to offer lessons that can be used throughout the completion of FasTracks itself, as well as for future programs. As several FasTracks corridors move from the planning to construction phase, it provides an excellent opportunity to reflect on Lessons Learned from the FasTracks program – things that have gone well that should be repeated, and things the FasTracks team would recommend be done differently. The FasTracks team intends to apply these Lessons Learned moving forward, to ensure continuous improvement on its implementation of FasTracks and welcomes other agencies and organizations to learn from our experience as well.

In addition, FasTracks plans to implement an ongoing Lessons Learned program to capture and update these ongoing experiences throughout the program.

FasTracks Program Background

FasTracks is the Regional Transportation District's (RTD's) voter-approved, multi-billion dollar program to build 122 miles of rail transit, including six new commuter rail and light rail lines and extensions of three existing lines; build 18 miles of bus rapid transit service, add 21,000 new parking spaces, redevelop Denver Union Station and redirect bus service to better connect the eight-county District. FasTracks is funded through a combination of sources, including the voter-approved sales tax increase of 0.4 percent (4 pennies on every $10), passed in 2004. RTD has adopted program goals and objectives to guide the implementation of FasTracks.

FasTracks Program Guiding Principles

- Ensure every step contributes to the full vision
- Focus money available to the greatest good
- Spend public money wisely
- Maximize outside funding before returning to taxpayers
- Deliver key investments in all corridors

FasTracks Program Goals

- Provide improved transportation choices and options to the residents of the District – additional transportation choices add to the region's quality of life.
- Increase transit mode share during peak travel times – existing congestion during peak travel times of the day is frustrating for many drivers and is expected to worsen as the region grows.
- Establish a proactive plan that balances transit needs with future regional growth – the Denver metropolitan region is expected to grow from 2.6 million (2005) people to nearly 4 million in 2030.

FasTracks Program Objectives

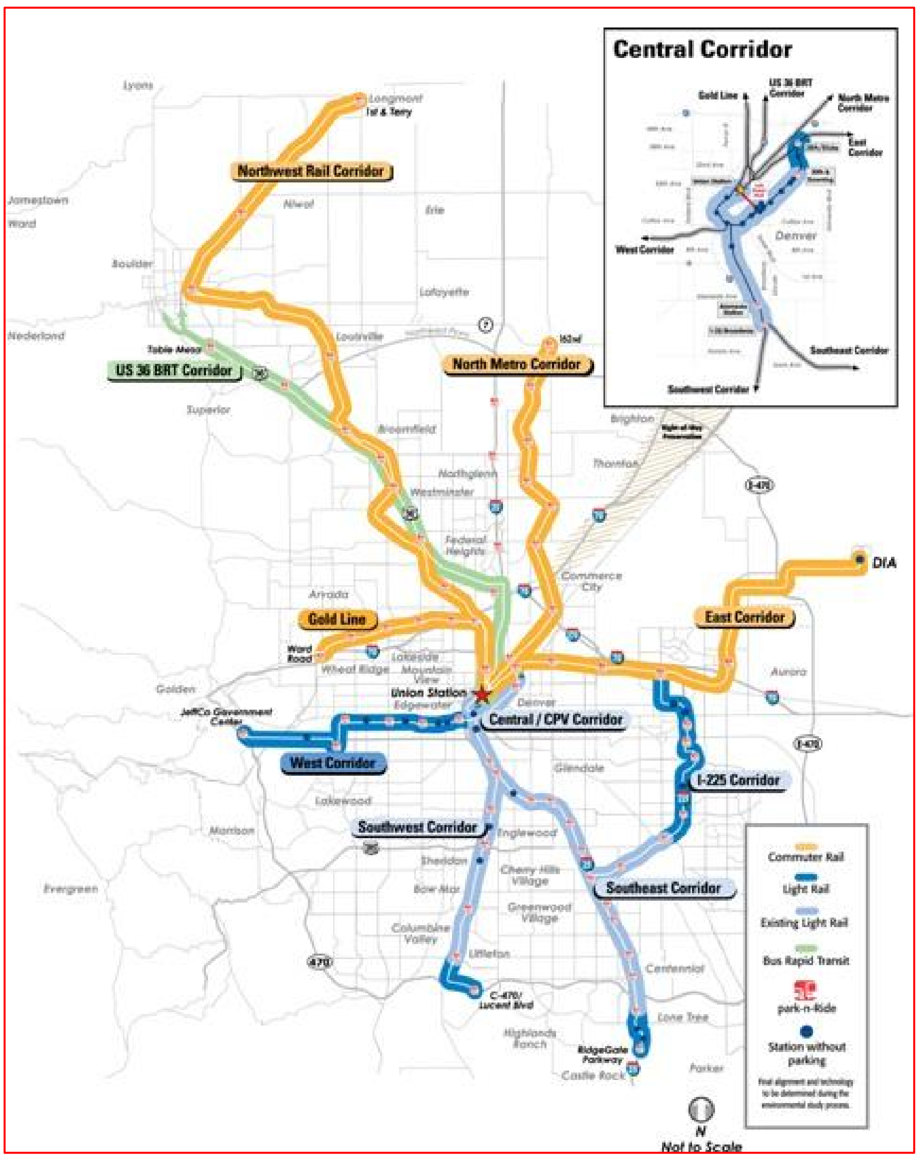
The FasTracks team's mission is to provide a reliable and safe transit system that enhances mobility, responds to the growing transportation needs within the Regional Transportation

District, and creates a legacy for current and future generations. The team will accomplish this by achieving the following objectives:

- Complete the FasTracks investment initiative
- Provide a quality program and transit system
- Ensure public and transit system safety
- Minimize negative impacts to the community
- Provide timely, accurate, clear, and consistent information to the public
- Create opportunities for Small and Disadvantaged Business Enterprises

FasTracks – An Economic Driver

FasTracks is projected to create more than 10,000 construction jobs alone during the height of construction. Economists estimate that every $1 invested in transportation infrastructure translates into $6 of local economic activity. The FasTracks investment initiative will pump billions of dollars into the regional economy.



FasTracks 2009 Lessons Learned – Master Contact List

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Project Web Site: www.RTD-FasTracks.com	

Lesson Learned # 1

Planning/Environmental Studies

1. Overview

Planning and environmental studies are the first key element of a successful public project. When voters approved FasTracks in November 2004, one of the 10 studies needed was complete (West Corridor) and two environmental studies on joint CDOT/RTD projects were already underway (U.S. 36 and I-70/East Corridor/Central Corridor Extension). FasTracks provided a funding stream for the Regional Transportation District (RTD) to launch studies in the remaining six projects. The Regional Transportation District's (RTD's) original internal schedules for completion of planning and environmental studies allotted approximately two years for completion of these studies. Consistent with the average length of planning and environmental studies nationwide, the majority have taken four to five years to complete. Schedule changes resulted from a variety of impacts, including the number of studies underway simultaneously, the length of the procurement process, changes in requirements or alternatives that arose from outside entities, station location requests, and other project elements that differed from original plans. Additionally, conducting multiple concurrent studies created challenges early on for RTD to staff the projects with sufficient levels of planning and engineering management and support personnel. Following are some of the primary lessons we've learned during planning:

- An Environmental Methodology Manual helps to streamline coordination efforts with local and Federal agencies
- RTD's planning and environmental study schedules should be based on national averages, and reflect the number of studies underway concurrently.
- Analysis of alternatives should be completed early in the planning and environmental process.
- Third-party requested changes in plans or requirements require significant analysis that can delay studies.
- Key stakeholder buy-in regarding plans and alternatives selected is critical to successfully advancing planning and environmental studies in a timely manner.
- Projects should be appropriately staffed with experienced planning and engineering project managers and support personnel from day one.

2. Background

Prior to implementing FasTracks, RTD successfully completed planning and environmental studies for a succession of projects, including the Southwest Corridor Environmental Impact Statement (EIS), the Southeast Corridor EIS – which was managed and funded by the Colorado Department of Transportation (CDOT), not RTD – the Central Platte Valley Environmental Assessment (EA) and the West Corridor EIS. These studies were performed with little overlap, allowing RTD to focus staff resources on each study sequentially through planning, environmental analysis, design phase(s) and construction.

With FasTracks, RTD embarked on multiple environmental studies at the same time. As a result, RTD faced staff resource challenges across all disciplines, including planning and environmental staff. At the outset, some of RTD's planning and environmental staff were assigned multiple corridor projects to manage, or were asked to manage a project while also leading key technical discipline analyses.

RTD also encountered numerous changes to corridor alternatives. Examples include the change in technology for the Gold Line from light rail to commuter rail as a result of Railroad (RR) requirements, the change in commuter rail alignments resulting from significant changes in RR negotiations, and the changes in location for the commuter rail maintenance facility as the process progressed. These types of changes had significant impacts to study schedules.

3. The Lessons

All of the FasTracks projects are nearing completion of the planning and environmental study process, with solid, implementable plans that have received extensive input and general concurrence from stakeholders, RTD staff and the RTD Board of Directors. As noted, many of these studies have extended beyond the original schedule, largely as a result of the issues addressed above, but remain within national averages of three-to-five years. Key lessons learned include:

- Allot three-to-five years for future planning/environmental studies.
- Early interaction and agreement with key stakeholders and third parties regarding project scope, alignments and stations is critical. This has helped project studies avoid further project delays as the projects progress.
- Begin studies fully staffed in all disciplines based on the scope and schedule identified.
- RTD's Environmental Methodology Manual, which incorporated lessons learned in real time and streamlined coordination efforts with local and Federal agencies, has been a success that helped lead the Federal Transit Administration's (FTA's) to award the Gold Line Environmental Impact Statement (EIS) for Excellence in Environmental Document Preparation.

Lesson Learned # 2

Cost Estimating

1. Overview

The cost estimates for the original FasTracks plan were developed in 2002 and 2003 with the best information available at the time. The original cost estimates do not cover the program costs as they are now projected. Several reasons account for this, including changes in technology, new alignments for the corridors, negotiations with the railroads (RRs), the number of right-of-way (ROW) acquisitions, extraordinary inflation in material prices, and existing conditions associated with utilities, drainage and environmental requirements. In addition, requirements imposed on the Regional Transportation District (RTD) by the RRs in order to occupy their ROW for shared use along the corridors also affected the ultimate cost for the plan. While the conceptual FasTracks plan presented to the public always included language that the plan was subject to the results of the Environmental Impact Statement (EIS) processes, it is now clear that the 25% construction cost contingency in the original plan was not sufficient to accommodate these changes. The major impacts to the cost estimates include:

- **Changes in Technology:** Electric Multiple Units (EMUs) are now proposed for the East and North Metro Corridors, which will increase the initial capital cost due to the cost of electrifying the corridors for commuter rail service. This cost will be offset by operating cost savings in the future, but the impact to the capital cost is not recoverable initially.
- **Railroad Negotiations:** RTD was precluded from negotiating agreements until after the vote, when the RRs would be assured that project funding was available. The cost for acquisition of their property was higher than was originally anticipated, including new safety requirements imposed on RTD by the RRs for use of shared corridors following a September 12, 2008 commuter rail accident in Los Angeles, California.
- **Material Costs:** From 2005 thru 2008, the cost of construction materials substantially increased. The cost of fuel increased from less than $2 per gallon to over $3 per gallon, steel prices more than doubled, from around $600 per ton to more than $1,500 per ton, the price of copper and other construction related materials also increased at unprecedented rates. Many of these cost spikes were influenced by global consumption of construction materials. This was a marked change from the 15-year period prior to the development of the FasTracks plan, when material costs increased at a rate similar to the Consumer Price Index (CPI).
- **Level of Design:** The level of design used to estimate the cost of the plan was at a conceptual level in 2003/2004. While RTD would have liked to complete more extensive design prior to the 2004 FasTracks vote, it didn’t have the funding and was constrained from doing so by Federal regulations. FasTracks projects are now at a more advanced level of design which addresses these impacts and they are reflected in the current cost estimates.

- **Contingency:** The amount of contingency used for the cost estimates was 25% of base construction costs, consistent with past regional projects done by RTD, CDOT and local agencies. Due to the size and complexity of FasTracks, a program-wide contingency applied to the entire cost of the plan, and not just construction, would be recommended.

2. Background

The original cost estimates for the FasTracks Plan were generated using the most current prices available at that time. The basis for the estimates were costs bid for the Transportation Expansion (T-REX) Project, the Southwest Corridor (SWC) and the Central Platte Valley (CPV) as well as costs generated for recent construction of park-n-Rides, CDOT construction bid items, recent City and County of Denver construction projects and costs used by the RRs for work of a similar nature. These costs were compared to other similar projects constructed throughout the United States using data generated by the Federal Transit Administration (FTA). In addition, an independent cost estimate comparing unit prices was prepared by EarthTech, an outside firm engaged by RTD to review RTD's cost estimates, as a means of validation. These cost estimates were vetted by the Denver Regional Council of Governments (DRCOG) through a Peer Review and were reviewed by CDOT in separate meetings. The costs were determined reasonable and the estimates were submitted for acceptance by DRCOG through the SB208 (Senate Bill 90-208) process.

The cost estimates were based on certain assumptions that were later modified during the EIS processes. For example, train technology was changed on four of the corridors. It was subsequently determined that EMUs would be used on the East, North Metro and Gold Lines rather than the originally assumed diesel technology on the East and North Metro corridors, and the original assumption of light rail transit (LRT) on the Gold Line. Diesel Multiple Unit (DMUs) would be used on the Northwest Corridor rather than Locomotive-Hauled Coach technology. The analysis determined that the operation of EMUs would mean a higher capital cost to the program initially, but lifecycle cost savings to the program would be achieved over time through energy cost savings.

Other general assumptions that were made initially also required adjustment as projects became more defined, including:

- Drainage requirements
- Deflection walls required by the RRs.
- RR ROW costs
- Impacts to existing infrastructure such as the rebuilding of streets
- Number of utility relocations

Finally, the cost of materials grew exponentially from the time the FasTracks cost estimates were developed, as evidenced by increases in the cost of steel, copper, fuel, and cement, accounting for approximately one-third of the program's estimated cost increases.

3. The Lessons

The estimated cost for the FasTracks plan has increased substantially since the vote in 2004. The cost estimates were generated using the best available information at the time. Lessons learned include:

- Provide a program-wide contingency to the plan to address potential uncertainty and unknown issues.
- Provide an allocated contingency to specific cost elements. Perform formal risk management analysis to major corridors to identify risks and the contingency that must be allocated for each risk.
- Increase the percentage applied to unspecified items such as utilities and drainage, based on the level of design.
- Increase the construction contingency level from 25% to 30% of the total calculable cost at the conceptual level of design to help mitigate for increases in construction and unforeseen elements within the corridors.
- Do not decrease the contingency for the project until the level of design is at a point where all the impacts and changes have been identified and a mitigating solution has been reached (usually at a 30% or better design level).
- Continue to incorporate risk assessments into design reviews to identify potential additional cost elements.
- Continue to perform independent, bottom-up cost estimates when the design level reaches 30% to provide a high level of confidence in the estimate.
- Advance engineering to identify risks and the costs associated with them, ensuring the FasTracks plan is shovel-ready before requesting any additional tax increase to construct the projects.
- Instead of assuming that future construction materials costs will escalate at the forecasted CPI, use forecasts specific to the types of materials used for transit construction.

Lesson Learned # 3

Revenue Forecasting

1. Overview

The Regional Transportation District (RTD) is very reliant on sales tax revenues for operation of its existing system and the build-out of FasTracks, which makes it vulnerable to economic cycles and short-term fluctuations in sales and use tax collections. For the past four years, sales and use tax collections, which are the primary source of funding for the FasTracks program, have fallen below the annual projections made at the time the FasTracks plan was adopted. While the forecast for FasTracks funding took into account economic ups and downs over the long-term (30 years), the sustained downturn that has occurred throughout the early years of the program has had a significant impact on RTD's ability to fund the increased capital cost of the program in the relative medium term (2017). Each year, staff revises the sales and use tax forecasts based on the most current available economic forecasts. The current forecast collections through 2035 are 31% lower than the original 2004 forecasts, resulting in insufficient funding to cover current projected program costs.

2. Background

The sales and use tax forecasts incorporated in the original FasTracks plan were based on the best available economic projections at that time. Short-term forecasts were based on statewide projections by the Colorado Legislative Council and the Office of State Planning and Budgeting. Longer-term forecasts were based on data from the Center for Business and Economic Forecasting. The long-term forecasts were adjusted downward prior to adoption of the final plan at the recommendation of the consultant engaged by the Denver Regional Council of Governments (DRCOG) to review the financial plan in the SB208 process. The resulting projections showed an average annual growth rate lower than RTD's 20-year historic average annual sales and use tax growth. The financial plan approved by DRCOG though the SB208 process included the adjusted projections.

Each year, RTD staff reviews the sales and use tax projections and updates them based on the most current available information. The Colorado Legislative Council (CLC) continues to provide statewide short-term projections, and RTD has refined its use of their projections to incorporate more detailed information available from them. However, we no longer have an external source for long-term sales and use tax forecasts. Therefore, staff has developed a conservative methodology that combines the Consumer Price Index forecast and DRCOG population growth projections.

FasTracks sales and use tax projections cover a longer time horizon than those of other state and local governments. CLC projections for the state of Colorado look three to four years into the future; and most local governments forecast revenues no more than five years into the future. On the other hand, RTD projections for FasTracks run 26 years into the future. Up to this point, many stakeholders have looked at RTD long-term growth projections through the lens of short-term economic trends, rather than recognizing them in the context of a 25-year planning horizon. RTD has realized that educating the public about the methodology for short- and long-term projections is necessary and will help clear up this misperception.

3. The Lessons

Sales and use tax revenue forecasting is not an exact science. It is unreasonable to expect that sales and use tax forecasts over a time horizon of 25 years will be 100% accurate. However, it is reasonable to look at forecasts within a margin of error, to ensure that RTD has a flexible plan to deliver FasTracks within the range of likely outcomes. To that end, RTD is implementing a combination of refinements to develop alternate sources of forecasts and examine a wider range of outcomes:

- Provide a range (best-case and worst-case cash flows) of potential sales and use tax collections, rather than an exact figure, for longer-term projections, and perform sensitivity analyses within the range.
- Investigate additional alternative sources for long-term economic projections and sales tax forecasts.
- Educate stakeholders and the public on RTD's sales and use tax forecasting methodologies, and the differences between short-term (3-4 years) and long-term (15+ years) forecasts.
- Emphasize more clearly that long-term growth projections are averages, rather than exact forecasts of annual growth rates.

Lesson Learned # 4

Railroad Right-of-Way

1. Overview

Many of the FasTracks corridors are dependent on use of railroad (RR) right-of-way (ROW), as they are the only contiguous properties that extend the limits needed for the corridors. However, because the RR properties provide interstate commerce and any impact to their properties or operations requires an entity to ensure that their continued operations remain at or better than existing conditions, RTD has been reliant on complex negotiations in order to mitigate railroad impacts and acquire the necessary railroad properties.

RTD entered into the negotiation with an understanding of the RR design criteria, operations and concerns, which was fundamental to establishing the deals. However, requirements changed throughout the negotiations due to two key events outside of RTD's control – a commuter rail accident in Los Angeles, California in January 2005 and another in September 2008. This placed RTD at a disadvantage in the negotiating process given that the railroads now required RTD to fund modifications to RR property to ensure the safety of ongoing RR operations. In addition, because the railroads have already assembled the necessary property for a contiguous corridor, there's a price to pay for that. Therefore, the railroads apply a corridor enhancement factor to any transaction to reflect this reality, often times increasing the cost for the ROW. Negotiations also move slowly because any transaction or modification to the RR system must be fully evaluated and ultimately accepted by numerous divisions within a RR corporation, which include operations, engineering, facilities, property, legal, and management. Several factors have emerged through railroad negotiations:

- Negotiations have required more time than was originally estimated. Furthermore, the RR negotiating team changed throughout the process, depending on the impacts to their facilities and operations. Also, as RR employees retired or were transferred, new representatives were introduced into the negotiating process, causing a learning curve for the new members.
- Cost for ROW was more than estimated due to the corridor enhancement factor attached to the contiguous property, and property values as appraised by the railroads tended to be higher than RTD appraisals.
- Negotiations with Union Pacific (UP) changed significantly in January 2008 when acquisition costs for a key property were much higher than RTD had programmed. As a result, RTD had to pursue alignment modifications on some corridors and seek a new location for the commuter rail maintenance facility. This impacted the EIS schedules due to the added analysis and the time required to design the modified corridor alignments.
- Additional requirements were placed on RTD to provide wider distances between the RR's freight tracks and RTD's proposed tracks, including the requirement to provide for

massive deflection walls where the track separation was less than 50 feet. This added significant cost to the corridors and impacted the EIS schedules.

- The amount of insurance required for RTD to operate in the corridor was raised to $200 million, whereas the amount on the Southwest Corridor (SWC) was $50 million. In addition, the RR's prerequisite for indemnification required RTD to have legislation passed by the State of Colorado, granting it the ability to indemnify the RRs before they would negotiate with RTD.

2. Background

RTD began discussions with the RRs in 2002 about the possibility of purchasing ROW for the various corridors in anticipation of proceeding with an initiative to construct additional rail lines for our system. RTD entered these discussions under the premise that the needs would be similar to the SWC requirements. Numerous relationships had been built with personnel from the RRs over the years and they were enthusiastic about continuing to work together. RTD approached management to determine if they would be amenable to selling RTD land on their existing corridors. The RRs appeared amenable to this approach.

Specific pricing was not discussed, but an understanding of what the cost would be was established, based on previous negotiations for the SWC and general estimates from the railroads for the potential value of RR facilities. RTD performed over-the-fence evaluations of property adjacent to the corridors and established a square-foot cost to be applied to the corridors. Based on this information, RTD proceeded with a plan it determined was reasonable.

After the vote was passed in 2004, RTD entered into negotiation with the RRs as they were then assured that funding for the plan was available. At the beginning of negotiations the RRs required indemnification and insurance coverage of $200 million, significantly more than was required on the SW Corridor. Concurrently, the January 2005 commuter rail accident in Los Angeles, California moved the RRs to require Federal Railroad Administration (FRA) compliant commuter rail vehicles to operate in their corridors, which required RTD to reconsider the light rail option for the Gold Line, impacting the Gold Line's environmental schedule. As negotiations continued with UP, the cost for maintaining their current operations increased with their determination that they needed a new yard and freight corridor to replace their Kansas Pacific (KP) line which was to be used for the East Corridor. Cost became prohibitive and negotiations came to a halt.

RTD reopened negotiations with UP, at which time the RR required additional separation of the track and/or a massive deflection wall to separate the commuter rail from freight rail. The associated costs to accomplish this increased the budget required to purchase the necessary property.

3. The Lessons

Several lessons were learned during the railroad negotiating process:

- The actual cost for the ROW is based not only on the cost for the land, but also involves a corridor enhancement factor that RTD did not fully consider in the initial estimate. Future estimates should use a corridor enhancement factor of two times the raw land cost to be on the conservative side when establishing a budget.
- Any impact to RR operations should be minimized in order to contain the cost of any relocation or enhancement. RRs operate in a challenging, competitive environment and are understandably protective of their operations, facilities and capacity.
- Alternatives must be provided for RTD alignments so as to not be totally dependent on the outcome of a single alternative that is prohibitively expensive.
- The RRs have an anticipated price that is difficult to negotiate. The elements contained in that price are negotiable and therefore RTD should anticipate beforehand what is actually needed as part of the negotiations.
- Allow sufficient time to negotiate with the RRs, as there are many aspects of the deal that need the approval of numerous RR departments. Time has not been as critical to the RRs as it has been to RTD, due to program schedule constraints.
- Understand the RR’s standards, operations and concerns prior to negotiations, as this plays an important role in the negotiations.
- Be willing to prepare all the plans and designs for RR facilities, even though they may redesign them, as this provides the basis for negotiations.

Lesson Learned # 5

Property Acquisition

1. Overview

Property acquisition is a necessary part of public infrastructure projects like FasTracks. Property acquisition will be an integrated part of FasTracks implementation over the next several years. Several lessons learned thus far can be applied as FasTracks moves forward. These include:

- The relocation process on complex properties acquired for a project can take anywhere from 12 to 36 months. RTD will determine and acquire the necessary staff resources to accommodate the needs of the FasTracks schedule.
- Consistent communication guidelines have been developed to ensure both compliance with the specifications of the Uniform Act and early, proactive communication with stakeholders and potentially impacted property owners.
- Communication with potentially impacted property owners should reflect the level of design and the environmental clearance process. Communication should become progressively more definitive as Right-of-Way plans are defined.

While FasTracks has faced some key challenges with property acquisition during its early stages, the West Corridor is progressing with the purchase of properties needed to build the first FasTracks rail line. Consistent, progressive communication and adequate time for the education and negotiating process are two key areas for improvement as FasTracks moves forward.

2. Background

RTD's Real Property group manages the agency's real estate holdings and oversees all land transactions related to the buying, selling, or leasing of property. In acquiring property, RTD follows federal guidance established through the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 as amended, 49 Code of Federal Regulations (CFR) Part 24, dated January 4, 2005 as well as Colorado Revised Statutes. Both the Uniform Act and Colorado law stipulate a very detailed process which is intended to protect the private property owner. RTD only acquires land that supports its primary mission related to the construction and operation of a mass transportation system.

The use of eminent domain for the acquisition of property can be controversial and one of the most difficult parts of a public infrastructure project. As FasTracks progresses, RTD will continue to follow a process that is consistent, provides appropriate communication with potentially impacted property owners and follows the prescribed process established by the federal government with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 as Amended, 49 Code of Federal Regulations (CFR) Part 24, dated January 4, 2005 and all applicable state laws.

3. The Lessons

The following highlights how the lessons on property acquisition will be applied as the FasTracks program moves forward:

- Coordination among internal disciplines is essential to providing consistent communication with potentially impacted property owners. This coordination involves joint communication/meetings to discuss design issues and also to answer any questions about the property acquisition process. The intent is to provide early and continuous communication with property owners.
- Closely evaluate schedules for ROW acquisition. As FasTracks progresses, more schedule contingency should be considered for the right-of-way acquisition process to account for unknowns and the potential for challenges.
- In communicating with potentially impacted property owners, information will be consistent with the level of design so that property owners have a clear understanding of what is and is not known at any given point. Communication will continue to stress that the acquisition of property takes place following the completion of the environmental process.
- Providing certified ROW plans to the Real Property group as early on in design as is feasible is key to completing property acquisitions prior to construction.

Thus far, there has been much progress with regards to acquiring property, with about 45% of the property needed on the West Corridor either acquired or under agreement. Much of the railroad right-of-way (ROW) needed for the balance of the FasTracks corridors is committed and will be available to RTD within the next 12 to 18 months. These successes will be built upon as FasTracks moves forward and the lessons learned thus far are applied to additional property acquisition for the program.

Lesson Learned # 6

Management

1. Overview

Management and organization of a program as large and complex as FasTracks has presented several challenges. Most large transit programs focus on a single corridor. The multi-corridor nature and unprecedented size of the FasTracks program has been very complex to manage and has led to several findings.

- The staffing resources in certain areas have not always been sufficient to adequately address the demands of the program.
- While the matrix organization works well in most cases, each corridor needs an adequate core group of personnel who are fully dedicated to that corridor.
- Assign full responsibility and final decision-making authority on program implementation to the FasTracks Program Manager, in conjunction with the General Manager and Board of Directors.
- Decision-making needs to be delegated to the appropriate manager, particularly the Project Manager on each corridor.
- The role and assignment of consultants on the program needs to be clearly defined to take advantage of these resources.

A program like FasTracks has not been attempted before. The management systems that were established have worked well overall. However, actual experience during the first four years has led the organization to evolve based on lessons learned.

2. Background

The FasTracks organization consists of a multi-disciplinary group of managers, engineers, planners, project controls, public information and support personnel assigned to the program. These personnel are generally assigned full-time at an office location dedicated to FasTracks. The program is also supported on a part-time basis by other Regional Transportation District (RTD) departments interfacing with FasTracks.

The personnel assigned to the program consist of both RTD personnel and consultants. The consultants function as an extension of staff and the organization is set-up as one overall team, without distinctions between RTD and consultant. A matrix organization has been established where personnel from various disciplines support assigned corridors.

The experience during the first four years of the program can be categorized into three areas: 1) areas that need improvement; 2) areas that improved after specific issues were identified and; 3) and areas that have worked well. A major area that experienced problems and is being addressed is the staffing resources for each corridor. For example, the West Corridor was initially set up with a Project Manager, two support professionals and support from the matrix organization. This proved inadequate to manage the complex issues during final design and movement into construction, particularly after one of the key personnel left the program. This particular case has been addressed – there is now a complete 20-person team dedicated to construction oversight on the West Corridor. However, as pointed out by the Federal Transit Administration (FTA) and our own peer review, inadequate project staffing is a false savings that must continue to be addressed.

In addition to staffing levels, management resources and processes must be evaluated. There are still several cases of key positions that are only "one-deep" with no ability to easily replace these resources. Top management is often forced to focus on day-to-day issues instead of strategic management decisions.

It is also important to assign full responsibility and authority to make the final decisions on program implementation to the FasTracks Program Manager, in conjunction with the General Manager and Board of Directors. In addition, the relevant FasTracks managers need to be involved in decision-making and should be delegated the appropriate level of decision-making authority.

3. The Lessons

The following describes how the lessons learned in management, organization and resources are being applied to the FasTracks program moving forward.

- Greater attention is being applied to the staffing of dedicated personnel on major corridors. Each corridor is being assigned a small team during planning that will increase as the project moves into design and construction. A full team has been deployed on the West Corridor, is being staffed on Denver Union Station and being planned on the Eagle P3 projects. Other corridors are being established with Project Managers, design managers and project controls personnel.
- Although a greater emphasis is to be placed on assigning dedicated personnel to corridors, we plan to continue the matrix organization. This enables efficiency in assigning personnel when a specific expertise or resource is required that may not be available on a corridor. It also assures a level of standardization and provides great experience for personnel who may later transfer or be promoted to a corridor position.
- Conduct a comprehensive evaluation of the FasTracks organization to identify gaps, succession planning and any staffing imbalances.
- Assign responsibility and accountability for program implementation to the FasTracks Program Manager including overall decision-making authority, in conjunction with the Board and General Manager. Assure that all decisions have the input and support of the appropriate team members.

- Maintain the current "one-team" approach with RTD and consultant personnel. Consultants will continue to be utilized for specialized areas of expertise that would be difficult for RTD to recruit, and can be moved in and out of the program on shorter-term assignments, as needed.

Lesson Learned # 7

Processes/Procedures

1. Overview

The Regional Transportation District (RTD) began implementation of the FasTracks program in 2005. FasTracks brought a major change to RTD's standard ways of doing business. Prior to FasTracks, RTD's business processes and procedures, as well as its financial systems, were designed to meet the needs of an agency that was focused on system operations and delivery of major corridor projects one at a time.

FasTracks, as a major capital investment program constructing seven corridors at the same time, changed the RTD paradigm. Almost overnight, RTD transformed from a major bus and light rail agency into a major operating agency with a massive capital program. However, its business processes and procedures remained oriented toward its prior focus on operations and relatively independent capital projects. These processes were not suited to facilitating and controlling a large-scale integrated capital investment program. RTD needs to update and refine its control processes and procedures to provide appropriate controls for an integrated, large-scale capital program, while maintaining its ability to meet the program goals and schedule.

2. Background

The FasTracks program was approved by the voters of the District in November 2004, with tax collections starting on January 1, 2005. Prior to the start of the FasTracks program, RTD had never undertaken a program of that size or scope. RTD's single largest construction project, T-REX, was a joint project with the Colorado Department of Transportation. It operated out of its own field office with a dedicated staff and its own internal procedures and control systems. Even though other RTD resources were involved in supporting the T-REX Project, the day-to-day impacts on most of RTD's operations were isolated.

On the other hand, the FasTracks program involves the simultaneous construction of multiple rapid transit corridors using three modes of transportation – light rail, commuter rail, and bus rapid transit. Unlike T-REX, FasTracks is exclusively an endeavor of RTD, meaning that RTD resources alone are used to complete the program. This results in a much greater impact on the remainder of RTD, and a greater need for policies and procedures that integrate with overall RTD processes. It also drives a need for processes that address the impacts of the different FasTracks corridors on each other.

3. The Lessons

FasTracks is a program of a different scope and scale than anything that RTD has done in the past. As a result, RTD cannot assume that procedures developed for an operations-focused agency will work for a capital development program at this scale. RTD needs to develop business processes and procedures that meet the program needs and schedule while maintaining adequate internal controls, rather than building an implementation program around business procedures designed for a very different situation. Specific areas to be targeted for improvement include:

- Focus progress reporting and issue resolution on critical schedule milestones.
- Improve communications/transparency of configuration change protocol, issues and decisions.
- Develop project change control procedures to expedite contract changes within allowable guidelines, allowing RTD to maintain the overall program schedule.
- Refine cost control procedures to account for the differences in funding structure between the FasTracks program and other RTD capital projects.
- Improve integration of FasTracks-specific control systems with overall RTD processes and systems.
- Ensure that adequate business processes and internal controls are in place before entering into joint construction agreements for projects.

Lesson Learned # 8

Project Delivery

1. Overview

There are several methods of delivering various projects on the FasTracks program – design-bid-build (DBB), design-build (DB), construction manager/general contractor (CMGC), design-build-operate-maintain (DBOM) and design-build-finance-operate-maintain (DBFOM). The Regional Transportation District (RTD) has successful experience with design-bid-build and design-build.

The FasTracks program is currently using or plans to use these project delivery methods based on experience gained and conditions specific to each project. Major findings in these areas include

- DB, DBOM and DBFOM bring a significant private sector component into the management of these projects, which maximizes contractor innovation and participation into the implementation of these projects. These methods also enable the fastest schedule to be accomplished.
- Negotiated contract prices are extremely challenging to implement and should be avoided in the future.
- CMGC contracts require the buy-in of the designer who works under a separate contract.
- DBB is appropriate for smaller projects and those that involve extensive risk and stakeholder involvement.

FasTracks has now defined its project delivery methods for each project based on this experience.

2. Background

The original FasTracks schedule was developed assuming DBB delivery for all corridors. This provided the most conservative schedule and still allowed for future analysis of delivery methods. After a workshop in 2005, the preferred method of delivery was largely changed to CMGC in an attempt bring contractors on-board earlier in the process while still affording RTD with greater control over final design. As the program has progressed, FasTracks has moved away from CMGC to largely DB or DBFOM, with DBB being utilized for projects with specific requirements.

CMGC involves bringing a contractor in early in the design process to provide input, value engineering and develop cost estimates. After the design is at 100%, the owner and contractor negotiate an acceptable price. CMGC is being used on the West Corridor project. Experience on the West Corridor showed that RTD, the designer and the contractor weren't always on the same page, as illustrated by the design engineer's (who was working under a separate contract and at a separate location) decision not to embrace many of the value engineering recommendations made by the CMGC contractor. Integration of RTD, designer, and contractor personnel, including co-location, along with fully assigned RTD design professionals could have addressed this gap. Although RTD believes that we have negotiated a fair and reasonable final price with the CMGC contractor, the negotiations were extremely challenging and RTD staff firmly believes that there is no substitute for the discipline of the marketplace under a competitive bidding environment. In addition, the benefits of contractor-designer collaboration are best secured under a DB contract.

The design-build project delivery method draws on many of the lessons learned from the T-REX project (NOTE: a separate lessons learned report was developed for that project). DB brings the contractor in as an essential part of the overall management for that project. Given that the contractor is so essential to the success of a design-build project, a best value selection (combination of price and technical capability) should be used as selection criteria with price as a major element. DBFOM is an extension of design-build, which is integrated into the Public-Private-Partnership (PPP) program for the Eagle P3 project.

3. The Lessons

The selection of project delivery methods is an example of where FasTracks has used its experiences and lessons learned to develop its program moving forward.

- Large corridor projects will take advantage of design-build and design-build-operate-maintain, with design-bid-build used mainly on specific, smaller projects.
- Contracts or delivery methods with negotiated contract prices are no longer planned for construction projects.
- Contracts relying on the experience of contractors as a key to success will use the best value method for selection.
- Co-locate RTD, design and construction personnel to the greatest extent possible.

These experiences will be critical as the FasTracks program moves largely into construction.

Lesson Learned # 9

Communications

1. Overview

The Regional Transportation District (RTD) FasTracks Public Information/Public Involvement (PI) Program was developed to establish and maintain a high level of communication and outreach to project stakeholders throughout the implementation of the FasTracks program. The communication function is an essential part of keeping communities connected and engaged throughout the FasTracks process, ensuring public confidence, and identifying and resolving issues and concerns. The FasTracks PI Program provides the communication integration necessary for consistent, accurate, and reliable internal and external communications. During the environmental planning phase, the public involvement process is a key element of determining and defining the project. Through the National Environmental Policy Act (NEPA), there are requirements an agency must follow regarding the public's input and involvement in helping to shape a project. The difference between the NEPA public involvement process and the public information program, which includes public involvement elements, is important to communicate so that internal team members understand the roles, responsibilities and purpose of these two facets of the PI program. One of the big challenges of a program of this magnitude with many individual projects that integrate into an overall program is keeping all of the various team members coordinated and disseminating consistent and updated information to stakeholders and the public. It is also a challenge to set clear expectations of the public's role and participation in the program as it evolves from one stage to the next.

2. Background

The FasTracks PI Program is a comprehensive communications program, which includes an array of strategies and activities related to public outreach, public involvement, media relations, government relations, internal communications, issues management and crisis communications. The PI Program is implemented at two levels: a program team to establish and implement public information, involvement and outreach activities at the program level; and project teams to facilitate the specific day-to-day corridor level public involvement and information efforts with project stakeholders. Corridor public involvement teams have carried out PI duties during the environmental processes and public information teams will be part of the construction contractors' teams during design and construction. The West Corridor, being the most advanced project of the FasTracks program, completed its EIS process in 2004 and was awaiting the outcome of the FasTracks vote to progress to the final design phase. There was nearly a two-year period from the end of the EIS and beginning of the final design phase, which presented a communication challenge – conveying to project stakeholders how their participation evolves from the very extensive public involvement during the environmental process to a more narrowed approach in design and construction. As a program transitions from planning to design to construction, the needs of the project and the public change, with input and involvement opportunities narrowing as a project becomes more defined. During construction, communication centers mainly on public information and focused issue resolution. Explaining the stakeholder participation process at the beginning and then re-emphasizing the changing nature of the public's role as a project progresses, helps to set appropriate expectations. The Senior Management Team, in partnership with the FasTracks Citizens Advisory Committee, developed a Stakeholder Participation Policy outlining this process, which was ultimately approved by the RTD Board of Directors. In addition, the PI Team developed graphics to help depict the stakeholder participation process.

3. The Lessons

- It is essential to clearly define the Public Information and Public Involvement Program as early in a program as possible. While public involvement is two-way interactive communication that fosters the public's participation in helping to shape a project or process, the one-way public information or public outreach effort is designed to help inform and educate stakeholders. Both should be integrated and fall under the larger umbrella of communication, so coordination and understanding of roles at the program and corridor levels are crucial for all internal team members so that communication efforts can complement each other.
- Establishing and communicating stakeholder engagement opportunities throughout the whole program is critical. It is important to have a policy and process in place at the beginning of a program of this nature.
- Internal policies and procedures should be defined up front so the entire team can adhere to decision-making and communication processes. This allows the project team to stand united on decisions that have been made and, when communicating those decisions, be confident of the information.
- Internal communication is one of the most important components of any program. Internal team members can be the best ambassadors for the program based on how well informed they are. The whole internal team – with the RTD Board of Directors at the top – needs to understand developments and changes in the program so that everyone is working from the same information. It is essential to make sure that the internal team is the first layer of communication before information is shared externally.
- The PI Liaison concept has worked well, with a member of the program PI team assigned to each corridor project as the central communication link between the program PI team and the corridor team. This structure establishes a liaison for the duration of the program to maintain consistency and familiarity with the project, its stakeholders and historical issues. It is important to have roles and responsibilities of the program PI Liaison and the corridor PI contractors clearly defined at the onset of the project.

FasTracks at Work

Since implementation began in January 2005, the FasTracks program has made substantial progress on a number of fronts, especially on the various environmental and design processes. As the program transitions from planning and design into construction, RTD remains committed to delivering key investments in all corridors.

Ceremonial Rail Pulling Event – May 2007

West Corridor retaining walls being erected along Kipling Street – May 2009

McCaslin Bridge grand opening on the U.S. 36 Corridor – June 2008

North Metro Corridor station planning meeting – 2008

West Corridor construction crews prepare to relocate utilities – November 2007

Students from the Ride to Dream Program learning about the I-225 Corridor– December 2008

The first of FasTracks' 55 new light rail vehicles arrives at the Elati Light Rail Maintenance Facility – August 2009

A FasTracks public meeting in Boulder – September 2008

Placing a pedestrian bridge on the West Corridor – November 2008

Disadvantaged Business Enterprise members at the P3 industry forum – July 2008

Architectural rendering of Old Town Arvada along the Gold Line – 2015 (est.)

Acronym List

CCD	City and County of Denver
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
CMGC	Construction Manager/General Contractor
CPI	Consumer Price Index
CPV	Central Platte Valley
DB	Design-Build
DBB	Design-Bid-Build
DBFOM	Design-Build-Finance-Operate-Maintain
DBOM	Design-Build-Operate-Maintain
DMU	Diesel Multiple Unit
DRCOG	Denver Regional Council of Governments
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMU	Electric Multiple Unit
FONSI	Finding of No Significant Impact
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
KP	Kansas Pacific
LRT	Light Rail Transit
MIS	Major Investment Study
NEPA	National Environmental Policy Act
PE	Preliminary Engineering
PI	Public Information
PPP	Public-Private-Partnership
ROD	Record of Decision
ROW	Right-of-Way
RR	Railroad
RTD	Regional Transportation District
SB208	Senate Bill 90-208
SWC	Southwest Corridor
T-REX	Transportation Expansion Project
UP	Union Pacific

LA County MTA (LACMTA)'s objective for this study is to position itself to deliver quality capital projects on time and within budget as we build a significant, long range portfolio. This questionnaire is designed to gather any best practices you have developed to address the challenges of delivering a complex portfolio of projects.

Guidelines:

- If a question is not applicable, please type in NA.
- Where tables are provided for your input, please feel free to re-format information or share existing attachments if that better reflects your response to the question(s).
- Please share attachments, where possible, which –
    - Elaborate your responses in this questionnaire AND/OR
    - Provide LACMTA additional insights, tips and guidance in building on its strengths but also in identifying our areas of improvements and proactively implement a robust project delivery and capital forecasting framework.
- Attachments can be shared by embedding files in this section or by attaching them to your transmitting email.

LACMTA is most appreciative of your time and efforts.

A. London Underground Information *(This section gathers info about your agency)*

1. London Underground Contact *(please fill in <u>your</u> contact information below)*

Contact Information	Description
Agency	London Underground
Contact person	Dave Bird
Title	Senior Project Manager (Benchmarking), Rail & Underground Finance
Phone Number	+44 20 3054 7188
Email	dave.bird2@tube.tfl.gov.uk

2.* London Underground Capital Plan Overview (*Please provide London Underground information below)

a. What is your primary business line? Metropolitan railway services

b. What is the total dollar value of agency Capital Plan $21.8bn

c. How many years does the capital plan above span? 2014/15 to 2023/24

d. How many projects are in the capital plan? There are 8 major programmes, each comprising a number of projects.

e. # of professional services contracts for the capital plan? Click here to enter text.

f. What is the total dollar value of professional contracts? Assuming you mean project management / engineering, etc then about 15-20% of the plan cost in b above.

g. Please fill in the table below: * most of the staff manage the work, the great bulk of the work is contracted out. There are some direct labour staff, e.g. for deep tube track renewal

Staff Type involved in capital program only	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff	2155*	
Consultants/agency staff	940	
Independent Contractors		
Total		100%

h. Please share any succession planning best practices you may be using to deal with an aging workforce

i. Please share any stakeholder management best practices you may be using   The TfL Pathway has a module covering Stakeholder management. Stakeholder engagement with external parties - local authorities, lobby groups, etc. is coordinated from the corporate centre (Stakeholder Communications).

j. What percentage of completed capital projects finished on time? LU measures milestone delivery – for 2014/15 94.3% of milestones were delivered on time compared to a target of 90%.

k. What percentage of completed capital projects finished within the original contingency budget? 98.1% in 2014/15

B. Questionnaire *(This section gathers best practices in each project phase)*

B.1 Planning

B.1.1 Project Manager's Role

The answers below draw heavily on the TfL Pathway for project management and control.

1. Please share information regarding your Project Manager's role in the table below: The Pathway Product Matrix shows the PM role (RACI) at each stage in the project lifecycle. A more general description is given in the Pathway Manual.

Does PM have Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes/No	This varies according to business unit. In some areas, yes. In others, for example a project development team progresses a project to Stage 3 (Concept) then hands over to a Delivery Team.	Some Programme Directors believe that different skills are required suiting different project managers. This flexibility of approach is permitted by Pathway.	

2. Describe any best practices used to develop a complete project scope and verify it with the end user Click here to enter text.

3. Describe any best practices used to capture early studies and planning costs to a project charge number Each project is allocated a unique identifier that is used throughout the approvals process. The initial authority will cover any early studies or planning and be increased as the project moves through to implementation.

B.1.2 Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below.

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used
Annual Capital Planning				
Conceptualization/ Study				
Project Planning				
Preliminary Design				
Final Design (CDs)				
Bid & Award				
Construction				
Closeout				

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project? The authority requested will include a risk allowance for such matters. Additionally, there are tolerances on estimates based on the project stages that progressively reduce as the project passes through from feasibility to final design and tender. The Board is free to authorize to the level it feels comfortable with. If it commits full authority, the project / programme will have to undertake normal assurance activity which is reported and any funding request above initial authority will have to return to the Board. Generally speaking, the major projects / programmes proceeding to the Board for authority (>£25m) do not receive full authority at a preliminary design phase.

6. What % contingency does the Board authorize for construction change orders? There is not a specific contingency. Contingency allowances are not used. There is a risk assessment from which a risk allowance is derived. This risk allowance is managed as set in the Pathway Handbook.

7. Who controls the contingency? See 6 above
8. What does the Board require the London Underground to do in order to get additional contingency? See 4 above, if a need for extra funding arises supplementary authority must be sought at the appropriate level for the revised value of the project.
9. Please provide a representative attachment, if possible, of the workflow and content required to obtain original and additional funding from the Board will be very helpful. Change is covered in the Pathway Change Request Guidance Note (For original authority, please refer to the Authority table in Question 4.
10. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings? The Rail & Underground Board does not generally meet or communicate with project teams outside board meetings. However, all projects in LU are overseen by the relevant Programme Board and these require R&U Board presence to be quorate.

B.2 Design

11. Please describe any best practice tools and processes that your London Underground uses to control scope creep throughout the project lifecycle Please see the Pathway Change Request Guidance Note attached to question 9.
12. Please describe any best practices you use for design reviews Please see Guide G1237
13. Please describe any best practice tools and processes that your London Underground uses to improve the quality of design. What department/group is responsible for ensuring quality of design? The Pathway philosophy is that quality is 'built-in' to the methodology. Therefore, key documents, such as Requirements, Design, Design Reviews, etc, all require the presence and signature of relevant and authorized personnel. This, it is believe, should allow quality because professional and accredited staff should do their jobs. Quality is not a parallel function acting in a checking capacity.

B.3 Construction

B.3.1 Construction Claims Management

14. Please describe any successful techniques you use to avoid claims The successful techniques used by TfL are firstly a procurement strategy based upon the NEC3 Contract. This is a collaborative suite of contracts that encourages client and contractor to work together thus addressing potential claim situations early. The other technique is extensive use of partnerships and frameworks. These are long term relationships with our suppliers which encourage working together
15. Do you require contractors to submit time extension requests as they happen during construction or do you wait until close-out? The NEC3 contract requires contractors to give notice immediately they become aware (Early Warning Notice). This approach avoids the wait until close-out syndrome.
16. Please describe any best practices you use to timely resolve claims Click here to enter text.

17. Please describe any best practices you use for dispute resolution of unresolved claims (DRB/arbitration/ litigation)? Click here to enter text.

B.3.2 Utility Relocation

18. Please describe any best practices you use to identify utilities in the way of construction

The documents attached to Question 19 cover identification of utilities in the way of construction.

19. Please describe any best practices you use to relocate utilities Click here to enter text.

20. If you issue advance utility contracts please discuss your experience with this mitigation approach. Generally, utility diversions would proceed the main works and arrangements will be made with the Utility companies to facilitate them and any diversions / final re-locations or reinstatements required to meet work stages.
21. Please discuss your experience partnering with utility companies to get timely relocations by their forces. Click here to enter text.
22. Please share your experience with Utility Relocation challenges in the table below. Click here to enter text.

Challenge Description	Impact on Capital Projects (High/Medium/Low)		London Underground Response to Mitigate Impacts	Additional Comments
	Cost	Schedule		

23. How does the London Underground resolve resource constraints that exist for a utility company? Click here to enter text.

B.4 Operations/Maintenance

24. Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations The key best practice point is to involve the maintenance staff as early as possible in the project so that they are able to influence the design for maintainability, also where major equipment (new trains, etc) is being manufactured to have maintenance representatives at the factory as part of the familarisation process.
25. Please discuss how you identify maintenance and capital improvement needs This is done through the process for developing the Line, Asset & Network Plans – see 29 below.

26. Please discuss how you do condition assessment The requirements are set out in Standard S1042 – Asset Condition Reporting and associated guide G042, attached. The requirements in the standard are set out in the first 15 pages, the remainder of the document (c335 pages) is the LU Asset Condition Certificate (the output of the standard).
27. Please discuss how you get the projects in the capital plan This is set out in the Governance document attached before these questions
28. Please discuss how you issue work orders. We understand works orders in the capital projects context to refer to Method Statements. These cover works on site and have to be in line with health and safety legislation.
29. Please describe any other best practice tools, processes and procedures the London Underground uses for Asset Management. London Underground is certified to ISO55001 standard for Asset Management, the link explains how this was achieved. http://www.railtechnologymagazine.com/Interviews/world-leading-asset-management-on-london-underground LU has is covered by the TfL AM policy and has an AM strategy and plan (Line, Asset & Network Plan)

B.5 Supporting Processes

B.5.1 Scheduling

30. Please check the box next to each best practice tools the London Underground uses for Cost/Schedule management? It should be noted that there is a project in place (completion end 2015) to replace the systems below with one, 'Integrated Project Controls'

☒ Enterprise schedule software (Provide software name) Primavera P6

☐ Integrated Master Schedule (all projects in capital plan in one schedule file)

☒ Contractors' Schedule Updates in one central schedule database Master Projects Database (MPD) is available for this.

☒ Cost-Loaded Schedules

☒ Cost Forecasting (Please describe method & tools) Costs are produced in accordance with the attached documents. Estimated final costs are re-forecast on a quarterly basis.

☒ Earned Value Management System (Please describe) MPD has this capability but is not used centrally although some Programmes / projects do use it.

☒ Off-the-shelf software (Please provide software name) Primavera P6 as noted above.

☒ Project Risk Management program (Please describe method & tools in the table below) Active Risk Manager (ARM). Primavera Risk Analsyis and At Risk (cost risk) feed into ARM

Project Size	Risk Registers	Type of Risk Analysis	Monte-Carlo Based Contingencies	Approved Project Budget or Capital Plan Includes Risk-based Contingencies

No set value. All significant projects and programmes.	Yes	Both	Yes	Both
Between $XX and $YY	Yes/No	Cost/Schedule/Both	Yes/No	Project/Capital/Both/None
Below $ZZ	Yes/No	Cost/Schedule/Both	Yes/No	Project/Capital/Both/None
Please edit/add thresholds as appropriate				

31. Please describe the process you follow to review contractor's schedules. Done at Programme level – Acumen Fuse is available for this.

32. Please describe any best practices you may follow to integrate progress payments with cost-loaded schedules This is dependent upon the type of contract. Some, mainly contacts for power works, have earned value milestones which are linked to payments.

33. Please describe any Lessons Learned program the London Underground has, noting how lessons are (1) collected (2) published and (3) retrieved as needed:

34. Please describe (and if possible provide a copy of) any written project management and controls procedures. A Pathway summary is included before these questions.

35. Describe how the London Underground ensures all participants are following the procedures. This is done via the Gate Review process and Integrated Assurance Reviews as set out in the attached documents

B.5.2 Human Resource Management

36. Is a Staffing Plan created and followed for every project?

☒ **Yes**

☐ **No**

37. Check the box next to any organization-wide HR Management procedures that the London Underground has implemented for individual/personnel development:

☒ Succession planning

☐ Training responsibilities are assigned to named individual(s).

☒ Training activities periodically reviewed.

☐ Budgets/funds direct and indirect costs of training.

☒ Data is collected to determine training effectiveness.

☒ A documented process is in place for recognizing outstanding performance on projects

☒ Linkage has been established between performance and reward.

☒ Project Management is an established career path

☒ A competency model is used that includes proficiency assessments.

☒ Established goals for improving project management capabilities.

☒ Employees have personal development plans.
☒ Training on team development exists
☐ Project Team development is planned and budgeted
☐ The effectiveness of the various HR programs are periodically reviewed.
☐ Key individuals on the project team are identified as critical to project performance
☒ Employee's contribution to organizational strategic goals and objectives are assessed
☐ A mentoring program is in use that provides timely feedback
☐ The effectiveness of mentoring is periodically reviewed.

38. Does your London Underground have any formal training programs?

☒ **Yes**
☐ **No**

If Yes:

39. What is the frequency of training? Essentially training is attended as is agreed necessary to develop competence.
40. What curriculum is taught? See attachment to qn 39.
41. What position titles are given training? Anyone can attend the introductory courses, attendance is otherwise based on applicability to the job holders role. For example, Advance Project Manager training is reserved for staff holding senior positions.
42. Are consultants also trained? Consultants and non-permanent labour are expected to be experts in their field. However, LU specific training is provided, for example PRINCE 2 no, but LU specific health & safety requirements or Pathway training, yes.
43. Who administers the program? HR Shared Service Centre takes the course bookings while PMO owns the course content and manages the schedule of courses.

B.5.3 Project Delivery Organization

44. Does the London Underground have a Project or Program Management Office (PMO)?

☒ **Yes**
☐ **No**

45. If Yes, please share the information in the table below –

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	No (except for business change projects)	Programme Directors		
Project	Yes for	Responsibility for		

Controls	framework and independent assurance reviews	project controls lies with the Project Manager		
Project Quality	No	Responsibility lies with Project Managers		
Project Safety	No	Responsibility resides with Project Managers. A CPD safety advisor sits within the Safety Directorate.		
Please edit/add functions as appropriate				

B.5.4 Contract Management

46. What contracting strategies does the London Underground use for its capital projects? Please use the table below. The contracting approach will depend upon the project delivery model adopted. The H Delivery Models document sets out the approach to determining the delivery model to be adopted. This is usually determined at programme level and applied to the projects in the programme.

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build				
Design/ Build (D-B)				
Public Private Partnership (PPP)				
Others (Please Add)				

47. If the London Underground has used D-B, what conditions guided the London Underground to consider it? Covered in the Delivery Models Handbook attached to question 46

48. If the London Underground has used PPP, what conditions caused the London Underground to pursue such a model? London Underground had in place three 30-year PPP contracts for renewal and maintenance of the network. Effectively these were a requirement of the then UK Government to secure the long-term stable

investment required in the network. Two of the contracts were brought in-house when the contractor went into administration as it could not fulfil the contract within the agreed contract sum and the other was bought-out and brought in-house as that was seen as a more cost effective way of doing the work.

49. Did the use of alternative contracting methodologies improve project success? If yes, please describe what aspect of that methodology made a difference. Direct control of project management has been seen as more effective than the arrangements under the PPP contracts both in terms of cost and timely delivery. A benchmarking exercise currently underway with other metros has shown that they mostly control large projects directly, not least because of the loss of knowledge if the project management is outsourced.
50. Please share the London Underground's change order approval authority via an attachment showing the signature authority and approval thresholds? Please see Change Control Form
51. Please describe any best practices you follow related to contract management or communications. Contract management processes are covered in the Commercial and Procurement Handbook attached before these questions

B.5.5 Document Management

52. What document management system do you use? Livelink.
53. Is it used for all projects? Livelink is recommended for all projects
54. Is a different tool used during construction? Sometimes in order to share documents with the supplier.
55. If yes how do you integrate the two systems? Custom basis depending on the systems
56. Are construction progress meeting minutes maintained in a database that tracks action items to completion? Customised at project level.

C. Catchall Question

57. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (ie- contract language, procedure, workflow, etc.) A key element of Pathway and all of the other management system elements covered above is the statement that success is primarily driven by the skills of the professional staff. The management system provides tools, allows and encourages collaboration, and is an aid to the correct behaviours. However, processes do not, of themselves, guarantee success. They can only create the environment for effective delivery.

<u>End of Questionnaire</u>

BUSINESS CHANGE PROGRAMMES

HEALTH, SAFETY AND ENVIRONMENT IMPROVEMENT

London Underground & London Rail have a clear health, safety and environment vision: 'Everyone home safe and healthy every day'. The vision covers our customers, employees and members of the public who may be affected by what we do. Today, based on statistics produced by the Office of Rail Regulation, London Underground & London Rail are among the safest railways in Europe. The strategic objectives of the Health, Safety and Environment Improvement programme are focused on further enhancing health, safety and environment performance on a prioritised risk basis.

ACCESS TRANSFORMATION

UNLOCKING ACCESS

The objective of this programme is to make improvements to the way the Underground plans and controls access to its key assets while transforming business culture to support these improvements. An efficient access process is essential to the delivery of engineering projects as well as extensive asset renewal and maintenance activities. The programme will deliver a more efficient, transparent process, with a single point of access through a self-service, computerised portal. It will also deliver changes to encourage increased work during traffic hours when safe and practical to do so.

FIT FOR THE FUTURE – STATIONS

Fit for the Future – Stations is a large and complex programme of change for London Underground. The objective of the programme is to redesign the way that Underground stations work so that staff are more accessible to customers and can respond to their needs quickly and effectively. To enable this, the programme aims to ensure that staff will be equipped with the relevant ticketing experience and technology, and have unnecessary and overly burdening processes removed or changed to allow them to concentrate on providing high levels of customer service.

INFORMATION COMMUNICATION TECHNOLOGY TRANSFORMATION

The programme will work to ensure that information and communication technology capabilities are in place to underpin the delivery of London Underground & London Rail's priorities. The focus of this programme is on operationally-critical and safety-related systems, as opposed to enterprise management systems. In addition, it acts as a key enabler for several other programmes, as well as delivering upgraded capability and/or reducing the cost of ownership for particular information technology systems.

NIGHT TUBE

The Night Tube programme will implement a ground-breaking all-night service on Friday and Saturday nights on the Central, Jubilee, Northern, Piccadilly and Victoria lines from 12 September 2015. The opening of the Tube network overnight reflects the rapidly growing demand for late evening and overnight travel. Night Tube will not only reduce travel times for existing night bus customers, but will provide a step-change in access to jobs, leisure and other facilities overnight, supporting London's evolution as a 24-hour economy.

PEOPLE & ENGAGEMENT

The goal of TfL is 'To keep London working, growing and to make life in London better'. A key enabler of this and a key pillar of our strategy is engaging with and building the capability and skills of our people. We need our people to be accountable, to actively seek solutions to problems and to work with others, directly, fairly and consistently. The People & Engagement programme will therefore seek to improve how we recruit, manage, reward and develop our people and through this grow and sustain employee engagement.

PREDICT & PREVENT

Predict & Prevent is a portfolio of projects which will transform how the business monitors and manages our network by sending data back to a command and control position, enabling us to flex plans for both the operation and maintenance of the railway. This will be achieved through better data utilisation and the development of predictive capabilities.

TfL COMMERCIAL DEVELOPMENT

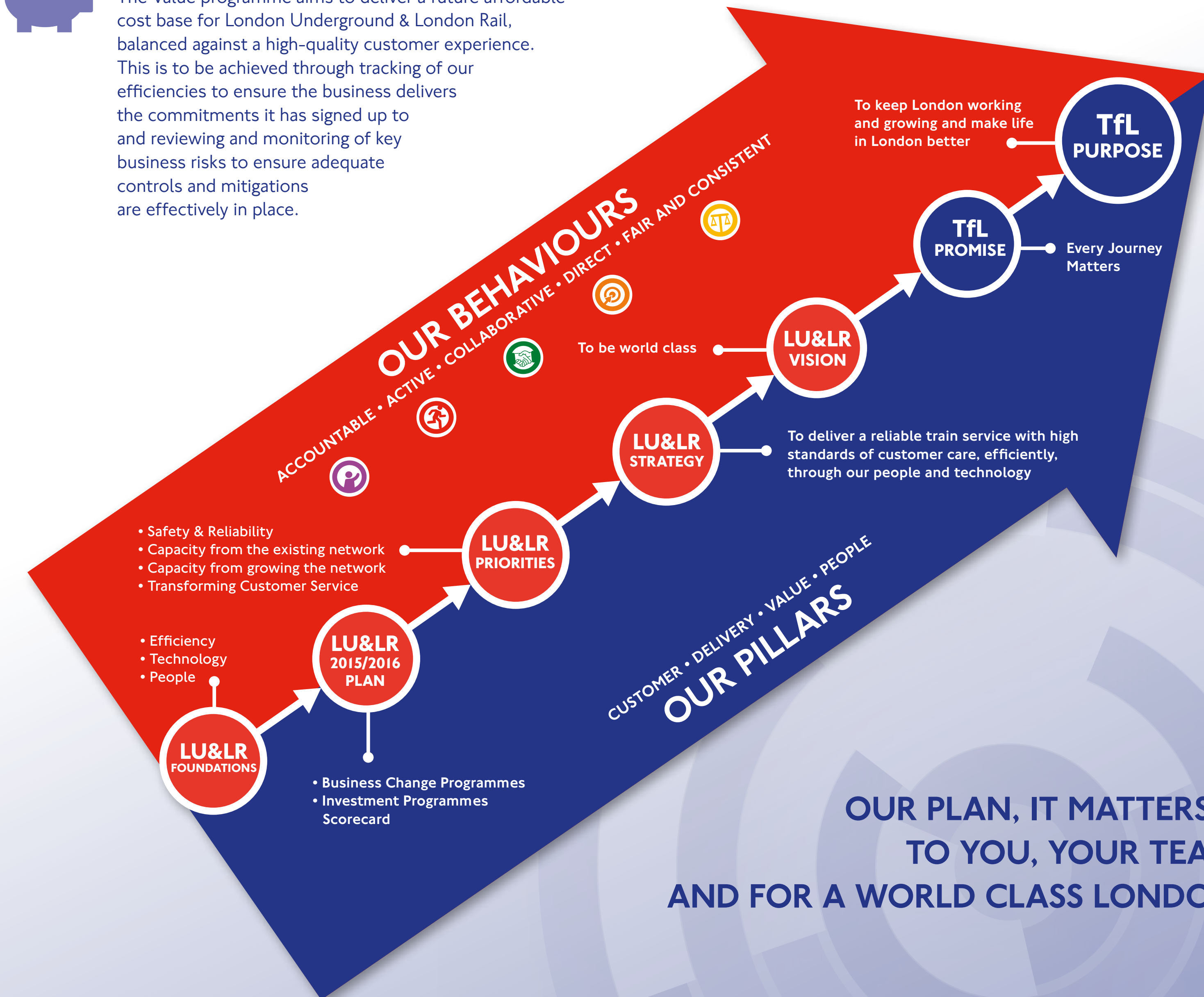
The overall objective of this programme is to generate £3.4 billion net income from TfL assets over a ten year period which can then be reinvested in TfL's services. Almost all the income will be realised from London Underground & London Rail assets. This revenue will be derived from the following main areas: property development, advertising, property and retail rental, car parking, telecommunications and commercial partnerships.

VALUE

The Value programme aims to deliver a future affordable cost base for London Underground & London Rail, balanced against a high-quality customer experience. This is to be achieved through tracking of our efficiencies to ensure the business delivers the commitments it has signed up to and reviewing and monitoring of key business risks to ensure adequate controls and mitigations are effectively in place.

OUR PLAN 2015/16

LONDON UNDERGROUND LONDON RAIL



UNDERGROUND
OVERGROUND
CROSSRAIL
DLR
TRAMLINK
AIR-LINE

For more info on the major programmes, their projects/workstreams and key milestones, search for 'Our Plan' on the London Underground & London Rail intranet

OUR PLAN, IT MATTERS...
TO YOU, YOUR TEAM
AND FOR A WORLD CLASS LONDON

INTRODUCTION

We can rightly feel proud of the remarkable achievements we delivered in 2014/15 and it promises to be another very busy year across London Underground & London Rail. London and our customers depend on us and we must be ready for the challenges ahead.

WORLD CLASS

On our journey to be world class in all that we do, it is not just important **what we do**, but **how we do it**. Our Plan for 2015/16 summarises the programmes and activities that will comprise our main focus. It is important that everyone understands how it fits with our key priorities and how it will help drive transformation.

Our success depends on you, our people, working with each other and behaving in a way that raises our performance. We should all take action now and know what it feels like to be in our customers' shoes, we should collaborate and celebrate success.

World class is not a distant pipedream. It requires a consistent, sustained and united effort like never before.

Mike Brown

Managing Director
London Underground & London Rail

OUR PROGRAMMES

'Our Plan' for London Underground & London Rail 2015/16 is our roadmap for the year ahead. It sets out our vision and key priorities, giving us a clear path to follow. This guide provides an overview of the 17 Business Change and Investment Programmes for this year.

OUR VISION

Our vision 'To be world class' requires us to be at the top of our game in everything we do, able to compare ourselves not just with other metros and rail services, but also with the best service organisations anywhere in the world.

OUR PRIORITIES

Reminding us what's most important are the four key priorities that will help us transform our business.

1. SAFETY & RELIABILITY

A safe and reliable service is the starting point for everything we do. We should be proud of our safety record, but we can never be complacent. The safety of our customers, staff and contractors always comes first. And while we've improved our reliability, the need to be more reliable is critical and becoming more challenging as we squeeze more capacity from the existing network.

2. CAPACITY FROM THE CURRENT NETWORK

With more people using our services, we must get the most we can from our existing infrastructure. We must continue to modernise, renew and maintain our assets to achieve a steady state of renewals as this will reduce disruption and increase value for London's travelling public. In addition, we're aiming to improve further capacity through line modernisations and station upgrade works across the network.

3. CAPACITY FROM GROWING THE NETWORK

As London continues to expand, we need to grow our network. This is part of a comprehensive, integrated transport system being planned to bring our services to new parts of the city and help stimulate growth and regeneration.

4. TRANSFORMING CUSTOMER SERVICE

Customers' expectations of our staff, stations, information, ticketing and accessibility continue to rise. We aim to offer our customers value for money and a personalised level of service supported by pioneering technology. We have to show we care – about having well-kept stations, providing honest and timely information and the cost of using the network.

OUR FOUNDATIONS

We will achieve our priorities by developing our **people**, improving the **efficiency** of everything we do and by harnessing the power of **technology**.

For more information on how the programmes, and our priorities and foundations are connected, search for 'Our Plan' on the London Underground & London Rail intranet.

INVESTMENT PROGRAMMES

INFRASTRUCTURE RENEWALS

A well-managed infrastructure portfolio is the bedrock of our network. Maintaining asset condition safeguards reliability and enables capacity improvements for our customers; by doing this to the best whole-life cost, the organisation can become ever-more efficient. The programme is made up of the following: track and drainage renewals, power upgrades, cooling upgrades, plant and depot portfolio and civils – earth structures.

LEGACY TRAIN SYSTEMS

This programme is responsible for all renewals projects associated with legacy fleets, line signalling and communication systems. The aim is to ensure that the existing asset base is kept in a safe and reliable condition until planned modernisations commence. The Legacy Train Systems programme will be delivering a range of renewals and refurbishments on the Bakerloo line '72 Tube Stock, Battery Locomotives (engineering trains), Central line '92 Tube Stock, installation of inter-car canopy barriers on the Waterloo & City line and improvements to track monitoring through the testing and installation of an automatic track monitoring system on LU fleets.

LONDON RAIL CAPACITY & GROWTH

To help increase capacity, ease overcrowding and grow the network while improving customer service and reliability, we will lengthen trains and improve accessibility at key stations across the London Overground network. Improvements are planned for stations along the West Anglia-inner route after we commence services. Other deliverables this year include enhancing key Tramlink sections between Croydon and Wimbledon, and procuring additional trams.

NEW TUBE FOR LONDON

A co-ordinated series of schemes for the Piccadilly, Central, Bakerloo and Waterloo & City lines, the New Tube for London programme will form the next generation of line modernisations. The programme provides a unique opportunity to capitalise on the need to renew life-expired assets, improve customer experience, and deliver a significant increase in capacity (e.g. 60 per cent on the Piccadilly line). The key milestone for the next phase of the programme is to issue the Invitation to Tender for the first phase of the new generation of trains.

NORTHERN LINE EXTENSION

The primary aim of the Northern line Extension (NLE) is to encourage growth in London and the wider UK economy by facilitating the sustainable regeneration of the Vauxhall Nine Elms Battersea Opportunity Area. The NLE will achieve this by providing a twin tunnelled extension from Kennington to Battersea via an intermediate station at Nine Elms. The programme will provide all the necessary infrastructure work, signalling, additional rolling stock, power supply, communications and control systems to support a peak service frequency of at least 28tph on the Northern line.

STATIONS, CROSSRAIL & THIRD PARTY

A programme of station capacity upgrades is central to London Underground's strategy to meet rising demand and changing customer needs. To ensure that congestion does not increase significantly, a programme of congestion relief interventions is being planned and implemented. As well as increasing capacity, we also need to ensure our station assets are maintained; the new Integrated Stations Programme supersedes the existing Station Stabilisation Programme and will implement a range of improvements to ensure stations remain safe, maintainable and operable, as well as delivering improvements to customer facing areas.

MODERNISATION OF THE DISTRICT, METROPOLITAN, CIRCLE AND HAMMERSMITH & CITY LINES

The Sub-surface Railway (SSR)/Modernisation of the District, Metropolitan, Circle and Hammersmith & City lines covers the four lines that make up 40 per cent of the Underground network. To boost capacity and continue running reliable services, a programme of fleet, signalling and supporting systems is underway to replace existing assets that are at, or beyond, their design life. This programme will deliver a 33 per cent increase in peak hour capacity.

WORLD CLASS CAPACITY

This programme will provide additional capacity beyond that delivered by the first upgrades on the Victoria, Jubilee and Northern lines. The second wave of upgrades are at differing stages with the Victoria line in implementation, Jubilee line in design and Northern line in feasibility. These improvements will increase peak capacity on the Victoria line from 34 to 36tph in 2016, on the Jubilee line from 30 to 36tph by 2019 and on the Northern line central branches from 24 to 36tph by 2021.

Our Succession Plans are the outputs of a number of different initiatives, some of which are well established and others are relatively new:

Workforce Planning

We have just completed a pilot scheme with Surface Transport to look at our Workforce Planning needs. This identified what workload we had going forward and what resources we needed to deliver that planned and also anticipated work.

Using the outputs of Workforce Planning we are able to plot how much resource, and in what areas, we require. It also identified what skill areas we had shortages for and whether there were areas where we no longer needed a successor due to reductions in work.

On the basis if the efficiencies Workforce Planning made to Surface Transport, it is being rolled out across TfL, starting with London Underground Capital Programmes.

Resource Planning

Resource Planning happens across each Programme but not through the wider business as a whole. We are in the process of rolling out 2 year Resource Plans which tell us where we have people (both permanent and non-permanent staff) and when they are no longer needed.

By having this overview we are able to identify promotional and development roles for people identified as through the 9-box grid for talent.

Maximising Potential

Maximising Potential gives us the framework, guidance and tools to be better at identifying, developing and mobilising our talent across TfL.

It builds on our performance management process. By having open and honest conversations about individual career aspirations and their potential, these performance and development conversations will have more meaning. It will also enable tailored development and align talent planning to resource planning.

The new framework supports TfL's People Strategy to recruit, manage, reward, engage and develop the people we need with the right skills, capabilities and behaviours to ensure delivery of our business priorities.

Maximising Potential gives us a common understanding of what talent is and how to recognise and develop it.

Identifying and managing talent consistently at both a local and organisational level is beneficial as it provides and supports:
- greater visibility of organisational bench strength,
- increased internal mobility,

- informed thinking on local and TfL wide succession planning
- tailored individual development plans.

After the individual conversations, employees are ‘plotted’ in a peer review session onto a Potential / Performance Matrix:

<u>Succession Planning</u>

In the short-term, and for the past few years, we have run Succession Planning as a one-off Powerpoint slide with an indication of ‘ready for new role’ either immediately, in 18 months time , or within 3 – 5 years.

This has then given us a list of Resources in the event that we needed a key member of staff replaced. (e.g MLE was an appointment from the Succession Plan, as was New Tube for London). Enhancements to this process, ahead of Maximising Potential, are to actually use it and track peoples development toward these roles.

Stakeholder Engagement Plan (Stages 1-5)

Purpose

To identify, analyse and plan stakeholder communication, negotiation and influencing activities. (Stakeholders are all those who have an interest or role in the Project, Programme or Delivery Portfolio, or are impacted by its activities.)

The next step after producing the Stakeholder Engagement Plan is to produce the Project, Programme or Delivery Portfolio's Communications Plan.

Applicability

This product must be produced for all projects.

This product may be produced stand-alone or as a section in the Project Execution Plan.

A Stakeholder Engagement Plan may be encompassed within another programme or delivery portfolio.

Templates

- Stakeholder Engagement Plan template

Contents

Content is defined by the template.

Quality criteria

- The amount of time and resources to be allocated to stakeholder engagement must be appropriate to the Project, Programme or Delivery Portfolio.
- Internal and external stakeholders are identified.
- Stakeholder involvement in relevant decision making processes and governance arrangements must be considered and recorded.
- The Power v Interest Map, Stakeholder Engagement Strategy and Stakeholder Communication Plan must be updated regularly throughout the lifecycle.
- Stakeholder consultation must be carried out and recorded following project changes (relevant stakeholders must be consulted dependant on the nature and impact of the change).
- Additional products may be needed for People Change projects and other projects which affect staff in the work place (including consultation with Trade Unions), these can be found on the Business Change Framework.

Business area specific

Area	Detail
LU	The programme/project manager must consult with the LU Stakeholder Engagement Framework team for guidance during the development of the plan.

Document management

Stakeholder Engagement Plans must be filed in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

Responsible (Responsible for producing all or part of quality product)	**Accountable** (Accountable for ensuring timely delivery of quality product)	**Consult** (Must be consulted when product is being produced)	**Inform** (A copy of the signed-off product must be sent to)
Project Manager	Sponsor	Group Public Affairs and Stakeholder Engagement (re external consultation activity) People Change Manager HSE Advisor Climate Change and Sustainability Co-ordinator	

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for consultation	IPPM
A2	08/04/2013	Issued for use	IPPM
A3	30/07/2013	Amendments to align with Business Change Framework	Bithika O'Dwyer/People Change SIG

Pathway Information (delete when you use this template)

Template reference	Template file name	Version	Date
F0870	T Stakeholder Engagement Plan	A2	15/08/13

PD reference	PD
PD0056	PD Stakeholder Engagement Plan
PD0078	PD Programme Stakeholder Engagement Plan
PD0128	PD Delivery Portfolio Stakeholder Engagement Plan

Programme

Project

Document reference

Stakeholder Engagement Plan

		Signature	Date
Prepared by	<Name> Project Manager	--	------------------------
Reviewed by	Endorsement statement	--	------------------------
Reviewed by	<Name> People Change Manager	--	------------------------
	<Name> [If appropriate, typically for external consultation activity that might be included in the Consultation Plan that sometimes sits within this document] Group Public Affairs and Stakeholder Engagement	--	------------------------

Approved by

I confirm that this deliverable meets the requirements of the relevant Pathway Product Description and that all consultation comments have been addressed to the satisfaction of consultees.

<Name>

Sponsor -- -----------------------------------

Distributed to <Name> <Role>

Document History

Revision	Date	Summary of changes
A	April 2013	First Version
B	August 2013	Alignment with the Business Change Framework

Table of Contents

1. Initial Stakeholder List

[DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY Who are your programme/project stakeholders – those involved, impacted, interested? What do you know about them? What do you need to find out about? The prompt lists below can be used to generate the initial stakeholder list, and the output can be recorded on the table on the next page.]

Typical stakeholder groups for consideration during identification:

Internal – **employee groups** impacted by and involved in the project, **change agents** and **solution builders** for the project and other **interested parties [see BCF Relationship Map]** , including:

- Senior Managers/Directors/Programme/Project Board
- Operations
- Maintenance
- IM
- Other functional/business areas (eg HR, ER, HSQE, Finance, Legal, Procurement etc)
- Line managers of associated project staff
- Project team members
- Other projects (internal or external)
- For individual projects, it may be appropriate to engage with local staff – eg station staff
- TfL's Interchange Team
- Other relevant business units within TfL
- Union representatives

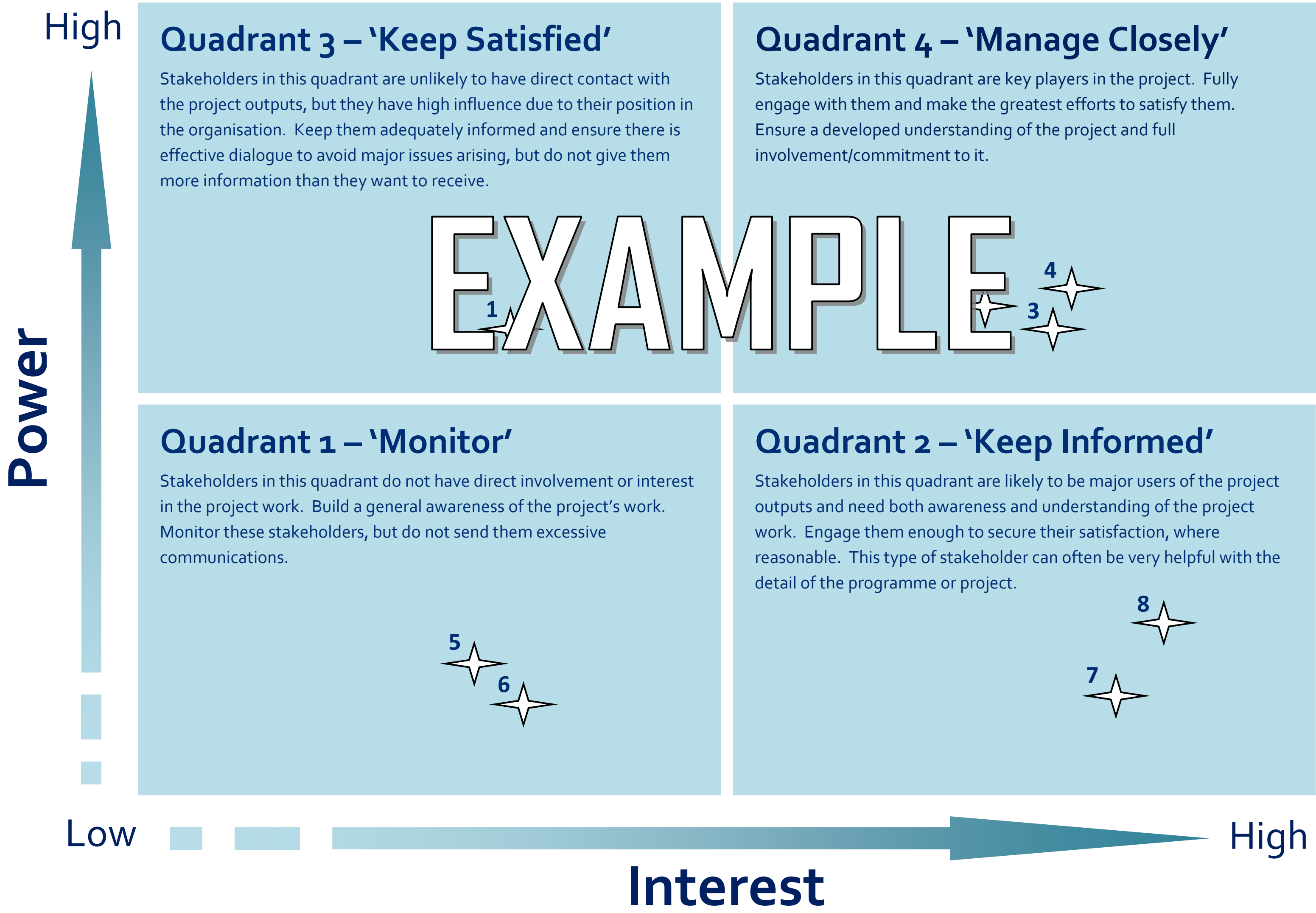
External:

- Central Government, including Department for Transport (DfT)
- Members of Parliament (MPs)
- London Assembly Members (AMs)
- Local authorities and elected representatives
- Key business and industry bodies – eg London Chamber of Commerce, CBI, London First
- London Fire & Emergency Planning Authority (LFEPA)
- Police authorities
- Other transport providers – eg bus operators, train operating companies (TOCs) and Network Rail
- Other national, regional and local decision makers
- Regulatory authorities
- Funding partners
- Alliance partners
- Lenders
- Suppliers
- Contractors
- Utility companies
- Trade associations
- Public and private sector organisations
- Statutory undertakers
- Customers/users
- Objectors/members of public who have expressed and interest
- Neighbours – community and residents' groups
- Transport user groups – eg Harrow Public Transport Users' Association
- Opinion-formers/media
- Faith/parish groups
- Local businesses
- Affected land owners, leaseholders and tenants
- Environmental groups
- Local interest groups – eg London TravelWatch
- Major event organisers – eg 02, Excel, Wembley Stadium, Earls Court Exhibition Centre, Olympia, Queen Elizabeth

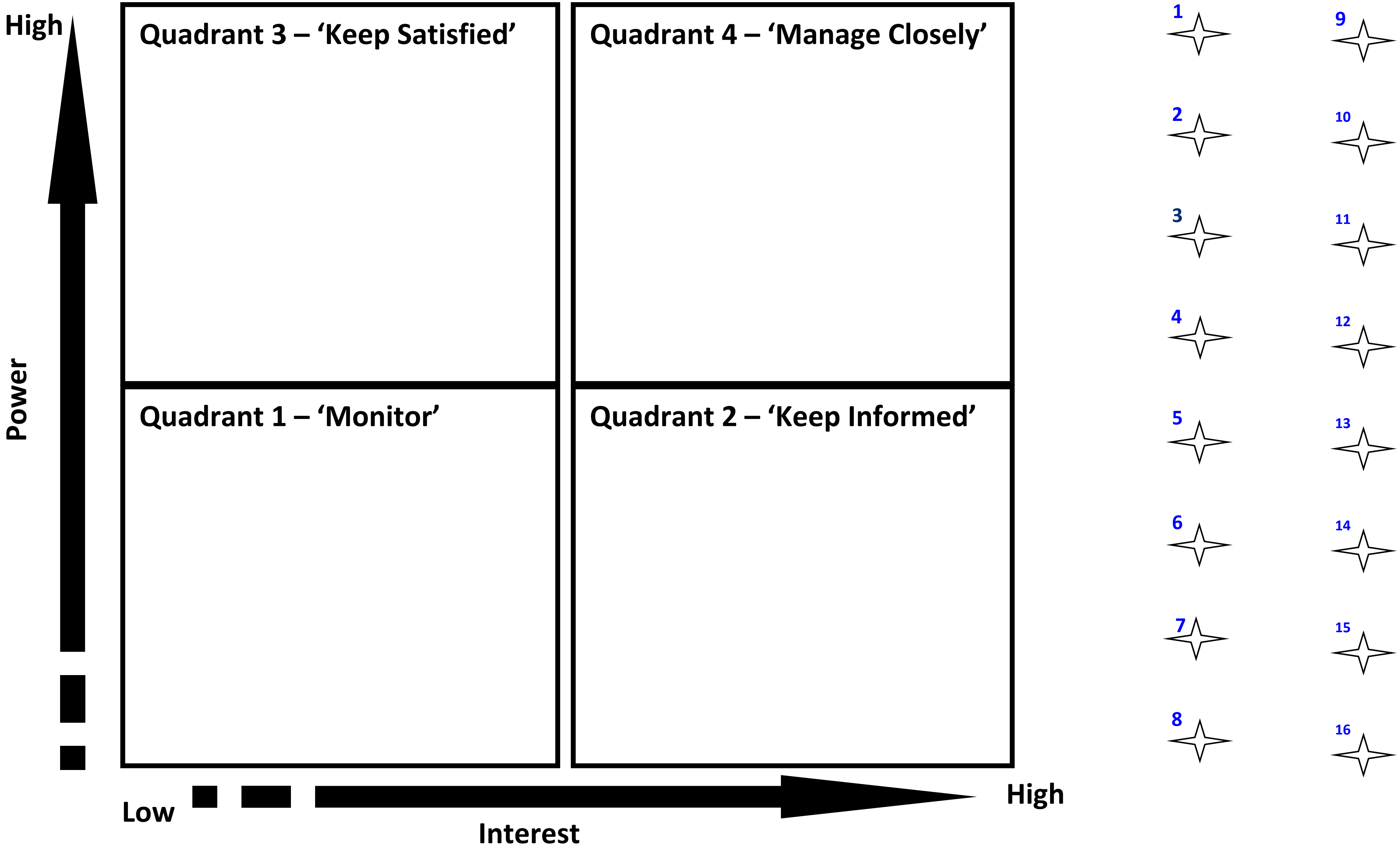
Stakeholder No (for mapping in Section 2)	Stakeholder Name/Group	Known Information/Position (Where the stakeholder is currently positioned)	Unknown/Info to Validate (Other information to find out)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			*Extend table as appropriate ...*

2. Power v Interest Map

[DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY Once the stakeholders have been identified, the sponsor, programme or project manager must prioritise them based upon their relationship to the proposed work. *How much power over or interest in the project does each stakeholder have? Which quadrant should they fall under on the Power v Interest map?* This will determine how they are engaged with/managed going forward. The picture below gives guidance on each quadrant and indicates how stakeholders can be mapped.]



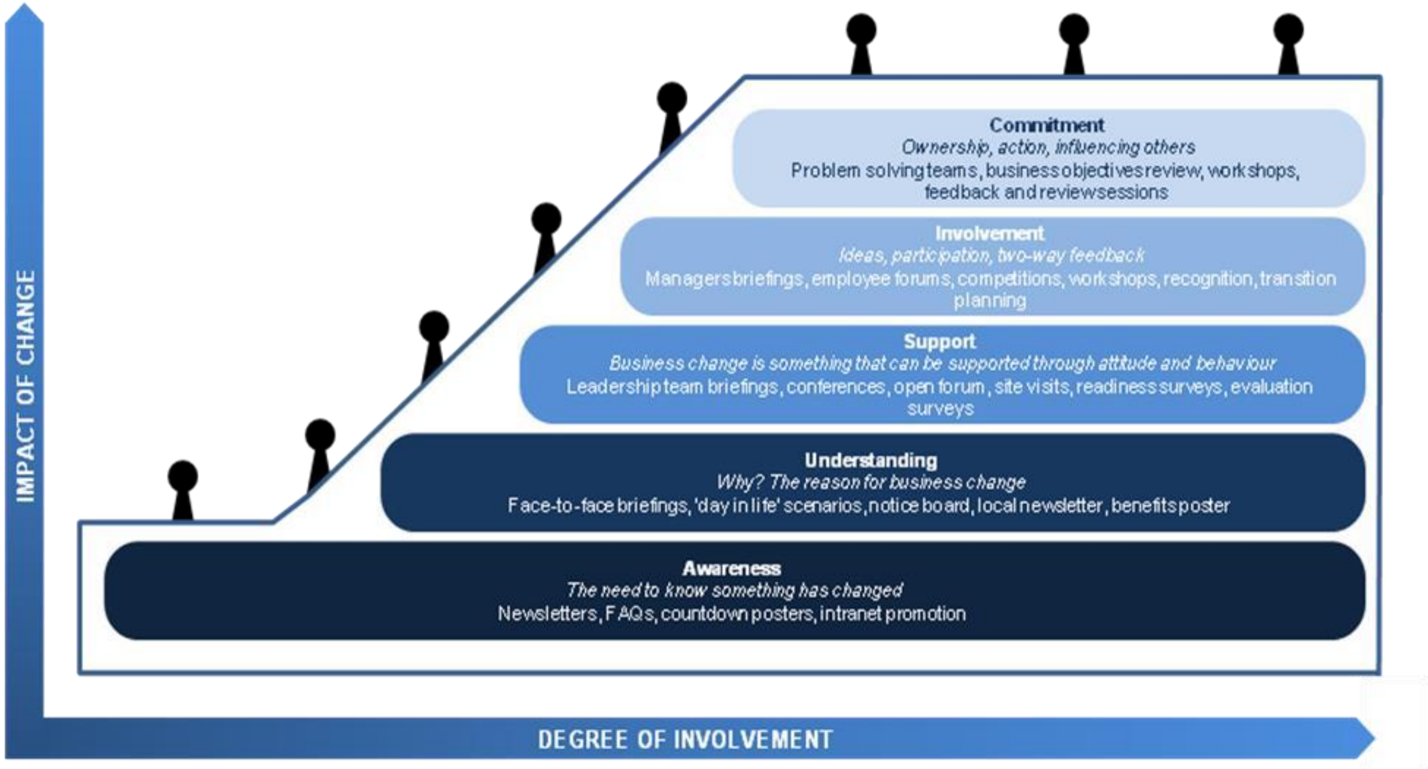
[DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY – this template diagram is for use in mapping stakeholders. Move the numbered stars around as necessary, and add the stakeholder number back on the stakeholder list from Section 1.]



3. Stakeholder Engagement Strategy

[DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY. Based upon the Power v Impact outputs from Section 2, the Engagement Commitment Ladder (below) can be used as guidance for producing the stakeholder engagement strategy: eg higher levels of involvement are important to gain commitment from highly impacted staff – eg those in Quadrant 4 ... *Which quadrant do the stakeholders fall within? What are the engagement objectives? Which communication options would be effective (see model below)?*

Also, there is an **Excel Version** of the word strategy template over the page, if preferred.**]**



KEEP THIS MODEL IN MIND WHEN PLANNING YOUR ENGAGEMENT ...

The **Vision for Change** is a useful tool within the **Business Change Framework (BCF)** for articulating the key messages for the project.

Stakeholder Name/Group	Their Key Interests	Objectives What do we want them to...	Communications Requirements Opportunities and Risks/Barriers	Key Channels	Owner and Feedback Mechanism	Issues/ Status
Q4 Manage Closely						
eg Programme Top Teams Lead Sponsors Programme Managers		**Feel...** - eg Confident in project delivering the right change for their area **Know...** - eg What the project is delivering and how it will make a difference (including imperative for change) **Do...** - eg Be Fully involved and influential in making the change happen	**To do this they need...** eg - Clarity on their role - Regular focused updates/briefings - Involvement in process - opportunity to 'co-create' solution - Confidence in supporting evidence and data **What might prevent them...?** eg - Competing priorities in own business area - Ineffective change leadership	eg - Monthly briefings 1:1 - Project communications pack - Staff briefings		

Stakeholder Name/Group	Their Key Interests	Objectives What do we want them to...	Communications Requirements Opportunities and Risks/Barriers	Key Channels	Owner and Feedback Mechanism	Issues/ Status
Q3 Keep Satisfied						
eg Project Managers Project Engineers		**Feel...** - eg They are consulted with at right times **Know...** - eg Have a clear view of what changes are being proposed and the staff who are involved in the process **Do...** - eg Provide feedback – both positive and negatives to enable change to be managed better	**To do this they need...** eg - Regular programme updates **What might prevent them ...?** eg - Lack of understanding of what is expected of them - Lack of resources available	eg - Monthly briefings - Staff briefings		

Stakeholder Name/Group	Their Key Interests	Objectives What do we want them to...	Communications Requirements Opportunities and Risks/Barriers	Key Channels	Owner and Feedback Mechanism	Issues/ Status
Q2 Keep Informed						
eg Other functional Heads		**Feel...** - eg Confident that project is delivering right change for the business **Know...** - eg How the project is progressing, including any change to realising the benefits **Do...** - eg Make informed decisions that help to progress the programme	**To do this they need...** eg - Accurate, well presented updates on the programme - To be engaged with at right level **What might prevent them...?** eg - Competing priorities - Conflicts of interest	eg - Monthly briefings - Staff briefings		

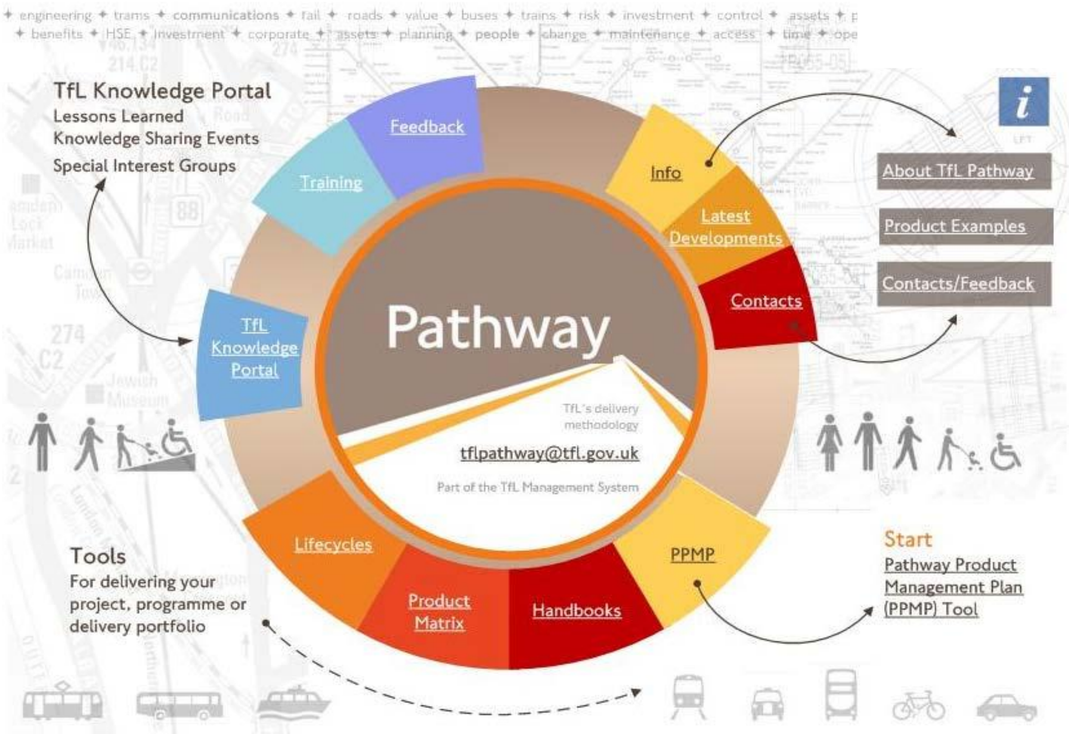
Stakeholder Name/Group	Their Key Interests	Objectives What do we want them to...	Communications Requirements Opportunities and Risks/Barriers	Key Channels	Owner and Feedback Mechanism	Issues/ Status
		Q1 Monitor				
eg Other functions – eg Legal, Comms		**Feel...** - eg Informed and 'in the know' about the changes **Know...** - eg What they need to do to support the project **Do...** - eg Take the necessary actions to support the project	**To do this they need...** eg - The right level of information at the right time **What might prevent them...?** eg - Lack of buy-in or interest in the project - Project not a priority	eg - Emails - Team/General briefings - Intranet articles		

TfL Pathway

TfL Pathway

TfL's Delivery Methodology

What is Pathway?



TfL Pathway

What is it?

The integrated project, programme and portfolio delivery methodology for TfL

Imperative from the TfL Commissioner's 2012 message:

'... common project methodology, assurance processes ... underpinned by a common management system to ensure a clear approach to how we deliver together.'

TfL Pathway

Pathway Benefits

Clarity	• Know exactly what you need to deliver – get things right the first time . . .
Consistency	• There is a single 'how we do things around here' – it's easier to move between projects
Certainty	• See clear progress before investing further – the stage gates flag up any issues
Visibility	• Progress is visible – stakeholder confidence increases as there are objective measures

The benefits of Pathway help achieve the TfL Story

TfL Pathway

Who is it for?

- ✓ TfL Pathway is for TfL Business Units that deliver Projects, Programmes or Delivery Portfolios

TfL Pathway

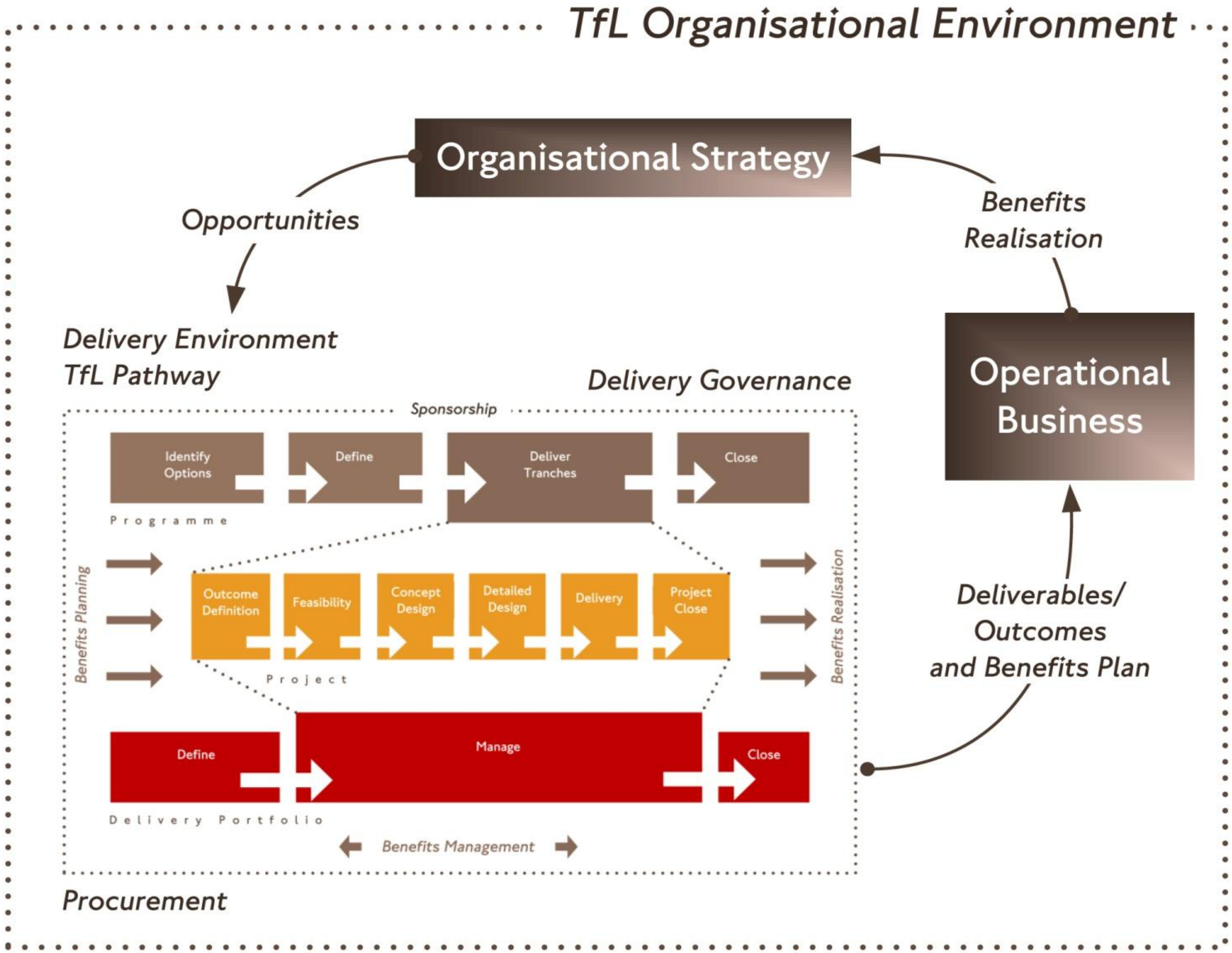
How different is Pathway?

- ✓ This is ***not*** a radical business process re-engineering initiative
- ✓ Legacy systems already have a common approach: emphasis on products rather than processes
- ✓ TfL Pathway is based on core project management good practice – eg APM
- ✓ Significant engagement during development has resulted in a framework that is fit-for-purpose
- ✓ Current pilots are evidencing strong working-level support – ***'it's all just common sense'***
- ✓ TfL Pathway, therefore, is readily understandable by all

A common methodology/vocabulary on a foundation of accepted good practice

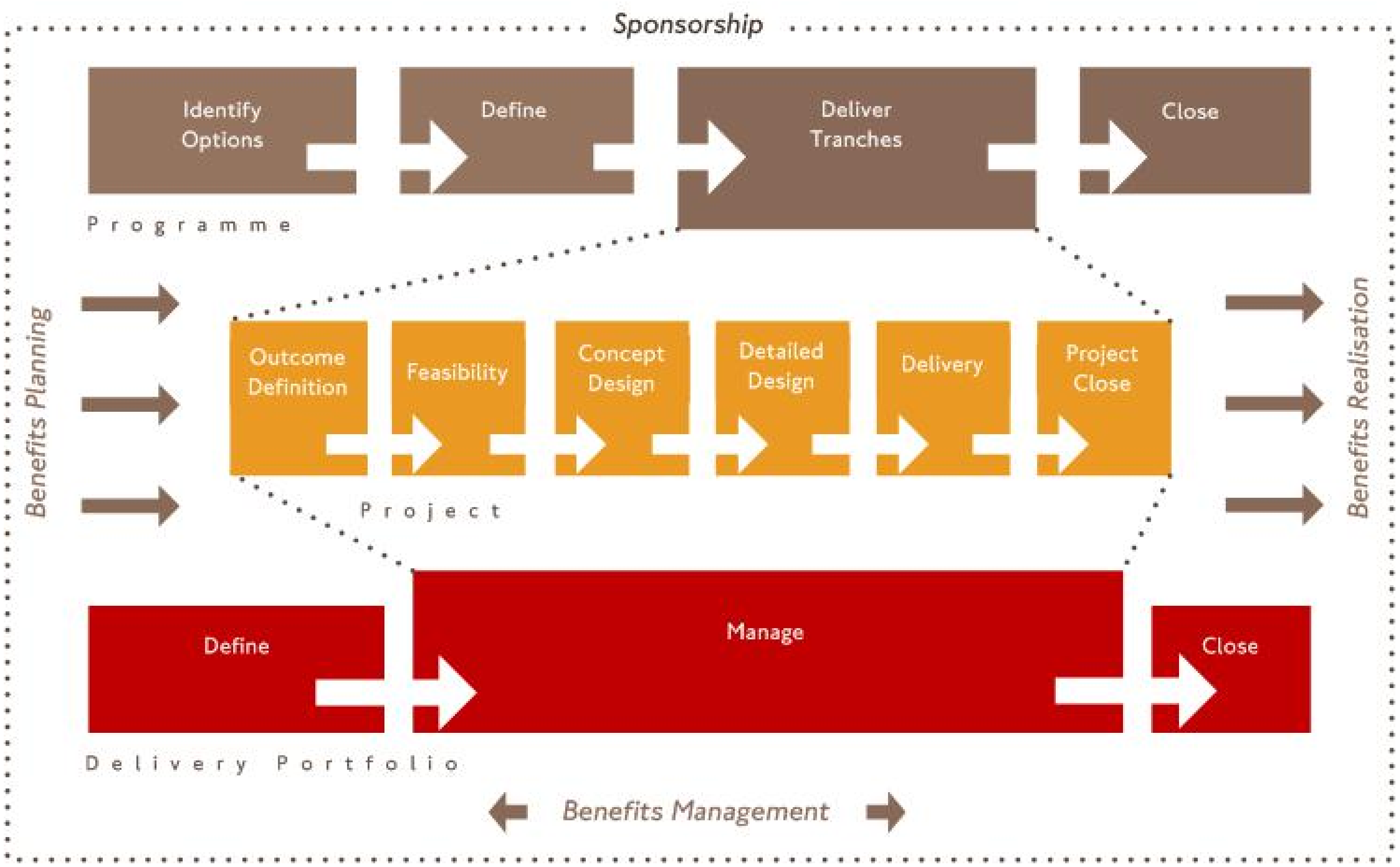
TfL Pathway

Scope of Action



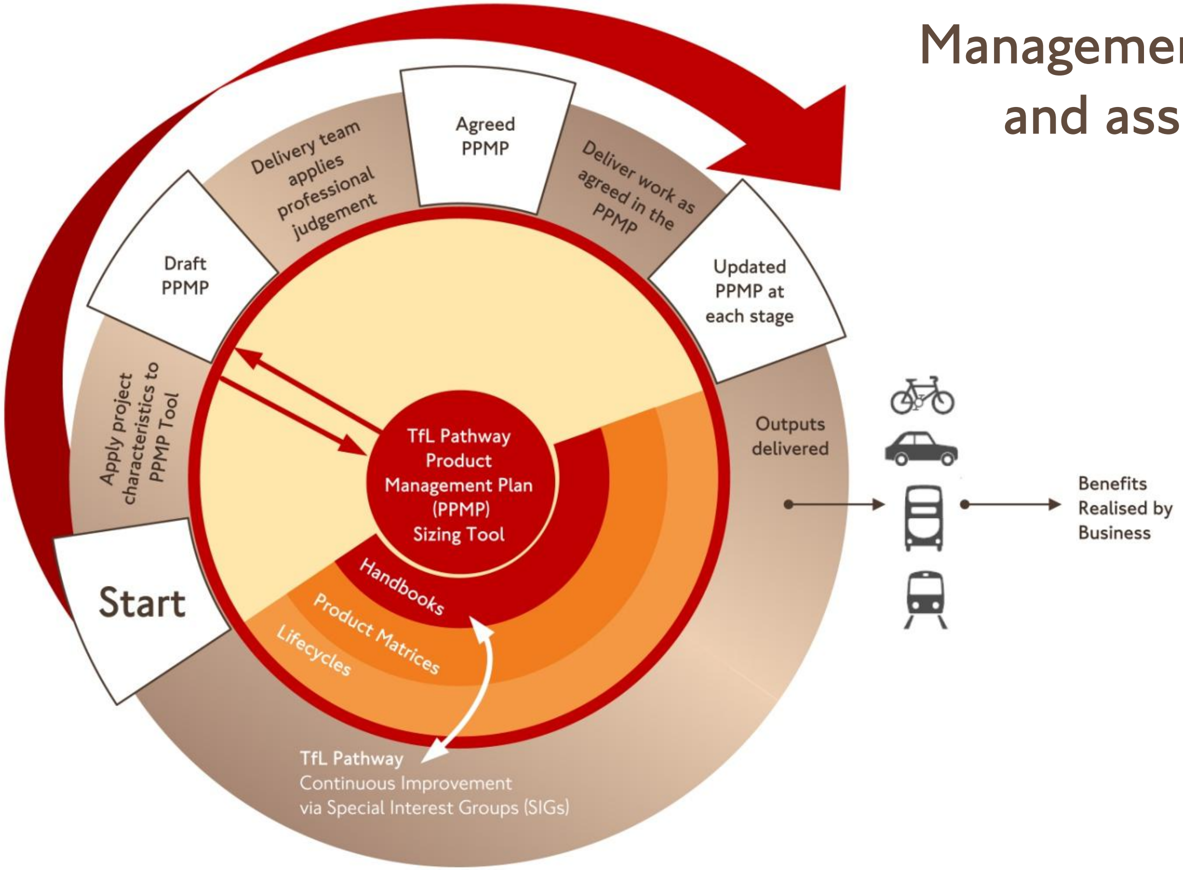
TfL Pathway

TfL Delivery Lifecycles



TfL Pathway

Pathway Product Management Plan (PPMP) and associated tool/s



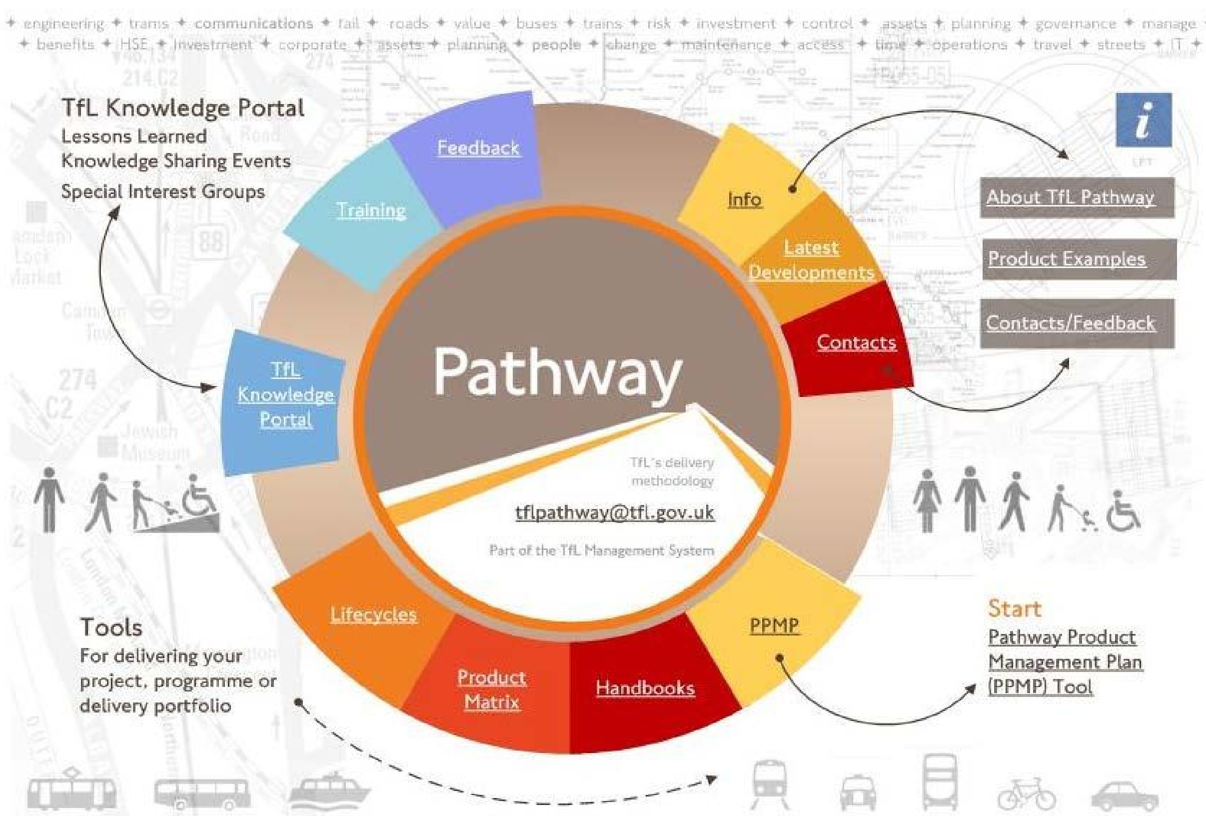
Access to TfL Pathway via SharePoint (links searchable on Source)

TfL Pathway

Where to explore

- ✓ TfL Pathway SharePoint Site
- ✓ TfL Pathway FAQs
- ✓ Have a look at the Product Matrix (and click through to products and templates)
- ✓ Have a look at the Handbooks
- ✓ Contact the TfL Pathway Representative for your Business Area
- ✓ Email us at tflpathway@tfl.gov.uk with any feedback or queries

TfL Pathway


✦ engineering ✦ trams ✦ communications ✦ rail ✦ roads ✦ value ✦ buses ✦ trains ✦ risk ✦ investment ✦ control ✦ assets ✦ planning ✦ governance ✦ manage ✦
✦ benefits ✦ HSE ✦ investment ✦ corporate ✦ assets ✦ planning ✦ people ✦ change ✦ maintenance ✦ access ✦ time ✦ operations ✦ travel ✦ streets ✦ IT ✦
TfL Knowledge Portal
Lessons Learned
Knowledge Sharing Events
Special Interest Groups
Feedback
Training
TfL Knowledge Portal
Info
Latest Developments
Contacts
Pathway
TfL's delivery methodology
tflpathway@tfl.gov.uk
Part of the TfL Management System
Lifecycles
Product Matrix
Handbooks
PPMP
i
About TfL Pathway
Product Examples
Contacts/Feedback
Start
Pathway Product Management Plan (PPMP) Tool
Tools
For delivering your project, programme or delivery portfolio

Pathway Manual

Managing Programmes, Projects and Delivery Portfolios at TfL

Contents

Introduction

TfL's strategic objective is to be a fully integrated organisation, fit for purpose, consistent and working as one. We aim to deliver the investment programme – with the upgrade and capital renewal of our Tube, rail and road networks, plus Crossrail at its core – on time and to budget. A common understanding of 'how we do things around here' is central to meeting these objectives. The TfL Story.

TfL Pathway is an integrated and consistent framework with the clear objective to provide the tools for delivery teams and their stakeholders to work effectively. Underpinned by common project management principles, it emphasises professional judgement in its flexible application to manage and control specific programme, project and delivery portfolio scenarios.

TfL Pathway has been developed in conjunction with more than 300 practitioners around the business. Now it must be owned by you – the users – and a fundamental concept is that it will also be improved over time with your input.

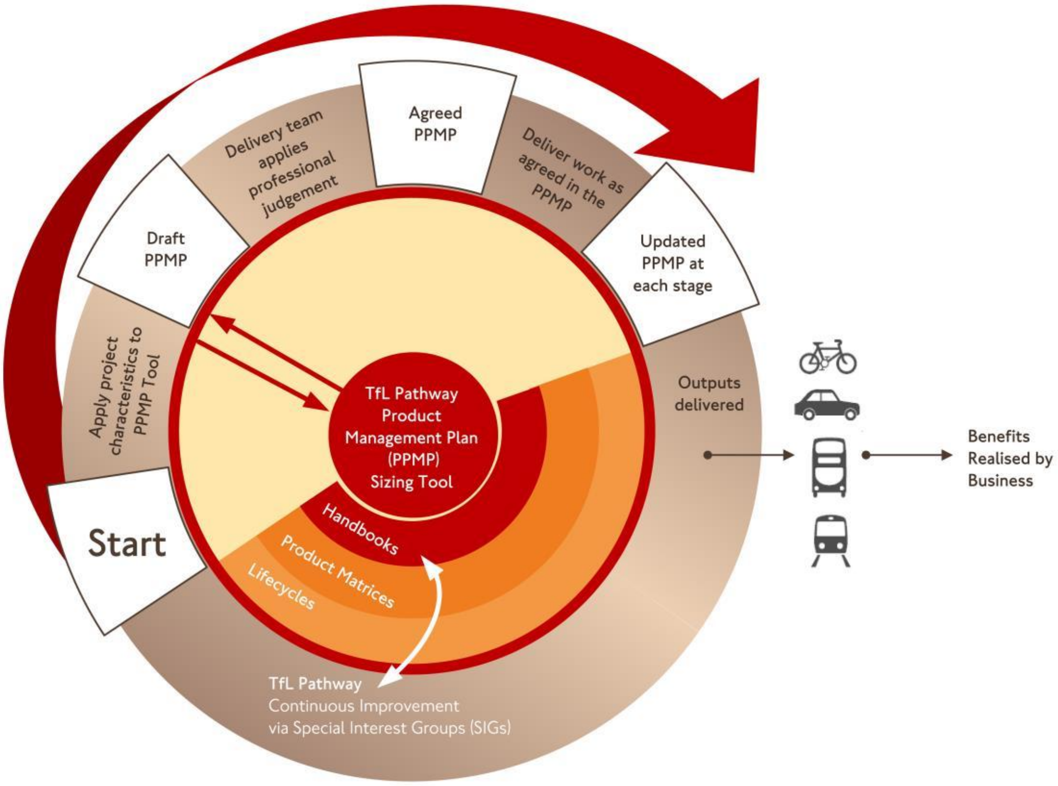
TfL Pathway is part of the TfL Management System and its use is mandatory for all project, programme and delivery portfolio work at TfL. It is the accountability of each business area to implement TfL Pathway effectively, supported by the TfL Programme Management Office (PMO).

For all information: search 'Pathway' on Source

Please send any feedback to: tflpathway@tfl.gov.uk

The TfL Pathway Manual

This document provides a route map through the various elements of the TfL Pathway – as illustrated in the diagram below.



Lifecycles

The Lifecycles (pages 6-9) encompass programme, project and delivery portfolios. Use the structures flexibly according to your needs.

Pathway Product Management Plan (PPMP)

At the heart of TfL Pathway is the Pathway Product Management Plan (PPMP). Based on the characteristics of your programme, project or delivery portfolio, this records the agreement between the delivery team and stakeholders as to how the programme, project or delivery portfolio will move through the lifecycle; which stage gates will be undertaken, which products will be produced, and which reviews will be undertaken.

Product Matrices

The Product Matrices list the full set of products and reviews for programmes, projects and delivery portfolios. Use the Pathway Product Management Plan (PPMP) and your professional judgement to identify what needs to be produced for your work.

Products are the documents produced by a programme, project or delivery portfolio during the stages of each Lifecycle. There are nine core documents – required for every type of work – with additional documents needed depending on the type of work being undertaken.

The reviews specified within TfL Pathway cover appropriate governance requirements and should be scaled according to your needs.

Handbooks

The objective of the handbooks is to provide context and guidance to the products.

Continuous Improvement via Special Interest Groups (SIGs)

A fundamental concept is that the TfL Pathway methodology must be owned by the business and that improvements must primarily come from the users. The Special Interest Groups (SIGs) and associated Communities provide the vehicles for user-driven improvement. (page 12)

Intranet and SharePoint sites

All of this is supported by the Intranet (Source) and the TfL Pathway Home sites, which provide

(i) online access to these materials,

(ii) inform on important changes and developments and

(iii) invite improvement suggestions.

Key Principles

Underpinning TfL Pathway are the following key principles. It is:

- The way we manage programmes, projects and delivery portfolios at TfL. It is designed to provide a clear, consistent framework and common language to all involved in delivering programmes, projects and delivery portfolios
- About programme, project and delivery portfolio professionals working with stakeholders to make conscious, visible decisions about what does and doesn't need be done for a specific programme, project or delivery portfolio
- About the application of professional judgement, not 'tick box' management
- Scalable, not a 'one-size-fits-all' approach
- Output focussed, rather than process focussed. This means that, in most cases, it specifies what needs to be produced, rather than how it is produced
- About us being able to deliver fundamental changes to the efficiency of our programme, project and portfolio management processes.

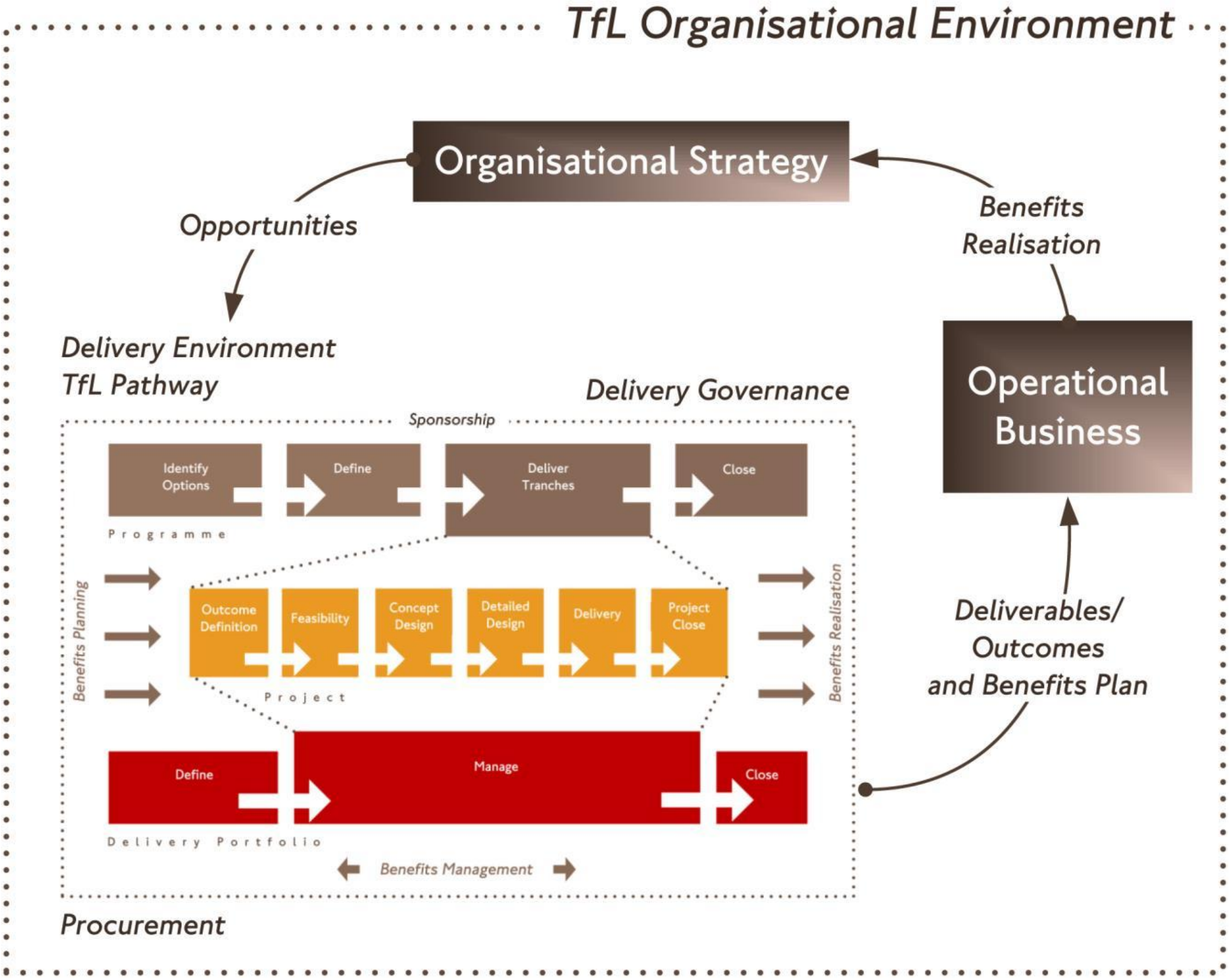
Application of TfL Pathway

All TfL programmes, projects and delivery portfolios must use the TfL Pathway from the earliest appropriate date as agreed in local implementation plans.

The Lifecycles

TfL delivers a wide range of work, such as installation of IT servers, resealing of street surfaces, deployment of the Oyster Card service, accommodation refurbishments, track renewal and upgrade of stations. This spectrum of work requires a delivery model that can cater for the entire TfL delivery suite.

The context in which TfL works from a delivery viewpoint can best be shown by reference to the Guidance on Project Management ISO 21500 – the below figure shows how the key strategy, delivery and operation concepts relate to each other.

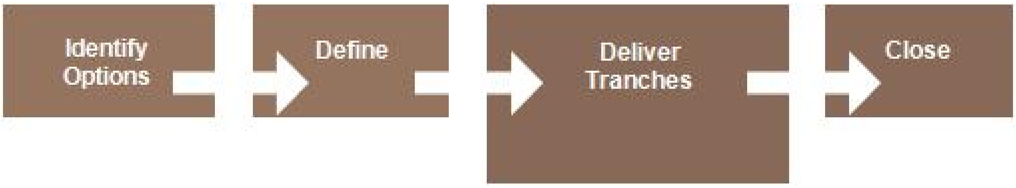


The delivery environment works within a set of Governance requirements as described in the Governance Handbook. The Commercial (Procurement and Contract Management) Handbook, describes how the delivery environment interfaces with procurement – it should be noted that procurement can be invoked at any point in the lifecycle.

As shown above and based on consultation with both external experts and TfL users, three lifecycles are available for delivery teams – Programme Lifecycle, Project Lifecycle and Delivery Portfolio Lifecycle. These lifecycles are underpinned by benefits management and delivery.

The Programme Stages

A programme is defined as a temporary structure which has been created to coordinate, direct and oversee the implementation of a set of projects and activities in order to deliver outcomes and benefits related to the organisation's strategic objectives. Examples within TfL are Surface's Barclays Cycle Hire, LU's Northern Line Extension and Customer Experience's Oystercard service.



All programmes follow the four stage Programme Lifecycle:

A	**Identify Options**	Look at the programme from a high level, consider strategic fit, vision, costs, duration, risks and prepare for the future
B	**Define**	Explore the options for delivering the required outcomes and benefits together with robust and detailed planning for delivery
C	**Deliver Tranches**	Implement the governance strategies to ensure capability is delivered and aligned to organizational objectives – manage the projects. Each programme will have one or more delivery tranches
D	**Close**	Confirm ongoing support is in place – disband resources and infrastructure so that the programme does not drift into normal operations

The programme will need to prepare for the proposed changes, manage the transition to business as usual activity in conjunction with its stakeholders and monitor benefits against plan whilst it is still live.

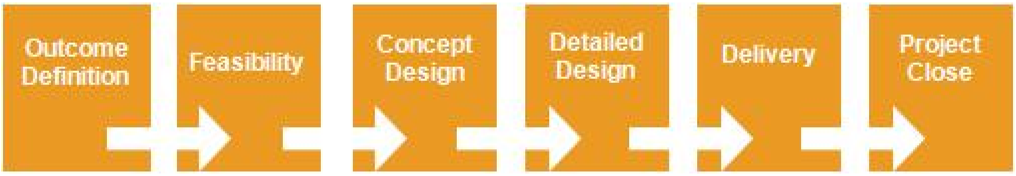
Delivery assurance will be captured using Stage Gates on completion of the stages and Integrated Assurance Reviews as per the requirements of the programme, both of which will be scheduled.

Annual reviews may also be performed based on need and length of each stage – this information will be documented in the Integrated Assurance and Approval Plan.

The programme is likely to contain several projects which should be delivered using the project lifecycle.

The Project Stages

The project is defined as a unique set of coordinated activities with definite start and finish points, undertaken to meet specific objectives within defined time, cost and performance parameters.



All projects follow the six stage Project Lifecycle – stages can be combined based on professional judgement.

1	**Outcome Definition**	Establishes the business outcomes and benefits that the project must deliver
2	**Feasibility**	Determines whether the outcomes and benefits are achievable – the options for their delivery and the option that will deliver them for the best value
3	**Concept Design**	Defines the design principles and freezes the scope of the project
4	**Detailed Design**	Produces a detailed design that delivers the required outcomes and is used as the basis of a contract for delivery of the physical outputs
5	**Delivery**	Builds the physical outputs of the project, confirms acceptance by end users and hands the outputs over into operational/business use and maintenance, including necessary supporting documentation
6	**Project Close**	Ensures that the project is closed in a controlled manner

Stage Gates on completion of the stages and Integrated Assurance Reviews as per the requirements of the project will be scheduled.

As stated above, stages can be merged for small projects. For example, a project may combine Outcome Definition with Feasibility, then combine Concept Design with Detailed Design before going on to Delivery and Project Close.

More complex projects may require the project to be either broken down into a number of sub-projects, or for specific stages to be broken down into a number of sub-stages.

The decision as to which stages apply to a project must be made consciously, in consultation with relevant stakeholders and with the agreement of the Sponsor – this agreement will be documented in the Integrated Assurance and Approval Plan and the Pathway Product Management Plan (PPMP).

> i Where a project is new / novel or high risk, additional focus should be given to the early stages. Historically, some projects in the past have had inadequate attention paid early in the lifecycle and developed momentum of their own due to time, cost and political pressures – leading to costly failure at later stages.

Therefore, for such projects, there are three avenues suggested:

The first option is to set up and run a full project whose output is the input to the main project - and the main project not to start until all parties are bought into the proposed solution(s).

The second option is to conduct an elongated Feasibility stage - applying for full Project Authority once more certainty is available on cost and schedule.

Finally, for particularly complex projects, a complexity analysis may contend that a higher than usual level of review may be required – personal overview by the Programme Engineering Manager and Programme Director for example.

In all cases, it is imperative that the Sponsor, Programme Delivery Director and associated stakeholders such as Commercial, develop delivery and procurement strategies to minimise risk to the business.

The Delivery Portfolio Stages

A Delivery Portfolio is defined as a grouping of an organisation's activities, schemes, or projects, likely to be agreed annually, taking into account resource constraints.

Examples are Surface Roads Resurfacing, Surface Traffic Signal replacement, LU's Track replacement and IM's server replacement.

All Delivery Portfolios should follow the three stage lifecycle:

1d	Define	Explores the options for delivering the required outcomes and benefits together with robust and detailed planning for delivery
2d	Manage	Implements the governance strategies to ensure capability is delivered and aligned to organizational objectives – manage the projects. Each delivery portfolio is likely to contain one or more projects
3d	Close	Ensures that the delivery portfolio is closed in a controlled manner

Delivery Portfolios should undertake a formal review at least every 12 months to confirm requirements and benefits.

The delivery portfolio is likely to contain several projects which should be delivered using the Project Lifecycle.

The Pathway Product Management Plan (PPMP) and the Product Matrix

The Pathway Product Management Plan (PPMP) is at the heart of the TfL Pathway and is described in more detail below. It records the agreement between the Sponsor or SRO, programme, project or delivery portfolio team and stakeholders about what does and doesn't need to be produced for a programme, project or delivery portfolio.

With the exception of a small number of 'core products', it is not the intention that Programmes, Projects or Delivery Portfolios will blindly produce all of the products listed in the Product Matrix. Please see the next section.

Using the Pathway Product Management Plan (PPMP) questionnaire to determine which products are required

The Pathway Product Management Plan (PPMP) contains a questionnaire/tool that creates an initial understanding of value, risk, complexity and stakeholder requirements for a Programme, Project or Delivery Portfolio.

The questionnaire is an evolving record of what is known at a particular point in time. During the early stages, the delivery team will not have sufficient knowledge to complete all of the questions. The questionnaire has therefore been designed to cope with 'don't know' as a valid answer.

The Pathway Product Management Plan (PPMP) questionnaire:

- Should be completed in the initial stage by the Sponsor. It may also be done by the programme, project or delivery portfolio team but approved by the Sponsor.
- Must be reviewed and updated in subsequent stages by the Programme, Project or Delivery Portfolio Manager.
- Must be consulted with appropriate team members and stakeholders to confirm that it accurately reflects what is known about the programme, project or delivery portfolio at the time it is completed.

Applying professional judgement to moderate the initial Pathway Product Management Plan (PPMP) output

The Pathway Product Management Plan (PPMP) tool will produce an initial set of products for a programme, project or delivery portfolio, but it does not replace the professional judgement that comes with experience of delivering programmes, projects or delivery portfolios.

The initial Pathway Product Management Plan (PPMP) output must be reviewed and moderated by the delivery teams and their stakeholders to reflect the actual risk and complexity of the programme, project or delivery portfolio. For example, on simple, low risk projects it may be appropriate to combine a number of products and/or stages, or simply not produce a product if the risk of doing so is acceptable. It may also be necessary to re-time one or more products to suit the specific circumstances of a programme, project or delivery portfolio. Where these adjustments are appropriate, they should be agreed and documented in the appropriate area of the Pathway Product Management Plan (PPMP) document.

Core products that all projects must have

There are a set of 9 ‘core’ products that all programmes/projects/delivery portfolios must produce:

- Pathway Product Management Tool (PPMP)
- Project Requirements
- Project Execution Plan
- Schedule
- Risk Register
- Progress Reporting
- Integrated Assurance and Approvals Plan
- Project Close Report
- Stage Gate Certificates

Handbooks

These describe how TfL manages specific aspects of programme, project and delivery portfolio activity.

The objective of the handbooks is to provide the programme, project or delivery portfolio manager with the context for the products and ensure specific organisational and statutory requirements are satisfied by all programme, project or delivery portfolio teams.

The handbooks are written for competent practitioners and assume the reader understands the generic principles of the subject. They are not intended to provide training on the subject covered in the handbook.

There are 10 handbooks covering:

- Governance

  Provides instructions and guidance on programme, project and delivery portfolio gates, governance and reviews, including funding.

- Sponsorship

  Contains instructions and guidance on the role and activities of sponsorship.

- Manage the Project, Programme or Delivery Portfolio

  Provides instruction and guidance on the planning and control of the programme, project or delivery portfolio.

- People Change

  Provides instructions and guidance on people change management – how to manage people through transition in the way they work as a result of the impact of delivery activity.

- Construction

  Provides instruction and guidance on managing construction works.

- Commission and Handover

  Provides instructions and guidance on managing assets during the design and construction of the works and their handover into operational use and maintenance.

- Consents

  Provides instructions and guidance on consents.

- Health, Safety & Environment

Provides an overview of TfL's health, safety and environmental (HSE) arrangements, and how they are managed throughout the project lifecycle.

- Commercial (Procurement and Contract Management)

  Provides managers with instructions and guidance on how to procure goods, services and works and on the generation of non-fare revenue.

- Risk Management

  Provides managers with instructions and guidance on successful risk management in TfL.

- Benefits and Value

  Provides managers with instructions and guidance on tools for Benefits and Value Management in TfL.

- Engineering (for London Underground only)

  This handbook gives instructions and guidance for the delivery of engineering products and services.

Special Interest Groups and Ownership of TfL Pathway

A fundamental principle of the TfL Pathway approach is that its development must be owned by the delivery teams and associated stakeholders who use it and that improvements should flow primarily from users of the methodology.

To safeguard this principle, Special Interest Groups (SIGs) will be created, aligned with each handbook. Some are operational already. These are pan-TfL groups with the remit to act as owners of their respective handbook and associated products on behalf of all users.

Any member of TfL is able to (i) ask a question, (ii) suggest improvements and (iii) take part in discussions by making use of the SIG sites.

Access to TfL Pathway Tools and Improvement

All TfL Pathway material is displayed on the following two pages. The objectives will be to:

- Ensure easy access to TfL Pathway materials
- Clear updates and one place for updates
- Ability to provide feedback for improvement
- Intranet (Source)
- TfL Pathway Home

Roles and Responsibilities

The following pages contain high level descriptions for a number of key roles in TfL Pathway.

Core roles are typical roles that exist within a project team to assist in the delivery of the project. Depending on the Business Unit, size and type of project, not all these roles will be required, and each area will adjust to suit its needs and this is part of professional judgement within TfL Pathway. In other words, it is not suggested that every project, programme or delivery portfolio have each of these – rather that such roles typical in this environment and each area will adjust to suit its needs.

Core functions provide business support to the project delivery team.

Core Roles

Sponsor

These common principles of the roles of Sponsor and Delivery team apply across TfL. They will be applied appropriately in the organisational structure pertaining to each business. The Sponsor can also be known as an SRO or Sponsor's Agent.

Sponsorship in TfL is based on the following principles, which cover different stages of the project and a number of generic principles.

There is only one Sponsor for any one programme, project or delivery portfolio.

As a minimum every project will have a Sponsor. The Sponsor may elect to establish and chair a Project Board to help them discharge their accountabilities for the project.

Project Prioritisation and Outcome Definition

The Sponsor (in consultation with stakeholders e.g. user, maintainer, delivery team)

- Considers the business needs for investment, ensuring alignment with Mayor's Transport Strategy
- Prepares the outline business case and justification
- Proposes priorities for investment for consideration against other requests
- Obtains Financial Authority

Feasibility and Concept Design (in consultation with stakeholders e.g. user, maintainer, delivery team)

- Defines the requirement outcomes
- Commissions feasibility studies to establish options to deliver the outputs (to deliver the benefits)
- Approves a single option
- Defines the investment's objectives, scope and requirements
- Prepares the full business case and maintains this throughout the life of the project through to benefits realisation
- Obtains the required authorities and any third party funding
- Commissions delivery team to deliver required outputs within constraints

Detailed Design and Delivery

- The Sponsor remains accountable to the Board for ensuring that delivery as required will enable the business case (benefits) to be satisfied.
- The Sponsor is assured that the requirements will be satisfied through:
- Periodic progress reports from the delivery team (cost, time, quality)
- Checking that the benefits are still deliverable:
- By controlling changes to the required outputs or constraints through the relevant board
- By controlling whether the project passes a stage gate by being the approving signatory or Project Board where applicable.
- The delivery team is accountable to the Board for delivering the required outputs within the constraints as defined by the Sponsor.

Benefits Realisation

The Sponsor is accountable for:

- Tracking the business case and projected benefits throughout the project
- Confirming that the capability to secure the planned benefits is in place at the end of the project
- Confirming actual benefits delivery as planned at one or more pre-agreed points following project completion

Generic Accountabilities

The Sponsor is accountable for:

- Agreeing the Integrated Assurance and Approval Plan and the TfL Pathway Product Management Plan
- Assisting the delivery team in the resolution of problems or issues
- Communicating widely; to the client organisation, the delivery team and those affected by the project
- Stakeholders; seeking to understand and, where possible, satisfy the requirements of all parties with an interest or concern in a project or programme
- Lessons; learning from other projects and from working closely with other clients, both within the organisation and the wider industry

Programme or Project Boards

All programmes and projects in TfL must be governed by a combination of boards and reviews. Boards and reviews can be discharged through a number of mechanisms. These mechanisms include:

- Programme reviews held by the Programme Manager
- Programme boards
- Project boards for high risk or complex projects

A Programme or Delivery Portfolio Board must:

- Be formally constituted with agreed terms of reference documenting its authority, membership, information needs and arrangements for meetings and reviews
- Be chaired by an authorised officer at Sponsor level
- Maintain focus on the overall strategic benefit realisation
- Ensure that the programme or delivery portfolio is delivering to time and cost

- Be independent of the delivery teams
- Ensure Board meetings are undertaken regularly
- Have cross-functional membership to reflect stakeholders in the programme or delivery portfolio
- Ensure the programme or delivery portfolio is adhering to policies, standards and legislative obligations
- Provide direction, guidance and support to programme or delivery portfolio managers
- Escalate to the next highest level of governance where necessary
- Request peer reviews to be undertaken if necessary
- Provide resolution or guidance to significant risks, issues and resource concerns
- Initiate corrective actions for any project deviating from its approved plans.
- Provides the resources and authorises the funds necessary for the successful completion of each project it commissions, subject to standing orders

A Project Board

The project board is accountable for the success of the project and reports to the programme or delivery portfolio board. It is the decision-making body for the project, but can delegate responsibility (not accountability) to the Project Manager for certain decisions subject to the tolerances and change control approach.

A Project Board is not a democracy. The Sponsor is the key decision maker, taking advice and guidance from others.

The board may consist of just the project Manager and Sponsor for simpler projects, but would be expected to include critical key stakeholders such as a user representative for most others.

The Project Board must**:**

- Be chaired by an authorised officer at Sponsor level
- Be accountable for the success or failure of the project in terms of the business, user and supplier interests
- Facilitate integration of the project management team with the functional units of the participating organisations
- Ensure effective decision making
- Provide visible and sustained support for the Project Manager

- Ensure effective communication both within the project team and with external stakeholders

- Authorise progress from one stage to the next

Programme or Delivery Portfolio Manager

The Programme Manager is accountable for leading and managing a programme or delivery portfolio from strategy to successful delivery, through effective coordination of the programme or projects, their interdependencies and risks.

The role provides an ongoing ‘health check’ of the programme by reassessing whether its programmes or projects continue to meet objectives, use funds and resources efficiently, and are on course to realise the agreed benefits.

Programme or Delivery Portfolio Managers are responsible for:

- Establishing the safety ethic within the programme and providing a safe working environment for the execution of work directly under their responsibility

- Managing and monitoring of benefits of projects within programme or portfolio

- Managing the successful development and delivery of the programme and its budget

- Managing the expectations of stakeholders impacted by or with an interest in a programme or portfolio

- Managing and delivering the portfolio/programme, to time, cost and quality targets

- Creating an environment within which Project Managers can successfully deliver their projects

- Ensuring that there is coordination between and integration of projects within the programme and activities [or schemes or small works] within the delivery portfolio

- Ensuring compliance with standards and processes – including TFL Pathway

- Reporting programme progress to the Portfolio/Programme Board and Sponsor

- Maximising efficiency in the allocation of resources and skills within the programme.

- Working with the Sponsor to design the most appropriate arrangement to fit their particular programme or project in accordance with the size, scale and complexity

- Minimising duplication between the various layers. For example, where a project reports on time or cost to a Programme Review then it should only provide a high level summary of time or cost at the programme board

- Putting in place arrangements for the appropriate boards and reviews within their programme or project, and this must be set out in the PEP

- Designing programme or project governance, aligning the interests of board directors, project teams and wider stakeholders, thus improving performance and reducing surprises at both boardroom level and for stakeholders.

Project Manager

The Project Manager is given authority to run the project on a day-to-day basis, within agreed constraints and authorities.

There is only one Project Manager for a project.

Project Managers are responsible for:

- Managing and delivering the project outputs to time, cost and quality targets

- Ensuring the project complies with health, safety and environmental regulations and that issues of health, safety and environment are paramount to the project

- Ensuring compliance with standards and processes – including TFL Pathway

- Ensuring that the project delivers the required products at each stage of the project lifecycle, to the required standard of quality, and within the specified constraints of time and cost

- Reporting project progress

- Being aware of the business objectives of the project and ensuring that these are satisfied

- Establishing the project organisation – defining roles, responsibilities and deliverables for all team members

- Managing/administering consultant/supplier contracts

- Managing project resources, including project works contractors

- Managing handover of the project and its products to business as usual

Construction Manager

Construction Managers are responsible for:

- Managing the construction works process consisting of five key activities across stages 2 to 6 of a project:

- Create the construction management plan

- Set up the organisation for managing the construction works
- Establish how the contract and contractual changes will be managed
- Manage construction HSQE requirements
- Manage the construction works on site
- Construction management activities must be distinct from project engineering activities and project management activities
- The construction manager would report to the Project Manager.

Project Engineer

A project engineer (PE) is an engineer from within the business who is assigned to work and deliver certain products or aspects of products to support the delivery of a project. The engineer is a staff resource assigned either fully or partially to the project, on a proactive basis to undertake specific delivery. They would usually undertake business as usual work and is assigned time to work on the project in order to ensure that in house skills and expertise are utilised to the best advantage to deliver products where appropriate. The engineer is the doer, who is principally responsible for doing the work required to deliver technical products. The engineer can draw on support from the Project Manager, SME and other project resource to help them deliver their obligations under the project.

Project Engineers are responsible for:

- Providing engineering advice and support to the Project Manager
- Acting as the central reference point for technical delivery excellence and all engineering assurance output
- Maintaining a close view of all the engineering disciplines deployed on a project and acting as the lead in coordination of such engineering disciplines
- Exercising experienced judgement in assessing and, if necessary, selecting from alternative design solutions
- Ensuring that interface and integration issues are satisfactorily addressed
- Ensuring that project requirements are captured and validation and verification activities are undertaken so that the delivered system works as intended
- Providing the control element of risk management both in assessment of engineering risk and in its mitigation
- Conducting the handover process in partnership with the Project Manager
- Ensuring the safety of new or altered assets.

Subject Matter Expert

The Subject Matter Expert (SME) is a person who is an expert on a particular domain, area or topic. The SME will bring expert knowledge to a project or programme to help steer and direct products influenced by that area of expertise. The SME would usually sit in the steering committee or as an advisory to the Project/Programme Board, but could also undertake or direct specific products in delivery. The SME will sit in the business, as an expert in their field and will use their knowledge to ensure that delivery is aligned with business requirements at a detailed technical level. Their input to the project is to steer, direct, review and provide technical validation of products to ensure that they meet and integrate with existing or future business requirements as appropriate.

Within individual business units this could translate into roles including, but not limited to:

- Real Time Operations
- Traffic Maintenance and Control Systems
- Traffic Technology
- Network Performance
- Traffic Infrastructure
- Discipline Engineer
- Asset Engineer
- Systems Integration as described below

Systems Integration – LU Specific

Systems Integration are responsible for:

- Systems Engineering
- Requirements and Verification & Validation (V&V)
- Engineering Simulation and Performance
- Reliability, Availability and Maintainability (RAM)
- System Safety
- Human Factors
- Electromagnetic Compatibility (EMC)
- Configuration Management
- Software Systems

User Representative

User Representative is responsible for the specification of the needs of all those who will use the final product(s), for user liaison with the project team and for monitoring that the solution will meet these needs within the constraints of the Business Case in terms of quality, functionality and ease of use.

The role represents the interests of all those who will use the final product(s) of the project, those for whom the project will achieve an objective or those that will use the product to deliver benefits.

User Representatives are responsible for:

- Ensuring that the specification of the user's needs is accurate, complete and unambiguous
- Developing, with the programme, project or delivery portfolio team, the concept of how the outputs of the programme, project or delivery portfolio will be integrated into business as usual within the business unit or department therein
- Ensuring any user resources required for the project are made available and monitors deliverables against requirements
- Briefing and advising user management on all matters concerning the project
- Ensuring that the business units are ready for the outputs of the programme, project or delivery portfolio to be integrated into business as usual within the business unit or department therein
- Accepting the outputs from the programme, project or delivery portfolio into business as usual within the business as usual or department therein
- Ensuring liaison is functioning effectively
- In London Underground, this role is identified as Asset Performance Reps. and Operations Reps.

People Change

Key activities need to take place to successfully implement people change management within projects. These activities can often be grouped together and clear owners for the activity groups must be identified. To help with ensuring the activities are undertaken, change roles have been established within the Business Change Framework (BCF) and activities assigned to those roles.

Consideration needs to be given to the size, scale, complexity and risk of the programme, delivery portfolio or project when assigning these roles – this is not a' one-size-fits-all' approach. On smaller projects, individuals may carry out more than one role, or there may be duplicate resources on larger projects. What is crucial is that these key activities are assigned to the appropriate staff members to enable effective people change management.

People Change Managers are responsible for:

- Working with the Project Manager to ensure that people change considerations are factored into the project as a whole.
- Applying the people change management activities defined in this handbook and the BCF, and writing the People Change Plan.
- Evaluating the scale and impact of the change and developing a customised approach to managing it.
- On programmes and projects with large-scale people change activity, a dedicated specialist resource should undertake this role. On smaller projects, this role may be fulfilled by the Project Manager, an HR Business Partner – along with the Internal Communications Team – or someone who is co-ordinating operational readiness or maintenance readiness activities in the user area.
- Key stakeholders consist of, but are not limited to:
- Sponsor - leads, sanctions and legitimises the change
- Line Managers – manages the change within their own teams
- Change Champions – are advocates for the change and link between local teams and the project team
- Employee Group – those affected by the change who are usually required to adapt
- Employee Representatives – formally represent employees
- Solution Providers – often specialists and subject matter experts outside of the project

HSE Adviser

The HSE Adviser's role in the programme, project or delivery portfolio team is to ensure that TfL and its suppliers comply with relevant health, safety and environmental (HS&E) legislation and TfL standards in the delivery of the programme, project or delivery portfolio.

HSE Advisers are responsible for:

- Undertaking those programme, project or delivery portfolio activities that must be undertaken by a competent HS&E professional
- Providing competent HS&E advice to members of the programme, project or delivery portfolio team as they execute works for which they are accountable
- Ensuring and monitoring compliance with HS&E requirements defined in TFL Pathway, HS&E legislation and TfL HS&E standards
- Escalating issues with HS&E compliance as appropriate.

Definition of Core Functions

Strategy & Planning

Responsible for defining the transport strategies and associated package of Projects, Programmes and Delivery Portfolios required to meet the business plan objectives for the coming business cycle. Utilising transport planning analysis to ensure that future investment is aligned to delivery of the key outcomes in the Mayor's Transport Strategy. Custodians of the Strategic Assessment Framework (SAF) which is used as the consistent means of appraising and comparing future investment options and essential component of any business case.

Also responsible for leading on the initiation of major infrastructure projects in partnership with relevant parts of the business, including business case preparation, stakeholder engagement and securing consents.

Performance and Project Controls

Responsible for periodic and quarterly reporting on the delivery of the Investment Programme to approval Boards within each Business Unit, the Projects and Planning Panel and the TfL Board. Management of change control processes for project authority, project baselines and milestone target dates. Provision of assurance on approval papers for both financial integrity and schedule quality, assistance with project setup in both SAP and project planning tools. Provision of administration and functional support and training for Primavera P6, Master Projects Database and Oracle Portfolio Manager software packages. Functional support provided for the LiveLink document management system. Responsible for setting the strategic direction of software used by project delivery teams and managing the relationship with IM.

Commercial

Responsible for implementing and managing contractual requirements with suppliers. Activities cover the complete commercial cycle from supporting business case development including the identification of funding, defining and implementing category and procurement strategies, through commercial contract management and review and exit. Throughout the cycle, Commercial ensure the delivery of value for money by assessing and managing commercial risk, providing estimating and cost management services, managing the performance of suppliers and ensuring that procurement is sustainable by implementing TfL's Responsible Procurement strategy.

Risk Management

Provides permanent TfL risk experts to champion and lead risk development and training i.e. Risk awareness courses, workshops. The OGCs Management of Risk has been adopted as a reference standard, together with the accredited training modules and are offered as part of PYRAMID training courses. Facilitation of the Risk Management Special Interest Group (SIG) with membership across TfL.

Health, Safety and Environmental advisers

TfL has advisers whose role in the programme, project or delivery portfolio team is to ensure that TfL and its suppliers deliver sustainability requirements and comply with relevant health, safety and environmental (HS&E) legislation and TfL standards in the delivery of the programme, project or delivery portfolio.

Health, safety and environmental advisers are responsible for:

- Seeking assurance that the programme, project or delivering portfolio considers and plans for delivering a full range of sustainability benefits as appropriate
- Undertaking those programme, project or delivery portfolio activities that must be undertaken by a competent HS&E professional
- Providing competent HS&E advice to members of the programme, project or delivery portfolio team as they execute works for which they are accountable
- Assuring and monitoring compliance with HS&E requirements defined in TFL Pathway, HS&E legislation and TfL HS&E standards
- Escalating issues with HS&E compliance as appropriate.

Managing HSE ensures HSE requirements are continually, systematically and proportionally managed in a consistent, effective and efficient way. It includes the following guiding principles and instructions:

Managing HSE consists of four key topics across stages 2 to 6 of a project:

- HSE planning and implementation
- The application of CDM and team competency
- Supplier procurement and HSE competency
- Monitoring and reporting

The primary focus of HSE activity is to meet the HSE obligations associated with TfL's role in programme or project delivery and the health and safety of our customers, assets, employees and environment

Programmes or Project Managers must deliver and demonstrate a review of sustainability benefits and compliance with HSE legislation and organisation's HSE policy through compliance with the HSE requirements that are embedded in the product descriptions and TfL's HSE management standards.

Programme or projects must obtain their competent health, safety and environmental advice and support from an HSE adviser from their particular area of the business, who will provide strategic direction on sustainability and compliance with HSE legislation.

Business Case

Project and Programme Business Case support and training - Maintain templates, such as Business Case Assistant & Narrative and maintain the repository of best practice information on parameters and procedures in the Business Case Development Manual (BCDM).

Provide advice on best practice, DfT and TfL Pathway Governance requirements. Ensure a consistent approach to business cases across TfL. Investigate evolving methodology and agree standard parameters. Provide support to Assurance teams with conclusions on individual business cases to gate reviews.

Benefits & Value Management

Provide Value and Benefits Leadership pan-TfL. The OGC's Management of Value has been adopted as a reference standard, together with the accredited training modules and are offered as part of Pyramid training course. Facilitation of the Value and Benefits Special Interest Group (SIG) with membership across TfL.

Assurance

- Conduct and facilitate Major Projects (over £5m budgeted) independent Integrated Assurance Review (IAR) resulting in a formal review report and recommendation to operational unit boards and other decision makers.

- Conduct and facilitate Minor Projects (under £5m budgeted) Operating unit specific assurance processes for LU, ST and IM.

- Maintain and monitor database of approval schedule.

- Provision of advice for Sponsors and project teams on compliance with project approval governance requirements and approval processes

The bigger picture for TfL delivery - improving project management capability

TfL Pathway is more than just a set of documentation. It is also a strategic change programme whose objectives are to:

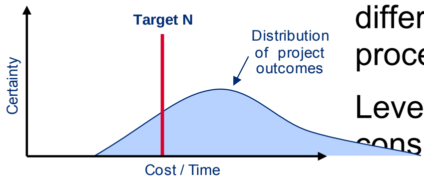
- Raise TfL's project management capability
- Improve delivery certainty
- Improve delivery efficiency (cost/time performance)
- Improve staff capability

Measuring project management capability

TfL uses the Portfolio, Programme and Project Management Maturity (P3M3) model to assess and score project management capability and put in place improvement plans for increasing its capability.

P3M3 uses a five level maturity framework. The five maturity levels are:

Level 1 – Awareness ('Heroes deliver')

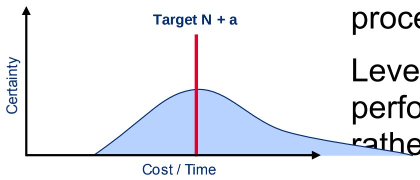


Projects are recognised as being different from, and run differently to, ongoing business. There is no standard process or tracking system.

Level 1 organisations are characterised by projects consistently missing cost and time targets.

There is wide variability in delivery certainty and cost/time performance. Typically only 'heroes' are able to meet or exceed the target.

Level 2 – Repeatable (Disciplined process)

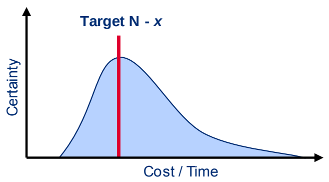


Projects are run according to their own processes and procedures. There is limited consistency between projects.

Level 2 organisations are typically able to use past performance to set more realistic cost and time targets – rather than actually improving performance.

There is still wide variability in delivery certainty and cost/time performance.

Level 3 – Defined (Standard, consistent process)

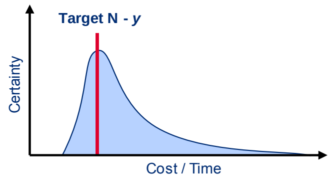


Projects are run to a single, corporate process and project teams can use professional judgement to flex specific processes to suit a particular project.

Level 3 organisations are able to truly start setting targets for improved cost and time performance and have a realistic expectation of achieving them.

There is less variability in delivery certainty and cost/time performance.

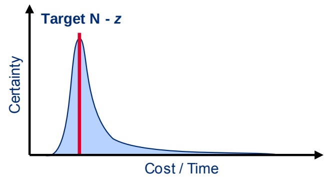
Level 4 – Managed (Predictable process)



The organisation is able to measure performance against the standard process and make specific changes to improve performance.

Level 4 organisations are typically able to set tougher efficiency targets and achieve them with even less variability in delivery certainty and cost/time performance than Level 3 organisations.

Level 5 – Optimised (Continuously improving process)



The organisation undertakes continuous, proactive process improvement to improve performance and optimise processes.

Level 5 organisations are able to set the toughest targets and achieve them within a very narrow range of outcomes.

And finally ...

TfL Pathway aims to provide staff with the necessary tools for successful delivery at TfL. The methodology is based on professional judgement and relies on the skills and experience of the delivery community and its stakeholders. In many ways that is a false distinction as we are, in fact, all involved in delivery - whether as Project Managers, Sponsors, functional experts or operators and maintainers. Where the tools may be considered ineffective, it is incumbent on the users to notify the SIGs of the elements for improvement.

However, no process can ever ultimately ensure that all staff ‘do the right thing’. Critical to the effective use of TfL Pathway, therefore, is your role in understanding and deploying effective behaviours while executing your delivery.

- For example, the most documented inefficiency of behaviour presently is lack of early lifecycle involvement of users – typically, operators and maintainers. For delivery not to involve users, for users not to provide the resources for review of proposed project activity and for gatekeepers to miss involvement are failures of behaviour. Lean analyses undertaken in the past year have proven these behaviours to ultimately delay handover and waste resources. TfL Pathway provides relevant vehicles for effective involvement of users at an early stage, such as the signing of design documents. Similarly, tools are provided for stakeholder engagement. Flexibility exists in how delivery may be managed and all will be underpinned by consistent governance and assurance requirements.

The TfL PMO will not run a police force to ensure compliance – it is your role to do the right thing and anything preventing you from doing so should be escalated through the Special Interest Groups or the Programme Management Office.

We look forward to your input for improvement as the TfL business uses and then improves TfL Pathway.

Please send any comments on this document to **tflpathway@tfl.gov.uk**

Pathway Handbook

Commercial (Procurement and Contract Management)

Contents

General

What this handbook is for

This handbook gives instructions and guidance on:

- How to procure goods, services and works,
- The generation of non-fare revenue (through Commercial Development).

You must follow the instructions and guidance in this handbook if you procure goods, services or works or you manage a contract through the delivery or contract closure stages.

Who needs this handbook

You will need this handbook if you deliver programmes, portfolio's or projects for Transport for London (TfL).

You will need this handbook if you:

- Are a commercial representative acting with the authority of the Director of Commercial or the Director of Commercial Rail and Underground to support, guide and assist accountable managers with their procurement and contract management activities,
- Need to procure works, service or suppliers or manage a contract through delivery and closure stage (the accountable manager),

Arrange or manage non-fare revenue agreements.

The application of the activities and instructions described in this handbook is not simply a matter of applying a "one size fits all" formula; it is about appropriately balancing combinations of knowledge, experience and behaviours with the application of size, scale, complexity and risk of the procurement or contract.

The Pathway Product Matrix details the products which support the governance of project, programmes and portfolios.

The specific roles, responsibilities, legislation and standards associated with the activities and instructions described in this handbook are detailed in the individual product descriptions.

All references to Transport for London (TfL) within this handbook refer to the Transport for London Group and all its subsidiaries.

All references to projects cover projects, programmes and portfolios.

The **accountable manager** is responsible for the acquisition of the works, supplies or services required. The accountable manager may be a manager in any directorate.

The **commercial representative** reports to the Director of Commercial or the Director of Commercial Rail and Underground. The commercial representative is responsible for procurement and management of a contract and provides expert input and guidance to support the accountable manager through the inception, procurement, contract management and closure phases. Commercial representatives:

Are often specialised in particular fields i.e. a category;

May be a shared resource dealing with a range of contracts;

May be dedicated to a specific programme, project or procurement exercise.

The accountable manager may be responsible for managing the contract on a day to day basis (may be Commercial Manager for IM, London Underground, or Surface Major Projects). Delegated Procurement Authority will only be granted to a commercial representative and they should be contacted if a variation to a contract is required.

A contract life-cycle will typically comprise some or all of the following stages:

- Planning and defining what needs to be procured (i.e. producing a specification)
- Defining the category and procurement strategy
- Estimating the resources, time and cost required to implement the contract
- Ensuring pathway 'gates' are assured and authorised in accordance with the relevant process
- Managing the procurement process including
- Undertaking Market Engagement and Analysis
- Undertaking the tender process, including: Supplier Selection, Tender and Contract Documentation, Tender Evaluation
- Contract agreement and award and obtaining Delegated Procurement Authority
- Managing a contract through the delivery and closure stages
- Monitoring and enforcing supplier's contractual obligations
- Ensuring that TfL's obligations in relation to a contract are met
- Undertaking Supplier Relationship Management
- Assessing benefits realised

The roles of each party at these stages are set out in the Business Unit's Commercial guidance and within the Pathway Product Management Plan and associated products.

Regardless of role, you must ensure that purchases directly support TfL business objectives and your directorate's objectives. TfL has legal obligations around purchases which must be followed. Contracts let within the scope of maintenance plans or capital projects and programmes must support the relevant Plan or Strategy such as: TfL Plan, Accommodation Strategy, asset group strategy, LU asset management plan or Category Strategy.

Applying this handbook will help you to comply with legal requirements and TfL governance and process arrangements.

Links are provided throughout this handbook for you to access the Commercial Toolkit and the applicable processes, instructions, guidance and forms.

You must contact the Commercial Directorate or Commercial Rail and Underground Directorate to identify your commercial representative and you must follow the instructions and guidance in the Commercial Toolkit.

If you are the commercial representative supporting or advising accountable managers, you must ensure:

The correct procurement processes are applied;

Adhere to the relevant Category Strategy by consulting with the relevant Category Manager;

Estimates of resource, cost and time are accurate;

Compliance with applicable legal, regulatory and TfL governance requirements in a timely and planned way.

All communications with suppliers in relation to this transaction are to be conducted by the Commercial lead only. Under no circumstances and at no time before or during the tender process are TfL staff other than the Commercial lead permitted to make contact with or respond to suppliers.

Governance and Commercial

Authorities

Under TfL Standing Orders the authorities listed below are required before entering into any transaction or project on behalf of Transport for London or any of its subsidiaries.

Financial Authority. The authority to do the following in respect of a project:

- Spend money;
- Receive income;
- Incur a financial liability, or;
- Redistribute funds to relevant third parties in respect of their respective budgets.

Project Authority. The authority to do the following in respect of a project:

- Spend money;
- Receive income;
- Incur a financial liability, or;
- Redistribute funds to relevant third parties in respect of their respective budgets.

Land Authority. The authority to engage in a land transaction.

Procurement Authority. The authority to make a binding contract or contractual commitment with a supplier for the purchase of goods, services, land or works or to receive income arising from TfL group activities in the areas of goods, services, land or works. Procurement Authority extends to any action required within any existing contracts or relationships (for example, unsatisfactory performance deductions and termination of contracts), except where actions relating to contract performance are in accordance with a pre-defined formula or process included in the contract.

Disposal Authority. The authority to dispose of any assets.

As accountable manager you must make any applications for delegated authority in accordance with TfL Standing Orders and TfL financial, commercial and project management instructions and guidance.

2-key process

TfL segregates financial and procurement authorities to ensure that no single individual is able to both award and pay for any transaction.

Accountable Manager

As an accountable manager you must:

- Raise and approve shopping carts in SAP for purchase orders and contracts and any amendments to these;
- Ensure that the contract is delivered and payments made in accordance with the agreed terms and conditions;
- Check that interim and final payment invoices fairly reflect the extent of delivery at the payment stage and approve these for payment in SAP including the deduction and release of retentions. (CPAF and SES forms must be used for LU contracts);
- Not approve the invoice and refer to your commercial representative for advice if the invoice should not be paid (in full or in part), for example, due to non-delivery of goods, services or works, sub-standard quality or over-evaluation of stage payment entitlement by the supplier;
- Record in SAP the receipt of goods, services or works;
- Ensure that, for relevant programmes and projects, the Pathway Product Management Plan is complied with and that the procurement and contract management activities support the project gate management plan gate reviews.

You must seek advice from your commercial representative(s) on any of the following that apply to your transaction:

- Procurement Strategy (including supplier selection, category plans);
- Tender process, tender evaluation and award recommendations;
- Raising purchase orders in SAP;
- Making any change to a contract, agreeing variations or New Engineering Contract (NEC) compensation events;
- Proposed claim settlements;
- Suspension or termination strategies;
- Basic access provision agreements (BAPAs) (London Underground Only);
- Bonds, guarantees or other agreements with suppliers.

! Your commercial representative should be contacted at the earliest possible opportunity to obtain value for money and comprehensive guidance.

You must comply with the governance requirements and guidance provided in the Commercial Toolkit and, for projects and programmes, Pathway.

i Useful Links

- Commercial Teams

- Commercial Toolkit
- Delegated Procurement Authority
- Pathway

As the accountable manager you must clearly specify what you wish to buy, where, when and in what sequence it is to be delivered and follow the instructions and guidance provided by the commercial representative.

The following information and actions are typically required from you as the accountable manager.

- Provide specifications, drawings, supporting data and technical input as needed to;
- Fully describe what is to be bought (specification or scope);
- Define applicable regulatory requirements, technical and safety standards;
- Ensure that the end products will be fully suitable for purpose and compatible with TfL infrastructure, operational, control and maintenance systems and safe methods of work;
- Establish the programme of work and delivery sequence;
- Make arrangements for the acceptance into service, including:
  - Provision of documentation,
  - As-made records,
  - Operation and maintenance manuals,
  - Safety information,
  - Ensuring competence of operational and maintenance staff,
  - Updating asset catalogues and maintenance plans,
- Provide technical input and support for the selection and assurance of suppliers
- Provide technical input for:
  - Evaluation and, where appropriate, trials and testing,
  - Approval of assets and working methods,
- Exercise approvals as per the Commercial process;
- Work with the commercial representative to evaluate tenders and make award recommendations, providing expert technical input and expertise as necessary;
- Manage contract delivery by suppliers;
- Verify delivery to contract requirements;

Services provided by Commercial

As the commercial representative you must support and guide accountable managers through the procurement and contract management processes.

The detailed roles and responsibilities of each party are set out in the Commercial Toolkit.

Commercial services summary

Category Management

Category management is an approach to understanding the true breadth and cost of a product or service that is being purchased across the business. Using this knowledge, Category Managers develop strategies to inform where efficiencies in both cost and process can be made during sourcing and contract management activities, and help identify links with Supplier Relationship Management to drive innovation.

Category Management key activities include:

- Scope definition, engaging stakeholders and understanding requirements;
- Developing supply market / industry knowledge;
- Creation of Pan TfL commercial Category Strategies
- Analysis of spend, contract data and future demand;
- Assessment of all opportunities and recommendations made based on various cost saving strategies e.g. aggregation of spend, standardised/ rationalised specification and technical or commercial innovation;
- Implementation of most appropriate cost saving strategies;
- Measurement and ongoing review of benefits; and
- Integration of Categories with Supplier Relationship Management activity.

Procurement Strategies: A Procurement Strategy Recommendation paper sets out the approach to the procurement being undertaken and how value for money will be achieved in support of business case submissions and project authority requests.

Tendering and contract award:

- Supplier sourcing and selection for tendering (including supplier assurance);
- Competitive tendering and negotiation with suppliers;
- Procurement and award of framework agreements and catalogues.

Contract administration:

- Commercial management of contract delivery including claims, changes to contracts, variations and compensation events;
- Contract cost reporting and cost management.

Supplier Relationship Management (SRM)

The purpose of SRM is to establish better relationships between TfL and its key suppliers in order to improve the collective performance of critical areas of the supply chain. SRM provides a mechanism by which TfL can realise its full organisational leverage and simultaneously offers suppliers the forum to better understand TfL's strategic goals so that they can collaborate more effectively. At is core, is the philosophy of continuous improvement with emphasis on evidence driven performance and encouraging innovation. It is fundamental to positioning TfL as a customer of choice.

SRM will provide pan TfL visibility of supplier performance and will generate more positive relationships between TfL and Key Suppliers. Sharing of good practice and lessons learnt across TfL coupled with innovative ideas suggested by suppliers will facilitate improvement. Improvements suggested through SRM discussions will be translated into Category Plans to help drive reductions in cost.

As the commercial representative you must:

- Optimise TfL's commercial cost reduction and value improvement including working towards optimum whole life costs, adding value to the business;
- Provide end to end commercial advice and guidance and ensure that the purchases comply with legislation, regulation and TfL governance;
- Procure goods, services and works which deliver effective and efficient business solutions enabling accountable managers to meet their obligations;
- Ensure that governance controls are put into effect and fraud mitigation around procurement activities;
- Ensure that official records are created and retained (for example, transparency, Freedom of Information obligations, IPR and asset data, legal and EU compliance);
- Manage the supply market and development;
- Mitigate works, supply and service delivery risks;
- Maintain work breakdown costs and unit prices for business planning;
- Manage and use the framework contracts and catalogues;
- Ensure sound commercial management of procured commitments.

! Refer to the Commercial site for an overview of what Commercial delivers for its customers, the processes and systems in use and the inputs required.

How to buy and who buys what

As the accountable manager you must follow the instructions and guidance accessible through the links in the information box below if you need to use the purchase process listed.

> Catalogues
>
> List of catalogues
>
> TfL's procured goods and services
>
> List of Frameworks
>
> Your commercial representative should be contacted at the earliest possible opportunity to obtain value for money and comprehensive guidance.
>
> Contract on sale and disposal must be treated as procurement transactions but in addition are subject to disposal authority (TfL Standing Orders)

Form of Contract and Terms and Conditions

As accountable manager you must obtain your commercial representative's advice and agreement when selecting the most appropriate form of contract or TfL standard terms and conditions. All contracts must have terms and conditions which are suitable for the specific case.

> The commercial representative will advise and guide you on the procurement strategy and selection of the most appropriate form of contract. The commercial representative will involve Legal Services as necessary.
>
> The form of contract may, for example, be the New Engineering Contract (NEC3) incorporating standard 'Z' clause amendments or standard equipment supply or services terms as appropriate to the case.
>
> The governance process for the use of non-standard terms and conditions (including for approval or amendment to the standard terms) can be obtained from your commercial representative.
>
> Bespoke forms of contract may be required such as variations to the PFI contracts (such as Connect) and for non-fare revenue contracts.

Responsible Procurement

The Greater London Authority (GLA) Group Responsible Procurement Policy requires TfL to implement, where relevant, the following themes of responsible procurement:

Equality and Supplier Diversity

Fair Employment: The London Living Wage

Strategic Labour Needs and Training

Community Benefits

Ethical Sourcing

Sustainable Freight

Environmental Sustainability

If you are involved in procurement or contract management you must review sustainability impacts as part of the procurement process and the delegated procurement decisions to ensure that LU procure goods, services and works that comply with the Responsible Procurement Policy.

The Responsible Procurement page on OneLink provides guidance, on which themes of Responsible Procurement (RP) are relevant to specific contracts, guidance on implementing RP requirements at each stage of the contract process, and contact details for the RP team. TfL's approach to implementing RP is governed by the principles of relevance and proportionality. Contact the RP team for advice on the approach to take to implement RP to your project.

Responsible Procurement should be considered at the implementation of a project and should be outlined in the Project Execution Plan.

Standards, Assurance and Health, Safety and Environment

If you are involved in procurement or contract management you must consider Health, Safety and Environment issues. Further guidance and support can be found in the Health, Safety and Environment Handbook.

Contract Management, Variations, Claims and Contract Closure

! As accountable manager you must follow the governance, instructions and guidance for managing contract contained in the Commercial Toolkit, including when Delegated Procurement Authority is required.

The management of contracts may be undertaken by the Commercial Representative in IM, London Underground or Surface Major Projects.

If you are managing a programme or project you must ensure that the procurement and contract management related Pathway products and schedule items are delivered and accepted at stage gates and any interim review.

You must follow the instructions and guidance in the Commercial Toolkit and the advice of your commercial representative before agreeing any:

- Variation to contract;
- NEC compensation event;
- Claim made against TfL;
- Claim made by TfL;
- Resolution of any dispute;
- Proposed termination or suspension of the contract.

At the closing stages of the contract you must follow the instructions and guidance of your commercial representative (where necessary), including:

- Hand back and closure process;
- Final account;
- Close down of the contract.

Commercial Development

Role of Commercial Development Directorate

The Commercial Development Directorate was created in January 2012 with responsibility for increasing secondary revenues across all TfL business units while reinforcing the customer experience and the value of TfL's brand.

Responsibility

Commercial Development team has responsibility for the following:

Property Development: working generally on large, high-value projects, Property Development work to maximise the value of TfL's property assets. This is achieved by disposal of surplus assets or through development above or around assets.

Commercial Property: responsible for marketing TfL's property assets and managing lease agreements and maintaining relationships with tenants and agents on an on-going basis.

Business Development: work internally with colleagues across the business and externally with potential commercial partners to identify, quantify and deliver mutual benefits. A number of work-streams are being explored by the Business Development team as a priority:

Car Parks

Advertising

Sponsorship

Telecommunications

London Visitors

Procurement Regulations and Commercial Development

The contracts and agreements which the Commercial Development Team negotiates on TfL's behalf are subject to the same European procurement regulations as all similar agreements across the EU. If TfL wishes to recruit a supplier or partner to deliver a service or provide a product to TfL's customers this commercial opportunity must be advertised in line with the appropriate procurement rules and regulations. Not doing this exposes TfL to considerable financial and reputational risk.

Commercial Development team provide company-wide support and will be happy to advise on the design of any commercial project to ensure that it meets your objectives and delivers the best possible value for TfL. The team will also be able to ensure that new projects complement and do not conflict with commercial agreements which are already in place.

How to contact Commercial Development Directorate

To contact the team with your ideas or to request support please email: businessdevelopment@tfl.gov.uk

To see the Business Development pages of TfL's website: Commercial Development Opportunities

Records

Certain records have to be retained to meet statutory requirements, rights of disclosure, TfL policies and LU standards. The period of retention and the method of storing the information must meet these requirements.

You must retain contract records as set out in the Commercial instruction Contract Records which must be read in conjunction with TfL records management pages on Source.

You must also comply with your local doctorate or Business Unit records management instructions and guidance and, for projects, with any specific requirement contained in the project's gate management plan.

Freedom of Information Act 2000

The Freedom of Information Act 2000 creates a statutory right of access to recorded information. Anyone wishing to use these rights must put their request in writing.

As accountable manager, before you respond to any requests relating to the Freedom of Information Act, you must ask the TfL Information Access & Compliance Team (IACT) for advice, including on availability of exemption for commercially sensitive data.

Pathway Handbook

Investment Governance

Contents

General

What this handbook is for

This Handbook covers all projects, programmes and delivery portfolios being funded or delivered by TfL. It gives instructions and guidance on TfL's investment governance requirements for obtaining and maintaining investment authorisation.

The Handbook should be read in conjunction with Standing Orders, which take precedence over this Handbook in the event of any ambiguity.

Who needs this handbook

You will need this Handbook if you are involved with the sponsorship and delivery of projects, programmes or delivery portfolios.

TfL's Investment Governance Framework

TfL's Investment Governance Framework comprises assurance activities and investment approval processes including:

- Defined Authorities, Authority Bodies and Delegation – complying with TfL's Standing Orders and TfL Governance arrangements. Guidance on the Authority Routes which describes the sequence of assurances, endorsements and approval signatures that are required to gain Authority should be sought, and if necessary discussed with the Secretariat. (see also separate LU and Surface Secretariat pages)
- Governance planning - using the Integrated Assurance & Approvals Plan (IAAP)
- Investment Assurance - using Stage Gates and Integrated Assurance Review (IAR)
- Authority requests and approvals - using the Authority Submission
- Governance Control – decisions regarding use of Risk and Contingency and decisions regarding approval of changes

TfL's Standing Orders

TfL's Investment Governance Framework ensures investment decisions align with corporate strategies and align with TfL's Standing Orders.

TfL's Standing Orders define the overall governance structure and rules by which TfL must be managed.

They define the types of authorities that are required for projects, programmes and delivery portfolios; the groups or organisational roles (Authority Bodies) that can grant authority; and how that authority can be delegated.

All projects, programmes and delivery portfolios must comply with the rules defined in the Standing Orders.

Authorities

Projects, programmes and delivery portfolios must obtain authority in order to:

- Spend money, receive income, incur a financial liability or redistribute funds (Financial Authority and Project Authority);
- Make a binding contractual commitment for the purchase of goods, services, land or works (Procurement Authority);
- Undertake land transactions (Land Authority); or
- Dispose of an asset (Disposal Authority).

Financial Authority is a pre-requisite for Project Authority and confirms the existence of a budget for the work in SAP. Budgets are established as part of the TfL annual business planning process. They are entered into SAP at project level and can then be aggregated to summary levels according to the Investment Programme Hierarchy (IPH). The local Business Accountant/Finance Manager can confirm that Financial Authority is in place by identifying the relevant SAP code in IPH (the IP number).

Project Authority is a pre-requisite for Procurement Authority (unless the procurement is not project related, e.g. for operational/maintenance items).

> i The term 'Project Authority' applies to projects, programmes and delivery portfolios.

Authority Approvals and Delegated Authorities

The chain of signatures required to gain 'Authority', the Authority Route, includes approvals that relate to (1) the assurance activities (within Delivery areas); and, (2) the approval chain (within the Authority process managed by the Secretariat). Evidence of each is as follows:

- Assurance completeness: the Pathway signature sheet demonstrating Product approval (required for a Stage Gate Certificate);
- Authority approval: completed Authority signature page within the Authority Submission template (required by the PMO Programme Controls Finance Team for entry of the Authority value into SAP in accordance with the Investment Programme Hierarchy (IPH)).

The Authority Route diagrams represent the accepted approvals sequence in TfL[1]. The default process is that given by Standing Orders, represented as the 'generic'

[1] The Authority Routes are presented as a set of matrices, the columns of which are colour coded: red (assurance); blue (Authority approval); yellow (delegated Authority).

diagram. Only the final signature in the chain grants ‘authority’. For example, for project value >£100m, only the TfL Board has powers to approve; preceding signatures are for endorsement only.

Included on the Authority Route diagrams are delegated authorities, allowed under Standing Orders via formal delegation by the senior officers typically the Chief Officer, MDs of the Operating Businesses. The forms of delegation currently available include:

- Programme Board delegated Authority, for both Project and Procurement (Rail and Underground only)
- Small value projects in Surface (under £5m) that allows authority to be granted without recourse to Surface Board.
- Procurement Authorities granted within Commercial via the delegated authority process.

Delegated Authorities are ‘special’ conditions that allow some flexibility. If there is doubt, the full routes should be used as the default approval routes. In all cases, the Secretariat can be consulted to confirm the approval requirements.

Programme Boards in TfL

Pathway recommends that Programme Boards (or Portfolio Boards) must be formally incorporated by having approved Terms of Reference based on the Rail and Underground Terms of Reference template provided in TfL Pathway.

The Terms of Reference must define:

- Who the Programme Board is accountable to
- The Programme Board’s membership and rules regarding alternate members
- The officer(s) required to approve authority requests along with their limits of delegation
- The frequency of meetings
- The information they require for their reviews
- The information they are required to provide to others
- The interfaces they have with other governance bodies

The use of Project Boards is not optional. As a minimum a Project Board consists of the Sponsor but could also include other key stakeholders such as the User Representative and representatives from Finance and Commercial. The Project Manager is accountable to the Project Board.

Project, Programme and Portfolio Boards do have power for assurance and endorsement, and can grant Stage Authority via signature of the Stage Gate Certificate.

Programme Board Delegated Authority (Rail and Underground)

The MD Rail and Underground[2] has delegated Authority powers to formally established Programme Boards. (This applies to the Rail and Underground part of the business only). Formalised Programme Boards will have a defined membership and Terms of Reference (ToR). The membership for a quorum comprises RUB member, Level 1 member, Finance, Commercial and Sponsor representatives.

Programme Boards have powers to grant Project Authority for EFC up to £5m; and, endorse Project Authority requests for up to £10m. They can approve Procurement Authority up to £10m. In accordance with the rules set by RUB and reflected on the Authority Route diagrams, the evidence of Programme Board Authority approval is as tabulated below :

Programme Board Decision	**Evidence of Authority Approval[3]**
Project Authority up to £5m (approval) and/or Procurement Authority up to £10m	Signature of single RUB member present on the Authority Approval sheet (of the template) plus Programme Board Feedback Form of approval decision.
Project Authority up to £10m and/or Procurement Authority (endorsement to Chief Officer approval) up to £25m (at discretion of Commercial Director)	Signature of RUB member and MD Finance on the Authority Approval sheet (of the template) plus Programme Board Feedback Form of endorsement.
Project Authority greater than £10m and Procurement Authority greater than £25m	Programme Board can provide feedback report endorsement only to higher Authority bodies; Approval signatures on the Authority Approval sheet (of the template) in accordance with the Authority Routes published in the IAAP
Change Control within the baseline Authority is at the discretion of the Delivery Board (<£2m of risk funds for financial change)	Programme Board minutes and local change control procedures; in accordance with Programme Board Terms of Reference .
Change Control exceeding baseline Authority as given by original Authority Submission	Programme Board feedback giving endorsement only; change of Authority must be referred to original Authority

[2] The Rail and Underground Leadership Team have approved how and to whom those powers are delegated. The paper includes a table of the members of RUB.

[3] The Authority Approval evidence is in addition to the required assurance signatures given on the Pathway signature page which provides the evidence that the Delivery area assurance has been completed.

	body as determined by RUB members on Programme Boards
Urgent Project Authority Approval	Programme Board Chair Action, through Finance Director and Director of Strategy and Service Development

Terms of Reference for Boards

Only formalised Programme Boards have delegated Authority. Formalisation means that the ToR has been submitted to the PMO and a record is kept of their key decisions using the above feedback form. Both the ToR and feedback form must be in place to confirm that the Board has the appropriate powers. The objectives, members, and specific terms of reference (ToR) are presented in accordance with the Rail and Underground Template for Rail and Underground Programme Boards. Other business areas should use a version relevant to the area concerned.

Programme Boards that do not have a formally submitted ToR have power to award Stage Authority only. Pathway provides broad guidance on the Programme Board Terms of Reference based on Rail and Underground practice.

Governance Planning

Integrated Assurance and Approval Plan (IAAP)

The Sponsor is accountable for preparing and gaining approval of an IAAP. PMO Assurance must be consulted on all IAAPs.

The IAAP sets out:

- The authorities required by the investment over its lifecycle
- The authority bodies required to grant those authorities
- The assurance activities required for each authority
- The assurers required to undertake the assurance activities
- The complexity and risk profile from the risk based assurance assessment.

Gaining Authority can take significant amounts of time to obtain. The Sponsor must ensure that the overall schedule takes account of the following pre-requisite assurance evidence for obtaining authorities:

- The Stage Gate Certificates for the previous stages to demonstrate the project management assurance.
- The assurance reports and management responses from any required IARs; including those done internal to the Programme, or with PMO Assurance team facilitation.
- Any TfL independent reviews performed by IIPAG

The number of times that separate authorities are sought, and how those authorities are aligned, can have a significant impact on the delivery timescales. The governance processes allow multiple authorities to be obtained simultaneously, which is encouraged.

This alignment (and getting approval of such alignment) is key to maximising the efficiency of governance. For example, in low complexity work, the award of Project Authority may simultaneously enable Procurement Authority. Equally, seeking Authority at Programme level enables multiple delegation of that Authority to Project level.

Determining which authorities are required

Financial Authority

All projects, programmes and delivery portfolios require Financial Authority prior to work being undertaken. Financial Authority is automatically granted for work that is "Budgeted" by being included in the TfL Business Plan.

Financial Authority is therefore only required for projects, programmes and delivery portfolios:

- That are unbudgeted
- Where the cost is greater than the existing Financial Authority – in which case the size of the "unbudgeted" element determines the level of Financial Authority required.

Project Authority

All projects must obtain specific Project Authority, which releases a proportion of the Financial Authority to the project, programme or delivery portfolio. In effect Financial Authority provides funding "in principle", whereas Project Authority actually releases some of the funding to the project.

The total Financial Authority is normally be released in "chunks" as a number of Project Authorities. Each Project Authority releases a proportion of the funds and will usually provide authority to proceed until a certain lifecycle stage or decision point.

Projects, programmes and delivery portfolios need to determine how they wish to release the funding agreed through the Financial Authority as a series of Project Authorities. This should be stated and agreed in the IAAP. In principle, the higher the cost and (overall) risk of a project, programme or delivery portfolio then the more frequently an Authority Body will want to provide Project Authority.

Project Authority decisions are made at the Business Case level. So if a programme is seeking Project Authority then it requires a programme business case. Where Project Authority is being granted for a programme, the budgeted Projects within the programme's plan inherit the programme's Project Authority unless explicitly excluded by the Authority Body granting Project Authority.

Special delegated Authorities have been established for minor and low value work (e.g. <£5m); and, for the ‘seed’ funding for larger projects that are pre-Stage 2. These provide greater control of the release of investment funds for small works than the rules suggested by Standing Orders.

Procurement Authority

Projects, programmes and delivery portfolios will require explicit Procurement Authority where they need to make binding or contractual commitments with a supplier for the purchase of goods, services, land or works. Most projects, programmes and delivery portfolios required multiple Procurement Authorities.

Changes which will increase the contract price, but remain within the pre-approved DPA must be approved through the Project’s governance structure and approved in SAP by the Commercial Manager.

Only if a change is forecast to go beyond pre-authorised DPA for the contract must a subsequent request be submitted to the relevant DPA holder in TfL’s scheme of delegation. The level of DPA required is based on the cumulative value of the contract i.e. original value plus all variations made to date.

Projects must consult with the appropriate contract manager to ensure any proposed expenditure against an existing contract does not exceed the Procurement Authority, or that additional Procurement Authority is obtained before proceeding.

Any subsequent approval of third party contractual expenditure must also refer to the appropriate value of Procurement Authority in the approval documents. In this way, there can be validation that expenditure is not exceeding the agreed Authority.

Procurement Authority is exercised by release of an order or instruction from TfL's electronic contract systems or by entering into a contract. In emergency situations, Procurement Authority may be granted orally but must be confirmed (by the release of an order or instruction from TfL's electronic contract systems or signature of a contract document) as soon as reasonably practicable.

Land Authority

Land Authority is required where a project, programme or delivery portfolio requires:

- the purchase, sale or exchange of freehold or leasehold land
- the purchase, grant, assignment, surrender, release or variation of leases, tenancies, covenants, easements and licences
- any other acquisition or disposal of land and buildings, or interests in, or rights over, land and buildings
- the settlement of compensation claims related to land and buildings or interests in, or rights over, land and buildings

The Standing Orders lists a number of exemptions related to TfL subsidiary companies and certain elements of PPP/PFI contracts.

When Land Authority is granted the associated Procurement Authority and any Disposal Authority is automatically granted unless the Authority Body requires those authorities to be separately obtained.

Disposal Authority

Disposal Authority is required to dispose of any assets.

Disposal Authority is automatically be granted when Land Authority is granted unless the Authority Body requires Disposal Authority to be separately obtained.

Investment Assurance

Before granting authority, Authority Bodies will seek confidence that a decision to grant the authority is justifiable; that the project, programme or delivery portfolio is well managed and likely to deliver the required outcomes and outputs.

Projects provide this confidence through one or more “investment assurance” activities agreed in advance through an IAAP. The assurance activity is not only that directly associated with a request for authority, but may be ad-hoc. The frequency of reviews is at the discretion of the Programme Board (or Sponsor); as agreed via the IAAP. However, investment assurance excludes ‘technical assurance’ activity; for example that to provide Cat Standard 1-538 compliance and design reviews (in LU). Both are implicitly accounted for within Pathway, as Product evidence is available for both.

> It is important to draw a distinction between “investment assurance” and other forms of assurance, such as technical assurance, that might be undertaken on a project. Investment Assurance is solely concerned with providing confidence to an Authority Body.

The two principle mechanisms for providing investment assurance are Stage Gates and Integrated Assurance Reviews (IAR). There is a fundamental principle that a Stage Gate or an IAR should not require the preparation of any additional products or documents.

Assurance requirements are determined by a balanced view of not only cost, but also the complexity and business risk associated with a project, programme or delivery portfolio.

The IAAP contains a Risk Based Assurance scoring tool that categorises risk at one of four levels. Each level has a distinct set of assurance requirements.

Assurance	Investment assurance requirements
Level 1	No additional investment assurance is required above and beyond that undertaken by the project, programme or delivery portfolio through its Stage Gates
Level 2	Additional investment assurance must be undertaken by a party

	that is independent of the project, programme or delivery portfolio, but not necessarily external to TfL – i.e. it may be a peer review from within TfL This assurance will be coordinated by TfL PMO
Level 3	Additional investment assurance must be undertaken by an external expert engaged by TfL through TfL PMO This assurance will be coordinated by TfL PMO
Level 4	Additional assurance requirement must be undertaken completely independently of TfL through the Independent Investment Programme Advisory Group (IIPAG) IIPAG sets the additional assurance requirements

Stage Gates provide the base level of investment assurance

Stage Gates provide base, minimum level of investment assurance by confirming project management assurance that:

- Planned products have been consulted on and approved
- Planned reviews have been undertaken
- Conditions attached to previous gates have been closed out
- There is a plan for which products must be produced for the next stage and which product reviews must be undertaken
- Plans and estimates are in place for the next stage.
- Where there is variance from the PPMP, the risk of proceeding into the next stage has been assessed and agreed by the sponsor.

This process provides confidence that TfL processes and policies defined within Pathway have been followed.

A Stage Gate is required to move from one Pathway stage to another (including the final, Closure, stage). Stage Gates are evidenced by Stage Gate Certificates, which must be submitted when applying for authority as proof of investment assurance.

The Sponsor should identify the appropriate representatives from directorates impacted by the project appropriate to the EFC, size, scale, complexity and risk. Generally, these include Operational representatives, Maintenance representatives, safety, quality and environmental advisor and relevant engineer.

The sponsor and project manager must attend all project stage gates. Where the sponsor, programme or project manager changes during a programme or project an interim stage gate review must be held. It must be attended by the outgoing and incoming person.

Integrated Assurance Reviews (IAR) provide additional assurance

An IAR is required:

- prior to any requests for Authority as defined in the Standing Orders (Financial, Project, Procurement, Land, Asset Disposal);
- at least once every 12 months;
- at the discretion of Programme or Operating Boards or above;
- if requested by the PMO.

Integrated Assurance Reviews (IAR) assess the deliverability, affordability and value for money offered by a project, programme or delivery portfolio. IARs provide confidence that if we keep doing what we're doing then TfL will get the desired outcomes. They provide supplementary investment assurance over and above that provided by a Stage Gate, which is focussed primarily on process compliance.

All reviews will be based on the Key Challenges defined in the IAR checklists. Further Detailed Challenges are required if determined by the Risk Based Assessment (in the IAAP) or by the type of Authority being requested (e.g. Commercial and Procurement detailed challenges will be used for IARs prior to Procurement Authority requests). The IAR checklists provide higher level, more integrative challenge than that just provided by the quality criteria and templates associated with individual products.

The choice of assurer is determined by the Risk Based Assessment in the IAAP and can be a choice of internal assurance, PMO facilitated assurance, external expert assurance and/or IIPAG assurance.

The level of Assurance is not necessarily static across the investment lifecycle:

- As confidence increases the required level of Assurance should decrease
- As confidence reduces the required level of Assurance should increase.

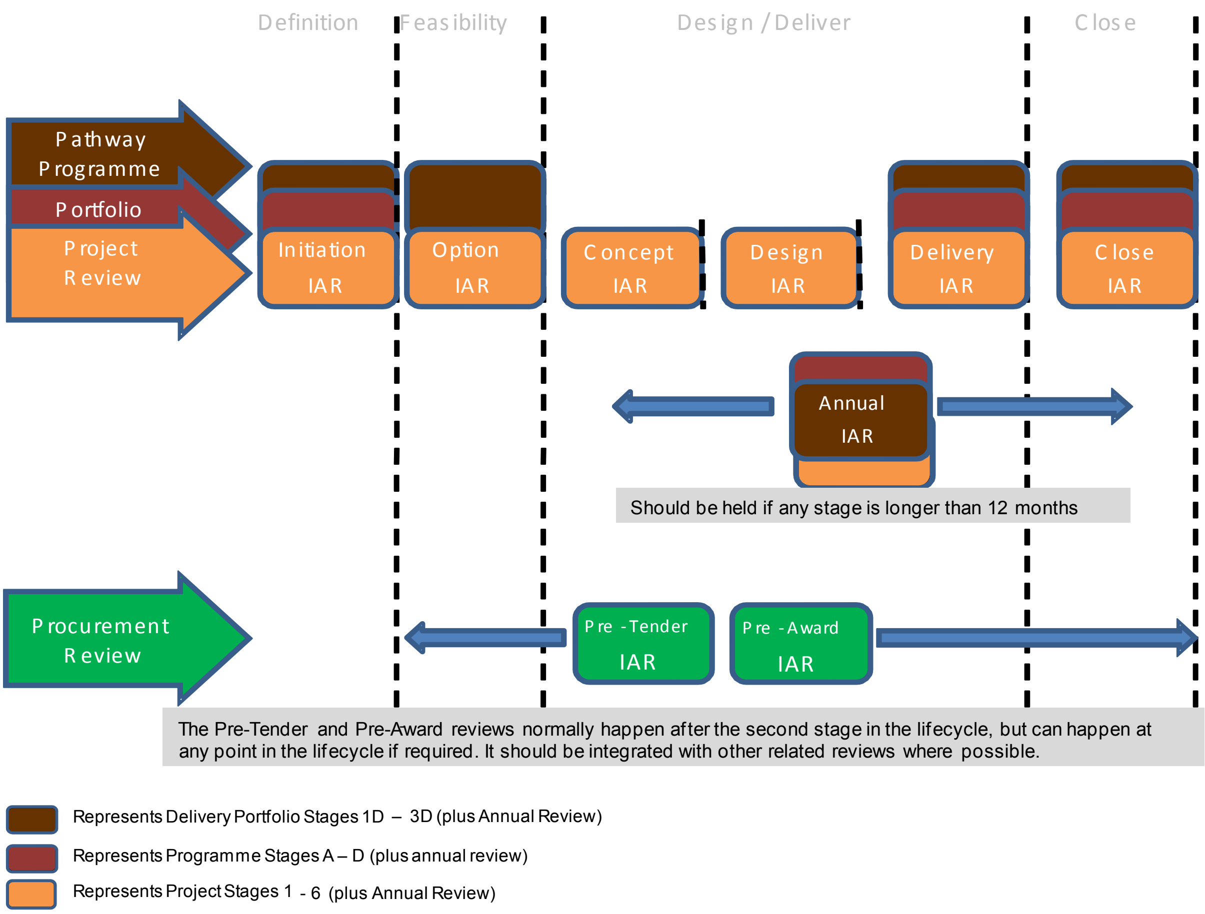
There is a default list of conditions defined in the IAR that when triggered may increase or decrease the level of Assurance for subsequent approvals (e.g. change of sponsor, change of project manager, missed milestone). These conditions are assessed at every gate.

PMO Assurance has the right of intervention to undertake internal-assurance or peer-assurance on investments. PMO Assurance also has authority to vary from the default level of Assurance determined by the Risk Based Assessment and will make final decision on choice of Detailed Challenges and the choice of assurers.

There are a number of sets of review challenges, which are tailored to the delivery methodology you are following, the stage and the type of authority you are looking to assure. The diagram below represents these.

Where an IAR is required in support of an Authority Submission then the review must be completed before the Authority Submission. Other than that:

- An IAR can take place at any time during a Stage – it is not tied to a Stage end or Stage Gate
- The project, programme or delivery portfolio team should plan the reviews to coincide when the evidence of assurance is most critical and most convenient.



Note: the above diagram illustrates the type of IAR's that can apply across the lifecycle for a project, programme or delivery portfolio. Not all these IARs are required for all investments. Plan as required.

Authority Requests, Routes and Approvals

Authority Requests

Authorities are obtained by making an Authority Submission. The submission is intended to summarise (not duplicate) the supporting information required by the Authority Bodies. Equally, it is discrete to the Business Case and should not duplicate either the business case content or consultation processes. An approved/agreed Business Case is assumed therefore; and, the Authority Submission principle role is to request funding.

The Sponsor is accountable for obtaining the investment authorities by preparing, submitting and championing the Authority Submission(s). It is the Sponsor's responsibility to ensure that the Authority Submission is of the required quality and that all necessary assurance and consultation has taken place.

Authority Submissions must be written for the ultimate Approver(s) and progress in that format through the preceding layers for Assurance and Endorsement. They should not be re-written for style/format as they progress through the layers. Where intermediate layers require more detail this is provided in supplementary sections that are subsequently removed if they are not needed by the next layer.

The core paper will be succinct, containing sufficient information to enable a decision as early as possible. The core paper is a précis of the authority request and its supporting documentation, not a cut down version of the supporting documents such as the Business Case.

Authority Routes

The routing of Authority Submissions is dependent on EFC, whether it is budgeted/unbudgeted, the type of authority being requested and the Operating Business hosting the project. Each step will be to either

- Assure (i.e. Independent review of the investment, provides advice to the approvers)
- Endorse (i.e. Agreement that the authority request for the investment can progress to the next step in the approval process)
- Approve (i.e. Grants Investment Authority).

Authority Bodies (TfL Board, F&PC, Operating Boards and Programme Boards) are managed by their respective Secretariats who will advise the Sponsor of when the body meets, deadlines for confirming agendas and submission deadlines for papers.

Authority Approvals

Authority Submissions approved by the TfL Board and Finance & Policy Committee (F&PC) are recorded in the minutes of their meetings.

Authority Submissions approved by the Commissioner, MD Finance, Managing Directors or other Officers are recorded in the Authority Submission by way of a signature. Such Authority Submissions are typically submitted to the relevant Operating Board (RUB or STB). Note that it is the relevant individual who approves and signs the Authority Submission, not the Operating Board.

Delivery work that is funding by Corporate areas (for example: Corporate IM; Commercial Developments, Projects and Accommodation; and others) may not have to be endorsed by either of the existing Operating Boards (RUB and Surface). For these cases, the Authority Route would follow the generic route recommended in the diagrams included with the IAAP, going directly to the Chief Officer or MD Finance (depending upon value) missing out the RUB/Surface Board endorsement step. Irrespective of this, there is still a requirement to demonstrate that an appropriate level of assurance has been completed. The Secretariat is ultimately the judge of what is appropriate and the decisions on Authority will be confirmed by them.

Governance Control

Change Control and Tolerance

Change must be managed within the tolerances set for both Project Authority and the overall Financial Authority. The default situation of zero financial tolerance unless explicitly stated otherwise.

Substantial changes to cost (exceeding available risk funds); to schedule (exceeding the float defined by the agreed milestones); or, to scope (defined by the original objectives) require an Authority Submission to be presented for re-authority following the same route for approval as the original Authority.

Using risk funds

A P50 risk value is included in the approved EFC based on Quantitative Risk Analyses using the identified risks from the Risk Register. Funds are allocated against identified risks that materialise throughout the course of the work. The Project/Programme Manager has some flexibility to manage financial variation through the application of the risk fund.

Permission to utilise risk funds is given via the Project/Programme/Portfolio level Change Control process. The risk fund must be managed at the Programme or Delivery Portfolio level and shown separately in the financial system, for which a discrete code is established within SAP.

The detailed management of risk, financial and otherwise, is covered within the Pathway Risk Management Handbook.

Management of contingency funding

Contingency is used to cover cost increases associated with target price or cost reimbursable contracts or where levels of risk provided have been exceeded (colloquially referred to as the unknown-unknowns). Contingency is not included as part of the estimated final cost (EFC) for which authority is granted.

Contingency is held centrally and its release is by the relevant Authority Body, dependent upon the revised EFC. In effect there is little difference between seeking additional authority for overspend and contingency release.

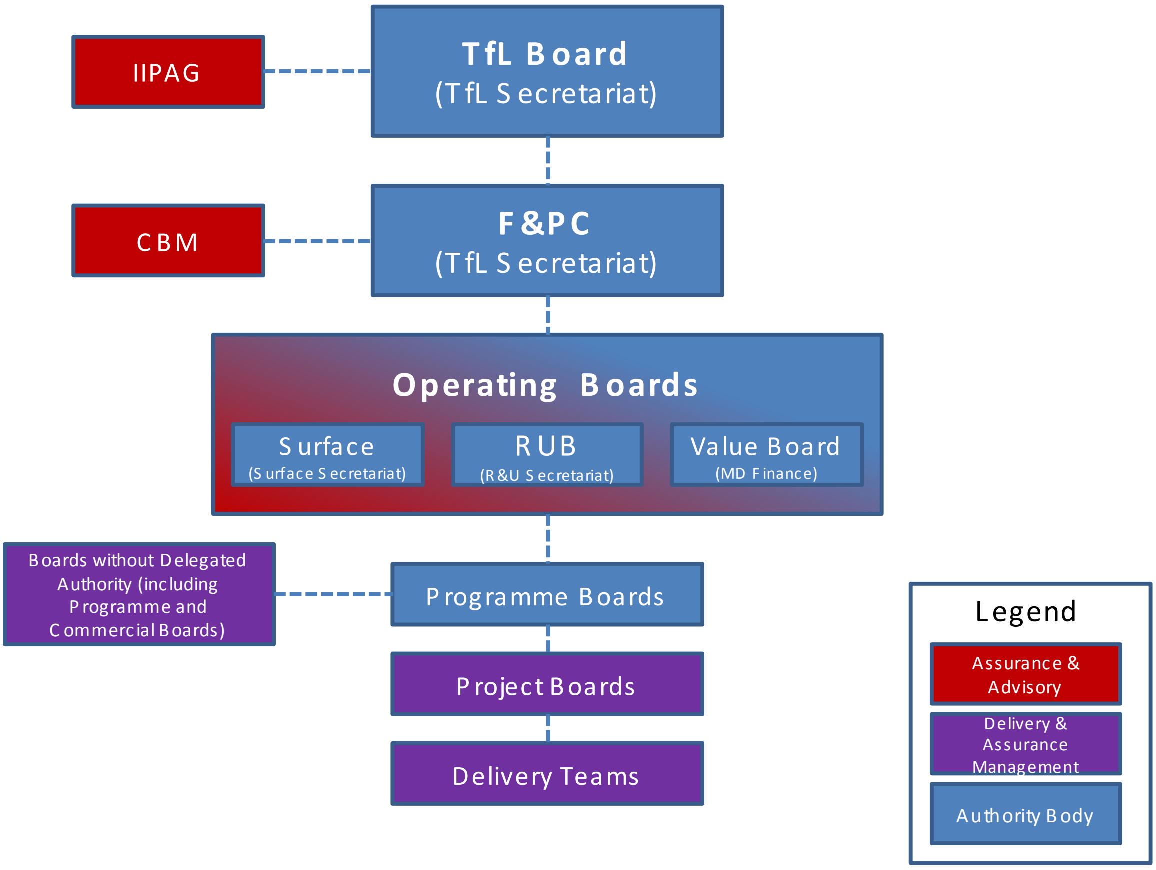
Closing a project

Closure of a project, programme or delivery portfolio requires evidencing that the promised work has been completed; project outputs and outcomes achieved and that there is a realistic plan in place for realising the promised benefits. In practical terms this means that:

- delivery work must be completed (end of Stage 5/ Stage C/ Stage 2D), all the asset information files and snags resolved to the satisfaction of the key stakeholders, thus enabling hand-back of the asset. The key evidence is typically the Project Completion and Handover Certificate which is essentially approval signatures of key stakeholders
- successful financial closure achieved, meaning, for example, no unidentified retentions or open purchases orders, allowing SAP (or equivalent) WBS closure. The key evidence is the Financial Close Report
- lessons learnt must be documented in the Lessons Learned Report
- Benefits Management Strategy must be submitted. Where longer term benefits exist, realised more than 6 to 18 months from the end of delivery, the evidence should demonstrate what is in place for ongoing benefits monitoring (the responsibility of the Sponsor)
- All the above evidence is subject to scrutiny and the Stage Authority process is invoked to formally close the work. This includes a review (part of the IAR scope); check on compliance; and, Authority to close decision. For EFC > £2m, the review minutes/report are submitted to Operating Board level, subject to the discretion of the Project/Programme Board.

Governance Roles and Bodies

Understanding the roles of the various bodies and individuals is vital to appreciating how an Authority Submission is routed for approval. Only those individuals or bodies identified in Standing Orders can approved Authority; all others either assure or endorse; but nevertheless are part of the investment governance process. The three fundamental hierarchical layers are: TfL Corporate; Operating Board and, Programme levels. The diagram below explains the hierarchy and roles. The table further elaborates of the individuals responsibilities that will be reflected mostly by the RACI requirements for each of the Products.



Role	Responsibility
Project/Programme Manager	Produce PPMP and IAAP Ensure products are produced, reviewed and approved in accordance with the PPMP.
Sponsor	Approve PPMP and IAAP Produce Authority Submission (for Project Authority Requests) Chair Stage Gates Chair Level 1 IARs
Commercial Manager	Consulted on IAAP, Stage Gate Certificate, IAR Product Authority Submission (for Procurement Authority requests)
Finance	Consulted on IAAP and Authority Submission
PMO Assurance	Consulted on IAAP and Authority Submission Facilitate or Chair Level 2, 3 or 4 IAR

Role	Responsibility
Secretariat	Consulted on IAAPs and Authority Submission Manage routing of submissions to Operating Boards, CBM, F&PC and TfL Board.
Commercial Procurement Steering Group (CPSG) for Rail & Underground or Commercial Peer Review Forum (CPRF) for Surface, IM and Services	Assurance of Procurement Strategy and Procurement Recommendation
Programme Board / Delivery Portfolio Board	Approve Authority Submission within Delegated Authority of the officers in attendance or endorse its progress to the next layer
Operating Board	Approve Authority Submission within Authority of the officers in attendance or endorse its progress to the next layer
MD Finance	Approve Authority Submission within Authority or endorse its progress to the next layer
Commissioner	Approve Authority Submission within Authority or endorse its progress to the next layer
IIPAG	Assure Authority Submission requiring F&PC or TfL Board approval
F&PC	Approve Authority Submission within Authority or endorse its progress to the next layer (note that a Chairman's Briefing Meeting (CBM) was introduced (April 2014) preceding FPC. Further guidance will be provided on their requirements in the process as soon as the terms of reference as available.
TfL Board	Approve Authority Submission requiring their level of authority

Document History

Version	Date	Changes since previous version
Rev A2	28 July 2014	Updated Terms of Reference and Feedback

		Form

Guidance Document

G1436 Stage Gates

Contents

What this guidance is for

This provides guidance on management of stage gates – with particular focus on project gates.

The application of the activities and instructions described in this guidance is not simply a matter of applying a “one size fits all” formula; it is about appropriately balancing combinations of knowledge, experience and behaviours with the application of size, scale, complexity and risk of the programme or project.

The specific roles, responsibilities, legislation and standards associated with the activities and instructions described in this guidance are detailed in the individual product descriptions.

General principles that apply to this guidance

The following are the main principles provided in this guidance:

- An approach to programme and project assurance, using the concept of “gates and reviews” to control a programme or project as it progresses between stages of the lifecycle, based on the delivery of agreed products and review outputs
- An emphasis on professionals working together to make conscious, viable decisions about what does and does not need to be undertaken for a specific programme or project
- Recording an agreement between the sponsor, programme or project manager, team and key stakeholders on what governance arrangements will be put in place and adhered to

Managing the Pathway Product Management Plan, products and stage gates

Pathway Product Management Plan questionnaire

The Pathway Product Management Plan (PPMP) questionnaire is the starting point when commencing a programme, project or delivery portfolio. It forms a contract between the sponsor, programme or project manger and key stakeholders for the delivery of products and reviews required to plan, manage progress and complete a programme or project.

Products are those things a programme or project must do to:

- Specify and manage the project, programme or delivery portfolio
- Provide evidence that what was promised was delivered
- Satisfy TFL’s statutory obligations
- Comply with TfL’s policies and standards

- Adhere to recognised professional practice.

All products are held in the Product Matrix, a controlled library of defined products.

The sponsor and the programme or project manager must be accountable for:

- Producing the products identified in the PPMP
- Obtaining approval for all products produced before a planned stage gate review – see the next section.

What Stage gates do

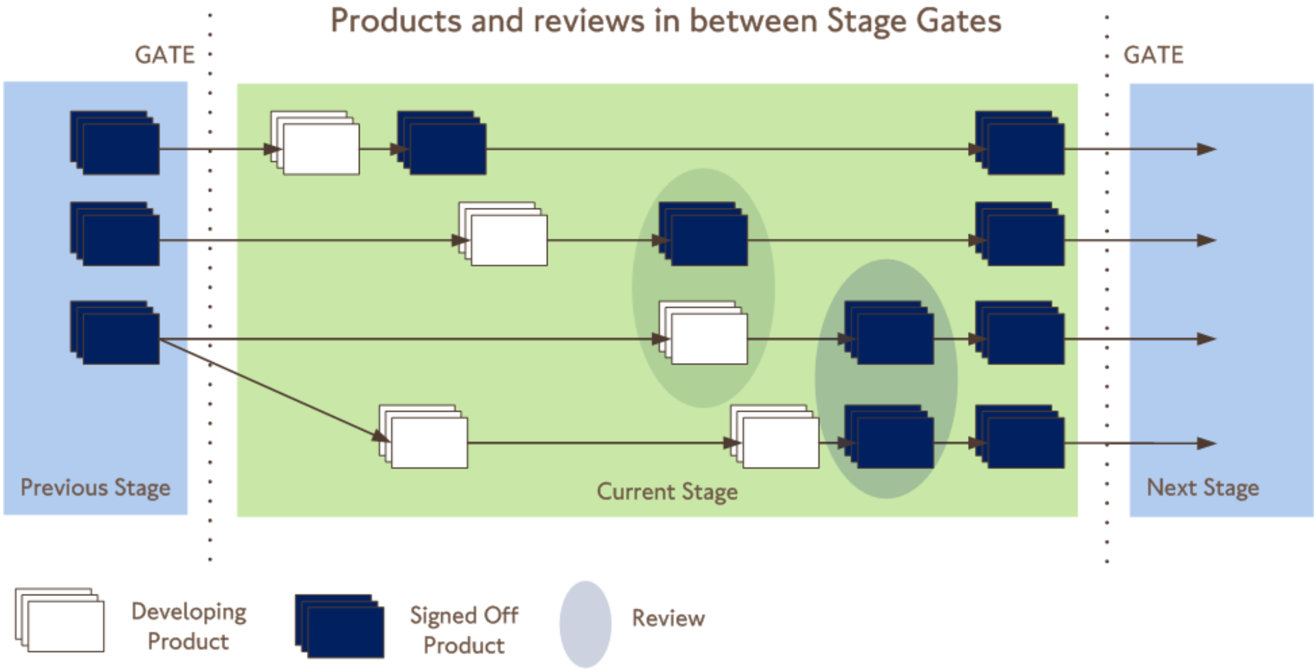
Progress through the project lifecycle is controlled by stage gates. A stage gate:

- Provides authority to proceed to the next project lifecycle stage,
- Is a pre-requisite for any authority submission that may be required

At a stage gate, the programme or project manager must confirm and sponsor verify that:

- Planned products – as identified in the PPMP have been consulted on and approved by the accountable/accredited individuals
    - **Build in quality through the stage by checking, reviewing, amending, finalising and do not leave checks for the end where the cost of change is much higher than earlier in the stage**
- Planned reviews have been undertaken
- Conditions attached to previous gates have been closed out. If this is not the case, the gate must be failed
- Core products are up to date and approved – or are about to be so within three weeks of the stage gate
- Products which must be produced for the next stage and which reviews must be undertaken are agreed
- Plans, resources and estimates are in place for the next stage
- Where there is variance from the PPMP and products have not been produced or approved, the risk of proceeding into the next stage has been assessed and agreed by the sponsor and other relevant stakeholders
    - There may be valid reasons why a project may not have produced something it planned to – an unexpected delay, unavailability of personnel. Where a product has not been approved during the stage or where a planned product has simply not been produced, the Stage Gate should take a risk based view about

whether it is acceptable for the project to proceed and whether any conditions should be attached to the project proceeding into the next stage.



What Stage Gates do not do

It is recommended that stage gates **do not** Review any product produced for the stage – this must be undertaken when products are approved by accountable/accredited individuals during the stage

- ○ **The stage gates do not directly examine the quality of products produced for the stage; this must be undertaken as part of progressive assurance when products are approved by individuals during the stage.**

- Assess the overall management of the project or progress against time and cost – these are done in period reports as part of daily business

    - ○ Stage gates are not a substitute for day to day good management of the project, programme or delivery portfolio but to draw breath, gather stakeholder views and support and move on with a solid foundation

- Provide an opportunity for interested parties to change the scope of the project

An Expanded Stage Gate

The philosophy of TfL Pathway is to build in quality through the stage and to carry out appropriate reviews – whether design reviews or full Integrated Assurance Reviews – at suitable points. Leaving critical questions to the stage gate meeting would risk excessive re-work and lost time.

However, it is appreciated that for some projects at some gates a more in-depth meeting at a Stage Gate may be appropriate. This is left to the discretion of the relevant Programme Manager and the Sponsor – risk based according to the local programme management strategy.

All of the issues noted below will have been covered in individual Pathway products with appropriate sign-off and should not need review. However, if believed appropriate:

- Each Programme or Business Area – for each of its programmes and projects – to identify those stages that require an expanded stage gate meeting and to identify particular attendees for particular gates

- The Programme Manager will join the Sponsor at the Stage Gate or will appoint another individual to attend

- Project or Programme Manager to submit a presentation

    - Summary of objectives, requirements, business case and context

    - Clear explanation with supporting rationale as to why the project or programme ready for the stage gate

    - Highlight lessons learned from similar projects or programmes and their affect

    - Issues, concerns, risks for the project or programme going forward up to the next Stage Gate and how these will be effectively managed

- Key Questions (if not answered in the presentation)

    - The challenges from the appropriate tab of the Integrated Assurance Review

    - Additional questions to probe beyond the TfL Pathway products in order to provide the Sponsor with assurance that the project or programme is delivering to the requirements in a cost effective and timely manner

        - Key internal or external interfaces – requirements of the rest of the business

        - Access requirements

        - Impact on operations during the project works

        - Estimated costs – accuracy and source

        - Top 5 risks

        - Resources planned for the project – experience and suitability

        - Key schedule dates – including Programme Accountability Milestones (PAM)

  - Procurement – strategy and issues

- TfL Pathway products
  - Review of products required by the Pathway Product Management Plan (PPMP)
  - Products review feedback from stakeholders
  - User Representative comments
  - Controls readiness – baseline, estimate, schedule, cost and work breakdown

Stage gate – chair and attendees

The Sponsor chairs stage gates. Individual agreements at a programme or business unit level may be made for joint chairing between the Sponsor and the Programme Manager but this is left to the discretion of the individual areas.

The Sponsor should identify the appropriate representatives from directorates impacted by the programme or project appropriate to the estimated final cost, size, scale, complexity and risk. Generally, these include operational representative, maintenance representatives, safety, quality and environmental advisor and relevant engineer.

The sponsor and programme or project manager (as relevant) must attend all programme or project level stage gates respectively, but delegation is allowed for sub-project level stage gate reviews.

Where the sponsor, programme or project manager changes during a programme or project an interim stage gate review must be held. It must be attended by the outgoing and incoming person.

The chair must decide the outcome (pass, conditional pass or fail) and record the result in the stage gate certificate held within the PPMP, together with a declaration of the products to be produced during the next stage.

Pass	The programme or project may proceed to the next stage as required.
Conditional Pass	The programme or project may proceed to the next stage subject to an agreed action plan (documented in the PPMP) within an agreed timeframe. No action should have a duration of more than three months Any outstanding core products must be signed off within three weeks of the stage gate
Fail	The programme or project is not fit to proceed to the next stage

	and must repeat the stage gate review when ready.

Stage Gates and Project / Programme Boards

For some projects and programmes at particular points, it may make business sense to hold the stage gates at the Project/Programme Board. This ensures that key, senior stakeholders are present and engaged in the process. This will not be practicable for all projects but should be encouraged for critical points. This may be in the format of a standard stage gate or an expanded gate

Stage Gate - complex projects with multiple sub-projects

Some projects are best managed by breaking them down into sub-projects at a point in the project lifecycle. For example, a project might have 30 or more geographic work sites, each requiring its own detailed design and delivery. In these cases:

- The project must be progressed as a single, integrated entity up until the end of stage 3 or stage 4, as appropriate to the project
- Multiple stage gate reviews must be undertaken for stages 4 and 5, as appropriate, although reviews may be grouped together where it is sensible to do so
- Single, integrated stage gate reviews of the whole project must then be undertaken for stage 6.

Where the project is broken into sub-projects this must be set out and agreed in advance with the sponsor via the Pathway Product Management Plan.

Where projects need to undertake enabling works in advance of completing the design of the main works then these must be treated as separate sub-projects.

Programme and Delivery Portfolio Stage Gates

Given the nature of programmes and delivery portfolios in terms of duration and expenditure, it is very likely that stage gates will be more in-depth in nature than project stage gates.

Every programme and delivery portfolio gate is likely to have an Integrated Assurance Review (IAR) preceding the gate – this is not the case with project stage gates.

However, the principle of ‘building in quality through the stage’ applies also for programmes and delivery portfolios as well as projects.

Stakeholders and Stage Gates

The mandated signatories on the Stage Gate Certificate are the Sponsor and the Project or Programme Manager.

However, several other signatories are shown. This recognises the fact that a project, programme or delivery portfolio does not deliver outputs in isolation from its stakeholders and nor is it capable of delivering without support. In particular, in TfL, projects, programmes and delivery portfolios usually deliver to maintainers and operators and require significant procurement. It is, therefore, critical that such stakeholders are involved from the beginning and, though not mandated, should form part of the signatories for the stage gate certificate.

It is certainly the case that the Sponsor must verify that the TfL Pathway products that require identified stakeholder signature/approval have been so approved.

A stage gate is not a democracy – the Sponsor will have final say taking all views into account and making a considered judgement but close stakeholder involvement helps to ensure support for the activity and provides an increase probability of success.

Document history

Revision	Date	Reason for change	Author
A1	30/11/12	First draft	IPPM
A2	April 2013	Issued for use	IPPM
A3	November 2013	Issued for use – inclusion of guidance for an ‘expanded stage gate’	Arnab Banerjee
A4	February 2014	Inclusion stating that gates may be held at the Programme Board level	Doug Norman

Project Execution Plan (PEP) (Stages 1-5)

Purpose

To act as the central reference document for managing all aspects of the execution of the project – including project management; engineering/ technical management; construction management; health, safety, environment and sustainability management; procurement; maintenance readiness; operational readiness; stakeholders.

This product supports compliance with the Construction (Design and Management) Regulations. Therefore, it is mandatory that **the supplied template must be used.**

Applicability

This product must be produced for all projects**.**

- It may be appropriate to create standalone PEPs for sub-projects or specific elements of the programme or project.
- The size, scale, and complexity of the PEP must reflect the size, scale, complexity and risk of the programme or project. This means that:
  - Unless otherwise indicated in the PEP template, sections of the PEP must only be completed if required and appropriate to the circumstances of the programme or project
  - In some cases, the necessary information can be written directly (and only) in the PEP without producing a separate, standalone product. Where this is done:
    - Obtain agreement to do this from the relevant people indicated in the roles and responsibilities section of the relevant Product Description.
    - Add a note against the relevant product in the project's Pathway Product Management Plan (PPMP) to say that it has been included in the PEP.
    - Ensure that the PEP is consulted with any roles indicated in the product's Product Description
    - For smaller / less complex projects, therefore, it may be entirely appropriate for the execution of the project to be largely or entirely managed using the PEP and without producing many other separate documents.

Templates

- Project Execution Plan (PEP) template
- IM Project Execution Plan template
- IM Small Works Project Execution Plan (PEP)

Contents

- Contents is defined by the template

Quality criteria

- The supplied template must be used
- The PEP must align with scope and requirements set out in the Project Requirements (PR)

Business area specific

Area	Detail
London Underground	This product is used to discharge part of the requirements for a Change Assurance Plan under LUL Category 1 Standard 1-538. As a consequence, it is mandatory that **the supplied template must be used.**
Rail and Underground	Please note Guidance Note - Timesheet Policy and Process

Document management

File Project Execution Plans in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

The comprehensive RACI table used within IM can be found here.

Responsible (Responsible for producing all or part of quality product)	Accountable (Accountable for ensuring timely delivery of quality product)	Consult (Must be consulted when product is being produced)	Inform (A copy of the signed-off product must be sent to)
Project Manager Project Engineer	Project Manager	Relevant Stakeholders but typically: Sponsor User Representatives Commercial Lead Subject Matter Expert	

Responsible (Responsible for producing all or part of quality product)	Accountable (Accountable for ensuring timely delivery of quality product)	Consult (Must be consulted when product is being produced)	Inform (A copy of the signed-off product must be sent to)
		Consents Specialist HSE Manager Environment Manager People Change Manager	

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for consultation	IPPM
A2	08/04/2013	Issued for use	IPPM
A3	10/07/2013	Updated for IM and link to template	IPPM
A4	21/08/2014	Updated for R&U – Timesheet Policy and Process (DRACCT 03000)	AB
A5	31/03/2015	Updated to reflect CDM 2015 Regulations and minor environmental amendments	HS&E SIGs
A6	31/07/2015	Updated for DRACCT No. 03940 – Embedding CEEQUAL	E SIG

Pathway Information (delete when you use this template)

Template reference	Template file name	Version	Date
F0857	T Project Execution Plan (PEP)	A4	03/01/13

PD reference	PD
PD0042	PD Project Execution Plan (PEP)

Project

Document reference

Project Execution Plan (PEP)

		Signature	Date
Prepared by	<Name> Project Manager	------------------------------	------------------------------
Prepared by	<Name> Project Engineer	------------------------------	------------------------------
Reviewed by	Endorsement statement <Name> Commercial Lead	------------------------------	------------------------------
Reviewed by	<Name> Sponsor	------------------------------	------------------------------
Reviewed by	<Name> User Representative	------------------------------	------------------------------
Reviewed by	<Name> Subject Matter Expert	------------------------------	------------------------------
Reviewed by	<Name> HSE Manager	------------------------------	------------------------------

Reviewed by

<Name>

People Change Manager

<Name>

Consents Specialist

Approved by

I confirm that this deliverable meets the requirements of the relevant TfL Pathway Product Description and that all consultation comments have been addressed to the satisfaction of consultees.

<Name>

Project Manager

Distributed to <Name> <Role>

Document History

Revision	Date	Summary of changes
A2	11/07/2014	Updated with ICT guidance (Section 41.) – DRACCT 02729)
A3	31/03/2015	Updated to reflect CDM 2015 Regulations
A4	31/07/2015	Updated for DRACCT 03940 – Embedding CEEQUAL

Table of Contents

DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY

General Guidance

Do not delete each heading, if the section isn't required. Write 'NA' to show that professional judgement has been applied.

The size and complexity of the Project Execution Plan (PEP) must reflect the size, scale, complexity and risk of the project. This means that:

- Sections of the PEP must only be completed if required and as appropriate to the project.
- In some cases, the necessary information can be written directly (and only) in the Project Execution Plan without producing a separate, standalone product. Where this is done:
    - Obtain agreement to do this from the relevant people indicated in the roles and responsibilities section of the relevant Product Description. In general this should have been done as part of the preparations for, or at, the relevant Stage Gate
    - Ensure that all relevant elements of the product's Product Description are addressed (unless something in the Product Description indicates that something is mandatory)
    - Add a note against the relevant product in the project's Pathway Product Management Plan
    - Ensure that this PEP is consulted with any roles indicated in the product's Product Description

For smaller/less complex projects then it may be entirely appropriate for the execution of the project to be largely or entirely managed using the PEP and without producing many other separate documents. This must be done with the agreement of the sponsor and project team

1 Project Scope

1.1 Core documents

Complete the following table.

Baseline Item	Document Reference & Link
Project Requirements	Core product
Business Case	
Benefits and Value Management Strategy	
Authority Submission	If a capital project or the project requires changes to operating expenditure

Estimate	

DO NOT repeat or summarise the project's scope and objectives in this document. (Provide link to Project Requirements)

1.2 Key milestones

<This section must be completed for all projects>

Provide a summary of the key milestones from the Schedule.

- Include CEEQUAL Interim Client and Design Award, if project meets criteria for CEEQUAL Whole Team Award.

2 Project Governance

2.1 Governance

Provide a summary of the governance arrangements, including:

- Project Boards that affect this project
- Project Management Meetings
- Regular programme level meetings

Provide a link to any terms of reference.

2.2 Organisation

Core project roles & resourcing

<This section must be completed for all projects>

Complete the following table.

The roles in **bold** are core TfL Pathway roles. See Pathway Glossary

Where any of the core TfL Pathway roles are not required then insert "Not Required" rather than deleting the row. Alongside each role, list the planned resource requirements which the project will need in order to meet the schedule.

Additional roles may be added to the table.

Role	Person	Directorate / Organisation	Commitment (hrs/wk)
Sponsor			
Programme Manager			
Project Manager			
Project Engineer			

Subject Matter Expert			
HSE Manager			
Commercial Lead			
People Change Manager			
Operations Representative			
Maintenance Representative			
Construction Manager			
<Add additional roles if appropriate>	E.g. Enviroment Manager		

Construction project roles

<This section required for all projects that involve construction>

[Do not delete] The following appointments have been made for this project:

Role	Directorate / Organisation
Client	
Principal designer	
Designer(s)	
Principal contractor / Contractor	

State the outcome of the CDM applicability assessment from the Pathway Product Management Plan questionnaire.

State the outcome from the discussion with the HSE Adviser regarding initial appointments of CDM duty holders and plan for ongoing appointments during the project.

For all CDM duties to be undertaken, complete the table in Appendix A, identifying the specific role within the project team that will be discharging each duty.

For guidance refer to the HSE handbook and the Construction handbook

Under CDM, this project is notifiable/ not notifiable (delete as appropriate)

Note: CDM is applicable for all construction works, even if NOT notifiable.

If the project is notifiable, provide a link to the F10 (HSE/ORR notification)

For all construction projects, provide a link to the HSE Pre-construction information and Team HSE Competency Assessment.

2.3 Project Controls

Describe how project controls will be implemented within the specific project setting. This should include the following elements:

- Organisation (responsibilities for project controls)
- Baseline Management
- Scope Management
- Change Control (including Design Change Control)
- Estimating
- Cost Management
- Planning and Scheduling
- Risk Management
- Data Governance
- Report Progress and Performance
- Document Management

Further guidance is provided within the Project Controls Handbook.

3 Project Interfaces

3.1 Key Stakeholders

<This section must be completed for all projects>

Appropriate to the size and complexity of the project, a stand alone **Stakeholder Engagement Plan** may be produced.

Provide a summary of the project's key internal and external stakeholders.

A key stakeholder is one that could directly impact the ability of the project to deliver its outcomes and benefits, e.g. regulator.

3.2 Sharing of information, co-ordination and co-operation arrangement

Provide details of how information will be shared with project team members, designers, suppliers, TfL operations, TfL stakeholders, interfacing projects and projects on adjacent sites in a timely manner. Include details regarding what type of information will be shared and when. Consider different arrangements/requirements for the different stages of the project life-cycle. This section shall include the arrangements for how to meet the information requirements of CDM.

Provide details of the arrangements for ensuring coordination and cooperation between project team members, designers, suppliers, TfL operations, TfL stakeholders, interfacing projects and projects on adjacent sites. Include details of how the project will interface, coordinate its activities with and cooperate with other parts of TfL to ensure that risks from and to those parts of TfL are understood and managed. This section shall include the arrangements for how to meet the coordination and cooperation requirements of CDM.

Where CEEQUAL Whole Team Award is a requirement, detail here how evidence to support submission will be collected and shared between Client, designers and other suppliers.

Include a link to your project folder/filing site (e.g. Shared drive, SharePoint site or Livelink area). Confirm standard filing structure being used.

3.3 Dependencies

<This section must be completed for all projects>

- Internal or project dependencies
- Internal TfL organisational dependencies
- External project dependencies

3.4 Key assumptions

<This section must be completed for all projects >

State the key assumptions that have been made in producing this PEP.

4 Project Change Impact

<This section must be completed for all projects >

4.1 Infrastructure Impact

Identify all functions and asset areas on which the project will have an impact. Tick one or more boxes (click the 'Options' button, just below the windows toolbar and select 'Enable this content 'to enable the ticks)(add asset type if not outlined below).

Primary: The main assets that will be affected by the project

Secondary: Other assets that will also be affected by this project

	Primary	Secondary
Highway	☐	☐
IM / Information Communication Technology	☐	☐

(ICT)see note		
Track	☐	☐
Civils	☐	☐
Premises	☐	☐
Fire	☐	☐
E&M	☐	☐
Power	☐	☐
Lifts & Escalators	☐	☐
Rolling Stock	☐	☐
Signalling	☐	☐
Communications & IT	☐	☐
Systems Integration	☐	☐
Human Factors	☐	☐
EMC	☐	☐
Station Planning	☐	☐
Operations	☐	☐
Maintenance	☐	☐
Other assets as required	☐	☐

Note: ICT is anything that has both data processing capability and telecommunication capability. **Typically involves systems containing:** Data processing, Data storage and retrieval, Software, Telecommunication, Person-system interfaces, Machine-system interfaces, Environment-system interfaces covering a **huge range of systems, including:** “Classic IT”; Telephony and radio systems; Remote monitoring; Remote control; Semi-autonomous systems; Un-real time systems; Real-time systems; Embedded systems under remote monitoring or supervision

LU only: If your project has an ICT requirement, for clarity, assistance or guidance, please email: ICTAssetStrategyl@tfl.gov.uk

4.2 People Change Impact

Provide a link to the project's **People Change Plan** or, for smaller/less complex projects where agreed by the Sponsor, describe the activities to be undertaken to facilitate successful adoption, commitment to and embedding of change by all affected groups.

This change may include (but is not limited to) aspects such as ways of working, processes and procedures, organisational structures, roles and responsibilities, new equipment/technology, rosters, location, etc. Describe who will lead and enable the change both at a senior level and locally. Include reference to actions which will be taken to communicate and achieve buy-in to the case for change, support people through it and respond to issues arising. Identify interventions to ensure communications and engagement, involvement, training and rewards/incentives for the change as appropriate.

Refer to the **TfL Business Change Framework** tools, as laid out in the **People Change Menu**.

4.3 Risks

Risk Management Strategy/Plan

<This section must be completed for all projects>

Appropriate to the size and complexity of the project a stand alone **Risk Management Strategy** may be produced.

Provide a summary of the project's **Risk Management Strategy**. This defines and communications the approach to the management of risks that could impact the execution and delivery of the work.

Risk Register

Provide a link to the project's **Risk Register** (eg ARM system).

Issue Register

Provide a link to the project's **Issue Register**

Strategy and register must include short to long term risks relating to health, safety, environment and sustainability.

4.4 Verification of Change

Provide a plan of activities that TfL will undertake to verify assurances given by those delivering assets, projects, changes or contracts for service that risks are controlled and requirements are met.**This should specify clearly how changes are managed throughout the lifecycle including the construction phase.**

It covers delivery by Suppliers or TfL itself and covers all activities by all Business Units. It does not apply solely to external suppliers.

If the change is minimal then a separate document is unnecessary and details may be inserted here.

Indicate the type of deliverable and the governance authority or named individual who will be Consulted to undertake verification.

For LU

Provide a link to, or provide details of the **Verfication Activity Plan**.

4.5 Acceptance Schedule – LU Only

For LU

Provide an Acceptance Schedule based on the Quality Management Plan or VAP.

For a project that follows a simple lifecycle (i.e. it goes through each assurance stage once), the following wording and table can be used.

Deliverable	**For checking by project (date)**	**Verification (name and date)**
Feasibility Report (stage 2)		
Concept Documentation (stage 3)		
Compliance Documentation (stage 4)		
Compliance Declaration (stage 4)		
Completion Documentation (stage 5)		
Completion Certificate (stage 5)		
{Add or delete items as required}		

For a project that follows a complex lifecycle that may be divided into multiple sub-stages of deliverables due to geographic work sites, migration phases or the number of assets being changed, the project should produce a deliverables Acceptance Schedule, based on the table above or as appropriate.

An initial version of the Acceptance Schedule shall be attached to this Project Execution Plan as **Appendix B** and a current updated version shall be attached each time this plan is revised. Between updates of this PEP, the Acceptance Schedule shall be kept up-to-date as a standalone document that reflects the current schedule for gaining acceptance of assurance deliverables. The Acceptance Schedule will be used by the Accredited Assurers as a look-ahead tool for planning their workload.

To describe this approach, the paragraph and table above for a simple acceptance plan should be deleted and the following wording added.

The complexity of providing assurance for this project requires that a detailed Acceptance Schedule be provided and kept up-to-date as the project progresses through the project lifecycles. The following outlines the reasons for subdividing the project lifecycle and the requirement for an Acceptance Schedule;

{for example}

- Conceptual or detailed designs based on several options
- Detailed designs for each site
- Specific designs for each asset provided by different suppliers or contractors
- Commissioning of the works in specific geographical areas
- The current version of the Acceptance Schedule, {hyperlinked reference number added here}, at the time of issue of this plan can be found in or referenced from Appendix B.

5 Project Delivery Approach

5.1 Approach Description

Description of the approach being used to deliver the Project – for example, is the solution:

- Being delivered by internal TfL staff?
- Being delivered by hiring in contracted expertise?
- Being purchased as a ready made solution?
- Bespoke?
- Contracted out?
- A modification of a current product?
- Being designed from scratch?

5.2 Approach Reason

Explain why the selected approach is considered optimal.

5.3 Procurement

<This section must be completed for all projects>

Procurement Strategy and Contract Award Recommendation

Provide a link to, or insert details of, the project's **Procurement Strategy** and **Contract Award Recommendation**. Note that where an approved Procurement Strategy / Contract Award Recommendation is required, a separate document must be produced and details must not be included in this PEP. More than one Procurement Strategy / Contract Award Recommendation may be required for the project – so all Procurement Strategies should be referenced here.

Responsible Procurement

Responsible Procurement must be considered for all Projects, see Responsible Procurement Guidance Document for guidance. (Link?)

See Commercial Handbook for further details.

Contract Management Plan

A separate Contract Management Plan is required for Contracts over £5 million in Surface and ICT. For smaller value contracts and in other Business Areas the below template can be utilised, if required.

Contract Name / Title	Summary of Contract	
Key Dates	Type of Contract	Key Personnel
Key Clauses		
Key Performance Indicators (KPI's) and measurement regime		
Performance against KPI's and Contract on a periodic basis		

Supplier Assurance

Where an external Supplier is being used to deliver aspects of the project, outline how assurance will be obtained from the Supplier.

Service	Supplier	Assurance Mechanism
[list all services to be provided]	[to be completed on appointment of service provider]	[eg Assurance Plan to be produced, or assurance to be obtained by another mechanism] [if not required, state "not required"]

5.4 Site Access

Provide details of any required approvals for site access.

For LU

Provide details of, or a link to, the projects **Access Plan**.

5.5 Remote Site Set Up

Provide details of any remote site setup requirements aas defined in the Remote Site Office Setup Guidance.

5.6 Operational Readiness

Provide details of, or a link to, the projects **Operational Readiness Plan**.

5.7 Maintenance Readiness

Provide details of, or a link to, the projects **Maintenance Readiness Plan**.

5.8 Consents Management

Provide details of, or a link to, the projects **Contents Plan** & **Consents Strategy**.

5.9 Health, Safety, Environmental and Sustainability Management

<This section is required for all projects>

Provide details of the overall sustainability objectives of the project.

Provide details of the project's HS&E objectives and targets throughout the lifecycle of the project / programme.

Detail the health, safety and environmental management arrangements for the project with reference to any supporting documents / plans.

State how roles and responsibilities for delivering HS&E requirements will be discharged by the project team if different from the roles and responsibilities as stated in the TfL Pathway Manual and RACI provided for each product.

Include reference to verification activities with regards to site monitoring activities, performance reporting, etc (HSEMS requirements).

Specify how consultation with operatives regarding health and safety matters will be carried out.

5.10 Technical/ Engineering Management

For non LU Business Units

Detail local practices for technical/engineering including management of design changes during the construction phase.

Provide details of, or a link to, the projects **Design Management Plan**.

For LU

Provide details of, or a link to, the projects **Design Management Plan**.

Provide details of, or a link to, the projects **Systems Engineering Management Plan (SEMP)**. The project manager must decide, depending on the size, scale, complexity and risk of the project, whether it is necessary to have the following products or combine the requirements into a single SEMP:

The TfL Corporate Requirements Management Process

Human Factors Integration Plan (HFIP)

Reliability, Availability & Maintainability (RAM) Plan

Interface Management Plan

EMC Control Plan

Verification & Validation Plan

Configuration Management Plan

Provide details of, or a link to, the projects **Engineering Safety Management Plan**

Provide details of, or a link to, the projects **Inspection & Testing Plan**

Provide details of, or link to Production Drawings, Red Line Information & As-Built Drawings, refer to guidance G1353

5.11 Construction Management

Provide details of, or a link to, the projects **Construction Phase and Environmental Management Plan** and/or **Construction Management Plan**

Appendix A (for projects with construction) – CDM duties and responsible person

Referenced from Section 2.2

The information in Appendix A describes who in the project team has the main responsibility for ensuring the listed CDM duties are complied with.

The team carries out its duties by compliance with Pathway and undertaking of risk based verification activities.

Allocation of CDM Duties (**Complete and attach to PEP as Appendix A**)

Appendix B – Acceptance Schedule

Referenced from Section 4.5

TfL Pathway Project Product Matrix

Pathway	Project Lifecycle					
	1	2	3	4	5	6
	Outcome Definition	Feasibility	Concept Design	Detailed Design	Delivery	Project Close
Governance						
● Pathway Product Management Plan (PPMP)	Created	Updated	Updated	Updated	Updated	Updated
● Stage Gate Certificate	Created	Undertaken	Undertaken	Undertaken	Undertaken	Undertaken
Authority Submission	Created	Created	Created	Created	Created	Created
Business Case	Created	Updated	Updated	Updated	Updated	Updated
● Project Close Report						Created
├ Financial Close Report						Created
Lessons Learned	Created	Updated	Updated	Updated	Updated	Updated
● Integrated Assurance and Approvals Plan (IAAP)	Created	Updated	Updated	Updated	Updated	Updated
Sponsorship						
● Project Requirements	Created	Updated	Updated	Updated	Updated	
Project Feasibility Report		Created				
Operational Concept	Created	Updated				
Maintenance Concept	Created	Updated				
Technical Requirements Specification			Created	Updated		
SDR - Scope / Design Review (Buildability)	Undertaken	Undertaken	Undertaken	Undertaken		
Manage the Project						
● Project Execution Plan (PEP)	Created	Updated	Updated	Updated	Updated	
├ Benefits and Value Management Strategy	Created	Updated	Updated	Updated	Updated	Updated
├ Estimate	Created	Updated	Updated	Updated	Updated	Updated
├ Risk Management Strategy	Created	Updated	Updated			
├ Stakeholder Engagement Plan	Created	Updated	Updated	Updated	Updated	
├ ├ External Consultation Strategy	Created	Updated	Updated	Updated	Updated	
├ ├ Communications Plan	Created	Updated	Updated	Updated	Updated	
● Schedule	Created	Updated	Updated	Updated	Updated	Updated
● Risk Register	Created	Updated	Updated	Updated	Updated	Updated
├ Issue Register	Created	Updated	Updated	Updated	Updated	Updated
Change Control Register	Created	Updated	Updated	Updated	Updated	Updated
Integrated Assurance Review (IAR)	Undertaken	Undertaken	Undertaken	Undertaken	Undertaken	Undertaken
● Progress Report	Created	Updated	Updated	Updated	Updated	Updated
People Change						
People Change Plan	Created	Updated	Updated	Updated	Updated	Updated
Manage Construction						
Construction Management Plan (CMP)				Created	Updated	
Commission and Handover						
Project Completion & Handover Certificate / Delivery Into Service (DIS)					Created	
Staged Completion Report					Created	
Operational Readiness Plan			Created	Updated	Updated	
Maintenance Readiness Plan			Created	Updated	Updated	
Asset Hierarchy Change Submission			Created	Updated	Updated	Updated
Snagging/Defects Registers					Created	
Asset Database Change Submission			Created	Updated	Updated	
Asset Database Verification Report			Created	Updated	Updated	
Consents						
Equality Impact Assessment - EqIA	Created	Updated	Updated			
Crime and Disorder Assessment Rationale	Created					
Consents Strategy	Created	Updated	Updated			
Consents Plan	Created	Updated	Updated	Updated	Updated	
Manage Health, Safety & Environment						
Team HSE Competency Assessment		Created	Updated	Updated	Updated	
F10 Notifications		Created	Updated	Updated	Updated	
Health Safety and Environment Pre-Construction Information		Created	Updated	Updated	Updated	

TfL Pathway Project Product Matrix

Construction Phase Plan and Environmental Management Plan				Created	Updated	
Safe System of Work		Created	Updated	Updated	Updated	
Site Emergency Preparedness Plan		Created	Updated	Updated	Updated	
Health & Safety File Information		Created	Updated	Updated	Updated	
Site Noise and Vibration Evaluation and Control			Created	Updated		
Waste Management Plan (WMP)			Created	Updated	Updated	Updated
Carbon and Energy Efficiency Plan		Created	Updated	Updated		
Sustainability Assessment	Created	Updated	Updated	Updated	Updated	Updated
Ecology Check		Created	Updated	Updated		

Engineering

Design Management Plan	Created	Updated	Updated	Updated	Updated	

Commercial

Procurement Strategy		Created	Updated	Updated	Updated	
Tender Process – Pre Qualification Questionnaire and Invitation to Tender (PQQ and ITT)		Created	Updated	Updated	Updated	
Contract Award Recommendation		Created	Updated	Updated	Updated	
Contract Management Plan		Created	Updated	Updated	Updated	

Key:

Products with a red dot are 'core' products which must be produced for every project

Products with this symbol can be produced

Project Requirements (Stages 1-5)

Purpose

To define the scope and objectives of a project; the business and user requirements the project must deliver and the criteria against which delivery will be accepted.

Project Requirements is the central document used to manage all requirements on the project. As such it forms a "contract" between the sponsor and the project manager and the basis against which the project is change controlled.

It is the foundation against which all other project deliverables must be written – including the Business Case, Estimate, Schedule, Benefits Management Strategy and Project Execution Plan (PEP), and must be consistent with the Technical Requirements Specification.

Applicability

This product must be produced for all projects.

Relevant projects in IM which follow Agile Delivery, requirements must be captured in both the IM Agile Delivery Vision Card and IM Agile Delivery Vision Document.

Templates

- Project Requirements (PR) template
- IM Project Requirements (PR) template
- IM Small Works Project Requirements
- IM Agile Delivery Vision Card template
- IM Agile Delivery Vision Document template
- A template is also available for the Requirements Management Plan

Contents

Contents is defined by the template.

Quality criteria

- The supplied template must be used

- The objectives set out in the project Requirements must be consistent with, and linked to, the TFL Business Plan
- Where appropriate, it must demonstrate consideration for multi-modal interchange as per TfL's Interchange Best Practice Guidelines
- It must demonstrate consideration for all stakeholders
- The TfL Corporate Requirements Management Process details an approach to assist the attainment of quality in developing requirements, and also provides further guidance.

Business area specific

Area	Detail
London Underground	If the project is being managed within London Underground the following points also apply. • This product is used to discharge part of the requirements for a Change Assurance Plan under LUL Category 1 Standard 1-538. As a consequence, it is mandatory that **the supplied template be used**. • This document should take account of the Network Asset Work Schedule • Must follow the guidance in the second item of the Capital Programmes Directorate Weekly Bulletin May 2013 • Also for LU projects, consideration should be given to major hazards that could lead to a fatality, as described in the London Underground Quantitative Risk Assessment (LUQRA), and local significant risks as recorded in the line / local Workplace and Customer Risk Assessments
TfL IM	• Must be in compliance with the Quality Criteria Checklist.

Document management

Project Requirements must be filed in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

The comprehensive RACI table used within IM can be found here.

Responsible (Responsible for producing all or part of quality product)	Accountable (Accountable for ensuring timely delivery of quality product)	Consult (Must be consulted when product is being produced)	Inform (A copy of the signed-off product must be sent to)
During Stage 1 Sponsor During Stage 2 Project Manager	Sponsor	Relevant Stakeholders but typically: Sponsor User Representatives Commercial Lead Project Engineer Subject Matter Expert Consents Specialist HSE Adviser People Change Manager	

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for consultation	IPPM
A2	08/04/2013	Issued for use	IPPM
A3	10/07/2013	Amended for IM and link to template and FRS quality checklist	IPPM
A4	11/12/2013	Amended Quality Criteria	TfL PMO
A5	20/10/2014	Updated sections with Agile Delivery reference	TfL PMO / IM

Pathway Information (delete when you use this template)

Template reference	Template file name	Version	Date
F0859	T Project Requirements	A2	31/03/15

PD reference	PD
PD0044	PD Project Requirements

Programme

Project

Document reference

Project Requirements

		Signature	Date
Prepared by	<Name> Sponsor (Stage 1) Project / Programme / Delivery Portfolio Manager (Stage 2)	--	------------------------
Reviewed by	Endorsement statement <Name> Sponsor	--	------------------------
Reviewed by	<Name> User Representative	--	------------------------
Reviewed by	<Name> Commercial Lead	--	------------------------
Reviewed by	<Name> Project / Programme /	--	------------------------

Delivery Portfolio Engineer

Reviewed by <Name>

Subject Matter Expert

Reviewed by <Name>

HSE Adviser

Reviewed by <Name>

People Change Manager

Reviewed by <Name>

Consent Specialist

Approved by I confirm that this deliverable meets the requirements of the relevant Pathway Product Description and that all consultation comments have been addressed to the satisfaction of consultees.

<Name>

Sponsor

Distributed to <Name> <Role>

Document History

Revision	Date	Summary of changes
A1	13/12/12	First draft
A2	**31/03/15**	**Revision to reflect additonal requests from Sponsors, Engineering & HSE**

Table of Contents

DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY

1 Business Objectives

Summarise the reason for undertaking the project.

What is the strategic objective of the project?

This section should explain the overall objectives of this project, this likely to be between 5-10 high level goals.

Identify how this project contributes towards both TfL and Business Unit strategic objectives including:

- effect upon corporate goals and performance indicators,
- quantification of contribution to strategic objectives (as far is possible)
- whole life cost effects
- the reason the status quo cannot continue.
- Asset Management Strategies
- Reference or link to Programme Level Requirements, Business Case Narative or Benefits Management Plan if one exists.

Refer to TfL Investment Plan, third party request, Strategic Assesment Framework

Refer to SAP reference, and copy Business Plan submission, Output, Justification, Outcome, Key Milestones, Forecast cost, Sustainability Assessment, Environmental Impact, Benefit/cost.

2 Project scope

In Stage 1

Provide clear statements of:

- what the project will be changing
- what the project will not be changing - the scope boundary
- any specific areas where the scope is unclear because what will change:will depend on how, when and where the project is delivered
    - needs confirming through a feasibility study or
    - needs confirming through further requirements elicitation

- any specific exclusions from scope that might be significant to stakeholders reviewing the project Requirements.

- That the project will be delivered sustainably

Boundary

Pay specific attention to what the project will change at the project boundaries. For example, if the project is:

- making a change that affects staffing levels then you need to be clear about whether the consequential impact on OPEX is within the project scope.

- is introducing or changing assets that may require consequential changes to other assets.

Where appropriate:

- provide a context diagram to show the high-level interfaces and boundaries (including systems) examples available

- identify changes to or introduction of any operational of business processes, particularly where these impact on the business organisation or people within that organisation.

- Briefly note the purpose in relationship to other documents or requirements activity to help define the scope of coverage and where the reader may need to establish boundaries of interest.

In Stage 2

Update the details provided in Stage 1 to reflect the option selected during the Feasibility Study if one has been carried out.

Interfaces with other projects and organisations

In addition you may split the requirements into two distinct contexts, one that identifies organisational interfaces for the Project and the other identifies the system interfaces:

1. Describe the Project's external interfaces including the relationships to other projects or organisations (responsibility scope)

2. Describe the system's external interfaces including the relationships to other systems, people, the physical environment etc.

Comment on the synergy of this project with other projects, both internal and external to TfL (definite projects, possible projects and outside developments) and analyse the options available for synergy and their effects.

State what effects this project will have on other organisations who work closely with TfL, for example Department for Transport, London Boroughs, any PFI organisations, 3rd Parties etc. Under the sub-heading of each organisation state the effects at each stage.

Provide specific details of what the project will change and will not change. For example, the rule book, specific assets, resource levels, ways of working, systems, organisational structures, new equipment/technology etc.

This definition of Scope must be reflected in the project Estimate and Schedule and be incorporated into the Project Authority Submission / Business Case

3 Outcomes and benefits

Benefits management should start with alignment with Strategic Objectives or Portfolio Strategy to ensure a consistent and contributory approach

Please refer to the Benefits Handbook for further information regarding the principles of Benefits Management within TfL

Detail the outcomes and benefits against which project success will be assessed (provide details of high level benefits – provide link to the project Benefits Management Strategy).

Identify and quantify the criteria which will confirm that the whole project is complete. e.g.achievement of external sustainable building or infrastructure vertification to ‘very good’ or ‘excellent’..

Further information on how to carry out Benefits activities can be found in the Benefits Guidance document

Benefits must be measurable when the project is completed, with interim reviews of the anticipated benefits during the project.

4 Functional Analysis

Functional Analysis mapping can support projects in thinking about a problem objectively and in identifying the scope of the project by showing the logical relationships between functions. The organisation of the functions into a function-logic, mapping diagram enables participants to identify of all the required functions.

The mapping diagram (known as Functional Analysis Systems Technique) can be used to verify if, and illustrate how, a proposed solution achieves the needs of the project, and to identify unnecessary, duplicated or missing functions

Further information on how to carry out Functional Analysis please contact Ben Ganney, PMO Functional lead for Benefits & Value

5 Change impact

In Stage 1

Provide an initial assessment of the potential impact of the project on:

- the health and safety of TfL's customers, staff or other persons affected by our operations. Please contact the project HSE Manager for assistance in compiling the initial assessment for Health, Safety and Environement.
- the environment aspects and impacts as recorded in e.g. EIAs and Environmental Aspects and Impact Assessments
- the operation or maintenance of the asset
- TfL's organisation and staff
- the service provided to TfL's customers, e.g. accessibility
- the security of TfL's network, customers, staff or other person affected by our operations
- the quality of life of TfL's customers or other persons affected by our operations
- revenue
- compliance with standards or TfL policies
- TfL's reputation
- TfL's assets and their resilience

Also for LU projects, consideration should be given to major hazards that could lead to a fatality, as described in the London Underground Quantitative Risk Assessment (LUQRA), and local significant risks as recorded in the line / local Workplace and Customer Risk Assessments

Where the impact of the project depends on the option selected for delivering the project then the comparative impacts of the options must be assessed as part of the Feasibility Study.

In Stage 2

Provide a more detailed assessment of the potential impact of the project against the categories above. Where there are a number of options for delivering the project then the impact assessment must be undertaken for the option selected to be taken through to Concept Design.

Identify any significant controls that need to put in place to manage the impacts of the project. These should include concessions to standards where the constraints on the project make it otherwise impossible to comply with TfL or business unit specific standards.

Where any of the controls give rise to specific project requirements then these must be recorded in the Project Requirements (section 7) below.

Where any of the impacts of the project give rise to risks to the project or business then these must be recorded as risks and escalated, if necessary, as detailed in the Risk Management Module.

For all Railway Projects confirm if the change satisfies the ROGS Schedule 4 two part test (indicated on the results of the Pathway Product Management Plan questionnaire) and is therefore subject to “Written Safety Verification Requirements”.

Where possible, there should be a preference for the specification of products that are included on the Government’s Energy Technology List (ETL) or the Water Technology List (WTL) over those that are not. This is to allow TfL to apply to Her Majesty’s Revenue and Customs (HMRC) for an Enhanced Capital Allowance (ECA).

6 Constraints

Identify any constraints on the project. These might include:

- options to be considered or evaluated
- cost constraints:
  - external funding limits,
  - annual cost ceiling targets – CAPEX and OPEX
- time constraints:
  - earliest start and latest finish targets for the whole project
  - intermediate milestones required by the business
- the requirement to obtain external consents or permissions e.g. land ownership and lease arrangements, where it would be necessary to consult group property
- dependencies on/with other projects or organisations
- technical constraints
- operational/maintenance constraints
- people constraints
- physical constraints (eg buildings, services)
- environmental constraints
- Business unit or external standards standards or TfL policies that it would be impossible for the project to comply with.
- Business unit or external standards or TfL policies, e.g. TfL Environmental Framework, that the project must comply with.External standards, e.g. CEEQUAL, which the project has committed to achieving (as per TfL Environment Framework).

7 Project requirements

This section provides a record of the requirements agreed with the business that the project must satisfy/deliver.

Where the project has a separate Operations Concept and/or Maintenance Concept, then provide a link to the documents.

Requirements must be:

- performance orientated and describe what the project is required to achieve
- realistic, clear and unambiguous
- identified by key stakeholders
- linked to the outcomes and benefits they provide
- verifiable against the previous stage.

Requirement statements must contain the following information:

ID	Requirement Text: Clear, concise and testable description of the requirement.	Source Name: Source of the requirement (stakeholder name, workshop, document etc).	Acceptance Body: Name of the body that will accept that the requirement has been delivered.	Acceptance Criteria: Criteria that will be fulfilled to demonstrate that requirement has been successfully met.	Owner: The person or organisation responsible for delivering the requirement.	Type: Optional usage. Useful to categorise requirements into different types, e.g. safety, functional, performance etc.	Impact on Business: sustainability,health & safety, environment, resilience, operations, maintenance, organisation, people, service, revenue, standards, reputation, assets, etc	Background Information / Rationale: Informative background information / rationale relevant to the requirement	Status: Must have, Nice to have, Under review
PR_001									

Specific clauses from standards must not be included as requirements unless requested by the stakeholder

Where the project affects stakeholders, then they must be consulted in the preparation of the Project Requirements.

Consideration should be given to the appropriateness of sharing all of the contents of the Project Requirements with external stakeholders. As a general rule, only those elements of the Project Requirements that affect the parties need be consulted with these stakeholders.

A list of stakeholders included in the requirements capture process must be provided as Appendix A.

8 Redundant requirements

This section should include any redundant requirements. These are most likely to be those previously captured, considered and agreed as either being a duplicate or no longer required (Status set as 'Withdrawn').

ID	Requirement Text:	Source Name:	Acceptance Body:	Acceptance Criteria:	Owner:	Type:	Impact on Business:	Background Information / Rationale:	Status:
PR_001									Withdrawn

9 Areas for Consideration

This section records further scope, remit or constraints that are presently unclear. This may be related to the way the project will be organised or managed, the technical needs of the end system or other assumptions which have been made to enable the business case to be developed so far.

The intention of this section is not to drive the sponsor to develop assumptions but to provide a space to record assumptions gathered whilst developing the project requirements recorded in section 7.

The table below can be used as a basis for capturing “assumptions, issues or unknowns” (AIU) and a reference to the related requirements that are captured in section 7.

AIU ID	AIU Text	Source	Related Req.ID
AIU_001	The sponsor does not have an expected solution to this requirement	A Sponsor	PR001
AIU_002	The extent of the performance of this function is dependent on available solution options and their cost trade-off.	C Another	PR032

10 Lessons learned from similar projects

Using the Lessons Learned Portal. Search and list similar Projects here and identify useful contacts (if possible)

Describe key lessons learned (good and bad) from these projects which will help the Project Manager, or provide a link to project specific entry on the portal where all the lessons from other projects have been copied across and new ones for this project added.

11 Appendix A – Key stakeholders

For the purpose of this document, key stakeholders are those individuals or groups who provide input into the process of defining project requirements. For further guidance on identifying and recording stakeholders refer to the Corporate Requirements Management Process.

Complete the following table.

Stakeholder	Directorate / Organisation & Job Title	Key Interest

Appropriate to the size, scale, complexity and risk of the project, provide link to

Project Execution Plan and/ or Stakeholder Management Plan.

12 Appendix B – Requirements elicitation process

Provide an overview of the process by which the requirements in this document were developed.

In this section you may confirm that the requirements outlined in this document have been generated through a Requirements Management Plan (where one has been generated).

Include any further relevant additional specific detail or any exceptions here.

For example, further information may now be available or changes in scope that may have occurred since the plan was written.

If a Requirements Management Plan has not been produced, some planning process may now be considered useful, and can be noted here together with brief explanations as to how the requirements are generated and managed.

13 Appendix C – Abbreviations, definitions

Provide a list of terms and abbreviations used in this document and their definitions. Use the format below. Refer to the requirements process glossary, and duplicate here only where absolutely necessary or a different definition is to be adopted. List important project-specific terms and abbreviations where helpful, but refer to existing project or programme glossaries where possible.

The following provides a glossary of terms and abbreviations used and their definitions:

Term	**Definition**	**Source**
e.g. Analysis	*e.g. A detailed examination of the structure and content of something and/ or statement of the results of such an examination.*	*link to a reference e.g. [1]*

14 Appendix D - References (optional)

Provide a list of documents referred to, or used to inform the development of this document in the format below:

[1]. <Reference Title, Reference doc number, Issue/ version number, date of issue, Author (person, company or regulatory body)>

15 Appendix E – Baseline Data

Any initial data which will be affected by this project. For example, an As-Is Analysis or survey i.e. what is the baseline that this project seeks to improve.

Authority Submission (Stages 1-6)

Purpose

To request Project (and/or Procurement) Authority to obtain funding through the commitment or reconciliation of funds; or procurement or allocation of resources. Also, to request changes to or re-authorisation of those funds or resources.

Applicability

This product is required for all authority requests in accordance with TfL Standing Orders and applies to Projects, Programmes and Portfolios (hereafter termed 'Project'). Authority requests may happen at any Stage, or in the case of Procurement Authority, at an interim Stage; and, is irrespective of the Project value. It is recommended that Authority is sought at the same level (Portfolio; Programme; Project) as the Business Case; and in accordance with the funding strategy that is presented by the IAAP.

This product is not required where a project is seeking Stage Authority only, in which case a Stage Gate Certificate is used to gain authority to progress to the next stage. Pathway recommends that in all cases, Submission authors consult with their local Secretariat to confirm the process, particularly where EFC > £2m when the senior Boards are involved.

If you are only submitting for information only (not Authority), you can also use the general Board Template (used for all other agenda items).

Template

Pathway recommends that authors consult their Secretariat to confirm how to develop the template. There is a single cross-TfL template that is based on the requirements and content set by the Secretariat for the senior Authority Bodies; specifically the Finance and Policy Committee (F&PC). The paper should be addressed to the (single and ultimate) Body who will grant the Authority, as presented by the Authority Route diagram; (compliant with Standing Orders). Adherence to the template and its appendices are mandatory. Guidance is provided in the template to accommodate smaller value (EFC<£2m); incorporation of Procurement Authority requests; and or special situations including Authority for IM investments.

A library is being established within the Governance SIG site that includes current examples.

Contents

Refer to the Authority Submission template. The content and any supporting information comprise:

- Pathway Product sign-off sheet – assurance of the Product and process by the Delivery Area leading up to submission to Secretariat (not part of submission package and not required by Secretariat; should be removed on submission). Signature should be consistent with the RACI table given at the end of this document. This sign-off sheet provides Product assurance and the record of those involved in the Product preparation. This should not be confused with Authority Submission approval sheet in the appendix of the Submission.
- Submission Content – as given by the Template, explaining the decision required, project background, proposal and opportunity, financial details, commercial and resource information, milestones and benefits and options considered. Section numbering should be maintained.
- Appendices -
    1. Assurance evidence; including the PMO Assurance, Integrated Assurance Review (IAR) or IIPAG reports (where available)
    2. Management responses to assurance issues (if any and if not in body of content);
    3. Any supplemental and/or supporting information, for example a Part 2 submission (not considered in public forum: seek advice from the Secretariat). Any requested supporting documentation or Pathway Products, such as the Business Case (the default situation is for no additional documentation, unless specifically requested by the Authority Body but this should be confirmed by the Secretariat)
    4. Approval Sign-off Sheet - containing signatures of those who assure, endorse or approve the request (must be consistent with the Authority Routes recommended by Pathway).

Quality criteria

The process is described in the Governance Handbook. Authority requests to be submitted to Programme Boards or Operating Boards will be in line with the timescales established by the Operating Businesses:

- R&U Board timetable
- Surface Board timetable

Authority requests for items to be submitted to the F&PC or TfL Board will be in line with the meetings deadlines set by the TfL Secretariat.

The following criteria reflect the condition of the Submission document as it progresses through its life-cycle:

Pre-submission to Secretariat

The following quality criteria are responsibilities of the Delivery area:

- The funding strategy is in accordance with the strategy set out in the Integrated Assurance and Approvals Plan (IAAP). This will show what Authority and what assurance has been planned. All Authority Submissions must provide evidence of the assurnance activites undertaken.
- All supporting Products should be in place to demonstrate the project management assurance processes specified by Pathway are being followed, including:
    - a valid Stage Gate Certificate confirming completeness of the documentation.
    - In particular, there is an approved Business Case, Schedule, Estimate, PEP and others (these Product may be requested for review as part of the Authority process: note that in the case of a requests for seed funding in Stages 1 or 2, there is not an expectation that these documents be mature but they should have been created).
    - The consultation process, mainly associated with the approval of the Business Case is complete.
- The Authority Submission accurately reflects the core Products.
- All additional assurance activities are complete and management responses provided, including the Integrated Assurance Review (IAR) and IIPAG Review (where done)
- The Product level quality of the Authority Submission, including the use of the correct template; and completeness of the Authority data, values and dates. The signatures on the Pathway signature page are complete, in accordance with the RACI. (This signature page is not required by the Secretariat and should be removed but retained in Delivery files.)
- **(LU CPD only)**: Pre-Authority Submission Approval is required to demonstrate the delivery robustness of the Submission. It can be achieved via the Pre-Authority Submission Template, or agreed in a face to face meeting with the CPD Director. If the template is used, it is not required to be submitted as part of the Authority Submission and, along with the Pathway sign-off sheet, should be removed before the package is submitted to the LU Secretariat.
- The Business Accountant has confirmed (signature on Pathway signature page) the budget status and location/SAP code as appropriate.
- The appropriate Authority approval route is in place and individuals identified are consistent with those names identified on the approval sign-off page of the

Submission template. Where Programme Board Authority has been assumed, the appropriate evidence of their Authority (posted Terms of Reference) and Board meeting arranged.

- The feedback decisions related the Authority granted by formal Programme Boards is posted and made available if requested by the PMO, as evidence of any Authority decision.
- Any style guides (for example for TfL Board papers and TfL Style Guide) have been complied with.

On Submission

Quality criteria responsibilities of the Secretariat:

- The Authority Submission template and Appendices (assurance documents etc) are complete.
- Any additional supporting material or Products have been provided, or the request made to the Delivery area.
- The assumed Authority Route is suitable, including that assumed for any Programme Board Authority.
- The timing of the paper for Submission is in accordance with senior Board time-tables.
- Feedback of Authority decisions are posted via the PMO expediently.

Quality criteria responsibilities of the Authority bodies and individuals

- The approval signature is in accordance with the rules given by Standing Orders or delegated Authority thereof.
- There is sufficient information provided in the Authority Submission and supporting documentation to demonstrate that the planned work is value for money and adequately assured with the evidence provided.

Post Submission (enabling the approved Authority)

Quality criteria responsibilities provided by the PMO Project/Programme Controls Finance Team.

- The Authority approval signatures are complete and the individuals concerned have the correct powers.

- Any delegated Authorities are valid, in particular Programme Boards have been formally established.
- The entry of Authority value into SAP is in accordance with the agreed WBS, described in the PEP or agreed with the Delivery area.

Document Management

Authority Submissions must be filed in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

The RACI table is for the approval of the product, not the approval of the decision: refer to the Authority Route explained in the Governance Handbook for this. The product sign-off sheet can be used to evidence product assurance. It verifies that the Authority Submission is ready to be routed through the Authority Bodies for endorsement and approval. The Sign-Off sheet in the template should be used to evidence decision approval.

Responsible **(Responsible for producing all or part of quality product)**	**Accountable** **(Accountable for ensuring timely delivery of quality product)**	**Consult** **(Must be consulted when product is being produced)**	**Inform** **(A copy of the signed-off product must be sent to)**
Sponsor (in case of Project Authority requests) Commercial Lead (in case of Procurement Authority requests) Operating Business Secretariat (for conversion of papers to F&PC or TfL Board template)	Lead Sponsor (in case of Project Authority requests) Head of Commercial (in case of Procurement Authority)	Delivery Board Rep / Delivery Area Director Business Unit Finance Team – to confirm budget and business case information Finance (Business Accountant) Operating Business Secretariat (scheduling submissions to Operating Boards, ensuring paper quality, providing feedback) TfL Secretariat (scheduling submissions to TfL	PMO Controls - for updating of SAP APPROVED PAS Mailbox

		Board, ensuring paper quality, providing feedback) Opex Impact Reviewer PMO Assurance – to confirm assurance information	

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for use	IPPM
A2	08/04/2013	Issued for use	IPPM
A3	22/10/2013	Substantial change reflecting PPP and Programme Board changes	SJW
A4	24/10/2013	See version control comments in SharePoint for record and all future change record	SJW
A4.1	24/04/2014	Updates reflecting the new universal TfL template	SJW

SUMMARY OF APPROVALS JULY 2014

The table below provides details of delegated authorities per TfL Standing Orders

	Procurement Authority	**Budgeted Project Authority**	**Unbudgeted Project Authority (Financial Authority)**
RUB Member at a Programme Board (see note 1)	£10m(see note 2)	Prefeasibility study funding of £1m or 5% of EFC (whichever is the lower) (see note 2) £5m Project EFC (see note 2) Recommend to MD Finance £10m Project EFC	Nil
Director (being a Direct Report to a Chief officer)	£5m	£1m	Nil
Finance Director and Director of Strategy and Service Development	-	£5m (See note 3)	£2m
Managing Director, Rail and Underground	£25m (See note 4)	£5m	£2m
Managing Director Finance	£25m	£25m	£10m
Commissioner	£100m	£50m	£25m
Finance and Policy Committee	Not applicable	£100m	Not applicable
TfL Board	Unlimited	Unlimited	Unlimited

Notes

1 For Procurement Authority and Delegated Project Authority being awarded at a Programme Board the meeting will need to be quorate as per the Terms of Reference - RUB member, the Finance Representative (in the event that the Finance Director is not a member of the Programme Board), the Commercial Representative (in the event that the Commercial Director is not a member of the programme Board) and the Sponsor.

2 For urgent items requesting Budgeted Project or Procurement Authority which would usually be approved by Programme Boards, Chair's Action, through a RUB Director can be obtained in the event that the Programme Board does not meet provided that the quorum for Programme Boards are in agreement and recommend approval.

3 The Finance Director and the Director of Strategy and Service Development can approve Budgeted Project Authority up to £5m for urgent items.

4 The Rail and Underground Commercial Director and Finance Director have delegated Procurement Authority of £25m and it is at their discretion whether this requires approval at RUB.

GRANTING OF AUTHORITIES

The table below provides details of the approvals that can be granted at RUB and Programme Boards.

Programme Boards	RUB
Project Authority for feasibility studies (seed funding) up to £1m or 5% of EFC (whichever is the lower) provided that the project is budgeted Approve budgeted project authority up to £5m EFC Recommend to MD Finance budgeted project authority from £5m to £10m EFC	Approve items which are considered to be contentious Recommend budgeted project authority in excess of £10m EFC as detailed in the Summary of Approvals table
-	Approve/recommend approval of unbudgeted project authority as detailed in the Summary of Approvals table
Approve Procurement Authority up to £10m	Approve procurement authority between £10m and £25m at the discretion of the R&U Commercial Director Recommend procurement authority in excess of £25m as detailed in the Summary of Approvals table
Risk drawdown – individual items- Approve up to £2m Recommend to Finance Director for individual items in excess of £2m	-
Approve extension of life changes with no cost impact	Approve extension of life changes with cost impact up to £25m except for budget or DfT milestones.
Review Integrated Assurance Reports for items seeking Project Authority at Programme Boards	Review Integrated Assurance Reports and IIPAG reports for all stages except those seeking Project Authority at Programme Boards
Approve milestone changes – except budget or DfT milestones	-

Approved Mike Brown ____________________________ July 2014

Pathway Handbook

Risk Management

Contents

Document Summary

This handbook aims to support TfL staff in successful risk management through a standard process and methodology supported by various product descriptions and templates to affect a consistent, efficient and best practice approach. It describes specific activities that will be undertaken to support effective risk management within a project, programme or delivery portfolio.

The content of this handbook has been based on the best practise in use across the TfL.

Sitting above this document at the Strategic Level is the TfL Risk Policy. Where appropriate this document will align to corporate standard but remain focussed on Programme, Project and Delivery Portfolio risk management.

Risk managers should use or reference this handbook when the preparing their Risk Management Strategies

Applicability and Quality Criteria

This document aims to provide a consistent approach and a clear understanding of how risk management will be carried out and who will be involved. It provides clear guidance for the mandated application of risk management implementation.

It should be noted that this document is intended to be scalable and not all projects and programmes in TfL will therefore be required to use all of this process.

Introduction

This document summarises the guidance and process to assist with managers to understand, evaluate and address all risks surrounding Projects, Programmes and Delivery Portfolios. It is to be used in conjunction with the localised Risk Management Strategies. It is part of a Pathway Handbook and owned by the PMO and Head of Risk. It is meant as a continuous and developing process which underpins TfL's business strategy. Best practise for Risk Management is underpinned by the OGC's MoR (Management of Risk) and ISO31000 (Risk Management Standard)

What is Risk?

In ISO31000 risk is defined as "Effect of uncertainty on objectives"

Where:

An effect is a deviation from the expected — positive and/or negative.

Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process).

Risk is often characterized by reference to potential events and consequences, or a combination of these.

- Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.
- Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood.

What is Risk Management?

The purpose of Risk Management is to ensure that risks and uncertainties as well as opportunities are appropriately identified, assessed and mitigated. Specific activities include:

- Ensuring risks and opportunities are continuously, systematically and proportionally managed in a consistent, effective and efficient way

- Enabling achievement of measurable organisational value
- Foreseeing and managing threats and opportunities so that their impact is optimised
- Providing an objective means of setting financial and time-scale contingencies
- Focusing and structuring the mind of the project team to help assess whether the right prioritisation is being applied to the work of a project driving project planning and management
- Including ‘opportunities’ in the process through analysing ways of maximising advantageous solutions to the benefit of the project.
- Engaging stakeholders and dealing with differing perceptions of risk

Risk Management should take assumptions into account

Benefits of Risk Management

- Driving down the cost of change for our stakeholders by protecting the business from uncertain events
- Reduced waste and lower cost of capital
- Reduced sudden shocks and unwelcome surprised
- Better use of resources across delivery
- Reduced amount of management time spent fire-fighting
- Increased focus on doing things properly

Levels of Risk

TfL faces many different types of risk. A risk can be considered as anything that may affect TfL’s current and future performance and prevent its objectives being met. These include financial, reputational, operational and strategic risks and missed opportunities. Risks need to be identified, evaluated and controlled.

Risk management is carried out at many levels within TfL as shown below:

Directorate

Risks at this level are aggregated from the individual projects and BAU risks and key issues then held in a directorate level risk register in **ARM** (e.g. departments in HR or Group Finance)

Programme

Programme risks are those concerned with transforming business strategy into new ways of working that deliver measurable benefits to the organisation. A number of programme risks will be identified from significant (and escalated) project risks.

Stakeholders with an interest in the programme benefits will be most aware of the programme risks; these stakeholders will include the supporting services/departments within the organisation.

Risks can be considered from three areas:

- **Aggregated risks:** i.e. those escalated from project level that may be duplicated across the programme or require a common mitigation strategy; these risks primarily relate to technical and commercial project level issues

- **Programme Risks:** i.e. those to programme benefits and also risks to the enablers of the programme as a whole which cannot be managed at project level e.g. related to funding cuts or freedom of Information requests

- **External Risks**: i.e. those risks that arise from outside the programme such as environmental risks and those that may interface with the programme e.g. procurement

The identification of opportunities is also encouraged at the programme level. From process, implementation and toolset perspectives, opportunity management shall parallel threat management.

Project

Projects will have risks occurring from a multitude of different events which may either pose a threat to the project or may be classified as an opportunity. Generally, project risks are those concerned with the delivery of defined outputs to an appropriate level of quality within the agreed time, cost and scope constraints.

Risk Categories

Categories are widely used to identify sources of risk, some will be of greater concern at the corporate level and some at the operational level, however there is no clear distinction and all levels of management should be concerned, to varying degrees, with the majority of the categories.ARM has a built in set of categories that can be assigned to each risk.

Annual Review

Each quarter the PMO will review the risk management approach across TfL through lessons learnt to focus on areas that are not working as well as expected. The review will inform the on-going **Risk Improvement Plan** which will be used to plan, monitor and rive the improvements forward.

Risk Management Lifecycle

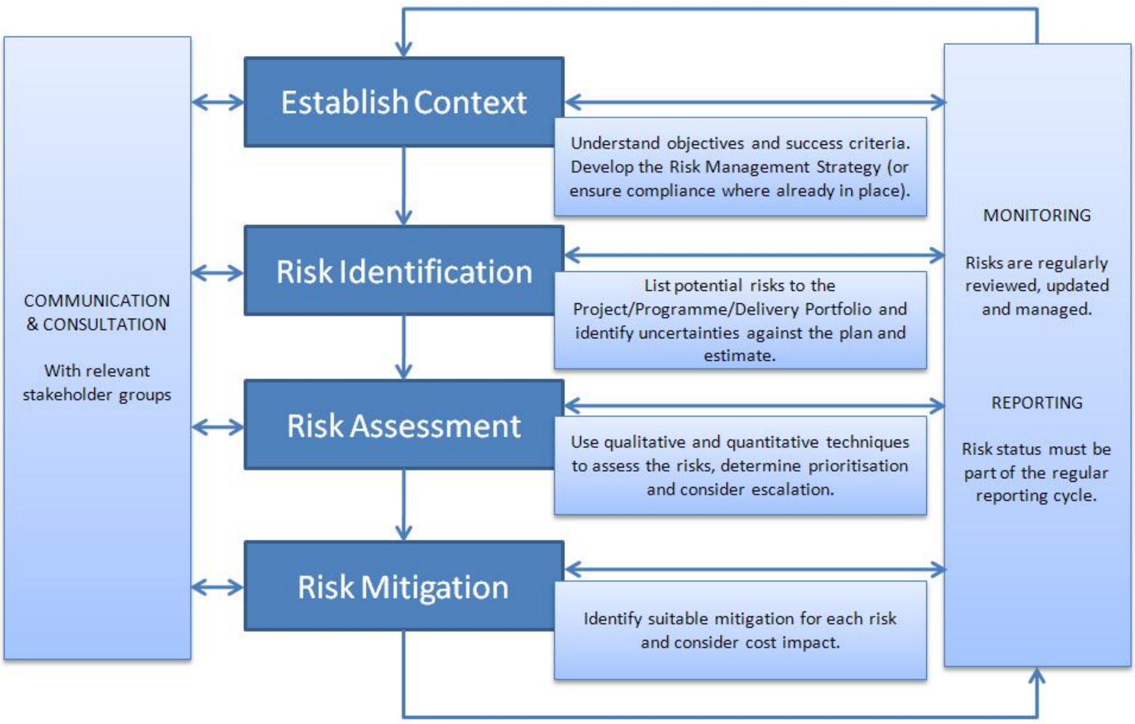


Figure 2: Project Risk Management Lifecycle

The project, programme or delivery portfolio manager must be responsible for the following risk process activities at the beginning, then throughout the project life cycle and record all significant risks in the **ARM** system. “Significant” is determined through a discussion and achieving agreement with relevant specialists and stakeholders. A typical Risk Management Process is shown above.

Risk Management Steps

Establish Project / Programme Project Context

The goal of identify – context is to obtain information about the planned activity and how it fits into the wider organization. Performing techniques such as PESTLE or SWOT analysis can help in positioning the programme / project and inform the Risk

Management Strategy. Other techniques such as Stakeholder Analysis and Horizon Scanning also support this step.

Risk identification

A Risk Manager can assist in risk identification by facilitating structured workshops, one-to-one interviews, documentation reviews, probability impact grids, lessons learnt reviews on similar projects/programmes and other appropriate means of identifying risks and opportunities.

These risks are inputted into **ARM**.

Risk Assessment

The goal of assess–estimate is to prioritise individual risks so that it is clear which risks are most important and most urgent. It is then important to evaluate the risk to understand the risk exposure faced by the activity by looking at the net effect of the identified threats and opportunities on an activity when aggregated together. Quantitative techniques for cost and schedule (QCRA, QSRA) are available to support this step.

The assessment process should be driven using **ARM.**

Risk Mitigation

Active Risk Management is key to successful project/programme delivery. The primary goal of risk mitigation is to deliver those mitigation actions identified to manage the threats and opportunities identified. The goal is to remove or reduce the threats and to maximise the opportunities. Accountability should be clearly defined, with specific, named individuals being responsible for owning and actioning mitigation of those related risks. Clear delivery dates should be committed to, with follow-up and monitoring of performance forming an integral and routine part of the risk process. Finally, senior-level input should focus on challenging the practicality, realism and ambition of mitigation plans; (i.e. ensuring they will actually protect TfL in practice, and not merely restate existing organisational routine).

More peripheral: Attention to this step ensures as far as possible that the business and its staff are not taken by surprise if a risk materialises. Key responses to risk are as follows (Transfer, Terminate, Treat, Tolerate). All relevant risks should be quantified and risk provision included in the project budget. The risk element should be clearly identified in all budget submissions.

Key responses to risk are as follows (Transfer, Terminate, Treat, Tolerate)

Monitoring & Reporting

Risks need to be assessed and re-assessed continuously throughout the project lifecycle. Where mitigating actions are being pursued, the post-mitigation expected value and the cost of the mitigation should be included instead of pre-mitigation expected value. Throughout the project lifecycle, the costs and risks or the current and future stages of the project should be reviewed on a regular basis.

Supporting Pathway Documentation

Products that support the Risk Management available in Pathway are described below.

Document/Product	Purpose
Programme/Project Risk Management Handbook	A high-level description of how TfL handles risk within the Project, Programme and Delivery Portfolio area. This forms the 1st section of this document and is available as a Handbook within Pathway.
Risk Management Process	This describes the key steps taken for Risk Management in Projects, Programmes and Delivery Portfolios. This forms the 2nd section of this document and is available as a handbook within Pathway.
TfL Risk Policy	This is a separate document produced by Finance that describes TfL Corporate Risk management (this document underpinned by ISO3100)
Risk Management Strategy	This document is used to capture supplementary or localised processes for Risk Management. It covers roles responsibilities, timing of risk interventions, the deliverables and tools that will be used and reporting timeframes.
Risk Register (ARM)	Used to capture & maintain info on all identified threats & opportunities relating to activity – see section 1.1
Risk Improvement Plan	Provides a current record of the current 'health' and/or maturity of risk management within the organisation, the targets that have been set, the time period within which it's planned targets will be achieved, and the planned mechanisms/methods that will be used to achieve the desired changes. This maybe written both within the Centre of Excellence and at Directorate,

	Programme / Sub-Programme Level (where required). Examples available in M_o_R
QSRA (Risk Schedule)	Quantitative risk schedule analysis. Technique used to analyse risk and the baseline schedule and assumptions.
Issue Register	Capture & maintain in consistent, structured manner all issues happening now & require action
Lessons Learnt	Process used to drive continual improvement (required for higher levels of risk maturity)
Risk Progress Reports	Periodic reports on risk management and mitigation progress

Risk Mechanisms

ARM

Active Risk Manager (ARM) is the server based Risk Management System used by Transport for London for recording risks. It supports the risk management process at a strategic, programme, project and delivery portfolio level.

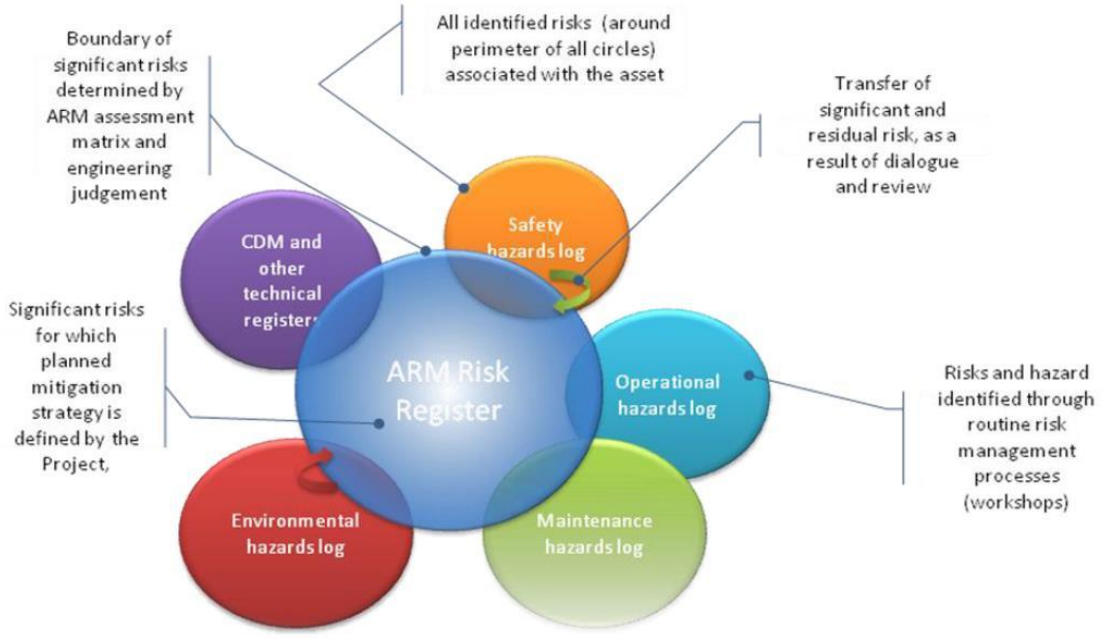


Figure 5: Active Risk Manager (ARM)

ARM provides:

- A single, consolidated repository of all risks and opportunities
- A standardised framework and process

- A predetermined hierarchy where specific risk information must be stored and recorded to mange risks and opportunities effectively, efficiently and systematically.
- An ability to calculate risk & contingency using Monte Carlo analysis
- Calculates the P50 (Risk Provision) and P80-P50 (Contingency) – required by Finance

Other than ARM **no** standalone risk registers should be held for the management of programmes, project and delivery portfolio significant risks.

For guidance and support you can:

- Book onto an ARM training course if you are new to the software
- Use the ARM user guide which contains useful tips on how to use the system seek advice and guidance from the head of project risk or programme risk manager at any stage for consistent messages on risk management.
- Contact your ARM administrator or Key Risk Representative (link to KRR list on Source)

Risk Scoring

ARM scoring is provided by the drop down menus as described in the ARM Guidance Document and is dependent on upon the Project/Programme Value. The scoring scheme is selected at project level (5 available)

The cost / time values are pre-set

		Project (Completion Cost) Value Bands						Time	Prob
Rating	Description	**£1m-£5m**	**£5m-£10m**	**£10m-£25m**	**£25m-£50m**	**£50m-£100m**	**>£100m**		
VH	Significant cost increate to the project	>£200k	>£1m	>£2m	>£5m	>£10m	>£20m	>6 months	>81%
H	Major Cost increase to the project	£100k-£200k	£400k-£1m	£500k-£2m	£1m-£5m	£5m-£10m	£5m-£20m	3-6 months	51-81%
M	Moderate cost increase to the project	£40k-£100k	£100k-£400k	£200k-£500k	£250k-£1m	£1m-£5m	£1m-£5m	1-3 months	26-50%
L	Small increase to project cost	£10k-£40k	£25k-£100k	£150k-£200k	£100k-£250k	£250k-£1m	£250k-£1m	>1 week but < 1 month	6-25%
VL	Negligible increase to	<£10k	<£25k	<£50k	<£100	<£250	<£250k	<1	0-5%

(N)	project cost				k	k		week	

Example table for **Customer** and **Reputation** - specific to London Underground.

Rating	Customer	Reputation
VH	Any one of the following: • Full/part line suspension of more than 1 line for more than 1 day • Full/ part line suspension on 1 line for more than a week • Very high impact on non-time elements of customers journeys e.g. ambience, staff customer service, information – sufficient to cause an impact of 2 points or more to the overall evaluation CSS score at Network level	Risk results in significant ongoing negative media coverage & major loss of confidence/significant intrusion by regulators/stakeholders leading to one of the following outcomes: • Fundamental changes to the RUB operating model/structures • High profile management changes (e.g. Directors) • Fundamental changes to safety procedures
H	Any one of the following: • Full, or part, line suspension for more than 1 line for a whole day • Full, or part, line suspension on 1 line for several days • Highly repeated severe delays (= severe delays occurring more than once over the course of >2 weeks) • High impact on non-time elements of customers journeys e.g. ambience, staff customer service, information – sufficient to cause impact to overall evaluation CSS score at Network level	Risk results in ongoing negative media coverage & loss of confidence/significant intrusion by regulators/stakeholders leading to one of the following outcomes: • Sustained (i.e. one week+) diversion of Directors and senior managers' time, energy & resources away from business as usual activities & planned projects, to deal with feedback • Loss of support leading to removal of key funding • Loss of trust leading to fundamental changes to governance arrangements • Series of strikes impacting operations (i.e. trains cancelled and/or stations closed)
M	Any one of the following: • Full/part line suspension • Depot access • Repeated severe delays (= severe delays occurring more than once over the course of the week) • Very major impact on non-time	Risk results in negative media coverage & loss of confidence/increase intrusion by regulators/stakeholders leading to one of the following outcomes: • Short-term (less than one week) diversion of Directors and senior

Rating	Customer	Reputation
	elements of customers journeys e.g. ambience, staff customer service, information – sufficient to cause impact to: o CSS scores for individual elements at Network level, or o impact overall average SIS or MSS scores at Network level, or o impact overall evaluation CSS score at Line level.	managers' time, energy & resources away from business as usual activities, & planned projects, to deal with feedback • Sustained (i.e. more than one week) diversion of middle managers' time, energy and resources away from business as usual activities & planned projects, to deal with feedback • Limited industrial actions such as a one-off strike or local strikes impacting operations (i.e. trains cancelled and/or stations closed)
L	Any one of the following: • Major delay (one instance of severe delay) • Major station closure – Waterloo, Victoria, Oxford Circus, Kings Cross, Liverpool Street, London Bridge, Bank & Monument, Canary Wharf • Repeated minor delays (= occurring on a daily basis over the course of the week) • Major impact on non-time elements of customers journeys e.g. ambience, staff customer service, information – sufficient to cause impact to: o CSS scores for individual elements at Line level, or o impact overall average SIS or MSS score at Line level, or o impact individual elements of SIS or MSS scores at Network level.	Risk results in short-term negative media coverage or impact on relations with regulators/stakeholders leading to one of the following outcomes: • Significant negative feedback from customers via the Customer Service Centre or from stakeholders via media outlets (Twitter, blog etc) • Short-term (less than one week) diversion of middle managers' time, energy & resources away from business as usual activities & planned projects, to deal with feedback • Unions building a case for action
VL (N)	Minor delay OR non-major station closure OR minor impact on non-time elements of customers journeys e.g. ambience, staff customer service, information – sufficient to cause impact to individual elements of SIS or MSS scores at Line level, or at a	Risk has negligible impact on regulators/stakeholders but does impact customers & employees leading to one of the following outcomes: • Low level of negative feedback from customers via the Customer Service Centre or from stakeholders via media

Rating	Customer	Reputation
	major station - Waterloo, Victoria, Oxford Circus, Kings Cross, Liverpool Street, London Bridge, Bank & Monument, Canary Wharf - but not at Network level.	outlets (Twitter, blog)

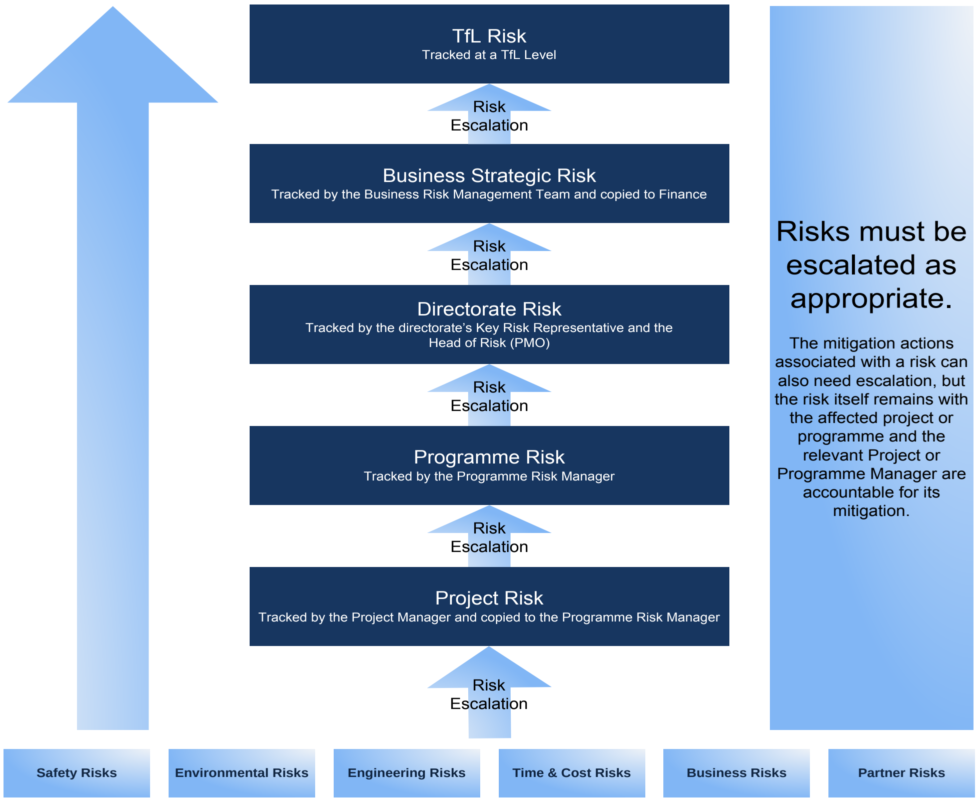
- **Current** This is used to record the current estimate of probability and impacts.
- The Threshold for determining whether an impact is low or high is preset by a system Administrator.
- **Target** When detailing risks, it is always important to note targets expected to achieve when the risk is mitigated. The fields are identical to that in the **Current** Impact section.

Escalation

Escalation can take place at any point in the risk management process. As general guidance, risks must be escalated if:

- Ownership of the actions associated with the mitigation of a risk or the capturing of an opportunity lie in part or in whole outside the boundaries of the relevant organisation (the ownership of such actions must not be considered to be in place until they have been communicated via the escalation process)
- A risk or opportunity is identified which is common to more than one programme or project with a potential impact that justifies a common management approach being taken
- Formal advice regarding the mitigation of a risk or capturing of an opportunity is being sought or if the risk is considered to be of particular concern to a higher management level
- Specific ‘show-stopper’-type risks have a potential of impacting the delivery of project’s or programme’s objectives, or those of another project or programme
- Intervention at a higher management level will result in a ‘quick-win’ for the organisation or business area
- The risk is a strategic risk, or is a direct contributor to a strategic risk impacting the organisation or business area

Typically, the project manager escalates project risk to the programme manager. Programme manager escalates risk to the head of risk for the directorate. Head of risk escalates business strategic risks to the business risk management team and copies finance. Roles can be delegated within this process, please refer to section 3.0.



Risk Provision & Contingency

Risk Provision & Contingency are allowances for unknown events, they are identified as follows:

Risk Provision

Risk provision is calculated from the quantification of the individual risks recorded in the **Project Risk Register**. Where risk mitigation actions have been approved, cost of these should be included in the base estimate and the post-mitigation risk values used to calculate risk provision. For project and programmes, risk provision will be calculated from the data in **ARM**, Monte Carlo analysis will be applied and the **P50** (i.e. the 50% cumulative probability distribution figure) value calculated of the costs in excess of the base estimate. For smaller projects, risk provision can be calculated as the sum of the expected impacts of the individual risks.

Contingency

Contingency is calculated using P80-P50. This is monitored by Finance & Planning teams in the operation businesses (on a quarterly basis, which relies on accurate risk estimates in **ARM.**

Please use the BCDM link to view information on TfL Project Risk Provision and Optimism Bias Standard

Roles and responsibilities

Risk management is the direct responsibility of **all** staff within TfL. The **Risk Management Strategy (RMS)** should set out named individuals who fulfil the roles and responsibilities, as outlined below:

Each Programme/Project Manager is accountable for risk management for their project and programme of work. Responsibility will be delegated to Project Managers/Workstream Managers for specific projects or streams of work.

Each project should have a named risk manager. The risk manager is responsible for producing and maintaining the risk documentation for that project, and for ensuring that the documentation is stored on the TfL **ARM** system. The risk manager does not own risk, nor are they accountable for the level of exposure. The risk manager's job is to carry out tasks and to provide information to assist the Project Manager in bearing the project's risk.

Each risk on the **Risk Register** is allocated a "Risk Owner" who is responsible for co-ordinating and monitoring the implementation of the approved mitigation action plan for control of the risk. The **Risk Management Strategy** could include a list of potential risk owners.

- Each Risk "Owner" will need to have the appropriate level of accountability, and control of the appropriate resources to manage the tasks, and should be selected on their:
- Ability to affect or control the cause of the risk
- Ability to mitigate the consequence of the risk
- Accountability for the impacted project activity/work package(s)
- Actions can be delegated to others, but the owner retains the responsibility for ensuring they are carried out.

The TfL Head of Risk in the PMO provides assurance to the business that acceptable procedures and processes are being followed.

Key Stakeholders should be invited to risk workshops and be given access to the **Risk Register**. Including a list of key stakeholders in the **Risk Management Strategy** can be helpful in ensuring those individuals are included in subsequent risk activities. **The Risk Management Strategy** is an iterative document and should be reviewed and updated regularly.

In construction projects, the **CDM** (Construction, Design and Management) Regulations are a critical part of project activity. The **Risk Management Strategy** should make reference to how the interaction between the **CDM Register** and the **Project Risk Register** will occur.

Head of Risk TfL	To develop and implement the Risk Policy, the Risk Management Strategy and the Risk Management Processes Take the lead in identifying and agreeing an approach to risk that works at group and modal level Provide support and leadership to the business areas on: risk management process; risk models and software tools
Head of Group Insurance	Design and implement insurance policy, philosophy and strategy Provide practical mitigation advice and insurance management to all functions Maintain an overview and awareness of the Group risk profile Manage insurer, broker and other supplier relationships Manage claims using claims handlers and external solicitors as appropriate Provide advice and guidance on liability indemnity and insurance clauses in contracts
Programme Risk Manager (Programme /Project Manager or other delegated person)	Ensures the risk management policy is implemented at a programme level Creates Risk Management Strategy documents at Programme level Ensures the adequate resources are available to implement the Risk Management Strategy Monitors programme level risk reports
Risk Manager (Programme / Project Manager or other delegated person)	Creates Risk Management Strategies at Project Level Facilitates / supports the risk process at a local level Regularly updates ARM throughout the risk process
Risk Analyst	Identifies risks Develops plans to improve the management of risk Undertakes qualitative and quantitative assessments of risk Supports the updates in ARM (Active Risk Manager)

Glossary

Terminology	Description
P50 / P80	The 50 or 80 percentile that the project will achieve success.
ARM	Single repository for risk across TfL
Goals	key outcomes of the process, both threats & opportunities facing the activity
Inputs	describes the info that is transformed by the process
Issue	A relevant event that has happened, was not planned and requires management action. Issues can be problems, benefits, or just situations that have occurred such as a query or change request
KPI	Key Performance Indicator
Monte Carlo	Often used to quantify risks, Monte Carlo methods are a class of computational algorithms that rely on repeated random sampling to compute their results.
Opportunity	An uncertain event that would have a favourable impact on objective or benefits if occurred
Optimism bias	Optimism bias is a bias that causes a person to believe that they are less at risk of experiencing a negative event compared to others.
Outputs	describes the information produced by the process, which will form the inputs to the subsequent process step
Probability trees	Is a analysis tool that uses a tree-like graph or model of different probable outcomes and their possible consequences
QCRA (Quantitative Cost Risk Analysis)	A Quantitative cost risk assessment used to calculate risk allowance for investment or project authority papers
QRA (Quantitative Risk Analysis)	The technique used to produce QCRA and QSRA
QSRA (Quantitative Schedule Risk Analysis)	Used to determine confidence around programme or project delivery
Sensitivity analysis	the study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be apportioned to different sources of uncertainty in its inputs
Techniques	Describes the risk management tools & techniques that may be applied to the process to help create the outputs
Tasks	The actions that need to be completed to transform the inputs into the outputs with the aid of the techniques
Contingency	Money held by each area of the organisation within TfL to fund any reasonable increase in project costs due to uncertain events.
Summary Risk profile	A visualisation of the total risks across a probability / impact graph (sometimes called a heat map)

Board blasting	Relies on the spontaneous generation of ideas that are collected, but importantly, not evaluated at the point of their generation.
Checklist	Repositories of organisational learning. They provide a mechanism to ensure that risks identified on previous similar activities are not overlooked for the current activity.
Prompt list	Stimulate thinking about the sources of risk in the widest context through the provision of risk categories and sources of risk from within the organisation
Cause and effect diagrams	Also known as fishbone diagrams, this technique helps in the understanding of causes or sources of uncertainty that may give risk to risks
Risk exposure trends	Tracking the combined effect of the expected value as it changes across a project
Nominal group	An technique for feeding in ideas anonymously before a group discussion (for example using sticky notes)
Delphi	A technique for eliciting responses from participants anonymously and remotely
Assumption analysis	As part of the QSRA assumptions analysis reviews the existing assumptions in a project that may relate to risk
Constraints analysis	As part of the QSRA, fixed or mandated items are reviewed and the validity tested
Expected value assessment	The process of assessing the expected value which is performed by multiplying the impact and the probability of the risk
Proximity assessment	The process of assessing the proximity of the risk which tells us when it is likely to occur
Impact assessment	The process of assessing the impact of the risk details the effect on objectives
Probability assessment	The process of assessing the impact of the risk measure the likelihood of the risk occurring
Probabilistic risk models	Covers techniques such as Mote Carlo and other software that may support the QRA technique
Cost benefit analysis	The assessment of cost verses benefits. Often used in risk to help with prioritising the response to mitigate a risk
Risk response planning	The process of choosing the best course of action to mitigate a risk
PESTLE	PESTLE (Political, Economic, Sociological, Technological, Legal Environmental) is a set of prompts that help facilitate a wide scan of the context and potential factors that would affect objectives if left unmanaged
SWOT	A SWOT analysis is a technique for focusing on individuals or groups attention on its Strengths, Weaknesses, Opportunities or Threats.
Horizon Scanning	Is the systematic examination of likely future developments that are on the margins of current thinking and planning that may influence risk exposure
Probability Impact	A grid used to position risks. The scales are defined by the

Grid	business or project area and can be driven by risk appetite
Activity analysis	A series of notes detailing key content when reviewing the context of the project
Lessons learned	As an input into the start of the risk lifecycle, lessons learnt from previous projects should be part of the initial identification phase
PMF	Project Management Framework (PMF) - The project lifecycle framework used in London Underground
CIMM	Common Information Management Methodology (CIMM) and Spearmint. The project lifecycle framework used in YourIM
Spearmint	The project lifecycle framework used in Surface Transport

Document History

Version	Date	Changes since previous version
V4	10th Oct 2012	(First Distributed Version)
V5	18th Oct 2012	Including comments / updates from PL, DI, DH
V5.3	29th Oct 2012	Including comments / updates from AB, WB, JB, KR
V5.5	1st Nov 2012	Including comments / updates from TA, AT, PL, CW
V5.6	13th Nov 2012	Including final comments from WB
V5.7	23rd July 2013	Minor updates from BH
V5.8	8th November 2013	Minor link updates from BH

Reference Documents

[1] MoR Management of Risk (OGC)

[2] ISO31000 (Risk Management Standard)

[3] HM Treasury Orange Book: Management of Risk – Principles and Concepts

[4] Addressing risk and uncertainty in the early cost estimates of infrastructure and programmes (supplementary guidance to the Green Book)

[5] TfL Risk Policy, (new version to be added)

[6] Active Risk manager (ARM) reference guide (R0483), A1, December 2014 (ARM is the centralised server based risk repository used across TfL)

[7] BCDM (Business Case Development Manager) including Project Risk Provision and Optimism Bias Standard advise

Transport for London
London Underground Limited

G1237

Guide on Conduct of Design Reviews

MAYOR OF LONDON

Transport for London

Transport for London
London Underground Limited

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Transport for London
London Underground Limited

1 Purpose

The purpose of the Design Review is to ensure that the product of design is fit for purpose, meets all stakeholder requirements and expectations. To ensure that the designs meet Industry and/or LU requirements and that designs satisfy CDM regulations.

2 Scope

This work instruction provides guidance to Project Delivery teams and contains requirements for planning and conducting design reviews and specific details concerning contributions by relevant Discipline Specialists and Project Engineers.

Typically a number of formal and informal reviews are conducted during the duration of a project and are identified in the Guide to Technical Reviews and whilst there are differing types of review, the conduct is essentially common and as such Engineers who are responsible for these reviews should apply the guidance in this note, tailoring as they see appropriate.

3 Objectives

The proper conduct of the review is key to meeting the objectives of ensuring that the technical solution is continuing to meet the following:

- The product meets specified requirements
- The product satisfies the client needs as identified within the Project Requirements
- Required design, manufacturing and installation methods are being implemented
- Components proposed are within their specified parameters
- The design considers the entire system and its interfaces
- The product and its elements can be safely installed, used, maintained, decommissioned and economically disposed
- Compliance with standards
- 3rd Party dependencies have been identified and considered

4 Preparation

The preparation for a review should begin as much in advance of the review as is practicable so as to ensure that there is appropriate representation from key stakeholders. It is the Project Engineers responsibility to ensure that reviews are scheduled and identified in the Project programme.

5 Responsibilities

5.1 Chairperson (PE)

The chairperson is responsible for the following:

- Define the design review objectives
- Ensure sufficient competent personnel are in attendance
- Ensuring LU design team receive sufficient notification of review dates
- Schedule and coordinate design reviews for LU review team

- Ensure adequate review periods
- Prepare, review and approve design reports/outputs
- Expedite action items and recommendations
- Mediate disagreement during reviews
- Actively participate in the design review

The chair person must be competent to conduct and lead the review. The general principle is that the chair should be a qualified Project Engineer under the LU PE Competency Scheme.

5.2 Discipline Engineers (Specialists)

Discipline Engineers are responsible for the following;

- To review in detail all pertinent aspects of the design for compliance within their particular field of knowledge & expertise and standards
- Prepare a suitably detailed design review checklist
- Interrogate the design and direct pertinent questions to the design organisation relevant to the design presented
- Provide input into design report/outputs
- Resolve pre-review issues directly with the design organisation

Discipline Engineers shall review design documentation and provide any comments prior to the design review being undertaken to enable the designer to address the comments and where applicable, incorporate those comments into the design.

Discipline Engineers who have undertaken a design documentation review must attend the review or have made suitable arrangements for a competent person to attend and make representation on their behalf. The representative shall be briefed by the Discipline Engineers with regard to those comments raised.

5.3 Design Review Team

The Project Engineer (PE) shall assemble and coordinate the design review team. He/She should invite all applicable stakeholders; the following provides generic guidance though it may be appropriate to extend (or even shrink) stakeholders for a particular review. It is the decision of the PE as to who should attend their Design Review.

- Project Manager
- Designers (internal and/or external)
- Asset Sponsor
- Affected Discipline Engineers or Professional Heads.
- Maintenance Representative
- Operations Representative
- SQE Adviser
- Construction Management
- System Engineers
- Testing and Commissioning

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6 Description of activities

6.1 Planning and Scheduling

The Project Engineer shall liaise with the design organisation to schedule, plan and confirm the timing of reviews and the required number and type of reviews. The PE will confirm to the design organisation what is required from the design organisation in order to complete a successful review i.e. Drawings, design calculations, design check certificates etc.

The PE will ensure that all relevant design documentation is provided to the nominated review attendees within a sufficient timeframe (normally 10 days), prior to the design review, in order that the attendees are suitably prepared for the review.

Note; timeframes can vary depending on size and complexity of the project.

6.2 Design Review Implementation

A notification and Design documentation will be distributed by the Chairperson to the design review team at least 10 days prior to the review. The notification and design documentation shall state:

- Participants and discipline attendees
- Project or part of project (e.g. electrical package) to be reviewed
- Type and expected duration of the review (e.g. intermediate, final etc)
- Design documents and input data to be reviewed (including open actions or issues from previous design review if applicable)
- Review timescales

The PE shall ensure that all key individuals are present or suitably represented at the design review.

6.3 Guidance for Conducting Design Review

6.3.1 General Guidance

- Questions should be objective and within the confines of the questioners knowledge base
- Questions should be asked within the constraints of what the design (Scope/Brief) considered not what it didn't consider
- Questions that stray away from the design organisations responsibilities should not be asked
- Open ended questions should not be asked

6.3.2 Introductory comments

The Chairperson will address the review team prior to the review to set the scope, tone and climate of the review (this can be done 5 minutes prior to arranged review time)

6.4 Analysis

The Chairperson shall ensure that;

- A systematic and structured approach during the course of the review will be undertaken by the review team
- Complex questions that take time and effort above what is normally expected should be submitted to the design organisation in advance to enable them to prepare and respond

- Questions should only be tabled if they request additional information or inquire as to the reason for a particular design decision being taken
- Derogatory remarks or responses are not made
- A decision to proceed or not proceed will be taken at the review

6.5 Comments and action items

Comments or actions/recommendations shall be recorded by the reviewer identifying the action/comment with the name of the person assigned with addressing the action/comment with timescales and corrective actions agreed. Copies of the action/comment shall be kept by both parties. (See appendices)

6.6 Minutes

Minutes shall be taken by the Chairperson (or their nominated representative) that will record relevant questions and answers, actions/comments and recommendations in sufficient detail to allow the preparation of a report in the required detail (where applicable)

Additionally minutes shall record

- Summary of findings
- Details of the design review
- Reference to distributed design documentation
- Status of recorded actions or issues from previous reviews
- List of reference documents (where applicable)
- Acceptance/No objection / Compliance Declaration status

6.7 Editorials

Typographical errors or minor editorial matters relating to input data should not be discussed at the design review.

6.8 Documentation

Project review team shall minute the design review activities to:

- Provide a means for follow up of actions and proposed resolutions
- Create a record of the development history of the design/product
- Verify that client requirements have been appropriately addressed

Documentation will consist of:

- Minutes
- Discipline review sheets
- Declaration of Compliance or Acceptance/Letter of No Objection

All documentation shall be kept within the appropriate project file/data base

6.9 Initial Document review

Prior to the formal design review, the design organisation shall, on request of the Chairperson (normally the PE), provide relevant design documentation to the discipline specialists for review purposes.

The review participants shall read the supplied material, mark it up with comments and complete the comments sheets. Comments and issues made by the reviewers should be forwarded to the designer and chairperson as early as possible to enable the designer to incorporate/amend the design as applicable in readiness for the formal design review.

This documentation shall also be the basis for initial inquiries to enable the designer to present an updated design at the formal design review.

6.10 Completion

The design review is deemed complete only when all outstanding actions and recommendations are resolved to the satisfaction of the review team.

6.11 Assuring Designs at a Design Review

Depending upon the Projects agreed acceptance/assurance plan(s), it may be appropriate to have the design review as the vehicle to ‘assure’ a design where assembled Discipline Engineers are the accredited signatories of that review. A signed declaration of “no objection” to that design shall demonstrate that the design is “Assured”. Where the Discipline Engineers are reviewing the Design on behalf of the Professional Heads, their signatures shall only be deemed as a precursor to allow the next level of assurance to be enabled. In this instance, only when the appropriate approvals have been obtained will the design be deemed “Assured”.

Site Obstructions/Utility Relocation Plan (Stages 1-5)

Purpose

To identify all utilities in the vicinity of the work area, specify how work will be carried out avoiding known utilities and define a strategy for dealing with unknown utilities if they are discovered. This includes utilities on TfL-owned sites.

Applicability

This product must be produced for all railway projects that involve construction works that include intrusive site works and where it may be reasonable to expect that there are obstructions/services/utilities in the vicinity of the work, including on TfL-owned sites.

Template

- Site Obstructions/Utility Relocation Plan Template

Contents

- Contents is defined by the template

Quality criteria

Must conform to LU Category 1 Standard 1-021 Works Near Mains Services and Structures

- The Site Obstructions/Utility Relocation Plan can be a separate plan or included within the Programme or Project Execution Plan (PEP) depending on the extent of the works and the size of the project
- Previously unidentified utilities that are found on site during the work must be added into the plan as they are discovered
- A survey of the site must be carried out
- Feasibility Phase: must include a completed checklist identifying project constraints
- Development Phase: need an Assessment template to bridge gap between checklist in Feasibility Phase and the P3e (LUPD/MPD) schedule
- Must include an LUPD/MPD schedule with constraint related activities planned and costs identified

Site Obstructions/Utility Relocation Plan (Stages 1-5)

Number: PD-10644
Issue no: A5
Issue date: 30/11/13

- Must contain copies of variation request(s) raised with PFI contracts team where Power or Connect utilities require diversion

Document management

Site Obstructions / Utility Relocation Plans must be filed in accordance the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

Responsible (Responsible for producing all or part of quality product)	Accountable (Accountable for ensuring timely delivery of quality product)	Consult (Must be consulted when product is being produced)	Inform (A copy of the signed-off product must be sent to)
Project Engineer *	Project Manager		SQE Adviser

* The people fulfilling these roles must be accredited to do so for this project in line with the Engineering Accreditation Matrices. The need for accreditation only relates to final approval of the product, not the preparation

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact EMO@tfl.gov.uk

Document history

Revision	Date	Reason for change	Author
A5	30/11/2013	Issued for use	EMO

(Refer to CMS Team for details of earlier changes)

Pathway Information (delete when you use this template)

Template reference	Template file name	Version	Date
F-10683	F-10863	A2	19/08/2014

PD reference	PD
PD-10644	Site Obstructions / Utility and Services Relocation Plan

Programme

Project

Document reference

Site Obstructions / Utility and Services Relocation Plan

Additional signatures may be added to reflect the size, scale, complexity and risk of the programme or project. However, Lead Project Engineer or equivalent approval must be sought when adding signatures.

Signature Date

Prepared by I confirm that professional skill and care has been used in the preparation of this deliverable and it meets the project requirements. I also confirm that this deliverable has been checked for accuracy and compliance by competent person(s) employing check process(es) commensurate with the level(s) of risk inherent to the assets and works.

<Name>

<Role>

--- -------------------------------------

Approved by I approve this deliverable as the designated co-ordinating authority for these works and am accredited to do so. I also confirm that approval from the other affected discipline technical authorities has been completed.

<Name>

<Role>

--- -------------------------------------

Accepted by

I accept this deliverable as the person accountable for its delivery and believe to the best of my knowledge that the above entities have undertaken and fulfilled their legal obligations as required with regard to this product.

<Name>

<Role>

-- -----------------------------------

Distributed to <Name> <Role>

Consulted

Add and/ or Delete to reflect the size, scale, complexity and risk of the programme or project. Where appropriate provide a link to any other relevant programme or project documentation e.g. PEP.

Name	Position
	SQE Adviser

Document History

Revision	Date	Summary of changes
xx.yy	xx/xx/xx	First draft

Table of Contents

DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY

1 Known Utilities and Services

Register of known Utilities and Services in the area

2 Effect on Utilities and Services

Description of how the work will be conducted to minimise effect on Utilities and Services

3 Type and location of Utilities and Services

A diagram detailing the type and location of Utilities and Services

4 Strategy for unknown Utilities and Services

The strategy of how the discovery of unknown Utilities and Services will be handled

Project Completion and Handover Certificate/Delivery Into Service (DIS) (Stage 5)

Purpose

To certify that the assets delivered are:

- Complete and fully meet the requirements of the project
- Assured as fit for service
- Compliant with necessary standards and regulatory requirements
- Ready to be accepted into operational service and delivered to maintenance
- To certify that the Health and Safety and 'As Built' information and Maintenance and Operational Readiness Plan deliverables have been achieved
- The documentation provided has been reviewed and approved and is sufficient to operate and maintain the assets
- Where applicable, that Asset Data has been provided, verified and loaded into the appropriate database (Ellipse, NAMS, BridgeStation, Maximo, SAP AMIS)
- Operational and maintenance arrangements have been applied to enable the management of the assets.

Applicability

This product must be produced for all projects that introduce, modify or remove assets or alter existing assets.

Templates

London Underground:

- LU Project Completion and Handover Certificate
- LU Snagging Completion Certificate

DLR:

- Handover/Handback Strategy
- Handover Checklist

Other business units:

- Project Completion and Handover Certificate
- Snagging Completion Certificate

Contents

Content is defined by the template.

Quality criteria

- The snagging completion certificate must be appended to the Project Completion and Handover Certificate/Delivery Into Service (DIS)
    - If snagging has not been completed, the latest version of the Snagging Register and a plan for closing out the snags must be appended to the Project Completion and Handover Certificate / Delivery Into Service (DIS). This plan must include details of the roles and responsibilities for addressing any outstanding issues.

Document management

Project Completion and Handover Certificate/Delivery Into Service (DIS)s must be filed in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

Responsible (Responsible for producing all or part of quality product)	**Accountable** (Accountable for ensuring timely delivery of quality product)	**Consult** (Must be consulted when product is being produced)	**Inform** (A copy of the signed-off product must be sent to)
Project Engineer	Project Manager	Subject Matter Expert User Representative Maintenance Representative LU Operations Representative (LU) Stakeholders	

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for consultation	IPPM
A2	08/04/2013	Issued for use	IPPM

<Programme>
<Project> <UIP Code>
<Document Reference>

Project Completion and Handover Certificate

Part 1. Project Manager Approval:

Statement(s) of Compliance (tick as appropriate):

☐ I certify that the Assets(s) described below is/are complete, and fully meet the requirements of the Authorised Project.

OR

☐ I certify that the Assets(s) described below is/are complete, and fully meet the requirements of the Authorised Project, with the exception of the items listed on the attached Snagging Register. The remaining snags will be rectified against the attached Snagging programme.

AND

☐ I also certify that the documentation provided in the Mandatory Asset Information Deliverables (MAID) and Asset Performance Readiness Plan is fully populated with all required information deliverables, including ADMF data and that all the deliverables have been reviewed and approved and are sufficient to maintain the assets.

Asset Checklist (please tick all asset types delivered by this project)

☐ Automatic Fare Collection	☐ Bridges & Structures	☐ C&I	☐ Communications
☐ Deep Tube Tunnel	☐ Depot & Plant	☐ Drainage	☐ Earth Structures
☐ Electrical	☐ Fencing & Environment	☐ Fire	☐ Lifts & Escalators
☐ Mechanical	☐ Power	☐ Premises	☐ Pumps
☐ Track	☐ Signals		

Name: ....Signed: ....Date: ....

Part 2. Project Engineer Approval:
Statement(s) of Compliance: ☐ I confirm that the Asset(s) is / are compliant with the necessary standards, regulatory requirements and LU procedures and is / are assured as fit for service. **OR** ☐ I confirm that the Assets(s) meet full operational requirements, with the exception of the items listed on the attached Snagging Register. **AND** ☐ I also certify that the Mandatory Asset Information Deliverables (MAID) is fully populated with all required information deliverables, including ADMF data, and that all the deliverables have been approved as appropriate.
Name: ....Signed: ....Date: ....

Part 3. Operations Representative:
Statement(s) of Compliance: ☐ I confirm that the Assets(s) meet full operational requirements and testing and commissioning of the asset(s) was witnessed by an Operational Representative. **OR** ☐ I confirm that the Assets(s) meet full operational requirements, with the exception of the items listed on the attached Snagging Register. **AND** ☐ I also certify that I have received operational documentation as specified in the operations contract for the works.
Name: ....Signed: ....Date: ....

Part 4. APD Acceptance: (ONLY COMPLETE THIS SECTION FOR PROJECTS WHERE LU, OR A THIRD PARTY UNDER CONTRACT TO LU, ARE TO MAINTAIN THE ASSET(S). (To be completed by APD Representative)

Statement(s) of Compliance:

☐ I confirm that the Assets(s) meet full operational requirements, have been checked on site and I will make all necessary maintenance provisions.

OR

☐ I confirm that the Assets(s) meet full operational requirements, with the exception of the items listed on the attached Snagging Register. I also confirm that the asset(s) have been checked on site and I will make all necessary maintenance provisions.

OR

☐ I confirm that the Assets(s) meet full operational requirements and testing and commissioning of the asset(s) was witnessed by a technically competent LU representative. I will make all necessary maintenance provisions.

OR

☐ I confirm that the Assets(s) meet full operational requirements, with the exception of the items listed on the attached Snagging Register. I also confirm that testing and commissioning of the asset(s) was witnessed by a technically competent LUL representative. I will make all necessary maintenance provisions.

AND

☐ I also certify that the documentation provided in the MAID deliverables has been reviewed and approved and is sufficient to maintain the assets.

AND

☐ I also certify that the Ellipse Asset Data has been provided, verified and loaded into Ellipse and the appropriate maintenance arrangements have been applied to enable the management of the assets using Ellipse.

AND

☐ All necessary training has been provided to adequately maintain the asset.

Name: ....Signed: ....Date: ....

Part 5. Principal Engineer Endorsement:
I endorse this deliverable as the designated technical authority for these works and am accredited to do so. I also confirm that approval from the other affected discipline technical authorities has been completed.
Name: ....Signed: ....Date: ....

Follow Using Word Styles for Formatting on how to format this template

<Programme>

<Project> <UIP Code>

<Document Reference>

Snagging Completion Certificate

Works Completion Statement		
I confirm that all snags on the attached Snagging Register have been rectified		
Project Manager		
Name:	Signed:	Date::
Works Completion Statement		
I confirm that all snags on the attached Snagging Register have been rectified to correct and current standards		
Project Engineer		
Name:	Signed:	Date:
Works Completion Statement		
I confirm that all snags on the attached Snagging Register have been rectified and I will make all necessary maintenance provisions		
Asset Performance Representative		
Name:	Signed:	Date:
Works Completion Statement		
I confirm that all snags on the attached Snagging Register have been rectified and meet all operational requirements		
Operations Representative		
Name:	Signed:	Date:

Minimum Distribution	LUL (Operator); Asset Performance (Maintainer); Engineering and Safety (Engineering Information) ADMF Team (Ellipse Catalogue); MAID

<Programme>

<Project> <UIP Code>

<Document Reference>

Operational Readiness Plan

		Signature	Date
Prepared by	<Name> Operational Representative	--	-----------------------------------
Approved by	<Name> Operations Upgrade Manager (or equivalent)	--	-----------------------
Agreed by	I confirm that this deliverable meets the requirements of the relevant Pathway Product Description and that all consultation comments have been addressed to the satisfaction of consultees. <Name> Project Manager	--	-----------------------------------

Document History

Revision	Date	Summary of changes
<xx.yy>	dd/mm/yyyy	First draft

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1 Introduction & Background

This document forms the Operational Task Manager's (OTM) Operational Readiness Plan which will be tracked as part of the **PROGRAMME NAME** programme and will link in with the COO Network plan, as well as Line Delivery Plans. The sections that follow indicate the workstreams that the OTM needs to consider to effectively support the delivery of the **PROJECT NAME** project team in delivering a successful project on time and within scope.

Give a short introduction to your project here, as well as delivery timescales.

DO NOT repeat or summarise the project's scope and objectives in this document. (Provide link to Programme or Project Requirements and/ or any other relevant project documentation)

1.1 Operational Readiness Planning Assumptions

Agreed with the consultees detailed in Section 2.1

- The Project Manager is accountable for delivering key documentation, as defined within the Pathway and in Project Management meetings, to the Operational Task Manager (OTM) in a timely manner.
- These key documents will be described & tracked in the **PROJECT NAME** Project Plan, which is updated and reviewed monthly in the [insert appropriate forum].
- These deliverables may also be tracked within the usual review meetings between the Project Manager and the key stakeholders (COO, APD, etc.)
- Key documents / deliverables may form PMMs within the project plan, as well as the Operational Readiness Plan.
- In order for the OTM to deliver their operational readiness plan, the Project manager must inform the OTM of all the products that are being delivered in the scope of this project at the start of the project, and keep the OTM informed of any changes to scope that occurs.
- Key risks are managed in a timely fashion to ensure that PMMs and milestones are not missed.

2 Enabling Works & Project Deliverables

List the key deliverables or provide link to relevant document.

2.1 Consultation

Amend to suit the relevant project. Where appropriate provide link to Stakeholder Management & Communications Plan and/ or any other relevant project documentation.

CONSULTATION		
Name	**Discipline**	**Department**
	Sponsor	S&CD
	LGM	COO
	Area Manager	COO
	Project Manager	CPD
	Project Engineer	CPD
	Asset Performance Representative	APD
	SQE Advisor	HS&E

3 Outcome Definition – Stage 1

- ❑ **Activity A1** - Identify with Sponsor and/or Project Manager if an Operational Concept is required
- ❑ **Activity A1** - if required by A1 above, create Operational Concept

3.1 Activity Plan in Stage 1

Activity Ref	OTM Activity	Due Date	Complete

4 Feasibility – Stage 2

- ❑ **Activity A1** **- Review Operational Concept**

4.1 Activity Plan in Stage 2

Activity Ref	OTM Activity	Due Date	Complete

5 Concept Design – Stage 3

This stage will have high level impact assessments on the following if applicable

- ❑ **Activity A 2** - Develop and agree Operational User Requirements Specification **and/or**
- ❑ **Activity A 3** - Review and categorise works
- ❑ **Activity A 3** - Identify requirements for new or altered operating rules
- ❑ **Activity A 4** - Stakeholder Management and Communications
- ❑ **Activity A 5** - People Deployment review
- ❑ **Activity A 6** - Trade Union consultation
- ❑ **Activity A 7** - Programme milestones (Enablers and Dependencies)

5.1 Activity Plan in stage 3

Activity Ref	OTM Activity	Due Date	Complete

6 Detailed Design – Stage 4

This stage will include

- ❑ **Activity B 1** - User Requirements Specification
- ❑ **Activity B 2** - Operational User Acceptance Criteria
- ❑ **Activity B 3** - New or Altered Operating Rules
- ❑ **Activity B 3** - Operational learning interventions
- ❑ **Activity B 4** - People Deployment
- ❑ **Activity B 5** - Trade Union consultation
- ❑ **Activity B 7** - Ongoing Stakeholder Management and Communications
- ❑ **Activity B 8** - Operational Migration Strategy

6.1 Activity details in stage 4

Activity Ref	OTM Activity	Due Date	Complete

7 Delivery– Stage 5

This stage will include

- ❑ **Activity C 1** - User Requirements Specification
- ❑ **Activity C 2** - Operational User Acceptance Criteria
- ❑ **Activity C 3** - New or Altered Operating Rules
- ❑ **Activity C 4** - Operational learning interventions
- ❑ **Activity C 5** - People Deployment
- ❑ **Activity C 6** - Trade Union consultation
- ❑ **Activity C 7** - Ongoing Stakeholder Management and Communications
- ❑ **Activity C 8** - Operational Migration Strategy
- ❑ **Activity C 9** - Update Operational Concept

7.1 Activity details in stage 5

Activity Ref	OTM Activity	Due Date	Complete

Appendix A - Critical Actions

Critical Actions for Handover					
Item	**Action**	**Start**	**Finish**	**Owner**	**Status**

<Programme>

<Project> <UIP Code>

<Document Reference>

Asset Performance Readiness Plan

		Signature	Date
Prepared by	<Name> Asset Performance Development Team Representative	--	------------------------------------
Checked by	I endorse this deliverable as the designated technical authority for the relevant engineering discipline and am accredited to do so. <Name> Project Engineer	--	------------------------------------
Approved by	I confirm that this deliverable meets the requirements of the relevant PMF Product Description and that all consultation comments have been addressed to the satisfaction of consultees. <Name> Project Manager	--	------------------------------------
Distributed to	<Name>	Sponsor	

Document History

Revision	Date	Summary of changes
<xx.yy>	14/12/66	First draft

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LIST OF ABBREVIATIONS

ADC.............................Asset Data Custodian

APD.............................Asset Performance Directorate

APDT...........................Asset Performance Development Team

COO............................Chief Operating Officer

CPD.............................Capital Programmes Directorate

LUL..............................London Underground Limited

MAID............................Mandatory Asset Information Deliverables

NOWRI.........................Notification of Works Requiring Inspection

PAS55..........................Publicly Available Specification

PEP..............................Project Execution Plan

PMF..............................Project Management Framework

RAMS...........................Reliability Availability Maintainability Safety

SSR..............................Sub Surface Railway

SUP..............................SSR Upgrade Programme

1 Purpose of the Readiness Plan

To plan the actions required, throughout the project lifecycle and the ongoing total life management of the system/asset. To enable new or modified assets to be handed over to Asset Performance Directorate (APD) and their ongoing maintenance, including:

- Understanding the impact that the project will have upon the maintenance of the railway
- Planning and preparing for any changes that will be required
- Preparing for the maintenance of new/modified assets.

The <Project Name> Asset Performance Development Team (APDT) representative, Asset Performance Directorate (APD) and the Project Team will collaboratively develop this Readiness document as required through the Project Management Framework and Gate Management Plan.

2 Costs and Finances

2.1 Whole life cost estimates

In this section, the Asset Performance Development Team (APDT) representative should communicate with the Project Sponsor in order to obtain the original whole life cost model. This must also include any APD related whole life cost estimates.

2.2 APD project costs

This section needs to be updated with the APD project estimate and should include any additional costs related to the introduction of the project, such as:

a) One-off costs through introduction of the asset

b) Additional unbudgeted ongoing period costs.

3 Organisation, Structure and Resources

State the impact of the project on the APD organisational structure following introduction. Also state how changes and risks will be managed in order to achieve the planned change.

Review the APD organisation to ensure that it meets its commitments efficiently, provides effective management and delivery. This may include better use of intelligence, predictive and preventative maintenance, maintenance optimisation, material warehousing and manufacturing management.

3.1 Staff competency

Staff that may work on new or novel equipment shall prove their competence through an accredited training/licensing scheme.

3.2 Training

In this section, the APDT representative needs to define the training requirements based on the assets installed in the project.

If the project is part of the SUP programme, the APDT representative will have to seek advice from the Operational Training Requirements and Delivery Guidelines document. This document details the SUP standard approach that should be adopted by the project to ensure handover to the operating railway with the necessary trained and competent staff in place.

3.2.1 Training needs analysis

The training needs will be defined by the APDT representative in consultation with the Project Team and the Asset Performance Directorate (APD).

3.2.2 Training specification

The training specification will be defined by the APDT representative in consultation with the Project Team and the Asset Performance Directorate (APD).

3.2.3 Delivery of training

Before any new systems, assets and/or interfaces are introduced to the railway, it is a requirement that suitable and appropriate training must be provided by the Supplier.

The Supplier may deliver training in one of the following ways:

- Direct to LUL trainers (referred to as 'Train the Trainer'), as a result of which the ongoing APD/COO training requirement will be undertaken by the LUL trainers.
- Suppliers to train LUL APD & COO staff directly.

APD must confirm the number of staff requiring training and their availability. CPD should be consulted regarding alignment of projects and any concurrent training requirements for the same APD team to ensure appropriate availability of staff.

3.3 Facilities

The APDT representative must confirm the requirement and availability of facilities for staff welfare with CPD and summarise it in this paragraph. LUL standards relating to facilities for staff welfare will also have to be taken into account whilst outlining the aforementioned requirements.

4 Maintenance support

The APDT representative shall confirm all asset warrantees with the Project Team and/or interim maintenance support agreements with suppliers.

4.1 Spares / Logistics

The APDT representative shall define the stock holding for spares to be provided by the project and minimum stock levels in consultation with COO and CPD.

4.2 Tools & Equipment

The APDT representative must verify and state the supplier of specialised tools and test equipment. Following communication with APD, confirmation is also necessary for the appropriate levels of maintenance and requirement of periodic calibration. Where calibration is required, a risk analysis must be undertaken to determine if tracking of the tools/equipment is required to meet company standards in line with PAS55.

4.3 Facilities

The APDT representative shall confirm the requirement and availability of facilities for tools/equipment with CPD and summarise it in this paragraph. LUL standards relating to facilities for tools/equipment will also have to be taken into account whilst outlining the aforementioned requirements.

4.4 Maintenance management (Ellipse)

In Stage 3 (Concept Design) the APDT representative must contact the Asset Data Custodian (ADC) to confirm asset type and commence, as appropriate, registration of new assets. This information needs to be updated in Stage 4 (Detailed Design) and Stage 5 (Delivery) respectively.

The Project Team is required to provide asset data with appropriate maintenance frequencies. This will be in a format specified by APD, on a date to be agreed, in order to enter the data into Ellipse prior to asset handover.

The PMF products required for this task are outlined below:

- Asset Hierarchy Change Submission
- Asset Register Change Submission
- Asset Register Verification Report

4.5 Work Instruction Management

New Work Instructions are required for any new assets. Where assets are altered by the Project, existing Work Instructions will need to be amended appropriately. The Work Instructions should:

- have content appropriate to the purpose
- use the LU format
- be processed for inclusion in the Management System in line with the Document Change Control section of the Managers Handbook for Change control.

For new assets CPD will be responsible, with support from APD, for Work Instructions being available at handover. For existing assets APD, with support from CPD, will review and amend existing Work Instructions.

4.6 Contract management

The APDT representative must verify and state the contract management requirements following consultation with CPD and Commercial Procurement. This information shall be updated as the project progresses through Stages 4 (Detailed Design) and 5 (Delivery).

5 Whole life management

Whole Life Management will be outlined as per the activities included by the Sponsor, in the whole life cost analysis.

The APDT representative shall include herein, a high-level assessment during Stage 3 (Concept Design) and update as appropriate in Stage 4 (Detailed Design) and Stage 5 (Delivery).

5.1 Warranty management

The APDT representative must clearly state the requirements for warranty management as per agreement with CPD and/or Commercial Procurement.

5.2 Configuration management

The APDT representative shall verify and state herein the Configuration Management System to be used following consultation with CPD. Such system must be in place prior to bringing assets into use.

5.3 Software management

All required software must be supplied to APD on handover. This will have to be accompanied by the appropriate licensing.

5.4 Obsolescence management

Asset obsolescence shall be confirmed with CPD by the APDT representative. Confirmation from APD on requirements for removal or management must also be sought.

The potential obsolescence risks and, if necessary, mitigation measures should be identified in the Obsolescence Strategy. If at any stage, it is decided that obsolescence will not impact upon the operation of the railway or its operating expenditure then this section is not applicable.

6 3rd Party arrangements

In this section, the APDT representative shall declare all 3rd party arrangements that are in place, relating to this project. In Stage 3 (Concept Design) a high-level assessment must be included which shall be updated in Stage 4 (Detailed Design) and Stage 5 (Delivery).

6.1 Supplier support arrangements

This section needs to determine the service level agreements for maintenance support, where appropriate.

7 Maintenance handover

Projects handing over to APD will have to follow the Railway Migration Strategy & Plan and Asset Performance acceptance criteria found within the Project Requirements. Handover must also be aligned with the Project Execution Plan (PEP). Final sign off will be achieved through the Project Completion & Handover Certificate.

8 Maintenance readiness roles & responsibilities

8.1 Project Manager

Project manager must:

- facilitate and support the commissioning process
- give final approval of the commissioning work.

- communicate project milestones relevant to APD and provide periodic updates on changes to the project plan.

8.2 Maintenance Rep

Maintenance representative must:

- provide maintenance readiness plan
- coordinate maintenance staff participation in commissioning activities
- attend NOWRI inspections (RAMS input)
- agree mandatory asset information deliverables (MAID) content
- facilitate the acceptance of assets back into maintenance.
- ensure APD attendance when requested at project meetings.

8.3 Operations Rep

Operation representative must:

- provide operational readiness plan
- coordinate operational staff participation in commissioning activities
- agree training requirements
- participate in commissioning tasks and performance testing, where applicable.
- ensure COO attendance when requested at project meetings

8.4 Other roles

Project engineer must:

- facilitate the commissioning process
- ensure that contractors perform their responsibilities and integrates commissioning into the construction process and schedule
- undertake construction surveillance activities
- coordinate the NOWRI process.

Contractor must:

- produce and implement commissioning plan and inspection and test plans to demonstrate correct system performance
- ensure works are ready for inspection by discipline engineers.

Suppliers must:

- ensure equipment manufacturers and vendors provide documentation to facilitate the commissioning work and population of MAID in a timely manner such that handover is not compromised.

9 Asset Performance Communications Plan

Prior to writing this section, the APDT representative must be familiar with the project specific Stakeholder Management & Communications Plan.

10 People Change Management

By Stage Gate 3:

- People change management activities completed that:
  - Verify the outputs of the change demand assessment from Stage Gate 2
  - Identify roles and teams and verify high-level impact on roles and teams in Maintenance
  - Identify leaders and engage their support
  - Develop key messages (central)
  - Develop and implement high level communications, involvement and engagement plan
  - Develop people change management measurement, reporting and action-planning approach

By Stage Gate 4:

- People change management activities completed that:
  - Identify roles and teams impacted locally and verify in detail what will change
  - Identify leaders and people taking on other roles during change locally and plan to engage them
  - Develop key messages (local)
  - Update and implement Communications, Involvement and Engagement Plan to support local implementation
  - Develop and agree standard recognition approach and plan to support local implementation
  - Develop and implement a local approach for people change management measurement, reporting and action-planning

By Stage Gate 5:

- People change management activities completed that demonstrate:
  - Local leaders support the new ways of working
  - Local communications, engagement and involvement plans are being implemented
  - Local recognition plans are being implemented
  - Local people issues in relation to the changes have been identified and the majority of them have been successfully addressed
  - People change management reports indicate people are ready to work in the new ways being rolled out by the programme

11 Identification of Core Asset and Maintenance Information Requirements

Identification of Core Asset and Maintenance Information Requirements will be detailed in the Mandatory Asset Information Deliverables.

12 Approval and Acceptance Criteria

Prior to writing this section, the APDT representative must be familiar with the project specific Inspection & Testing Strategy. For each asset area the standards or procedures must be identified in the matrix within the Verification & Validation Plan.

13 Key maintenance "readiness" milestones

These dates will be updated when detailed plans will become available.

Milestones	Dates
Maintenance Manuals and Work Instructions in place	12 weeks before training commences
Staff Training	6 weeks before hand over
Required tools in place	6 weeks before hand over
Test Equipment in place	6 weeks before hand over
Spares available (MSH)	6 weeks before hand over

Appendix A

Append agreed MAID

Transport for London
London Underground

Category 1 Standard

S1042 Asset Condition Reporting (ACR)

Issue date: July 2015
Issue No.: A12
Review date: July 2020

MAYOR OF LONDON

Contents

1 Purpose

1.1 The purpose of this Standard is to define the requirements for the annual reporting and certification of the condition of all engineering Assets owned by London Underground (LU) on the 1st of June in the reporting year.

1.2 The Asset Condition Reports and Asset Safety & Management Certificates together:

- Provide assurance to the LU Executive and other stakeholders that the Assets are of known condition and are fit for purpose;
- Allow Asset condition trends to be monitored;
- Identify residual safety and performance risks and their associated mitigations and controls;
- Inform the Asset investment planning process.

Notes
ACR Guidance Document, G-042, provides guidance, references and explanations to enable satisfactory completion of an ACR.

2 Scope

2.1 This Standard applies to engineering Assets listed in the Attachments to the Standard.

Attachment No.	Asset Group
1	Civils – Bridges & Structures
2	Civils – Deep Tube Tunnels
3	Civils – Earth Structures
4	Civils – Pumps & Drainage – Pumping Systems
5	Civils – Pumps & Drainage – Station Drainage
6	Civils – Pumps & Drainage – Track Drainage
7	Track
8	Power Non-PFI
9	Power HV
10	Communications
11	Electrical
12	Mechanical
13	Fire Protection inc. Compartmentation
14	Escalators
15	Lifts
16	Premises – Stations and Non-Public/Lineside Buildings
17	Premises – Depots
18	Premises – Facilities
19	Depots Plant & Equipment
20	Rolling Stock
21	Signalling
22	Signalling - Control & Information
23	Non Passenger Rolling Stock

2.2 The scope of reporting is limited to:

a. Residual Life of the Asset base;
b. Failures to meet Required Duty that result in Functional Condition Concerns:
   - Statutory non-compliance; including the failure to carry out required programmed inspections and/or
   - Safety risks that may result in customer or staff fatalities and/or injuries, which require either control or mitigation to achieve risk levels of ALARP or better; and/or
   - Extraordinary maintenance and/or operational activities, outside of the maintenance regime, which are uneconomic and/or unsustainable; and/or
c. Performance Risks
d. Degradation Concerns.

2.3 The scope of reporting includes software and firmware, but excludes:

a) Information and documentation used to support management of a physical Asset;
b) Any aspect of failure to meet Required Duty that does not result in any of the business impacts covered by 2.2 above (i.e. transient defects).

Notes
Any exceptions to 2.3 are explicitly listed in the Attachments to the Standard.
For simplicity the term “engineering Asset” is shortened to “Asset” within the Standard and accompanying Guidance Document. Similarly the term "Asset" shall be interpreted to include "Asset systems", "Asset sub-systems" or "part of an Asset" as appropriate.

3 Requirements

3.1 Overview

3.1.1 The Asset Condition Report shall describe the condition of the entire Asset base broken down as prescribed in the Attachments to the Standard as of the delivery date stated in 1.1 of this Standard. All Asset condition data shall be fully evidenced by auditable information.

Note
The Standard differentiates between Residual Life (RL) and Residual Risk. Residual Life is reported for 100% of the Asset base using Physical Condition Codes (A-D) and any specific Degradation Concerns are also recorded. Residual Risk is assessed separately by assigning Functional Condition Codes (1-4) to the affected Assets only.

3.2 Physical Condition (Residual Life)

3.2.1 Residual Life of the Asset base shall be determined with reference to the nominal Asset life defined in the Attachments to the Standard using Residual Life (Nominal) and/or Residual Life (Measured) and recorded in the Detailed Report. Where there is no Residual Life methodology, then Asset degradation is reported in the Concerns Workbook (termed Degradation Concern).

3.2.2 For Assets which are managed to achieve a nominally infinite life (i.e. their life can be continually extended through remedial works and maintenance activity without loss of function or performance, such as Bridges and Structures Assets), then the Time To Next Economic Intervention (TTNEI), shall be recorded as the Asset life. For simplicity the term Residual Life will encompass TTNEI in this Standard.

3.2.3 Physical Condition of all Assets shall be reported in accordance with this coding system:

Code A	An expected residual life of at least 10 years; or Where TTNEI is applicable an intervention is not required for at least 10 years.
Code B	An expected residual life of between five and 10 years; or Where TTNEI is applicable an intervention is required between five & 10 years.
Code C	An expected residual life of less than five years; or Where TTNEI is applicable an intervention in less than five years.
Code D	Beyond Nominal or Residual Life. Note: An Asset in this category can be reassessed to determine if it has further Residual Life if the relevant Asset group has an agreed method and approval process in place.

3.3 Functional Condition Concerns

3.3.1 Functional Condition Concerns reported in the ACR shall be linked to a defect; in terms of either a failure to meet Required Duty or through a state of degradation. In both cases the Concerns Workbook should contain a clear and objective description.

3.3.2 Concerns reported within ACR shall be given a unique reference consisting of a prefix, to identify the Asset group and responsible business unit (BCV/JNP/SSL), followed by a suffix which will be the unique reference number used by the responsible Asset group to identify the Concern. The coding structure is set out in detail in Appendix 1.

3.3.3 The Functional Condition Concerns reported in the Concerns Workbook shall be used to categorise and quantify concerns that result in a loss of functionality creating a business impact (i.e. inability to meet Required Duty).

3.3.4 All the Functional Condition Codes (1-4) which apply to a Specific Concern must be reported, and the required details recorded, in the Concerns Workbook.

3.3.5 Where a concern is common to identical assets, in multiple locations, this should be reported on the ASMC as a single concern with the number of instances stated. This will be reported on the ASMC as “xxx (yyy)” where xxx is the number of different concerns and yyy is the number of locations where the concerns occur.

Note
The Functional Condition Concerns are summarised in Appendix 2 and are described in further detail in the ACR Guidance Document, G-042.

4 Responsibilities

4.1 Assessors shall

4.1.1 Have a reasonable knowledge of the condition of the Assets for which they are accountable by considering the following factors:
a) The functions that the Assets have to perform;
b) Any applicable Standards, legal requirements and contractual obligations;
c) Nominal lives of the Assets and appropriate RL method (if relevant);
d) Degraded condition of the Assets and any resultant business impact.

4.1.2 Take into consideration factors described in 4.1.1 to enable an accurate report to be made on the condition of the Assets.

4.1.3 Prepare the Asset Condition Report (ACR), Asset Safety and Management Certificate (ASMCs) and the ACR Summary Report by working jointly with the relevant Head of Technical Discipline and Asset Managers. Regular meetings shall take place to ensure all parties are aware of the Physical Condition (A-D) of the Asset base and any Functional Condition and Degradation Concerns.

4.1.4 Uniquely number each Specific Concern in accordance with Appendix 1.

4.1.5 Submit the following documents to the Asset Development Manager before the 31st July and in final draft by 23rd June, in the reporting year:

a) A report for each Asset group by business unit (BCV/JNP/SSL) and/or by line and/or by location as defined in the Attachments;
b) A detailed report, if required, to support 4.1.1 a), for each Asset group at the level defined in the 'Basis of Condition Reporting' section of the Attachments;
c) A Concerns Workbook for each Asset group as per the requirements of the Standard and Guidance Document (Except BCV & SSL Civils.
d) An Asset Safety and Management Certificate (Appendix 3) for each Asset group.
e) A Summary Report describing changes in Physical Condition and Functional Concerns for comparison with the previous year's ACR report.

4.1.6 Submit any proposed changes of this Standard to the Asset Development Manager before 1st October.

Notes
Signed documents shall be delivered in hard copy and electronic format. All other ACR deliverables shall be provided electronically Any areas of concern and/or development with regards to the accuracy of the information in the completed ACR should be clearly documented.

4.2 Asset Managers shall:

4.2.1 Understand the role carried out by the Assessor.

4.2.2 Ensure that the ACR process remains fit for purpose and provides the information required to support investment planning.

4.2.3 Take an active role in joint working with Assessors and the Head of Technical Discipline during the ACR process.

4.2.4 Identify and quantify any ongoing and future performance risks of £250k or more per year (Code 4) resulting from the condition of the Assets. These risks are to be shared with the Assessor, for inclusion in the Concerns Workbook, at least three weeks prior to submission of the final draft ACR to the Asset Development Manager.

4.2.5 Review any Code 1, 2 & 3 Concerns reported in the Concerns Workbook for their Asset group and quantify any that are likely to have a performance (Code 4) impact of £250k or more per year.

4.2.6 Ensure relevant issues raised within the ACR are addressed within the Asset Management Plan.

4.2.7 Assess condition in relation to benchmarks or targets in the Asset Group Strategy (AGS), if applicable.

4.2.8 Be responsible for assuring and signing off the Physical Condition Codes "A" to "D" and Codes 3 & 4.

4.2.9 Submit any proposed changes of this Standard to the Asset Development Manager before 1st October.

Note
The signed off ASMCs must be submitted to the Asset Development Manager on or before 31st July in the reporting year.

4.3 Heads of Technical Discipline shall:

4.3.1 Understand the roles carried out by the Assessor and the Asset Manager.

4.3.2 Have a reasonable knowledge of the condition of the Assets for which they are accountable, which shall include (but not be limited to) knowledge of the following:

a) Any applicable Standards, legal requirements and contractual obligations;
b) Technologies of the Assets and the functions that the Assets have to perform;
c) Applicable measures, thresholds and detailed information on the Assets;
d) Nominal lives of the Assets and the calculation of the residual lives of the Assets;
e) Likely business impact of an Asset's inability to meet its Required Duty.

4.3.3 Take an active role in joint working with Assessors and Asset Managers during the ACR process with a focus on Code 1 & 2 Concerns.

4.3.4 Confirm or deny the existence of any Code 1 Concerns "Suspected" by Assessors in the Concerns Workbook during the ACR process and verify the controls and/or mitigations in place to achieve ALARP status and the proposed solution (if applicable).

4.3.5 If the Head of Technical Discipline is designated the principal point of contact for the regulatory authority they shall lead engagement and notify HSE. If not the principal point of contact then the Head of Technical Discipline equivalent shall notify the appropriate team in HSE and work with them to agree a plan for engaging the relevant regulatory authority.

4.3.6 Be responsible for assuring that the railway is safe to operate and all stated safety risks are ALARP, by signing off Codes 1 & 2, reported in the Asset Safety and Management Certificate.

4.3.7 Submit any proposed changes of this Standard to the Asset Development Manager before 1st October.

Note:
The signed off ASMCs must be submitted to the Asset Development Manager on or before 31st July in the reporting year.

4.4 Asset Development Manager shall:

4.4.1 Publish any formal revision to the Standard, Attachments to the Standard and Guidance Document via The Management System no later than 1st February of the reporting year.

4.4.2 Review and submit to the relevant ACR Managers comments on the final draft submissions within two weeks post 23rd June, in the reporting year

4.4.3 Ensure the source and quality of information used in the compilation of the ACR report are demonstrated and assured if this is not clearly documented.

4.4.4 Receive the final submissions on or before the 31st of July.

4.4.5 Submit a report to the LU Executive summarising the findings of the ACR and highlighting any critical risks to the business.

4.4.6 Review proposals for continuous improvement submitted by Assessors, Asset Managers and/or Heads of Technical Discipline.

5 Supporting information

5.1 Background

5.1.1 This standard is accompanied by a Guidance Document, G-042, which provides guidance, references and explanations to assist satisfactory completion of the ACR.

5.2 Safety considerations

5.2.1 Safety considerations are covered in section 8.2 of this Standard.

5.3 Environmental considerations

5.3.1 Environmental considerations which are non-compliant with statute are covered in section 8.1 of this Standard.

5.3.2 Environmental and other considerations which necessitate extraordinary maintenance are covered in section 8.3 of this Standard.

5.4 Customer considerations

5.4.1 Customer considerations which are related to safety are covered in section 8.2 of this Standard.

5.4.2 Customer considerations which are related to performance are covered in section 8.4 of this Standard.

6 References

6.1 Abbreviations

6.1.1 The following abbreviations are created:
a) within London Underground's Glossary of Terms (S1622) (a Category 1 Standard);
b) from published sources that are clearly identified.

Abbreviation	Definition	Source
ACR	Asset Condition Reporting	
AGS	Asset Group Strategy	
ALARP	As Low As Reasonably Practicable	
ASMC	Asset Safety and Management Certificate	
HSE	Health, Safety and Environment	
LU	London Underground	
LUQRA	London Underground Quantified Risk Assessment	
RAV	Relative Asset Value	

Abbreviation	Definition	Source
TTNEI	Time To Next Economic Intervention	

6.2 Definitions

6.2.1 The following abbreviations are created:

a) within London Underground's Glossary of Terms (S1622) (a Category 1 Standard);
b) from published sources that are clearly identified.

Term	Definition	Source
Asset group	Set of Assets that interact and/or are inter-related so as to deliver a required business function or service.	
Concern	In relation to Asset condition, a defect in the Asset that will need to be addressed outside of the agreed maintenance regime. A Concern may describe: a) Failure to meet Required Duty; and/or b) State of degradation; and/or c) Failure to reach the expected Residual Life.	
Condition	The state of an Asset in terms of its continued ability to meet its Required Duty on account of its physical and functional attributes.	
Defect	A fault or shortcoming.	
Degradation Concern	Where the Asset group has no Residual Life methodology Asset degradation will be reported in the Concerns Workbook.	
Economic Intervention	Any work required to address an Asset Condition Concern which is outside the agreed maintenance regime. Typically includes replacement or refurbishment.	
Extraordinary Maintenance	Maintenance activities which are either outside the maintenance schedule determined during design, construction and commissioning of an operational Asset and included in an agreed Asset Management Regime, or in addition to the maintenance regime agreed or carried out with appropriate approvals, and in existence prior to the year in which the ACR is carried out.	
Firmware	Permanent software programmed into a read-only memory.	
Functional Condition Concern	One of the following: Code 1: Statutory Non-Compliance; Code 2: Safety Risks to Customers and Staff; Code 3: Extraordinary Maintenance and/or Operational Activities; Code 4: Performance Risks	
Intervention	Any work required to address an Asset Condition Concern which is outside the agreed maintenance regime.	

Term	Definition	Source
Job Titles	Assessor for "Asset Area" Produces the ACR for an Asset Area within a Business Unit. Asset Manager for "Asset Area" Works alongside the Head of Technical Discipline for the "Asset Area" but deals with the codes 3 & 4. Head of Technical Discipline for "Asset Area" Works alongside the Asset Manager but deals with codes 1 & 2 and is the ultimate arbiter for an Asset Area within a Business Unit. Asset Development Manager (S&SD) Receives the final, signed, ACR outputs on behalf of LU/TfL. ACR Manager Manages the process for the production of the ACR.	
Maintenance Regime	All maintenance activities identified in the Asset maintenance regime within the AGS or Asset Management Plan.	
Nominal Life	The period of time after commissioning for which an engineering Asset, subject to an agreed maintenance regime, is expected to meet or exceed its Required Duty. Where usage dictates the nominal life of the Asset its capability will need to be converted into a time equivalent.	
Relative Asset Value	Relative Asset Values (RAVs) for each Asset group, except Signalling and C&I, are Modern Equivalent Asset Values (MEAVs) from the 1997 re-pricing exercise minus the pound sign. For ACR reporting 100% of the total RAV for an Asset group must be allocated to the A, B, C and D classifications.	
Residual Life	The remaining life of an Asset at the reporting date, in terms of the estimated time required before the next Intervention, taking into account physical degradation to date, agreed changes to the maintenance regime, obsolescence and any other relevant factors (but not any planned changes to Required Duty).	
Required Duty	A statement of the requirements placed on an engineering Asset in order to deliver satisfactory service to the railway and supporting services in accordance with LU Cat 1 Standards, British Standards, International Standards and associated codes of practice, or other contractual obligations.	
Safety Implication	Any Concern which has potential to result in serious injury or death to any person or persons.	
Software	Intellectual creation comprising the programs, procedures, rules and any associated documentation pertaining to the operation of a system.	
Specific Concern	Specific Concern (1): A concern developed by an Asset group as a statement of how a particular operational Asset type, operational Asset type element or individual operational Asset fails to meet Required Duty. Specific Concern (2): A concern developed by a Supplier as a statement of how a particular Operational Asset type, Operational Asset type Element or individual Operational Asset fails to meet Required Duty.	
Staff	All TfL employees, including those in subsidiary companies, and any contractors, consultants or other 3rd parties working on the Underground Network.	

Term	Definition	Source
Time To Next Economic Intervention (TTNEI)	TTNEI is used for Assets which are managed to provide a nominally infinite life and therefore residual life is not meaningful. The TTNEI will be the time until the next intervention is required to stem the degradation of the Asset and increase its life.	
Transient Defect	A defect which can be rectified either under the Asset's normal and budgeted maintenance regime or through maintenance which is deemed economic in comparison to renewal or replacement over the life of the Asset.	
Underground Network	The stations and depots (wherever situated), Assets, systems, track, and other buildings which are used in the maintenance and provision of the underground service known as 'London Underground.'	

6.3 Person accountable for the document

Person accountable for the document
Richard Moore - Asset Development Manager

6.4 Document history

Issue no	Date	Changes	Author
V1.0	March 2011	Original Cat 5Standard revised following extensive consultation with APD, CPD, S&C and TLL prior to update to Cat 1.	Elliot Simmons
V1.1	January 2012	References to Code 2 (Staff Only) concerns removed since these are addressed through the Workplace Risk Assessment process. Role of Head of technical Discipline in contacting the Regulatory authority clarified.	Elliot Simmons
S1042 A3	January 2012	Renumbered and updated as per DRACCT No. 00863,00930 & 00950	Graham Bessant
S1042 A4	February 2012	Updated as per DRACCT No. 01115	Marc Sims
A5	March 2012	As per DRACCT No. 1260 Attachments omitted in error when updating A4 covering ACR reporting, Civils, Deep Tube Tunnels and Pumps & Drains inserted have been inserted.	Marc Sims
A6	June 2012	As per DRACCT 01440 – Definition of Travelling Access Gantry added.	Graham Bessant
A7	March 2013	Updated as per DRACCT No. 1577	Marc Sims
A8	April 2013	As per DRACCT 01837 – Definition of linear Station Staircase altered.	Graham Bessant
A9	July 2013	As per DRACCT 01958 – Definition of Vehicle Collision Protection Barriers added. Definitions 401, 402, 403 & 404 amended.	Graham Bessant
A10	November 2013	As per DRACCT 02144 – Concern code 02144 applicability defined.	Graham Bessant

Issue no	Date	Changes	Author
A11	March 2014	As per DRACCT 02407 - Station Floodboard definition amended and definitions for Disused Station and Sub Station Premises added.	Graham Bessant
A12	January 2015	Clarify the Standard to ensure all Assets are considered and reported in a consistent manner. Enhance the Attachments to the Standard to ensure that all "orphan" Assets are allocated to an Asset Area	Joe Crow

7 Appendix 1: Referencing ACR Concerns

ACR Concerns are required to have a unique reference as set out below:

Asset Group Character	Business Unit	Unique Ref No.
Character to identify the Asset group without reference to the responsible business unit.	Identifies the organisation responsible for the Concern.	The unique identifier used by the responsible Asset Group to refer to the Concern.

Asset Group Letter

Automatic Fare Collection	A	Signals	S
Bridges & Structures	X	Control & Information	N
Earth Structures	B	Communications	C
Station Drainage	W	Electrical	K
Track Drainage	G	Mechanical	M
Pumping Systems	D	Fire	F
Deep Tube Tunnels	H	Power Non PFI	V
Track	T	Power HV	
Rolling Stock	R	Premises Stations and Non-Public/Lineside Buildings	P
Depot Plant & Equipment ~~Workshops~~	Y	Premises Facilities Buildings	P
Lifts	L	Premises Depot Buildings	P
Escalators	E	PFI Power	J
Non Passenger Rolling Stock	Z		

Business Unit Code

JNP	01
SSL	02
BCV	03

Example

B — Earth Structures

02 — SSL

B1001510 — Unique reference used by the SSL Earth Structures team to identify the Concern

8 Appendix 2: Functional Concerns

8.1 Code 1: Statutory Non-Compliance

8.1.1 A Condition Concern that states an Asset is non-compliant with statute.

8.1.2 In this context "statutory compliance" refers to requirements set out in law. "Statutory compliance" does not include the following, unless they have been incorporated into law:

a) European Standards;
b) British Standards;
c) London Underground Standards;
d) Codes of Practice and all other similar documents.

8.1.3 If an Asset was legally compliant at the time of installation, but the legislation has since changed to prevent installation of a similar Asset, this shall not be deemed a Code 1 concern for the purposes of ACR, unless that legislation is to be applied retrospectively.

8.1.4 If legal non-compliance is suspected the Assessor must alert the appropriate internal authority, the Head of Technical Discipline, who will confirm or deny the existence of a Code 1 after examining the Concern and consulting the LU Statutory Instrument Register.

8.1.5 For any confirmed Code 1 Concerns the Head of Technical Discipline shall act as the principle point of contact for the regulatory authority, they shall lead engagement and notify HSE; if not the principle point of contact then the Head of Technical Discipline shall notify the appropriate team in HSE and work with them to agree a plan for engaging the relevant regulatory authority.

8.2 Code 2: Safety Risks to Customers and Staff

8.2.1 A Condition Concern that may cause an event with a potential safety consequence, fatalities and/or injuries, for customers and staff, which requires either control or mitigation to achieve a risk level of ALARP or better by either:

a) Withdrawal of the Asset from full duty; or
b) Risk reduction by either control or mitigation measures not required by the original design of the Asset.

8.2.2 The risk to customers is quantified in financial terms in the Concerns Workbook using data from the LUQRA models (for more information see the ACR Guidance Document, G-042).

8.3 Code 3: Extraordinary Maintenance and/or Operational Activities

8.3.1 A Condition Concern that requires extraordinary operational and/or maintenance activities, which are outside the maintenance regime and considered to be uneconomic and/or unsustainable. Unsustainable maintenance can be applied to Assets if it is economic to provide additional maintenance for a planned period before total or part replacement of the Asset.

8.4 Code 4: Performance Risks

8.4.1 A Condition Concern that presents a Lost Customer Hours (LCH) performance risk on the Underground Network.

8.4.2 To ensure consistency the value of a Lost Customer Hour (LCH) given in the latest version of the Business Case Development Manual should be used.

9 Appendix 3: Asset Safety and Management Certificate

9.1 An Annual Safety and Management Certificate shall be completed for each Asset group being reported upon, as set out within this section.

Asset Safety and Management Certificate (ASMC) <Assessment Year><Asset Group><BCV/JNP/SSL>

Declaration

We certify that, so far as we can reasonably ascertain, at the due reporting date of <insert date>:

Scope
All engineering Assets within this classification for which <BCV/JNP/SSL> is responsible are covered by this certificate.

(Any exceptions are to be identified here, with explanations)

Summary of Asset Condition
The Physical Condition of these engineering Assets is summarised as being:

Code A 10+yrs	Code B 10-5yrs	Code C 5-0yrs	Code D 0yrs
<aa.aa>%	<bb.bb>%	<cc.cc>%	<dd.dd>%

The Functional Condition of these engineering Assets is summarised as being:

Code 1 Legally Non-compliant	Code 2 Safety Risks to Customers and Staff	Code 3 Uneconomical and/or unsustainable maintenance	Code 4 Performance Risk for the year
Number of different Concerns (Number of Locations)	£xx k	£xx k	£xx k

Legislation
The Assets covered by this certificate are compliant with legislative requirements with the exceptions listed in the table on the following page.

Safety Risks
Any condition Concern with a safety implication has been assessed in accordance with <BCV/JNP/SSL> safety management system.

Any Code 2 Concerns that required a mitigation to be applied in order to achieve ALARP status are listed with the relevant mitigation(s) in the Concerns Workbook The Safety Risk (£) for Customer Concerns is stated in the table above.

Extraordinary Maintenance/operation
The total number of Code 3 Concerns, indicating that extraordinary operation or maintenance is required, is: <number of Code 3 Concerns> with an annual extra over cost stated in the table above.

Performance
The Code 4 Concerns indicating consequential risk to service loss from condition defects is <LCH> which

equates to the cost stated in the table above.

Maintenance Regime
These Assets are maintained using controlled processes which support the above physical condition summary and control their contribution to LU's system risk.
(Any exceptions are to be identified here, with explanations).

The residual lives and Times To Next Economic Intervention (TTNEI) used to compile the above physical condition summary are consistent with those used within the controlled processes in the corporate management strategy for these Assets.
(Any exceptions are to be identified here, with explanations).

Process Followed
The reports supporting this certificate have been produced in accordance with Standard S1042 Asset Condition Reporting and Attachments.
(Any exceptions are to be identified here, with explanations)

Provenance of Information
The information within the supporting report has been managed in accordance with Cat 1 Standard 1-691 Information and derived from the information sources appropriate to this engineering Asset group, supplemented where appropriate by engineering knowledge.
(Any exceptions are to be identified here, with explanations).

Legislation
Exceptions to legislative compliance are listed below

ACR Ref. No.	Line(s) / Location(s)	Concern Description	Plan to Ensure Future Legal Compliance [Code 1 Concerns Only]

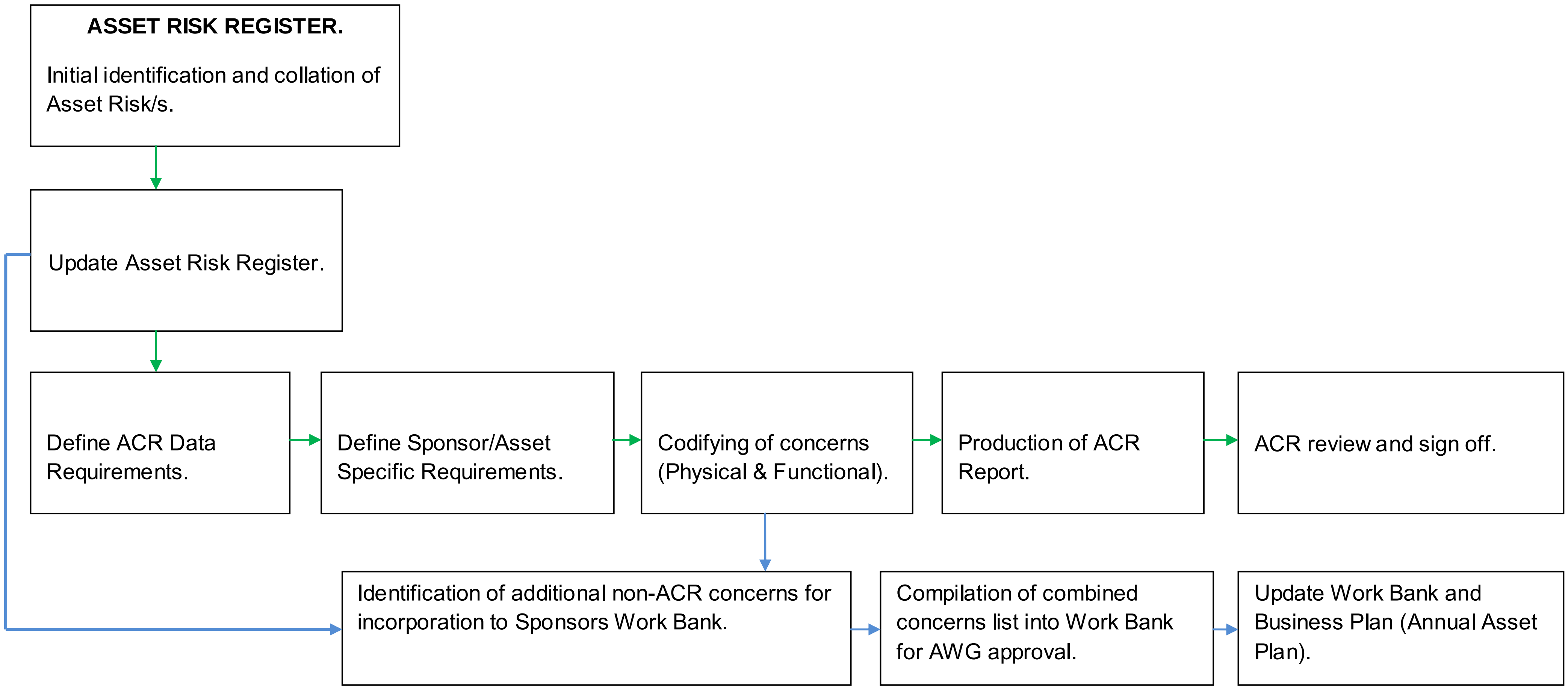
Authority for Issue

Assessor: Responsible for assessment of this Asset group	Signature:	
	Name:	Date
	Position in company:	
Maintenance Manager: Responsible for the maintenance of this Asset group and the production of its ACR	Signature:	
	Name:	Date:
	Position in company:	
Asset Manager: Responsible for managing Physical Condition (A-D) and Code 3 & 4 Concerns reported for this Asset group	Signature:	
	Name:	Date:
	Position in company:	
Head of Technical Discipline: Responsible for assuring Code 1 & 2 Concerns reported for this Asset group	Signature:	
	Name:	Date:
	Position in company:	

Attachments to ACR Standard – Contents

Note: Should any duplication or discrepancies exist between the content of the Generic attachments and the Asset-Specific attachments, the Generic attachment shall take precedence.

Assessment Flow Diagram



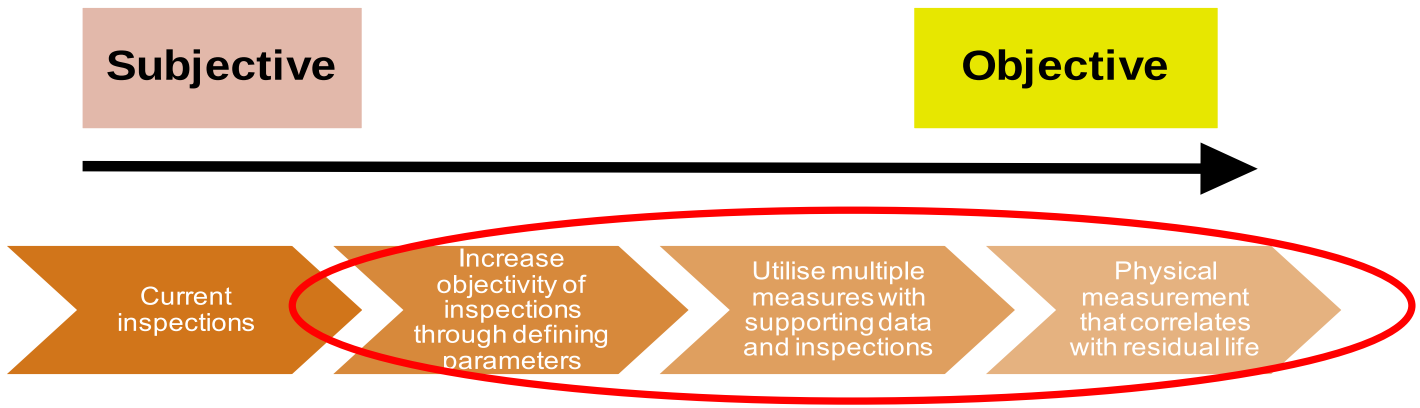
Residual Life Principles

There are two approaches for assessing Residual Life

1. Residual Life Measured – RL (M)

The driver for implementing a RL (M) approach is to improve objectivity in determining A - D Residual Life categorisation.
The illustration depicts ways in which objectivity has been improved across the asset areas.
The calculation of RL (M) is ideally determined using a physical measure that can be correlated with residual life.
If it is not possible to physically measure the condition of an asset, condition is scored 1 – 5 (excellent to poor) based on an objective visual inspection.

Objectivity is improved by developing a set of statements that describe what 1 – 5 scores look like.
The assessment may also take into account other factors which indicate the amount of remaining residual life.
These may include but are not limited to: obsolescence and reliability.



Where it is not possible or appropriate to implement a Residual Life (Measured) approach, Residual Life (Nominal) is used.

2. Residual Life Nominal - RL (N)

This uses the nominal design life of the asset and assumes a straight line degradation and is calculated as:

RL (N) = (nominal life) – (time in service)

It is possible to re-life assets upon Nominal Life expiry, following a risk-based assessment as agreed by the asset area and outlined in the Attachments

Residual Life Framework APBCV & APSSL

	Residual Life Approach				Factor						Method		
Asset Area	Time to Next Economic Intervention	Residual Life (Nominal)	Residual Life (Measured)	Varies between assets	Physical Deterioration	Reliability	Obsolescence	Usage	Environment	Design	Desktop Exercise	Visual Inspection	Physical Measurement
Civils	☑				☑						☑	☑	
Rolling Stock		☑			☑							☑	
Depot, Plant & Equipment			☑		☑		☑				☑	☑	
Track			☑		☑			☑	☑		☑	☑	☑
Premises			☑		☑						☑	☑	
Signalling and C&I			☑		☑	☑	☑				☑		
Electrical		☑			☑		☑				☑	☑	
Mechanical			☑		☑		☑				☑	☑	
Lifts and Escalators				☑	☑		☑				☑	☑	☑
Fire				☑	☑		☑				☑	☑	
Comms		☑				☑	☑				☑		
Power Non PFI			☑		☑	☑	☑	☑	☑	☑	☑	☑	

Residual Life Framework - APJNP

	Residual Life Approach				Factor						Method				
Asset Area	Time to Next Economic Intervention	Residual Life (Nominal)	Residual Life (Measured)	Varies between assets	Physical Deterioration	Reliability	Obsolescence	Usage	Environment	Design	Desktop Exercise	Visual Inspection	Physical Measurement	Fix on Failure	Nominal Life
Civils Bridges & Structures	✓				✓				✓		✓	✓		✓	
Civils Earth Structures	✓			✓	✓				✓	✓	✓	✓	✓	✓	
Civils Pumps & Drainage Pumping Systems	✓				✓	✓			✓	✓	✓	✓		✓	
Civils Pumps & Drainage Station Drainage	✓				✓	✓			✓	✓	✓	✓		✓	
Civils Pumps & Drainage Track Drainage	✓				✓	✓			✓	✓	✓	✓		✓	
Civils - Tunnels	✓			✓	✓				✓		✓	✓	✓	✓	
Rolling Stock	✓	✓			✓							✓	✓	✓	
Depot, Plant & Equipment			✓		✓		✓		✓		✓	✓		✓	
Track			✓		✓			✓	✓	✓	✓	✓	✓	✓	✓
Premises					✓						✓	✓		✓	
Signalling		✓		✓	✓	✓	✓	✓			✓	✓		✓	
C&I		✓		✓	✓	✓	✓		✓		✓	✓		✓	
Electrical		✓			✓		✓				✓	✓		✓	
Mechanical			✓		✓		✓				✓	✓		✓	
Lifts				✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Escalators				✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Fire Protection				✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Fire Compartmentation				✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Comms		✓				✓	✓				✓	✓	✓	✓	
Power Non PFI			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	
Non Passenger Rolling Stock		✓			✓							✓		✓	

Station Categories

	General Information - for all asset areas						Communications Information		Premises Information
	Station	Owner	Infraco	Line	Urban/ Suburban	Surface/ Cut and Cover/ Deep Tube	Category (Based on Foundation Stations model)	Counts 2011 Entries/ exits (m)	Category
1	Acton Town	LUL	**TLL**	Piccadilly	Suburban	Surface	Medium	5.46	Small/Medium
2	Aldgate	LUL	**SSL**	Metropolitan	Urban	Cut and Cover	Medium	6.24	Small/Medium
3	Aldgate East	LUL	**SSL**	District	Urban	Cut and Cover	Medium	9.16	Small/Medium
4	Alperton	LUL	**TLL**	Piccadilly	Suburban	Surface	Small	2.95	Small/Medium
5	Amersham	LUL	**SSL**	Metropolitan	Suburban	Surface	Medium	2.10	Small/Medium
6	Angel	LUL	**TLL**	Northern	Urban	Deep Tube	Medium	17.78	Small/Medium
7	Archway	LUL	**TLL**	Northern	Suburban	Deep Tube	Medium	8.08	Small/Medium
8	Arnos Grove	LUL	**TLL**	Piccadilly	Suburban	Surface	Medium	4.16	Small/Medium
9	Arsenal	LUL	**TLL**	Piccadilly	Suburban	Deep Tube	Medium	3.07	Small/Medium
10	Baker Street	LUL	SSL	Metropolitan	Urban	Deep Tube	Mega	27.02	Major Interchange
11	Balham	LUL	TLL	Northern	Suburban	Deep Tube	Medium	11.46	Small/Medium
12	Bank/Monument	LUL	BCV	Central	Urban	Deep Tube	Mega	47.80	Major Interchange
13	Barbican	LUL	SSL	Metropolitan	Urban	Surface	Medium	9.23	Small/Medium
14	Barking	NR	SSL	District	see note below	see note below	see note below	13.96	see note below
15	Barkingside	LUL	BCV	Central	Suburban	Surface	Small	1.16	Small/Medium
16	Barons Court	LUL	SSL	District	Urban	Surface	Medium	6.54	Small/Medium
17	Bayswater	LUL	SSL	Metropolitan	Urban	Cut and Cover	Medium	5.10	Small/Medium
18	Becontree	LUL	SSL	District	Suburban	Surface	Small	2.76	Small/Medium
19	Belsize Park	LUL	TLL	Northern	Suburban	Deep Tube	Medium	5.75	Small/Medium
20	Bermondsey	LUL	TLL	Jubilee	Suburban	Deep Tube	Medium	7.38	Small/Medium
21	Bethnal Green	LUL	BCV	Central	Suburban	Deep Tube	Medium	15.09	Small/Medium
22	Blackfriars	LUL	SSL	District	Urban	Cut and Cover	Medium	13.14	Small/Medium
23	Blackhorse Road	LUL	BCV	Victoria	Suburban	Deep Tube	Medium	6.47	Small/Medium
24	Bond Street	LUL	BCV	Central	Urban	Deep Tube	Large	36.02	Interchange
25	Borough	LUL	TLL	Northern	Suburban	Deep Tube	Medium	4.57	Small/Medium
26	Boston Manor	LUL	TLL	Piccadilly	Suburban	Surface	Small	1.89	Small/Medium
27	Bounds Green	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	5.59	Small/Medium
28	Bow Road	LUL	SSL	District	Urban	Cut and Cover	Medium	5.08	Small/Medium
29	Brent Cross	LUL	TLL	Northern	Suburban	Surface	Small	2.21	Small/Medium
30	Brixton	LUL	BCV	Victoria	Suburban	Deep Tube	Medium	22.51	Small/Medium
31	Bromley-by-Bow	LUL	SSL	District	Suburban	Surface	Small	2.75	Small/Medium
32	Buckhurst Hill	LUL	BCV	Central	Suburban	Surface	Small	1.85	Small/Medium
33	Burnt Oak	LUL	TLL	Northern	Suburban	Surface	Small	3.79	Small/Medium
34	Caledonian Road	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	5.27	Small/Medium
35	Camden Town	LUL	TLL	Northern	Suburban	Deep Tube	Large	20.99	Small/Medium
36	Canada Water	LUL	TLL	Jubilee	Urban	Deep Tube	Large	9.91	Interchange
37	Canary Wharf	LUL	TLL	Jubilee	Urban	Deep Tube	Large	46.59	Interchange
38	Canning Town	LUL	TLL	Jubilee	Suburban	Surface	Large	8.71	Interchange
39	Cannon Street	LUL	SSL	District	Urban	Cut and Cover	Medium	4.05	Small/Medium
40	Canons Park	LUL	TLL	Jubilee	Suburban	Surface	Small	1.82	Small/Medium
41	Chalfont & Latimer	LUL	SSL	Metropolitan	Suburban	Surface	Medium	1.19	Small/Medium
42	Chalk Farm	LUL	TLL	Northern	Suburban	Deep Tube	Medium	4.94	Small/Medium
43	Chancery Lane	LUL	BCV	Central	Urban	Deep Tube	Medium	16.04	Small/Medium
44	Charing Cross	LUL	BCV	Bakerloo	Urban	Deep Tube	Large	19.51	Major Interchange
45	Chesham	LUL	SSL	Metropolitan	Suburban	Surface	Small	0.62	Small/Medium
46	Chigwell	LUL	BCV	Central	Suburban	Surface	Small	0.46	Small/Medium
47	Chiswick Park	LUL	SSL	District	Suburban	Surface	Small	1.97	Small/Medium
48	Chorleywood	LUL	SSL	Metropolitan	Suburban	Surface	Small	0.91	Small/Medium
49	Clapham Common	LUL	TLL	Northern	Suburban	Deep Tube	Medium	9.06	Small/Medium
50	Clapham North	LUL	TLL	Northern	Suburban	Deep Tube	Medium	5.83	Small/Medium
51	Clapham South	LUL	TLL	Northern	Suburban	Deep Tube	Medium	7.82	Small/Medium
52	Cockfosters	LUL	TLL	Piccadilly	Suburban	Surface	Medium	1.72	Small/Medium
53	Colindale	LUL	TLL	Northern	Suburban	Surface	Small	4.13	Small/Medium
54	Colliers Wood	LUL	TLL	Northern	Suburban	Deep Tube	Medium	5.57	Small/Medium
55	Covent Garden	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	20.28	Small/Medium
56	Croxley	LUL	SSL	Metropolitan	Suburban	Surface	Small	0.82	Small/Medium
57	Dagenham East	LUL	SSL	District	Suburban	Surface	Small	2.22	Small/Medium
58	Dagenham Heathway	LUL	SSL	District	Suburban	Surface	Small	4.71	Small/Medium
59	Debden	LUL	BCV	Central	Suburban	Surface	Small	2.12	Small/Medium
60	Dollis Hill	LUL	TLL	Jubilee	Suburban	Surface	Small	3.08	Small/Medium
61	Ealing Broadway	NR	BCV	Central	Suburban	Surface	Medium	16.09	Small/Medium
62	Ealing Common	LUL	TLL	Piccadilly	Suburban	Surface	Small	3.25	Small/Medium
63	Earl's Court	LUL	SSL	District	Urban	Deep Tube	Large	20.97	Interchange
64	East Acton	LUL	BCV	Central	Suburban	Surface	Small	3.41	Small/Medium
65	East Finchley	LUL	TLL	Northern	Suburban	Surface	Medium	6.29	Small/Medium
66	East Ham	LUL	SSL	District	Suburban	Surface	Small	13.37	Small/Medium
67	East Putney	LUL	SSL	District	Suburban	Surface	Small	4.93	Small/Medium
68	Eastcote	LUL	SSL	Metropolitan	Suburban	Surface	Small	2.43	Small/Medium
69	Edgware	LUL	TLL	Northern	Suburban	Surface	Medium	4.37	Small/Medium
70	Edgware Road (Bakerloo)	LUL	BCV	Bakerloo	Urban	Deep Tube	Medium	4.06	Small/Medium
71	Edgware Road (H&C)	LUL	SSL	Metropolitan	Urban	Surface	Medium	5.94	Small/Medium
72	Elephant & Castle	LUL	BCV	Bakerloo	Urban	Deep Tube	Large	17.72	Interchange
73	Elm Park	LUL	SSL	District	Suburban	Surface	Small	2.44	Small/Medium
74	Embankment	LUL	SSL	District	Urban	Deep Tube	Mega	19.79	Major Interchange
75	Epping	LUL	BCV	Central	Suburban	Surface	Small	3.10	Small/Medium

	General Information - for all asset areas						Communications Information		Premises Information
	Station	**Owner**	**Infraco**	**Line**	**Urban/ Suburban**	**Surface/ Cut and Cover/ Deep Tube**	**Category (Based on Foundation Stations model)**	**Counts 2011 Entries/ exits (m)**	**Category**
76	Euston	LUL	TLL	Northern	Urban	Deep Tube	Mega	35.32	Major Interchange
77	Euston Square	LUL	SSL	Metropolitan	Urban	Cut and Cover	Medium	10.89	Small/Medium
78	Fairlop	LUL	BCV	Central	Suburban	Surface	Small	0.92	Small/Medium
79	Farringdon	LUL	SSL	Metropolitan	Urban	Surface	Medium	19.02	Interchange
80	Finchley Central	LUL	TLL	Northern	Suburban	Surface	Medium	5.49	Small/Medium
81	Finchley Road	LUL	TLL	Jubilee	Suburban	Surface	Medium	8.98	Interchange
82	Finsbury Park	LUL	TLL	Piccadilly	Suburban	Deep Tube	Large	24.29	Interchange
83	Fulham Broadway	LUL	SSL	District	Urban	Cut and Cover	Small	9.56	Small/Medium
84	Gants Hill	LUL	BCV	Central	Suburban	Deep Tube	Medium	5.48	Small/Medium
85	Gloucester Road	LUL	SSL	District	Urban	Deep Tube	Medium	14.16	Interchange
86	Golders Green	LUL	TLL	Northern	Suburban	Surface	Medium	7.81	Small/Medium
87	Goldhawk Road	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.60	Small/Medium
88	Goodge Street	LUL	TLL	Northern	Urban	Deep Tube	Medium	10.62	Small/Medium
89	Grange Hill	LUL	BCV	Central	Suburban	Surface	Small	0.49	Small/Medium
90	Great Portland Street	LUL	SSL	Metropolitan	Urban	Cut and Cover	Medium	7.17	Small/Medium
91	Green Park	LUL	TLL	Piccadilly	Urban	Deep Tube	Mega	31.72	Major Interchange
92	Greenford	LUL	BCV	Central	Suburban	Surface	Medium	3.95	Small/Medium
93	Gunnersbury	STS	SSL	District	see note below	see note below	see note below	4.39	see note below
94	Hainault	LUL	BCV	Central	Suburban	Surface	Medium	2.95	Small/Medium
95	Hammersmith (D&P)	LUL	SSL	District	Suburban	Surface	Medium	28.94	Interchange
96	Hammersmith (H&C)	LUL	SSL	Metropolitan	Suburban	Surface	Medium	8.89	Small/Medium
97	Hampstead	LUL	TLL	Northern	Suburban	Deep Tube		4.31	Small/Medium
98	Hanger Lane	LUL	TLL	Piccadilly	Suburban	Surface		3.36	Small/Medium
99	Harlesden	NR	BCV	Bakerloo	see note below	see note below	see note below	2.28	see note below
100	Harrow & Wealdstone	NR	BCV	Bakerloo	see note below	see note below	see note below	4.47	see note below
101	Harrow-on-the-Hill	LUL	SSL	Metropolitan	Suburban	Surface	Medium	8.75	Interchange
102	Hatton Cross	LUL	TLL	Piccadilly	Suburban	Cut and Cover	Medium	2.93	Small/Medium
103	Heathrow Terminal 4	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	2.46	Small/Medium
104	Heathrow Terminals 1,2,3	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	7.72	Small/Medium
105	Heathrow Terminal 5	HAH	HAH	Piccadilly	Suburban	Deep Tube	Medium	3.21	Medium
106	Hendon Central	LUL	TLL	Northern	Suburban	Surface	Small	7.01	Small/Medium
107	High Barnet	LUL	TLL	Northern	Suburban	Surface	Medium	3.14	Small/Medium
108	High Street Kensington	LUL	SSL	District	Urban	Cut and Cover	Medium	11.99	Small/Medium
109	Highbury & Islington	LUL	BCV	Victoria	Suburban	Deep Tube	Medium	16.26	Small/Medium
110	Highgate	LUL	TLL	Northern	Suburban	Deep Tube	Medium	4.98	Small/Medium
111	Hillingdon	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.40	Small/Medium
112	Holborn	LUL	BCV	Central	Urban	Deep Tube	Large	31.98	Interchange
113	Holland Park	LUL	BCV	Central	Suburban	Deep Tube	Medium	3.37	Small/Medium
114	Holloway Road	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	8.05	Small/Medium
115	Hornchurch	LUL	SSL	District	Suburban	Surface	Small	1.98	Small/Medium
116	Hounslow Central	LUL	TLL	Piccadilly	Suburban	Surface	Medium	3.90	Small/Medium
117	Hounslow East	LUL	TLL	Piccadilly	Suburban	Surface	Medium	4.27	Small/Medium
118	Hounslow West	LUL	TLL	Piccadilly	Suburban	Cut and Cover	Medium	3.18	Small/Medium
119	Hyde Park Corner	LUL	TLL	Piccadilly	Urban	Deep Tube	Medium	6.07	Small/Medium
120	Ickenham	LUL	SSL	Metropolitan	Suburban	Surface	Small	0.98	Small/Medium
121	Kennington	LUL	TLL	Northern	Suburban	Deep Tube	Medium	4.52	Small/Medium
122	Kensal Green	NR	BCV	Bakerloo	see note below	see note below	see note below	2.32	see note below
123	Kensington (Olympia)	NR	SSL	District	see note below	see note below	see note below	1.74	see note below
124	Kentish Town	LUL	TLL	Northern	Suburban	Deep Tube	Medium	7.21	Small/Medium
125	Kenton	NR	BCV	Bakerloo	see note below	see note below	see note below	1.94	see note below
126	Kew Gardens	NR	SSL	District	see note below	see note below	see note below	3.13	see note below
127	Kilburn	LUL	TLL	Jubilee	Suburban	Surface	Small	7.52	Small/Medium
128	Kilburn Park	LUL	BCV	Bakerloo	Suburban	Deep Tube	Medium	3.46	Small/Medium
129	King's Cross St. Pancras	LUL	SSL	Metropolitan	Urban	Deep Tube	Mega	77.11	Major Interchange
130	Kingsbury	LUL	TLL	Jubilee	Suburban	Surface	Medium	3.44	Small/Medium
131	Knightsbridge	LUL	TLL	Piccadilly	Urban	Deep Tube	Medium	20.70	Small/Medium
132	Ladbroke Grove	LUL	SSL	Metropolitan	Suburban	Surface	Medium	5.09	Small/Medium
133	Lambeth North	LUL	BCV	Bakerloo	Urban	Deep Tube	Medium	3.50	Small/Medium
134	Lancaster Gate	LUL	BCV	Central	Urban	Deep Tube	Medium	6.68	Small/Medium
135	Latimer Road	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.70	Small/Medium
136	Leicester Square	LUL	TLL	Piccadilly	Urban	Deep Tube	Interchange	38.78	Interchange
137	Leyton	LUL	BCV	Central	Suburban	Surface	Small	13.29	Small/Medium
138	Leytonstone	LUL	BCV	Central	Suburban	Surface	Medium	10.45	Small/Medium
139	Liverpool Street	LUL	SSL	Metropolitan	Urban	Deep Tube	Large	63.65	Interchange
140	London Bridge	LUL	TLL	Jubilee	Urban	Deep Tube	Mega	65.44	Major Interchange
141	Loughton	LUL	BCV	Central	Suburban	Surface	Medium	3.00	Small/Medium
142	Maida Vale	LUL	BCV	Bakerloo	Suburban	Deep Tube	Medium	2.99	Small/Medium
143	Manor House	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	9.21	Small/Medium
144	Mansion House	LUL	SSL	District	Urban	Cut and Cover	Medium	7.42	Small/Medium
145	Marble Arch	LUL	BCV	Central	Urban	Deep Tube	Medium	16.87	Small/Medium
146	Marylebone	LUL	BCV	Bakerloo	Urban	Deep Tube	Medium	11.40	Small/Medium
147	Mile End	LUL	BCV	Central	Suburban	Cut and Cover	Medium	14.01	Interchange
148	Mill Hill East	LUL	TLL	Northern	Suburban	Surface	Small	1.09	Small/Medium
149	~~Monument~~	~~LUL~~	~~BCV~~	~~Central~~	~~Urban~~	~~Deep Tube~~	~~Major Interchange~~		~~Major Interchange~~
150	Moor Park	LUL	SSL	Metropolitan	Suburban	Surface	Small	0.82	Small/Medium
151	Moorgate	LUL	SSL	Metropolitan	Urban	Deep Tube	Large	21.23	Interchange
152	Morden	LUL	TLL	Northern	Suburban	Surface	Medium	7.20	Small/Medium

	General Information - for all asset areas						Communications Information		Premises Information
	Station	Owner	Infraco	Line	Urban/ Suburban	Surface/ Cut and Cover/ Deep Tube	Category (Based on Foundation Stations model)	Counts 2011 Entries/ exits (m)	Category
153	Mornington Crescent	LUL	TLL	Northern	Suburban	Deep Tube	Medium	4.30	Small/Medium
154	Neasden	LUL	TLL	Jubilee	Suburban	Surface	Small	2.70	Small/Medium
155	Newbury Park	LUL	BCV	Central	Suburban	Surface	Small	3.92	Small/Medium
156	North Acton	LUL	BCV	Central	Suburban	Surface	Small	4.64	Small/Medium
157	North Ealing	LUL	TLL	Piccadilly	Suburban	Surface	Small	0.94	Small/Medium
158	North Greenwich	LUL	TLL	Jubilee	Urban	Deep Tube	Interchange	15.70	Interchange
159	North Harrow	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.42	Small/Medium
160	North Wembley	NR	BCV	Bakerloo	see note below	see note below	see note below	1.57	see note below
161	Northfields	LUL	TLL	Piccadilly	Suburban	Surface	Small	3.79	Small/Medium
162	Northolt	LUL	BCV	Central	Suburban	Surface	Small	4.28	Small/Medium
163	Northwick Park	LUL	SSL	Metropolitan	Suburban	Surface	Small	3.58	Small/Medium
164	Northwood	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.97	Small/Medium
165	Northwood Hills	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.29	Small/Medium
166	Notting Hill Gate	LUL	BCV	Central	Suburban	Deep Tube	Large	17.36	Interchange
167	Oakwood	LUL	TLL	Piccadilly	Suburban	Surface	Small	2.74	Small/Medium
168	Old Street	LUL	TLL	Northern	Urban	Deep Tube	Medium	21.04	Small/Medium
169	Osterley	LUL	TLL	Piccadilly	Suburban	Surface	Small	2.15	Small/Medium
170	Oval	LUL	TLL	Northern	Suburban	Deep Tube	Medium	5.85	Small/Medium
171	Oxford Circus	LUL	BCV	Bakerloo	Urban	Deep Tube	Mega	77.09	Major Interchange
172	Paddington (Main)	LUL	SSL	Metropolitan	Urban	Deep Tube	Large	33.78	Interchange
173	Paddington (Suburban)	LUL	SSL	Metropolitan	Urban	Surface	Small	12.71	Small/Medium
174	Park Royal	LUL	TLL	Piccadilly	Suburban	Surface	Small	1.58	Small/Medium
175	Parsons Green	LUL	SSL	District	Suburban	Surface	Small	5.94	Small/Medium
176	Perivale	LUL	BCV	Central	Suburban	Surface	Small	2.08	Small/Medium
177	Piccadilly Circus	LUL	BCV	Bakerloo	Urban	Deep Tube	Large	40.58	Interchange
178	Pimlico	LUL	BCV	Victoria	Urban	Deep Tube	Medium	8.79	Small/Medium
179	Pinner	LUL	SSL	Metropolitan	Suburban	Surface	Small	2.30	Small/Medium
180	Plaistow	LUL	SSL	District	Suburban	Surface	Small	6.34	Small/Medium
181	Preston Road	LUL	SSL	Metropolitan	Suburban	Surface	Small	2.96	Small/Medium
182	Putney Bridge	LUL	SSL	District	Suburban	Surface	Small	5.33	Small/Medium
183	Queen's Park	NR	BCV	Bakerloo	see note below	see note below	see note below	5.53	see note below
184	Queensbury	LUL	TLL	Jubilee	Suburban	Surface	Small	3.18	Small/Medium
185	Queensway	LUL	BCV	Central	Urban	Deep Tube	Medium	8.86	Small/Medium
186	Ravenscourt Park	LUL	SSL	District	Suburban	Surface	Small	2.65	Small/Medium
187	Rayners Lane	LUL	SSL	Metropolitan	Suburban	Surface	Small	3.98	Small/Medium
188	Redbridge	LUL	BCV	Central	Suburban	Cut and Cover	Medium	2.63	Small/Medium
189	Regent's Park	LUL	BCV	Bakerloo	Urban	Deep Tube	Medium	3.78	Small/Medium
190	Richmond	NR	SSL	District	see note below	see note below	see note below	7.47	see note below
191	Rickmansworth	LUL	SSL	Metropolitan	Suburban	Surface	Small	2.03	Small/Medium
192	Roding Valley	LUL	BCV	Central	Suburban	Surface	Small	0.22	Small/Medium
193	Royal Oak	LUL	SSL	Metropolitan	Suburban	Surface	Small	2.05	Small/Medium
194	Ruislip	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.57	Small/Medium
195	Ruislip Gardens	LUL	BCV	Central	Suburban	Surface	Small	1.00	Small/Medium
196	Ruislip Manor	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.60	Small/Medium
197	Russell Square	LUL	TLL	Piccadilly	Urban	Deep Tube	Medium	14.73	Small/Medium
198	Seven Sisters	LUL	BCV	Victoria	Suburban	Deep Tube	Large	12.53	Interchange
199	Shepherd's Bush (Central)	LUL	BCV	Central	Suburban	Deep Tube	Medium	21.59	Small/Medium
200	Shepherd's Bush Market (H&C)	LUL	SSL	Metropolitan	Suburban	Surface	Small	3.00	Small/Medium
201	Sloane Square	LUL	SSL	District	Urban	Cut and Cover	Medium	14.94	Small/Medium
202	Snaresbrook	LUL	BCV	Central	Suburban	Surface	Small	2.60	Small/Medium
203	South Ealing	LUL	TLL	Piccadilly	Suburban	Surface	Small	3.32	Small/Medium
204	South Harrow	LUL	TLL	Piccadilly	Suburban	Surface	Small	2.28	Small/Medium
205	South Kensington	LUL	SSL	District	Urban	Deep Tube	Large	30.61	Interchange
206	South Kenton	NR	BCV	Bakerloo	see note below	see note below	see note below	0.96	see note below
207	South Ruislip	LUL	BCV	Central	Suburban	Surface	Small	1.76	Small/Medium
208	South Wimbledon	LUL	TLL	Northern	Suburban	Deep Tube	Medium	3.75	Small/Medium
209	South Woodford	LUL	BCV	Central	Suburban	Surface	Small	4.39	Small/Medium
210	Southfields	LUL	SSL	District	Suburban	Surface	Small	5.26	Small/Medium
211	Southgate	LUL	TLL	Piccadilly	Suburban	Deep Tube	Small	4.91	Small/Medium
212	Southwark	LUL	TLL	Jubilee	Urban	Deep Tube	Large	11.07	Interchange
213	St. James's Park	LUL	SSL	District	Urban	Cut and Cover	Medium	13.50	Small/Medium
214	St. John's Wood	LUL	TLL	Jubilee	Suburban	Deep Tube	Medium	6.74	Small/Medium
215	St. Paul's	LUL	BCV	Central	Urban	Deep Tube	Medium	17.08	Small/Medium
216	Stamford Brook	LUL	SSL	District	Suburban	Surface	Small	2.52	Small/Medium
217	Stanmore	LUL	TLL	Jubilee	Suburban	Surface	Medium	3.02	Small/Medium
218	Stepney Green	LUL	SSL	District	Urban	Cut and Cover	Medium	4.38	Small/Medium
219	Stockwell	LUL	TLL	Northern	Suburban	Deep Tube	Large	8.33	Interchange
220	Stonebridge Park	NR	BCV	Bakerloo	see note below	see note below	see note below	2.59	see note below
221	Stratford	LUL	TLL	Jubilee	Suburban	Surface	Large	48.57	Interchange
222	Sudbury Hill	LUL	TLL	Piccadilly	Suburban	Surface	Small	2.01	Small/Medium
223	Sudbury Town	LUL	TLL	Piccadilly	Suburban	Surface	Small	2.06	Small/Medium
224	Swiss Cottage	LUL	TLL	Jubilee	Suburban	Deep Tube	Medium	6.91	Small/Medium
225	Temple	LUL	SSL	District	Urban	Cut and Cover	Medium	9.99	Small/Medium
226	Theydon Bois	LUL	BCV	Central	Suburban	Surface	Small	0.74	Small/Medium
227	Tooting Bec	LUL	TLL	Northern	Suburban	Deep Tube	Medium	6.56	Small/Medium
228	Tooting Broadway	LUL	TLL	Northern	Suburban	Deep Tube	Medium	13.04	Small/Medium
229	Tottenham Court Road	LUL	TLL	Northern	Urban	Deep Tube	Large	23.99	Interchange

	General Information - for all asset areas						Communications Information		Premises Information
	Station	**Owner**	**Infraco**	**Line**	**Urban/ Suburban**	**Surface/ Cut and Cover/ Deep Tube**	**Category (Based on Foundation Stations model)**	**Counts 2011 Entries/ exits (m)**	**Category**
230	Tottenham Hale	LUL	BCV	Victoria	Suburban	Deep Tube	Medium	8.86	Small/Medium
231	Totteridge & Whetstone	LUL	TLL	Northern	Suburban	Surface	Small	1.98	Small/Medium
232	Tower Hill	LUL	SSL	District	Urban	Cut and Cover	Medium	21.58	Small/Medium
233	Tufnell Park	LUL	TLL	Northern	Suburban	Deep Tube	Medium	3.55	Small/Medium
234	Turnham Green	LUL	SSL	District	Suburban	Surface	Medium	5.83	Small/Medium
235	Turnpike Lane	LUL	TLL	Piccadilly	Suburban	Deep Tube	Small	9.80	Small/Medium
236	Upminster	NR	SSL	District	see note below	see note below	see note below	4.56	see note below
237	Upminster Bridge	LUL	SSL	District	Suburban	Surface	Small	0.99	Small/Medium
238	Upney	LUL	SSL	District	Suburban	Surface	Small	2.11	Small/Medium
239	Upton Park	LUL	SSL	District	Suburban	Surface	Small	11.01	Small/Medium
240	Uxbridge	LUL	SSL	Metropolitan	Suburban	Surface	Medium	6.91	Small/Medium
241	Vauxhall	LUL	BCV	Victoria	Urban	Deep Tube	Medium	20.87	Small/Medium
242	Victoria	LUL	BCV	Victoria	Urban	Deep Tube	Mega	82.25	Interchange
243	Walthamstow Central	NR	BCV	Victoria	Suburban	Deep Tube	Medium	14.32	Small/Medium
244	Wanstead	LUL	BCV	Central	Suburban	Deep Tube	Medium	2.57	Small/Medium
245	Warren Street	LUL	BCV	Victoria	Urban	Deep Tube	Large	15.69	Interchange
246	Warwick Avenue	LUL	BCV	Bakerloo	Suburban	Deep Tube	Medium	4.30	Small/Medium
247	Waterloo	LUL	TLL	Jubilee	Urban	Deep Tube	Mega	84.12	Major Interchange
248	Watford	LUL	SSL	Metropolitan	Suburban	Surface	Medium	1.57	Small/Medium
249	Wembley Central	NR	BCV	Bakerloo	see note below	see note below	see note below	4.56	see note below
250	Wembley Park	LUL	TLL	Jubilee	Suburban	Surface	Large	9.66	Interchange
251	West Acton	LUL	BCV	Central	Suburban	Surface	Small	1.62	Small/Medium
252	West Brompton	LUL	SSL	District	Urban	Surface	Small	4.25	Small/Medium
253	West Finchley	LUL	TLL	Northern	Suburban	Surface	Small	1.37	Small/Medium
254	West Ham	LUL	TLL	Jubilee	Suburban	Surface	Large	3.42	Small/Medium
255	West Hampstead	LUL	TLL	Jubilee	Suburban	Surface	Small	8.23	Small/Medium
256	West Harrow	LUL	SSL	Metropolitan	Suburban	Surface	Small	1.08	Small/Medium
257	West Kensington	LUL	SSL	District	Urban	Surface	Small	4.64	Small/Medium
258	West Ruislip	LUL	BCV	Central	Suburban	Surface	Medium	1.64	Small/Medium
259	Westbourne Park	LUL	SSL	Metropolitan	Suburban	Surface	Small	3.03	Small/Medium
260	Westminster	LUL	TLL	Jubilee	Urban	Deep Tube	Large	20.78	Interchange
261	White City	LUL	BCV	Central	Suburban	Surface	Medium	7.74	Small/Medium
262	Whitechapel	LUL	SSL	District	Suburban	Surface	Medium	12.62	Interchange
263	Willesden Green	LUL	TLL	Jubilee	Suburban	Surface	Small	7.81	Small/Medium
264	Willesden Junction	NR	BCV	Bakerloo	see note below	see note below	see note below	3.92	see note below
265	Wimbledon	NR	SSL	District	see note below	see note below	see note below	11.75	see note below
266	Wimbledon Park	LUL	SSL	District	Suburban	Surface	Small	2.00	Small/Medium
267	Wood Green	LUL	TLL	Piccadilly	Suburban	Deep Tube	Medium	11.35	Small/Medium
268	Wood Lane	LUL	SSL	Metropolitan	Suburban	Surface?	Small	3.44	Small/Medium
269	Woodford	LUL	BCV	Central	Suburban	Surface	Small	4.89	Small/Medium
270	Woodside Park	LUL	TLL	Northern	Suburban	Surface	Small	2.69	Small/Medium

Key

(green)	Typical 2 Platform Station (Surface)	Small
(yellow)	2 platforms or more and/or 2 booking halls (Sub Surface)	Medium
(orange)	Interchange or NR terminus station	Large
(red)	Largest Stations	Mega

Note: Any equipment put on to a Network Rail station purely for the benefit of LU then belongs to LU and should be reported in the ACR in the appropriate asset area.
If the entity is the TOC at a NR station then it is also required to perform the TOC duties and include those assets in the ACR Report.

The stations with the comment "see note below" are included so that there is a complete list of stations served by London Underground.

ACR Concerns Workbook Template

The master version of the concerns workbook shall contain the columns shown below;

FUNCTIONAL CONDITION CONCERNS

Asset Group	
Company	

Reference No.			Location(s)	BCV				JNP			SSL			Asset Hierarchy Details		
Group	Company	Unique Reference Number	Location(s)	Bak	Cen	Vic	W&C	Jub	Nor	Pic	C&H	Dis	Met	Subasset Group	Subasset Affected	ACR No.

Concern Details		
Concern Description	Control and/or Mitigation	Plan to Ensure Future Legal Compliance [Code 1 Concerns Only]

No. of Assets with Concern			Frequency				Code 1	Code 2			
No. of Assets with Concern	Total Asset Population on Selected Line(s)	% of Assets Affected	No. Base Events per Asset (i.e. for ONE asset with the Concern)	Every	Unit of Time	Annual Frequency of Concern per Asset	Code 1	Code 2	Top Event	Base Event	Total Annual Safety Risk (£) (Top 20 Events Only)

VoT	8.82

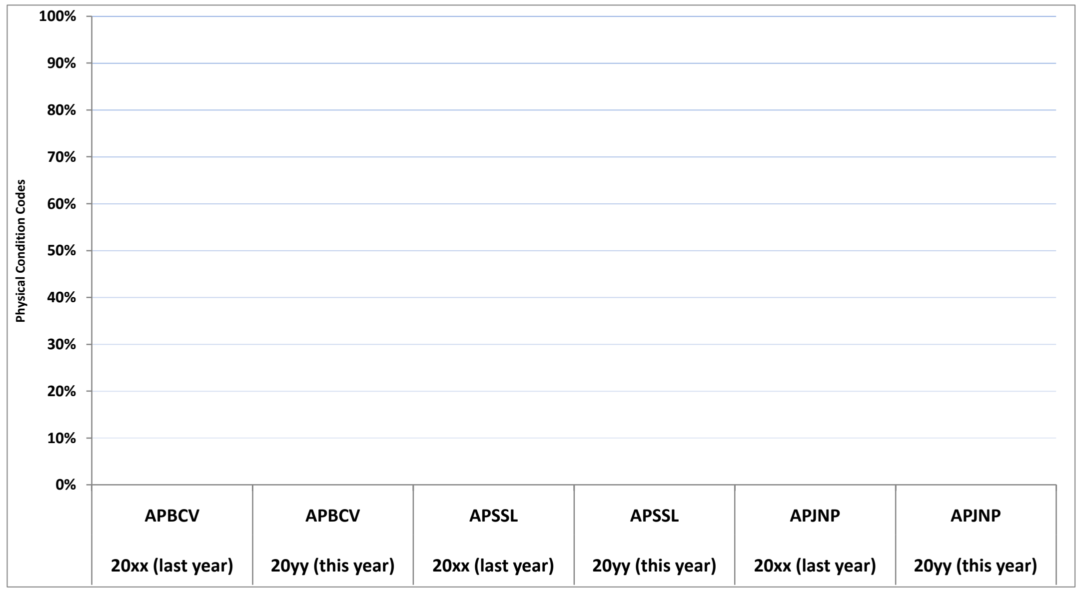
Code 3		Code 4					Degradation Concern
Code 3	Total Annual Uneconomic and/or Unsustainable Cost (£)	Code 4	Type of Consequence	Total ONE Day LCH Impact for ALL Assets with Concern	Average Estimated Duration (Days)	Total Annual Performance Risk (£) [Frequency Section Must Be Completed]	Physical Condition Code

ACR Summary Report Template

Asset Group

ACR Physical Condition

		A	B	C	D
20xx (last year)	APBCV				
20yy (this year)	APBCV				
20xx (last year)	APSSL				
20yy (this year)	APSSL				
20xx (last year)	APJNP				
20yy (this year)	APJNP				



APBCV Physical Condition Commentary

Insert commentary here describing reasons for any significant changes to physical condition profile, compared to previous year.

APSSL Physical Condition Commentary

Insert commentary here describing reasons for any significant changes to physical condition profile, compared to previous year.

APJNP Physical Condition Commentary

Insert commentary here describing reasons for any significant changes to physical condition profile, compared to previous year.

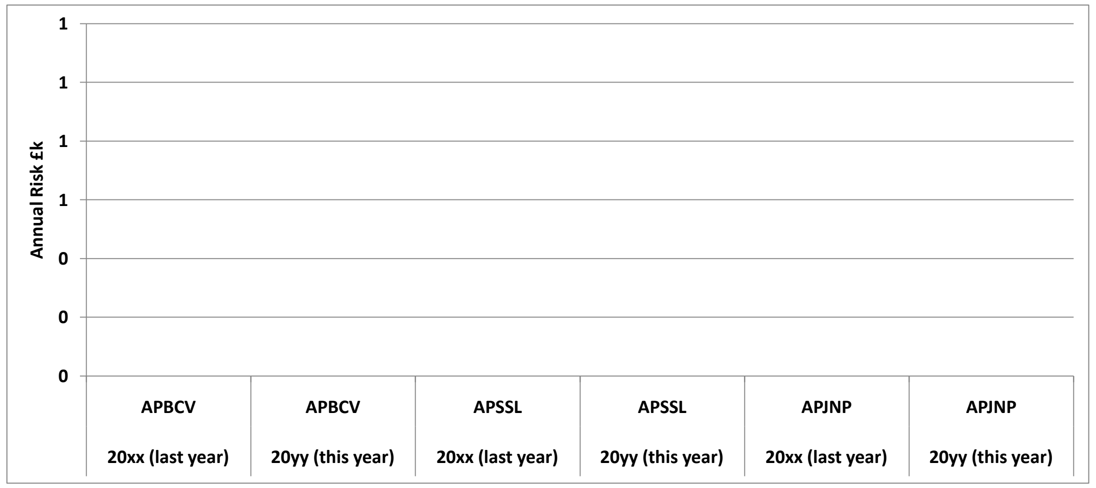
Asset Group

ACR Functional Concerns (1-4): APBCV, APSSL & APJNP

		No.
		Code 1
20xx (last year)	APBCV	
20yy (this year)	APBCV	
20xx (last year)	APSSL	
20xx (last year)	APSSL	
20xx (last year)	APJNP	
20yy (this year)	APJNP	

		Annual Risk £k		
		Code 2	Code 3	Code 4
20xx (last year)	APBCV			
20yy (this year)	APBCV			
20xx (last year)	APSSL			
20yy (this year)	APSSL			
20xx (last year)	APJNP			
20yy (this year)	APJNP			

Graph: ACR Codes 2, 3 & 4



APBCV Functional Concerns Commentary

Code 1	Insert commentary here describing the most significant Code 1 concerns. Comment on the reasons for any significant changes to the quantity of Code 1 concerns compared to the previous year.
Code 2	Insert commentary here describing the most significant Code 2 concerns. Comment on the reasons for any significant changes to the total annual value of Code 2 concerns compared to the previous year.
Code 3	Insert commentary here describing the most significant Code 3 concerns. Comment on the reasons for any significant changes to the total annual value of Code 3 concerns compared to the previous year.
Code 4	Insert commentary here describing the most significant Code 4 concerns. Comment on the reasons for any significant changes to the total annual value of Code 4 concerns compared to the previous year.

APSSL Functional Concerns Commentary

Code 1	Insert commentary here describing the most significant Code 1 concerns. Comment on the reasons for any significant changes to the quantity of Code 1 concerns compared to the previous year.
Code 2	Insert commentary here describing the most significant Code 2 concerns. Comment on the reasons for any significant changes to the total annual value of Code 2 concerns compared to the previous year.
Code 3	Insert commentary here describing the most significant Code 3 concerns. Comment on the reasons for any significant changes to the total annual value of Code 3 concerns compared to the previous year.
Code 4	Insert commentary here describing the most significant Code 4 concerns. Comment on the reasons for any significant changes to the total annual value of Code 4 concerns compared to the previous year.

APJNP Functional Concerns Commentary

Code 1	Insert commentary here describing the most significant Code 1 concerns. Comment on the reasons for any significant changes to the quantity of Code 1 concerns compared to the previous year.
Code 2	Insert commentary here describing the most significant Code 2 concerns. Comment on the reasons for any significant changes to the total annual value of Code 2 concerns compared to the previous year.
Code 3	Insert commentary here describing the most significant Code 3 concerns. Comment on the reasons for any significant changes to the total annual value of Code 3 concerns compared to the previous year.
Code 4	Insert commentary here describing the most significant Code 4 concerns. Comment on the reasons for any significant changes to the total annual value of Code 4 concerns compared to the previous year.

UNDERGROUND

S1042 Asset Condition Reporting (ACR)

Civils

1.1.1 Basis of Condition Reporting for Civils

ACR No.	FD* No.	Asset Description	RAV (k)	Unit	Nominal Life	Source of Nominal Life
1000		**Bridges and Structures**				
1001	101	Cable, Pipe, Bridge	250	each	N/A	N/A
1002	102	Foot, Bridge	250	each	N/A	N/A
1003	103	Overline Bridge	1500	each	N/A	N/A
1004	103	Overline Bridge (Large)	4000	each	N/A	N/A
1005	104	Underline Bridge	2000	each	N/A	N/A
1006	104	Underline Bridge (Large)	6000	each	N/A	N/A
1007	105	Viaduct	50	metre	N/A	N/A
1008	121	Cable Post Runs	15	Kilometre	N/A	N/A
1009	122	Cable Stiles	5	each	N/A	N/A
1010	123	Cable Draw Chamber	50	each	N/A	N/A
1011	141	Canopy (Platform)	800	each	N/A	N/A
1012	142	Canopy (Station Entrance)	50	each	N/A	N/A
1013	161	Chimney - Concrete or Masonry	250	each	N/A	N/A
1014	162	Chimney - Metal	250	each	N/A	N/A
1015	181	Covered Way	either 50	metre	N/A	N/A
			or 10	metre squared	N/A	N/A
1016	201	Culvert 600 diameter or over	150	each	N/A	N/A
1017	221	Escalator Machine Room steelwork	250	each	N/A	N/A
1018	241	Escalator Support Structures	250	each	N/A	N/A
1019	261	Girdering	1500	each	N/A	N/A
1020	281	Lift Support Structures	500	each	N/A	N/A
1021	301	Linear Station Staircase	25	each	N/A	N/A
1022	321	Load Gauge	100	each	N/A	N/A
1023	341	Pipe Crossing Over Track	3000	each	N/A	N/A
1024	342	Pipe Crossing Under Tack	150	each	N/A	N/A
1025	361	Platform (Station)	1600	each	N/A	N/A
1026	362	Disused Station	2000	each	N/A	N/A
1027	363	Sub-Station Premises	250	each	N/A	N/A
1028	381	Roof Structure and support	2000	each	N/A	N/A
1029	401	Shafts	450	each	N/A	N/A
1030	402	Shafts - Cable	450	each	N/A	N/A
1031	403	Shafts - Disused	450	each	N/A	N/A
1032	404	Shafts - Lift	450	each	N/A	N/A
1033	405	Shafts - Pump	450	each	N/A	N/A
1034	421	Signal Gantry	100	each	N/A	N/A
1035	422	Access Gantry or Access Platform	10	each	N/A	N/A
1060	423	Travelling Access Gantry	100	each	N/A	N/A
1036	441	Spiral Staircase	35	each	N/A	N/A
1037	461	Subway	3000	each	N/A	N/A
1038	481	Brick Tunnel	70	metre	N/A	N/A
1039	501	Ventilation Plant / Ventilator	500	each	N/A	N/A
1040	521	Ventilator (struts)	5000	each	N/A	N/A
1041	541	Boundary Wall (free standing wall)	50	each	N/A	N/A
1042	542	Dry Stone Walls	100	each	N/A	N/A
1043	543	Gabion Walls	100	each	N/A	N/A
1044	544	Retaining Walls <1m in height	100	each	N/A	N/A
1045	545	Retaining Walls >1m in height	250	each	N/A	N/A
1046	546	Non - Boundary Wall (free standing wall)	50	each	N/A	N/A
1064	547	Vehicle Collision Protection Barrier	50	each	N/A	N/A
1047	561	Water Tower	250	each	N/A	N/A
1048	571	Lighting Tower	200	each	N/A	N/A
1049	572	Lighting Standard	2	each	N/A	N/A
1050	573	Lighting Mast	100	each	N/A	N/A
1061	580	River Pier	500	each	N/A	N/A
1062	590	Advertising Hoarding	50	each	N/A	N/A
1051	601	Side Hinged watertight door	500	each	N/A	N/A
1052	602	Horizontal Sliding watertight door	500	each	N/A	N/A
1053	603	Horizontal Sliding electro-mechanical	2500	each	N/A	N/A
1054	604	Top Hinged electro-mechanical Floodgate	2500	each	N/A	N/A
1055	605	Sector Gate	1000	each	N/A	N/A
1056	606	Hydraulic Floodgate	3000	each	N/A	N/A
1057	607	Diaphragm Floodgate	2000	each	N/A	N/A
1058	608	Vertically sliding Floodgate	2500	each	N/A	N/A
1058	609	Penstock Chamber	500	each	N/A	N/A
1063	610	Station Flood Board	10	each	N/A	N/A

* Foundation Document No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

1.1.1 Basis of Condition Reporting for Civils

ACR No.	FD* No.	Asset Description	RAV (k)	Unit	Nominal Life	Source of Nominal Life
2000		**Deep Tube Tunnels**				
2001	101	Platform or Concourse Tunnels	33.33	metre	N/A	N/A
2002	102	Station Passageway Tunnels	10.7	metre	N/A	N/A
2003	103	Running Tunnels	10.7	metre	N/A	N/A
2004	104	Cross Passages Between Running Tunnels	10.7	metre	N/A	N/A
2005	105	Step Plate Junctions	46.0	metre	N/A	N/A
2006	106	Crossover Tunnels	67.0	metre	N/A	N/A
2007	107	Depot Approach Tunnels (e.g. London Road)	10.7	metre	N/A	N/A
2008	108	Overrun Tunnel	10.7	metre	N/A	N/A
2009	109	Siding Tunnels	10.7	metre	N/A	N/A
2010	110	Inclined Shafts (e.g. escalator shafts)	33.33	metre	N/A	N/A
2011	111	Vertical Shafts (e.g. ventilation; access; service; lift; and substation shafts).	10.7	metre	N/A	N/A
2012	112	Disused Tunnels	10.7	metre	N/A	N/A
2013	113	Disused Shafts	10.7	metre	N/A	N/A
2014	114	Other Tunnels	10.7	metre	N/A	N/A
2015	115	Miscellaneous Structures (e.g. TTMS)	10.7	metre	N/A	N/A
3000		**Earth Structures**				
3001	100	Embankments (where material has been placed > 1m above original ground level to support the track asset)	2.0	metre	N/A	N/A
3002	200	Cuttings (where an excavation has been formed >1m below original ground level to carry the track asset)	1.5	metre	N/A	N/A
4000		**Pumps & Drainage**				
4100	**100**	**Pump Drainage****				
4101	101	Pump Control Panel / Small - Simple	3.69	each	N/A	N/A
4102	102	Pump Control Panel / Medium - Non Critical	7.37	each	N/A	N/A
4103	103	Pump Control Panel / Large - Critical	11.06	each	N/A	N/A
4104	104	Pump Control Panel / JLE and Victoria - Critical extra large	14.74	each	N/A	N/A
4105	105	Pumps Auxiliary Panels	1.84	each	N/A	N/A
4106	106	Auxillary Isolator	0.37	each	N/A	N/A
4110	110	Pumping Mains - suction and delivery / Surface	0.15	per 10 metres	N/A	N/A
4111	111	Pumping Mains - suction and delivery / Buried	0.59	per 10 metres	N/A	N/A
4112	112	Pumping Mains - suction and delivery / JLE and Victoria - extra large	0.44	per 10 metres	N/A	N/A
4113	113	Vent System - dedicated to pumping system	0.33	per 10 metres	N/A	N/A
4120	120	Valves / Mechanical small	0.15	each	N/A	N/A
4121	121	Valves / Mechanical large	0.37	each	N/A	N/A
4122	122	Valves / Electrical	0.92	each	N/A	N/A
4130	130	Pumps / Submersible - small	0.29	each	N/A	N/A
4131	131	Pumps / Submersible - medium	2.21	each	N/A	N/A
4132	132	Pumps / Submersible - large	3.69	each	N/A	N/A
4133	133	Pumps / Strate	11.06	each	N/A	N/A
4134	134	Pumps / Sewage handling unit	11.06	each	N/A	N/A
4135	135	Pumps / Centrifugal (GGG or similar)	5.90	each	N/A	N/A
4136	136	Pumps / Centrifugal (Varisco or similar)	1.11	each	N/A	N/A
4137	137	Pumps / JLE and Victoria - extra large	8.84	each	N/A	N/A
4140	140	Pump control gear including sensors, level probes, transducers etc. / Critical	2.21	per sump	N/A	N/A
4141	141	Pump control gear including sensors, level probes, transducers etc. / Non-critical	1.11	per sump	N/A	N/A
4142	142	Pump control gear including sensors, level probes, transducers etc. / Simple	0.37	per sump	N/A	N/A
4143	143	Pump control gear including sensors, level probes, transducers etc. / JLE and Victoria - extra large	3.69	per sump	N/A	N/A
4150	150	Pump alarm systems / Local	1.47	each system	N/A	N/A
4151	151	Pump alarm systems / Remote - SCADA	4.42	each system	N/A	N/A
4160	160	Sumps / Small (typically up to 1m plan size and 1.5m deep) larger would typically be a B&S asset	4.42	each	N/A	N/A
4161	161	Tanks / Small	1.47	each	N/A	N/A
4162	162	Tanks / Medium	2.95	each	N/A	N/A
4163	163	Tanks / Large	7.37	each	N/A	N/A
4164	164	Tanks / Saniflo	0.74	each	N/A	N/A
4170	170	Cables / Power	0.07	per 10 metres	N/A	N/A
4171	171	Cables / Alarm / Indication	0.04	per 10 metres	N/A	N/A
4300	**300*****	**Station Drainage - Section 12**				
4301	301	Buried Gravity Drainage Pipes	0.35	metre	N/A	N/A
4302	302	Venting Pipes	1	each	N/A	N/A
4303	303	Manholes	12.5	manhole	N/A	N/A
4304	304	Inspection Chamber	5	chamber	N/A	N/A
4305	305	Channels (including gratings)	0.2	metre	N/A	N/A
4306	306	Gullies	1	each	N/A	N/A
4307	307	Grease Traps	3	each	N/A	N/A
4308	308	Oil interceptors	5	each	N/A	N/A
4309	309	Drip Trays	2.5	each	N/A	N/A
4310	310	Sumps	3	sump	N/A	N/A

ACR No.	FD* No.	Asset Description	RAV (k)	Unit	Nominal Life	Source of Nominal Life
4311	311	Flow Control Device	1	each	N/A	N/A
4400	**400**	**Station Drainage - Non Section 12**				
4401	401	Buried Gravity Drainage Pipes	0.22	metre	N/A	N/A
4402	402	Venting Pipes	0.5	each	N/A	N/A
4403	403	Manholes	7.5	manhole	N/A	N/A
4404	404	Inspection Chamber	4	chamber	N/A	N/A
4405	405	Channels (including gratings)	0.12	metre	N/A	N/A
4406	406	Gullies	0.75	each	N/A	N/A
4407	407	Grease Traps	2.5	each	N/A	N/A
4408	408	Oil interceptors	4	each	N/A	N/A
4409	409	Drip Trays	2	each	N/A	N/A
4410	410	Sumps	2.5	each	N/A	N/A
4411	411	Flow Control Device	0.75	each	N/A	N/A
4500	**500**	**Track and Off Track Drainage - Section 12**	Drains in sub surface area: 0.7 per metre - for non brick 1.0 per metre - for open cut (brick drain) Catchpits: 6.0 per catchpit Syphon: 500 per syphon			
4501	501	Gravity Pipes - Non Brick			N/A	N/A
4502	502	Gravity Pipes - Brick			N/A	N/A
4503	503	Venting Pipes			N/A	N/A
4504	504	Catchpits			N/A	N/A
4505	505	Manholes			N/A	N/A
4506	506	Flow control device			N/A	N/A
4507	507	Storage Tank			N/A	N/A
4508	508	Channels			N/A	N/A
4509	509	Syphon			N/A	N/A
4510	510	Gratings			N/A	N/A
4511	511	Pipe Crossings up to 600 mm nominal bore			N/A	N/A
4512	512	Sumps			N/A	N/A
4513	513	Interstices between the pipe bedding			N/A	N/A
4514	514	Trench backfill			N/A	N/A
4600	**600**	**Track and Off Track Drainage - Non Section 12**	Drains in open track area: 0.700 per metre - for open cut (20% of track drain was assumed in this category) Drains in open track area: 0.310 per metre - for trenchless (80% of track drain was assumed in this category) Drains in open track area: An average track drainage cost - 0.388 per metre Catchpit: 6.0 per catchpit Syphon: 500 per syphon Ditch:0.08 per metre			
4601	601	Gravity Pipes - Non Brick			N/A	N/A
4602	602	Gravity Pipes - Brick			N/A	N/A
4603	603	Venting Pipes			N/A	N/A
4604	604	Catchpits			N/A	N/A
4605	605	Manholes			N/A	N/A
4606	606	Soakaways			N/A	N/A
4607	607	Flow control device			N/A	N/A
4608	608	Storage Tank			N/A	N/A
4609	609	Channels			N/A	N/A
4610	610	Syphon			N/A	N/A
4611	611	Gratings			N/A	N/A
4612	612	Pipe Crossings up to 600 mm nominal bore			N/A	N/A
4613	613	Open ditches			N/A	N/A
4614	614	Screens			N/A	N/A
4615	615	Oil interceptors			N/A	N/A
4616	616	Sumps			N/A	N/A
4617	617	Interstices between the pipe bedding			N/A	N/A
4618	618	Trench backfill			N/A	N/A

* Foundation Document No. To provide cross reference to ACAC Foundation document reference numbering

** Note: Pumping System: All equipment associated with a pump control panel.

*** In the Foundation Document numbering system for 'Pumps & Drainage' 200 was previously used for 'Pump Drainage - Non Section 12'; however, the distinction between Section 12 and Non-Section 12 Pump Drainage has been removed, with both now being covered under 100 in the hierarchy, so 200 is no longer required. To avoid confusion 4200 is not used in the ACR Hierarchy either.

1.1.2 Asset Definitions for Civils

ACR No.	FD* No.	Asset Definition
4100		**Bridges and Structures**
4101	101	Bridge - Cable & Pipe; a structure that covers or spans a gap and carries cables and pipes.
4102	102	Bridge - Foot; a structure that covers or spans a gap and carries pedestrian traffic.
1003/1004	103	Bridge - Overline; a structure that covers or spans a gap and carries public or private road traffic.
1005/1006	104	Bridge - Underline; a structure that covers or spans a gap and carries rail traffic.
1007	105	Bridge - Viaduct; a structure composed of at least 3 masonry arches that cover or span gaps and carry road or rail traffic.
1008	121	Cable Post Run; a series of posts installed alongside the railway tracks which carry signal and traction cables and usually an air main.
1009	122	Cable Stiles; a series of steps to allow pedestrian access over a cable post run.
1010	123	Cable Draw Chamber - a structure forming a void below ground level with or without a roof, used for the drawing of cables, and containing cables.
1011	141	Canopy (Platform); a roof structure covering all or part of a station platform to provide passengers with shelter from the weather.
1012	142	Canopy (Station Entrance) - a covered structure over the area in front of the station entrance.
1013	161	Chimney - Concrete or Masonry; a hollow vertical structure of masonry that carries combustion products or steam away from an engine boiler or fire.
1014	162	Chimney - Metal; a hollow vertical structure that carries combustion products away from an engine boiler or fire.
1015	181	Covered Way; a structure that covers or spans a gap which is at least twice as wide as its span and is constructed by excavating a trench and then constructing the spanning members.
1016	201	Culvert; a structure that covers or spans a gap under the track through which water flows.
1017	221	Escalator Machine Room Steelwork: The structural steel beams, columns, floor slab and floor trays but not floor plates forming the roofs of Escalator Machine chambers.
1018	241	Escalator Support Structures: The structural truss and the foundations of the truss which carry the escalator machinery including floor plates, BUT only where these trusses are manufactured and installed separately from the escalator machinery. Where trusses are delivered and installed as a complete package including escalator machinery and where they do not provide support for the machine room roofs, they are classified as a Lift and Escalator Asset.
1019	261	Girdering; a structure that covers or spans a gap and is composed of multiple columns and beams with infill slabs.
1020	281	Lift Support Structures; including a 3 dimensional tower composed of structural steel elements which carries loads from passenger/goods lift components.
1021	301	Linear Station Staircase; a single or multiple staircase in a station consisting entirely of straight structural elements, but not including stairs resting on and supported by soil or fill. Where Linear Station Staircases carry walls and or roofs, these walls and roofs shall be considered to be part of the staircase.
1022	321	Load Gauge; a structure that carries a profile of the load gauge.
1023	341	Pipe Crossing Over Track; a structure spanning over LUL tracks that supports a pipe carrying fluids.
1024	342	Pipe Crossing Under Track; a circular or oval hollow prismatic structure under LUL tracks that supports dead and live railway loading and conducts fluids within itself.
1025	361	Platform (Station); an elevated level surface alongside the railway for the purpose of enabling passengers to enter or leave trains.
1026	362	Disused Station; a station structure/premises no longer in operational use
1027	363	Sub- Station Premises. A place in the electrical transmission system where the voltage of the electric current is transfomed.
1028	381	Roof Structure & Support; a structure that covers or forms the top of a building.
1029	401	Shaft; the structural components within a vertical passageway giving access to the railway.
1030	402	Shaft - Cable; the structural components within a vertical passageway giving access to the railway and used for carrying cables.
1031	403	Shaft - Disused; the structural components within a vertical passageway giving access to the railway that now has no operational use.
1032	404	Shaft - Lift; the structural components within a vertical passageway giving access to the railway that contains a lift.
1033	405	Shaft - Pump; a vertical passageway that contains a pump carrying fluids.
1034	421	Signal Gantry; a metal framed structure carrying a signal or signals.
1035	422	Access Gantry or Access Platform – a fixed metal structure providing access to an installation.
1060	423	Travelling Access Gantry - A moveable framework travelling on a rail system fixed to a structure or building for the purpose of servicing that building.
1036	441	Spiral Stairway; a staircase following a plane curve formed by a point winding about a fixed point at an ever increasing distance from it.
1037	461	Subway; an underground passageway.
1038	481	Tunnel - Brick; an adit constructed of brick for the passage of trains.
1039	501	Ventilation Plant; a structure, or a number of structures of steel, concrete or brick, or a combination of these used as a duct to introduce fresh air or remove vitiated air from the railway system.
1040	521	Ventilator; an opening to ventilate the railway.
1041	541	Wall - Boundary; free standing vertical structure made of brick, stone or concrete with a length and height much greater than its thickness, delineating LUL ownership.
1042	542	Wall - Drystone; a vertical structure made of stone or concrete blocks which retains soil.
1043	543	Wall - Gabion; a vertical structure made of stone filled gabion baskets which retains soil.
1044	544	Wall - Retaining <1m high; a vertical structure less than 1m height made of brick or concrete with a length and height greater than its width which retains soil.
1045	545	Wall - Retaining >1m high; a vertical structure greater than 1m height made of brick or concrete with a length and height greater than its width which retains soil.
1046	546	Wall - Non-Boundary; free standing vertical structure made of brick, stone or concrete with a length and height much greater than its thickness.
1064	547	Vehicle Collision Protection Barrier; an installation provided to prevent errant road vehicles penetrating the railway or impacting LU assets.
1047	561	Water Tower; a structure carrying an elevated cistern containing water.
1048	571	Lighting Tower - a metal framed structure supporting flood lighting. Required to perform to lighting standard.
1049	572	Lighting Standard - a vertical single member structure of steel or reinforced concrete carrying electric lighting.
1050	573	Lighting Mast - a vertical single member metal structure carrying an array of lights.
1061	580	River Pier - A structure projecting from the shore into a river used as a landing stage for boats.
1062	590	Advertising Hoarding - A large free standing board used to display advertisments.
1051	601	Side Hinged Watertight Door - A manually operated flat construction fabricated from metal and hinged in a frame on a vertical edge to close an opening so that the entry of water is prevented.
1052	602	Horizontal sliding watertight door - A manually operated flat construction fabricated from metal and sliding on horizontal tracks to close an opening so that the entry of water is prevented.
1053	603	Horizontal sliding electro-mechanical floodgate - A gate operated by a combination of mechanical and electrical means fabricated from metal and sliding on horizontal tracks to close an opening so that the entry of water is prevented.
1054	604	Top Hinged electro mechanical floodgate - A gate operated by a combination of mechanical and electrical means fabricated from metal and hinged on its top edge to close an opening so that the entry of water is prevented.
1055	605	Sector Gate A gate fabricated from metal, a vertical section of which forms the sector of a circle and sliding on tracks which form the sector of a circle to close an opening so that the entry of water is prevented.
1056	606	Hydraulic Floodgate - A gate operated by hydraulic means fabricated from metal and hinged on its top edge to close an opening so that the entry of water is prevented.
1057	607	Diaphragm Floodgate - A manually erected flat construction fabricated from metal and bolted to a frame to close an opening so that the entry of water is prevented.
1058	608	Vertically Sliding Floodgate - A gate operated by manual or electro-mechanical means and fabricated from metal which is raised and lowered vertically and seals against a frame to prevent the entry of water.

ACR No.	FD* No.	Asset Definition
1059	609	Penstock Chamber - A chamber containing penstocks which are connected to a watercourse via a pipe and which could be used to dewater a flooded tunnel.
1063	610	Flood Board - Removable board(s) fitted between guides at entrances to buildings and infrastructure to prevent the ingress of water.

ACR No.	FD* No.	Asset Definition
3000		**Earth Structures**
3001	100	Embankments (where material has been placed > 1m above original ground level to support the track asset)
3002	200	Cuttings (where an excavation has been formed >1m below original ground level to carry the track asset)

1.1.2 Asset Definitions for Civils		
Deep Tube Tunnel, Earth Structures and Pumps & Drainage Definitions		
4000		**Pumps & Drainage**
4100	1000	Pumping System: All equipment associated with a pump control panel

1.1.4 Reporting Requirements for Bridges and Structures

1.1.4.1 Bridges & Structures ACR - all Lines

		Bridges and Structures – all Lines								
			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	FD* No.	Actuals:					Quantity	£ Risk	£ Risk	£ Risk
1000		**Bridges and Structures:**								
1001	101	Cable, Pipe, Bridge								
1002	102	Foot, Bridge								
1003	103	Overline Bridge								
1004	103	Overline Bridge (large)								
1005	104	Underline Bridge								
1006	104	Underline Bridge (large)								
1007	105	Viaduct								
1008	121	Cable Post Runs								
1009	122	Cable Stiles								
1010	123	Cable Draw Chamber								
1011	141	Canopy (Platform)								
1012	142	Canopy (Station Entrance)								
1013	161	Chimney - Concrete or Masonry								
1014	162	Chimney - Metal								
1015	181	Covered Way								
1016	201	Culvert 600 diameter or over								
1017	221	Escalator Machine Room steelwork								
1018	241	Escalator Support Structures								
1019	261	Girdering								
1020	281	Lift Support Structures								
1021	301	Linear Station Staircase								
1022	321	Load Gauge								
1023	341	Pipe Crossing Over Track								
1024	342	Pipe Crossing Under Tack								
1025	361	Platform (Station)								
1026	362	Disused Station								
1027	363	Sub-Station Premises								
1028	381	Roof Structure and support								
1029	401	Shafts								
1030	402	Shafts - Cable								
1031	403	Shafts - Disused								
1032	404	Shafts - Lift								
1033	405	Shafts - Pump								
1034	421	Signal Gantry								
1035	422	Access Gantry or Access Platform								
1060	423	Travelling Access								

		Bridges and Structures – all Lines								
			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	**FD* No.**	**Actuals:**					**Quantity**	**£ Risk**	**£ Risk**	**£ Risk**
1036	441	Spiral Staircase								
1037	461	Subway								
1038	481	Brick Tunnel								
1039	501	Ventilation Plant / Ventilator								
1040	521	Ventilator (struts)								
1041	541	Boundary Wall (free standing wall)								
1042	542	Dry Stone Walls								
1043	543	Gabion Walls								
1044	544	Retaining Walls <1m in height								
1045	545	Retaining Walls >1m in height								
1046	546	Non - Boundary Wall (free standing wall)								
1064	547	Vehicle Collision Protection Barrier								
1047	561	Water Tower								
1048	571	Lighting Tower								
1049	572	Lighting Standard								
1050	573	Lighting Mast								
1061	580	River Pier								
1062	590	Advertising								
1051	601	Side Hinged watertight door								
1052	602	Horizontal Sliding watertight door								
1053	603	Horizontal Sliding electro-mechanical								
1054	604	Top Hinged electro-mechanical Floodgate								
1055	605	Sector Gate								
1056	606	Hydraulic Floodgate								
1057	607	Diaphragm Floodgate								
1058	608	Vertically sliding Floodgate								
1059	609	Penstock Chamber								
1063	610	Flood Board								
		Bridges and Structures:								
		Previous								
		Actual								
		Variance								

1.1.4 Reporting Requirements for Bridges and Structures

1.1.4.2 Bridges & Structures ACR - by Line

Bridges and Structures – Summary Report for xxx Line

ACR No.	FD* No.	Actuals:	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant Quantity	Residual safety risk £ Risk	uneconomic/ unsustainable £ Risk	Risk of Performance Loss £ Risk
1000		**Bridges and Structures:**								
1001	101	Cable, Pipe, Bridge								
1002	102	Foot, Bridge								
1003	103	Overline Bridge								
1004	103	Overline Bridge (large)								
1005	104	Underline Bridge								
1006	104	Underline Bridge (large)								
1007	105	Viaduct								
1008	121	Cable Post Runs								
1009	122	Cable Stiles								
1010	123	Cable Draw Chamber								
1011	141	Canopy (Platform)								
1012	142	Canopy (Station Entrance)								
1013	161	Chimney - Concrete or Masonry								
1014	162	Chimney - Metal								
1015	181	Covered Way								
1016	201	Culvert 600 diameter or over								
1017	221	Escalator Machine Room steelwork								
1018	241	Escalator Support Structures								
1019	261	Girdering								
1020	281	Lift Support Structures								
1021	301	Linear Station Staircase								
1022	321	Load Gauge								
1023	341	Pipe Crossing Over Track								
1024	342	Pipe Crossing Under Tack								
1025	361	Platform (Station)								
1026	362	Disused Station								
1027	363	Sub-Station Premises								
1028	381	Roof Structure and support								
1029	401	Shafts								
1030	402	Shafts - Cable								
1031	403	Shafts - Disused								
1032	404	Shafts - Lift								
1033	405	Shafts - Pump								
1034	421	Signal Gantry								
1035	422	Access Gantry or Access Platform								
1060	423	Travelling Access								
1036	441	Spiral Staircase								
1037	461	Subway								
1038	481	Brick Tunnel								
1039	501	Ventilation Plant / Ventilator								
1040	521	Ventilator (struts)								

Bridges and Structures – Summary Report for xxx Line

			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	**FD* No.**	**Actuals:**					**Quantity**	**£ Risk**	**£ Risk**	**£ Risk**
1000		**Bridges and Structures:**								
1041	541	Boundary Wall (free standing wall)								
1042	542	Dry Stone Walls								
1043	543	Gabion Walls								
1044	544	Retaining Walls <1m in height								
1045	545	Retaining Walls >1m in height								
1046	546	Non - Boundary Wall (free standing wall)								
1064	547	Vehicle Collision Protection Barrier								
1047	561	Water Tower								
1048	571	Lighting Tower								
1049	572	Lighting Standard								
1050	573	Lighting Mast								
1061	580	River Pier								
1062	590	Advertising								
1051	601	Side Hinged watertight door								
1052	602	Horizontal Sliding watertight door								
1053	603	Horizontal Sliding electro-mechanical								
1054	604	Top Hinged electro-mechanical								
1055	605	Sector Gate								
1056	606	Hydraulic Floodgate								
1057	607	Diaphragm Floodgate								
1058	608	Vertically sliding Floodgate								
1059	609	Penstock Chamber								
1063	610	Flood Board								
		Bridges and Structures:								
		Previous								
		Actual								
		Variance								

Commentary on Variances:

A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

1.1.5 Reporting Requirements for Deep Tube Tunnels

1.1.5.1 Deep Tube Tunnel ACR - all Lines

ACR No.	FD* No.	Actuals:	Physical Condition Code A % RAV	Code B % RAV	Code C % RAV	Code D % RAV	Functional Condition Code 1 Statutory non compliant Quantity	Code 2 Residual safety risk £ Risk	Code 3 uneconomic/ unsustainable £ Risk	Code 4 Risk of Performance Loss £ Risk
		Deep Tube Tunnels – all Lines								
2000		**Deep Tube Tunnels:**								
2001	101	Platform or Concourse Tunnels								
2002	102	Station Passageway Tunnels								
2003	103	Running Tunnels								
2004	104	Cross Passages Between Running Tunnels								
2005	105	Step Plate Junctions								
2006	106	Crossover Tunnels								
2007	107	Depot Approach Tunnels (e.g. London Road)								
2008	108	Overrun Tunnel								
2009	109	Siding Tunnels								
2010	110	Inclined Shafts (e.g. escalator shafts)								
2011	111	Vertical Shafts (e.g. ventilation; access; service; lift; and substation shafts)								
2012	112	Disused Tunnels								
2013	113	Disused Shafts								
2014	114	Other Tunnels								
2015	115	Miscellaneous Structures (e.g. TTMS)								
		Deep Tube Tunnels:								
		Previous								
		Actual								
		Variance								

1.1.5 Reporting Requirements for Deep Tube Tunnels

1.1.5.2 Deep Tube Tunnel ACR - by Line

		Deep Tube Tunnels – Summary Report for xxx Line								
			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	**FD* No.**	**Actuals:**					**Quantity**	**£ Risk**	**£ Risk**	**£ Risk**
2000		**Deep Tube Tunnels:**								
2001	101	Platform or Concourse Tunnels								
2002	102	Station Passageway Tunnels								
2003	103	Running Tunnels								
2004	104	Cross Passages Between Running Tunnels								
2005	105	Step Plate Junctions								
2006	106	Crossover Tunnels								
2007	107	Depot Approach Tunnels (e.g. London Road)								
2008	108	Overrun Tunnel								
2009	109	Siding Tunnels								
2010	110	Inclined Shafts (e.g. escalator shafts)								
2011	111	Vertical Shafts (e.g. ventilation; access; service; lift; and substation shafts)								
2012	112	Disused Tunnels								
2013	113	Disused Shafts								
2014	114	Other Tunnels								
2015	115	Miscellaneous Structures (e.g. TTMS)								
		Deep Tube Tunnels:								
		Previous								
		Actual								
		Variance								

Commentary on Variances:
A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

1.1.6 Reporting Requirements for Earth Structures

1.1.6.1 Earth Structures ACR - all Lines

ACR No.	FD* No.	Earth Structures – all Lines	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
		Actuals:					Quantity	£ Risk	£ Risk	£ Risk
3000		**Earth Structures:**								
3001	100	Embankments								
3002	200	Cuttings								
		Earth Structures:								
		Previous								
		Actual								
		Variance								

1.1.6 Reporting Requirements for Earth Structures

1.1.6.2 Earth Structures ACR - by Lines

ACR No.	FD* No.	Earth Structures – Summary Report for xxx Line	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
		Actuals:					Quantity	£ Risk	£ Risk	£ Risk
3000		**Earth Structures:**								
3001	100	Embankments								
3002	200	Cuttings								
		Earth Structures:								
		Previous								
		Actual								
		Variance								

Commentary on Variances:
A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

1.1.7 Reporting Requirements for Pumps and Drainage

1.1.7.1 Pumps and Drainage ACR - all Lines

		Pumps and Drainage – all Lines								
			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
4000		**Actuals:**					**Quantity**	**£ Risk**	**£ Risk**	**£ Risk**
4100	**100**	**Pump Drainage**								
4101	101	Pump Control Panel / Small - Simple								
4102	102	Pump Control Panel / Medium - Non Critical								
4103	103	Pump Control Panel / Large - Critical								
4104	104	Pump Control Panel / JLE and Victoria - Critical extra large								
4105	105	Pumps Auxiliary Panels								
4106	106	Auxillary Isolator								
4110	110	Pumping Mains - suction and delivery / Surface								
4111	111	Pumping Mains - suction and delivery / Buried								
4112	112	Pumping Mains - suction and delivery / JLE and Victoria - extra large								
4113	113	Vent System - dedicated to pumping system								
4120	120	Valves / Mechanical small								
4121	121	Valves / Mechanical large								
4122	122	Valves / Electrical								
4130	130	Pumps / Submersible - small								
4131	131	Pumps / Submersible - medium								
4132	132	Pumps / Submersible - large								
4133	133	Pumps / Strate								
4134	134	Pumps / Sewage handling unit								
4135	135	Pumps / Centrifugal (GGG or similar)								
4136	136	Pumps / Centrifugal (Varisco or similar)								
4137	137	Pumps / JLE and Victoria - extra large								
4140	140	Pump control gear including sensors, level probes, transducers etc. / Critical								
4141	141	Pump control gear including sensors, level probes, transducers etc. / Non-critical								
4142	142	Pump control gear including sensors, level probes, transducers etc. / Simple								
4143	143	Pump control gear including sensors, level probes, transducers etc. / JLE and Victoria -								
4150	150	Pump alarm systems / Local								
4151	151	Pump alarm systems / Remote - SCADA								
4160	160	Sumps / Small (typically up to 1m plan size and 1.5m deep) larger would typically be a B&S asset								
4161	161	Tanks / Small								
4162	162	Tanks / Medium								
4163	163	Tanks / Large								
4164	164	Tanks / Saniflo								
4170	170	Cables / Power								
4171	171	Cables / Alarm / Indication								
4300	**300**	**Station Drainage - Section 12**								
4301	301	Buried Gravity Drainage Pipes								
4302	302	Venting Pipes								
4303	303	Manholes								
4304	304	Inspection Chamber								
4305	305	Channels (including gratings)								
4306	306	Gullies								
4307	307	Grease Traps								
4308	308	Oil interceptors								
4309	309	Drip Trays								
4310	310	Sumps								
4311	311	Flow Control Device								
4400	**400**	**Station Drainage - Non Section 12**								
4401	401	Buried Gravity Drainage Pipes								
4402	402	Venting Pipes								
4403	403	Manholes								
4404	404	Inspection Chamber								

		Pumps and Drainage – all Lines								
			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
4000		**Actuals:**					**Quantity**	**£ Risk**	**£ Risk**	**£ Risk**
4100	**100**	**Pump Drainage**								
4405	405	Channels (including gratings)								
4406	406	Gullies								
4407	407	Grease Traps								
4408	408	Oil interceptors								
4409	409	Drip Trays								
4410	410	Sumps								
4411	411	Flow Control Device								
4500	**500**	**Track and Off Track Drainage - Section 12**								
4401	501	Gravity Pipes - Non Brick								
4402	502	Gravity Pipes - Brick								
4403	503	Venting Pipes								
4404	504	Catchpits								
4405	505	Manholes								
4406	506	Flow control device								
4407	507	Storage Tank								
4408	508	Channels								
4409	509	Syphon								
4410	510	Gratings								
4411	511	Pipe Crossings up to 600 mm nominal bore								
4412	512	Sumps								
4413	513	Interstices between the pipe bedding								
4414	514	Trench backfill								
4600	**600**	**Track and Off Track Drainage - Non Section 12**								
4501	601	Gravity Pipes - Non Brick								
4502	602	Gravity Pipes - Brick								
4503	603	Venting Pipes								
4504	604	Catchpits								
4505	605	Manholes								
4506	606	Soakaways								
4507	607	Flow control device								
4508	608	Storage Tank								
4509	609	Channels								
4510	610	Syphon								
4511	611	Gratings								
4512	612	Pipe Crossings up to 600 mm nominal bore								
4513	613	Open ditches								
4514	614	Screens								
4515	615	Oil interceptors								
4516	616	Sumps								
4517	617	Interstices between the pipe bedding								
4518	618	Trench backfill								
		Pumps & Drainage:								
		Previous								
		Actual								
		Variance								

1.1.7 Reporting Requirements for Pumps and Drainage

1.1.7.2 Pumps and Drainage ACR - by Line

		Pumps and Drainage – all Lines								
			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
4000		Actuals:					Quantity	£ Risk	£ Risk	£ Risk
4100	100	Pump Drainage								
4101	101	Pump Control Panel / Small - Simple								
4102	102	Pump Control Panel / Medium - Non Critical								
4103	103	Pump Control Panel / Large - Critical								
4104	104	Pump Control Panel / JLE and Victoria - Critical extra large								
4105	105	Pumps Auxiliary Panels								
4106	106	Auxillary Isolator								
4110	110	Pumping Mains - suction and delivery / Surface								
4111	111	Pumping Mains - suction and delivery / Buried								
4112	112	Pumping Mains - suction and delivery / JLE and Victoria - extra large								
4113	113	Vent System - dedicated to pumping system								
4120	120	Valves / Mechanical small								
4121	121	Valves / Mechanical large								
4122	122	Valves / Electrical								
4130	130	Pumps / Submersible - small								
4131	131	Pumps / Submersible - medium								
4132	132	Pumps / Submersible - large								
4133	133	Pumps / Strate								
4134	134	Pumps / Sewage handling unit								
4135	135	Pumps / Centrifugal (GGG or similar)								
4136	136	Pumps / Centrifugal (Varisco or similar)								
4137	137	Pumps / JLE and Victoria - extra large								
4140	140	Pump control gear including sensors, level probes, transducers etc. / Critical								
4141	141	Pump control gear including sensors, level probes, transducers etc. / Non-critical								
4142	142	Pump control gear including sensors, level probes, transducers etc. / Simple								
4143	143	Pump control gear including sensors, level probes, transducers etc. / JLE and Victoria -								
4150	150	Pump alarm systems / Local								
4151	151	Pump alarm systems / Remote - SCADA								
4160	160	Sumps / Small (typically up to 1m plan size and 1.5m deep) larger would typically be a B&S asset								
4161	161	Tanks / Small								
4162	162	Tanks / Medium								
4163	163	Tanks / Large								
4164	164	Tanks / Saniflo								
4170	170	Cables / Power								
4171	171	Cables / Alarm / Indication								
4300	300	Station Drainage - Section 12								
4301	301	Buried Gravity Drainage Pipes								
4302	302	Venting Pipes								
4303	303	Manholes								
4304	304	Inspection Chamber								
4305	305	Channels (including gratings)								
4306	306	Gullies								
4307	307	Grease Traps								
4308	308	Oil interceptors								
4309	309	Drip Trays								
4310	310	Sumps								
4311	311	Flow Control Device								
4400	400	Station Drainage - Non Section 12								

4401	401	Buried Gravity Drainage Pipes								
4402	402	Venting Pipes								
4403	403	Manholes								
4404	404	Inspection Chamber								
4405	405	Channels (including gratings)								
4406	406	Gullies								
4407	407	Grease Traps								
4408	408	Oil interceptors								
4409	409	Drip Trays								
4410	410	Sumps								
4411	411	Flow Control Device								
4500	**500**	**Track and Off Track Drainage - Section 12**								
4401	501	Gravity Pipes - Non Brick								
4402	502	Gravity Pipes - Brick								
4403	503	Venting Pipes								
4404	504	Catchpits								
4405	505	Manholes								
4406	506	Flow control device								
4407	507	Storage Tank								
4408	508	Channels								
4409	509	Syphon								
4410	510	Gratings								
4411	511	Pipe Crossings up to 600 mm nominal bore								
4412	512	Sumps								
4413	513	Interstices between the pipe bedding								
4414	514	Trench backfill								
4600	**600**	**Track and Off Track Drainage - Non Section 12**								
4501	601	Gravity Pipes - Non Brick								
4502	602	Gravity Pipes - Brick								
4503	603	Venting Pipes								
4504	604	Catchpits								
4505	605	Manholes								
4506	606	Soakaways								
4507	607	Flow control device								
4508	608	Storage Tank								
4509	609	Channels								
4510	610	Syphon								
4511	611	Gratings								
4512	612	Pipe Crossings up to 600 mm nominal bore								
4513	613	Open ditches								
4514	614	Screens								
4515	615	Oil interceptors								
4516	616	Sumps								
4517	617	Interstices between the pipe bedding								
4518	618	Trench backfill								
		Pumps & Drainage:								
		Previous								
		Actual								
		Variance								

1.1.8 Detail reports for Civils ACR

company shall submit a report with the asset condition classifications for all asset subgroups as detailed in 1.1.1 Basis of Condition Reporting for Civils for each of the locations for which it is responsible.

This report shall include the following data and is consistent with the requirements of the ACAC Cat 1 Standard:

Fields required:	Definition:
Line	Line the asset is allocated to
Equipment Reference 1	Unique asset reference
Equipment Reference 2	Alternative asset reference number (not mandatory)
Location 1 (LUL Area Location)	Geographical location of asset
Location 2 (Further Location Information)	Additional geographical location information (not mandatory)
Equipment Group ID (Ellipse)	Unique equipment asset reference (not mandatory)
LCS Code	LCS code for the geographical location of the asset
A.D. No	Asset Definition Number as referenced within the ACAC Foundation Documents
Asset Definition	Text description for the Asset Definition Number
Quantity	Quantity of assets being reported
MEAV £	MEAV value per unit of measure
/unit	Unit of measure
E1 %	% of assessed assets in ACAC condition grade E1
E2 %	% of assessed assets in ACAC condition grade E2
D %	% of assessed assets in ACAC condition grade D
C %	% of assessed assets in ACAC condition grade C
B %	% of assessed assets in ACAC condition grade B
A %	% of assessed assets in ACAC condition grade A
A % Assessed	% of an asset identified as a Grey asset for which condition has been assessed as condition A. When an asset has been assessed the entry in this column should be N/A as the % should be distributed between E1 to A.
A % Unassessed	% of an asset identified as a Grey asset as it has not been assessed. The entry in this column and the A% column should be the same.
Concern(s)	List of specific concerns affecting the reported asset base.
Value of Asset £m	Total MEAV value of the assets reported
E1 £m	MEAV value of assets assessed in ACAC condition grade E1
E2 £m	MEAV value of assets assessed in ACAC condition grade E2
D £m	MEAV value of assets assessed in ACAC condition grade D
C £m	MEAV value of assets assessed in ACAC condition grade C
B £m	MEAV value of assets assessed in ACAC condition grade B
A £m	MEAV value of assets assessed in ACAC condition grade A

1.1.10 ACAC to ACR Translation for Civils

ACAC to ACR A-D Translation Tables

The method for assessing and the reporting of asset condition for the Civils assets shall continue to be in accordance with the ACAC (Cat 1 Standard 1-031) method and in accordance with the Controlled Type 1 Information Foundation Documents for Bridges and Structures, Deep Tube Tunnels, Earth Structures and Pumps & Drainage. This includes the rules for the allocation of ACAC classifications from class A- E1/2 and the allocation of MEAV.

The asset hierarchies and RAV values detailed within this ACR attachment for Civils are wholly consistent with the hierarchies and MEAV values within the ACAC Foundation documents. Therefore the ACR for the Civils asset areas shall be produced from the ACAC outputs; the tables below define the translation from ACAC concern classes to ACR physical codes for each of the four Civils asset areas.

Physical Codes A-D are assigned according to TTNEI - i.e. when the works need to be carried out by, not necessarily when they are actually planned for.
All Physical Codes are assigned by the S&C Sponsor.
<u>NOTE: Only OPEX interventions that are over and above those covered by Maintenance Regime are included.</u>

The TTNEI for each Concern is determined according to the priority of the works, based on a number of drivers including; Safety and Business Risks, Degradation Rates, ongoing OPEX costs and Whole Life Costs. A Prioritisation tool for CAPEX works is currently under development, which will prioritise the workbank according to these factors.

Bridges & Structures: ACAC to ACR

ACAC Classification	ACR Classification
	Physical Class
C	A-D*
D	A-D
E1	A-D
E2	A-D

* Excludes normal preventaive and corrective covered by the maintenance regime

Deep Tube Tunnels: ACAC to ACR

ACAC Classification	ACR Classification
	Physical Class
B	A-D*
C	A-D*
D	A-D
E2	A-D

* Excludes normal preventaive and corrective covered by the maintenance regime

Pumps & Drainage: ACAC to ACR

ACAC Classification	ACR Classification
	Physical Class
B	A-D*
C	A-D*
D	A-D
E2	A-D

* Excludes normal preventaive and corrective covered by the maintenance regime

Note; The following P&D Concerns are <u>not</u> reported in ACR but shall be retained as part of Civils P&D ACAC;

Generic Concern No:	ACAC Classification	ACR Classification
		Physical Class
DGEN101	B – E2	N/A
DGEN108	Grey	N/A
DGEN117	C	N/A
DGEN120	C	N/A
DGEN207	D	N/A
DGEN208	D - E2	N/A
DGEN401	D	N/A
DGEN402	D	N/A

Earth Structures: ACAC to ACR

ACAC Classification	ACR Classification
	Physical Class
B	A-D*
C	A-D*
D	A-D
E2	A-D

* Excludes normal preventaive and corrective covered by the maintenance regime

ACAC to ACR 1-4 Translation Tables

The Civils Assets will continue to have their condition assessed in accordance with the ACAC (Cat 1 Standard 1-031) . The ACAC is translated to the ACR, by converting the ACAC condition categories (A-E1/E2) into ACR Physical Concern Codes (A-D) and Functional Codes 1-4. The asset hierarchies and RAV values detailed within this ACR attachment for Civils are wholly consistent with the hierarchies and MEAV values within the ACAC.

The Code 3 Risk values will be Provided by the Civils Sponsor Team. For Civils, a Code 3 will only apply in the following cases;

1. Assets with significant degradation as a result of the deferral of corrective maintenance or project work, which has lead to a significant increase in the cost of the repair.
2. Assets where significant repairs are required as a result previously hidden degradation, such as a buried defect or defects behind cladding.
3. Assets with poor design details, leading to significant degradation and costly repairs or strengthening works being required
4. Assets requiring substantial monitoring costs in order to maintain risks ALARP, either because they are non-compliant or due to their condition. NB- This includes the cost of additional Inspections, where these are considered an uneconomical.
5. Assets where significant temporary works are required in order to maintain risks ALARP and / or to keep the asset available for service.
6. Assets where significant additional maintenance is required to maintain risks ALARP and / or to keep the asset available for service

The Code 4 risk values are provided by the S&C Principal Client Engineer, directly from the Civils Strategic Risk Model

Code's 1 and 2 will be applied to ACAC Concerns, as shown in the Table below. The Risk Values will be assigned by the S&C Principal Client Engineer, directly from the Civils Strategic Risk Model, and approved by the Professional Head, Engineering (CPD).

BRIDGES AND STRUCTURES		
Concern No:	**ACA Classification**	**ACR Functional Classification (1 & 2 only)**
XGEN801	E1	**1 (BE4) 2 (BD21)**
XGEN802	E1	**2**
XGEN803	E2	**2**
XGEN804	E1	**2**
XGEN805	E2	**2**
XGEN806	E2	**2**
XGEN807	C	**-**
XGEN808	E2	**2**
XGEN809	C	**-**
XGEN810	E2	**2**
XGEN811	C	**-**
XGEN812	E1	**2**
XGEN813	C	**-**
XGEN814	E2	**2**
XGEN815	E2	**2**
XGEN816	C	**-**
XGEN817	C	**-**
XGEN818	E2	**2**
XGEN819	E2	**2**
XGEN820	E2	**2**
XGEN821	C	**-**
XGEN822	E1	**2**
XGEN823	C	**-**
XGEN824	C	**-**
XGEN825	C	**-**
XGEN826	C	**-**
XGEN827	C	**-**
XGEN828	E2	**2**
XGEN829	D	**-**
XGEN830	C	**-**
XGEN831	C	**-**
XGEN832	C	**-**
XGEN833	C	**-**
XGEN834	C	**-**
XGEN835	E1	**2**
XGEN836	E1	**2**
XGEN838	E1	**2**

EARTH STRUCTURES		
Concern No:	**ACA Classification**	**ACR Functional Classification (1 & 2 only)**
BGEN001	D - E1/E2	**2 where E1 or E2 2 or none where D**
BGEN002	B - C	**-**
BGEN003	D	**-**
BGEN004	E1/E2	**2**
BGEN005	D	**None or 2**
BGEN006	C	**-**
BGEN007	B	**-**

DEEP TUBE TUNNELS		
Concern No:	**ACA Classification**	**ACR Functional Classification (1 & 2 only)**
HGEN001	B-E2	**2 where E1 or E2**
HGEN002	B-E2	**2 where E1 or E2**
HGEN003	B-E2	**2 where E1 or E2**
HGEN004	B-E2	**2 where E1 or E2**
HGEN005	B-E2	**2 where E1 or E2**
HGEN006	B-E2	**2 where E1 or E2**
HGEN007	B-E2	**2 where E1 or E2**
HGEN008	B-E2	**2 where E1 or E2**
HGEN009	B-E2	**2 where E1 or E2**
HGEN010	E2	**2**
HGEN012	E2	**2**
HGEN013	E2	**2**

PUMPS AND DRAINAGE		
Concern No:	**ACA Classification**	**ACR Functional Classification (1 & 2 only)**
DGEN101	B – E2	**N/A**
DGEN102	D	**-**
DGEN103	B – D	**-**
DGEN104	D	**-**
DGEN105	C – E2	**1**
DGEN106	D	**-**
DGEN107	E2	**2**
DGEN108	Grey	**N/A**
DGEN109	B – C	**-**
DGEN110	D	**-**
DGEN111	B – D	**-**
DGEN112	E1 – E2	**1**
DGEN113	D	**2**
DGEN114	C - D	**-**
DGEN115	E1 – E2	**2**
DGEN117	C	**N/A**
DGEN118	B	**-**
DGEN119	B	**-**
DGEN120	C	**N/A**
DGEN121	C	**-**
DGEN201	E2	**2**
DGEN202	E2	**2**
DGEN203	E2	**2**
DGEN204	D	**-**
DGEN206	D	**-**
DGEN207	D	**N/A**
DGEN208	D - E2	**N/A**
DGEN209	B - D	**-**
DGEN210	B - C	**-**
DGEN301	D	**None or 2**
DGEN302	B - D	**2**
DGEN304	D	**-**
DGEN305	B - C	**-**
DGEN401	D	**N/A**
DGEN402	D	**N/A**
DGEN403	B - D	**-**
DGEN404	B - D	**-**
DGEN406	D	**2**

ASSET CONDITION ASSESSMENT AND CERTIFICATION
LUL CONTROLLED TYPE 1 INFORMATION

STATUS SHEET

Asset	Bridges & Structures
Document Type	Asset Condition Assessment and Certification Foundation Documents (comprising Asset Definition; Required Duty; Generic Concerns List; Basis of Asset MEAV).
Summary of changes	
Concern Code XGEN806 revised as per DRACCT 02144.	
Limitations on use	
For use in ACAC and in Asset Management Planning. Not directly compatible with structural failure top event in LUL QRA.	
Issue No	#REF!
Authorised by: **Brian McGinnity** **Head of Civil Engineering (CPD)**	
Technical Approval:	**Process Approval:**
Graham Bessant **Profession Head - Bridges & Structures**	
Valid from	18-Nov-13
Review date	18-Nov-16

Note:
Within this Foundation Document the Generic Concerns listed are defined as concerns (expressed in terms of failure to meet Required Duty), which act as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

Asset Definition
Bridges & Structures

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

DRACCT Log 01958: Definition 547 Vehicle Collision Protection Barrier added. Definitions 401, 402, 403 and 404 amended.

Asset No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)	Comment
101	Bridge - Cable & Pipe; a structure that covers or spans a gap and carries cables and pipes.	Track, Signals, Power. Sometimes with Premises and Outside Parties.		
102	Bridge - Foot; a structure that covers or spans a gap and carries pedestrian traffic.	Track and usually with Premises, sometimes with signals and Power.	All	
103	Bridge - Overline; a structure that covers or spans a gap and carries public or private road traffic.	Track, Outside Parties sometimes with Signals, Power and Premises.	All	
104	Bridge - Underline; a structure that covers or spans a gap and carries rail traffic.	Track, Signals, Power and Outside parties, sometimes with Premises.	All	
105	Bridge - Viaduct; a structure composed of at least 3 masonry arches that cover or span gaps and carry road or rail traffic.	Track, Signals, Power and Outside parties, sometimes with Premises.	All	
121	Cable Post Run; a series of posts installed alongside the railway tracks which carry signal and traction cables and usually an air main.	Signals, Power, Track and Earth structures.		
122	Cable Stiles; a series of steps to allow pedestrian access over a cable post run.	Signals, Power, Track and Earth structures.		
123	Cable Draw Chamber - a structure forming a void below ground level with or without a roof, used for the drawing of cables, and containing cables.	Signals, Power and Outside parties, sometimes with Premises.		CCF-CPX-0304-002 (Addition)
141	Canopy (Platform); a roof structure covering all or part of a station platform to provide passengers with shelter from the weather.	Track and Premises.	All - Stations Asset	
142	Canopy (Station Entrance) - a covered structure over the area in front of the station entrance.	Premises.		CCF-CPX-0304-003 (Addition)
161	Chimney - Concrete or Masonry; a hollow vertical structure of masonry that carries combustion products or steam away from an engine boiler or fire.	Premises.		
162	Chimney - Metal; a hollow vertical structure that carries combustion products away from an engine boiler or fire.	Premises.		
181	Covered Way; a structure that covers or spans a gap which is at least twice as wide as its span and is constructed by excavating a trench and then constructing the spanning members.	Track, Signals, Power and Outside Parties.	All	
201	Culvert; a structure that covers or spans a gap under the track through which water flows.	Track and outside Parties.		
221	Escalator Machine Room Steelwork: The structural steel beams, columns, floor slab and floor trays but not floor plates forming the roofs of Escalator Machine chambers.	Premises, Escalators and Power.		CCF-CPX-2006-002
241	Escalator Support Structures: The structural truss and the foundations of the truss which carry the escalator machinery including floor plates, BUT only where these trusses are manufactured and installed separately from the escalator machinery. Where trusses are delivered and installed as a complete package including escalator machinery and where they do not provide support for the machine room roofs, they are classified as a Lift and Escalator Asset.	Premises, Lifts & Escalators and Power.		CCF-CPX-2006-002
261	Girdering; a structure that covers or spans a gap and is composed of multiple columns and beams with infill slabs.	Usually interfaces with Premises, sometimes with Track and Signals, and sometimes with Outside Parties.	All	
281	Lift Support Structures; including a 3 dimensional tower composed of structural steel elements which carries loads from passenger/goods lift components.	Premises, Lifts and Power.		
301	Linear Station Staircase; a single or multiple staircase in a station consisting of straight **structural** elements**, but not including stairs resting on and supported by soil or fill. Where Linear Station Staircases carry walls and or roofs, these walls and roofs shall be considered to be part of the staircase.**	Premise**s** and sometimes with Signals.	All - Stations Asset	Revised asset definition DRACCT Log 01837
321	Load Gauge; a structure that carries a profile of the load gauge.	Track and Trains.		
341	Pipe Crossing Over Track; a structure spanning over LUL tracks that supports a pipe carrying fluids.	Track and Outside parties.		

Asset Definition
Bridges & Structures

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

DRACCT Log 01958: Definition 547 Vehicle Collision Protection Barrier added. Definitions 401, 402, 403 and 404 amended.

Asset No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)	Comment
342	Pipe Crossing Under Track; a circular or oval hollow prismatic structure under LUL tracks that supports dead and live railway loading and conducts fluids within itself.	Track and Outside parties.		

Asset Definition
Bridges & Structures

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

DRACCT Log 01958: Definition 547 Vehicle Collision Protection Barrier added. Definitions 401, 402, 403 and 404 amended.

Asset No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)	Comment
361	Platform (Station); an elevated level surface alongside the railway for the purpose of enabling passengers to enter or leave trains, (includes the platform end ramps).	Premises, Track, Signals, Power, Trains.	All - Stations Asset	The inclusion of platform end ramps in the asset definition
362	Disused Station.	Usually interfaces with Premises, sometimes with Track, Signals, Power and Outside Parties.		
363	Sub- Station Premises	Track and sometimes Premises.		
381	Roof Structure & Support; a structure that covers or forms the top of a building.	Premises.	All - Stations Asset	
401	Shaft; the structural components within a vertical passageway giving access to the railway.	Premises, Deep Tube Tunnels		Amended definition DRACCT Log 01958
402	Shaft - Cable; the structural components within a vertical passageway giving access to the railway and used for carrying cables.	Premises, Deep Tube Tunnels, Signals and Power.		Amended definition DRACCT Log 01958
403	Shaft - Disused; the structural components within a vertical passageway giving access to the railway that now has no operational use.	Premises, Deep Tube Tunnels		Amended definition DRACCT Log 01958
404	Shaft - Lift; the structural components within a vertical passageway giving access to the railway that contains a lift.	Premises, Deep Tube Tunnels, Lifts and Power.		Amended definition DRACCT Log 01958
405	Shaft - Pump; a vertical passageway that contains a pump carrying fluids.	Premises, and Power.		
421	Signal Gantry; a metal framed structure carrying a signal or signals.	Track and Signals , sometimes with Premises.		
422	Access Gantry or Access Platform – a fixed metal structure providing access to an installation.	Sometimes Premises		CCF-CPX-0304-004 (Addition)
423	Travelling Access Gantry - A moveable framework travelling on a rail system fixed to a structure or a building for the purpose of servicing that structure or building.	Usually interfaces with Premises, sometimes with bridge structures.		New Asset definition DRACCT Log 01440
441	Spiral Stairway; a staircase following a plane curve formed by a point winding about a fixed point at an ever increasing distance from it.	Premises.		Deleted in error in Issue 3
461	Subway; an underground passageway.	Usually interfaces with Premises, sometimes with Track, Signals, Power and Outside Parties.	All	
481	Tunnel - Brick; an adit constructed of brick for the passage of trains.	Track, Signals, Power and Outside Parties, sometimes with Premises.	All	
501	Ventilation Plant; a structure, or a number of structures of steel, concrete or brick, or a combination of these used as a duct to introduce fresh air or remove vitiated air from the railway system.	Premises.	All	
521	Ventilator; an opening to ventilate the railway.	Track and Outside Parties.		
541	Wall - Boundary; free standing vertical structure made of brick, stone or concrete with a length and height much greater than its thickness, delineating LUL ownership.	Track and outside Parties sometimes with Premises.		
542	Wall - Drystone; a vertical structure made of stone or concrete blocks which retains soil.	Track.		
543	Wall - Gabion; a vertical structure made of stone filled gabion baskets which retains soil.	Track.		
544	Wall - Retaining <1m high; a vertical structure less than 1m height made of brick or concrete with a length and height greater than its width which retains soil.	Track, sometimes with Signals, Power and Outside Parties.	All	
545	Wall - Retaining >1m high; a vertical structure greater than 1m height made of brick or concrete with a length and height greater than its width which retains soil.	Track, sometimes with Signals, Power and Outside Parties.	All	
546	Wall - Non-Boundary; free standing vertical structure made of brick, stone or concrete with a length and height much greater than its thickness.	Track and sometimes Premises.		
547	Vehicle Collision Protection Barrier: an installation provided to prevent errant road vehicles penetrating the railway or impacting LU assets	Track and sometimes Premises.		New Asset Definition DRACCT Log 01958
561	Water Tower; a structure carrying an elevated cistern containing water.	Track and sometimes Premises.		
571	Lighting Tower - a metal framed structure supporting flood lighting. Required to perform to lighting standard.	Track and sometimes Premises		CCF-CPX-0304-001 (Addition)

Asset Definition
Bridges & Structures

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

DRACCT Log 01958: Definition 547 Vehicle Collision Protection Barrier added. Definitions 401, 402, 403 and 404 amended.

Asset No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)	Comment
572	Lighting Standard - a vertical single member structure of steel or reinforced concrete carrying electric lighting.	Track and sometimes Premises		CCF-CPX-0304-001 (Addition)
573	Lighting Mast - a vertical single member metal structure carrying an array of lights.	Track and sometimes Premises		CCF-CPX-0304-001 (Addition)
580	River Pier - A stucture projecting from the shore into a river used as a landing stage for boats			New asset definition DRACCT Log 00863
590	Advertising Hoarding - A large free standing board used to display advertisements	Track and sometimes Premises.		New asset definition DRACCT Log 00863

Asset Definition
Bridges & Structures

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

DRACCT Log 01958: Definition 547 Vehicle Collision Protection Barrier added. Definitions 401, 402, 403 and 404 amended.

Asset No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)	Comment
601	Side Hinged Watertight Door - A manually operated flat construction fabricated from metal and hinged in a frame on a vertical edge to close an opening so that the entry of water is prevented.	Premises		New asset definition LUL-CPX-2007-001
602	Horizontal sliding watertight door - A manually operated flat construction fabricated from metal and sliding on horizontal tracks to close an opening so that the entry of water is prevented.	Premises		New asset definition LUL-CPX-2007-001
603	Horizontal sliding electro-mechanical floodgate - A gate operated by a combination of mechanical and electrical means fabricated from metal and sliding on horizontal tracks to close an opening so that the entry of water is prevented.	Premises, signalling, track, power and electrical & mechanical		New asset definition LUL-CPX-2007-001
604	Top Hinged electro mechanical floodgate - A gate operated by a combination of mechanical and electrical means fabricated from metal and hinged on its top edge to close an opening so that the entry of water is prevented.	Premises, signalling, track, power and electrical & mechanical		New asset definition LUL-CPX-2007-001
605	Sector Gate A gate fabricated from metal, a vertical section of which forms the sector of a circle and sliding on tracks which form the sector of a circle to close an opening so that the entry of water is prevented.	Premises, signalling, track, power and electrical & mechanical		New asset definition LUL-CPX-2007-001
606	Hydraulic Floodgate - A gate operated by hydraulic means fabricated from metal and hinged on its top edge to close an opening so that the entry of water is prevented.	Premises, signalling, track, power and electrical & mechanical		New asset definition LUL-CPX-2007-001
607	Diaphragm Floodgate - A manually erected flat construction fabricated from metal and bolted to a frame to close an opening so that the entry of water is prevented.	Premises, signalling & track		New asset definition LUL-CPX-2007-001
608	Vertically Sliding Floodgate - A gate operated by manual or electro-mechanical means and fabricated from metal which is raised and lowered vertically and seals against a frame to prevent the entry of water.	Premises, signalling, track & power		New asset definition LUL-CPX-2007-001
609	Penstock Chamber - A chamber containing penstocks which are connected to a watercourse via a pipe and which could be used to dewater a flooded tunnel.			New asset definition LUL-CPX-2007-001
610	Station Flood Board - Removable board(s) fitted between guides at station entrances to prevent the ingress of water.	Premises		New asset definition DRACCT Log 00863

Exclusions

None

Required Duty	
The required duty is based on a set of ten generic statements which include all aspects of the asset duty in the context of the operating railway and environment.	
The required duty below shows the generic section statement at the beginning of each section. These have a cardinal number (1 to 10 inclusive) and are shown in **bold** type.	
The asset is required to:	
1	**Meet railway operating requirements (within the performance specification at system installation or at the most recent system upgrade).**
1.1	Maintain inherent structural integrity (support itself so as not to suffer complete or partial collapse).
1.2	Maintain the ability to carry without restriction any permitted applied static and dynamic design loads.
1.3	Maintain the planned design envelope and adequate clearance to permit the safe passage of rail vehicles.
1.4	Provide appropriate access and egress for all planned uses (including maintenance), and for reasonably anticipated emergency uses.
1.5	Sustain a condition and state so as not to cause unplanned interruption to, or restriction of, any aspect of the operating railway; this includes externally sourced wear or damage which is greater than that currently accepted for the asset.
1.6	Sustain a condition and state so as to maintain all interfacing non-railway services and facilities at full design capability.
2	**Ensure support at asset interfaces without undue wear and tear.**
2.1	Minimise the degradation of all interfacing assets (e.g. as evidenced through maintenance cycles). This includes interfaces with the railway and adjacent infrastructure (e.g. track, structures, stations and premises).
2.2	Minimise the degradation of all interfacing assets which support non-railway services or facilities (e.g. as evidenced through maintenance cycles). This includes interfaces with dynamic & static assets (e.g. roads, buildings, walkways, etc).
3	**Match LUL policy in respect of realistic user perceptions.**
3.1	Ensure the asset does not cause undue degradation of interfacing assets, disruption to railway operations or unacceptable environmental nuisance.
4	**Provide resistance against external interference and events.**
4.1	Asset minimises the likelihood and consequence of asset abuse. Asset abuse encompasses, vandalism, planned/unplanned work, damage due to external event, etc.

Required Duty	
4.2	Asset minimises the likelihood of occurrence of, and enhances the ability to respond to, personal attack on passengers or staff.
5	**Present acceptable environmental impact.**
5.1	Present an acceptable societal environmental impact (noise, vibrations, vegetation cover, adverse weather management, etc).
6	**Minimise environmental impact throughout lifecycle.**
6.1	Minimise environmental impact and demands at all stages in the lifecycle; this includes effects now and into the future, including successive refurbishment, final decommissioning, and disposal routes.
7	**Function within the legal and standards framework.**
7.1	Ensure the asset functions within the framework defined by legislation (including environmental); regulatory guidance; LUL, Infraco and applicable national and international standards; and LUL and Infraco policies.
8	**Ensure safe operation as defined by LUL.**
8.1	Ensure safe operation and condition as specified by LUL requirements; this includes passengers, employees and members of the general public.
8.2	Ensure safe ingress/egress by passengers, general public, employees, and emergency services in planned & reasonably anticipated emergency scenarios. This includes the means of transfer from the bridges and structures asset to the principal interfacing assets and transfer mediums (e.g. public footpaths).
8.3	Safeguard the health and safety of passengers, employees and members of the general public.
9	**Provide above within reliability and availability targets.**
9.1	Provide all aspects of the required duty within the defined LUL requirements.
10	**Ensure Required Duty is performed without incurring excessive or prohibitive costs.**

Generic Concerns List
Bridges & Structures

A Generic Concern is defined as: A Concern (expressed in terms of failure to meet Required Duty), which acts as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

Concern No:	Description	Classif-ication (See Notes 1 & 2 below)	Rules for allocation of MEAV to Generic Concern and associated Classification (See Note3 & 4 below) and General Comments	Comment
XGEN801	Bridges that fail BE4 or BD21/97. Potentially may result in bridge overloading and collapse, leading to train collision or derailment.	E1	Overbridges and overline pipe crossings shall have 60% of the asset MEAV allocated. For covered ways and girderings the allocation shall be 60% of the asset MEAV factored by the linear length of the asset that fails the assessment. For example: Half the linear length of a covered way is subject to highway loading and fails BE4, so 0.5 x 60% = 30% of the asset MEAV shall be allocated. Note: Shallow Tunnels which fail BE4 shall have Generic Concerns XGEN801 and XGEN828 entered, but the percentage MEAV allocation shall be as for XGEN828.	
XGEN802	Footways of Bridges that fail accidental wheel loading assessment as specified in the BD21 series of the Highways Agency standards. Footways may potentially fail under loading resulting in collapse leading to train collision or derailment.	E1	Overbridges shall have 10% of the asset MEAV allocated, on the basis of 5% per footway. For covered ways and girderings the 10% shall be factored by the linear length of the asset that fails the assessment. For example: Half the linear length of a covered way is subject to highway loading and the footway fails BD21, so 0.5 x 10% = 5% of the asset MEAV shall be allocated. Note: Where the structure also fails the P6 parapet containment requirement (XGEN803) both XGEN802 and XGEN803 shall be entered, but the percentage MEAV allocation shall be as for XGEN803. This is because it is assumed that installing a P6 parapet would require the footway of the bridge to be strengthened.	
XGEN803	Overbridge parapets that do not meet type P6 requirements. The parapet may potentially collapse due to impact leading to derailment or collision. This Generic Concern applies automatically unless physical mitigation such as Trieff kerbs have been installed.	E2	Overbridges shall have 20% of the asset MEAV allocated for each parapet. For example: An overbridge with a single parapet shall have 20% of the asset MEAV allocated. An overbridge with two parapets shall have 40% of the asset MEAV allocated. For covered ways, girderings and brick tunnels a carriageway width of 10m shall be assumed adjacent to the parapet and the cost of each parapet replacement shall be calculated as 20% of the asset MEAV factored by the 10m width divided by the total length of the structure.	
XGEN804	Underbridges that fail to satisfy ~~E3314~~ **1-051**. Potentially may fail under live loading leading to collision or derailment.	E1	Allocate 60% of the asset MEAV.	Revised standard number LUL-CPX-2007-002
XGEN805	Underline bridge parapet or viaduct parapet may collapse due to overload by cables, wind or dynamic loading from passing trains. Potentially may result in debris on track resulting in collision or derailment or injury to those on the structure.	E2	Allocate 5% of the asset MEAV for each parapet that fails the assessment. Where appropriate, this shall be factored for the linear length of the parapet that fails.	
XGEN806	Underline structure or culvert in or near water at risk from scour. Removal of material from under the structure may potentially result in collapse leading to collision or derailment.	E2	Allocate 5% of the asset MEAV. This concern only applies to assets that generate a risk priority greater than 13 when assesssed in accordance with HR Wallingford Report EX2502	Revised as per DRACCT02144
XGEN807	Brick tunnel or other structure deformation or loss of mortar, individual bricks or a complete ring of bricks may fall or are missing, or the structure may distort sufficiently to encroach onto the structural gauge. Potentially may lead to collision or derailment.	C	Using the tunnel or other structure charts in the inspection report, the deformed and (or) lost mortar area shall be calculated as a percentage of the whole, and 10% of the asset MEAV shall be factored by this percentage and allocated.	
XGEN808	Corrosion of tendons in segmental post - tensioned bridges. Potentially may result in collapse leading to collision or derailment.	E2	Allocate 60% of the asset MEAV. Note: It is likely that a more severe Generic Concern will also apply, e.g. XGEN 801, which would therefore re-allocate the MEAV to E1.	
XGEN809	Corrosion of steel reinforcement in concrete. Potentially may result in failure of structural members leading to collision or derailment.	C	Using the extent code from the inspection report, multiply the indicated area percentage by 3 and take 10% of the asset MEAV for that portion of the structure. For example: An underbridge deck has an extent category B. Allocate 5% x 3 x 10% x [60% of the whole bridge MEAV (£2m)] = £18k.	
XGEN810	Retaining wall that fails to satisfy assessment under ~~E3320-~~ **1-051**. Potentially may result in structural failure by overturn, sliding failure or the soil may slip-along a slip circle leading to a collision or derailment.	E2	Allocate 100% of the asset MEAV.	Revised standard number LUL-CPX-2007-002
XGEN811	Lack of thermal movement provisions result in overstressing and buckling of structural members e.g seized bearings or lack of expansion joints in walls. Potentially may result in structural collapse leading to collision or derailment.	C	Allocate 10% of the deck portion of the asset MEAV. For example: A bridge deck is 60% of the asset MEAV, so allocate 10% x 60% x asset MEAV.	
XGEN812	Fatigue assessment failure of a structural member. Potentially may result in a partial or total failure of a structure leading to collision or derailment.	E1	Allocate 100% of the deck portion of the asset MEAV.	
XGEN813	Corrosion of steel in a main or secondary structural member. Potentially may result in a total or partial collapse of a structure leading to collision or derailment.	C	Using the extent code from the inspection report, multiply the indicated area percentage by 3 and take 10% of the asset MEAV for that portion of the structure. For example: An underbridge deck has an extent category B (5%). Allocate 5% x 3 x 10% x 60% of the whole bridge MEAV (£2m) = £18k	

Generic Concerns List
Bridges & Structures

A Generic Concern is defined as: A Concern (expressed in terms of failure to meet Required Duty), which acts as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

Concern No:	Description	Classif-ication (See Notes 1 & 2 below)	Rules for allocation of MEAV to Generic Concern and associated Classification (See Note3 & 4 below) and General Comments	Comment
XGEN814	**Underline and Overline** bridge supports that fail to comply with ~~E3304~~ **1-051** for resisting accidental impact loads**, and for which there is no physical mitigation such as check rails**. Failure to comply may potentially result in complete or partial collapse of the structure leading to ~~collision or~~ derailment.	E2	Allocate 100% of the asset MEAV. Note: Where a structure also fails its assessment and Concerns XGEN801, XGEN804 or XGEN815 have been used, Concern XGEN814 shall be added, but the percentage allocation of MEAV shall be based only on the rules for XGEN801, XGEN804, or XGEN815 as appropriate.	Revised wording LUL-CPX-2007-002
XGEN815	Cyclic stresses imposed on cast iron spanning members by thermal changes leads to fatigue failure. Failed member may potentially fall onto the track or foul structure gauge leading to collision or derailment.	E2	Allocate 60% of the asset MEAV. Note: Where a structure also fails its assessment and Concern XGEN801 or XGEN804 have been used, Concern XGEN815 shall be added, but the percentage allocation of MEAV shall be based only on the rules for XGEN801, or XGEN804, as appropriate.	
XGEN816	Ring separation of a multi-ring arch causes a weakened bridge or tunnel. Structure may potentially fail under load leading to collision or derailment.	C	Using the tunnel charts in the inspection report, the deformed area shall be calculated as a percentage of the whole, and 25% of the asset MEAV shall be factored by this percentage and allocated.	
XGEN817	Clinker aggregate concrete contains corrosive substances which corrode embedded steel. Potentially may lead to collapse of structure or to concrete falling from the soffits which could injure passengers, staff or contractors.	C	Allocate 100% of the asset MEAV for that portion of the asset.	
XGEN818	Cast iron columns may potentially fail due to impact or tension induced by eccentric loading. Potentially may result in collapse of structure resulting in collision or derailment or injury to those on the structure. This Generic Concern applies automatically to all cast iron columns unless they have passed an analytical assessment for such effects, or protection/ mitigation is in place.	E2	Allocate 100% of the asset MEAV. Note: Where a structure also fails its assessment and Concern XGEN801, XGEN804 or XGEN815 have been used, Concern XGEN818 shall be added, but the percentage allocation of MEAV shall be based only on the rules for XGEN801, XGEN804 or XGEN815 as appropriate. Where XGEN814 has been used, XGEN818 shall be applied but no additional percentage of MEAV shall be allocated.	
XGEN819	Cast iron struts may fail due to changes in soil conditions or eccentric loading. Potentially may result in collapse of structure leading to collision or derailment. This Generic Concern applies automatically to all cast iron struts, unless they have passed an analytical assessment for such effects.	E2	Allocate 100% of the asset MEAV, except where some of the cast iron struts have already been replaced. In this case the 100% shall be factored by the ratio of cast iron struts to the total number of struts. For example: A ventilator (£5m) has a total of 10 struts of which 6 are cast iron, so allocate 0.6 x 100% x £5M = 60% x £5m = £3m.	
XGEN820	Cast iron spanning structures may fail due to live load or fatigue. Potentially may result in collapse of structure leading to collision or derailment. This Generic Concern applies automatically to all cast iron spanning structures subject to live loading, unless strengthening has been implemented.	E2	Allocate 60% of asset MEAV.	
XGEN821	Timber members deteriorate. Potentially may fail through live loading leading to collision or derailment. This Generic Concern applies automatically to any timber structure with a Condition Rating from ~~E3701~~ **1-051** of 80% or less.	C	Allocate 25% of the asset MEAV for that portion of the structure. For example: A bridge deck - allocate 25% x 60% x MEAV for whole bridge.	Revised standard number LUL-CPX-2007-002
~~XGEN822~~	~~Structures that fail an E3319 1051assessment. Structures may potentially fail under live or dead loading resulting in collision, derailment or injury to those on the bridge.~~	~~E1~~	~~Allocate 10% of the asset MEAV, on the basis that footbridges, cablebridges and gantries that fail the assessment can be strengthened instead of needing replacement.~~	Deleted, DRACCT Log 00930
XGEN823	Cable Posts fail due to deterioration or overload. Potentially may result in obstruction of the structure gauge leading to collision or derailment. This Generic Concern applies automatically to all cable posts with a Condition Rating from ~~E3701~~ **1-051** of 80% or less.	C	Allocate 100% of the asset MEAV.	Revised standard number LUL-CPX-2007-002
XGEN824	Cable Stiles deteriorated. Potentially may fail in use and cause injury to persons using the stile. This Generic Concern applies automatically to all cable stiles with a Condition Rating from ~~E3701~~ **1-051** of 80% or less.	C	Allocate 100% of the asset MEAV (unless the value has been included in the cable posts under XGEN823).	Revised standard number LUL-CPX-2007-002
XGEN825	Walls cracked or subsided. Potentially may fall onto the tracks causing derailment or collision, or onto passengers staff or neighbours. This Generic Concern applies automatically to all walls with a Condition Rating from ~~E3701~~ **1-051** of 80% or less.	C	Allocate 100% of the asset MEAV factored, where applicable, by the linear length of the wall affected.	Revised standard number LUL-CPX-2007-002
XGEN826	Damaged or deteriorated Lift Support Structures. Potentially may lead to death or injury to passengers or staff. (Use XGEN835 where structure fails analytical assessment). This Generic concern applies automatically to all such structures with a Condition Rating from ~~E3701~~ **1-051** of 80% or less.	C	Allocate 100% of the asset MEAV.	Revised standard number LUL-CPX-2007-002

Generic Concerns List
Bridges & Structures

A Generic Concern is defined as: A Concern (expressed in terms of failure to meet Required Duty), which acts as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

Concern No:	Description	Classif-ication (See Notes 1 & 2 below)	Rules for allocation of MEAV to Generic Concern and associated Classification (See Note3 & 4 below) and General Comments	Comment
XGEN827	Damaged or deteriorated Escalator Support Structures. Potentially may result in failure of escalator leading to death or injury to passengers or staff. (Use XGEN835 where structure fails analytical assessment). This Generic Concern applies automatically to all such structures with a Condition Rating from ~~E3701~~ **1-051** of 80% or less.	C	Allocate 100% of the asset MEAV.	Revised standard number LUL-CPX-2007-002
XGEN828	Shallow Brick Tunnels that fail to satisfy ~~E3318~~ **1-051**. Potentially may fail under live loading resulting in partial or total collapse leading to collapse or derailment.	E2	Allocate 60% of the asset MEAV, factored by the actual length which fails the assessment.	Revised standard number LUL-CPX-2007-002
XGEN829	Longitudinally timbered bridges suffer from fractured restraining cleats, fatigue or inadequate structural design of the timbers. Potentially may lead to derailment. This Generic Concern applies automatically to all longitudinally timbered bridges.	D	Allocate 60% of the asset MEAV.	
XGEN830	Culverts or pipe crossings that are blocked causing build-up of water on the embankment. Potentially may cause embankment to fail leading to derailment.	C	Allocate 10% of the asset MEAV.	
XGEN831	Vegetation growing in brickwork causes cracks and bursting. Potentially may result in weakening or partial collapse of the structure leading to derailment or injury to passengers or staff.	C	Allocate 10% of the asset MEAV.	
XGEN832	Concrete or brickwork with cracking, and/ or spalling and / or pointing loss. Potentially may result in weakening or partial collapse of the structure leading to derailment or injury to passengers or staff.	C	Allocate 10% of the asset MEAV, factored by the actual area identified in the inspection reports that requires repairs.	
XGEN833	Seepage through brick tunnels or other structures washes out mortar. Potentially may cause brickwork deterioration and loss of strength, leading to collapse or derailment.	C	Allocate 10% of the asset MEAV, factored by the actual area identified in the inspection reports that requires repairs.	
XGEN834	Failure of protective coatings to bridge or structure. Potentially may lead to corrosion and loss of strength leading to collision or derailment.	C	Allocate 10% of the asset MEAV, factored by the actual area identified in the inspection reports that requires repairs.	
XGEN835	Structures that fail to satisfy an ~~E3317 1051and/or 1-053~~ **S1061** assessment. Potentially may fail in service leading to collision or derailment.	E1	Allocate 100% of the asset MEAV.	Revised DRACCT Log 00930
~~XGEN836~~	~~Missing or damaged structural components, or other deterioration, resulting in the need for an up-dated analytical assessment. Structures may potentially fail under live loading leading to collapse or derailment.~~		~~Allocate the proportion of asset MEAV as appropriate for the Generic Concern which would represent failure of the part of the structure to meet the relevant analytical assessment standard.~~ ~~Use XGEN836 until a new analytical assessment has been undertaken.~~	Delete, the requirement for a revised assessment is not a quantifiable structural condition. It is a procedural requirement.
~~XGEN837~~	~~Bridges and Structures that do not have a current site inspection in Accordance with LUL Standards. May result in structural failure leading to collision or derailment.~~		~~Deleted, as lack of inspection is a procedural, not condition, deficiency.~~	
~~XGEN838~~	~~Lift, escalator or moving walkway support structure with a failed Analytical Assessment. Potentially may fail in service and cause jamming of machinery and death or injury.~~		~~Allocate 100% of the asset MEAV.~~	Deleted, There is no LU assessment standard for lifts, escalators or moving walkways, so these assets cannot fail an LU assessment. The concern code is therefore irrelevant. DRACCT Log 00863
XGEN839	Missing or damaged floodboards or obstructed flood board guides. Potentially could allow inundation flooding of a station or tunnels with consequent loss of life.	E2	Allocate 100% of the asset MEAV.	New concern, DRACCT Log 00863

Note 1
The pre-defined Classification given in the Foundation Documents for each Generic Concern is the highest Classification (nearest to A) that shall be used when applying that Generic Concern to an asset, unless justified by engineering judgement which shall be auditable and verifiable by LUL. The justification to raise the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Note 2
When applying Generic Concerns to an asset, a lower Classification (nearer to E1/E2) than the pre-defined Classification given in the Foundation Documents shall be used where justified by the extent, severity or consequences of the Specific Concern affecting the asset, which shall be auditable and verifiable by LUL. The justification for lowering the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Note 3
The following general proportions have been used, for underbridges and overbridges, to derive the allocations of MEAV shown in the Table above:

Deck -	60% of asset MEAV;
Abutment and foundations -	40% of asset MEAV;
Parapets -	20% of asset MEAV, per parapet (assuming that the bridge deck is not also to be replaced);
Footways -	5% of asset MEAV, per footway (assuming that the bridge deck is not also to be replaced).

Note 4
The method of distributing the MEAV where more than one Generic Concern applies shall be in accordance with the requirements of the Manual of Good Practice ~~M1501~~ **G-031**: Asset Condition Assessment and Certification.

Basis for MEAV
Bridges & Structures

Asset No	Asset Description	Generic MEAV	Comment
101	Cable, Pipe, Bridge	£250k	
102	Foot, Bridge	£250k	
103	Overbridge	£1.5m	
103	Overbridge (Large)	£4m	
104	Underbridge	£2m	
104	Underbridge (Large)	£6m	
105	Viaduct	£50k/m	
121	Cable Post Runs	£15k/km	
122	Cable Stiles	£5k	
123	Cable Draw Chamber	£50k	CCF-CPX-0304-002 (New Asset Defined)
141	Canopy (Platform)	£800k	
142	Canopy (Station Entrance)	£50k	CCF-CPX-0304-003 (New Asset Defined)
161	Chimney - Concrete or Masonry	£250k	
162	Chimney - Metal	£250k	
181	Covered Way	£50k/m or £10k/m^2	
201	Culvert 600 diameter or over	£150k	
221	Escalator Machine Room	£250K	
241	Escalator Support Structures	£250K	
261	Girdering	£1.5m	
281	Lift Support Structures	£500k	
301	Linear Station Staircase	£25k	
321	Load Gauge	£100k	
341	Pipe Crossing Over Track	£3.0m	
342	Pipe Crossing Under Tack	£150k	
361	Platform (Station)	£1.6m	
362	Disused Station	£2.0m	
363	Sub-Station Premises	£250k	
381	Roof Stucture and support	£2.0m	

Basis for MEAV
Bridges & Structures

401	Shafts	£450k	
402	Shafts - Cable	£450k	
403	Shafts - Disussed	£450k	
404	Shafts - Lift	£450k	
405	Shafts - Pump	£450k	
421	Signal Gantry	£100k	
422	Access Gantry or Access Platform	£10k	Correction from Issue 3 (CCF-CPX-0304-004)
423	Travelling Access Gantry	£100k	New Asset definition, DRACCT Log 01440
441	Spiral Staircase	£35k	
461	Subway	£3m	
481	Brick Tunnel	£70k/m	
501	Ventilation Plant / Ventilator	£500k	
521	Ventilator (struts)	£5m	
541	Boundary Wall (free standing wall)	£50k	
542	Dry Stone Walls	£100k	
543	Gabion Walls	£100k	
544	Retaining Walls <1m in height	£100k	
545	Retaining Walls >1m in height	£250k	
546	Non - Boundary Wall (free standing wall)	£50k	
547	Vehicle Collision Protection Barrier	£50	New Asset definition DRACCT Log 01958
561	Water Tower	£250k	
571	Lighting Tower	£200k	CCF-CPX-0304-001 (New Asset Defined)
572	Lighting Standard	£2k	CCF-CPX-0304-001 (New Asset Defined)
573	Lighting Mast	£100k	CCF-CPX-0304-001 (New Asset Defined)
580	River Pier	£500k	New asset definition, DRACCT Log 00863
590	Advertising Hoarding	£50k	New asset definition, DRACCT Log 00863
601	Side Hinged watertight door	£500k	New MEAV LUL-CPX-2007-001
602	Horizontal Sliding watertight door	£500k	New MEAV LUL-CPX-2007-001
603	Horizontal Sliding electro-mechanical Floodgate	£2.5m	New MEAV LUL-CPX-2007-001
604	Top Hinged electro-mechanical Floodgate	£2.5m	New MEAV LUL-CPX-2007-001
605	Sector Gate	£1m	New MEAV LUL-CPX-2007-001
606	Hydraulic Floodgate	£3m	New MEAV LUL-CPX-2007-001
607	Diaphragm Floodgate	£2m	New MEAV LUL-CPX-2007-001
608	Vertically sliding Floodgate	£2.5m	New MEAV LUL-CPX-2007-001
609	Penstock Chamber	£500k	New MEAV LUL-CPX-2007-001
610	Station Flood Boards	£10k	New asset definition, DRACCT Log 00863

ASSET CONDITION ASSESSMENT AND CERTIFICATION
LUL CONTROLLED TYPE 1 INFORMATION

STATUS SHEET

Asset	Deep Tube Tunnels
Document Type	Asset Condition Assessment and Certification Foundation Documents (comprising Asset Definition; Required Duty; Generic Concerns List; Basis of Asset MEAV).
Summary of changes	
Miscellaneous Structures an additional asset with MEAV. Concern Classification revised updating the derivation of A to E1/2 classification. Two additional Generic Concerns separating concerns identified from the length of tunnels and their openings/headwalls/ringwalls.	
Limitations on use	
For use in ACAC and in Asset Management Planning. Not directly compatible with structural failure top event in LUL QRA.	
Issue No	7
Authorised by: **Brian McGinnity** **LU Head Of Civil Engineering (CPD)**	
Technical Approval:	**Process Approval:**
Keith Bowers **LU Head of Profession** **Deep Tube Tunnels**	
Valid from	31-Jan-11
Review date	31-Aug-11

Note:
Within this Foundation Document the Generic Concerns listed are defined as concerns (expressed in terms of failure to meet Required Duty), which act as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

Asset Definition
Deep Tube Tunnels

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

New asset definition to cover Miscellaneous Structures

No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)
100	**Deep Tube Tunnels**		
101	Platform or Concourse Tunnels	Rolling Stock; Track; Signals; E&M; Comms; Power; Premises; Pumps & Drainage; Fire Protection; AFC; Bridges & Structures; L&E.	
102	Station Passageway Tunnels	Signals; E&M; Comms; Power; Premises; Pumps & Drainage; Fire Protection; AFC; Bridges & Structures; L&E.	
103	Running Tunnels	Rolling Stock; Track; Signals; E&M; Comms; Power; Premises; Pumps & Drainage.	
104	Cross Passages Between Running Tunnels	Comms; E&M; Pumps & Drainage; Signals.	
105	Step Plate Junctions	Rolling Stock; Track; Signals; E&M; Comms; Power; Premises; Pumps & Drainage; Bridges & Structures.	
106	Crossover Tunnels	Rolling Stock; Track; Signals; E&M; Comms; Power; Premises; Pumps & Drainage; Bridges & Structures.	
107	Depot Approach Tunnels (e.g. London Road)	Rolling Stock; Track; Signals; E&M; Comms; Power; Premises; Pumps & Drainage; Bridges & Structures.	
108	Overrun Tunnel	Rolling Stock; Track; Signals; E&M; Comms; Power; Premises; Pumps & Drainage.	
109	Siding Tunnels	Rolling Stock; Track; Signals; E&M; Comms; Power; Premises; Pumps & Drainage.	
110	Inclined Shafts (eg escalator shafts)	Comms; E&M; Power; Premises; L&E; Fire Protection; Pumps & Drainage; Bridges & Structures.	

Asset Definition
Deep Tube Tunnels

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

New asset definition to cover Miscellaneous Structures

No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)
111	Vertical Shafts (eg ventilation; access; service; lift; and substation shafts).	Comms; E&M; Power; Premises; L&E; Fire Protection; Pumps & Drainage; Bridges & Structures.	
112	Disused Tunnels	Track; Comms; Power; E&M; Pumps & Drainage; Signals; Bridges & Structures; Fire Protection; Premises.	
113	Disused Shafts	Track; Comms; Power; E&M; Pumps & Drainage; Signals; Bridges & Structures; Fire Protection; Premises.	
114	Other Tunnels	Track; Comms; Power; E&M; Pumps & Drainage; Signals; Bridges & Structures; Fire Protection; Premises.	
115	**Miscellaneous Structures (e.g. TTMS)**	**Track; Comms; Power; E&M; Pumps & Drainage; Signals; Bridges & Structures; Fire Protection; Premises.**	

Exclusions

The Deep Tube Tunnels ACAC only includes shafts associated with deep tube tunnels. All other shafts are included in the Bridges and Structures ACAC. Structural components within a deep tube tunnel or a shaft eg escalator steelwork, ladders, shaft landings / gratings etc are included within Bridges and Structures ACAC. Subsurface brick tunnels are also included in the Bridges and Structures ACAC.

Required Duty : Deep Tube Tunnels

The required duty is based on a set of ten generic statements which include all aspects of the asset duty in the context of the operating railway and environment.

The required duty below shows the generic section statement at the beginning of each section. These have a cardinal number (1 to 10 inclusive) and are shown in **bold** type.

Specific Required Duty statements for this asset are shown as sectional numbers (1.1; 1.2 etc) and are shown in normal type. This may include a "not applicable" statement.

Where there are no Specific Required Duty statements within a section the generic statement is considered to be all that is required for this asset under that particular section of required duty.

The asset is required to:

1	**Meet railway operating requirements (within the performance specification at system installation or at the most recent system upgrade).**
1.1	Maintain inherent structural integrity (support itself so as not to suffer complete or partial collapse).
1.2	Support static and dynamic design loads within acceptable stress limits.
1.3	Maintain the planned design envelope and adequate clearance to permit the safe passage of rail vehicles.
1.4	Provide appropriate access and egress for all planned uses (including maintenance), and for reasonably anticipated emergency uses.
1.5	Sustain a condition and state so as not to cause unplanned interruption to, or restriction of, any aspect of the operating railway; this includes externally sourced wear or damage which is greater than that currently accepted for the asset.
1.6	Sustain a condition and state so as to maintain all interfacing non-railway services and facilities at full design capability.
2	**Ensure support at asset interfaces without undue wear and tear.**
2.1	Minimise the degredation of all interfacing assets (e.g. as evidenced through maintenance cycles). This includes interfaces with the railway and adjacent infrastructure (e.g. track, structures and stations, and dynamic and static assets (e.g. not contributing to degradation of the signalling equipment).
2.2	Minimise the degredation of all interfacing assets which support non-railway services or facilities (e.g. as evidenced through maintenance cycles). This includes interfaces with dynamic & static assets (e.g. roads, third party buildings, etc).

Required Duty : Deep Tube Tunnels	
3	**Match LUL policy in respect of realistic user perceptions.**
3.1	Ensure the asset does not cause undue degradation of interfacing assets, disruption to railway operations or unacceptable environmental nuisance, and that asset provides acceptable appearance and general ambience. This includes visual evidence of seepage even where this is not a structural problem.
4	**Provide resistance against external interference and events.**
4.1	Asset minimises the likelihood and consequence of asset abuse. Asset abuse encompasses, vandalism, planned/unplanned work, damage due to external event (e.g. piling), etc. This applies primarily to new or refurbished assets.
5	**Present acceptable environmental impact.**
5.1	Present an acceptable societal environmental impact (noise, vibrations, odours, groundborne contaminants, etc).
5.2	Provide for ease of cleaning and support environmentally acceptable routes for disposal of cleaning residues.
5.3	Support (intrinsically and at asset interfaces) appropriate temperature mechanisms to control temperatures within the range considered societally acceptable by LUL policy.
6	**Minimise environmental impact throughout lifecycle.**
6.1	Minimise environmental impact and demands at all stages in the lifecycle; this includes effects now and into the future, including successive refurbishment, final decommissioning, and disposal routes.
7	**Function within the legal and standards framework.**
7.1	Ensure the asset functions within the framework defined by legislation (including environmental); regulatory guidance; LUL, Infraco and applicable national and international standards; and LUL and Infraco policies.
8	**Ensure safe operation as defined by LUL.**
8.1	Ensure safe operation and condition as specified by LUL requirements this includes passengers, employees and members of the general public.
8.2	Ensure safe ingress/egress by passengers, general public, employees, and emergency services in planned & reasonably anticipated emergency scenarios. This includes the means of transfer from the asset to the principal interfacing assets and transfer mediums (e.g. walking over trackbed or interaction with tunnel during evacuation).
8.3	Safeguard the health and safety of passengers, employees and members of the general public.
9	**Provide above within reliability and availability targets.**
9.1	Provide all aspects of the required duty within the defined LUL requirements.
10	**Ensure Required Duty is performed without incurring excessive or prohibitive costs.**

Generic Concerns List
Deep Tube Tunnels

2007 Review: Two additional Generic Concerns to distinguish between tunnels/shafts, their headwalls, ringwalls or openings. Removal of Tables 1 to 5 in response to CCF-CPH-2006-003.
2011 Review: An additional Generic Concern HGEN014 for contamination after construction by potentially harmful foreign material

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An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

No:	Description	Classification (See Interpretation sheet)	Rules for Allocation of MEAV
HGEN001	Active seepage through tunnel or shaft linings. Potentially may lead to corrosion of rails and increased arcing risk; also potential for disruption of signalling system and operational impact.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN002	Active seepage through tunnel or shaft lining joints. Potentially may lead to corrosion of rails and increased arcing risk; also potential for disruption of signalling system and operational impact.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN003	Active seepage through head wall or infill wall. Potentially may lead to corrosion of rails and increased arcing risk; also potential for disruption of signalling system and operational impact.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN004	Chemical or micro-biological induced deterioration of tunnel or shaft linings or other structural components. Potentially may lead to structural failure with safety or operational consequences.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN005	Tunnel or shaft linings with multiple concentrated cracks and/or spalling. Potentially may lead to structural collapse with safety or operational consequences.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN006	Deterioration of tunnel or shaft lining material or other structural component. Potentially may lead to structural failure with safety or operational consequences.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN007	Excessive tunnel or shaft deformation. Potentially may lead to jamming of lift or escalator machinery, or train strikes. Consequence of a safety hazard or station closure.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN008	Bad build problems and/or flawed/thin segments. Potentially may lead to structural failure with safety or operational consequences.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN009	Weakening of tunnel or shaft through asset abuse (e.g.notching of ribs or due to uncontrolled modifications). Potentially may lead to structural failure with safety or operational consequences.	~~B – E2 But subject to lowest Classification (nearer to E1) derived from Table 5 below.~~	See MEAV Rules and Table 6 below
HGEN010	Tunnels or shafts that do not meet the requirements of an analytical assessment to 2-01304-006. Potentially may lead to structural failure with safety or operational consequences. **Excluding concerns included under HGEN012 and HGEN013.**	~~E2~~	See MEAV Rules and Table 6 below
HGEN011	Deleted from Issue 3.		
HGEN012	**Openings that do not meet the requirements of an analytical assessment to 2-01304-006. Potentially may lead to structural failure with safety or operational consequences.**		**See MEAV Rules and Table 6 below**
HGEN013	**Headwalls or ringwalls that do not meet the requirements of an analytical assessment to 2-01304-006. Potentially may lead to structural failure with safety or operational consequences.**		**See MEAV Rules and Table 6 below**

Generic Concerns List
Deep Tube Tunnels

HGEN014	Tunnel or shaft structure that has become contaminated after construction by potentially harmful foreign material. Potentially may lead to a health and safety risk.	D (requires extraordinary operational and/or maintenance regime)	See MEAV Rules and Table 6 below

Generic Concerns List
Deep Tube Tunnels

~~**Table 1 Asset Information Scores for Ground Conditions**~~

~~**Ground conditions**~~	~~**Asset score**~~	~~**Criteria, potential hazard**~~
~~Cohesive~~	~~4~~	~~Typically London clay with low permeability, self supporting for short time.~~
~~Lambeth group~~	~~4 to 2~~	~~Dependent on location, Cohesive - 4, Non Cohesive - 2.~~
~~Non-cohesive Thames gravel~~	~~2~~	~~Could allow rapid ground failure in case of lining failure. Potential for rapid ingress of water and segment corrosion.~~
~~Thanet Beds~~	~~1~~	~~Potential for water ingress at high pressure and segment corrosion.~~
~~Corrosive ground water~~	~~1*~~	~~Potential for water ingress, segment corrosion and deterioration.~~ ~~*Note: Where there is corrosive ground water the asset information score for all ground conditions shall be 1 regardless of the score for the type of ground.~~

~~**Table 2 Asset Information Scores for Lining Types**~~

~~**Lining type**~~	~~**Asset score**~~	~~**Criteria, potential hazard**~~
~~Bolted SG Cast Iron~~	~~4~~	~~Linings are stronger and less brittle than grey cast iron, less likely to have been damaged during construction particularly during thrusting shield forward.~~
~~Bolted grey cast iron~~	~~3 or 2~~	~~Most common lining with inherent durability. Where poor quality segments have been identified, for example associated with a particular manufacturer, a lower asset score i.e. 2 may be assigned.~~
~~Expanded concrete~~	~~2~~	~~Various types of expanded concrete have been used generally in clay. Corrosion of any reinforcement is a potential durability problem being dependent on ground water chemistry and cover (and therefore quality of the linings) over the reinforcement. Concrete deterioration such as sulphate attack is also a potential concern.~~
~~Bolted concrete~~	~~2~~	~~Limited use at Ilford. Corrosion of reinforcement is a potential durability problem being dependent on ground water chemistry and quality of the linings.~~
~~Sprayed Concrete~~	~~3~~	~~Corrosion of any reinforcement is a potential durability problem being dependent on ground water chemistry and cover (and therefore quality of the linings) over the reinforcement. Concrete deterioration such as sulphate attack is also a potential concern.~~
~~Steel~~	~~2~~	~~Potential for corrosion problems, except asset score for stainless steel shall be 4.~~
~~Flexible grey Cast Iron~~	~~1~~	~~Limited use length of Victoria line. Considerable damage during construction. Concerns are that reduction in hoop load or cracking could lead to rapid lining failure.~~

Generic Concerns List
Deep Tube Tunnels

~~**Table 3 Asset Condition Scores for Leakage, Cracking, Material condition and Deformation**~~

~~**Parameter**~~	~~**Criteria for asset condition score**~~				~~**Comments**~~
	~~**Asset Scores**~~				
	~~**4**~~	~~**3**~~	~~**2**~~	~~**1**~~	
~~**Leakage**~~	~~None~~	~~Damp~~	~~Wet~~	~~Uncon-trolled flow~~	~~Deposits and growths associated with leakage shall be noted and influence the asset score~~
~~**Cracking**~~	~~None~~	~~Minor~~	~~Moder-ate~~	~~Severe~~	~~New cracks or propagation of cracks highlighted. The structural significance of the cracking should be specifically considered by the assessment engineer in assessing the asset score.~~
~~**Material condition**~~	~~None~~	~~Minor~~	~~Moder-ate~~	~~Severe~~	~~Corrosion, spalling, concrete deterioration, damage and modification.~~
~~**Deformation**~~	~~None~~	~~Minor~~	~~Moder-ate~~	~~Severe~~	~~Deformation or displacement of the lining potentially resulting in infringement of the kinematic envelope and/or affecting load bearing characteristics of the lining.~~

~~**Table 4 Matrix for Combining Asset Information and Condition Scores**~~

~~**Asset Information Scores – Stage 1**~~		~~**Asset Condition Scores – Stage 2**~~	
~~**Parameter**~~	~~**Score**~~	~~**Parameter**~~	~~**Score**~~
~~(i) Ground conditions (Table 1)~~		~~(iii) Leakage~~	
~~(ii) Lining type (Table 2)~~		~~(iv) Cracking~~	
		~~(v) Material condition~~	
		~~(vi) Deformation~~	
~~**(vii) Total Score =** (i) + (ii)~~		~~**(viii) Total Score** = (iii)+(iv)+(v)+(vi)~~	
~~**(ix) Asset Information and Condition Score** (used in Table 5) = (vii) x 1 + (viii) x 5~~			

Generic Concerns List
Deep Tube Tunnels

~~**Table 5 Classification of Deep Tube Tunnel Assets**~~

~~The prescribed Classification of each Generic Concern shall be modified in accordance with the following details and scores where applicable to the Generic Concern and the Asset.~~	
~~**Quantitative description**~~	~~**Classification**~~
~~One of the following:~~ ~~a) From Table 4 a Parameter Score for items (iii), (iv), (v) or (vi) = 1;~~ ~~OR~~ ~~b) Calculated assessment load effects are greater than the assessment resistance as in E3322.~~	~~E1 / E2 *~~
~~One of the following:~~ ~~a) From Table 4 a Parameter Score for items (iii), (iv), (v) or (vi) = 2;~~ ~~OR~~ ~~b) Calculated assessment load effects are greater than the assessment resistance as in E3322, and a Safety Risk Assessment has been undertaken which justifies using Classification D.~~	~~D~~
~~All of the following apply:~~ ~~a) From Table 4 Asset Information and Condition Score (ix) > 50;~~ ~~AND~~ ~~b) From Table 4 all Parameter Scores for each item (iii), (iv), (v) or (vi) > 2;~~ ~~AND~~ ~~c) Analytical Assessment raises no concerns.~~	~~C~~
~~All of the following apply:~~ ~~a) From Table 4 Asset Information and Condition Score (ix) > 65;~~ ~~AND~~ ~~b) From Table 4 all Parameter Scores for each item (iii), (iv), (v) or (vi) > 2;~~ ~~AND~~ ~~c) Analytical Assessment raises no concerns.~~	~~B~~

~~* Classification E1 or E2 depends on results of risk assessment and any mitigating actions taken.~~

~~**Note 1**~~

~~The pre-defined Classification (identified in Table 5 above) for each Generic Concern is the highest Classification (nearest to A) that shall be used when applying that Generic Concern to an asset, unless justified by engineering judgement which shall be auditable and verifiable by LUL. The justification for raising the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.~~

~~**Note 2**~~

~~When applying Generic Concerns to an asset, a lower Classification (nearer to E1/E2) than the pre-defined Classification (identified in Table 5 above) shall be used where justified by the extent, severity or consequences of the Specific Concern affecting the asset, which shall be auditable and verifiable by LUL. The justification for lowering the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.~~

Generic Concerns List
Deep Tube Tunnels

Rules for the Allocation of MEAV to Generic Concerns and Classifications

The Generic Concerns do not each have a prescribed percentage of the whole asset MEAV identified, as the percentage will depend on the extent and severity of the defect, and the scope of the remedial work required. As a guide, the % MEAV values in the following Table should be allocated to the Classification (B to E1/E2) for the applicable Generic Concern. If different % values are used by the Assessor, the % shall be justified in the ACAC reports and shall be used consistently year on year for the individual asset.

Where the Generic Concern only affects part of the linear length of the asset, the % of MEAV allocated shall be factored by the ratio of the affected linear length to the whole asset length. The ACAC report shall record the length factor (where applicable) and % factor from the Table below used to establish the % MEAV allocated to the Generic Concern, which shall be auditable and verifiable by LUL.

Allocation of MEAV to HGEN010 shall be based on the length of the part of the asset directly affected by the Generic Concern.

Allocation of MEAV to HGEN012:
The MEAV assigned to the Generic Concern shall be calculated as follows:

MEAV per metre of tunnel containing the opening * (width of opening + 2 metres)

Allocation of MEAV to HGEN013:
The MEAV assigned shall be calculated as follows:

5 * MEAV per metre of larger tunnel

Table 6

Deep Tube Tunnels: MEAV % Allocation	
Extent and Severity of Defect	**% MEAV**
The defect will require full replacement of the tunnel lining, or the estimated costs of repair / renewal approximates to the MEAV of the asset. For example: > Tunnel encroaches on kinematic envelope and requires breakout of existing lining and replacement with new.	100%
The defect requires replacement of individual tunnel segments or the estimated cost of repair / renewal is less than the MEAV of the asset. For example: > Replacement of individual segments which have been damaged > Additional back grouting behind segments to reduce water infiltration.	50%
The estimated cost of repair / renewal is significantly less than the MEAV of the asset, and the repair work is “minor”. For example: > Replacing bolts; > Repair of segments (not replacement); > Replacement of caulking between segments.	20%

The method of distributing the MEAV where more than one Generic Concern applies shall be in accordance with the requirements of the Manual of Good Practice M1501: Asset Condition Assessment and Certification.

Concern Classification

Replacement of Generic Concerns Tables 1 to 5, in response to CCF-CPH-2006-001.

Step 1 - Inspection Works Priority		Step 2 - Identify corresponding Capacity of Structure and check mitigation / additional works			Step 3 - Identify ACAC Classification
Works to be undertaken by Year	**Inspection Result** (2-01304-006, Table 4 Defect Classification - Priority)	**Analytical Assessment Result**[1] (2-01304-006, 3.4 Analytical Assessment)	**Specific Concern** (2-01015-001, 6.3 Definition)	**Mitigation / Works**	**ACAC Classification**
				(2-01015-001, 3.2 Classifying asset condition)	
0	Immediate (I)	None Capacity of the Structure ≥ 1.00 Capacity of the Structure < 1.00	Principal Inspection shows Asset fails to meet required duty.	Asset withdrawn from full service.	**E1**
0	Immediate (I)	None Capacity of the Structure ≥ 1.00 Capacity of the Structure < 1.00	Principal Inspection shows Asset fails to meet required duty.	Provision of additional inspections or protective devices.	**E2**
0	High (H), Medium (M), Low (L), Review (R)	Capacity of the Structure < 1.00	Analytical Assessment shows Asset fails to meet required duty.	Asset withdrawn from full service.	**E1**
0	High (H), Medium (M), Low (L), Review (R)	Capacity of the Structure < 1.00	Analytical Assessment shows Asset fails to meet required duty.	Provision of additional inspections or protective devices.	**E2**
0	High (H), Medium (M), Low (L), Review (R)	None	Insufficient information to complete Analytical Assessment. Unable to demonstrate that Asset meets required duty.	Provision of additional inspections or protective devices.	**E2**
1	High (H)	Capacity of the Structure ≥ 1.00	Asset in poor condition or inherent design deficiencies identified.	Asset requires extraordinary operational and / or maintenance regime; or immediate replacement , modification or overhaul.	**D**
2 3 4 5	Medium (M) Low (L)	Capacity of the Structure ≥ 1.00	Currently fulfils required duty and does not require extraordinary operational and / or maintenance.	Will require works other than routine maintenance within the next 5 years.	**C**
6 7 8 9 10	Low (L)	Capacity of the Structure ≥ 1.00	Currently fulfils required duty and does not require extraordinary operational and / or maintenance.	Will require works other than routine maintenance with 6 to 10 years.	**B**
> 10	Review (R)	Capacity of the Structure ≥ 1.00	Currently fulfils required duty and does not require extraordinary operational and / or maintenance.	Works other than routine maintenance not required within 10 years.	**A**

Note 1:
Analytical Assessment Result of None would identify the asset as Grey notwithstanding a B to E1/2 asset condition classification.

Note 2:
The pre-defined Classification for each Specific Concern is the highest Classification (nearest to A) that shall be used when applying a Generic Concern to an asset, unless justified by engineering judgement which shall be auditable and verifiable by LUL. The justification for raising the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Note 3:
When applying Generic Concerns to an asset, a lower Classification (nearer to E1/E2) than the pre-defined Classification shall be used where justified by the extent, severity or consequences of the Specific Concern affecting the asset, which shall be auditable and verifiable by LUL. The justification for lowering the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Basis for MEAV
Deep Tube Tunnels

The Assets identified within this Foundation Document are those mandated under Category 1 Standard 2-01304-006 Civil Engineering - Deep Tube Tunnels and Shafts.

New Asset MEAV to cover Miscellaneous Structures.

Asset No:	Asset	Value per metre (£)
101	Platform or Concourse Tunnels	33,330
102	Station Passageway Tunnels	10,700
103	Running Tunnels	10,700
104	Cross Passages Between Running Tunnels	10,700
105	Step Plate Junctions	46,000
106	Crossover Tunnels	67,000
107	Depot Approach Tunnels (e.g. London Road)	10,700
108	Overrun Tunnel	10,700
109	Siding Tunnels	10,700
110	Inclined Shafts (eg escalator shafts)	33,330
111	Vertical Shafts (eg ventilation; access; service; lift; and substation shafts)	10,700
112	Disused Tunnels	10,700
113	Disused Shafts	10,700
114	Other Tunnels	10,700
115	**Miscellaneous Structures (e.g. TTMS)**	**10,700**

LUL Controlled Specific Concerns List : Deep Tube Tunnels

No	Classification	Description	Current Nos in Use

ASSET CONDITION ASSESSMENT AND CERTIFICATION LUL CONTROLLED TYPE 1 INFORMATION	
STATUS SHEET	
Asset	Earth Structures
Document Type	Asset Condition Assessment and Certification Foundation Documents (comprising Asset Definition; Required Duty; Generic Concerns List; Basis of Asset MEAV).
Summary of changes	
Required Duty statements updated. Generic Concerns updated with rules for asset classification (for Issue 3). Change of Authorising and Approval signatures (for Issue 4). Addition of Generic Concern definition (for Issue 5).	
Limitations on use	
For use in ACAC and in Asset Management Planning. Not directly compatible with structural failure top event in LUL QRA	
Issue No	#REF!
Authorised by: **Eddie Goddard** **LU Chief Engineer**	
Technical Approval:	**Process Approval:**
Jim Moriarty **LU Civils Asset Engineer**	**Geoff Greenland** **LU Asset Condition Manager**
Valid from	
Review date	31-Aug-06

Note:
Within this Foundation Document the Generic Concerns listed are defined as concerns (expressed in terms of failure to meet Required Duty), which act as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

Asset Definition
Earth Structures

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)
100	Embankments (where material has been placed > 1m above original ground level to support the track asset)	Track Stations on embankments Drainage Structures formed on embankments Vegetation on embankment slope Fencing on embankments Lineside services	All
200	Cuttings (where an excavation has been formed >1m below original ground level to carry the track asset)	Track Stations in cuttings Drainage Structures in cuttings Vegetation on cutting slope Fencing in cuttings Lineside services	All

Exclusions

The Earth Structures ACAC includes embankments and cuttings as defined above but excludes the following asset groups which are covered by other ACACs: Track, Pumps and drainage, Bridges and Structures, Vegetation and Fencing.
Track formation and "at grade" sections of the railway are not currently covered by any of the ACAC disciplines.

Required Duty : Earth Structures

The required duty is based on a set of ten generic statements which include all aspects of the asset duty in the context of the operating railway and environment.

The required duty below shows the generic section statement at the beginning of each section. These have a cardinal number (1 to 10 inclusive) and are shown in **bold** type.

Specific Required Duty statements for this asset are shown as sectional numbers (1.1; 1.2 etc) and are shown in normal type. This may include a "not applicable" statement.

Where there are no Specific Required Duty statements within a section the generic statement is considered to be all that is required for this asset under that particular section of required duty.

Specific Required Duty statements revised February 2005. Orange signifies a change to the last issue.
Strikethrough identifies removal and embolden identifies new to this issue.

The asset is required to:

1	**Meet railway operating requirements (within the performance specification at system installation or at the most recent system upgrade).**
1.1	Maintain inherent structural integrity (support itself so as not to suffer complete or partial collapse), i.e. meet or exceed factors of safety currently specified in LUL standards.
1.2	Maintain the ability to carry without restriction any permitted applied static and dynamic design loads.
1.3	Allow adequate clearance to ensure the safe passage of rail vehicles.
1.4	Provide appropriate access and egress for all planned uses (including maintenance), and for reasonably anticipated emergency uses.
1.5	Sustain a condition and state so as not to cause unplanned interruption to, or restriction of, any aspect of the operating railway.
1.6	Sustain a condition and state so as to maintain all interfacing non-railway services and facilities at full design capability.
1.7	Meet or exceed the serviceability requirements currently specified in LUL standards (e.g. deformation).
2	**Ensure support at asset interfaces without undue wear and tear.**
2.1	Minimise the degradation of all interfacing assets (e.g. as evidenced through maintenance cycles). This includes interfaces with the railway and adjacent infrastructure (e.g. track, structures, stations and premises).

Required Duty : Earth Structures	
2.2	Minimise the degradation of all interfacing assets which support non-railway services or facilities (e.g. as evidenced through maintenance cycles). Includes interfaces with dynamic & static assets (e.g. roads,buildings,walkways,etc).
3	**Match LUL policy in respect of realistic user perceptions.**
3.1	Ensure the asset does not cause undue degradation of interfacing assets, disruption to railway operations or unacceptable environmental nuisance.
4	**Provide resistance against external interference and events.**
4.1	Asset minimises the likelihood and consequence of asset abuse. Asset abuse encompasses, vandalism, planned/unplanned work, damage due to external event, etc.
5	**Present acceptable environmental impact.**
5.1	Present an acceptable societal environmental impact (noise, vibrations, vegetation cover, adverse weather management, etc).
6	**Minimise environmental impact throughout lifecycle.**
6.1	Minimise environmental impact and demands at all stages in the lifecycle; this includes effects now and into the future, including successive maintenance and renewal, final decommissioning, and disposal routes.
7	**Function within the legal and standards framework.**
7.1	Ensure the asset functions within the framework defined by legislation (including environmental); regulatory guidance; LUL, Infraco and applicable national and international standards; and LUL and Infraco policies.
8	**Ensure safe operation as defined by LUL.**
8.1	Ensure safe operation and condition as specified by LUL requirements; this includes passengers, employees and members of the general public.
8.2	Ensure safe ingress/egress by passengers, employees, and emergency services in planned & reasonably anticipated emergency scenarios.
8.3	Safeguard the health and safety of passengers, employees and members of the general public.
9	**Provide above within reliability and availability targets.**
9.1	Provide all aspects of the required duty within the defined LUL requirements.
10	**Ensure Required Duty is performed without incurring excessive or prohibitive costs.**
10.1	**Use the most efficient and cost effective asset management methods, such as inspection, maintenance, monitoring or renewal to deliver the required duty.**

Generic Concerns List
Earth Structures

Issue 3: Revised Generic Concerns List as agreed between LUL and InfraCos at Joint Review Panel held on 13 January 2005. Included below are Classification rules to be used with the Generic Concerns. Issue 5: Addition of Generic Concern definition. Issue 6: Update and addition of Generic Concerns and classification rules Orange signifies a change from Issue 5. Strikethrough identifies removal and embolden identifies new.

A Generic Concern is defined as: A Concern (expressed in terms of failure to meet Required Duty), which acts as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

		New for Issue 6 3		
No	**Description**	**Classificat-ion (See Notes 1 and 2)**	**Rules for Allocation of MEAV in ACAC Matrix**	**Comment**
BGEN001	Earth Structures with a "Poor" Condition Category (with a Condition Rating of ~~less than~~ **0 to** 40%). Potentially may result in Earth Structure failure leading to collision or derailment.	**D - E1/E2 ***	~~**See Note 3 and Table below**~~	**The Assessor shall classify the asset as E1/E2 or D as follows: E1/E2 - Condition Rating of 0% to 20% D - Condition Rating of >20% to 40%**
BGEN002	Earth Structures with a "Marginal" Condition Category (with a Condition Rating of >40 to 65%). Potentially may result in Earth Structure failure leading to collision or derailment.	**B - C**	~~**See Note 3 and Table below**~~	The Assessor shall use engineering judgement to classify the asset as C or B as follows: C - **Condition Rating of >40% to 65%, but** major maintenance or renewal anticipated to be required within one to five years. B - **Condition Rating of >40% to 65%, but** major maintenance or renewal anticipated to be required within six to ten years.
BGEN003	Earth Structures that require extraordinary maintenance and / or further site investigation or assessment but do not have a "Poor" or "Marginal" Condition Category . Potentially may result in Earth Structure failure leading to collision or derailment.	**D**	~~**See Note 3 and Table below**~~	
BGEN004	Earth Structures that have undergone a site investigation and slope stability assessment to ~~**E3321**~~ **1-054** resulting in a "Poor" Condition Category (with a Condition Rating of 0 to 20%) ~~and / or a~~ **after incorporating the** factor of safety against deep seated slips into the **Condition Rating Tool** ~~of <1.15~~. or a factor of safety against deep seated slips of <1.15 where it is considered to be representative of the physical condition of the structure. Potentially may result in Earth Structure failure leading to collision or derailment.	**E1/E2 ***	~~**See Note 3 and Table below**~~	
BGEN005	Earth Structures that have undergone a site investigation and slope stability assessment to ~~**E3321**~~ **1-054** resulting in a "Poor" Condition Category (with a Condition Rating of >20 to 40%) **after incorporating the** ~~and /or a~~ factor of safety against deep seated slips **into the Condition Rating Tool** ~~of >1.15 but less than <1.3.~~ Potentially may result in Earth Structure failure leading to collision or derailment.	**D**	~~**See Note 3 and Table below**~~	
BGEN006	Earth Structures that have undergone a site investigation and slope stability assessment to ~~**E3321**~~ **1-054** resulting in a "Marginal" Condition Category (with a Condition Rating of >40 to 65%) **after incorporating the** ~~and a~~ factor of safety against deep seated slips **into the Condition Rating Tool** ~~of >1.15 but less than <1.3~~. Potentially may result in Earth Structure failure leading to collision or derailment.	**C**	~~**See Note 3 and Table below**~~	
BGEN007	Earth Structures that have undergone a site investigation and slope stability assessment to ~~E3321~~ **1-054** resulting in a "Marginal" Condition Category (with a Condition Rating of >40 to 65%) **after incorporating the factor of safety against deep seated slips into the Condition Rating Tool** and a factor of safety against deep seated slips of >1.3. Potentially may result in Earth Structure failure leading to collision or derailment.	**B**	~~**See Note 3 and Table below**~~	
~~BGEN008~~	~~Earth Structures that do not have a current site inspection in accordance with LUL Standards. May result in Earth Structure failure leading to collision or derailment.~~			**Deleted, as lack of inspection is a procedural, not condition, deficiency.**
BGEN009	**Earth Structures that have undergone a site investigation and slope stability assessment to 1-054 resulting in a "Poor" embankment shoulder condition and/or other serviceability concerns. The structures otherwise meet the requirements of the standard for deep seated stability.**	**D_S**	**80%**	**See Notes 4 to 6**
BGEN010	**Earth Structures that have undergone a site investigation and slope stability assessment to 1-054 resulting in a "Marginal" embankment shoulder condition and/or other serviceability concerns. The structures otherwise meet the requirements of the standard for deep seated stability.**	**C_S**	**50%**	**Major maintenance or renewal anticipated to be required within one to five years. See Notes 4 to 6.**
BGEN011	**Earth Structures that have undergone a site investigation and slope stability assessment to 1-054 resulting in a "Marginal" embankment shoulder condition and/or other serviceability concerns. The structures otherwise meet the requirements of the standard for deep seated stability.**	**B_S**	**20%**	**Major maintenance or renewal anticipated to be required within six to ten years. See Notes 4 to 6.**

Generic Concerns List
Earth Structures

Issue 3: Revised Generic Concerns List as agreed between LUL and InfraCos at Joint Review Panel held on 13 January 2005. Included below are Classification rules to be used with the Generic Concerns. Issue 5: Addition of Generic Concern definition. Issue 6: Update and addition of Generic Concerns and classification rules Orange signifies a change from Issue 5. Strikethrough identifies removal and embolden identifies new.

A Generic Concern is defined as: A Concern (expressed in terms of failure to meet Required Duty), which acts as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

		New for Issue 6 3		
No	**Description**	**Classificat-ion (See Notes 1 and 2)**	**Rules for Allocation of MEAV in ACAC Matrix**	**Comment**
BGEN012	**Earth Structures with a "Poor" embankment shoulder condition and/or other serviceability concerns. The structures otherwise meet the requirements of the standard for deep seated stability.**	D_S	**80%**	**See Notes 4 to 6**
BGEN013	**Earth Structures with a "Marginal" embankment shoulder condition and/or other serviceability concerns. The structures otherwise meet the requirements of the standard for deep seated stability.**	C_S	**50%**	**Major maintenance or renewal anticipated to be required within one to five years. See Notes 4 to 6.**
BGEN014	**Earth Structures with a "Marginal" embankment shoulder condition and/or other serviceability concerns. The structures otherwise meet the requirements of the standard for deep seated stability.**	B_S	**20%**	**Major maintenance or renewal anticipated to be required within six to ten years. See Notes 4 to 6.**

Note 1

The pre-defined Classification given in the Foundation Documents for each Generic Concern is the highest Classification (nearest to A) that shall be used when applying that Generic Concern to an asset, unless justified by engineering judgement which shall be auditable and verifiable by LUL. The justification to raise the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Note 2

When applying Generic Concerns to an asset, a lower Classification (nearer to E1/E2) than the pre-defined Classification given in the Foundation Documents shall be used where justified by the extent, severity or consequences of the Specific Concern affecting the asset, which shall be auditable and verifiable by LUL. The justification for lowering the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Note 3

The Generic Concerns do not each have a prescribed percentage of the whole asset MEAV identified, as the percentage will depend on the extent and severity of the defect, and the scope of the remedial work required. As a guide, the % MEAV values in the following Table should be allocated to the Classification ~~(B to E1/E2)~~ **(B_S to D_S)** for the applicable Generic Concern. If different % values are used by the Assessor, the % shall be justified in the ACAC reports and shall be used consistently year on year for the individual asset.

Note 4

Serviceability concerns other than shoulder condition may include ravelling of material resulting in toe debris, wash-out erosion, scour erosion and asset abuse, among others.

Note 5

The changes shown in this Issue 4 of the Generic Concern List are to be applied hereafter and as and when concerns are raised following inspection and/or assessment.

Note 6

The condition of the shoulder is defined in the "Earth Structures Inspection Procedure", Document No. PRC-ENG-TM00-0594504 and as shown in Figure 1. The algorithm in the Condition Rating Tool will be revised in order to incorporate shoulder defects in accordance with Figure 1 and corresponding condition scores.

Generic Concerns List
Earth Structures

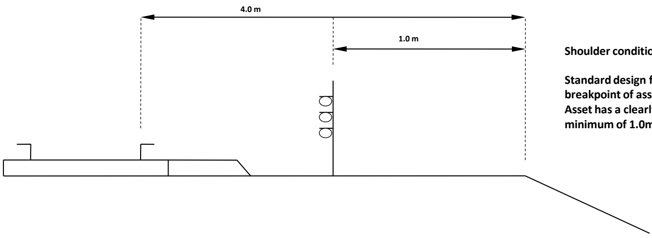
Issue 3: Revised Generic Concerns List as agreed between LUL and InfraCos at Joint Review Panel held on 13 January 2005. Included below are Classification rules to be used with the Generic Concerns. Issue 5: Addition of Generic Concern definition. Issue 6: Update and addition of Generic Concerns and classification rules Orange signifies a change from Issue 5. Strikethrough identifies removal and embolden identifies new.

A Generic Concern is defined as: A Concern (expressed in terms of failure to meet Required Duty), which acts as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

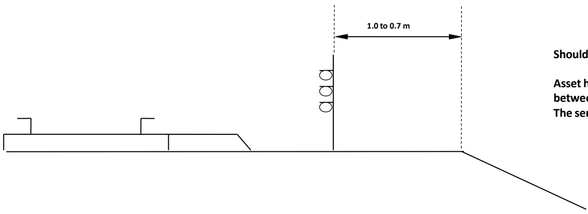
		New for Issue 6 3		
No	Description	Classification (See Notes 1 and 2)	Rules for Allocation of MEAV in ACAC Matrix	Comment

Figure 1 : Shoulder Condition



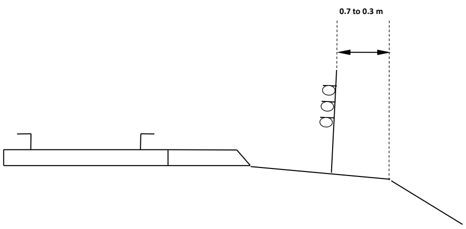
Shoulder condition: Good

Standard design for remediation stipulates 4.0m distance between nearest running rail and breakpoint of asset.
Asset has a clearly defined flat walkable area between the ballast shoulder and the services and minimum of 1.0m width beyond the services.



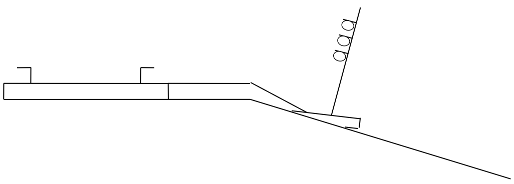
Shoulder condition: Serviceable

Asset has a clearly defined flat walkable area between the ballast shoulder and the services and between 1.0m and 0.7m width beyond the services.
The services may have a slight lean.



Shoulder condition: Marginal

Defined walkable area between the ballast shoulder and the services is narrow and sloping away from the track and may be undulating along its length with between 0.7m and 0.3m width beyond the services. The above condition may have led to the following:
The depth of ballast may be increasing – up to 0.4m.
Services leaning down slope up to 5° and may be showing minor horizontal or vertical displacement.



Shoulder condition: Poor

No defined walkable area between the ballast shoulder and the services and less than 0.3m width beyond the services. Ballast shoulder ravelling down slope. Cable post toes are exposed. Access along the slope may be difficult due to localised oversteepening.
The above condition may have led to the following:
Ballast depth greater than 0.4m.
Services leaning down slope greater than 10° and showing distinct horizontal or vertical displacement.
Track may be undulating.

Generic Concerns List
Earth Structures

Issue 3: Revised Generic Concerns List as agreed between LUL and InfraCos at Joint Review Panel held on 13 January 2005. Included below are Classification rules to be used with the Generic Concerns. Issue 5: Addition of Generic Concern definition. Issue 6: Update and addition of Generic Concerns and classification rules Orange signifies a change from Issue 5. Strikethrough identifies removal and embolden identifies new.

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		New for Issue 6 3		
No	**Description**	**Classificat-ion (See Notes 1 and 2)**	**Rules for Allocation of MEAV in ACAC Matrix**	**Comment**

Where the Generic Concern only affects part of the linear length of the asset, the % of MEAV allocated shall be factored by the ratio of the affected linear length to the whole asset length. The ACAC report shall record the length factor (where applicable) and % factor from the Table below used to establish the % MEAV allocated to the Generic Concern, which shall be auditable and verifiable by LUL.

Earth Structures: MEAV % Allocation	
Extent and Severity of Defect	**% MEAV**
The defect will require substantial stabilisation or renewal works to the entire earth structure cross-section, or the estimated costs of repair / renewal approximates to the MEAV of the asset. For example: > Major slope regrading and drainage works over the entire cross-section; > Construction of a major slope retaining wall.	100%
The defect only affects part of the earth structure cross-section, or the estimated cost of repair / renewal is marginally less than the MEAV of the asset. For example: > Substantial repair, reconstruction or stabilisation of the toe of an embankment or cutting or shoulder of an embankment; > Replacement of the earth structure drainage system.	**80%**
The defect only affects part of the earth structure cross-section, or the estimated cost of repair / renewal is less than the MEAV of the asset. For example: > Substantial repair, reconstruction or stabilisation of the toe of an embankment or cutting **or shoulder of an embankment**; > Replacement of the earth structure drainage system.	50%
The estimated cost of repair / renewal is significantly less than the MEAV of the asset, and the repair work is "minor" for example: > Slope surface repair works; > Removal of vegetation growth; > Minor drainage works. **> Minor shoulder stabilisation of an embankment**	20%

The method of distributing the MEAV where more than one Generic Concern applies shall be in accordance with the requirements of the Manual of Good Practice M1501: Asset Condition Assessment and Certification.

Basis for MEAV
Earth Structures

Asset No:	Asset	Basis of MEAV Calculation (cost in £/metre)
100	Embankments	2,000
200	Cuttings	1,500

LUL Controlled Specific Concerns List : Earth Structures

No	Classification	Description	Current Nos in Use

ASSET CONDITION ASSESSMENT AND CERTIFICATION
LUL CONTROLLED TYPE 1 INFORMATION

STATUS SHEET

1. Asset	Pumps & Drainage
2. Document Type	Asset Condition Assessment and Certification Foundation Documents (comprising Asset Definition; Required Duty; Generic Concerns List; Basis of Asset MEAV).
Summary of changes	
Four minor asset definition changes and two removed asset definitions and new MEAVs for station drainage.	
Limitations on use	
For use in ACAC and in Asset Management Planning. Not directly compatible with structural failure top event in LUL QRA.	
Issue No	#REF!
Authorised by: **Eddie Goddard** **LU Chief Engineer**	
Technical Approval:	**Process Approval:**
Jim Moriarty **LU Civils Asset Engineer**	**Hazel McCartney** **AM Account Manager** **Stations, Civil & Power**
Valid from	01-Feb-11
Review date	31-Aug-12

Note:
Within this Foundation Document the Generic Concerns listed are defined as concerns (expressed in terms of failure to meet Required Duty), which act as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

Asset Definition
Pumps & Drainage

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

2007 Review: Two deleted asset definitions and four minor revisisions to asset definitions.

2010 Review: Pump Drainage hierarchy and numbering updated updated

No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)
100	**Pump Drainage***		
101	Pump Control Panel / Small - Simple		
102	Pump Control Panel / Medium - Non Critical		
103	Pump Control Panel / Large - Critical		
104	Pump Control Panel / JLE and Victoria - Critical extra large		
105	Pumps Auxiliary Panels		
106	Auxillary Isolator		
110	Pumping Mains - suction and delivery / Surface		
111	Pumping Mains - suction and delivery / Buried		
112	Pumping Mains - suction and delivery / JLE and Victoria - extra large		
113	Vent System - dedicated to pumping system		
120	Valves / Mechanical small		
121	Valves / Mechanical large		
122	Valves / Electrical		
130	Pumps / Submersible - small		
131	Pumps / Submersible - medium		
132	Pumps / Submersible - large		
133	Pumps / Strate		
134	Pumps / Sewage handling unit		
135	Pumps / Centrifugal (GGG or similar)		
136	Pumps / Centrifugal (Varisco or similar)		
137	Pumps / JLE and Victoria - extra large		
140	Pump control gear including sensors, level probes, transducers etc. / Critical		
141	Pump control gear including sensors, level probes, transducers etc. / Non-critical		
142	Pump control gear including sensors, level probes, transducers etc. / Simple		
143	Pump control gear including sensors, level probes, transducers etc. / JLE and Victoria - extra large		
150	Pump alarm systems / Local		
151	Pump alarm systems / Remote - SCADA		
160	Sumps / Small (typically up to 1m plan size and 1.5m deep) larger would typically be a B&S asset		
161	Tanks / Small		
162	Tanks / Medium		
163	Tanks / Large		
164	Tanks / Saniflo		
170	Cables / Power		
171	Cables / Alarm / Indication		
200	**Station Drainage - Section 12**		
201	**Buried** Gravity **Drainage** Pipes ~~(including those carrying grey and/or foul waste from sanitary ware)~~		TLL-CPD-2007-001
202	Venting Pipes		
203	Manholes		
204	Inspection Chamber		
205	Channels **(including gratings)**		TLL-CPD-2007-001
206	Gullies		
207	~~Gratings~~		TLL-CPD-2007-001
208	Grease Traps		
209	Oil interceptors		
210	Drip Trays		
211	Sumps		

Asset Definition
Pumps & Drainage

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2007 Review: Two deleted asset definitions and four minor revisisions to asset definitions.

2010 Review: Pump Drainage hierarchy and numbering updated updated

No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)
212	Flow Control Device		

Asset Definition
Pumps & Drainage

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

2007 Review: Two deleted asset definitions and four minor revisisions to asset definitions.

2010 Review: Pump Drainage hierarchy and numbering updated updated

No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)
300	**Station Drainage - Non Section 12**		
301	**Buried** Gravity **Drainage** Pipes ~~(including those carrying grey and/or foul waste from sanitary ware)~~		TLL-CPD-2007-001
302	Venting Pipes		
303	Manholes		
304	Inspection Chamber		
305	Channels **(including gratings)**		TLL-CPD-2007-001
306	Gullies		
307	~~Gratings~~		TLL-CPD-2007-001
308	Grease Traps		
309	Oil interceptors		
310	Drip Trays		
311	Sumps		
312	Flow Control Device		
400	**Track and Off Track Drainage - Section 12**	**Track**	All
401	Gravity Pipes - Non Brick		
402	Gravity Pipes - Brick		
403	Venting Pipes		
404	Catchpits		
405	Manholes		
406	Flow control device		
407	Storage Tank		
408	Channels		
409	Syphon		
410	Gratings		
411	Pipe Crossings up to 600 mm nominal bore		
412	Sumps		
413	Interstices between the pipe bedding		
414	Trench backfill		

Asset Definition
Pumps & Drainage

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

2007 Review: Two deleted asset definitions and four minor revisisions to asset definitions.

2010 Review: Pump Drainage hierarchy and numbering updated updated

No	Definition Groups	Interfaces With	PPP Condition Benchmarks (Schedule 3.2)
500	**Track and Off Track Drainage - Non Section 12**	**Track**	All
501	Gravity Pipes - Non Brick		
502	Gravity Pipes - Brick		
503	Venting Pipes		
504	Catchpits		
505	Manholes		
506	Soakaways		
507	Flow control device		
508	Storage Tank		
509	Channels		
510	Syphon		
511	Gratings		
512	Pipe Crossings up to 600 mm nominal bore		
513	Open ditches		
514	Screens		
515	Oil interceptors		
516	Sumps		
517	Interstices between the pipe bedding		
518	Trench backfill		

Exclusions

Sanitary Ware; Roof Drainage; Guttering; Down Pipes

Notes

* A pumping system is defined as all equipment associated with a pump control panel

Required Duty
Pumps & Drainage

The required duty is based on a set of ten generic statements which include all aspects of the asset duty in the context of the operating railway and environment.

The required duty below shows the generic section statement at the beginning of each section. These have a cardinal number (1 to 10 inclusive) and are shown in **bold** type.

Specific Required Duty statements for this asset are shown as sectional numbers (1.1; 1.2 etc) and are shown in normal type. This may include a "not applicable" statement.

Where there are no Specific Required Duty statements within a section the generic statement is considered to be all that is required for this asset under that particular section of required duty.

The asset is required to:

1	**Meet railway operating requirements (within the performance specification at system installation or at the most recent system upgrade).**
1.1	Maintain inherent structural integrity (support itself so as not to suffer complete or partial collapse).
1.2	Maintain the ability to carry without restriction any permitted applied static and dynamic design loads.
1.3	Allow adequate clearance to ensure the safe passage of rail vehicles.
1.4	Operate without risk of blockage or failure to minimise the risk of flooding or disruption to railway operations.
1.5	Provide sufficient hydralic capacity to convey the flow requirements.
1.6	Provide appropriate access and egress for all planned uses (including maintenance), and for reasonably anticipated emergency uses (including maintenance).
1.7	Sustain a condition and state so as not to cause unplanned interruption to, or restriction of, any aspect of the operating railway.
2	**Ensure support at asset interfaces without undue wear and tear.**
2.1	Minimise the degredation of all interfacing assets (e.g. as evidenced through maintenance cycles). This includes interfaces with the railway and adjacent infrastructure e.g. track, structures, stations and premises.

Required Duty Pumps & Drainage	
3	**Match LUL policy in respect of realistic user perceptions.**
3.1	Ensure pumping and drainage systems collect, convey and discharge their content without undue degradation to interfacing assets, disruption to railway operations, unacceptable environmental nuisance, or risk to the health and safety of passengers, employees and members of the general public.
4	**Provide resistance against external interference and events.**
4.1	Provide a drainage system which minimises the likelihood and consequence of asset abuse. Asset abuse encompasses, vandalism, planned/unplanned work, damage due to external event, protection of manholes,etc.
5	**Present acceptable environmental impact.**
5.1	Provide an acceptable societal environmental impact (adverse weather management, toxicity, public health, odours, etc.).
5.2	Protect receiving waters from pollution within statutory limits
6	**Minimise environmental impact throughout lifecycle.**
6.1	Minimise environmental impact and demands at all stages in the lifecycle; this includes effects now and into the future, including successive refurbishment, final decommissioning, and disposal routes.
7	**Function within the legal and standards framework.**
7.1	Ensure the asset functions within the framework defined by legislation (including environmental); regulatory guidance; LUL, Infraco and applicable national and international standards; and LUL and Infraco policies.
8	**Ensure safe operation as defined by LUL.**
8.1	Ensure safe operation and condition as specified by LUL requirements; this includes passengers, employees and members of the general public.
8.2	Ensure safe ingress/egress by passengers, general public, employees, and emergency services in planned & reasonably anticipated emergency scenarios. Appropriate access/egress shall be provided for maintenance purposes.
8.3	Safeguard the health and safety of passengers, employees and members of the general public.
9	**Provide above within reliability and availability targets.**
9.1	Provide all aspects of the required duty within the defined LUL requirements.
10	**Ensure Required Duty is performed without incurring excessive or prohibitive costs.**

Generic Concerns List
Pumps and Drainage

A Generic Concern is defined as: A Concern (expressed in terms of failure to meet Required Duty), which acts as a basic prompt for an Entity to develop Specific Concerns for the operational assets for which they are responsible.

An Entity must demonstrate that all Specific Concerns that have potential safety implications are subject to appropriate mitigation measures, clearly linked to the Entities Safety Management System and that the risks are ALARP.

2007 Review: One minor generic concern word change and three classification changes.

No:	Description	Previous Concern No	Classif-ication	Allocation of MEAV in ACAC Matrix	Comments
DGEN101	Missing, broken or damaged covers to manholes, sumps, inspection chambers, gratings, gullies and catchpits. May result in injury from tripping or falling through covers. Potential consequence is injuries to passengers or staff.	DGEN001	B – E2	20%	B (minor cracks) to E2 (missing cover)
DGEN102	Manhole/sump/inspection chamber/catchpit/sump cover that cannot be opened and therefore unable to inspect or maintain asset. Potential consequence is potential flooding or gas build up leading to train services being suspended or closure of station.	DGEN102	D	100%	
DGEN103	Catchpit/manhole/sump in poor condition but not covered by DGEN102 or DGEN202. Cracked chamber or poorly constructed connections which will deteriorate further. Potential consequence is potential flooding or gas build up leading to train services being suspended or closure of station.	DGEN103	B – D	20%	
DGEN104	Pumps and drainage systems with access restricted by third parties. Not practicable to inspect and maintain the asset. Potential consequence is flooding or gas build up leading to train services being suspended or closure of station.	DGEN104	D	100%	
DGEN105	Pumps and drainage systems that have become contaminated with for example foul water or oil/chemicals contaminating surface water systems oil/chemicals. Track/station drainage discharges into surface water or watercourses. Infraco/LUL risk prosecution for illegal discharge.	DGEN105	C – E2	20%	
DGEN106	Catchpits/manholes/sumps which require extraordinary maintenance but not replacement. Further deterioration of asset condition may potentially lead to collapse resulting in train services being suspended or closure of station.	DGEN106	D	20%	
DGEN107	Defective or inadequate drainage ventilation system. May result in the explosion of inflammable gases/vapour or asphyxiation from lack of oxygen. Potential consequences are train services being suspended or closure of station, or injuries or fatalities.	DGEN107	E2	100%	
DGEN108	Pumps and drainage systems that have lack of knowledge on the condition of the existing asset. May lead to flooding or collapse resulting in train services being suspended or closure of station.	DGEN108	Grey	See Note 3	A only, unless another Generic Concern applies.
DGEN109	Drains with WRc structural grade 2 or 3 where there are no other signs of collapse. Can deteriorate further to grade 4 or 5. May lead to flooding or collapse resulting in train services being suspended or closure of station.	DGEN109	B – C	100%	CCF-CPD-0203-002
DGEN110	Drains with diameters less than 450mm with WRc structural grades 4 or 5 or where there are other signs of structural collapse or may be in unacceptable structural condition. Potential for collapse causing localised flooding/poor track quality. ConsequencesPotential consequences are speed restrictions, service loss and station flooding.	DGEN110	D	100%	
DGEN111	Pumps and drainage systems that require an extraordinary maintenance or operating regime. Further deterioration of asset condition may potentially lead to collapse resulting in train services being suspended or closure of station.	DGEN111	B – D	See Note 3	Generally D, but use B for tree roots.
DGEN112	Pumps and drainage systems which contravene legislative regulations/LUL standards (e.g. fire, electricity,etc). Non compliance may potentially lead to the injury or death to staff or passengers, damage to asset or track flooding.	DGEN112	E1 – E2	100%	Do not use DGEN112 if new DGEN117 to DEGN121 applies.
DGEN113	Unhygienic drainage conditions. Drainage systems create a hazard to health that could result in Infraco/LUL being prosecuted. Potential consequence is passenger or staff illness and/or injury.	DGEN113	D	20%	
DGEN114	Pumps and drainage system that is subject to regular **or long term** surcharge without causing flooding, resulting in an extraordinary maintenance or operating regime.	DGEN114	**C - D**	See Note 3	CCF-CPD-2006-001
DGEN115	Drainage system inspection access system (ladders, etc) that has deteriorated (e.g. corrosion, restriction, etc) to the point that access is hazardous for maintenance personnel to use. May result in injury to maintenance staff.	DGEN115	E1 – E2	10%	10% of a catchpit MEAV.
DGEN116	Deleted.	DGEN116			

Generic Concerns List
Pumps and Drainage

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2007 Review: One minor generic concern word change and three classification changes.

No:	Description	Previous Concern No	Classif-ication	Allocation of MEAV in ACAC Matrix	Comments
DGEN117	Pumps and drainage systems with missing structure ID plate.	New	C	5%	
DGEN118	Pumps and drainage systems with excessive spacing of access chambers/manholes (pipe length is greater than 50m).	New	B	100%	100% of a chamber / manhole MEAV.
DGEN119	Pumps and drainage systems with undersized catchpit (less than 900mm).	New	B	100%	100% of a catchpit MEAV.
DGEN120	Pumps and drainage systems with metal cover within 250mm of conductor rail.	New	C	20%	20% of a catchpit MEAV
DGEN121	Twin wall plastic pipes found within the pumps and drainage systems.	New	C	100%	
DGEN201	Pumps and drainage systems which support track loading and cannot be inspected. Potentially may result in a structural collapse affecting track leading to train derailment.	DGEN201	E2	See Note 3	
DGEN202	Pumps and drainage systems which support track loading and which requires temporary support to prevent collapse. Potentially may result in a structural collapse affecting track leading to train derailment.	DGEN202	E2	See Note 3	
DGEN203	Drain with diameter greater than or equal to 450mm which supports track loading in a poor WRc structural grades 4 or 5 or where there are other signs of structural collapse. Potentially may result in a structural collapse affecting track leading to train derailment.	DGEN203	E2	See Note 3	
DGEN204	Inadequate or poor design which may cause flooding of track area. Potentially may result in signalling and power supply being affected leading to the suspension of train services.	DGEN204	D	See Note 3	
DGEN205	Deleted.	DGEN205			Deleted. Use DGEN108 CCF-CPD-0203-001
DGEN206	Track drain that has poor serviceability (grades 4 or 5) or hydraulic inadequacy and potentially causes flooding of track above ballast level. Potentially may result in signalling and power supply being affected leading to the suspension of train services.	DGEN206	D	20%	20% on the basis of cleaning out, not replacement.
DGEN207	Track Drainage - inadequate design of outfall potentially causes flooding of passenger/staff area or track. Potential public/staff injury due to slipping or through sudden stopping of escalator; or train service suspended. (To be used where DGEN204 does not apply).	DGEN207	D	See Note 3	
DGEN208	Track drainage that has a blockage or has inadequate hydraulic capacity potentially causing flooding above ballast level. May result in the flooding of track potentially causing signal failure and the suspension of train services or the damaging/flooding of third party property.	DGEN208	**D** - E2	See Note 3	CCF-CPD-2006-001
DGEN209	Track Drainage - absence of a positive drainage system. May result in the flooding of track potentially causing signal failure and the suspension of train services or the damaging/flooding of third party property.	DGEN209	~~E2~~ **B - D**		**CCF-CPD-2006-001** Create a proposed asset and MEAV value since there is no existing asset to report.
DGEN210	Track drain that has poor serviceability (grades 2 or 3, and may deteriorate to grade 4 or 5) or hydraulic inadequacy and potentially causes flooding of track above ballast level. Potentially may result in signalling and power supply being affected leading to the suspension of train services.	New	B - C	20%	20% on the basis of cleaning out, not replacement.
DGEN301	Inadequate station drainage system. May cause flooding of passenger/public /staff areas and potential injury due to slipping or unhygienic condition. Potential consequence is closure of part or whole station.	DGEN301	D	See Note 3	
DGEN302	Poor structural condition station drainage which may cause flooding of passenger/staff/public areas and potential injury due to slipping, or through sudden stopping of escalator. Potential consequence is closure of part or whole station.	DGEN302	B - D	See Note 3	
DGEN303	Deleted.	DGEN303			Deleted. Use DGEN301
DGEN304	Station drainage with poor serviceability (drains that have serviceability grades 4 or 5). Future development need dependent on deteriorating performance/condition of asset. Potential consequence is flooding leading to closure of part or whole station.	DGEN304	D	20%	20% on the basis of cleaning out, not replacement.

Generic Concerns List
Pumps and Drainage

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2007 Review: One minor generic concern word change and three classification changes.

No:	Description	Previous Concern No	Classif-ication	Allocation of MEAV in ACAC Matrix	Comments
DGEN305	Station drainage with poor serviceability (drains that have serviceability grades 2 or 3 and may deteriorate to grades 4 or 5). Future development need dependent on deteriorating performance/condition of asset. Potential consequence is flooding leading to closure of part or whole station.	New	B - C	20%	20% on the basis of cleaning out, not replacement.
DGEN401	Pump site failure, which may result in flooding of track and/or station potentially causing signal system failure, or injury . Potential consequence is closure of part or whole of station, or train service suspended.	DGEN401	D	See Note 3	
DGEN402	Pump sites that have faulty alarm systems which may result in flooding of track and/or station potentially affecting signalling and power supply of track areas, or leading to injury. Potential consequence is closure of part or whole of station, or train service suspended.	DGEN402	D	10%	
DGEN403	Pumping system is beyond its life span and its level of deterioration and maintenance required is unacceptable. Potential consequence is closure of part or whole of station or train service suspended.	DGEN403	B - D	See Note 3	
DGEN404	Inadequate/poor design of pump system which may potentially result in flooding of track and/or station, or cause injury. Potential consequence is closure of part or whole station or train service suspended.	DGEN404	B - D	See Note 3	
DGEN405	Deleted.	DGEN405			Deleted. Use DGEN403.
DGEN406	Pump system in poor environmental condition (e.g. dampness) and creates a hazard to health. Potential consequence is injuries to staff and asset deterioration.	DGEN406	D	See Note 3	

DGEN500 to DGEN752 have all been deleted from this document and are not to be used.

* Classification E1 or E2 depends on results of risk assessment and any mitigating actions taken.

Notes

Note 1

The pre-defined Classification given in the Foundation Documents for each Generic Concern is the highest Classification (nearest to A) that shall be used when applying that Generic Concern to an asset, unless justified by engineering judgement which shall be auditable and verifiable by LUL. The justification to improve the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Note 2

When applying Generic Concerns to an asset, a lower Classification (nearer to E1/E2) than the pre-defined Classification given in the Foundation Documents shall be used where justified by the extent, severity or consequences of the Specific Concern affecting the asset, which shall be auditable and verifiable by LUL. The justification for lowering the Classification shall either be recorded on the inspection or Analytical Assessment report for the individual asset, with an auditable cross reference in the ACAC report, or shall be recorded in the ACAC report.

Note 3

Where the Generic Concerns do not have prescribed percentages of the whole asset MEAV identified, the percentage will depend on the extent and severity of the defect, and the scope of the remedial work required, in relation to the asset as a whole. The allocation of MEAV shall be based, as applicable to the asset, on the following rules:-

(a) For non-pipework assets where the whole asset or a discrete part of an asset is affected, allocate 100% of the whole asset MEAV or the MEAV of the discrete part of the asset;

(b) For pipework assets, allocate 100% of the MEAV of the asset, factored by the proportion of the linear length of the asset that is affected. The ACAC report shall record the length factor where it is less than 100%.

Basis for MEAV
Pumps & Drainage

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

2007 Review: This sheet has been completely re-written such that its sequence follows, where possible, that appearing on the asset definition sheet. The MEAVs for Station Drainage have then been revised into a format that matches the asset definition structure. The Pump Drainage and Track and Off-Track Drainage MEAVs remain as previously published but are now correctly re-ordered within this document.

2010 Review: New Pump Drainage MEAVs added to accompany new hierarchy. Numbering also updated.

No	Definition Groups	Basis of MEAV calculation	Remarks
~~100~~	~~**Pump Drainage - Section 12**~~		
	~~Minor Sites~~	~~£10,000 per system~~	
	~~Section 12~~	~~£100,000 per system~~	
~~200~~	~~**Pump Drainage - Non Section 12**~~		
	~~Minor Sites~~	~~£10,000 per system~~	
	~~Non-Section 12~~	~~£60,000 per system~~	
100	**Pump Drainage**		
101	Pump Control Panel / Small - Simple	£3690 each	
102	Pump Control Panel / Medium - Non Critical	£7370 each	
103	Pump Control Panel / Large - Critical	£11060 each	
104	Pump Control Panel / JLE and Victoria - Critical extra large	£14740 each	
105	Pumps Auxilliary Panels	£1840 each	
106	Auxillary Isolator	£370 each	
110	Pumping Mains - suction and delivery / Surface	£150 per 10 metres	
111	Pumping Mains - suction and delivery / Buried	£590 per 10 metres	
112	Pumping Mains - suction and delivery / JLE and Victoria - extra large	£440 per 10 metres	
113	Vent System - dedicated to pumping system	£330 per 10 metres	
120	Valves / Mechanical small	£150 each	
121	Valves / Mechanical large	£370 each	
122	Valves / Electrical	£920 each	
130	Pumps / Submersible - small	£290 each	
131	Pumps / Submersible - medium	£2210 each	
132	Pumps / Submersible - large	£3690 each	
133	Pumps / Strate	£11060 each	
134	Pumps / Sewage handling unit	£11060 each	
135	Pumps / Centrifugal (GGG or similar)	£5900 each	
136	Pumps / Centrifugal (Varisco or similar)	£1110 each	
137	Pumps / JLE and Victoria - extra large	£8840 each	
140	Pump control gear including sensors, level probes, transducers etc. / Critical	£2210 per sump	
141	Pump control gear including sensors, level probes, transducers etc. / Non-critical	£1110 per sump	
142	Pump control gear including sensors, level probes, transducers etc. / Simple	£370 per sump	
143	Pump control gear including sensors, level probes, transducers etc. / JLE and Victoria - extra large	£3690 per sump	
150	Pump alarm systems / Local	£1470 each system	
151	Pump alarm systems / Remote - SCADA	£4420 each system	
160	Sumps / Small (typically up to 1m plan size and 1.5m deep) larger would typically be a B&S asset	£4420 each	
161	Tanks / Small	£1470 each	
162	Tanks / Medium	£2950 each	
163	Tanks / Large	£7370 each	
164	Tanks / Saniflo	£1,000	

Basis for MEAV
Pumps & Drainage

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

2007 Review: This sheet has been completely re-written such that its sequence follows, where possible, that appearing on the asset definition sheet. The MEAVs for Station Drainage have then been revised into a format that matches the asset definition structure. The Pump Drainage and Track and Off-Track Drainage MEAVs remain as previously published but are now correctly re-ordered within this document.

2010 Review: New Pump Drainage MEAVs added to accompany new hierarchy. Numbering also updated.

No	Definition Groups	Basis of MEAV calculation	Remarks
170	Cables / Power	£70 per 10 metres	
171	Cables / Alarm / Indication	£40 per 10 metres	
200	**Station Drainage - Section 12**		
201	**Buried** Gravity **Drainage** Pipes ~~(including those carrying grey and/or foul waste from sanitary ware)~~	£350 per metre	TLL-CPD-2007-001
202	Venting Pipes	£1,000 each	TLL-CPD-2007-001
203	Manholes	£12,500 per manhole	TLL-CPD-2007-001
204	Inspection Chamber	£5,000 per chamber	TLL-CPD-2007-001
205	Channels **(including gratings)**	£200 per metre - #	TLL-CPD-2007-001
206	Gullies	£1,000 each	TLL-CPD-2007-001
207	~~Gratings~~	-	TLL-CPD-2007-001
208	Grease Traps	£3,000 each	TLL-CPD-2007-001
209	Oil interceptors	£5,000 each	TLL-CPD-2007-001
210	Drip Trays	£2,500 each	TLL-CPD-2007-001
211	Sumps	£3,000 per sump	TLL-CPD-2007-001
212	Flow Control Device	£1,000 each	TLL-CPD-2007-001
300	**Station Drainage - Non Section 12**		
301	**Buried** Gravity **Drainage** Pipes ~~(including those carrying grey and/or foul waste from sanitary ware)~~	£220 per metre	TLL-CPD-2007-001
302	Venting Pipes	£500 each	TLL-CPD-2007-001
303	Manholes	£7,500 per manhole	TLL-CPD-2007-001
304	Inspection Chamber	£4,000 per chamber	TLL-CPD-2007-001
305	Channels **(including gratings)**	£120 per metre - #	TLL-CPD-2007-001
306	Gullies	£750 each	TLL-CPD-2007-001
307	~~Gratings~~	-	TLL-CPD-2007-001
308	Grease Traps	£2,500 each	TLL-CPD-2007-001
309	Oil interceptors	£4,000 each	TLL-CPD-2007-001
310	Drip Trays	£2,000 each	TLL-CPD-2007-001
311	Sumps	£2,500 each	TLL-CPD-2007-001
312	Flow Control Device	£750 each	TLL-CPD-2007-001
400	**Track and Off Track Drainage - Section 12**	**Track**	All
	Drains in sub surface area	£700 per metre - for non brick £1000 per metre - for open cut (brick drain)	
404	Catchpits	£6,000 per catchpit	
409	Syphon	£500,000 per syphon	

Basis for MEAV
Pumps & Drainage

The asset is attributed to an Infraco and Line or Network on the basis of geographical location. Assets leased to an external supplier are considered to be LUL assets within the Suppliers' Stewardship in accordance with relevant contractual conditions.

2007 Review: This sheet has been completely re-written such that its sequence follows, where possible, that appearing on the asset definition sheet. The MEAVs for Station Drainage have then been revised into a format that matches the asset definition structure. The Pump Drainage and Track and Off-Track Drainage MEAVs remain as previously published but are now correctly re-ordered within this document.

2010 Review: New Pump Drainage MEAVs added to accompany new hierarchy. Numbering also updated.

No	Definition Groups	Basis of MEAV calculation	Remarks
500	**Track and Off Track Drainage - Non Section 12**	**Track**	All
	Drains in open track area	£700 per metre - for open cut (20% of track drain was assumed in this category)	
	Drains in open track area	£310 per metre - for trenchless (80% of track drain was assumed in this category)	
	Drains in open track area	An average track drainage cost - £388 per metre	
504	Catchpits	£6,000 per catchpit	
510	Syphon	£500,000 per syphon	
513	Ditch	£80 per metre.	

Exclusions

Sanitary Ware; Roof Drainage; Guttering; Down Pipes

\# Where only the gratings are affected a value of 50% of the MEAV should be used.

S1042 Asset Condition Reporting (ACR)

Rolling Stock

11.01.13 Rolling Stock RL Method Review v4.1

The Residual Life approach for Rolling Stock assets is as detailed below:

The Rolling Stock Fleets currently operating on the LUL network have nominal design lives of 36 to 40 years.

Each Fleet can be operated to its design life and beyond provided:

- The Train Maintenance Regime (TMR) is delivered in an efficient manner, representing good practice (i.e. being mileage/service hours based);
- All known concerns are managed/mitigated through a recognised process, such as enhanced maintenance, modifications and train reliability improvement programmes.;
- Costs and performance are in line with relevant benchmarks, taking due consideration of life/age of fleet, operating environment and progress through heavy maintenance lifecycle;
- Obsolescence is understood and strategies/plans are place to mitigate performance risks;
- Structural integrity is understood and strategies/plans are in place to mitigate safety risks;
- There is a comprehensive management system in place that assures the quality of all fleet maintenance activities;
- There is evidence that decisions are optimised based on cost, performance and risk;
- Refurbishments and train systems renewals are delivered in an efficient manner at optimal intervals based upon assessments of condition, performance and cost.

Fleets are typically replaced for reasons other than sub-system performance and cost, although this may be a contributing factor. Instead, fleets are usually replaced as part of major upgrades that seek an increase in capacity and improvement in journey times. Political, legislative (e.g. RVAR) and social factors can also be considerable drivers.

Therefore fleet nominal life shall be regarded as the design life, adjusted in accordance with good industry practice, taking account of required duty (e.g. mileage), loadings and environment.

The residual life shall be the adjusted nominal life, less the number of years in service.

By example only, say the Central Line has a design life of 36 years, but in recent years has increased its annual mileage to a level greater than that allowed for in the original design. The impact of this increase mileage is assessed and adjusts the design life downwards by 2 years. Therefore the adjusted nominal life is 34 years. The vehicle has been in service since 1992 (18 years of service), therefore the residual life is 34-18 = 16 years.

The only exception to this approach is if obsolescence occurs to a component listed in the asset hierarchy. In this instance the residual life of the obsolete component will be separately assessed and the appropriate Physical Code entered in the ACR return.

Residual Life (Nominal) approach will be assessed as follows:

Annual Assessment

To ensure the validity of this approach the Sponsor, HoP and TLL will provide assurance when completing the annual ACR return that the provisions set out in the previous section are being met with reference to agreed data sources such as, but not limited to:

- Ellipse/Maximo/RailSys reports demonstrating that the train maintenance regime is being delivered and that there is no out of tolerance;
- CuPID data demonstrating that failure trends of subsystems are assessed as ‘normal’ or in line with professional expectations;
- Audit Regimes & Reports to demonstrate that fleet management systems are scrutinised and improved where found to be deficient;
- Routine Condition Assessments to verify that the maintenance is being delivered to the required quality;
- Regulatory controls (such as Case for Continued Safe Operation, Regulatory Notices, etc) to demonstrated that sub-standard conditions are identified, assessed and controlled;
- Evidence of obsolescence strategies for key sub-systems;
- Evidence of that structural issues are identified, assessed and controlled (i.e. fracture maps and NDT programmes);
- Evidence of good whole life decision making, demonstrating that condition concerns are managed in a manner that it is consistent with good industry practice.
- Progress towards self-assurance;

The Sponsor, HoP and TLL may agree, on the basis of the output from the above sources, to adjust the nominal design life of the fleet.

Major Interventions Assessment

Maintainers to take the opportunity afforded by major interventions (heavy overhauls and refurbishments) to confirm there are no significant fatigue or corrosion issues with the main car body or bogies. A detailed assessment of the under frame area should uncover any issues earlier than would otherwise be the case.

Detailed Re-life Assessment

Once 90% of the adjusted nominal life has elapsed a detailed assessment should be undertaken to assess whether the fleet can be “re-lifed” and, if so, for how long. The Sponsor and HoP can decide to undertake this assessment earlier depending upon the reliability and condition of the asset. The scope of the assessment shall be determined by the Sponsor, fleet maintenance representatives, Principal Engineers, HoP and TLL.

This assessment will take place via a work package or project requested by the Sponsor and undertaken by internal or external resources as required.

The output of the assessment shall be referred to a “Life Extension Report” with conclusions and recommendations ensuring that fleet condition, safety and reliability is not compromised.

Sampling for the Assessment

Typically one unit shall be used as a sample, along with additional data gathered from normal fleet and assurance activities. The unit is normally randomly selected and representative of the entire fleet or in particular circumstances a worst case may be selected depending on the key concerns.

Method of assessment and Roles and Responsibilities

Component condition assessment will be undertaken by CMO/TLL or another Engineering resource as appropriate. The resource should be assessed as competent to undertake the condition assessments.

The scope of assessment will be determined by the Sponsor in consultation with the HoP and TLL and is likely to compromise removing panels for inspection, striping down components, testing components and examining failure data.

Risk assessment based on obsolescence (in accordance with LU's obsolescence management guidelines) and performance will be recorded in the Asset Risk Register.

Rules regarding Re-lifing

Assets can only be re-lifed by completing the actions required in the Life Extension Report (e.g. ensuring maintenance repairs, modifications and monitoring is completed).

The Sponsor is responsible for ensuring that appropriate resources are secured (e.g. maintenance or projects) for all re-life workstreams.

2.1.1 Basis of Condition Reporting for Rolling Stock

ACR No.	FD* No.	Asset Description	RAV (%)	Unit	Nominal Life	Source of Nominal Life
1000	00	**General**	**0%**	N/A	40	N/A
2000	10	**Braking**	**5%**	N/A	40	N/A
3000	11	**Traction/Propulsion**	**18%**	N/A	40	N/A
4000	12	**Doors**	**5%**	N/A	40	N/A
5000	13	**Carbody**	**9%**	N/A	40	N/A
6000	14	**Bogie/Suspension**	**9%**	N/A	40	N/A
7000	15	**Couplings**	**3%**	N/A	40	N/A
8000	16	**Underframe**	**5%**	N/A	40	N/A
9000	17	**Auxiliaries**	**6%**	N/A	40	N/A
10000	18	**Heating/Ventilation**	**10%**	N/A	40	N/A
11000	19	**Air Supply**	**5%**	N/A	40	N/A
12000	20	**Cleaning**	**0%**	N/A	40	N/A
13000	21	**Electrical Distribution**	**7%**	N/A	40	N/A
14000	22	**Emergency Equipment**	**0.5%**	N/A	40	N/A
15000	23	**Fault Recording Equipment**	**1%**	N/A	40	N/A
16000	24	**Automatic Train Control**	**6%**	N/A	40	N/A
17000	25	**Communications**	**5%**	N/A	40	N/A
18000	26	**Paint**	**0.5%**	N/A	40	N/A
19000	27	**Labels and Notices**	**0%**	N/A	40	N/A
20000	28	**Shoegear**	**5%**	N/A	40	N/A
21000	29	**Certification/Maintenance/Technical Information**	**0%**	N/A	40	N/A

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

2.1.3 Reporting Requirements for Rolling Stock

2.1.3.1 Rolling Stock ACR - all Lines

ACR No.	FD* No.	Rolling Stock – all Lines	Physical Condition					Functional Condition		
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	FD* No.	Actuals:					Quantity	£ Risk	£ Risk	£ Risk
1000	00	General								
2000	10	Braking								
3000	11	Traction/Propulsion								
4000	12	Doors								
5000	13	Carbody								
6000	14	Bogie/Suspension								
7000	15	Couplings								
8000	16	Underframe								
9000	17	Auxiliaries								
10000	18	Heating/Ventilation								
11000	19	Air Supply								
12000	20	Cleaning								
13000	21	Electrical Distribution								
14000	22	Emergency Equipment								
15000	23	Fault Recording Equipment								
16000	24	Automatic Train Control								
17000	25	Communications								
18000	26	Paint								
19000	27	Labels and Notices								
20000	28	Shoegear								
21000	29	Certification/Maintenance/Technical Information								
		Rolling Stock								
		Previous								
		Actual								
		Variance								

2.1.3 Reporting Requirements for Rolling Stock

2.1.3.2 Rolling Stock ACR - by Line

		Rolling Stock – Summary Report for xxx Line	Physical Condition					Functional Condition		
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	FD* No.	Actuals:					Quantity	£ Risk	£ Risk	£ Risk
1000	00	General								
2000	10	Braking								
3000	11	Traction/Propulsion								
4000	12	Doors								
5000	13	Carbody								
6000	14	Bogie/Suspension								
7000	15	Couplings								
8000	16	Underframe								
9000	17	Auxiliaries								
10000	18	Heating/Ventilation								
11000	19	Air Supply								
12000	20	Cleaning								
13000	21	Electrical Distribution								
14000	22	Emergency Equipment								
15000	23	Fault Recording Equipment								
16000	24	Automatic Train Control								
17000	25	Communications								
18000	26	Paint								
19000	27	Labels and Notices								
20000	28	Shoegear								
21000	29	Certification/Maintenance/Technical Information								
		Rolling Stock								
		Previous								
		Actual								
		Variance								

Commentary on Variances:

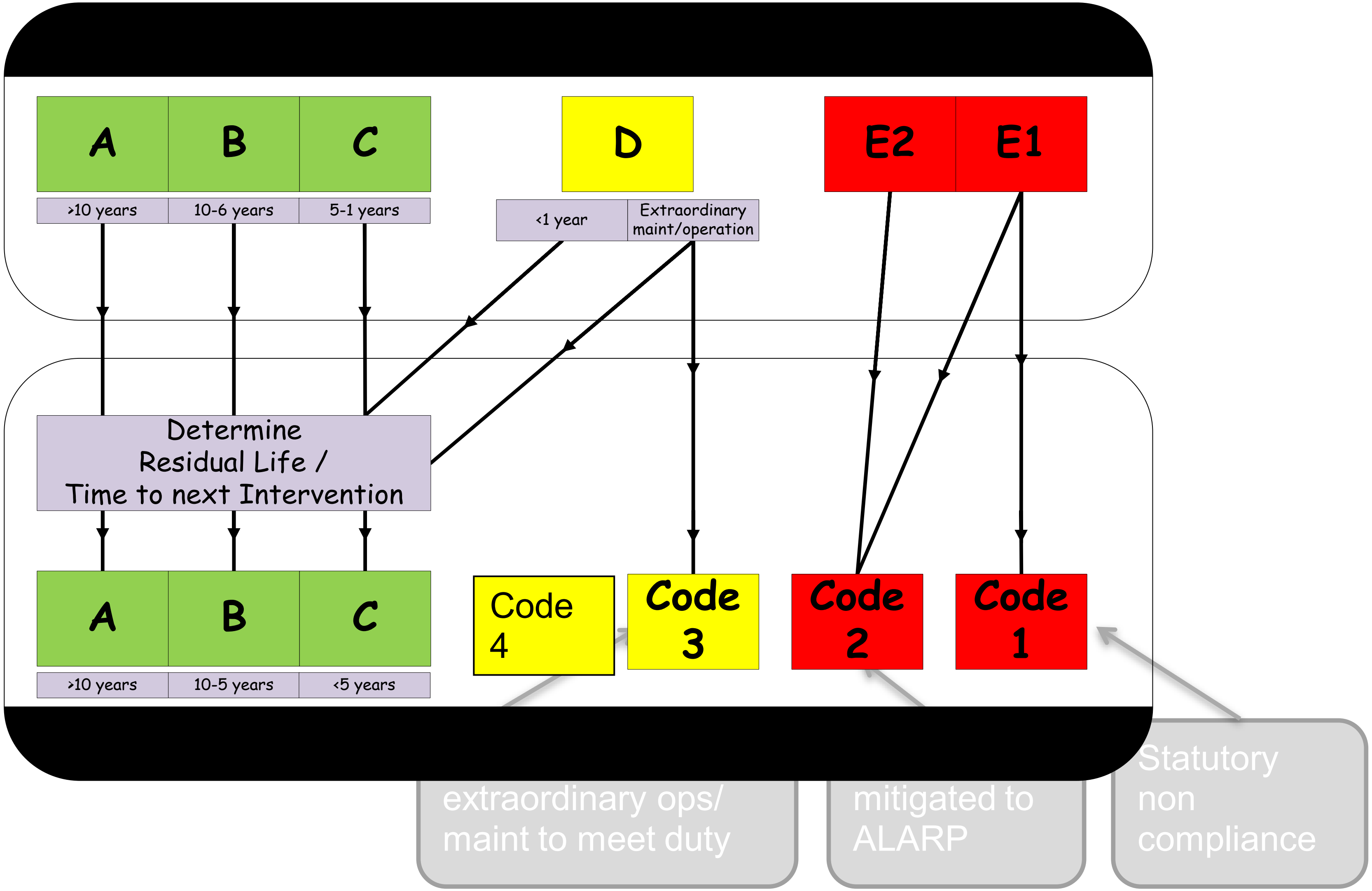
A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

S1042 Asset Condition Reporting (ACR)

Depots

ACR Principle



Residual Life Approach for Depot, Plant & Equipment

The Residual Life approach for Depot, Plant & Equipment assets varies as detailed below.

All Depot, Plant & Equipment (DP&E) assets are assessed using the residual life (measured) approach, although the level/objectivity of the assessment varies based upon the asset value as follows:
- Assets with an estimated replacement value (ERV) **greater** than £250k are assessed on an individual asset basis to give a measured residual life for the specific asset. The measured residual life is based upon answering a number of questions to give a conclusion with improved objectivity.

- Assets with an estimated replacement value **lower** than £250k are assessed on a site basis (each Depot) rather than a per asset basis. Assets in the same sub-definition group at a particular depot are grouped together and an average measured residual life is calculated. The residual life of the assets is based upon professional judgement of the assessor rather than an objective assessment. *If an objective measured approach is not used, the nominal life must be used instead. If the installation date is not known then this can be estimated,*

Residual Life (Measured) approach will be assessed as follows.

The DP&E Asset Condition Report (ACR) has five sections specific to the DP&E asset area. Each section is detailed on a separate worksheet within this spreadsheet. Each Section is explained below:

Residual Life Proforma
The proforma is common across all ACR asset areas but is tailored to suit the requirements of each. The proforma details how the DP&E ACR is to be assessed and managed.

Scoring Guide
The scoring guide details the expected condition and obsolescence for each score. It should be refered to when determining the score for
The scoring guide has been compiled by the Depot Sponsor and DP&E engineers and should only be altered periodically when the ACR process is being updated.

Asset Hierarchy
The hierarchy is common to all ACR asset areas but is tailored to suit the requirements of the DP&E assets.
The hierarchy is an agreed data set and changes should only be made after agreement from; Depot Sponsor, DP&E Manager and Head of Rolling Stock & Depots Engineering.
The hierarchy includes the weighting between condition and obsolescence for each asset with an ERV greater than £250k. The weightings are based on the relative impact these two factors have on the residual life of the assets, and have been agreed by the Depot Sponsor and the DP&E Engineers - any alterations are to be agreed by both parties and any updates should only be made annually prior to the ACR being conducted. Changes to the ACR Standard Attachment will be managed through LU's formal change control process
The hierarchy includes the parameters to be assessed for each assets with an ERV greater than £250k. The scoring against each of these parameters enables the condition/measured life of the asset to be calculated.
Please note that alterations made to the hierarchy worksheet will filter through the rest of this DP&E ACR spreadheet, as such the hierarchy worksheet has been protected to restrict alterations being made. Only the DP&E Engineer and Depot Sponsor have permission

Asset Scores (Inputs)
The asset scores worksheet is the only worksheet where inputs should be made when conducting the ACR. Cells highlighted yellow are those where inputs can be made. Cells with crosshatching are not to be populated and any cell highlighted red indicates an error and as such data should be deleted from the particular cell.
The worksheet contains a list of all the DP&E assets which are to be measured for the DP&E ACR. The assets are divided into each location (Depots) to help with locating the required asset.
When conducting the ACR the first item to be completed is the year that the ACR is being conducted (top left hand corner). The year should be selected from the drop down list.
Once the year has been selected data/scores should be inputted for all of the yellow input cells for each asset. Assets with an ERV greater than £250k require scores for the particular condition parameters and obsolescence. Assets lower than £250k require the number of assets within each life category to be completed. To determine the condition and obsolesence score a scoring guide has been
The asset scores sheet also calculates the measured residual life and physical condition for each asset (except assets lower than an ERV of £250k which are compiled together).
NB If an asset has a nominal life less than or equal to 10 years, the residual life cannot be selected as greater than 10 years (Catagory A). If selected the cell will become highlighted in red, indicating an input error.

Reference Worksheet
The reference worksheet is a hidden sheet and is only used to enable the spreadsheet to function. Alterations should not be made to it unless agreed by the Depot Sponsor and DP&E engineers.
The reference sheet captures the degradation curve/rate that underpins the DP&E residual life calculations.

Function Condition and Concerns Tables

Concerns Table
This sheet records fuctional concerns relating to the DP&E asset base. Residual risks are calculated as per LU Cat 1 standards.

Resolved Concerns
This sheet records the concrns from previous years which have been resolved, indication the measures taken and the year of removal from the concerns table.

DP&E ACR Output Sheets

DP&E ACR By Line
This sheet records the output from the ACR process by line.

DP&E ACR By Asset
This sheet records the output from the ACR process by asset type.

Asset Summary
The summary gives the aggregated scores/measures for each of the assets within the asset hierarchy.
No inputs/alterations should be made to the summary sheet (unless a periodic update is being made by the depot sponsor or DP&E engineer) as it compiles data from other worksheets.

Additional information

The DP&E team undertake the ACR measurements and as such will populate this spreadsheet.

The ACR measurements will be undertaken annually.

Any alterations to this document/spreadsheet shall only be made when the depot sponsor and DP&E engineers agree. Any alterations to the document should be detailed in the comments section of the Version Control worksheet and an up-issue of the document version

Any new DP&E equipment shall be captured within the subsequent round of ACR assessment. If the new asset is not included on the DP&E asset hierachy then the Depot Sponsor and DP&E engineers should be informed such that the hierarchy can be ammended prior

Asset Condition

	1	2	3	4	5
Control Equipment & Remote Monitoring Stations	Equipment has no physical damage. Equipment operatesas per original specification. All labels and markings in place and secure.	Equipment may have minor marks not affection operation. Equipment operates in as per original specification. All labels and markings in place and secure.	Equipment may have minor wear and tear, not affecting operation. Equipment operates as per original specification. All labels and markings in place and legible.	Equipment may have minor wear and tear, not affecting safety. Some labels and markings defaced or missing. Equipment operates safely.	Equipment may have significant wear and tear. Labels and markings defaced or missing. Equipment does not meet the requirement of specification. Equipment to be removed from use / replaced immediately.
Control System Hardware	No damage & all labels visible	Minor cosmetic damage & all labels visible	Damage with no Functional effect & minor wear to labelling	Slight damage with potential impact on production. Minor wear to labelling	Damage with impact on production. Labelling worn or missing
Crane Control Equipment	Equipment has no physical damage. All labels and markings in place and secure. Equipment operates in accordance with LOLER and original specification.	Equipment may have minor marks not affection operation. All labels and markings in place and secure. Equipment operates in accordance with LOLER and original specification.	Equipment may have minor wear and tear, not affecting operation. All labels and markings in place and secure. Equipment operates safely in accordance with LOLER.	Equipment may have minor damage, not affecting safety. All statutory labels and markings in place. Equipment operates safely in accordance with LOLER.	Equipment may have significant damage. All statutory labels and markings in missing or defaced. Equipment does not meet the requirement of LOLER. Equipment to be removed from use / replaced immediately.
Electrical Items	Recently installed in accordance with current standards and requirements. Operates as per original Specification. Electrical Equipement has no damage. All insulation clean and undamaged.	Installed in accordance with current standards and requirements. Operates as per original Specification. Electrical Equipement has minor cosmetic damage. All insulation undamaged.	Installed in accordance with current practices and requirements, but not recently. Terminations in good condition, connections secure, but not to current standards. Operates as per original Specification. Electrical Equipement has minor cosmetic damage. No damage to insulation affecting integrity.	Installed in accordance with current practices and requirements, but not recently. Terminations generally in good condition, connections secure, but not to current standards. Operates as per original Specification. Electrical Equipement has minor damage. Damage to insulation affecting integrity.	Installed in accordance with current practices and requirements, but not recently. Terminations in poor condition, connections loose. Not installed to current standards. Does not operate in accorsance with specification. Electrical Equipement damaged affecting operation/safety. Damage to insulation affecting integrity.
Enclosures & Cabinets	Enclosure has no physical damage. All protective finishes unmarked. All fixings and fastenings in place and secure. All labels and markings in place and secure.	Enclosure may have minor dents in casings that do not affect operation. Protective finishes may have slight marks not affecting function. All fixings and fastenings in place and secure. clean environment, no water ingress. All labels and markings present, in good condition and secure.	Enclosure may have dents in casings that do not affect operation. Protective finishes may have slight marks not affecting function. Some signs of superficial corrosion. Some minor fixings and fastenings may be not fitted or loose. All labels and tally plates in place and secure. Minor deterioration / degradation.	Enclosure may have large dents in casings that may affect operation. Protective finishes may be severely marked with evidence of corrosion. Some minor fixings and fastenings may be missing or loose. Some labels and markings not fitted, missing or illegible, Deterioration / degradation of equipment.	Enclosure may have large dents in casings affecting operation. Protective finishes may be severely marked, evidence of severe corrosion. Fixings and fastenings are missing or loose. All labels and markings not fitted. Unacceptable condition and requires immediate replacement.

Asset Condition

	1	2	3	4	5
Equipment Operation	Equipment has never failed.	Equipment has failed but very infrequently and less than would be expected for a piece of equipment of this nature.	Equipment has failed generally in-line with what would be expected for a piece of equipment of this nature.	Equipment fails fairly frequently which causes problems to the operational use.	Equipment fails frequently which causes real problems to the operational use.
Hoists (not load ropes)	Equipment has no physical damage. All safety catches operate freely and correctly. All fixings and fastenings in place and secure. All labels and markings in place and secure. Equipment operates in accordance with LOLER and original specification.	Equipment may have minor marks not affecting operation. All safety catches operate correctly. All fixings and fastenings in place and secure. All labels and markings in place and secure. Equipment operates in accordance with LOLER and original specification.	Equipment may have minor wear and tear, not affecting operation. Some signs of surface corrosion. Equipment operates as per original specification. All labels and markings in place and secure. Equipment operates safely in accordance with LOLER.	Equipment has minor wear and tear, not affecting safety. Protective finishes may be severely marked with evidence of corrosion. All statutory labels and markings in place and secure. Equipment operates safely in accordance with LOLER.	Equipment has significant wear and tear. All statutory labels and markings in missing or defaced. Equipment does not meet the requirement of LOLER. Equipment to be removed from use / replaced immediately.
Mechcanical Items	Equipment has no physical damage. All protective finishes unmarked. All fixings and fastenings in place and secure. All labels and tally plates in place and secure. Equipment operates as per original specification.	Equipment may have minor wear and tear that does not affect operation. Protective finishes may have slight marks with evidence of re-coating. All fixings and fastenings in place and secure. All labels and tally plates in place and secure. Equipment operates as per original specification and no problems exist.	Equipment may have minor damage that does not affect operation. Protective finishes may have slight marks with evidence of re-coating. Some signs of surface corrosion. Some minor fixings and fastenings may be not fitted or loose. Equipment operates as per original specification. some superficial corrosion Minor wear and tear	Equipment may have damge that is unlikely to affect operation. Protective finishes may be severely marked with evidence of corrosion. Some minor fixings and fastenings may be missing or loose. Equipment operates as per original specification. Deterioration / degradation of equipment.	Equipment has damage that will affect operation. Protective finishes may be severely marked, evidence of severe corrosion. Fixings and fastenings are missing or loose. Equipment does not operate as per original specification and requires immediate replacement. Severe corrosion / degradation
Pipework (incl Comp. Air)	Pipework has no physical damage or signs of leakage. No deadlegs present. All valves, stopcocks etc have no physical damage or signs of leakage. All valves, stopcocks operate correctly. All pipework fixings and fastenings in place and secure.	Pipework has no physical damage or signs of leakage. No deadlegs present. All valves, stopcocks etc have no physical damage or signs of leakage. All valves, stopcocks operate correctly. Some pipework fixings and fastenings may be loose.	Pipework may have some minor damage or signs of leakage. No deadlegs present. All valves, stopcocks etc have no physical damage or signs of leakage. Some valves, stopcocks may be stiff to operate. Some pipework fixings and fastenings may be loose.	Pipework may have some minor damage or signs of leakage. Minor deadlegs may be present. Valves, stopcocks etc may have physical damage or signs of leakage. Some valves, stopcocks stiff to operate. Some pipework fixings and fastenings may be loose or missing.	Pipework may have severe damage or signs of leakage. Pipework of may contain lead. Numerous deadlegs may be present. Valves, stopcocks etc have physical damage or signs of leakage. Majority of valves, stopcocks stiff to operate. Numerous pipework fixings and fastenings may be loose or missing. Severe corrosion / degradation.

Asset Condition

	1	2	3	4	5
Power Supply System	Equipment has no physical damage. All fixings and fastenings in place and secure. All labels and markings in place and secure.	Equipment may have minor wear and tear that does not affect operation. Protective finishes may have slight marks not affecting function. All fixings and fastenings in place and secure. All labels and markings present, in good condition and secure.	Equipment may have minor damage that does not affect operation. Some signs of siperficial corrosion. Some minor fixings and fastenings may be not fitted or loose. Minor deterioration / degradation.	Equipment has minor damage that does not affect operation. Some minor fixings and fastenings may be missing or loose. Some labels and markings not fitted, missing or illegible, Deterioration / degradation of equipment.	Equipment has damage affecting operation. Fixings and fastenings may be missing or loose. All labels and markings missing or defaced. Unacceptable condition and requires immediate replacement.

Asset Obselesence

	1	2	3	4	5
Obsolescence	Current product with unknown end	N/A	End of Life Warning issued / Adequate spares available. Report if a notification has been received	N/A	Software / hardware no longer manufactured or supported by original equipment manufacturer. Report if a notification has been received or if it is otherwise clear that they are no longer available from the original equipment manufacturer

Definition Group	FD No.	ACR No.	Sub-Definition Group	Unit	Responsibility	Nominal Life / Yrs	ERV's / £k	Weighting (assets >£250k)		Assessment Parameters										
								Condition	Obsolescence	Control Equipment & Remote Monitoring Stations	Control System Hardware	Crane Control Equipment	Electrical Items	Enclosures & Cabinets	Equipment Operation	Hoists (not load ropes)	Mechcanical Items	Pipework (incl Comp. Air)	Power Supply System	Obsolescence
Battery Chargers (Train Batteries)	270	1100	Battery Charging System	Train Battery Chargers per Fleet	DP&E	30	15													
Battery Chargers (Train Batteries)	270	1200	Battery Chargers	per charging system e.g bench, screening, extraction etc (excluding battery chargers).	DP&E	20	70													
Train Cleaning Equipment	210	2100	Train Washing Machine	per Train Wash	DP&E	30	1,500	70%	30%				✓	✓			✓			✓
Train Cleaning Equipment	N/A	2200	Water Softening Plant	per system.	DP&E	10	15													
Train Cleaning Equipment	N/A	2300	Foam Arch	per system.	DP&E	10	75													
Train Cleaning Equipment	N/A	2400	Acid Dosing Plant	per system.	DP&E	10	30													
Train Cleaning Equipment	N/A	2500	Caustic Dosing Plant	per system.	DP&E	10	30													
Train Cleaning Equipment	250	2600	Train Vacuum System	per system.	DP&E	15	80													
Train Cleaning Equipment	N/A	2700	Underframe Cleaner	per system.	DP&E	20	150													
De-Icing Equipment	260	3000	De-Icing Equipment	per permanent De-icing plant	DP&E	30	75													
Fixed Train Monitoring Equipment	310	4000	Wheelset Monitoring Equipment	per installation	DP&E	20	500	60%	40%	✓			✓	✓			✓	✓		✓
Shutter Doors	510	5000	Shutter Doors	per Shutter door	DP&E	30	8													
Brake Test Equipment		6000	Brake Test Equipment	Valve Test Rig	DP&E	30	60													
E.O.T. Cranes	110	7100	Twin Gantry Overhead Cranes	per synchronised pair of cranes	DP&E	30	270	80%	20%			✓	✓	✓		✓	✓		✓	✓
E.O.T. Cranes	110	7200	Single Gantry Overhead Cranes	per crane	DP&E	30	100													
Train Lifting Jacks	120	8000	Train Lifting Jacks	per single jack	DP&E	20	18													
Jib Cranes	130	9000	Jib Cranes	per crane	DP&E	30	9													
Bogie Maintenance Equipment	N/A	10100	Mobile Bogie Lifting Equipment	per lift.	DP&E	20	30													
Bogie Maintenance Equipment	N/A	10200	Bogie Presses	per press.	DP&E	20	200													
Traverser	150	11000	Traverser	per traverser	DP&E	30	2,000	85%	15%				✓	✓			✓		✓	✓
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	220	12100	Lathe (M&E) - Twin Head	per Twin-head UFWL	DP&E	30	1,500	75%	25%				✓	✓			✓			✓
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	220	12110	Lathe (M&E) - Single Head	per single-head UFWL	DP&E	30	1,200	75%	25%				✓	✓			✓			✓
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	220	12200	Swarf Crusher - UFWL	per crusher/conveyor	DP&E	15	17													
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	220	12300	Fume Extractor - UFWL	per extraction system	DP&E	15	8													
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	220	12400	Bogie Height Adjustment Station	per installation	DP&E	30	150													
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	220	12500	Lathe (Control & Software) - Single & Double Head	per UFWL	DP&E	15	300	30%	70%		✓				✓					✓
Train Mules	240	13000	Train Mules	per mule	DP&E	30	84													
Surface Wheel Lathes	230	14100	Lathe (M&E) - Surface	per lathe	DP&E	30	1,300	85%	15%	✓			✓	✓			✓			✓
Surface Wheel Lathes	230	14200	Swarf Crusher - Surface	per crusher/conveyor	DP&E	30	17													
Surface Wheel Lathes	230	14300	Fume Extractor - Surface	per extraction system	DP&E	30	8													

Notes: Yellow cells are for inputs

Selection of the Sub-Definition Group (Column F) and inputting the number of assets (column K) will reveal the input cells required for that asset type.

Any cell in red has a value which should not be there, hence the value should be deleted.

Year of Assessment = 2010

ASSETS

										Physical Condition Input Parameters: Condition Assessment Parameters Score											Residual Life (no. of assets)					Condition Weighting: Weighting (assets >£250k)		ACR Output Values: Value of Assests in Each Catagory				Percentage of Assets in each Category					Information for Sponsor Use								
Depot Name	**Line**	**Definition Group**	**ACR No.**	**Sub-Definition Group**	**Responsibility**	**Nominal Life**	**Total ERV**	**Number of Assets**	**Installation Date / Yr**	**Control Equipment & Remote Monitoring Stations**	**Control System Hardware**	**Crane Control Equipment**	**Electrical Items**	**Enclosures & Cabinets**	**Equipment Operation**	**Hoists (not load ropes)**	**Mechcanical Items**	**Pipework (incl Comp. Air)**	**Power Supply System**	**Obsolescence**	**A (> 10Yrs)**	**B (5 - 10 Yrs)**	**C (1 - 5 Yrs)**	**D (Life Expired)**	**Check**	**Condition**	**Obsolescence**	**A (> 10Yrs)**	**B (5 - 10 Yrs)**	**C (1 - 5 Yrs)**	**D (Life Expired)**	**A (> 10Yrs)**	**B (5 - 10 Yrs)**	**C (1 - 5 Yrs)**	**D (Life Expired)**	**Functional Condition**	**Condition**	**Obsolescence**	**Total Weighted Score**	**Residual Life (Nominal) / Yrs**	**Residual Life (Measured) / Yrs**	**Physical Condition**	**Relative Asset Value (RAV) / %**	**Unit**	**Comments**
Hainault	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	0	0																	OK																			Train Battery Chargers per Fleet	
Hainault	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers).	
Hainault	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	1,500	1	1982				3	3			3			3					OK	0.7	0.3	####	####	####	####	####	####	####	####		3	3	3	2	#REF!	#REF!	31.8	per Train Wash	
Hainault	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	1,500	1	1996				3	3			3			3					OK	0.7	0.3	####	####	####	####	####	####	####	####		3	3	3	16	#REF!	#REF!	31.8	per Train Wash	
Hainault	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	15	1														1			OK				15				100%								8	#REF!	0.3	per system.	
Hainault	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	75	1														1			OK				75				100%								8	#REF!	1.6	per system.	
Hainault	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Hainault	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Hainault	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	240	3													3				OK			240				100%									13	#REF!	5.1	per system.	
Hainault	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
Hainault	#REF!	De-icing Equipment	3000	De-icing Equipment	DP&E	30	75	1														1			OK				75				100%								8	#REF!	1.6	per permanent De-icing plant	
Hainault	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	0	0																	OK																			per installation	
Hainault	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	264	33														33			OK				264				100%								8	#REF!	5.6	per Shutter door	
Hainault	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	0	0																	OK																			Valve Test Rig	
Hainault	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	270	1	2003			2	2	2		1	2		2	3					OK	0.8	0.2	####	####	####	####	####	####	####	####		1.833	3	2.067	23	#REF!	#REF!	5.7	per synchronised pair of cranes	
Hainault	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	0	0																	OK																			per crane	
Hainault	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	468	26													20	6			OK			360	108			77%	23%								13	#REF!	9.9	per single jack	
Hainault	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	45	5														5			OK				45				100%								8	#REF!	1.0	per crane	
Hainault	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	0	0																	OK																			per lift.	
Hainault	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	200	1														1			OK				200				100%								8	#REF!	4.2	per press.	
Hainault	#REF!	Traverser	11000	Traverser	DP&E	30	0	0																	OK																			per traverser	
Hainault	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	0	0																	OK																			per Twin-head UFWL	
Hainault	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
Hainault	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	0	0																	OK																			per crusher/conveyor	
Hainault	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	0	0																	OK																			per extraction system	
Hainault	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	0	0																	OK																			per installation	
Hainault	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	0	0																	OK																			per UFWL	
Hainault	#REF!	Train Mules	13000	Train Mules	DP&E	30	0	0																	OK																			per mule	
Hainault	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
Hainault	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
Hainault	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							4,712																																						
Ruislip	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	0	0																	OK																			Train Battery Chargers per Fleet	
Ruislip	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers).	
Ruislip	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	1,500	1	1982				3	3			3			3					OK	0.7	0.3	####	####	####	####	####	####	####	####		3	3	3	2	#REF!	#REF!	31.8	per Train Wash	
Ruislip	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	15	1														1			OK				15				100%								8	#REF!	0.3	per system.	
Ruislip	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	75	1														1			OK				75				100%								8	#REF!	1.6	per system.	
Ruislip	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Ruislip	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Ruislip	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	80	1														1			OK				80				100%								8	#REF!	1.7	per system.	
Ruislip	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
Ruislip	#REF!	De-icing Equipment	3000	De-icing Equipment	DP&E	30	75	1														1			OK				75				100%								8	#REF!	1.6	per permanent De-icing plant	
Ruislip	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	0	0																	OK																			per installation	
Ruislip	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	344	43													36	5	3		OK			280	40	24		81%	12%	7%							17	#REF!	7.3	per Shutter door	
Ruislip	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	0	0																	OK																			Valve Test Rig	
Ruislip	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	270	1	1999			2	2	3		4	3		2	3					OK	0.8	0.2	####	####	####	####	####	####	####	####		2.667	3	2.733	19	#REF!	#REF!	5.7	per synchronised pair of cranes	
Ruislip	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	0	0																	OK																			per crane	
Ruislip	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	666	37													26	9	2		OK			468	162	36		70%	24%	5%							13	#REF!	14.1	per single jack	
Ruislip	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	144	16														16			OK				144				100%								8	#REF!	3.1	per crane	
Ruislip	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	0	0																	OK																			per lift.	
Ruislip	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	200	1														1			OK				200				100%								8	#REF!	4.2	per press.	
Ruislip	#REF!	Traverser	11000	Traverser	DP&E	30	0	0																	OK																			per traverser	
Ruislip	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	0	0																	OK																			per Twin-head UFWL	
Ruislip	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
Ruislip	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	0	0																	OK																			per crusher/conveyor	
Ruislip	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	0	0																	OK																			per extraction system	
Ruislip	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	0	0																	OK																			per installation	
Ruislip	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	0	0																	OK																			per UFWL	
Ruislip	#REF!	Train Mules	13000	Train Mules	DP&E	30	0	0																	OK																			per mule	
Ruislip	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
Ruislip	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
Ruislip	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							3,429																																						
Northumberland Park	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	15	1														1			OK				15				100%								8	#REF!	0.3	Train Battery Chargers per Fleet	
Northumberland Park	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers).	
Northumberland Park	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	1,500	1	1994				3	3			3			3					OK	0.7	0.3	####	####	####	####	####	####	####	####		3	3	3	14	#REF!	#REF!	31.8	per Train Wash	
Northumberland Park	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	15	1														1			OK				15				100%								8	#REF!	0.3	per system.	
Northumberland Park	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	75	1														1			OK				75				100%								8	#REF!	1.6	per system.	
Northumberland Park	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Northumberland Park	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Northumberland Park	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	80	1														1			OK				80				100%								8	#REF!	1.7	per system.	
Northumberland Park	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
Northumberland Park	#REF!	De-icing Equipment	3000	De-icing Equipment	DP&E	30	0	0																	OK																			per permanent De-icing plant	
Northumberland Park	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	500	1	2006	3			4	4			4	4		3					OK	0.6	0.4	####	####	####	####	####	####	####	####		3.8	3	3.48	16	#REF!	#REF!	10.6	per installation	
Northumberland Park	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	208	26													20	3	3		OK			160	24	24		77%	12%	12%							17	#REF!	4.4	per Shutter door	
Northumberland Park	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	60	1														1			OK				60				100%								8	#REF!	1.3	Valve Test Rig	
Northumberland Park	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	270	1	1995			4	3	4		3	4		3	5					OK	0.8	0.2	####	####	####	####	####	####	####	####		3.5	5	3.8	15	#REF!	#REF!	5.7	per synchronised pair of cranes	

Notes: Yellow cells are for inputs

Selection of the Sub-Definition Group (Column F) and inputting the number of assets (column K) will reveal the input cells required for that asset type.

Any cell in red has a value which should not be there, hence the value should be deleted.

Year of Assessment = 2010

ASSETS

									Physical Condition Input Parameters	Condition Assessment Parameters Score											Residual Life (no. of assets)					Condition Weighting (assets >£250k)		ACR Output Values: Value of Assets in Each Catagory				Percentage of Assets in each Category					Information for Sponsor Use								
Depot Name	Line	Definition Group	ACR No.	Sub-Definition Group	Responsibility	Nominal Life	Total ERV	Number of Assets	Installation Date / Yr	Control Equipment & Remote Monitoring Stations	Control System Hardware	Crane Control Equipment	Electrical Items	Enclosures & Cabinets	Equipment Operation	Hoists (not load ropes)	Mechanical Items	Pipework (incl Comp. Air)	Power Supply System	Obsolescence	A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	Check	Condition	Obsolescence	A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	Functional Condition	Condition	Obsolescence	Total Weighted Score	Residual Life (Nominal) / Yrs	Residual Life (Measured) / Yrs	Physical Condition	Relative Asset Value (RAV) / %	Unit	Comments
Northumberland Park	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	100	1														1			OK				100				100%								8	#REF!	2.1	per crane	
Northumberland Park	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	612	34													20	12	2		OK			360	216	36		59%	35%	6%							12	#REF!	13.0	per single jack	
Northumberland Park	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	27	3														3			OK				27				100%								8	#REF!	0.6	per crane	
Northumberland Park	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	60	2														2			OK				60				100%								8	#REF!	1.3	per lift.	
Northumberland Park	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	0	0																	OK																			per press.	
Northumberland Park	#REF!	Traverser	11000	Traverser	DP&E	30	0	0																	OK																			per traverser	
Northumberland Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	1,500	1	2002				4	4			5			3					OK	0.75	0.25	####	####	####	####	####	####	####	####		4.333	3	4	22	#REF!	#REF!	31.8	per Twin-head UFWL	
Northumberland Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
Northumberland Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	17	1														1			OK				17				100%								8	#REF!	0.4	per crusher/conveyor	
Northumberland Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	8	1														1			OK				8				100%								8	#REF!	0.2	per extraction system	
Northumberland Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	150	1														1			OK				150				100%								8	#REF!	3.2	per installation	
Northumberland Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	300	1	2002		5				5					5					OK	0.3	0.7	####	####	####	####	####	####	####	####		5	5	5	7	#REF!	#REF!	6.4	per UFWL	
Northumberland Park	#REF!	Train Mules	13000	Train Mules	DP&E	30	84	1														1			OK				84				100%								8	#REF!	1.8	per mule	
Northumberland Park	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
Northumberland Park	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
Northumberland Park	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							5,641																																						
Stonebridge Park	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	15	1														1			OK				15				100%								8	#REF!	0.3	Train Battery Chargers per Fleet	
Stonebridge Park	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers)	
Stonebridge Park	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	1,500	1	1998				3	3			3			3					OK	0.7	0.3	####	####	####	####	####	####	####	####		3	3	3	18	#REF!	#REF!	31.8	per Train Wash	
Stonebridge Park	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	15	1														1			OK				15				100%								8	#REF!	0.3	per system.	
Stonebridge Park	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	75	1														1			OK				75				100%								8	#REF!	1.6	per system.	
Stonebridge Park	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Stonebridge Park	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Stonebridge Park	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	80	1														1			OK				80				100%								8	#REF!	1.7	per system.	
Stonebridge Park	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
Stonebridge Park	#REF!	De-Icing Equipment	3000	De-Icing Equipment	DP&E	30	75	1														1			OK				75				100%								8	#REF!	1.6	per permanent De-icing plant	
Stonebridge Park	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	0	0																	OK																			per installation	
Stonebridge Park	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	216	27													15	8	3	1	OK			120	64	24	8	56%	30%	11%	4%						14	#REF!	4.6	per Shutter door	
Stonebridge Park	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	0	0																	OK																			Valve Test Rig	
Stonebridge Park	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	270	1	2006			3	4	3		3	4		3	5					OK	0.8	0.2	####	####	####	####	####	####	####	####		3.333	5	3.667	26	#REF!	#REF!	5.7	per synchronised pair of cranes	
Stonebridge Park	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	0	0																	OK																			per crane	
Stonebridge Park	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	0	0																	OK																			per single jack	
Stonebridge Park	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	117	13														13			OK				117				100%								8	#REF!	2.5	per crane	
Stonebridge Park	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	0	0																	OK																			per lift.	
Stonebridge Park	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	0	0																	OK																			per press.	
Stonebridge Park	#REF!	Traverser	11000	Traverser	DP&E	30	0	0																	OK																			per traverser	
Stonebridge Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	0	0																	OK																			per Twin-head UFWL	
Stonebridge Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
Stonebridge Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	0	0																	OK																			per crusher/conveyor	
Stonebridge Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	0	0																	OK																			per extraction system	
Stonebridge Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	0	0																	OK																			per installation	
Stonebridge Park	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	0	0																	OK																			per UFWL	
Stonebridge Park	#REF!	Train Mules	13000	Train Mules	DP&E	30	0	0																	OK																			per mule	
Stonebridge Park	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
Stonebridge Park	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
Stonebridge Park	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							2,423																																						
Queens Park	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	32	4																4	OK						32				100%						1	#REF!	0.7	per Shutter door	
							32																																						
Waterloo	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	0	0																	OK																			Train Battery Chargers per Fleet	
Waterloo	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers)	
Waterloo	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	1,500	1	2006				3	3			3			3					OK	0.7	0.3	####	####	####	####	####	####	####	####		3	3	3	26	#REF!	#REF!	31.8	per Train Wash	
Waterloo	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	15	1														1			OK				15				100%								8	#REF!	0.3	per system.	
Waterloo	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	75	1															1		OK					75				100%							3	#REF!	1.6	per system.	
Waterloo	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	30	1														1			OK				30				100%								8	#REF!	0.6	per system.	
Waterloo	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	30	1																1	OK						30				100%						1	#REF!	0.6	per system.	
Waterloo	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	0	0																	OK																			per system.	
Waterloo	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
Waterloo	#REF!	De-Icing Equipment	3000	De-Icing Equipment	DP&E	30	0	0																	OK																			per permanent De-icing plant	
Waterloo	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	0	0																	OK																			per installation	
Waterloo	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	24	3														3			OK				24				100%								8	#REF!	0.5	per Shutter door	
Waterloo	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	0	0																	OK																			Valve Test Rig	
Waterloo	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	270	1	1992			3	2	2		2	3		2	1					OK	0.8	0.2	####	####	####	####	####	####	####	####		2.333	1	2.067	12	#REF!	#REF!	5.7	per synchronised pair of cranes	
Waterloo	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	0	0																	OK																			per crane	
Waterloo	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	144	8														8			OK				144				100%								8	#REF!	3.1	per single jack	
Waterloo	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	18	2														2			OK				18				100%								8	#REF!	0.4	per crane	
Waterloo	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	0	0																	OK																			per lift.	
Waterloo	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	0	0																	OK																			per press.	
Waterloo	#REF!	Traverser	11000	Traverser	DP&E	30	0	0																	OK																			per traverser	
Waterloo	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	0	0																	OK																			per Twin-head UFWL	
Waterloo	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
Waterloo	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	0	0																	OK																			per crusher/conveyor	
Waterloo	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	0	0																	OK																			per extraction system	

Notes: Yellow cells are for inputs

Selection of the Sub-Definition Group (Column F) and inputting the number of assets (column K) will reveal the input cells required for that asset type.

Any cell in red has a value which should not be there, hence the value should be deleted.

Year of Assessment = 2010

ASSETS

										Physical Condition Input Parameters																Condition Weighting		ACR Output Values									Information for Sponsor Use								
										Condition Assessment Parameters Score											Residual Life (no. of assets)					Weighting (assets >£250k)		Value of Assets in Each Catagory				Percentage of Assets in each Category													
Depot Name	Line	Definition Group	ACR No.	Sub-Definition Group	Responsibility	Nominal Life	Total ERV	Number of Assets	Installation Date / Yr	Control Equipment & Remote Monitoring Stations	Control System Hardware	Crane Control Equipment	Electrical Items	Enclosures & Cabinets	Equipment Operation	Hoists (not load ropes)	Mechancial Items	Pipework (incl Comp. Air)	Power Supply System	Obsolescence	A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	Check	Condition	Obsolescence	A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	Functional Condition	Condition	Obsolescence	Total Weighted Score	Residual Life (Nominal) / Yrs	Residual Life (Measured) / Yrs	Physical Condition	Relative Asset Value (RAV) / %	Unit	Comments
Waterloo	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	0	0																	OK																			per installation	
Waterloo	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	0	0																	OK																			per UFWL	
Waterloo	#REF!	Train Mules	13000	Train Mules	DP&E	30	0	0																	OK																			per mule	
Waterloo	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
Waterloo	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
Waterloo	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							2,106																																						
Lillie Bridge	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	0	0																	OK																			Train Battery Chargers per Fleet	
Lillie Bridge	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers)	
Lillie Bridge	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	0	0																	OK																			per Train Wash	
Lillie Bridge	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	0	0																	OK																			per system.	
Lillie Bridge	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	0	0																	OK																			per system.	
Lillie Bridge	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	0	0																	OK																			per system.	
Lillie Bridge	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	0	0																	OK																			per system.	
Lillie Bridge	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	0	0																	OK																			per system.	
Lillie Bridge	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
Lillie Bridge	#REF!	De-Icing Equipment	3000	De-Icing Equipment	DP&E	30	0	0																	OK																			per permanent De-icing plant	
Lillie Bridge	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	0	0																	OK																			per installation	
Lillie Bridge	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	0	0																	OK																			per Shutter door	
Lillie Bridge	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	0	0																	OK																			Valve Test Rig	
Lillie Bridge	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	0	0																	OK																			per synchronised pair of cranes	
Lillie Bridge	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	300	3													3				OK			300				100%									20	#REF!	6.4	per crane	
Lillie Bridge	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	0	0																	OK																			per single jack	
Lillie Bridge	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	0	0																	OK																			per crane	
Lillie Bridge	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	0	0																	OK																			per lift.	
Lillie Bridge	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	0	0																	OK																			per press.	
Lillie Bridge	#REF!	Traverser	11000	Traverser	DP&E	30	0	0																	OK																			per traverser	
Lillie Bridge	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	0	0																	OK																			per Twin-head UFWL	
Lillie Bridge	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
Lillie Bridge	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	0	0																	OK																			per crusher/conveyor	
Lillie Bridge	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	0	0																	OK																			per extraction system	
Lillie Bridge	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	0	0																	OK																			per installation	
Lillie Bridge	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	0	0																	OK																			per UFWL	
Lillie Bridge	#REF!	Train Mules	13000	Train Mules	DP&E	30	0	0																	OK																			per mule	
Lillie Bridge	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
Lillie Bridge	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
Lillie Bridge	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							300																																						
Ruislip LWR	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	0	0																	OK																			Train Battery Chargers per Fleet	
Ruislip LWR	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers)	
Ruislip LWR	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	0	0																	OK																			per Train Wash	
Ruislip LWR	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	0	0																	OK																			per system.	
Ruislip LWR	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	0	0																	OK																			per system.	
Ruislip LWR	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	0	0																	OK																			per system.	
Ruislip LWR	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	0	0																	OK																			per system.	
Ruislip LWR	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	0	0																	OK																			per system.	
Ruislip LWR	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
Ruislip LWR	#REF!	De-Icing Equipment	3000	De-Icing Equipment	DP&E	30	0	0																	OK																			per permanent De-icing plant	
Ruislip LWR	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	0	0																	OK																			per installation	
Ruislip LWR	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	0	0																	OK																			per Shutter door	
Ruislip LWR	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	0	0																	OK																			Valve Test Rig	
Ruislip LWR	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	0	0																	OK																			per synchronised pair of cranes	
Ruislip LWR	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	1,700	17														17			OK				1700				100%								8	#REF!	36.1	per crane	
Ruislip LWR	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	0	0																	OK																			per single jack	
Ruislip LWR	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	0	0																	OK																			per crane	
Ruislip LWR	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	0	0																	OK																			per lift.	
Ruislip LWR	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	0	0																	OK																			per press.	
Ruislip LWR	#REF!	Traverser	11000	Traverser	DP&E	30	0	0																	OK																			per traverser	
Ruislip LWR	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	0	0																	OK																			per Twin-head UFWL	
Ruislip LWR	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
Ruislip LWR	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	0	0																	OK																			per crusher/conveyor	
Ruislip LWR	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	0	0																	OK																			per extraction system	
Ruislip LWR	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	0	0																	OK																			per installation	
Ruislip LWR	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	0	0																	OK																			per UFWL	
Ruislip LWR	#REF!	Train Mules	13000	Train Mules	DP&E	30	0	0																	OK																			per mule	
Ruislip LWR	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
Ruislip LWR	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
Ruislip LWR	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							1,700																																						
REW / TMU	#REF!	Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	30	0	0																	OK																			Train Battery Chargers per Fleet	
REW / TMU	#REF!	Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	20	0	0																	OK																			per charging system e.g bench, screening, extraction etc (excluding battery chargers)	
REW / TMU	#REF!	Train Cleaning Equipment	2100	Train Washing Machine	DP&E	30	0	0																	OK																			per Train Wash	
REW / TMU	#REF!	Train Cleaning Equipment	2200	Water Softening Plant	DP&E	10	0	0																	OK																			per system.	
REW / TMU	#REF!	Train Cleaning Equipment	2300	Foam Arch	DP&E	10	0	0																	OK																			per system.	

Notes: Yellow cells are for inputs

Selection of the Sub-Definition Group (Column F) and inputting the number of assets (column K) will reveal the input cells required for that asset type.

Any cell in red has a value which should not be there, hence the value should be deleted.

Year of Assessment = 2010

ASSETS

Depot Name	Line	Definition Group	ACR No.	Sub-Definition Group	Responsibility	Nominal Life	Total ERV	Number of Assets	Installation Date / Yr	Physical Condition Input Parameters – Condition Assessment Parameters Score: Control Equipment & Remote Monitoring Stations	Control System Hardware	Crane Control Equipment	Electrical Items	Enclosures & Cabinets	Equipment Operation	Hoists (not load ropes)	Mechcanical Items	Pipework (incl Comp. Air)	Power Supply System	Obsolescence	Residual Life (no. of assets): A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	Check	Condition Weighting – Weighting (assets >£250k): Condition	Obsolescence	ACR Output Values – Value of Assests in Each Catagory: A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	Percentage of Assets in each Category: A (> 10Yrs)	B (5 - 10 Yrs)	C (1 - 5 Yrs)	D (Life Expired)	Functional Condition	Information for Sponsor Use: Condition	Obsolescence	Total Weighted Score	Residual Life (Nominal) / Yrs	Residual Life (Measured) / Yrs	Physical Condition	Relative Asset Value (RAV) / %	Unit	Comments
REW / TMU	#REF!	Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E	10	0	0																	OK																			per system.	
REW / TMU	#REF!	Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E	10	0	0																	OK																			per system.	
REW / TMU	#REF!	Train Cleaning Equipment	2600	Train Vacuum System	DP&E	15	0	0																	OK																			per system.	
REW / TMU	#REF!	Train Cleaning Equipment	2700	Underframe Cleaner	DP&E	20	0	0																	OK																			per system.	
REW / TMU	#REF!	De-icing Equipment	3000	De-Icing Equipment	DP&E	30	0	0																	OK																			per permanent De-icing plant	
REW / TMU	#REF!	Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	20	0	0																	OK																			per installation	
REW / TMU	#REF!	Shutter Doors	5000	Shutter Doors	DP&E	30	320	40														40			OK				320				100%								8	#REF!	6.8	per Shutter door	
REW / TMU	#REF!	Brake Test Equipment	6000	Brake Test Equipment	DP&E	30	0	0																	OK																			Valve Test Rig	
REW / TMU	#REF!	E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E	30	0	0																	OK																			per synchronised pair of cranes	
REW / TMU	#REF!	E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E	30	2,200	22														22			OK				2200				100%								8	#REF!	46.7	per crane	
REW / TMU	#REF!	Train Lifting Jacks	8000	Train Lifting Jacks	DP&E	20	144	8														8			OK				144				100%								8	#REF!	3.1	per single jack	
REW / TMU	#REF!	Jib Cranes	9000	Jib Cranes	DP&E	30	0	0																	OK																			per crane	
REW / TMU	#REF!	Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E	20	0	0																	OK																			per lift.	
REW / TMU	#REF!	Bogie Maintenance Equipment	10200	Bogie Presses	DP&E	20	0	0																	OK																			per press.	
REW / TMU	#REF!	Traverser	11000	Traverser	DP&E	30	2,000	1	1985				3	3			3		3	3					OK	0.85	0.15	####	####	####	####	####	####	####	####		3	3	3	5	#REF!	#REF!	42.4	per traverser	
REW / TMU	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E	30	0	0																	OK																			per Twin-head UFWL	
REW / TMU	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E	30	0	0																	OK																			per single-head UFWL	
REW / TMU	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E	15	0	0																	OK																			per crusher/conveyor	
REW / TMU	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E	15	0	0																	OK																			per extraction system	
REW / TMU	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E	30	0	0																	OK																			per installation	
REW / TMU	#REF!	Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E	15	0	0																	OK																			per UFWL	
REW / TMU	#REF!	Train Mules	13000	Train Mules	DP&E	30	0	0																	OK																			per mule	
REW / TMU	#REF!	Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E	30	0	0																	OK																			per lathe	
REW / TMU	#REF!	Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E	30	0	0																	OK																			per crusher/conveyor	
REW / TMU	#REF!	Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E	30	0	0																	OK																			per extraction system	
							4,664																																						

3.1.3 Reporting Requirements for Depot Plant & Equipment 2011

3.1.3.1 Depot Plant & Equipment ACR - by Line

Depot Plant & Equipment **Bakerloo**

Actuals:		Physical Condition				Functional Condition			
		Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
	RAV	% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance
						Quantity	£ Risk	£ Risk	£ Risk
Battery Charging System	-								
Battery Chargers	-								
Train Washing Machine	-								
Water Softening Plant	-								
Foam Arch	-								
Acid Dosing Plant	-								
Caustic Dosing Plant	-								
Train Vacuum System	-								
Underframe Cleaner	-								
De-Icing Equipment	-								
Wheelset Monitoring Equipment	-								
Shutter Doors	-								
Brake Test Equipment	-								
Twin Gantry Overhead Cranes	-								
Single Gantry Overhead Cranes	-								
Train Lifting Jacks	-								
Jib Cranes	-								
Mobile Bogie Lifting Equipment	-								
Bogie Presses	-								
Traverser	-								
Lathe (M&E) - Twin Head	-								
Lathe (M&E) - Single Head	-								
Swarf Crusher - UFWL	-								
Fume Extractor - UFWL	-								
Bogie Height Adjustment Station	-								
Lathe (Control & Software) - Single & Double Head	-								
Train Mules	-								
Lathe (M&E) - Surface	-								
Swarf Crusher - Surface	-								
Fume Extractor - Surface	-								
Depot Plant & Equipment									
Previous									
Actual	-	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	£ -	£ -	£ -	£ -
Variance									

3.1.3 Reporting Requirements for Depot Plant & Equipment 2011

3.1.3.1 Depot Plant & Equipment ACR - by Line

Depot Plant & Equipment **Central**

Actuals:		Physical Condition				Functional Condition			
		Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
	RAV	% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance
						Quantity	£ Risk	£ Risk	£ Risk
Battery Charging System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Battery Chargers	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Washing Machine	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Water Softening Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Foam Arch	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Acid Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Caustic Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Vacuum System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Underframe Cleaner	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
De-Icing Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Wheelset Monitoring Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Shutter Doors	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Brake Test Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Twin Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Single Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Lifting Jacks	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Jib Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Mobile Bogie Lifting Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Presses	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Traverser	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Twin Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Single Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Height Adjustment Station	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (Control & Software) - Single & Double Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Mules	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Depot Plant & Equipment									
Previous									
Actual	-	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Variance									

3.1.3 Reporting Requirements for Depot Plant & Equipment 2011

3.1.3.1 Depot Plant & Equipment ACR - by Line

Depot Plant & Equipment Victoria

Actuals:		Physical Condition				Functional Condition			
		Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
	RAV	% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance
						Quantity	£ Risk	£ Risk	£ Risk
Battery Charging System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Battery Chargers	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Washing Machine	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Water Softening Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Foam Arch	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Acid Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Caustic Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Vacuum System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Underframe Cleaner	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
De-Icing Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Wheelset Monitoring Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Shutter Doors	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Brake Test Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Twin Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Single Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Lifting Jacks	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Jib Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Mobile Bogie Lifting Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Presses	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Traverser	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Twin Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Single Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Height Adjustment Station	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (Control & Software) - Single & Double Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Mules	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Depot Plant & Equipment									
Previous									
Actual	-	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Variance									

3.1.3 Reporting Requirements for Depot Plant & Equipment 2011

3.1.3.1 Depot Plant & Equipment ACR - by Line

Depot Plant & Equipment W&C

Actuals:		Physical Condition				Functional Condition			
		Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
	RAV	% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance
						Quantity	£ Risk	£ Risk	£ Risk
Battery Charging System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Battery Chargers	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Washing Machine	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Water Softening Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Foam Arch	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Acid Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Caustic Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Vacuum System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Underframe Cleaner	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
De-Icing Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Wheelset Monitoring Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Shutter Doors	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Brake Test Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Twin Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Single Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Lifting Jacks	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Jib Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Mobile Bogie Lifting Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Presses	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Traverser	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Twin Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Single Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Height Adjustment Station	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (Control & Software) - Single & Double Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Mules	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Depot Plant & Equipment									
Previous									
Actual	-	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Variance									

3.1.3 Reporting Requirements for Depot Plant & Equipment 2011

3.1.3.1 Depot Plant & Equipment ACR - by Line

Depot Plant & Equipment NonAtt

Actuals:		Physical Condition				Functional Condition			
		Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
	RAV	% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance
						Quantity	£ Risk	£ Risk	£ Risk
Battery Charging System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Battery Chargers	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Washing Machine	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Water Softening Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Foam Arch	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Acid Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Caustic Dosing Plant	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Vacuum System	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Underframe Cleaner	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
De-Icing Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Wheelset Monitoring Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Shutter Doors	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Brake Test Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Twin Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Single Gantry Overhead Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Lifting Jacks	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Jib Cranes	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Mobile Bogie Lifting Equipment	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Presses	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Traverser	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Twin Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Single Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - UFWL	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Bogie Height Adjustment Station	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (Control & Software) - Single & Double Head	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Train Mules	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Lathe (M&E) - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Swarf Crusher - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Fume Extractor - Surface	-	0%	0%	0%	0%	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Depot Plant & Equipment									
Previous									
Actual	-	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Variance									

3.1.3 Reporting Requirements for Depot Plant & Equipment 2010

3.1.3.2 Depot Plant & Equipment ACR - all Lines

Depot Plant & Equipment

Actuals:		Physical Condition				Functional Condition			
		Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
	RAV	% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance
						Quantity	£ Risk	£ Risk	£ Risk
Battery Charging System	30								
Battery Chargers	-								
Train Washing Machine	9,000								
Water Softening Plant	75								
Foam Arch	375								
Acid Dosing Plant	150								
Caustic Dosing Plant	150								
Train Vacuum System	480								
Underframe Cleaner	-								
De-Icing Equipment	225								
Wheelset Monitoring Equipment	500								
Shutter Doors	1,408								
Brake Test Equipment	60								
Twin Gantry Overhead Cranes	1,350								
Single Gantry Overhead Cranes	4,300								
Train Lifting Jacks	2,034								
Jib Cranes	351								
Mobile Bogie Lifting Equipment	60								
Bogie Presses	400								
Traverser	2,000								
Lathe (M&E) - Twin Head	1,500								
Lathe (M&E) - Single Head	-								
Swarf Crusher - UFWL	17								
Fume Extractor - UFWL	8								
Bogie Height Adjustment Station	150								
Lathe (Control & Software) - Single & Double Head	300								
Train Mules	84								
Lathe (M&E) - Surface	-								
Swarf Crusher - Surface	-								
Fume Extractor - Surface	0								
Depot Plant & Equipment									
Previous									
Actual	**25,007**	**#REF!**	**#REF!**	**#REF!**	**#REF!**	**£ -**	**£ -**	**£ -**	**£ -**
Variance									

Depot Plant and Equipment Asset Condition Report (ACR) Hierachy & Residual Life

Current Year = 2010
Version = #REF!

SUMMARY

Definition Group	ACR No.	Sub-Definition Group	Responsibility	Comments	Nominal Life / Yrs	ERV's / £k	Total of Nominal Lives / Yrs	Total ERV's / £k	Total Number of Asset	Total Average ERV / £k	Total Average Installation Year	Weighting (assets >£250k) Condition	Weighting (assets >£250k) Obsolescence	Total Average Score (assets >£250k) Condition	Total Average Score (assets >£250k) Obsolescence	Total Weighted Score	Residual Life (Nominal) / Yrs	Residual Life (Measured) / Yrs Assets >£250k	Residual Life (Measured) / Yrs Assets <£250k	Physical Condition	Relative Asset Value (RAV) / %	Unit
Battery Chargers (Train Batteries)	1100	Battery Charging System	DP&E	A little confusion over who has responsibility for battery chargers within depots.	30	15	60	30	2	15									15	#REF!	0.1	Train Battery Chargers per Fleet
Battery Chargers (Train Batteries)	1200	Battery Chargers	DP&E	A little confusion over who has responsibility for battery chargers within depots.	20	70	0	0	0	0									No Data	No Data	0.0	per charging system e.g bench, screening, extraction etc (excluding battery chargers).
Train Cleaning Equipment	2100	Train Washing Machine	DP&E		30	1500	180	9000	6	1,500	1993	0.7	0.3	3.00	3.00	3.0	13	#REF!	#REF!	#REF!	36.0	per Train Wash
Train Cleaning Equipment	2200	Water Softening Plant	DP&E		10	15	50	75	5	15									38	#REF!	0.3	per system.
Train Cleaning Equipment	2300	Foam Arch	DP&E		10	75	50	375	5	75									33	#REF!	1.5	per system.
Train Cleaning Equipment	2400	Acid Dosing Plant	DP&E		10	30	50	150	5	30									38	#REF!	0.6	per system.
Train Cleaning Equipment	2500	Caustic Dosing Plant	DP&E		10	30	50	150	5	30									31	#REF!	0.6	per system.
Train Cleaning Equipment	2600	Train Vacuum System	DP&E		15	80	90	480	6	80									35	#REF!	1.9	per system.
Train Cleaning Equipment	2700	Underframe Cleaner	DP&E		20	150	0	0	0	0									No Data	No Data	0.0	per system.
De-Icing Equipment	3000	De-Icing Equipment	DP&E		30	75	90	225	3	75									23	#REF!	0.9	per permanent De-icing plant
Fixed Train Monitoring Equipment	4000	Wheelset Monitoring Equipment	DP&E	Structure of Talgo systems to be captured within Premises ACR (Hugh Corrigan).	20	500	20	500	1	500	2006	0.6	0.4	3.80	3.00	3.5	16	#REF!	#REF!	#REF!	2.0	per installation
Shutter Doors	5000	Shutter Doors	DP&E		30	8	5280	1408	176	8									71	#REF!	5.6	per Shutter door
Brake Test Equipment	6000	Brake Test Equipment	DP&E		30	60	30	60	1	60									8	#REF!	0.2	Valve Test Rig
E.O.T. Cranes	7100	Twin Gantry Overhead Cranes	DP&E		30	270	150	1350	5	270	1999	0.8	0.2	2.73	3.40	2.9	19	#REF!	#REF!	#REF!	5.4	per synchronised pair of cranes
E.O.T. Cranes	7200	Single Gantry Overhead Cranes	DP&E		30	100	1290	4300	43	100									43	#REF!	17.2	per crane
Train Lifting Jacks	8000	Train Lifting Jacks	DP&E		20	18	2260	2034	113	18									52	#REF!	8.1	per single jack
Jib Cranes	9000	Jib Cranes	DP&E		30	9	1170	351	39	9									38	#REF!	1.4	per crane
Bogie Maintenance Equipment	10100	Mobile Bogie Lifting Equipment	DP&E		20	30	40	60	2	30									8	#REF!	0.2	per lift.
Bogie Maintenance Equipment	10200	Bogie Presses	DP&E		20	200	40	400	2	200									15	#REF!	1.6	per press.
Traverser	11000	Traverser	DP&E		30	2000	30	2000	1	2,000	1985	0.85	0.15	3.00	3.00	3.0	5	#REF!	#REF!	#REF!	8.0	per traverser
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12100	Lathe (M&E) - Twin Head	DP&E		30	1500	30	1500	1	1,500	2002	0.75	0.25	4.33	3.00	4.0	22	#REF!	#REF!	#REF!	6.0	per Twin-head UFWL
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12110	Lathe (M&E) - Single Head	DP&E		30	1200	0	0	0	0		0.75	0.25						No Data	No Data	0.0	per single-head UFWL
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12200	Swarf Crusher - UFWL	DP&E		15	17	15	17	1	17									8	#REF!	0.1	per crusher/conveyor
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12300	Fume Extractor - UFWL	DP&E		15	8	15	8	1	8									8	#REF!	0.0	per extraction system
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12400	Bogie Height Adjustment Station	DP&E		30	150	30	150	1	150									8	#REF!	0.6	per installation
Underfloor Wheel Lathes (includes Mobile Wheel lathe)	12500	Lathe (Control & Software) - Single & Double Head	DP&E		15	300	15	300	1	300	2002	0.3	0.7	5.00	5.00	5.0	7	#REF!	#REF!	#REF!	1.2	per UFWL
Train Mules	13000	Train Mules	DP&E		30	84	30	84	1	84									8	#REF!	0.3	per mule
Surface Wheel Lathes	14100	Lathe (M&E) - Surface	DP&E		30	1300	0	0	0	0		0.85	0.15						No Data	No Data	0.0	per lathe
Surface Wheel Lathes	14200	Swarf Crusher - Surface	DP&E		30	17	0	0	0	0									No Data	No Data	0.0	per crusher/conveyor
Surface Wheel Lathes	14300	Fume Extractor - Surface	DP&E		30	8	0	0	0	0									No Data	No Data	0.0	per extraction system
							Sum =	25,007													100	

S1042 Asset Condition Reporting (ACR)

Track

Production of the Track ACR

Version R2

Introduction

This paper sets out the requirements and plan for delivery of the ACR for Track assets.

The track community is committed to the development of an ACR process that forms an integral part of the way we do business. The standard and associated asset specific appendix describe a future state significantly further developed from today's capability (for example - drawing on the benefits offered from introduction of the Asset Inspection Train and ATMS systems and their associated support tools). It is therefore important to describe what will be delivered and how it will be delivered.

The Sponsor has established an understanding of the "as is" position and set out requirements for ACR. These requirements reflect:

- Status of development of the existing Track Condition Model (TCM – WILCO)
- Concerns over base data (ACA, Ellipse and WILCO all reflect different asset type and age of installation data sets)
- The availability of asset Hazard Logs
- The availability of data used at the Maintenance Assurance and Performance Meeting (MAPM)

The Track Condition Model (TCM) has been subject to development to move from an Excel based platform to WILCO (proprietary software). The model takes asset type, installation date and other key attributes (annual tonnage, curvature etc.) and determines life expectancy for rail, sleepers and base assets using pre-defined algorithms. This life expectancy is broadly consistent with the concept of Nominal Book Life as being developed for ACR. For further detail please see Track AGS Appendix A1.

Requirements

Development of the ACR will therefore concentrate on the following aspects:

1) Update Ellipse asset type and installation date datasets for rail, sleepers, ballast/concrete and Junctionwork (CMO)
2) Identification of asset type for conductor rail (CMO)
3) Use of the Track Condition Model to determine residual life (nominal book life) based on the updated datasets for rail, sleepers, ballast/concrete (S&C) in accordance with the Track AGS Appendix A1.
4) Use of the P&C Schedule to determine P&C residual life (nominal book life)
5) Update the Hazard Logs and determine/fill any gaps (CMO)
6) Use of the maintenance condition KPI monitoring undertaken for the MAPM (CMO)

These aspects are shown in context in Appendix A.

In order to determine the residual life for P&C the following book lives shall be used:

Intervention	Life Expectancy
Full Renewal (Ballasted)	40 years
Full Renewal (Deep Tube)	50 years
Refurbishment (Ballasted)	10 years
Refurbishment (Deep Tube)	15 years

With respect to the risk review (Workstream 4) the completed register shall comprise a schedule of asset risks that are a function of design and/or degraded condition which results in exposure of London Underground to intolerable safety risk, poor performance or excessive maintenance costs.

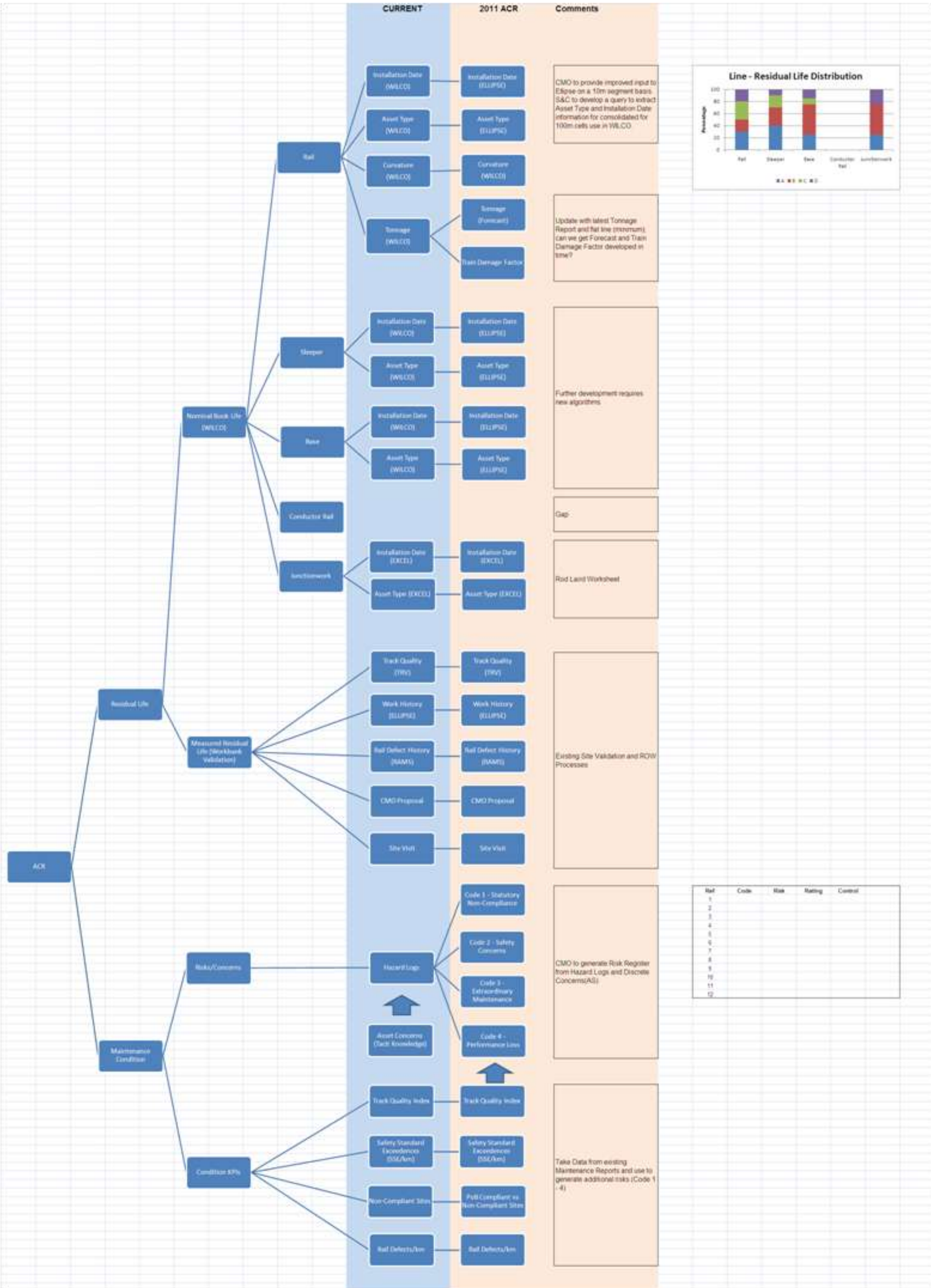
Programme

A consolidated programme is shown in Appendix B.

In order to meet the prescribed deadline (May) it may be necessary to use the best/latest available data allowing for processing time rather than maintaining a true year end position. For example – Period 13 data is generally reviewed in week three (MAPM Meeting) following the end of period. TRV processed data (standard deviations) is generally not available for some time later. CMO shall advise which data sets have been used and, where required, ensure that a rolling 13 periods is used to give an annualised view.

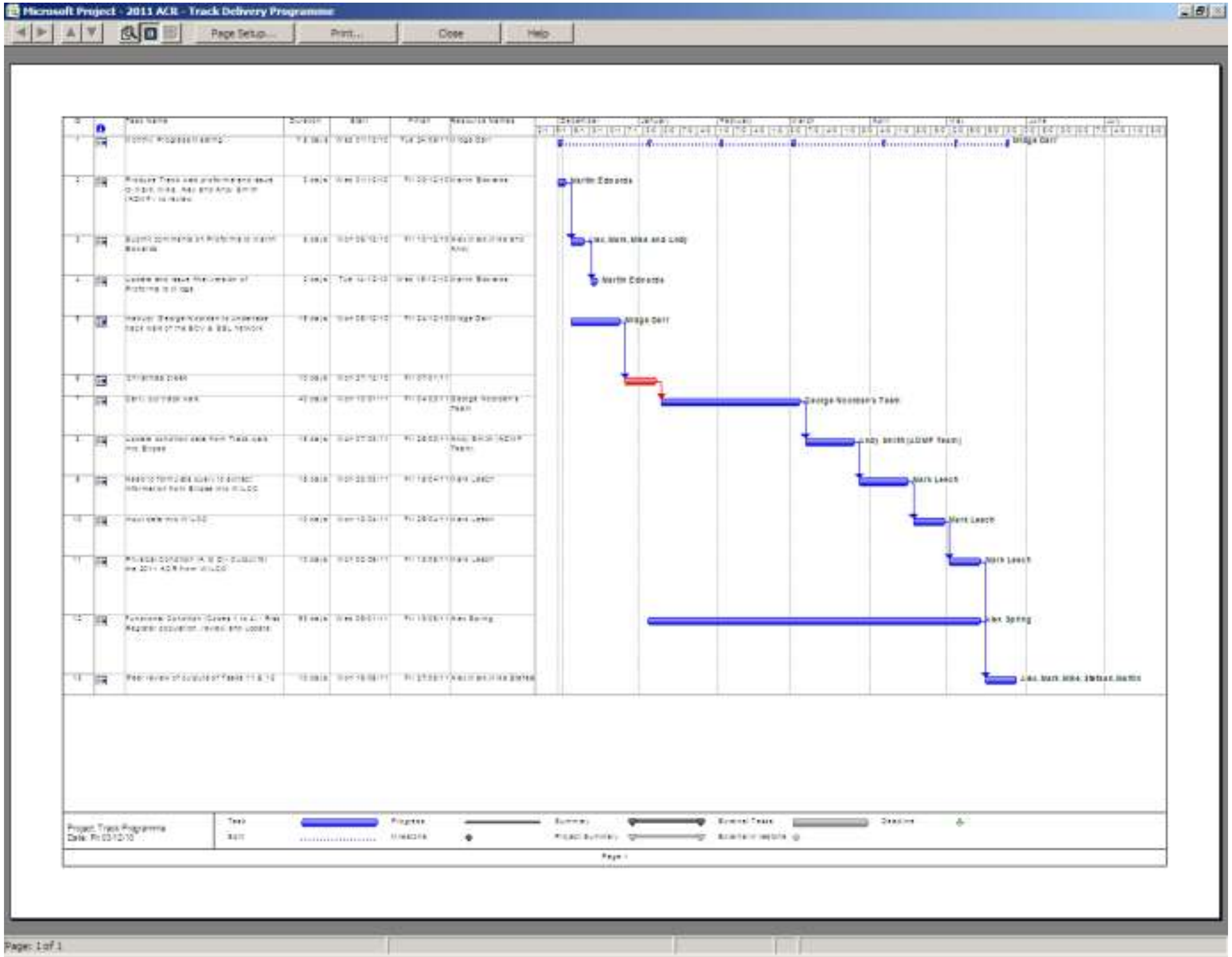
Appendix A

ACR in Context



Appendix B

Programme



4.1.1 Basis of Condition Reporting for Track

ACR No.	FD* No.	Asset Description		RAV (M)	Unit	Nominal Life	Source of Nominal Life
1000		**Formation Treatment**					
1001	T151	Formation treatment (including sand blankets and/or Terram, Tensar etc.)	Open	0.300	km	30	Engineering judgement
1002	T152		Sub - Surface	0.300	km	30	Engineering judgement
1003	T153		Tube	0.300	km	30	Engineering judgement
1004	T154		Depot & Sidings	0.200	km	30	Engineering judgement
2000		**Running Rail (plain line)**					
2001	T201	Rail - BH (both rails including blockjoints & railjoints)	Open	0.537	km	28	Page 17 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
2002	T202		Sub - Surface	0.537	km	16	Page 17 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
2003	T203		Tube	0.343	km	34	Page 17 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
2004	T204		Depot & Sidings	0.403	km	40	Based on the serviceable rates (unlikely to be less in reality)
2005	T205		D&S Serviceable	0.403	km	40	Engineering judgement
2011	T211	Rail - FB (both rails including blockjoints & railjoints)	Open	0.537	km	31	Based upon BH rail life + 10%
2012	T212		Sub - Surface	0.537	km	18	Based upon BH rail life + 10%
2013	T213		Tube	0.343	km	37	Based upon BH rail life + 10%
2014	T214		Depot & Sidings	0.403	km	40	Based on the serviceable rates (unlikely to be less in reality)
2015	T215		D&S Serviceable	0.403	km	40	Engineering judgement
2024	T224	Rail - other section (both rails including blockjoints & railjoints)	Depot & Sidings	0.403	km	40	Based on depot rail life
2025	T225		D&S Serviceable	0.403	km	40	Based on depot rail life
2051	T251	Check Rail - (BH) (single rail including blockjoints,	Open	0.080	km	28	Based upon BH running rail life
2052	T252		Sub - Surface	0.080	km	16	Based upon BH running rail life
2053	T253		Tube	0.080	km	34	Based upon BH running rail life
2054	T254		Depot & Sidings	0.080	km	40	Based upon BH running rail life
2061	T261	Check Rail - (UIC33) (single rail including blockjoints,	Open	0.080	km	31	Based upon FB running rail life
2062	T262		Sub - Surface	0.080	km	18	Based upon FB running rail life
2063	T263		Tube	0.080	km	37	Based upon FB running rail life
2064	T264		Depot & Sidings	0.080	km	40	Based upon FB running rail life
2071	T271	Check Rail - (FB 113A) (single rail including	Open	0.080	km	31	Based upon FB running rail life
2072	T272		Sub - Surface	0.080	km	18	Based upon FB running rail life
2073	T273		Tube	0.080	km	37	Based upon FB running rail life
2074	T274		Depot & Sidings	0.080	km	40	Based upon FB running rail life
3000		**Conductor Rail**					
3001	T601	Conductor Rail - steel - (both rails including fittings)	Open	0.200	km	40	Engineering judgement - new train performance
3002	T602		Sub - Surface	0.200	km	40	Engineering judgement - new train performance
3003	T603		Tube	0.200	km	40	Engineering judgement - new train performance
3004	T604		Depot & Sidings	0.175	km	40	Engineering judgement - new train performance
3011	T611	Conductor Rail - composite - (both rails including	Open	0.270	km	40	Engineering judgement - new train performance
3012	T612		Sub - Surface	0.270	km	40	Engineering judgement - new train performance
3013	T613		Tube	0.270	km	40	Engineering judgement - new train performance
3014	T614		Depot & Sidings	0.270	km	40	Engineering judgement - new train performance
4000		**Sleepers timber (Ballasted Track)**					
4001	T301	Sleepers (wood) (including chairs / baseplates, fittings)	Open	0.576	km	24	Page 16 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4001	T302		Sub - Surface	0.724	km	41	Page 16 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4001	T303		Tube	2.298	km	41	Based upon Sub-surface rates (& may in reality be better)
4001	T304		Depot & Sidings	0.576	km	50	Assumed to be the same as serviceable
4001	T305		D&S Serviceable	0.432	km	50	Engineering judgement
4011	T311	Sleepers (concrete) (including chairs / baseplates, fittings)	Open	0.576	km	50	Page 18 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4012	T312		Sub - Surface	0.724	km	50	Page 18 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4013	T313		Tube	2.298	km	50	Based upon Sub-surface rates (& may in reality be better)
4014	T314		Depot & Sidings	0.576	km	50	Based upon Open Section rates
4024	T324	Depot pot blocks (concrete) with 20%-25% integral wood sleepers	Depot & Sidings	0.576	km	40	Based on wood sleeper life less 10 years due to problems holding gauge
4025	T325		D&S Serviceable	0.432	km	40	Based on wood sleeper life less 10 years due to problems holding gauge
4052	T352	Sleepers (wood) (including chairs / baseplates, fittings), base concrete & invert shingle (includes "spring ended")	Sub - Surface	1.115	km	48	Page 16 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4053	T353		Tube	2.689	km	48	Page 16 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4061	T361	Sleepers (wood) (including chairs / baseplates, fittings) & full concrete support	Open	0.967	km	48	Based on Tube Section rates (although in reality this may be on the high side)
4062	T362		Sub - Surface	1.115	km	48	Based on wood sleepers, base concrete & shingle life
4063	T363		Tube	2.689	km	48	Based on wood sleepers, base concrete & shingle life
4064	T364		Depot & Sidings	0.967	km	48	Based upon Open Section rates
4071	T371	Sleepers (concrete) (including chairs / baseplates, fittings), base concrete & invert shingle	Open	0.967	km	50	Based on Tube Section rates (although in reality this may be on the high side)
4072	T372		Sub - Surface	1.115	km	50	Engineering judgement
4073	T373		Tube	2.689	km	50	Engineering judgement
4081	T381	Sleepers (concrete) (including chairs / baseplates, fittings) & full concrete support	Open	0.967	km	43	Based on Tube Section rates (although in reality this may be on the high side)
4082	T382		Sub - Surface	1.115	km	50	Based on concrete sleepers, base concrete & shingle life
4083	T383		Tube	2.689	km	50	Based on concrete sleepers, base concrete & shingle life
4084	T384		Depot & Sidings	0.967	km	43	Based upon Open Section rates
4101	T401	Pitblocks (wood) (including chairs / baseplates, fittings) & base concrete	Open	6.143	km	43	Based on Tube Section rates (although in reality this may be on the high side)
4102	T402		Sub - Surface	6.143	km	43	Page 16 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4103	T403		Tube	6.143	km	43	Page 16 - Civil Engineer (Works), P Way Dev. Sect. - Interim Report No. 2 - Running Rail Support. Plain Line Track - Ballasted Sections of the Railway.
4112	T412	Pitblocks (concrete) (including chairs / baseplates, fittings) & base concrete	Sub - Surface	6.143	km	50	Engineering judgement
4113	T413		Tube	6.143	km	50	Engineering judgement
4151	T451	Longitudinal bridge timbers (including chairs / baseplates, fittings)	Open	0.967	km	24	Engineering judgement - should be no worse than wood sleeper life
4152	T452		Sub - Surface	1.115	km	41	Engineering judgement - should be no worse than wood sleeper life
4154	T454		Depot & Sidings	0.967	km	50	Based upon Open Section rates
4163	T463	Longitudinal timbers (including chairs / baseplates, fittings), base concrete & invert shingle	Tube	2.689	km	48	Based on wood sleepers, base concrete & shingle life
4171	T471	Longitudinal timbers (including chairs / baseplates, fittings) & full concrete support	Open	0.967	km	48	Based on Tube Section rates (although in reality this may be on the high side)
4172	T472		Sub - Surface	1.115	km	48	Based on wood sleepers, base concrete & shingle life
4173	T473		Tube	2.689	km	48	Based on wood sleepers, base concrete & shingle life
4174	T474		Depot & Sidings	0.967	km	48	Based upon Open Section rates

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

4.1.1 Basis of Condition Reporting for Track

ACR No.	FD No.	Asset Description	System Level 1	RAV (M)	Unit	Nominal Life	Source of Nominal Life
5000		**Trackbed (ballast)**					
5051	T551	Ballast (Ash) to the level of any Terram sheet/sand blanket	Open	0.391	km	30	Based on equivalent section life for limestone
5052	T552		Sub - Surface	0.391	km	30	Based on equivalent section life for limestone
5053	T554		Depot & Sidings	0.298	km	40	Engineering judgement
5061	T561	Ballast (Limestone) to the level of any Terram sheet/sand blanket	Open	0.391	km	30	Engineering judgement
5062	T562		Sub - Surface	0.391	km	30	Engineering judgement
5063	T563		Tube	0.391	km	30	Based upon Sub-surface rates (& may in reality be better)
5064	T564		Depot & Sidings	0.298	km	30	Based upon Open Section rates
5071	T571	Ballast (Granite) to the level of any Terram sheet/sand blanket	Open	0.391	km	50	Engineering judgement
5072	T572		Sub - Surface	0.391	km	50	Engineering judgement - assumes ballast cleaning will take place
5073	T573		Tube	0.391	km	50	Based upon Sub-surface rates (& may in reality be better)
5074	T574		Depot & Sidings	0.298	km	50	Based upon Open Section rates
6000		**Trackbed (Concrete)**					
6001	T501	Slab track (including chairs / baseplates, fittings)	Open	0.967	km	50	Engineering judgement
6002	T502		Sub - Surface	1.115	km	50	Engineering judgement
6003	T503		Tube	2.689	km	50	Engineering judgement
6014	T514	Depot Slab Track; All types (including chairs / baseplates, fittings, but excluding rails)	Depot & Sidings	0.967	km	50	Based upon Open Section rates
6024	T524	Depot Slab Track with integral pit; All types (including chairs / baseplates, fittings, but excluding rails)	Depot & Sidings	0.967	km	50	Based upon Open Section rates
7000		**Junctionwork**					
7051	T651	P&C Turnouts/Diamonds - Bullhead (BH) rail - (including fittings, crossing timbers/bearers, ballast/base concrete, hand-worked point mechanisms, stretchers and fittings).	Open	0.300	ea	30	Engineering judgement
7052	T652		Sub - Surface	0.350	ea	20	Engineering judgement
7053	T653		Tube	0.400	ea	33	Engineering judgement
7054	T654		Depot & Sidings	0.225	ea	30	Engineering judgement
7061	T661	P&C Turnouts/Diamonds - Flat-Bottom (FB) rail - (including fittings, crossing timbers/bearers, ballast/base concrete, hand-worked point mechanisms, stretchers and fittings).	Open	0.300	ea	30	Engineering judgement
7062	T662		Sub - Surface	0.350	ea	20	Engineering judgement
7063	T663		Tube	0.400	ea	33	Engineering judgement
7064	T664		Depot & Sidings	0.300	ea	30	Engineering judgement

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

4.1.1 Basis of Condition Reporting for Track

ACR No.	FD No.	Asset Description	System Level 1	RAV (M)	Unit	Nominal Life	Source of Nominal Life
8000		**Train_Arrestors_and_Buffer_Stops**					
8001	T701	Train arrestors (hydraulic, friction etc.) (each)	Open	0.075	ea	30	Engineering judgement
8002	T702		Sub - Surface	0.075	ea	30	Engineering judgement
8003	T703		Tube	0.075	ea	30	Engineering judgement
8004	T704		Depot & Sidings	0.075	ea	30	Engineering judgement - similar value used throughout
8011	T711	Train arrestors (fabricated buffer stop with sand drag) (each)	Open	0.045	ea	30	Engineering judgement - similar value used throughout
8012	T712		Sub - Surface	0.045	ea	30	Engineering judgement - similar value used throughout
8013	T713		Tube	0.045	ea	30	Engineering judgement - similar value used throughout
8014	T714		Depot & Sidings	0.045	ea	30	Engineering judgement - similar value used throughout
8021	N/A	Train arrestors (concrete buffer stop with sand drag) (each)	Open	0.045	ea	30	`
8022	N/A		Sub - Surface	0.045	ea	30	Engineering judgement - similar value used throughout
8023	N/A		Tube	0.045	ea	30	Engineering judgement - similar value used throughout
8024	N/A		Depot & Sidings	0.045	ea	30	Engineering judgement - similar value used throughout
8051	T751	Buffer Stops (fabricated) (each)	Open	0.015	ea	30	Engineering judgement - similar value used throughout
8052	T752		Sub - Surface	0.015	ea	30	Engineering judgement - similar value used throughout
8053	T753		Tube	0.015	ea	30	Engineering judgement - similar value used throughout
8054	T754		Depot & Sidings	0.015	ea	30	Engineering judgement - similar value used throughout
8061	T761	Buffer Stops (concrete) (each)	Open	0.015	ea	30	Engineering judgement - similar value used throughout
8062	T762		Sub - Surface	0.015	ea	30	Engineering judgement - similar value used throughout
8063	T763		Tube	0.015	ea	30	Engineering judgement - similar value used throughout
8064	T764		Depot & Sidings	0.015	ea	30	Engineering judgement - similar value used throughout
9000		**Fencing and Vegetation**					
9001	T801	Fencing - each side of the line and each other section is quantified separately and summed.	Open	0.040	km	20	Engineering judgement/recent experience
9002	T802		Sub - Surface	0.040	km	20	Engineering judgement/recent experience
9014	T814	Fencing - actual extent	Depot & Sidings	0.040	km	20	Based on Open Section assumed life
9051	T851	Lineside Vegetation - initial band extends up to 10m (measured in plan) from the track. Additional bands are assessed in increments 10m wide (measured in plan); each band on each side of the line is quantified separately and the results summed.	Open	0.005	km	20	Assumed
9052	T852		Sub - Surface	0.005	km	20	Assumed
9064	T864	Vegetation - actual linear extent, in 10m wide strips (measured in plan)	Depot & Sidings	0.005	km	20	Based on Open Section assumed life
10000		**Other**					
10001	T901	Other track items (including lubricators, track identification plates, etc.) - track metrage (without deduction for P&C, etc.)	Open	0.020	km	20	Miscellaneous items - generalisation
10002	T902		Sub - Surface	0.015	km	20	Miscellaneous items - generalisation
10003	T903		Tube	0.015	km	20	Miscellaneous items - generalisation
10014	T914	Other Depot track items (including lubricators, track identification plates, point lever boxes, etc.) -	Depot & Sidings	0.010	km	30	Miscellaneous items - generalisation
11000		**Walkways**					
11051	T951	Defined cross-track walkways (wooden, concrete,	Open	0.010	km	20	Engineering judgement
11061	T961	Defined track linear walkways (ash, granular fill and similar. Includes track elements of Places of Safety) - each side of the line and each other section is quantified separately and summed.	Open	0.010	km	20	Engineering judgement
11071	T971	Track walkways - actual extent.	Sub - Surface	0.010	km	20	Engineering judgement
11072	T972		Tube	0.010	km	20	Engineering judgement
11084	T984	Depot walkways (Wood, ash, tarmac, concrete, rubber) - actual extent	Depot & Sidings	0.015	km	20	Engineering judgement

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

4.1.3 Reporting Requirements for Track

4.1.3.1 Track ACR - all Lines

Track – all Lines

ACR No.	FD* No.	Actuals:		Physical Condition Code A % RAV	Code B % RAV	Code C % RAV	Code D % RAV	Functional Condition Code 1 Statutory non compliant Quantity	Code 2 Residual safety risk £ Risk	Code 3 uneconomic/ unsustainable £ Risk	Code 4 Risk of Performance Loss £ Risk
1000		**Formation Treatment**									
1001	T151		Open								
1002	T152	Formation treatment (including sand blankets and/or Terram, Tensar etc.)	Sub - Surface								
1003	T153		Tube								
1004	T154		Depot & Sidings								
2000		**Running Rail (plain line)**									
2001	T201		Open								
2002	T202		Sub - Surface								
2003	T203	Rail - BH (both rails including blockjoints & railjoints)	Tube								
2004	T204		Depot & Sidings								
2005	T205		D&S Serviceable								
2011	T211		Open								
2012	T212		Sub - Surface								
2013	T213	Rail - FB (both rails including blockjoints & railjoints)	Tube								
2014	T214		Depot & Sidings								
2015	T215		D&S Serviceable								
2024	T224	Rail - other section (both rails including blockjoints & railjoints)	Depot & Sidings								
2025	T225		D&S Serviceable								
2051	T251	Check Rail - (BH) (single rail including blockjoints, railjoints, chairs / baseplates & fittings)	Open								
2052	T252		Sub - Surface								
2053	T253		Tube								
2054	T254		Depot & Sidings								
2061	T261	Check Rail - (UIC33) (single rail including blockjoints, railjoints, chairs / baseplates, fittings)	Open								
2062	T262		Sub - Surface								
2063	T263		Tube								
2064	T264		Depot & Sidings								
2071	T271	Check Rail - (FB 113A) (single rail including blockjoints, railjoints, chairs / baseplates, fittings)	Open								
2072	T272		Sub - Surface								
2073	T273		Tube								
2074	T274		Depot & Sidings								
3000		**Conductor Rail**									
3001	T601		Open								
3002	T602	Conductor Rail - steel - (both rails including fittings)	Sub - Surface								
3003	T603		Tube								
3004	T604		Depot & Sidings								
3011	T611	Conductor Rail - composite - (both rails including fittings)	Open								
3012	T612		Sub - Surface								
3013	T613		Tube								
3014	T614		Depot & Sidings								
4000		**Sleepers timber (Ballasted Track)**									
4001	T301		Open								
4001	T302	Sleepers (wood) (including chairs / baseplates, fittings)	Sub - Surface								
4001	T303		Tube								
4001	T304		Depot & Sidings								
4001	T305		D&S Serviceable								
4011	T311		Open								
4012	T312	Sleepers (concrete) (including chairs / baseplates, fittings)	Sub - Surface								
4013	T313		Tube								
4014	T314		Depot & Sidings								
4024	T324	Depot pot blocks (concrete) with 20%-25% integral wood sleepers	Depot & Sidings								
4025	T325		D&S Serviceable								
4052	T352	Sleepers (wood) (including chairs / baseplates, fittings), base concrete & invert shingle (includes "spring ended")	Sub - Surface								
4053	T353		Tube								
4061	T361		Open								
4062	T362	Sleepers (wood) (including chairs / baseplates, fittings) & full concrete support	Sub - Surface								
4063	T363		Tube								
4064	T364		Depot & Sidings								
4071	T371	Sleepers (concrete) (including chairs / baseplates, fittings), base concrete & invert shingle	Open								
4072	T372		Sub - Surface								
4073	T373		Tube								
4081	T381		Open								
4082	T382	Sleepers (concrete) (including chairs / baseplates, fittings) & full concrete support	Sub - Surface								
4083	T383		Tube								
4084	T384		Depot & Sidings								
4101	T401		Open								
4102	T402	Pitblocks (wood) (including chairs / baseplates, fittings) & base concrete	Sub - Surface								
4103	T403		Tube								
4112	T412	Pitblocks (concrete) (including chairs / baseplates, fittings) & base concrete	Sub - Surface								
4113	T413		Tube								
4151	T451		Open								
4152	T452	Longitudinal bridge timbers (including chairs / baseplates, fittings)	Sub - Surface								
4154	T454		Depot & Sidings								
4163	T463	Longitudinal timbers (including chairs / baseplates, fittings), base concrete & invert shingle	Tube								
4171	T471		Open								
4172	T472	Longitudinal timbers (including chairs / baseplates, fittings) & full concrete support	Sub - Surface								
4173	T473		Tube								
4174	T474		Depot & Sidings								

4.1.3 Reporting Requirements for Track

4.1.3.1 Track ACR - all Lines

Track – all Lines

ACR No.	FD No.	Actuals:		Physical Condition					Functional Condition		
				Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
				% RAV	% RAV	% RAV	% RAV	Statutory non compliant Quantity	Residual safety risk £ Risk	uneconomic/ unsustainable £ Risk	Risk of Performance Loss £ Risk
5000		**Trackbed (ballast)**									
5051	T551	Ballast (Ash) to the level of any Terram sheet/sand blanket	Open								
5052	T552		Sub - Surface								
5053	T554		Depot & Sidings								
5061	T561	Ballast (Limestone) to the level of any Terram sheet/sand blanket	Open								
5062	T562		Sub - Surface								
5063	T563		Tube								
5064	T564		Depot & Sidings								
5071	T571	Ballast (Granite) to the level of any Terram sheet/sand blanket	Open								
5072	T572		Sub - Surface								
5073	T573		Tube								
5074	T574		Depot & Sidings								
6000		**Trackbed (Concrete)**									
6001	T501	Slab track (including chairs / baseplates, fittings)	Open								
6002	T502		Sub - Surface								
6003	T503		Tube								
6014	T514	Depot Slab Track; All types (including chairs / baseplates, fittings, but excluding rails)	Depot & Sidings								
6024	T524	Depot Slab Track with integral pit; All types (including chairs / baseplates, fittings, but excluding rails)	Depot & Sidings								
7000		**Junctionwork**									
7051	T651	P&C Turnouts/Diamonds - Bullhead (BH) rail - (including fittings, crossing timbers/bearers, ballast/base concrete, hand-worked point mechanisms, stretchers and fittings).	Open								
7052	T652		Sub - Surface								
7053	T653		Tube								
7054	T654		Depot & Sidings								
7061	T661	P&C Turnouts/Diamonds - Flat-Bottom (FB) rail - (including fittings, crossing timbers/bearers, ballast/base concrete, hand-worked point mechanisms, stretchers and fittings).	Open								
7062	T662		Sub - Surface								
7063	T663		Tube								
7064	T664		Depot & Sidings								
8000		**Train_Arrestors_and_Buffer_Stops**									
8001	T701	Train arrestors (hydraulic, friction etc.) (each)	Open								
8002	T702		Sub - Surface								
8003	T703		Tube								
8004	T704		Depot & Sidings								
8011	T711	Train arrestors (fabricated buffer stop with sand drag) (each)	Open								
8012	T712		Sub - Surface								
8013	T713		Tube								
8014	T714		Depot & Sidings								
8021	N/A	Train arrestors (concrete buffer stop with sand drag) (each)	Open								
8022	N/A		Sub - Surface								
8023	N/A		Tube								
8024	N/A		Depot & Sidings								
8051	T751	Buffer Stops (fabricated) (each)	Open								
8052	T752		Sub - Surface								
8053	T753		Tube								
8054	T754		Depot & Sidings								
8061	T761	Buffer Stops (concrete) (each)	Open								
8062	T762		Sub - Surface								
8063	T763		Tube								
8064	T764		Depot & Sidings								
9000		**Fencing and Vegetation**									
9001	T801	Fencing - each side of the line and each other section is quantified separately and summed.	Open								
9002	T802		Sub - Surface								
9014	T814	Fencing - actual extent	Depot & Sidings								
9051	T851	Lineside Vegetation - initial band extends up to 10m (measured in plan) from the track. Additional bands are	Open								
9052	T852		Sub - Surface								
9064	T864	Vegetation - actual linear extent, in 10m wide strips (measured in plan)	Depot & Sidings								
10000		**Other**									
10001	T901	Other track items (including lubricators, track identification plates, etc.) - track metrage (without deduction for P&C, etc.)	Open								
10002	T902		Sub - Surface								
10003	T903		Tube								
10014	T914	Other Depot track items (including lubricators, track identification plates, point lever boxes, etc.) - track metrage (without deduction for P&C, etc.)	Depot & Sidings								
11000		**Walkways**									
11051	T951	Defined cross-track walkways (wooden, concrete, rubber and similar) - actual extent.	Open								
11061	T961	Defined track linear walkways (ash, granular fill and similar. Includes track elements of Places of Safety) - each side of the line and each other section is quantified separately and summed.	Open								
11071	T971	Track walkways - actual extent.	Sub - Surface								
11072	T972		Tube								
11084	T984	Depot walkways (Wood, ash, tarmac, concrete, rubber) - actual extent	Depot & Sidings								
		Track									
		Previous									
		Actual									
		Variance									

4.1.3 Reporting Requirements for Track

4.1.3.2 Track Reports - by line

Track – Summary Report for xxx Line

				Physical Condition					Functional Condition		
				Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
				% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	FD* No.	Actuals:						Quantity	£ Risk	£ Risk	£ Risk
1000		**Formation Treatment**									
1001	T151	Formation treatment (including sand blankets and/or Terram, Tensar etc.)	Open								
1002	T152		Sub - Surface								
1003	T153		Tube								
1004	T154		Depot & Sidings								
2000		**Running Rail (plain line)**									
2001	T201	Rail - BH (both rails including blockjoints & railjoints)	Open								
2002	T202		Sub - Surface								
2003	T203		Tube								
2004	T204		Depot & Sidings								
2005	T205		D&S Serviceable								
2011	T211	Rail - FB (both rails including blockjoints & railjoints)	Open								
2012	T212		Sub - Surface								
2013	T213		Tube								
2014	T214		Depot & Sidings								
2015	T215		D&S Serviceable								
2024	T224	Rail - other section (both rails including blockjoints & railjoints)	Depot & Sidings								
2025	T225		D&S Serviceable								
2051	T251	Check Rail - (BH) (single rail including blockjoints, railjoints, chairs / baseplates & fittings)	Open								
2052	T252		Sub - Surface								
2053	T253		Tube								
2054	T254		Depot & Sidings								
2061	T261	Check Rail - (UIC33) (single rail including blockjoints, railjoints, chairs / baseplates, fittings)	Open								
2062	T262		Sub - Surface								
2063	T263		Tube								
2064	T264		Depot & Sidings								
2071	T271	Check Rail - (FB 113A) (single rail including blockjoints, railjoints, chairs / baseplates, fittings)	Open								
2072	T272		Sub - Surface								
2073	T273		Tube								
2074	T274		Depot & Sidings								
3000		**Conductor Rail**									
3001	T601	Conductor Rail - steel - (both rails including fittings)	Open								
3002	T602		Sub - Surface								
3003	T603		Tube								
3004	T604		Depot & Sidings								
3011	T611	Conductor Rail - composite - (both rails including fittings)	Open								
3012	T612		Sub - Surface								
3013	T613		Tube								
3014	T614		Depot & Sidings								
4000		**Sleepers timber (Ballasted Track)**									
4001	T301	Sleepers (wood) (including chairs / baseplates, fittings)	Open								
4001	T302		Sub - Surface								
4001	T303		Tube								
4001	T304		Depot & Sidings								
4001	T305		D&S Serviceable								
4011	T311	Sleepers (concrete) (including chairs / baseplates, fittings)	Open								
4012	T312		Sub - Surface								
4013	T313		Tube								
4014	T314		Depot & Sidings								
4024	T324	Depot pot blocks (concrete) with 20%-25% integral wood sleepers	Depot & Sidings								
4025	T325		D&S Serviceable								
4052	T352	Sleepers (wood) (including chairs / baseplates, fittings), base concrete & invert shingle (includes "spring ended")	Sub - Surface								
4053	T353		Tube								
4061	T361	Sleepers (wood) (including chairs / baseplates, fittings) & full concrete support	Open								
4062	T362		Sub - Surface								
4063	T363		Tube								
4064	T364		Depot & Sidings								
4071	T371	Sleepers (concrete) (including chairs / baseplates, fittings), base concrete & invert shingle	Open								
4072	T372		Sub - Surface								
4073	T373		Tube								
4081	T381	Sleepers (concrete) (including chairs / baseplates, fittings) & full concrete support	Open								
4082	T382		Sub - Surface								
4083	T383		Tube								
4084	T384		Depot & Sidings								
4101	T401	Pitblocks (wood) (including chairs / baseplates, fittings) & base concrete	Open								
4102	T402		Sub - Surface								
4103	T403		Tube								
4112	T412	Pitblocks (concrete) (including chairs / baseplates, fittings) & base concrete	Sub - Surface								
4113	T413		Tube								
4151	T451	Longitudinal bridge timbers (including chairs / baseplates, fittings)	Open								
4152	T452		Sub - Surface								
4154	T454		Depot & Sidings								
4163	T463	Longitudinal timbers (including chairs / baseplates, fittings), base concrete & invert shingle	Tube								
4171	T471	Longitudinal timbers (including chairs / baseplates, fittings) & full concrete support	Open								
4172	T472		Sub - Surface								
4173	T473		Tube								
4174	T474		Depot & Sidings								

4.1.3 Reporting Requirements for Track

4.1.3.2 Track Reports - by line

Track – Summary Report for xxx Line

				Physical Condition					Functional Condition		
				Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
				% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	FD No.	Actuals:						Quantity	£ Risk	£ Risk	£ Risk
5000		**Trackbed (ballast)**									
5051	T551	Ballast (Ash) to the level of any Terram sheet/sand blanket	Open								
5052	T552		Sub - Surface								
5053	T554		Depot & Sidings								
5061	T561	Ballast (Limestone) to the level of any Terram sheet/sand blanket	Open								
5062	T562		Sub - Surface								
5063	T563		Tube								
5064	T564		Depot & Sidings								
5071	T571	Ballast (Granite) to the level of any Terram sheet/sand blanket	Open								
5072	T572		Sub - Surface								
5073	T573		Tube								
5074	T574		Depot & Sidings								
6000		**Trackbed (Concrete)**									
6001	T501	Slab track (including chairs / baseplates, fittings)	Open								
6002	T502		Sub - Surface								
6003	T503		Tube								
6014	T514	Depot Slab Track; All types (including chairs / baseplates, fittings, but excluding rails)	Depot & Sidings								
6024	T524	Depot Slab Track with integral pit; All types (including chairs / baseplates, fittings, but excluding rails)	Depot & Sidings								
7000		**Junctionwork**									
7051	T651	P&C Turnouts/Diamonds - Bullhead (BH) rail - (including fittings, crossing timbers/bearers, ballast/base concrete, hand-worked point mechanisms, stretchers and fittings).	Open								
7052	T652		Sub - Surface								
7053	T653		Tube								
7054	T654		Depot & Sidings								
7061	T661	P&C Turnouts/Diamonds - Flat-Bottom (FB) rail - (including fittings, crossing timbers/bearers, ballast/base concrete, hand-worked point mechanisms, stretchers and fittings).	Open								
7062	T662		Sub - Surface								
7063	T663		Tube								
7064	T664		Depot & Sidings								
8000		**Train_Arrestors_and_Buffer_Stops**									
8001	T701	Train arrestors (hydraulic, friction etc.) (each)	Open								
8002	T702		Sub - Surface								
8003	T703		Tube								
8004	T704		Depot & Sidings								
8011	T711	Train arrestors (fabricated buffer stop with sand drag) (each)	Open								
8012	T712		Sub - Surface								
8013	T713		Tube								
8014	T714		Depot & Sidings								
8021	N/A	Train arrestors (concrete buffer stop with sand drag) (each)	Open								
8022	N/A		Sub - Surface								
8023	N/A		Tube								
8024	N/A		Depot & Sidings								
8051	T751	Buffer Stops (fabricated) (each)	Open								
8052	T752		Sub - Surface								
8053	T753		Tube								
8054	T754		Depot & Sidings								
8061	T761	Buffer Stops (concrete) (each)	Open								
8062	T762		Sub - Surface								
8063	T763		Tube								
8064	T764		Depot & Sidings								
9000		**Fencing and Vegetation**									
9001	T801	Fencing - each side of the line and each other section is quantified separately and summed.	Open								
9002	T802		Sub - Surface								
9014	T814	Fencing - actual extent	Depot & Sidings								
9051	T851	Lineside Vegetation - initial band extends up to 10m (measured in plan) from the track. Additional bands	Open								
9052	T852		Sub - Surface								
9064	T864	Vegetation - actual linear extent, in 10m wide strips (measured in plan)	Depot & Sidings								
10000		**Other**									
10001	T901	Other track items (including lubricators, track identification plates, etc.) - track metrage (without deduction for P&C, etc.)	Open								
10002	T902		Sub - Surface								
10003	T903		Tube								
10014	T914	Other Depot track items (including lubricators, track identification plates, point lever boxes, etc.) - track metrage (without deduction for P&C, etc.)	Depot & Sidings								
11000		**Walkways**									
11051	T951	Defined cross-track walkways (wooden, concrete, rubber and similar) - actual extent.	Open								
11061	T961	Defined track linear walkways (ash, granular fill and similar. Includes track elements of Places of Safety) - each side of the line and each other section is quantified separately and summed.	Open								
11071	T971	Track walkways - actual extent.	Sub - Surface								
11072	T972		Tube								
11084	T984	Depot walkways (Wood, ash, tarmac, concrete, rubber) - actual extent	Depot & Sidings								
		Track									
		Previous									
		Actual									
		Variance									

Commentary on Variances:

A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

ASSET CONDITION REPORTING – TRACK
(Final –5 July 2010)

Contents

1 Purpose

The purpose of this track standard is to define how residual life, maintenance condition and specific concerns of the track asset are to be determined and reported.

2 Scope

2.1. The scope of the Track assets covered by this standard is as follows:-

All track, including plain line and junction work configurations, installed on the running lines and sidings and within depots but excluding track within enclosed depot buildings.

2.2 The scope of reporting required by this standard is as follows:-

- Residual Life (in years) – referred to as physical condition in standard 5-042
- Maintenance Condition (state of adjustment)
- Functional Condition and Specific Concerns

3 Requirements

3.1 General

The residual life, maintenance condition and specific concerns shall be reported annually.

3.2 Asset Structure

For the purpose of Asset Condition Reporting, the Track assets shall be broken down generally in accordance with the structure defined in Standard 1-041.

For the reporting of Residual Life, information must be provided for each of the following Track components:-

- Running rails (including check rails). LH & RH rail are to be reported separately
- Sleepers, timbers, bearers or pit blocks(including rail fastenings, and base plates where present);
- Track bed, comprising ballast, concrete or ash;
- Conductor rails. Positive and negative rail are treated separately.
- Switches (Full Sets)
- Crossings

For the reporting of Maintenance Condition, information must be provided in respect of the following aspects-

- track geometry
- rail head condition – RCF and corrugations
- track integrity
- prevention of buckling requirements
- track, tunnel walls and railway embankments cleanliness – to be developed
- lineside vegetation – to be developed
- lubrication – to be developed
- conductor rail position.- to be developed

3.3 Asset Segmentation

3.3.1 Requirement for Segmentation

As the component life expectancy, condition and Residual Life will vary by location, it is necessary to segment the Plain Line track into sections with similar characteristics. For the purposes of ACR plain line includes check rail.

The definition of junctionwork is contained in Standard 1-622. Junctionwork is to be treated as individual units. The units are turnouts (stock and switches and crossing) and diamond crossings (including switch diamonds and slips where appropriate).

The means of defining asset location used for all aspects of Asset Condition Reporting must align with the LU Location Coding System as defined in Standard 1-035.

The requirements for segmentation are as follows:

3.3.2 Segmentation for Reporting of Residual Life

3.3.2.1 Segmentation of Plain Line track

The segmentation of Plain Line track, including checked track, is to be done as follows:

a. Each of the principal track components is to be divided up over the length of the Line into segments (lengths) where the component's Service Life is essentially the same.
b. Each of the principal track components is to be divided up over the length of the Line to provide segments (lengths) where the component's time in service is essentially the same.
c. The two sub-divisions of the Line achieved from (a) and (b) above are overlaid to provide the final level of sub-division of the Line. This resultant segmentation of the Line is the greatest level of sub-division required and is used for the reporting of residual life.
d. The minimum segment length to be reported is 10 metres.

3.3.2.2 Segmentation of Junctionwork

The segmentation of junctionwork is to be done on the following basis:

Ironwork for turnout units is to be sub-divided into:
- crossing and 50% of lead and closure rails
- switches and the remaining 50% of lead and closure rails
- sleepers/timbers and trackbed are each treated as one segment for the junction work concerned

Ironwork for diamond units does not need to further sub divided

3.3.2.3 Segmentation of depots

The segmentation of depots shall be based on the principles in clauses 3.3.2.1 and 3.3.2.2.

3.3.3 Segmentation for Reporting Maintenance Condition

Segmentation of the track asset shall align with the LCS system and may if necessary be different for each of the maintenance condition aspects.

The segmentation shall also take account of the level of aggregation in the reporting of maintenance condition. Reporting of maintenance condition of the applicable aspect shall be at the Line and track environment (tube, sub-surface and open) level for plain line and junction work unit.

3.4 Reporting of Residual Life

3.4.1 General

For the purpose of this standard the Residual Life of the asset is determined on the basis of degradation that cannot be reversed by maintenance intervention either on the grounds of practicability or of cost.

For the purpose of Asset Condition Reporting the assessment of asset Residual Life will not take account of replacement practices or methodologies. For example if the track ballast is assessed to be life expired, this must not be allowed to influence the Residual Life attributed to interfacing assets

It is assumed that routine inspection and maintenance in accordance with LU standards is being implemented and will recover situations where the track or its individual component parts are out of adjustment, or where individual components (e.g. rail pads, isolated sleepers etc) are life-expired but the replacement of which does not fundamentally affect the life of the asset as a whole.

Residual life may be determined on the basis of Service Life expectancy and time in service (referred to in standard 5-042 as Residual Life (Nominal)), or the Residual Life may be calculated using the measured condition (degree of degradation) and estimated degradation rate (referred to in standard 5-042 as Residual Life (Measured)). The details of these two methods of determining residual life are explained below. There must be at least one form of residual life measure available for each component segment at all times.

3.4.2 Service Life

Service life is defined as the estimated asset service life expectancy measured in years. For the purpose of ACR, there are two variants of Service Life. These are as follows:

Service Life – Notional
The estimated asset service life expectancy measured in years based on notional asset life. (Appendix A). This notional asset life is defined in terms of a service life expectancy in MGT and the location specific life expectancy modifying factors that are used to adjust the average service life. (the average notional life is derived from historic average usage over the network and engineering judgement.

Service Life – Informed
The estimated asset service life expectancy measured in years determined from local knowledge and experience of degradation rates previously experienced by similar components installed at this site. Declaration of Service Life (Informed) is to be evidence based and may either be may be declared based on actual known service life or may be a further informed adjustment of the Service Life – Notional.

A service life for all assets shall be declared as either Service Life – Notional or Service Life – Informed.

The Service Life (Notional or Informed) declared for a newly installed asset or at the first ACR report for an existing asset shall be retained until the asset is replaced unless there are changes in service conditions or environment etc in which case the Service Life (Notional or Informed) may be amended during the asset's life and this amended value used to calculate residual life

If a renewal or new installation is non-compliant, its life expectancy may be affected, in which case the effect shall be documented with appropriate changes made to the Service Life

Any changes to the Service Life must be agreed with the Head of Profession and Asset Sponsor and progressed as a change to the ACR Standard, as stated in the ACR Manual of Good Practice (G-5-042).

3.4.3 Residual Life – Notional [RL(N)]

Residual life is defined as the time in years before the asset concerned will require complete renewal.

RL(N) is calculated from the Service Life and the time elapsed since the asset entered service:

RL(N) = Service Life – number of years in use

Where it is not possible to calculate RL(N) (owing to no *time in service* information) then Residual Life -Measured RL(M) (see below) must be determined by the next due date for the ACR report.

3.4.4 Residual Life – Measured [RL(M)]

Residual Life (Measured) is calculated or estimated from the actual measured or assessed asset condition. The calculation of RL(M) shall not be a substitute for calculating RL(N) and RL(N) shall always be assessed and reported, unless insufficient information about the date into service is available to enable this.

RL(M) = (total degradation permitted)/(degradation rate) – number of years in use

The Residual Life – Measured RL(M) may be amended at any time through the life of the asset subject to the availability of adequate evidence to support the change. The assessment of RL(M) shall be objective and repeatable using agreed and auditable methods of measurement.

Residual life (measured) shall be determined in the following cases:

- when RL(N) cannot be calculated. (see 3.3.3)
- when RL(N) is zero but a positive residual life is claimed.
- where track inspections or the maintenance condition assessment (clause 3.6) indicate that an asset is degrading at a faster rate than would be expected from the previously estimated Residual Life (Notional or Measured) then the RL(M) is to be reported or amended to reflect this improved information.

Registering a residual life greater than that recorded as RL(N) will only be permitted on the basis of the condition being assessed in accordance with the requirements described below and adequate evidence, including site-specific degradation rates being available to support the predicted residual life.

3.4.5 Requirements for Condition Assessment and Determination of Residual Life – Measured

3.4.5.1 General

The following section provides details of the requirements for measuring or assessing asset condition and using this information to determine residual life.

The condition assessment shall take account of measured or assessed degradation rates. For this purpose any intervention (“SS”) limits in 1-159 relating to irreversible degradation shall in most cases be regarded as “life expired”. Inspections of the track shall incorporate sufficient capture of relevant wear or other degradation data for rates to be assessed. Unless there is evidence to the contrary, these rates shall be assumed to be linear with time.

Although life limiting degradation modes are assessed separately for simplicity, it needs to be recognised that the residual life of assets will be determined by a combination of these life limiting degradation modes.

. The mode giving the lowest residual life [RL(M)] estimate shall be used when reporting the residual life of the asset.

Assets that cannot be assessed against the life limiting factors shall be assumed to have a residual life of zero once their book life has expired (i.e. once RL(N) is zero).

The assessments required to determine RL(M) for the various assets are as follows.

3.4.5.2 Plain Line Rail

Each rail (LH and RH) shall be assessed separately.

The extent of degradation for each life limiting feature shall be measured or assessed and the residual life estimated as follows:

Life limiting feature - Rail wear	
Condition assessment method	Head & side wear measurement as stated by 1-159 clause 3.5.2 tables 4.1, & 4.5. Measured either manually or by AIT/TRV
Distance between assessment or sample size	For manual measurement: R > 800m:– 1 measurement per 50m, with at least 3 readings for an identified segment 200m < R < 800m:- 2 measurements in each transition & 1 measurement every 50m (at least 3 measurements) in the circular portion of curve. R < 200m - 2 measurements in each transition & 3 measurements in the circular portion of curve. “Continuous” in the case of the TRV/AIT
Application of assessment	Worst side and headwear of sample to be applied to the relevant segment The worst result of head & side wear or its combination will apply.
Life expired limit	SS Level 3
Determination of Residual Life RL(M)	<u>At first wear assessment</u>. Calculate the rate of degradation assuming that it has been linear since the date of entry into service. Estimate the residual life assuming the same rate of wear. <u>At subsequent wear assessments</u>: Determine the actual degradation rate and calculate residual life accordingly.

Life limiting feature - Rail head condition	
Condition assessment method	Visual assessment::3 categories (Light, medium, heavy): Light - visible RCF crack length < 10mm or light lipping, flaking on field side Medium - visible RCF crack length 10mm -19mm, or light lipping, flaking on field side Heavy - visible RCF crack length .> 20mm or heavy lipping, flaking on field side. Appendix B has illustrations for each rating
Distance between assessment or sample size	Continuous
Application of assessment	Apply the rating to the relevant segment. If the rating varies over the segment involved then use the most representative rating. If the segment is longer than the section affected by the life limiting feature apply to whole segment
Life expired limit	Heavy rating - i.e. not reversible by maintenance input. (See RL(M) for where rail head profiling is not economic and efficient or practical)
Determination of Residual Life RL(M)	Sections classified as light or medium are usually assumed to be reversible and hence this would not affect the residual life. Where it is not economic and efficient or practical to carry out rail head profiling etc the rate of degradation to reach current rating shall be estimated and a residual life determined

Life limiting feature - Internal rail defects	
Condition assessment method	Assess the number of rail breaks, cracks and internal fatigue related rail defects and the trend over the past 5 years. The information as logged on the Railfail/RAMS database shall be used. (See Appendix C for the list of internal fatigue related defect codes to be included.)
Distance between assessment or sample size	NA
Application of assessment	Relevant section being assessed for RL(M)
Life expired limit	No specific limit.- see determination of RL(M) below
Determination of Residual Life RL(M)	The outcome of the assessment and the resultant potential impact on the safety and operational performance and the potential cost of repairs and disruptions shall be used to decide the remaining residual life.

3.4.5.3 Plain line sleepers - general

Sleepers shall be assessed in 100m sections of track. On this basis a 100m section's RL(M) can be positive even if some individual sleepers in the 100m section have zero RL(M).

3.4.5.4 Plain line sleepers and pit blocks (softwood and hardwood and associated fastenings)

The life-limiting feature and resulting residual life shall be assessed and estimated as follows:

Life limiting feature - Decay, Splits/shakes, Loss of fastening ability(chair/base plate to sleeper), Chair indentation, Number of Packings	
Condition assessment method	Each aspect shall be assessed and given the most appropriate classification (Minor, medium, severe)for the majority of sleepers in a 100m section. The typical features relating to an aspect and classification are given in Appendix D.
Distance between assessment or sample size	The full 100m section is to be assessed.
Application of assessment	Result applies to that 100m section
Life expired limit	The resultant overall score for a 100m section is greater than or equal to 15.
Determination of Residual Life RL(M)	The RL(M) for the 100m section is determined by assigning a score to each of the life limiting aspects (Minor = 1, Medium = 2, Severe = 4) and totalling for all six aspects. RL(M) for each 100m section may be extended as follows: Where the overall score is :- =>6<10 - Minor degradation = 5 years remaining life =>10<13 - Medium degradation = 3 to 4 years remaining life =>13<15 - Severe degradation = 2 years and less remaining life. The above assumes the RL(B) is zero. See Appendix G for worked example.

Life limiting feature - Soffit attrition	
Condition assessment method	(Soffit inspection is an intrusive procedure so it is recommended that augering of the sleeper is carried out first in order to establish whether a full inspection is required.) Only to be assessed in Open and Sub-surface sections and when the following are present. Poor vertical geometry (TRV Vertical SD = ML or worse) Poor ballast condition (signs of wet beds, drainage problems, voiding). 5 sleepers in 100m shall be removed from track for assessment of the soffit. This shall be used to visually assess the attrition, decay, splits and shakes, and to adjust the results obtained above if required.
Distance between assessment or sample size	1 in 20 sleepers or 5 consecutive sleepers every 100m
Application of assessment	Result applies to that 100m section
Life expired limit	Severe
Determination of Residual Life RL(M)	Estimate the degradation rate based on the date of entry into service and the time taken to reach the present condition rating and estimate a residual life

3.4.5.5 Plain line sleepers and pit blocks (concrete and associated fastenings)

The life limiting feature and resulting residual life shall be assessed and estimated as follows:

Life limiting feature - Cracking/spalling/mechanical damage/chemical damage, rail seat abrasion, loss of fastening ability (cast in housing defects)	
Condition assessment method	Each aspect shall be assessed and given the most appropriate classification (Minor, medium, severe) for the majority of sleepers in a 100m section. The typical features relating to an aspect and classification are given in Appendix E.
Distance between assessment or sample size	The full 100m section is to be assessed.
Application of assessment	Result applies to that 100m section
Life expired limit	The resultant overall score for a 100m section is greater than or equal to 13
Determination of Residual Life RL(M)	The RL(M) for the 100m section is determined by assigning a score to each of the life limiting aspects (Minor = 1, Medium = 2, Severe = 4) and totalling for all six aspects =>5<8 - Minor degradation = 5 years remaining life =>8<10 - Medium degradation = 3 to 4 years remaining life =>10<13 - Severe degradation = 2 years and less remaining life The above assumes the RL(B) is zero.

Life limiting feature - Soffit attrition	
Condition assessment method	Only to be assessed in Open and Sub-surface sections and when the following are present. Poor vertical geometry (TRV Vertical SD = ML or worse) Poor ballast condition (signs of wet beds, drainage problems, voiding). 5 sleepers in 100m shall be removed from track for assessment of the soffit. This shall be used to visually assess the attrition, decay, splits and shakes, and to adjust the results obtained above if required.
Distance between assessment or sample size	1 in20 sleepers or 5 continuous every 100m
Application of assessment	Apply average result to the relevant segment
Life expired limit	10mm
Determination of Residual Life RL(M)	Estimate the degradation rate based on the date of entry into service and the time taken to reach the present condition rating and estimate a residual life

Note: Network Rail standard RT/CE/S/062 (Serviceable concrete sleepers for use in running lines and sidings) may be referred to for guidance.

3.4.5.6 Ballast

The life-limiting features are accumulation of fine material and contaminants (from migration of fine particles from the surface and underlying layers and from damage such as caused by traffic loading and tamping) loss of angularity and loss of depth. Symptoms of degradation are loss of track geometry quality and poor drainage.

Loss of angularity is not amenable to routine inspection and is accounted on the basis that material tests of the various material characteristics will account for this.

Five years' residual life may be claimed if there are no TRV or drainage issues of concern. However, no further residual life beyond the service life may be claimed for limestone ballast where the sleepers are concrete. In other situations the life-limiting features and resulting residual life shall be assessed and estimated as follows:

Life limiting feature - Ballast depth	
Condition assessment method	Ground Probing Radar and/or trial pits or Automatic Ballast Sampling. Ballast depth shall be measured from the soffit of the sleeper or bearer (from the low end when the track is canted).
Distance between assessment or sample size	From trial pit or Automatic Ballast Sampling: Sufficient to represent the ballast depth taking account of track configuration, observed & measured geometric condition and service conditions. Continuous in the case of Ground Probing Radar.
Application of assessment	In the case of trial pit the result will represent the relevant sections either side of the pit location. In the case of Ground Probing Radar the average ballast depth over 100m section is to be calculated.
Life expired limit	≤ 150mm See note 1 below.
Determination of Residual Life RL(M)	Ballast depths above 150mm will be assumed to be repairable with ballast supplementation and it will be assumed that residual life is unaffected in this case. (Note: It is assumed that the track is not constrained by vertical clearance limits).

Life limiting feature – Ballast attrition and contamination (see Note 3, below)	
Condition assessment method	Trial pits and material logging and sub sampling. Material testing to determine particle size distribution, resistance to fragmentation (Los Angeles co-efficient), resistance to wear (Micro-Deval co-efficient) and Uniformity co-efficient.
Distance between assessment or sample size	400m
Application of assessment	The result will represent 200m either side of the location.
Life expired limit	Particle size distribution results – the percentage fines passing the 1.18mm or 14mm sieve exceeding either 9% or 30% Uniformity coefficient (U_c) > 36.
Determination of Residual Life RL(M)	The results of the particle size distribution test and U_c calculation and the rate of degradation and the annual tonnage carried and predicted to calculate a residual life. At first assessment Calculate the rate of degradation assuming that it has been linear since the date of entry into service. Estimate the residual life assuming the same rate of degradation. At subsequent assessment s: Determine the actual degradation rate and calculate residual life accordingly.

Note 1: Standard 1-157 gives ballast depth for new track as 230mm. A minimum depth for load distribution and machine tamping of 150mm shall be taken as an end-of-life value.

Note 2: New ballast should not contain more than 3% by weight passing a 22.4mm sieve (see 1-157). If more than 30% passes a 14mm sieve the RL(M) should be set at zero [Network Rail Specification – *Formation Treatments* (NR/SP/TRK/9039 Issue 1)].

Note 3: Criteria in this table are based on Scott Wilson's report *Hatton Cross, Piccadilly Eastbound and Westbound lines 62.142km to 64.931km* (Document no. D125833/TL/PL/HACR/1), March 2010. The Uniformity coefficient is related to track quality and it has been found that if U_c exceeds 36 the ballast ceases to respond to maintenance by tamping. U_c is defined as D60/D10 where D60 is the grain diameter corresponding to 60% passing by weight and D10 is the grain diameter corresponding to 10% passing by weight.

3.4.5.7 Base Concrete (tube track)

In the case of direct fix track it is assumed that the rail and base plate fixing condition are considered as part of the maintenance regime. It is also recognised that loss of strength is only measurable by intrusive means and will not be measured. It is assumed that loss of strength will manifest itself in the life limiting features that can be assessed.

The life-limiting features and resulting residual life shall be assessed and estimated as follows

Life limiting feature - Cracking, spalling, loss of strength	
Condition assessment method	Visual assessment of the indicators of the life limiting features. For each 100m segment the indicators of the life-limiting feature shall be rated on a 3-point scale depending on the degree of degradation: Minor = 1 Medium = 2 Severe = 3. Appendix F shows the degradation rating for each indicator of a feature.
Distance between assessment or sample size	The track is to be segmented into 100m sections.
Application of assessment	Apply the rating to the relevant segment. If the rating varies over the segment involved then use the most representative rating. If the segment is longer than the section affected by the life limiting feature apply to whole segment.
Life expired limit	Severe degradation
Determination of Residual Life RL(M)	Estimate the degradation rate based on the date of entry into service and the time taken to reach the present condition rating and estimate a residual life or deduce from the estimated time to intervention.

3.4.5.8 Conductor rail

Each rail (positive and negative) shall be assessed separately.

Conductor rail crippling has been considered as a maintenance condition as it predominantly occurs over short distances.

The life limiting features and resulting residual life for steel and composite conductor rail shall be assessed and estimated as follows:

Life limiting feature – Wear - *Steel conductor rail*	
Condition assessment method	Head wear as stated in 1-164 clause 3.6.1 table 1.8. Measured either manually or by AIT.
Distance between assessment or sample size	Manual measurement A minimum of 1 measurement every 50m. In the case of signs of excessive wear a minimum of 3 measurements for the affected section. AIT measurement Continuous
Application of assessment	The worst headwear measurement is to be applied to the relevant segment.
Life expired limit	1-164 gives no SS Level 3 value for steel conductor rail. ML Level 2 value triggers planning of replacement depending on rate of wear. On this basis estimate this limit.
Determination of Residual Life RL(M)	At first wear assessment. Calculate the rate of degradation assuming that it has been linear since the date of entry into service .Estimate the residual life assuming the same rate of wear. At subsequent wear assessments: Determine the actual degradation rate and calculate residual life accordingly.

Life limiting feature – Wear of cap *Composite conductor rail*	
Condition assessment method	Cap wear as stated in 1-164 clause 3.6.1 table 1.8. Initially this may be assessed by use of callipers giving the depth of the whole rail, but when an accurate cap depth is required this can be measured ultrasonically.
Distance between assessment or sample size	Measurements to be sufficiently close to represent the wear condition taking account of observed conductor rail configuration, condition and service conditions.
Application of assessment	Average headwear to be calculated for relevant segmentation applied.
Life expired limit	SS Level 3
Determination of Residual Life RL(M)	At first wear assessment. Calculate the rate of degradation assuming that it has been linear since the date of entry into service .Estimate the residual life assuming the same rate of wear. At subsequent wear assessment s: Determine the actual degradation rate and calculate residual life accordingly

Life limiting feature – Conductivity – *Steel and Composite conductor rail*	
Assessment method	Resistance measure as per 1-107
Distance between assessment or sample size	Electrical section
Application of assessment	NA
Life expired limit	Limits set in 1-107
Determination of Residual Life RL(M)	Should the limits in 1-107 be met the residual life will not be affected by this factor.

3.4.5.9 Junction work

The life limiting features and resulting residual life shall be assessed and estimated as follows:

Asset	Mode of degradation	Measurement or assessment method	Distance between measurements	Application of measure/assessment to the asset.	Life expired limit	Determination of Residual Life Measured
Stock & switches and half the associated lead and closure rails	Wear	As for plain line rail	As required in PM 4 inspection.	Determine the measurement that gives the worst residual life for each stock and switch	SS level 3	Estimate the degradation rate based on the date of entry into service for each stock and switch. Estimate a residual life based on the average of these two.
	Switch tip damage	As per PM4				
	Switch distortion	As per PM4				
	Surface defects	As per PM4				
	Rail end damage	As per PM4				
	Internal defects	Ultrasonic				
	Corrosion	Visual as for plain rail				
	Chair gall	As for plain rail				
Crossing and half the associate lead and closure rails	Wear	As per PM 4	As required in PM 4 inspection.	Determine the measurement that gives the worst residual life for the crossing	SS level 3	Estimate the degradation rate based on the date of entry into service.
	Nose damage					
	Surface defects					
	Cracks & internal defects					
	Rail end damage					
Timbers	As for plain line	As for plain line + assess warping/ bowing	All timbers	Applies to unit	As for plain line	As for plain line
Ballast	As for plain line	As for plain line	1 trial pit	Will apply to the unit	As for plain line	As for plain line
Base concrete	As for plain line	As for plain line	Unit length	Will apply to unit	As for plain line	As for plain line

3.5 Declaration of Functionality

In exceptional circumstances there may be segments where the track bed (ballast) RL(M) is zero (i.e. the condition is outside normally acceptable limits) but where the track continues to perform satisfactorily and renewal is not considered to be an economic or efficient course of action.

In such cases a declaration of functionality is required in order to justify the decision to retain the degraded ballast in service. No Track components other than track bed ballast can be declared functional when their RL(M) is zero.

The declaration of functionality shall provide all of the information required to understand the case for retention in service including evidence of:

- Service Performance
- Safety Performance
- Maintenance history
- Performance and maintenance requirement projections
- Comparison of system costs for renewal and alternative strategies.

The evidence that an asset with zero RL(M) is fit for continued use must demonstrate that all required service performance capability, including such things as tolerance of adverse weather and other adverse conditions, have been considered.

Assets accepted for a continued use when RL(M) is zero shall be listed as Specific Concerns, with appropriate risk assessments and their RL(M) shall continue to be reported as zero.

3.6 Reporting of Maintenance Condition

3.6.1 General

For the purpose of this standard the maintenance condition is defined as condition that can be improved or corrected by maintenance intervention. Maintenance condition is determined at a particular point in time from the condition measures required by the various track standards and good industry practice.

The maintenance condition shall form the basis for reporting the functional condition and specific concerns.

Maintenance condition is assessed for various aspects. The aspects indicate the state of adjustment of either an asset or the track sub systems. The aspects to be measured and assessed are

- track geometry
- rail head condition – RCF and corrugations
- track integrity
- prevention of buckling requirements
- track, tunnel walls and railway embankments cleanliness – to be developed
- lineside vegetation – to be developed
- lubrication – to be developed
- conductor rail position.- to be developed

3.6.2 Maintenance condition bands

To allow the aggregation of maintenance condition and comparisons between Lines the maintenance condition measures (either a value or rating) will be converted to maintenance condition for each aspect and measure by classifying it from band 1 to 4.

Maintenance condition band limits are set based on the applicable track standard minimum requirements and recommended maintenance thresholds and Good Industry Practice. (Note: The principle of quality threshold bands implicit in 1-159 has been expanded to cover all aspects.)

The principles for setting the band limits are.(refer to diagram below)

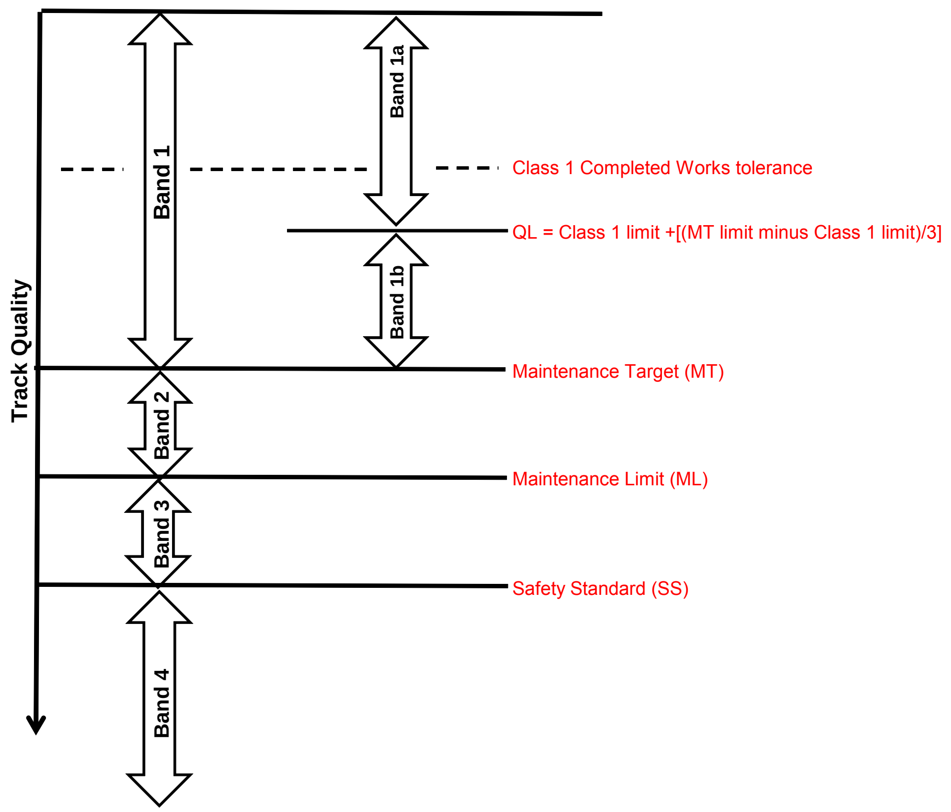
- Band 1 track is where the condition measure is better than MT (TRV SD), TRV discrete SS exceedance level is low, no defect detected,(Rail head condition or defects) and fully compliant.(PoB).
  For plain line track geometry, where condition is assessed in SD terms, Band 1 is split into Bands 1a and 1b. The band 1a limit is the Quality Level (QL), which for the purposes of ACR ,is one third between the Class I limit (from 1-159 Completed Works) and the MT limit. For example, if the Class I SD is 1.5mm and MT is 3.9mm, then QL is 2.3mm;

- Band 2 track is where the, condition measure is between MT and ML or the rating is minor;

- Band 3 track is where the condition measure is between ML and SS or the rating is medium;

- Band 4 is where the condition measure is worse than SS (where applicable), severe/heavy rating or non compliant.

MAINTENANCE CONDITION BANDS



Classification of the condition measure from band 1 to 4 and the subsequent determination of maintenance condition will be on the basis of the percentage length of track within the set limits.

3.6.3 Determination of Maintenance Condition

Maintenance condition will be determined from the condition measures as follows

:

Aspect	Maintenance Condition measure	Measure application	Environment	Band limits: Band 1 - no defect, better than MT or compliant	Band 2 between MT & ML, or minor	Band 3 between ML & SS or medium	Band 4 worse than SS or severe or non compliant
Plain line track geometry	TRV TQI SD	TQI SD per 100m (TQI SD is mean of LTOP, RTOP, ALIN and DNXL SDs)	Open and Sub Surface	% length of track with TQI SD < 2.1 (Band 1a) or between 2.1 and 3.6 (Band 1b)	% length of track with TQI SD between 3.6 and 4.8	% length of track with TQI SD between 4.8 and 6.5	% length of track with TQI SD > 6.5
			Tube	% length of track with TQI SD<2.3 (Band 1a) or between 2.3 and 3.6 (Band 1b)	As above	As above	As above
	TRV discrete exceedences	No of SS exceedences per100m (Note: a differentiation between Open, Sub-surface and Tube may be made at a later date)	Open	% length of track with number of SS exceedences per 100m < 0.015	% length of track with number of SS exceedences per100m between 0.015 & 0.025	% length of track with number of SS exceedences per100m between 0.025 & 0.045	% length of track with number of SS exceedences per100m > 0.045
			Sub Surface	As Open	As Open	As Open	As Open
			Tube	As Open	As Open	As Open	As Open
		No of ML exceedences per100m (Note: a differentiation between Open, Sub-surface and Tube may be made at a later date)	Open	% length of track with number of ML exceedences per100m < 0.15	% length of track with number of ML exceedences per100m between 0.15 & 0.25	% length of track with number of ML exceedences per100m between 0.25 & 0.45	% length of track with number of ML exceedences per100m > 0.45
			Sub Surface	As Open	As Open	As Open	As Open
			Tube	As Open	As Open	As Open	As Open
Junction Work track geometry	TRV discrete exceedences	No of SS exceedences/unit		Declare number of SS and ML exceedences. The output will be used to determine suitable Band limits in a re-issue of this document.			
		No of ML exceedences/unit					
Rail head Condition	RCF assessment (Minor, medium or severe) see section in residual life)	Rating to relevant length		% length of track with No Fault RCF assessment rating	% length of track with Minor RCF assessment rating	% length of track with Medium RCF assessment rating	% length of track with Severe RCF assessment rating
	Corrugations (see residual life)	Rating to relevant length		% length of track with ERR <20dB	% length of track with ERR between 20dB and 30dB	% length of track with ERR between 30dB and 40dB	% length of track with ERR >40dB

Aspect	Maintenance Condition measure	Measure application	Environment	Band limits: Band 1 - no defect, better than MT or compliant	Band 2 between MT & ML, or minor	Band 3 between ML & SS or medium	Band 4 worse than SS or severe or non compliant
Rail internal defects	See Appendix C for list of relevant defect types	No. of defects. Report number of defects/km – not banded at this stage.	All				
Track Integrity	Track faults related to joint or fastening or sleeper condition (Tables 5.2, 5.5, 6.1, 6.2, 6.3, 6.4.1, 6.4.3, 9.3.1, 9.3.3 and 9.3.4 in 1-159)	No of SS exceedances	All	Declare number of SS and ML exceedences. The output will be used to determine suitable Band limits in a re-issue of this document.			
		No of ML exceedances	All				
Prevention of Buckling	POB assessment results)	Rating (Compliant/Non compliant) of POB site	Open	% number of POB sites compliant with all POB requirements	NA	NA	% number of POB sites non compliant with all POB requirements

3.7 Functional Condition and Specific Concerns

Standard 5-042 requires the reporting of specific functional condition concerns under 4 functional condition codes. Appendix 2 of the standard 5-042 lists nine generic statements which act as prompts to assess the safety and performance risks associated with each asset.

For the track assets the specific concerns and functional condition coding shall be determined as follows.

Code1: Shall be determined as required by standard 5-042.

Code 2: List any specific concerns prompted by the generic concerns list. In addition any aspect with a Band 4 classification in the Maintenance Condition Assessment shall be used to generate a specific concern and associated calculated risk (in equivalent fatalities) in accordance with clause 6.1 in G-5-042.

Code 3: List any specific concerns prompted by the generic concerns list. In addition any assets

for which RL(N) =0 and RL(M) has not been assessed,
for which RL(M) = 0
any aspects with a Band 1b, 2 or 3 classification in the Maintenance Condition Assessment

and that have no or insufficient renewal or maintenance interventions included in the current and/or future AAMPs or where the actual renewal or maintenance interventions in a year indicates a shortfall (as reported in APRM report) shall be used to generate a specific concern and calculate an additional cost in accordance with clause 6.2 in G-5-042.

Code 4: Shall be determined as required in standard 5-042 based on the performance data held in CUPID against the track assets in accordance with clause 4.3 in G-5-042.

3.7 Reporting Output

In addition to the requirements of standard 5-042 the following information shall be provided for the track assets at a summarised and detailed level..

3.7.1 Residual Life (Physical Condition)

For each line, environment (Tube, Sub Surface, Open, Depot) and asset the following shall be declared at a summarised level.

- Asset quantity
- Asset value (RAV x quantity)
- Classification into Code A to D

For each line the detail information as the following detailed information shall be provided electronically at the relevant segmented level.

- Service life (Notional or informed)
- Residual life (Book)
- Residual life (Measured) – where required
- Asset quantity
- Asset value (RAV x quantity)
- Classification into Code A to D

3.7.2 Maintenance condition

For each line, environment (Tube, Sub-Surface, Open) and aspect the volume of the aspect classified in each condition band (i.e. Band 1 to 4) shall be declared.

For each line at the detail level the maintenance condition result for each aspect shall be declared at the same segmentation as used for the residual life.

3.7.3 Functional condition and Specific concerns

The specific concerns and functional codes shall be entered into the table as per Appendix 1 of the Manual of Good Practice (G-5-042)

4 Responsibilities and competence

4.1 Responsibilities are as set out in standard 5-042.

4.2 Staff carrying out the assessments and analysing the findings shall have demonstrated the required competence.

4.3 Staff recommending and approving the ACR shall be accredited by the Track Head of Profession.

5 Supporting Information

The following principles and assumptions have been used in setting the requirements.

5.1 Principles of the track ACR methodology

The ACR will require separate assessments for the residual life and for the maintenance condition of an asset.

The residual life will be determined solely on the basis of degradation that cannot be reversed by maintenance intervention either on the grounds of practicability or of cost.

The maintenance condition will be determined on the basis of the state of adjustment or cleanliness etc of the asset compared to a defined requirement.

5.2 Assumptions

Unless more accurate information is available, all degradation rates shall be assumed to be linear.

When predicting residual life it will be assumed that the usage and maintenance arrangements will be in accordance with the AGS/AAMP unless otherwise stated.

6 References

6.1 References

LU standards

Document no.	Title
1-041	Provision of engineering asset information
1-107	Requirements for electrical track equipment
1-035	Location Coding System
1-157	Track – Performance, design and configuration
1-159	Track – Dimensions and tolerances
1-164	Conductor rail – Dimensions and tolerances
1-622	Glossary of terms and abbreviations
G-5-042	ACR Manual of Good Practice

Network Rail standards

Document no.	Title
RT/CE/S/062	Serviceable concrete sleepers for use in running lines and sidings
NR/SP/TRK/9039	Formation treatments

6.2 Abbreviations

The following abbreviations are used in this document

Abbreviation	Definition
ACR	Asset Condition Reporting
AIT	Asset Inspection Train
ALIN	Alignment (TRV output)
DNXL	Dynamic Cross-level (TRV output)
ERR	Equivalent Rail Roughness (TRV output)
LTOP	Vertical Left (vertical alignment of left-hand rail) (TRV output)
ML	Maintenance Limit
MT	Maintenance Target
PoB	Prevention of buckling
QL	Quality Level
RAV	Relative Asset Value
RCF	Rolling contact fatigue
RL(B)	Residual Life – Book
RL(M)	Residual Life – Measured
RTOP	Vertical Right (vertical alignment of right-hand rail) (TRV output)
SD	Standard Deviation
SS	Safety Standard
TQI	Track Quality Index (TRV output)
TRV	Track Recording Vehicle

6.3 Definitions

Life expired limit – is the threshold of degradation at which the asset is deemed to have zero residual life.
Track Quality Index (TQI) – for the purposes of this document this is defined as the mean of the SDs of LTOP, RTOP, ALIN and DNXL.

7 Appendices

Appendix A Service Life (Notional)

1. General

The Service Life (Notional) for any specific location is to be calculated from the average service life expectancy expressed in MGT and the modifying factors appropriate to the location.

The service life expectancy of sleepers, ballast and track bed concrete for junction work is to be determined from the plain line average service life expectancy and relevant factors.

The Service Life (Notional) (expressed in years) for any specific location is derived from the expected service life (expressed in accumulated tonnage (MGT)) for the asset concerned divided by the annual tonnage (MGT/year) appropriate for the location. This is expressed as follows

$$Average\ service\ life\ (years) = \frac{Average\ service\ life\ (MGT)}{T\ (MGT/year)}$$

Where *T = annual gross tonnage for the section*

Note 1: In view of some assets being sensitive to degradation due to exposure to the weather and environment a limit to the time before an RL(M) assessment is set for softwood sleepers, and limestone ballast. The time limits before a RL (M) assessment for these assets is to be carried out are set in the table below.

Note 2: The service life expectancy for switches and crossings assumes:
Crossings cannot be welded more than three times.
Weld repair of switches is prohibited
Switch rails are manufactured from R260 grade rail

2. Plain Line (rails sleepers, bearers, pit blocks, ballast, track bed concrete)

Asset		Time Limit Cap	Service life	Environment				Curvature				Rail Configuration		Train damage factor		Maintenance regime factor		Support type	
		Years(*see note 1 in General above*)	**MGT**	**Open**	**Sub Surface**	**Tube**	**Depot**	**Radius Less than 200 m**	**Radius between 200 m and 400 m**	**Radius between 400 m and 1000 m**	**Radius greater than 1000 m**	**Jointed**	**Welded**	**Track Friendly Rolling Stock (J, P, B,SSL)**	**Track Hostile Rolling Stock (N, C, V, W&C)**	**Enhanced Preventative Maintenance Regime planned in AAMP**	**Current Maintenance Regime planned in AAMP**	**Granite**	**Limestone**
Running rail	R260 grade or less	NA	1000	0.9	1.0	1.1	1.7	0.075	0.4	1	1.2	0.75	1	1	0.9	TBA	1	NA	NA
	Premium grade rail	NA	1200	0.9	1.0	1.1	1.7	0.1	0.5	1	1.2	0.75	1	1	0.9	TBA	1	NA	NA
Sleepers	Softwood	30	540	1	1	NA	1	0.55	0.8	1	1	0.7	1	NA	NA	NA	NA	1	1
	Hardwood	NA	720	1	1	1.2	1	0.55	0.8	1	1	0.8	1	NA	NA	NA	NA	1	1
	Concrete	NA	900	1	1	1	1	0.95	1	1	1	0.8	1	NA	NA	NA	NA	1	0.8
Pit blocks	Hardwood	NA	774	NA	NA	1	NA	0.55	0.8	1	1	0.8	1	NA	NA	NA	NA	NA	NA
	Concrete	NA	900	NA	NA	1	NA	0.95	1	1	1	0.8	1	NA	NA	NA	NA	NA	NA
Bearers	Softwood	30	540	1	1	NA	1	0.7	0.8	1	1	0.7	1	NA	NA	NA	NA	1	1
	Hardwood	NA	720	1	1	1.2	1	0.7	0.8	1	1	0.8	1	NA	NA	NA	NA	1	1
	Concrete	NA	900	1	1	1	1	0.95	1	1	1	0.8	1	NA	NA	NA	NA	1	0.8

Asset		Time Limit Cap	Service life	Environment				Curvature				Rail Configuration		Train damage factor		Maintenance regime factor		Support type	
		Years(*see note 1 in General above)*	**MGT**	**Open**	**Sub Surface**	**Tube**	**Depot**	**Radius Less than 200 m**	**Radius between 200 m and 400 m**	**Radius between 400 m and 1000 m**	**Radius greater than 1000 m**	**Jointed**	**Welded**	**Track Friendly Rolling Stock (J, P, B,SSL)**	**Track Hostile Rolling Stock (N, C, V, W&C)**	**Enhanced Preventative Maintenance Regime planned in AAMP**	**Current Maintenance Regime planned in AAMP**	**Granite**	**Limestone**
Ballast	Granite	NA	720	1	1.1	NA	1.5	0.9	0.95	1	1.1	0.8	1	1	1	TBA	1	NA	NA
	Limestone	30	540	1	1.1	NA	1.3	0.9	0.9	1	1.1	0.8	1	1	1	NA	1	NA	NA
	Ash	NA	216	1	1	NA	1.3	0.9	0.95	1	1.1	0.8	1	1	1	NA	1	NA	NA
Track bed concrete	Direct fix	NA	1440	NA	1	1	NA	0.95	1	1	1.1	0.8	1	NA	NA	NA	NA	NA	NA
	Full sleeper	NA	1440	NA	1	1	NA	0.95	1	1	1	0.8	1	NA	NA	NA	NA	NA	NA
	Pit Blocks	NA	900	NA	1	1	NA	0.95	1	1	1	0.8	1	NA	NA	NA	NA	NA	NA
Conductor rail	Steel	NA	1800	0.95	1	1.05	1	0.95	1	1	1.1	0.9	1	1	1	NA	NA	NA	NA
	Composite	NA	1800	0.95	1	1.05	1	0.9	1	1	1.1	0.9	1	1	1	NA	NA	NA	NA

Junctionwork (switches and crossings)

Asset		Service life *(see assumptions in 1 above)*	Factors														
			Environment				Approach Curvature			Switch length		Crossing Angle		Rail Configuration		Train damage factor	
		MGT *(see Note 2 in General above)*	**Open**	**Sub Surface**	**Tube**	**Depot**	**Radius Less than 200 m**	**Radius between 200 m and 400 m**	**Radius greater than 400 m**	**A to C**	**D and longer**	**Less than 1: 9.5**	**Greater than 1:9.5**	**Jointed**	**Welded**	**Track Friendly Rolling Stock (J, P, B,SSL)**	**Track Hostile Rolling Stock (N, C, V, W&C)**
SWITCHES	Bullhead	200	0.9	1	1.1	1.4	0.8	0.9	1	1	1.2	NA	NA	1	1.2	1	0.9
	Flat bottom	230	0.9	1	1.1	1.4	0.8	0.9	1	1	1.2	NA	NA	1	1.2	1	0.9
CROSSINGS	Fabricated	200	0.9	1	1.1	1.4	0.8	0.9	1	NA	NA	1	1.2	1	1.2	1	0.9
	Semi Welded	230	0.9	1	1.1	1.4	0.8	0.9	1	NA	NA	1	1.2	1	1.2	1	0.9
	Cast AMS	270	0.9	1	1.1	NA	0.8	0.9	1	NA	NA	1	1.2	1	1.2	1	0.9
	Cast Bainitic (Titan)	180	0.9	NA	1.1	NA	0.8	0.9	1	NA	NA	1	1.2	1	1.2	1	0.9

Appendix B Rail Head Condition Rating Criteria

Minor – Minor false flange contact on the field side and signs of minor lipping. Gauge corner RCT crack lengths <10mm.

Heavy – Heavy false flange contact and lipping on the field side or visible cracks on gauge corner > 20mm in length.

Appendix B Rail Head Condition Rating Criteria – continued

Heavy – further example

Appendix C List of fatigue-related rail defect codes

Code	Description
112	Horizontal cracking of head at rail end
135	Star-cracking of fishbolt holes
141	Battered rail end
157	Fretting of rail foot
199	Untestable rail end
211	Progressive transverse cracking (tache ovale)
212	Horizontal cracking of head
213	Longitudinal vertical cracking of head
223	Gauge corner cracking
233	Longitudinal vertical cracking (piping)
243	Rail head deformation
253	Longitudinal vertical cracking in rail foot
254	Rail foot corrosion
299	Untestable rail
411	Progressive transverse cracking (tache ovale) at a weld
432	Horizontal cracking of web at a weld
471	Porosity
611	Progressive transverse cracking (tache ovale) in reduced section rail
721	Shelling of the gauge corner of the casting
1321	Horizontal cracking at the web-head fillet radius at rail end
1322	Horizontal cracking at the web-foot fillet radius at rail end
1323	Horizontal cracking in the web away from the fillet radius at rail end
2322	Horizontal cracking at the web-foot fillet radius
7111	Transverse cracking of casting - crossing vee
7112	Transverse cracking of casting - wing rails

Appendix D Timber Sleeper Rating Criteria

		Aspect					
		Vertical or Lateral sleeper movement	**Splits/Shakes in sleeper**	**Chair/Base plate configuration**	**Loose Fastenings**	**Sleeper indentation**	**Number of packings under base plate/chair**
Severity rating	Indicates	**Potential sleeper decay**	**As above**	**Loss of fastening ability**	**Loss of fastening ability (screwspike to sleeper or key//clips to chair/base plate)**	**Sleeper decay and indentation**	**Indentation, decay, geometry correction**
Minor		Minor sleeper decay (Photo D1)	Small surface splits (Photo S1)	S1 chair M screwspikes	1	0 to 3mm	3 to 12 mm
Medium		Medium sleeper decay (Photo D2)	Medium splits (Photo S2)	S1 chair & M screwspikes & chair moved or LI chair	2	3mm	12mm to 20mm
Severe		Severe sleeper decay (Photo D3	Severe splits (Photo S3)	Chair substituted with Check rail chair or cleats holding chairs or track lowering chair,	3	8mm	20 to 25 mm
	Source of criteria	Std 1-159 table 9.3.3 lists number of sleepers per 100m cell. Photos been rated on Engineering judgement	Std 1-159 cl 9.3.3 lists number of sleepers per 100m cell. Photos rated on Engineering judgement	Above criteria are based on engineering judgement	Std 1-159 tables 6.3 & 6.4.1 list number of sleepers per 100m cell. Above limits been set based on Engineering judgement	Std 1-159 table 9.3.1 - lists dimensions	At 25mm the screwspike design limits are exceeded.

Appendix E Concrete Sleeper Rating Criteria

	Cracking or spalling	Mechanical damage	Chemical damage	Loss of fastening ability	Rail seat abrasion
Severity rating					
Minor	Hair line cracks	Minor mechanical damage - Photo	Minor chemical damage present –not affecting structural integrity or ability to hold design geometry Photo	Housing secure – minor movement	<2mm
Medium	Visible cracks more than 150mm from housings	Medium tamping tine damage or other mechanical damage - Photo	Medium – affecting structural integrity but not geometry Photo	Damage to housing affecting ability to hold design location >3mm	>2mm & <5mm
Severe	Visible cracks within 150mm from housings	Severe – pre stress tendons exposed not anchored in concrete or severe tamping tine damage- Photo	Severe –affects structural integrity and geometry Photo	Damage to housing affecting ability to hold design location >3mm	>5mm

Appendix F Base Concrete Rating Criteria

Minor – minor crack, generally not in the vicinity of the sleeper and usually associated with shrinkage.

Medium – signs of dull crack. Usually associated with movement in the past (dull) Cracks may be in the vicinity of the sleeper but concrete shows no signs of breaking out.

Heavy – large and clear cracks with dust, showing signs of movement, or concrete is breaking out and will potentially affect track stability

Appendix G Worked example – sleeper RL(M)

Asset Condition Reporting

LCS Code	Start LCS (m)	Finish LCS (m)	Date

SLEEPERS (WOOD)

Guidance: ***Assign one description for each of the life limiting aspects, that best describes the condition of the majority of sleepers in the 100m cell.***

Give an indication of Sleeper decay (Vertical/Lateral Sleeper movement)

Minor sleeper decay	Medium sleeper decay	Severe sleeper decay
	y	

Give an indication of splits/shakes

Small surface splits	Medium splits	Severe splits
		y

What is the Chair/Baseplate configuration?

S1 chair M screwspikes	S1 chair & M screwspikes & chair moved or LI chair	Chair substituted with Check rail chair or cleats holding chairs or track lowering chair,
	y	

Describe the loss of fastening ability (screwspike to sleeper or key//clips to chair/base plate)

One	Two	Three
	y	

Give an indication of Sleeper indentation

0 to 3mm	3mm	8mm
	y	

What height of packing is used under chairs/baseplates

3 to 12 mm	12mm to 20mm	20 to 25 mm
y		

Score =13 Severe degradation - two years and less remainig

Appendix G Worked example – sleeper RL(M) - continued

Asset Condition Reporting

LCS Code	Start LCS (m)	Finish LCS (m)	Date

SLEEPERS (CONCRETE)

Guidance: ***Assign one description for each of the life limiting aspects, that best describes the condition of the majority of sleepers in the 100m cell.***

Give an indication of cracking or spalling

[ ]	[y]	[ ]
Hair line cracks	Visible cracksmore than 150mm from housing	Visible cracks within 150mm from housings

Give an indication of mechanical damage

[ ]	[y]	[ ]
Minor mechanical damage	Medium tamping tine damage or other mechanical damage	Severe – pre stress tendons exposed not anchored in concrete or severe tamping tine damage

Give an indication of chemical damage

[y]	[ ]	[ ]
Minor chemical damage present –not affecting structural integrity or ability to hold design geometry.	Medium – affecting structural integrity but not geometry	Severe –affects structural integrity and geometry

Describe the loss of fastening ability

[ ]	[y]	[ ]
Housing secure – minor movement	Damage to housing affecting ability to hold design location <3mm	Damage to housing affecting ability to hold design location >3mm

Give an indication of rail seat abrasions

[ ]	[y]	[ ]
<2mm	>2mm & <5mm	>5mm

Score =9 Medium degradation - 3 to 4 years remaining life

S1042 Asset Condition Reporting (ACR)

Premises

TABLE OF CONTENTS

Business Objectives

The purpose scope and requirements of the ACR is defined in the Cat 1 Standard 5-042.

In addition the Sponsor requires the ACR to provide a systematic process for the evaluation of the condition of our assets supporting the preparation of the annual asset management plan and longer term business planning. This will:

- Achieve a balance between capital and maintenance funds
- Demonstrate functional suitability and performance
- Demonstrate physical and operational condition

Additionally, the review will be used to:

- Demonstrate safety and statutory compliance
- Demonstrate energy and environmental performance

1. Purpose

This requirements specification sets out the Sponsors Requirements for the premises ACR 2011 and forms an appendix to standard 5-042. This includes asset coverage, data requirements and methodology. This provides visibility by which London Underground can understand:

- How the asset condition is performing with regard to its age and environmental conditions
- How to plan the timely and most cost effective renewal of the asset
- Whether the maintenance regimes are robust enough to deliver the anticipated life expectancy

2. Scope

The scope of the premises ACR includes BCV/SSL stations and non-station buildings. The premises assets which will be included in ACR will be agreed between the Stations Asset Sponsor and the Head of Stations Maintenance each year and will be listed in Appendix B of this document.

The primary source of data for the premises ACR will be survey information collated using the ESTEEM handheld data collection tool. Guidance notes for conducting surveys using the ESTEEM handheld are embedded in Appendix E. The ACR report will be produced by the Stations Asset Sponsor from ESTEEM, using a report format agreed between the Stations Asset Sponsor, CMO and the Stations Client Engineer.

Additional information required to be included in the ACR report, which is not available through the ESTEEM handheld, is listed in section 4 of this document. Where practicable, this information will be manually entered into ESTEEM, to be incorporated into the automated ESTEEM ACR report.

Any additional report required for the ACR which cannot be included in the ESTEEM ACR report, will be collated by CMO and presented as an addition to the ESTEEM ACR report.

3. Responsibilities and timescales

It is the joint responsibility of the Maintenance Sponsor, Client Engineer, Head of Profession and engineering representatives of CMO to compile concerns from asset data and information, convert the concerns to specific ACR condition codes and provide necessary supporting information to validate the coding. Key personnel are listed in Appendix A. Key delivery dates are:

Trail run from ESTEEM
Jan 28 2011
John Darbyshire

Complete surveys of 74 Stations and 10% Lineside buildings using HHDs
Mar 31 2011
CMO and S&C

Provide output from ESTEEM for all Stations and Lineside Buildings
Apr 29 2011
John Darbyshire

Validation of outputs from ESTEEM
May 20 2011

Russell Smith

The responsibilities through the cycle of reporting shall be as follows:

Description of Activity	CMO	Client Engineer	Stations Sponsor	Head of Profession	Asset Management
Confirmation of asset base and hierarchy	C	R	A	C	C
Confirmation of Legislation changes and obsolescence issues for review	I	C	A	R	I
Asset concern reporting requirements	I	C	R, A	C	C
Asset data collection methodology	I	C	R,A	C	C
Develop review content and delivery programme	R	C	A	I	I
Generation of condition and functional concerns	R	C	A	I	I
Codifying asset condition:					
Physical condition	R	A	C	I	I
Functional Condition (Legislation and Safety)	I	A	C	R	I
Functional Condition (Extraordinary maintenance / operation)	R	C	R, A	I	I
Functional Condition (Performance)	R	C	R, A	I	I
Concern table compilation	R	C	A	I	I
ACR report production	R	C	A	I	I
ACR Review	R,A	R	R	R,	C
ACR output to AAMP and work bank	C	R	A	I	I
ACR output to Risk Register	I	C	R, A	C	I

Responsible: The person who does the work to achieve the task.

Accountable: The person who is accountable for the correct completion of the task.

Consulted: The people who provide information for the Review and with whom there is two-way communication.

Informed: The people who are kept informed about progress and with whom there is one-way communication.

4. Source Information

In order to generate the initial list of physical condition concerns it will be necessary to review information from a number of different sources. The expected source of information shall be from the list detailed below:

- Survey data compiled using the ESTEEM handheld data collection tool for stations and non-station buildings listed in appendix B

- Roof survey reports, stations and non-stations buildings
- Survey reports non-stations buildings which are not listed in appendix B
- Records and information regarding known asbestos risks from preceding ACR
- Asset stabilisation work bank.
- Where applicable, other survey data and records of condition of the asset (e.g. PGI's and EPGI's)
- Any changes in legislation detailed in the Sponsors requirements (Appendix C)
- Any obsolescence issues detailed in the Sponsors requirements (Appendix D)

Details of pre-existing concerns shall be provided by the Maintenance Sponsor and Client Engineer at the commencement meeting with the CMO Assessors to ensure both physical and functional concerns are considered as part of the initial review.

5. Generation of Initial physical condition concerns

The assessor is to provide an initial listing of concerns for review by the Client Engineer prior to the final codifying of each concern to validate coverage and content of the review.

Any safety related or transitory defects noted during the assessment shall be reported to the relevant fault report centre. Faults of a transitory nature are not required to be recorded in the ESTEEM handheld.

6. Codifying physical condition concerns – Residual life Codes A-D

Where assets are surveyed using the ESTEEM handheld, residual life will be determined and graded Code A to D using degradation (time to failure) curves built into ESTEEM software. This requires:

- The surveyor to enter assessed asset condition (time to next condition grade), observed defects and any special environment, into the ESTEEM handheld.
- The site survey to be signed off by LU Senior Surveyor.

Where assets have not been surveyed using the ESTEEM software, residual life will be determined using the following:

- Stations premises – Stations modernisation / refurbishment, in the period 2005-2010 will be assumed to be Code A, unless amended as a result of defects recorded in the asset stabilisation work bank (stations risk register).
- Non-stations buildings – Estimate of condition (Code A-D) will be based on other survey information from Maintenance. As no measured surface area data is available, estimates will be made based on average area per non- stations building, for those buildings surveyed using the hand held.

Details of pre-existing concerns shall be provided by the Maintenance Sponsor and Client Engineer at the commencement meeting with the CMO Assessors to ensure both physical and functional concerns are considered as part of the initial review.

7. Functional Condition Issues

Concerns relating to statutory compliance and safe operation (Codes 1-2) are determined from joint review by the Client Engineer and Head of Profession.

Concerns relating to extraordinary maintenance and or operation and asset performance (Codes 3 & 4) are determined by Joint review by CMO and the Maintenance Sponsor.

It is unusual for premises assets to require extraordinary maintenance, however the following issues should be considered in the review:

- Assets where deterioration of Physical condition leads to more frequent inspection
- Asset where deterioration of physical condition leads to regular planned maintenance.

Concerns relating to risk of service loss, (functional Code 4), are relatively unusual for premises assets, however where there are concerns that condition of premises assets could result in service loss this should be brought the attention of the stations asset sponsor for valuation of LCH.

8. Output to asset work bank / Stations asset risk register

The Client Engineer shall be responsible for the generation of issues to be taken from the initial concerns list into the Asset Stabilisation Work Bank in the Asset Risk Register. To populate the additional issues in the work bank the Client Engineer in conjunction with Maintenance Sponsor determine:

- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work
- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

In the event that issues are identified where there is no clear solution, the Maintenance Sponsor shall be responsible for adding to the list of known risks in the Stations Asset Risk Register

9. Output to Asset Risk Register

The Maintenance Sponsor is responsible for ensuring the Stations Asset Risk Register is used to inform the corporate asset register (ARM).

Appendix A – Key stakeholders

For the purpose of this document, key stakeholders are those individuals or groups who provide input into the process of asset condition reporting for premises assets or have an interest in the output of the assessment.

Stakeholder	Directorate / Organisation	Key Interest
Mike Everett	Maintenance Sponsor, S&C	Scope coverage, Informing work bank and risk registers, compiling maintenance and improvement plans
David Jones	Asset Sponsor, S&C	Compiling asset improvement plans
Richard Knowles	Client Engineer, S&C	Scoping of asset improvement plans
John Caves	Head of Profession, Projects	Confirmation of statutory compliance and safe operation
Russell Smith	Senior Building Surveyor, CMO	Validation of survey data. Identification of asset condition issues.
Paul Haynes	Premises Manager	Identification of asset condition issues. Confirmation of statutory compliance and safe operation, agreeing maintenance and enhanced maintenance plans
Chris Skuse	Stations and Structural Maintenance Manager, CMO	Confirmation of statutory compliance and safe operation, agreeing maintenance and enhanced maintenance plans

Appendix B – Asset Locations 2011 Premises ACR

Asset locations which are within the scope of surveys to be delivered by CMO are:

Stations	**Line-side Buildings**
Bethnal Green	Barbican Pump House
East Acton	Bow Road P-Way cabin
Gloucester Road	Chesham Signal Cabin
Loughton	Chigwell P-Way cabin
South Ruislip	Chorleywood Signal Cabin
Wimbledon Park	Ealing Broadway IMR
	Gillingham St Vent Shaft (Nr Victoria Stat)
	Greenford -GSM Accom
	Kings Cross IMR
	Loughton Depot - telephone exchange
	Preston Road Air Raid Shelter
	Rickmansworth former booking on centre
	Rickmansworth Signal Cabin
	Ruislip P-Way cabin
	Ruislip Siding IMR
	Ruislip Signal Cabin
	Triangle Sidings (Gloucester Rd)
	Uxbridge Signal Cabin
	Watford SER
	West Acton P-Way cabin
	West Ruislip -Train Crew Accom

Asset locations which are within the scope of surveys to be delivered by the ESTEEM project are:

Amersham	Gants Hill	Parsons Green
Baker Street	Goldhawk Road	Pimlico
Bank	Grange Hill	Rayners Lane
Barbican	Greenford	Redbridge
Barkingside	Hammersmith (D&P)	Rickmansworth
Barons Court	Hanger Lane	Royal Oak
Blackhorse Road	Harrow on the Hill	Seven Sisters
Buckhurst Hill	High Street Kensington	Sloane Square
Cannon Street	Highbury & Islington	South Kensington
Chalfont & Latimer	Hillingdon	St. James Park
Chancery Lane	Holland Park	Stepney Green
Charing Cross	Hornchurch	Temple
Chesham	Ickenham	Tottenham Hale
Chorleywood	Kilburn Park	Turnham Green
Croxley	Lambeth North	Upney
Ealing Broadway	Latimer Road	Upton Park
Earls Court	Chiswick Park	Vauxhall
East Ham	Leytonstone	Warwick Avenue
East Putney	Liverpool Street	West Acton
Edgware Road (Bakerloo)	Mansion House	West Brompton
Edgware Road (H&C)	Marylebone	West Harrow
Embankment	Moor Park	West Kensington
Euston Square	Moorgate	Westbourne Park
Farringdon	Newbury Park	Whitechapel
Fulham Broadway	North Acton	

Appendix C – Changes in Legislation

Statutory Legislation – Changes to be considered by Assessors of 2011 ACR in Codifying Functional Condition

Legislation	Came into force	Asset Group Impact	Outline description and impact
Building Regulations 2010	1/10/10	Premises, Mechanical, Electrical	Consolidation of Building Regulations 2000 and amendments and introduces further EU Directive requirements on the use of energy from renewable sources
Building (Approved Inspectors etc. Regulations 2010-10-04	1/10/10	Premises, Mechanical, Electrical	Consolidation of 2000 regulations but now includes self certification schemes, Co2 emission calculations, energy performance certificate, water consumption calculations, sound insulation testing, mechanical flow rate testing and pressure testing.
Directive 2010/31/EU on the energy performance of buildings	9/07/10	Premises, Electrical, Mechanical, Communications and Fire	Update on the 2002 Directive and now includes building renovation. Public buildings must comply by January 2013
CRC Energy Efficiency Scheme Order 2010	22/03/10	Premises, Electrical, Mechanical, Communications and Fire	Energy efficiency scheme to reduce carbon emissions in public sector.
Environmental Permitting (England and Wales) 2009	6/04/10	Premises	Simplification of the regulatory framework for environmental risk waste recovery and disposal in England.
Planning (Listed Buildings and Conservation Areas) (England) Regulations 2010	6/04/10	Premises	Changes to consultation process
Energy Performance of buildings (Certificates and Inspections) (England and Wales) (Amendment) Regulations 2010	21/05/10	Premises, Electrical, Mechanical, Communications and Fire	Revised requirements for certification including large public buildings

Appendix D – Known Obsolescence and Spares Issues

None known for premises assets

Appendix E – ESTEEM –Building Surveyors Guide

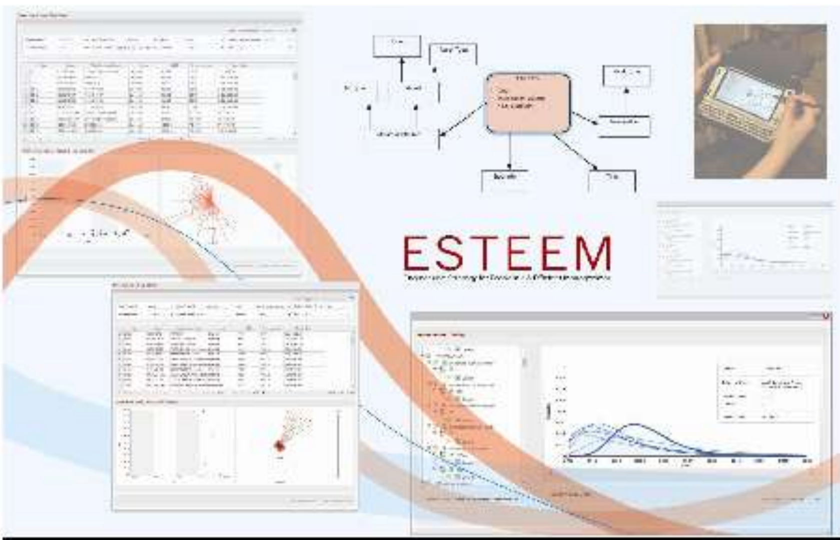
Embedded document

Stations - ESTEEM Building Surveyors Guidance November 2010

DRAFT DOCUMENT FOR REVIEW AND COMMENT

ESTEEM

BUILDING SURVEYORS' GUIDANCE



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OWNER	INFRACO	LINE	STATION		ASSET_TYPE	ACR Reporting E+F	MI_LEVEL_0_DESC_PARENT	MI_LEVEL_0_P_DESC_CHILD
OWNER	INFRACO	LINE	STATION	CANOPY Covering	CANOPY	Covering	Covering Slate	Painted
OWNER	INFRACO	LINE	STATION	CANOPY Fascia/Soffit	CANOPY	Covering	Covering Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM Floor	CANOPY	Covering	Covering Concrete Tile	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM Wall	CANOPY	Covering	Covering Lead Sheet	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM Ceiling	CANOPY	Covering	Covering Copper Sheet	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM Door	CANOPY	Covering	Covering Zinc Sheet	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM Column	CANOPY	Covering	Covering Asbestos - Profiled Sheet	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM Nosing	CANOPY	Covering	Covering Felt	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM Tactile Strip	CANOPY	Covering	Covering Metal Profiled Sheet	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA Grounds	CANOPY	Covering	Covering Metal Framed Glazing Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA Wall	CANOPY	Covering	Covering EPDM Rubber Sheet Membrane	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA Door	CANOPY	Covering	Covering GRP Profiled Sheet	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA Window	CANOPY	Covering	Covering Complete Glass Canopy	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA Column	CANOPY	Covering	Covering Georgian Wired Glass	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA Stairs	CANOPY	Covering	Covering Lead Sheet	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Grounds	CANOPY	Covering	Covering Copper Sheet	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Wall	CANOPY	Covering	Covering Zinc Sheet	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Door	CANOPY	Covering	Covering Mastic Asphalt	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Window	CANOPY	Covering	Covering Solar Reflective Paint	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Column	CANOPY	Fascia/Soffit	Fascia / Soffit Timber / Calcium Silcate	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Stairs	CANOPY	Fascia/Soffit	Fascia / Soffit Suspect Material	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Nosing	CANOPY	Fascia/Soffit	Fascia / Soffit UPVC	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM Tactile Strip	DEEP TUBE PLATFORM	Floor	Floor Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOF Covering	DEEP TUBE PLATFORM	Floor	Floor Concrete Paving Slab	Painted
OWNER	INFRACO	LINE	STATION	ROOF Fascia/Soffit	DEEP TUBE PLATFORM	Floor	Floor Timber or Board	Painted / Varnish
OWNER	INFRACO	LINE	STATION	ROOM Floor	DEEP TUBE PLATFORM	Floor	Floor Terrazzo Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM Wall	DEEP TUBE PLATFORM	Floor	Floor Vinyl	Painted
OWNER	INFRACO	LINE	STATION	ROOM Ceiling	DEEP TUBE PLATFORM	Floor	Floor Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM Door	DEEP TUBE PLATFORM	Floor	Floor Granite Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM Window	DEEP TUBE PLATFORM	Floor	Floor Carpet Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM Column	DEEP TUBE PLATFORM	Floor	Floor Metal Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOM Stairs	DEEP TUBE PLATFORM	Floor	Floor Carpet Sheet	Painted
OWNER	INFRACO	LINE	STATION	Cut & Cover PLATFORM Floor	DEEP TUBE PLATFORM	Floor	Floor Granolithic Screed	Painted
OWNER	INFRACO	LINE	STATION	Cut & Cover PLATFORM Wall	DEEP TUBE PLATFORM	Floor	Floor Resin Screed	Painted
OWNER	INFRACO	LINE	STATION	Cut & Cover PLATFORM Ceiling	DEEP TUBE PLATFORM	Floor	Floor Raised System - Metal Tile	Painted
OWNER	INFRACO	LINE	STATION	Cut & Cover PLATFORM Door	DEEP TUBE PLATFORM	Floor	Floor Raised System - Vinyl Tile	Painted
OWNER	INFRACO	LINE	STATION	Cut & Cover PLATFORM Column	DEEP TUBE PLATFORM	Floor	Floor Mastic Asphalt	Painted
OWNER	INFRACO	LINE	STATION	Cut & Cover PLATFORM Nosing	DEEP TUBE PLATFORM	Floor	Floor Quarry Tile	Painted
OWNER	INFRACO	LINE	STATION	Cut & Cover PLATFORM Tactile Strip	DEEP TUBE PLATFORM	Floor	Floor Matwell	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Floor	Floor Varna/Rubber	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Exposed Reinforced Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Plaster	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Clay Tile	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Stone Cladding	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Aluminium, Brass, Bronze or Stainless Steel Panels	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Wall	Wall Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Timber	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Metal Panels	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Plaster	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Fibre Tiles on Grid	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Asbestos Sheet	Painted
OWNER	INFRACO	LINE	STATION		DEEP TUBE PLATFORM	Ceiling	Ceiling Sand Cement Render	Painted

OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Ceiling	Ceiling Brick	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Door	Door Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Door	Door Bostwick Gates Steel	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Door	Door Concertina	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Door	Door Aluminium or Steel Roller Shutter	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Door	Door Glass	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Door	Door UPVC	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Exposed Reinforced Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Plaster	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Stone Cladding	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Aluminium, Brass, Bronze or Stainless Steel panels	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Column	Column Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Nosing	Nosing Concrete	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Nosing	Nosing Stone	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Nosing	Nosing Brick	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Tactile Strip	Tactile Strip Concrete/Clay	Painted
OWNER	INFRACO	LINE	STATION	DEEP TUBE PLATFORM	Tactile Strip	Tactile Strip Plastic	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Grounds	Ground Paving Slabs	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Grounds	Ground Mastic Asphalt	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Grounds	Ground Block Paving	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Grounds	Ground Concrete Grass Blocks	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Grounds	Ground In situ Concrete	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Exposed Reinforced concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Stone Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Calcium Silicate Panels Painted	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Aluminium, Brass, Bronze or Stainless Steel panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Wall	Wall Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Door	Door Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Door	Door Bostwick Gates Steel	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Door	Door Concertina Metal	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Door	Door Aluminium or Steel Roller Shutter	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Door	Door Glass	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Door	Door UPVC	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Door	Door Steel	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Window	Window Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Window	Window Metal	Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Window	Window UPVC	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Exposed Reinforced concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Glazed or Ceramic Tile	Painted

OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Stone Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Calcium Silicate Panels Painted	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Aluminium, Brass, Bronze or Stainless Steel panels	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Column	Column Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Hardwood Timber	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Hardwood Timber	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Hardwood Timber	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Hardwood Timber	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Metal	Painted
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	EXTERNAL AREA	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Grounds	Ground Paving Slabs	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Grounds	Ground Mastic Asphalt	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Grounds	Ground Block Paving	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Grounds	Ground Concrete Grass Blocks	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Grounds	Ground In situ Concrete	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Exposed Reinforced concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Stone Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Calcium Silicate Panels Painted	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Aluminium, Brass, Bronze or Stainless Steel panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Wall	Wall Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door Bostwick Gates Steel	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door Concertina Metal	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door Aluminium or Steel Roller Shutter	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door Glass	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door UPVC	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door Steel	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Door	Door Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Window	Window Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Window	Window Metal	Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Window	Window UPVC	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Exposed Reinforced concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Stone Cladding Panels	Painted

OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Calcium Silicate Panels Painted	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Aluminium, Brass, Bronze or Stainless Steel panels	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Column	Column Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Hardwood Timber	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Hardwood Timber	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Hardwood Timber	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Hardwood Timber	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Metal	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Nosing	Nosing Concrete	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Nosing	Nosing Stone	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Nosing	Nosing Brick	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Tactile Strip	Tactile Strip Concrete/Clay	Painted
OWNER	INFRACO	LINE	STATION	OPEN PLATFORM	Tactile Strip	Tactile Strip Plastic	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Slate	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Concrete Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Lead Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Copper Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Zinc Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Asbestos - Profiled Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Felt	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Metal Profiled Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Metal Framed Glazing Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering EPDM Rubber Sheet Membrane	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering GRP Profiled Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Georgian Wired Glass	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Perspex	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Mastic Asphalt	Solar Reflective Paint
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Profiled Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Covering	Covering Paving Slabs	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Fascia/Soffit	Fascia / Soffit Timber / Calcium Silcate	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Fascia/Soffit	Fascia / Soffit Suspect Material	Painted
OWNER	INFRACO	LINE	STATION	ROOF	Fascia/Soffit	Fascia / Soffit UPVC	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Concrete Paving Slab	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Timber or Board	Painted / Varnish
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Terrazzo Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Vinyl	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Granite Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Carpet Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Metal Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Carpet Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Granolithic Screed	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Resin Screed	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Raised System - Metal Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Raised System - Vinyl Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Mastic Asphalt	Painted

OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Quarry Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Matwell	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Floor	Floor Varna/Rubber	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Exposed Reinforced Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Plaster	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Stone Cladding	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Aluminium, Brass, Bronze or Stainless Steel Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Wall	Wall Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Timber	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Plaster	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Fibre Tiles on Grid	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Asbestos Sheet	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Sand Cement Render	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Ceiling	Ceiling Brick	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Door	Door Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	ROOM	Door	Door Bostwick Gates Steel	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Door	Door Concertina	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Door	Door Aluminium or Steel Roller Shutter	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Door	Door Glass	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Door	Door UPVC	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Door	Door Steel	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Window	Window Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	ROOM	Window	Window Metal	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Window	Window UPVC	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Exposed Reinforced Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Plaster	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Stone Cladding	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Aluminium, Brass, Bronze or Stainless Steel panels	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Column	Column Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Concrete, Mastic Asphalt or Resin	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Terrazzo, Granite or Ceramic	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Hardwood Timber	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Hardwood Timber	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Hardwood Timber	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Hardwood Timber	Aluminium Nosing

OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Metal	Painted
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	HDLT Cast Iron / Gun Metal Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	Cordoroy Strip
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	Aluminium Nosing
OWNER	INFRACO	LINE	STATION	ROOM	Stairs	Step Tread/Riser Varna, Rubber or Vinyl	HDLT Nickle Bronze Nosing
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Concrete Paving Slab	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Timber or Board	Painted / Varnish
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Terrazzo Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Vinyl	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Granite Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Carpet Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Metal Sheet	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Carpet Sheet	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Granolithic Screed	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Resin Screed	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Raised System - Metal Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Raised System - Vinyl Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Mastic Asphalt	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Quarry Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Matwell	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Floor	Floor Varna/Rubber	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Exposed Reinforced Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Plaster	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Stone Cladding	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Timber Boarding / Cladding Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Aluminium, Brass, Bronze or Stainless Steel Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Wall	Wall Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Timber	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Plaster	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Fibre Tiles on Grid	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Asbestos Sheet	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Sand Cement Render	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Ceiling	Ceiling Brick	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Door	Door Timber	Painted or Stained
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Door	Door Bostwick Gates Steel	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Door	Door Concertina	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Door	Door Aluminium or Steel Roller Shutter	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Door	Door Glass	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Door	Door UPVC	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Door	Door Steel	Powder Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Exposed Brick	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Exposed Glazed Brick	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Exposed Concrete Block	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Exposed Reinforced Concrete	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Sand Cement Render	Coated / Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Plaster	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Clay Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Glazed or Ceramic Tile	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Stone Cladding	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Timber Boarding / Cladding Panels	Painted

OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Calcium Silicate Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Powder Coated Metal Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Vitreous Enamel Panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Aluminium, Brass, Bronze or Stainless Steel panels	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Column	Column Painted Architectural Ironwork	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Nosing	Nosing Concrete	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Nosing	Nosing Stone	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Nosing	Nosing Brick	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Tactile Strip	Tactile Strip Concrete/Clay	Painted
OWNER	INFRACO	LINE	STATION	SECTION12 COVERED PLATFORM	Tactile Strip	Tactile Strip Plastic	Painted

Premises ACR Hierarchy

Stations

CANOPY Covering
CANOPY Fascia/Soffit
EXTERNAL AREA Grounds
EXTERNAL AREA Wall
EXTERNAL AREA Door
EXTERNAL AREA Window
EXTERNAL AREA Column
EXTERNAL AREA Stairs
ROOF Covering
ROOF Fascia/Soffit
ROOM Floor
ROOM Wall
ROOM Ceiling
ROOM Door
ROOM Window
ROOM Column
ROOM Stairs
Cut & Cover PLATFORM Floor
Cut & Cover PLATFORM Wall
Cut & Cover PLATFORM Ceiling
Cut & Cover PLATFORM Door
Cut & Cover PLATFORM Column
Cut & Cover PLATFORM Nosing
Cut & Cover PLATFORM Tactile Strip
DEEP TUBE PLATFORM Floor
DEEP TUBE PLATFORM Wall
DEEP TUBE PLATFORM Ceiling
DEEP TUBE PLATFORM Door
DEEP TUBE PLATFORM Column
DEEP TUBE PLATFORM Nosing
DEEP TUBE PLATFORM Tactile Strip
OPEN PLATFORM Grounds
OPEN PLATFORM Wall
OPEN PLATFORM Door
OPEN PLATFORM Window
OPEN PLATFORM Column
OPEN PLATFORM Stairs
OPEN PLATFORM Nosing
OPEN PLATFORM Tactile Strip
DRAINAGE Rainwater
DRAINAGE Sanitary
External Landscaping
Fences

Non Public Buildings

CANOPY Covering
CANOPY Fascia/Soffit
EXTERNAL AREA Grounds
EXTERNAL AREA Wall
EXTERNAL AREA Door
EXTERNAL AREA Window
EXTERNAL AREA Column
EXTERNAL AREA Stairs
ROOF Covering
ROOF Fascia/Soffit
ROOM Floor
ROOM Wall
ROOM Ceiling
ROOM Door
ROOM Window
ROOM Column
ROOM Stairs
DRAINAGE Rainwater
DRAINAGE Sanitary
External Landscaping
Fences

S1042 Asset Condition Reporting (ACR)

Signalling and C&I

Signalling and C&I Review v4.1 (11.01.31)

Determination of Residual Asset Life for Signal and C&I Assets

The residual life classification for Signalling and C&I assets listed in the ACR Hierarchy will be the lowest A-D score received from an assessment of obsolescence and asset performance.

1. Obsolescence

The impact of obsolescence on residual life shall be assessed by CMO Signalling and C&I assessors using the scoring system developed by the CMO Obsolescence Manager and incorporated into the ACR Standard, which is summarised below:

Code A	Either It is expected that replacements, significant components and in-service support will remain available for at least 10-years, or It is expected that action taken to mitigate the effects of obsolescence will be effective for at least 10-years
Code B	Either It is expected that replacements, significant components and in-service support will remain available for at least 5-years but reported that replacements or significant components or in-service support will become unavailable in less than 10-years; or It is expected that action taken to mitigate the effects of obsolescence will be effective for at least 5-years but will become ineffective in less than 10-years
Code C	Either It is reported that replacements or significant components or in-service support will become unavailable in less than 5-years; or It is expected that action taken to mitigate the effects of obsolescence will become ineffective in less than 5-years
Code D	Replacements or significant components or in-service support are no longer available and no action has been taken to mitigate the effects of obsolescence

2. Asset Performance

Signalling: Asset performance is assessed using information recorded in ELLIPSE - the asset management system (Method 1);
C&I: Until ELLIPSE data is available the maintainer's viewpoint is to be used (Method 2).

Method 1: Asset Performance based on ELLIPSE asset data to determine residual life

Sponsor to use corrective work orders recorded by CMO in ELLIPSE to provide a measure of residual life by as set out below:

Code A	Asset physical condition has required no corrective work orders to be assigned over the previous 12 months
Code B	Asset physical condition has required an intervention rate of 1 to 5 corrective work orders over the previous 12 months
Code C	Asset physical condition has required an intervention rate of 6 to 10 corrective work orders over the previous 12 months
Code D	Asset physical condition has required an intervention rate greater than 10 corrective work orders over the previous 12 months

ACR classification to be validated by a review of the maintenance regime - corrective maintenance forms, annual certified tests, Signal Maintenance Quality Checks (SMQC) and audits.

Method 2: Asset Performance based upon maintainers knowledge to determine Residual Life

If ELLIPSE data is not available the following questions are used to determine the maintainer's viewpoint of asset residual life (the overall A-D score for Asset Performance is the lowest recorded):

1. Has there been an increase in the number of faults with this asset/system over the previous 12 months?

Code A	Assets that the maintainer considers has a below average, or average maintenance intervention rate over the previous 12 months
Code B	Assets that the maintainer considers has an above average maintenance intervention rate, either consistently, or as part of a rising trend, up to a level equivalent to 1.5 times the average maintenance intervention rate over the previous 12 months
Code C	Assets that the maintainer considers has a disproportionately above average maintenance intervention rate, equivalent to between 1.5 and 3 times the average maintenance intervention rate over the previous 12 months
Code D	Assets that the maintainer considers has an excessive maintenance intervention rate, equivalent to above 3 times the average maintenance intervention rate over the previous 12 months

2. Has there been an increase in the level of maintenance over the past year to maintain the level of reliability?

Code A	Assets that the maintainer considers has a below average, or average maintenance cost over the previous 12 months
Code B	Assets that the maintainer considers have an above average maintenance cost, either consistently, or as part of a rising trend, up to a level equivalent to 1.5 times the average maintenance cost over the previous 12 months
Code C	Assets that the maintainer considers has a disproportionately above average maintenance cost, equivalent to between 1.5 and 3 times the average maintenance cost over the previous 12 months
Code D	Assets that the maintainer considers has an excessive maintenance cost, equivalent to above 3 times the average maintenance cost over the previous 12 months

6.1.1 Basis of Condition Reporting for Signalling and C&I version 2.3 Proposed

~~2010 ACR No.~~	ACR No.	C&I FD* No.	Signalling FD* No.	Asset Description	RAV**	RAV %**	Unit	Nominal Life Legacy	Nominal Life Upgraded	Source of Nominal Life
~~1000~~	**1000**	**N/A**	**N/A**	**Control Centre**						
~~2000~~	**1100**	**110/120/130/310**	**1113**	**Centralised Signalling Control**	**6**	**6.00%**				
~~2001~~	1110	111/112/113/114/116/130	6000/6100/6131	Signalling Control Workstations	(Included above)	(Included above)	N/A	10	30	Professional Judgement
~~2002~~	1120	115/121/122/123/131/132/311	N/A	Signalling Control Servers			N/A	10	10	Professional Judgement
~~3000~~	**1200**	**140**	**N/A**	**Centralised Customer Information**						
~~3001~~	1210	141/142/143/142/143	N/A	Customer Information Server	2	2.00%	N/A	10	10	Professional Judgement
~~4000~~	**1300**	**180/300**	**7300/7301**	**Management Information**						
~~4001~~	1310	151/181	N/A	Data Warehouse Simulator	4	4.00%	N/A	10	10	Professional Judgement
~~5000~~	**1400**	**230**	**N/A**	**Training Systems or Simulators & Development Facilities**	**0.25**	**0.25%**				
~~5001~~	1410	231	N/A	Signalling Simulator	(Included above)	(Included above)	N/A	10	30	Professional Judgement
~~5002~~	1420	N/A	N/A	Asset Specific Test/Development Equipment			N/A	10	30	Professional Judgement
~~6000~~	**1500**	**N/A**	**N/A**	**Signals & C&I Power**						
~~6001~~	1510	N/A	5000/5101/5102/5102/5103/5104/5105	Power Supply	0.5	0.50%	N/A	40	30	Professional Judgement
~~7000~~	**1600**	**160/190**	**N/A**	**Transmission Systems or LAN/Fibre Optics**						
~~7001~~	1610	161/191/192/193/511/512	N/A	Signals & C&I Interface and Communication Bearers	0.5	0.50%	N/A	10	30	Professional Judgement
~~8000~~	**2000**	**N/A**	**N/A**	**WaySide**						
~~9000~~	**2100**	**200/220/320/321**	**1113**	**Train Control System**						
~~9001~~	2110	221/312/322/323	1135/6121/1622/6123/6131	Wayside Signalling Control incl Depots & Sidings	12	12.00%	N/A	15	30	Professional Judgement
~~9002~~	2120	322/323	N/A	Signalling Communications Bearer	0.25	0.25%	N/A	10	30	Professional Judgement
~~9003~~	2130	143/144/145/201/202	N/A	Station Information	3	3.00%	N/A	10	30	Professional Judgement
~~9004~~	2140	N/A	N/A	ATO Trackside	1	1.00%	N/A	15	30	Professional Judgement
~~10000~~	**2200**	**N/A**	**1500**	**Train Detection Systems**	**14**	**14.00%**				
~~10001~~	2210	N/A	1201/1202/1203/1204/1205/1206/1207/1208/1209/1210/1211	Train Detection	(Included above)	(Included above)	N/A	15	30	Professional Judgement
~~10002~~	2220	N/A	N/A	Position Detectors			N/A	15	30	Professional Judgement
~~10003~~	2230	N/A	N/A	Axle Counters			N/A	15	30	Professional Judgement
~~10004~~	2240	N/A	1501/1502/1503/1504/1505/1506/1507	Gauge Detectors			N/A	15	30	Professional Judgement
~~10005~~	2250	N/A	1213/1214/1215/1501/1502/1503/1504/1505/1506/1507	ATP Trackside	1	1.00%	N/A	15	30	Professional Judgement
~~11000~~	**2300**	**N/A**	**1300/6200**	**Train Routing System or Point Operating Equipment**	**4.9**	**4.90%**				
~~11001~~	2310	N/A	1301/1302/1303/1304/1305/1306/1307/1308/1309/1310/6201/6202/6203/6204/6205/6206/6207/6208/6209/6210/6211/6212	Air Powered Point Operating Equipment	(Included above)	(Included above)	N/A	100	100	Professional Judgement
~~11002~~	2320	N/A	8000/8001/8002/8003/8004	Electric Powered Point Operating Equipment			N/A	100	100	Professional Judgement
~~12000~~	**2400**	**N/A**	**1212/1400/6300**	**Train Movement and Protection Systems**						
~~12001~~	2410	N/A	1117/1118/1121/1136/1137/1141/1142/1401/1402/1404/1405/6141/6142/6304	Signals, Signs & Indicators	1.6	1.60%	N/A	40	30	Professional Judgement
~~12003~~	2420	N/A	6301/6302/6303	Trainstops	2	2.00%	N/A	100	-	Professional Judgement
~~13000~~	**2500**	120	**1111/2000/2400/6110**	**Interlocking Systems**	**13**	**13.00%**				
~~13001~~	2510		1111/1112/1115/1131/2101/6111/6112/6113/6132/6133	Mechanical Interlocking	(Included above)	(Included above)	N/A	100 (40 for manual sites)	40	Professional Judgement
~~13002~~	2520		1111/1112	Relay Interlocking			N/A	100	40	Professional Judgement
~~13003~~	2530	121/122	2401/2402/2403/2404	Computer Interlocking			N/A	20	30	Professional Judgement
~~14000~~	**2600**	**N/A**	**N/A**	**Signals & C&I Premises / Containment**						
~~14001~~	2610	N/A	N/A	Trackside Kiosks & Boxes	2	2.00%	N/A	100	30	Professional Judgement
~~14002~~	2620	N/A	1111	Signalling Equiment Rooms	22.99	22.99%	N/A	100	30 (REBs)	Professional Judgement
~~15000~~	**2700**	**240**	**5100/5107**	**Signals & C&I Power**						
~~15001~~	2710	241/710/711/712/713	5101/5102/5103/5104/5105	Power Supply	1.5	1.50%	N/A	60	30	Professional Judgement
~~15002~~	2720		5200/5200/5201/5202/5203/5204/	Air Main (includes air main assets outside substation boundary - pipework, isolation cocks, drain cocks and pressure valves)	1	1.00%	N/A	100	-	Professional Judgement
~~16000~~	**2800**	**170**	**4000**	**Transmission Systems**						
~~16001~~	2810		4100/4102/4103/4104/4105/4106/4107/4108/41	Cables & Routes	4	4.00%	N/A	40	30	Professional Judgement
~~16002~~	2820	N/A	N/A	Radio Control Systems	0.25	0.25%	N/A	20	30	Professional Judgement
~~16003~~	2830	171	4400/6400/6401/6402/6403/6404/6500/6600/6601/6602	Track-Train Comms	0.25	0.25%	N/A	20	30	Professional Judgement

~~2010 ACR No.~~	ACR No.	C&I FD* No.	Signalling FD* No.	Asset Description	RAV**	RAV %**	Unit	Nominal Life		Source of Nominal Life
								Legacy	Upgraded	
~~**17000**~~	**3000**	**N/A**	**1600**	**TrainBorne**						
~~**18000**~~	**3100**	**N/A**	**6400/6401/6402/6403/6404/6500/6600/6500/6600/6601/6602**	**Train Control Systems**						
~~18001~~	3110	N/A	N/A	ATO	1	1.00%	N/A	20	30	Professional Judgement
~~**19000**~~	**3200**	**N/A**	**N/A**	**Train Position Detection Systems**						
~~19001~~	3210	N/A	N/A	ATP	1	1.00%	N/A	20	30	Professional Judgement
~~**21000**~~	**4000**	**N/A**	**7000**	**Support Subsystems**						
~~21001~~	4100	N/A	7100/7200	Drawings & Manuals***	0.01	0.01%	N/A	100	100	Professional Judgement

* FD No. To provide cross reference to ACAC Foundation document reference numbering

** RAV: No MEAVs available for Signalling & C&I assets since these asset groups were not repriced in 1997 (RAVs = MEAVs minus £). In absence of MEAVs the RAVs are based upon an estimate of failure impact as a percentage by LUL Signalling and C&I engineers. The per line figures are available on RAVs - Line Values Sheet if required

*** Exception to clause 2.3 of ACR Standard 1-042

N/A not applicable

6.1.2 Asset Definition : Signalling and C&I			
ACR No.	**FD No.**	**Asset Definition**	**Comments**
2720	E&M 500	Compressed Air (including pipework, isolation cocks, drain cocks and pressure valves)	Signals are responsible for the air main assets outside the substation boundary (including pipe work, Isolation cocks, drain cocks and the pressure vessels which are positioned outside most interlocking machine rooms). This is included in the Signals hierarchy and has been removed from the E&M hierarchy
n/a	E&M 503 / 504	Compression plant and drying equipment	Compressors and the drying equipment within the substations are a PFI power asset, and they are therefore not currently in scope of the ACR

6.1.3 Reporting Requirements for Signalling and C&I

6.1.3.1 Signalling ACR - by Company

Signalling & C&I – Summary Report for xxx Company

~~2010 ACR N~~	ACR No.	C&I FD* No.	Signalling FD* No.	Actuals	RAV**	Physical Condition Code A % RAV	Code B % RAV	Code C % RAV	Code D % RAV	Functional Condition Code 1 Statutory non compliant Quantity	Code 2 Residual safety risk £ Risk	Code 3 uneconomic/ unsustainable £ Risk	Code 4 Risk of Performance Loss £ Risk
~~1000~~	1000	N/A	N/A	**Control Centre**									
~~2000~~	1100	110/120/130	1113	**Centralised Signalling Control**	**6**								
~~2001~~	1110	111/112/113	6000/6100/6131	Signalling Control Workstations	(Included above)	-	-	-	-				
~~2002~~	1120	115/121/122	N/A	Signalling Control Servers		-	-	-	-				
~~3000~~	1200	140	N/A	**Centralised Customer Information**		-	-	-	-				
~~3001~~	1210	141/142/143	N/A	Customer Information Server	2								
~~4000~~	1300	180/300	7300/7301	**Management Information**		-	-	-	-				
~~4001~~	1310	151/181	N/A	Data Warehouse Simulator	4								
~~5000~~	1400	230	N/A	**Training Systems or Simulators & Development Facilities**	**0.25**								
~~5001~~	1410	231	N/A	Signalling Simulator	(Included above)	-	-	-	-				
~~5002~~	1420	N/A	N/A	Asset Specific Test/Development Equipment		-	-	-	-				
~~6000~~	1500	N/A	N/A	**Signals & C&I Power**		-	-	-	-				
~~6001~~	1510	N/A	5000/5101/5102/51	Power Supply	0.5								
~~7000~~	1600	160/190	N/A	**Transmission Systems or LAN/Fibre Optics**		-	-	-	-				
~~7001~~	1610	161/191/192	N/A	Signals & C&I Interface and Communication Bearers	0.5								
~~8000~~	2000	N/A	N/A	**WaySide**									
~~9000~~	2100	200/220/320	1113	**Train Control System**		-	-	-	-				
~~9001~~	2110	221/312/322	1135/6121/1622/61	Wayside Signalling Control incl Depots & Sidings	12								
~~9002~~	2120	322/323	N/A	Signalling Communications Bearer	0.25								
~~9003~~	2130	143/144/145	N/A	Station Information	3								
~~9004~~	2140	N/A	N/A	ATO Trackside	1								
~~10000~~	2200	N/A	1500	**Train Detection Systems**	**14**								
~~10001~~	2210	N/A	1201/1202/1203/12	Train Detection	(Included above)	-	-	-	-				
~~10002~~	2220	N/A	N/A	Position Detectors		-	-	-	-				
~~10003~~	2230	N/A	N/A	Axle Counters		-	-	-	-				
~~10004~~	2240	N/A	1501/1502/1503/15	Gauge Detectors		-	-	-	-				
~~10005~~	2250	N/A	1213/1214/1215/15	ATP Trackside	1								
~~11000~~	2300	N/A	1300/6200	**Train Routing System or Point Operating Equipment**	**4.9**								
~~11001~~	2310	N/A	1301/1302/1303/13	Air Powered Point Operating Equipment	(Included above)	-	-	-	-				
~~11002~~	2320	N/A	8000/8001/8002/80	Electric Powered Point Operating Equipment		-	-	-	-				
~~12000~~	2400	N/A	1212/1400/6300	**Train Movement and Protection Systems**		-	-	-	-				
~~12001~~	2410	N/A	1117/1118/1121/11	Signals, Signs & Indicators	1.6								
~~12003~~	2420	N/A	6301/6302/6303	Trainstops	2								
~~13000~~	2500	120	1111/2000/2400/61	**Interlocking Systems**	**13**								
~~13001~~	2510		1111/1112/1115/11	Mechanical Interlocking	(Included above)	-	-	-	-				
~~13002~~	2520		1111/1112	Relay Interlocking		-	-	-	-				
~~13003~~	2530	121/122	2401/2402/2403/24	Computer Interlocking		-	-	-	-				
~~14000~~	2600	N/A	N/A	**Signals & C&I Premises / Containment**		-	-	-	-				
~~14001~~	2610	N/A	N/A	Trackside Kiosks & Boxes	2								
~~14002~~	2620	N/A	1111	Signalling Equiment Rooms	22.99								
~~15000~~	2700	240	5100/5107	**Signals & C&I Power**		-	-	-	-				
~~15001~~	2710	241/710/711	5101/5102/5103/51	Power Supply	1.5								
~~15002~~	2720		5200/5200/5201/52	Air Main (includes air main assets outside substation boundary - pipework, isolation cocks, drain cocks and pressure values)	1								
~~16000~~	2800	170	4000	**Transmission Systems**		-	-	-	-				
~~16001~~	2810		4100/4102/4103/41	Cables & Routes	4								
~~16002~~	2820	N/A	N/A	Radio Control Systems	0.25								
~~16003~~	2830	171	4400/6400/6401/64	Track-Train Comms	0.25								
~~17000~~	3000	N/A	1600	**TrainBorne**									
~~18000~~	3100	N/A	6400/6401/6402/64	**Train Control Systems**									
~~18001~~	3110	N/A	N/A	ATO	1								
~~19000~~	3200	N/A	N/A	**Train Position Detection Systems**									
~~19001~~	3210	N/A	N/A	ATP	1								
~~21000~~	4000	N/A	7000	**Support Subsystems**									
~~21001~~	4100	N/A	7100/7200	Drawings & Manuals	0.01								
				Signalling & C&I									
				Previous									
				Actual									
				Variance									
				Commentary on Variances:									
				A brief explanation of any significant variances of previous vs.									
				The Nominee Company shall complete and submit one									

6.1.3 Reporting Requirements for Signalling and C&I

6.1.3.1 Signalling ACR - By Line

				Signalling & C&I – Byl Line								
				Actuals	Physical Condition				Functional Condition			
					Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
~~2010 ACR N~~	ACR No.	C&I FD* No.	Signalling FD* No.		%RAV	%RAV	%RAV	%RAV	Statutory non Quantity	Residual safety risk £ Risk	uneconomic/ unsustainabl £ Risk	Risk of Performance £ Risk
~~1000~~	1000	N/A	N/A	**Control Centre**								
~~2000~~	1100	110/120/130	1113	**Centralised Signalling Control**								
~~2001~~	1110	111/112/113	6000/6100/6131	Signalling Control Workstations								
~~2002~~	1120	115/121/122	N/A	Signalling Control Servers								
~~3000~~	1200	140	N/A	**Centralised Customer Information**								
~~3001~~	1210	141/142/143	N/A	Customer Information Server								
~~4000~~	1300	180/300	7300/7301	**Management Information**								
~~4001~~	1310	151/181	N/A	Data Warehouse Simulator								
~~5000~~	1400	230	N/A	**Training Systems or Simulators & Development Facilities**								
~~5001~~	1410	231	N/A	Signalling Simulator								
~~5002~~	1420	N/A	N/A	Asset Specific Test/Development Equipment								
~~6000~~	1500	N/A	N/A	**Signals & C&I Power**								
~~6001~~	1510	N/A	5000/5101/5102/51	Power Supply								
~~7000~~	1600	160/190	N/A	**Transmission Systems or LAN/Fibre Optics**								
~~7001~~	1610	161/191/192	N/A	Signals & C&I Interface and Communication Bearers								
~~8000~~	2000	N/A	N/A	**WaySide**								
~~9000~~	2100	200/220/320	1113	**Train Control System**								
~~9001~~	2110	221/312/322	1135/6121/1622/61	Wayside Signalling Control incl Depots & Sidings								
~~9002~~	2120	322/323	N/A	Signalling Communications Bearer								
~~9003~~	2130	143/144/145	N/A	Station Information								
~~9004~~	2140	N/A	N/A	ATO Trackside								
~~10000~~	2200	N/A	1500	**Train Detection Systems**								
~~10001~~	2210	N/A	1201/1202/1203/12	Train Detection								
~~10002~~	2220	N/A	N/A	Position Detectors								
~~10003~~	2230	N/A	N/A	Axle Counters								
~~10004~~	2240	N/A	1501/1502/1503/15	Gauge Detectors								
~~10005~~	2250	N/A	1213/1214/1215/15	ATP Trackside								
~~11000~~	2300	N/A	1300/6200	**Train Routing System or Point Operating**								
~~11001~~	2310	N/A	1301/1302/1303/13	Air Powered Point Operating Equipment								
~~11002~~	2320	N/A	8000/8001/8002/80	Electric Powered Point Operating Equipment								
~~12000~~	2400	N/A	1212/1400/6300	**Train Movement and Protection Systems**								
~~12001~~	2410	N/A	1117/1118/1121/11	Signals, Signs & Indicators								
~~12003~~	2420	N/A	6301/6302/6303	Trainstops								
~~13000~~	2500	120	1111/2000/2400/61	**Interlocking Systems**								
~~13001~~	2510		1111/1112/1115/11	Mechanical Interlocking								
~~13002~~	2520		1111/1112	Relay Interlocking								
~~13003~~	2530	121/122	2401/2402/2403/24	Computer Interlocking								
~~14000~~	2600	N/A	N/A	**Signals & C&I Premises / Containment**								
~~14001~~	2610	N/A	N/A	Trackside Kiosks & Boxes								
~~14002~~	2620	N/A	1111	Signalling Equipment Rooms								
~~15000~~	2700	240	5100/5107	**Signals & C&I Power**								
~~15001~~	2710	241/710/711	5101/5102/5103/51	Power Supply								
~~15002~~	2720		5200/5200/5201/52	Air Main (includes air main assets outside substation boundary - pipework, isolation cocks, drain cocks and pressure values)								
~~16000~~	2800	170	4000	**Transmission Systems**								
~~16001~~	2810		4100/4102/4103/41	Cables & Routes								
~~16002~~	2820	N/A	N/A	Radio Control Systems								
~~16003~~	2830	171	4400/6400/6401/64	Track-Train Comms								
~~17000~~	3000	N/A	1600	**TrainBorne**								
~~18000~~	3100	N/A	6400/6401/6402/64	**Train Control Systems**								
~~18001~~	3110	N/A	N/A	ATO								
~~19000~~	3200	N/A	N/A	**Train Position Detection Systems**								
~~19001~~	3210	N/A	N/A	ATP								
~~21000~~	4000	N/A	7000	**Support Subsystems**								
~~21001~~	4100	N/A	7100/7200	Drawings & Manuals								
				Signalling & C&I								
				Previous								
				Actual								
				Variance								

6.1.1 Signalling and C&I version: RAVs Per Line

~~2010 ACR~~	ACR No.	C&I FD* No.	Signalling FD* No.	Asset Description	RAV (%)	RAV Bak	RAV Cen	RAV Cir	RAV Dis	RAV Jub	RAV Met	RAV Nor	RAV Pic	RAV Vic	RAV W&C	Unit	Nominal Life Legacy	Nominal Life Upgraded	Source of Nominal Life
~~1000~~	**1000**	**N/A**	**N/A**	**Control Centre**												N/A	N/A	N/A	
~~2000~~	**1100**	**110/120/130/310**	**1113**	**Centralised Signalling Control**															
~~2001~~	1110	111/112/113/114/ 116/130	6000/6100/6131	Signalling Control Workstations	6.0%	7627	71595	30580	48591	72408	21592	42959	15586	56874	3157	N/A	10	30	Professional Judgement
~~2002~~	1120	115/121/122/123/ 131/132/311	N/A	Signalling Control Servers												N/A	10	10	Professional Judgement
~~3000~~	**1200**	**140**	**N/A**	**Centralised Customer Information**															
~~3001~~	1210	141/142/143/142/ 143	N/A	Customer Information Server	2.0%	2542	23865	10193	16197	24136	7197	14320	5195	18958	1052	N/A	10	10	Professional Judgement
~~4000~~	**1300**	180/300	7300/7301	**Management Information**															
~~4001~~	1310	151/181	N/A	Data Warehouse Simulator	4.0%	5085	47730	20387	32394	48272	14395	28639	10391	37916	2105	N/A	10	10	Professional Judgement
~~5000~~	**1400**	230	N/A	**Training Systems or Simulators & Development Facilities**															
~~5001~~	1410	231	N/A	Signalling Simulator	0.25%	318	2983	1274	2025	3017	900	1790	649	2370	132	N/A	10	30	Professional Judgement
~~5002~~	1420	N/A	N/A	Asset Specific Test/Development Equipment												N/A	10	30	Professional Judgement
~~6000~~	**1500**	**N/A**	**N/A**	**Signals & C&I Power**															
~~6001~~	1510	N/A	5000/5101/5102/ 5102/5103/5104/ 5105	Power Supply	0.5%	636	5966	2548	4049	6034	1799	3580	1299	4740	263	N/A	40	30	Professional Judgement
~~7000~~	**1600**	**160/190**	**N/A**	**Transmission Systems or LAN/Fibre Optics**															
~~7001~~	1610	161/191/192/193/ 511/512	N/A	Signals & C&I Interface and Communication Bearers	0.5%	636	5966	2548	4049	6034	1799	3580	1299	4740	263	N/A	10	30	Professional Judgement
~~8000~~	**2000**			**WaySide**												N/A	N/A	N/A	
~~9000~~	**2100**	200/220/320/321	1113	**Train Control System**															
~~9001~~	2110	221/312/322/323	1135/6121/1622/ 6123/6131	Wayside Signalling Control incl Depots & Sidings	12.0%	15254	143190	61160	97181	144815	43184	85917	31173	113749	6315	N/A	15	30	Professional Judgement
~~9002~~	2120	322/323	N/A	Signalling Communications Bearer	0.25%	318	2983	1274	2025	3017	900	1790	649	2370	132	N/A	10	30	Professional Judgement
~~9003~~	2130	143/144/145/201/ 202	N/A	Station Information	3.0%	3813	35797	15290	24295	36204	10796	21479	7793	28437	1579	N/A	10	30	Professional Judgement
~~9004~~	2140	N/A	N/A	ATO Trackside	1.0%	1271	11932	5097	8098	12068	3599	7160	2598	9479	526	N/A	15	30	Professional Judgement
~~10000~~	**2200**	**N/A**	**1500**	**Train Detection Systems**															
~~10001~~	2210	N/A	1201/1202/1203/ 1204/1205/1206/ 1207/1208/1209/ 1210/1211	Train Detection	14.0%	17796	167055	71353	113378	168951	50381	100237	36368	132707	7367	N/A	15	30	Professional Judgement
~~10002~~	2220	N/A	N/A	Position Detectors												N/A	15	30	Professional Judgement
~~10003~~	2230	N/A	N/A	Axle Counters												N/A	15	30	Professional Judgement
~~10004~~	2240	N/A	1501/1502/1503/ 1504/1505/1506/ 1507	Gauge Detectors															
~~10005~~	2250	N/A	1213/1214/1215/ 1501/1502/1503/ 1504/1505/1506/ 1507	ATP Trackside	1.0%	1271	11932	5097	8098	12068	3599	7160	2598	9479	526	N/A	15	30	Professional Judgement
~~11000~~	**2300**	**N/A**	**1300/6200**	**Train Routing System or Point Operating Equipment**															
~~11001~~	2310	N/A	1301/1302/1303/ 1304/1305/1306/ 1307/1308/1309/ 1310/6201/6202/ 6203/6204/6205/ 6206/6207/6208/ 6209/6210/6211/ 6212	Air Powered Point Operating Equipment	4.9%	5085	47730	20387	32394	48272	14395	28639	10391	37916	2105	N/A	100	100	Professional Judgement
~~11002~~	2320	N/A	8000/8001/8002/ 8003/8004	Electric Powered Point Operating Equipment												N/A	100	100	Professional Judgement
~~12000~~	**2400**	**N/A**	**1212/1400/6300**	**Train Movement and Protection Systems**															
~~12001~~	2410	N/A	1117/1118/1121/ 1136/1137/1141/ 1142/1401/1402/ 1404/1405/6141/ 6142/6304	Signals, Signs & Indicators	1.60%	2034	19092	8155	12957	19309	5758	11456	4156	15167	842	N/A	40	30	Professional Judgement
~~20003~~	2420	N/A	6301/6302/6303	Trainstops	2.0%	2542	23865	10193	16197	24136	7197	14320	5195	18958	1052	N/A	100	-	Professional Judgement
~~13000~~	**2500**	120	**1111/2000/2400/ 6110**	**Interlocking Systems**															
~~13001~~	2510		1111/1112/1115/ 1131/2101/6111/ 6112/6113/6132/ 6133	Mechanical Interlocking	13.0%	16525	155122	66256	105280	156883	46783	93077	33770	123228	6841	N/A	100 (40 for manual sites)	40	Professional Judgement
~~13002~~	2520		1111/1112	Relay Interlocking												N/A	100	40	Professional Judgement
~~13003~~	2530	121/122	2401/2402/2403/ 2404	Computer Interlocking												N/A	20	30	Professional Judgement

~~2010 ACR~~	ACR No.	C&I FD* No.	Signalling FD* No.	Asset Description	RAV (%)	RAV Bak	RAV Cen	RAV Cir	RAV Dis	RAV Jub	RAV Met	RAV Nor	RAV Pic	RAV Vic	RAV W&C	Unit	Nominal Life		Source of Nominal Life
																	Legacy	Upgraded	
~~14000~~	**2600**	**N/A**	**N/A**	**Signals & C&I Premises / Containment**															
~~14001~~	2610	N/A	N/A	Trackside Kiosks & Boxes	2.0%	2542	23865	10193	16197	24136	7197	14320	5195	18958	1052	N/A	100	30	Professional Judgement
~~14002~~	2620	N/A	1111	Signalling Equiment Rooms	22.99%	29224	274328	117172	186183	277442	82733	164603	59722	217924	12098	N/A	100	30 (REBs)	Professional Judgement
~~15000~~	**2700**	**240**	**5100/5107**	**Signals & C&I Power**															
~~15001~~	2710	241/710/711/712/ 713	5101/5102/5103/ 5104/5105	Power Supply	1.5%	1907	17899	7645	12148	18102	5398	10740	3897	14219	789	N/A	60	30	Professional Judgement
~~15002~~	2720		5200/5200/5201/ 5202/5203/5204/	Air Main (includes air main assets outside substation boundary - pipework, isolation cocks, drain cocks and pressure values)	1.0%	1271	11932	5097	8098	12068	3599	7160	2598	9479	526	N/A	100	-	Professional Judgement
~~16000~~	**2800**	**170**	**4000**	**Transmission Systems**															
~~16001~~	2810		4100/4102/4103/ 4104/4105/4106/ 4107/4108/4109	Cables & Routes	4.0%	5085	47730	20387	32394	48272	14395	28639	10391	37916	2105	N/A	40	30	Professional Judgement
~~16002~~	2820	N/A	N/A	Radio Control Systems	0.25%	318	2983	1274	2025	3017	900	1790	649	2370	132	N/A	20	30	Professional Judgement
~~16003~~	2830	171	4400/6400/6401/ 6402/6403/6404/ 6500/6600/6601/ 6602	Track-Train Comms	0.25%	318	2983	1274	2025	3017	900	1790	649	2370	132	N/A	20	30	Professional Judgement
~~17000~~	**3000**	**N/A**	**1600**	**TrainBorne**															
~~18000~~	**3100**	**N/A**	**6400/6401/6402/ 6403/6404/6500/ 6600/6500/6600/ 6601/6602**	**Train Control Systems**															
~~18001~~	3110	N/A	N/A	ATO	1.0%	1271	11932	5097	8098	12068	3599	7160	2598	9479	526	N/A	20	30	Professional Judgement
~~19000~~	**3200**	**N/A**	**N/A**	**Train Position Detection Systems**															
~~19001~~	3210	N/A	N/A	ATP	1.0%	1271	11932	5097	8098	12068	3599	7160	2598	9479	526	N/A	20	30	Professional Judgement
~~21000~~	**4000**	**N/A**	**7000**	**Support Subsystems**												N/A	N/A	N/A	
~~21001~~	4100	N/A	7100/7200	Drawings & Manuals	0.01%	13	119	51	81	121	36	72	26	95	5	N/A	100	100	
Train Control Average Annual LCH (2005 - 2009) at 2014 NACHs					100.0%	127114	1193249	509664	809843	1206795	359867	715977	259772	947907	52622				

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable
NOTE Regarding RAV values detailed above. Column F shows a percentage figure, this represents the percentage of total LCH a given subsystem would be expected to attract from the total LCH assigned to the Train Control System. The bottom row (58) "Train Control Average Annual LCH...." details the average annual LCH for the Train Control System per Line (figures provided by LU Performance Team from CuPID averaged over years 2005/6 to 2009/10 using the 2014 NACHS calculation. The columns titled "RAV Bak, RAV Cir etc" contain the RAV % proportion of the Train Control Average LCH for each of the Train Control System Assets in column D for each line.

Asset Definition : Control & Information				Comments raised at meeting 26/11/10
No	**Definition Groups**	**~~Old ACR Mapping~~**	**ACR Mapping**	
2007 Review: One minor asset definition change.				
The asset is attributed to an Infraco and Line on the basis of stewardship with assets leased				
100	**Interfaces (including input & output)**		**Removed**	
110	**Control Room Operations**	~~2000~~	1100	Is 2000 correct mapping? YES
111	Consoles (including push button desks; VDU display suites; tracker balls; keypad mouse; pushbutton programme machine control desk; desk mountings/housings)	~~2001~~	1110	
112	Overview Diagrams (including Fixed line diagrams; rear projection systems; VDUs; PTI displays.)	~~2001~~	1110	Agreed on 2001 mapping
113	Push Button Desks	~~2001~~	1110	
114	Displays (including tracker; PIMS display)	~~2001~~	1110	
115	Tracker	~~2002~~	1120	
116	Human Computer Interface (HCI)	~~2001~~	1110	
120	**Schedules [Local and Control centre equipment]**	~~13000 & 2000~~	1100/2500	What heading is required here as mapped to 2 areas? Local and Control centre equipment
121	Timetable (Timetable formats (effectively train management) including floppy disc, magnetic tape, e-mail etc. Includes how timetable information is translated into the control system (reader compatibility etc.).	~~13003 & 2002~~	1120/2530	
122	Crew Management (Crew schedule formats in any form including floppy disc, magnetic tape, e-mail etc. TIMIS interfaces such as entry pads on station headwalls. Includes how schedule information is translated into the control system (reader compatibility etc.))	~~13003 & 2002~~	1120/2531	
123	Programme Machine Roll	~~13003~~	1120	
130	**Maintenance**	~~2000~~	1100	Is this to be changed to 2000 Centralised Signalling Control? YES
131	Maintenance facility (Logging facilities etc.)	~~2002~~	1120	
132	System Related Warnings (Warnings and indications to Technical Officers.)	~~2002~~	1120	
140	**Customer Information**	~~3000~~	1200	
141	Customer Information System Displays (as far as C&I have responsibility) (Passenger Information Management System (PIMS); Sign Controllers; Display Media (including dot matrix; platform arrows etc.); Baker Street VDUs)	~~3001~~	1210	
142	Customer Information System Management (as far as C&I have responsibility) (LIA desk; CIS processors)	~~3001~~	1210	
143	Passenger Information Management System (PIMS)	~~3001/9003~~	1210/2130	Dependant on location of equipment (i.e. Control Centre or Station (Wayside))
144	Sign Controllers	~~9003~~	2130	
145	Display Media (including dot matrix; platform arrows etc.)	~~9003~~	2130	
150	**LUL Train Service Reporting**	~~4000~~	1300	Agreed on 4000 mapping
151	Management Information System (NORMIS etc.)	~~4001~~	1310	Agreed on 4001 mapping
160	**Signalling (e.g. Collection of Signalling Information)**	~~7000~~	1600	Agreed on 7000 mapping
161	Interfaces (S2; TEML40; SERCK)	~~7001~~	1610	Revised Heading
170	**~~Train~~ Transmission Systems**	~~16000~~	2800	Heading amended and agreed on 16000

171	Train Interface (Platform ATO Communicator; Positive Train Identification; TIMIS beacons/On Board Units)	**~~16003~~**	**2830**	Agreed on 16003 mapping
180	**Logging**	**~~4000~~**	**1300**	Agreed on 4000 mapping
181	Database (Quality and integrity of logging (from base information through to logging outputs))	**~~4001~~**	**1310**	Agreed on 4001 mapping
190	**Communications**	**~~7000~~**	**1600**	Agreed on 7000 mapping
191	Processing (DS network; X.25; RS232)	**~~7001~~**	**1610**	Agreed on 7001 mapping
192	Interface Boxes (Modems)	**~~7001~~**	**1610**	
193	Telephone Networks (Included in transmission)	**~~7001~~**	**1610**	
200	**Operations Rooms (e.g. Duty Manager Trains; Station Supervisors etc.)**	**~~9000~~**	**2100**	Is this to be mapped to 9000 Train Control System? YES
201	Control System Information terminals (including tracker) (Remote terminal; tracker; train arrival lists)	**~~9003~~**	**2130**	Agreed on 9003 mapping
202	Tracker	**~~9003~~**	**2130**	Agreed on 9003 mapping
210	**~~Traction~~**		**Not a C&I Asset**	
211	~~SCADA~~ ~~(Currently in abeyance)~~	**~~NOT A C&I ASSET~~**	**Not a C&I Asset**	REMOVE as Agreed NOT A C&I ASSET
220	**Depots**	**~~9000~~**	**2100**	Should this be 9000 Train Control System? YES
221	Depot interfaces (**e.g.** Shunters Panels; plungers; ~~CBI;~~ depot control system (SMD); ~~TIMIS terminals~~ **and similar**)	**~~9001~~**	**2110**	Agreed on 9001 mapping
230	**Training**	**~~5000~~**	**1400**	Asset Group responsible to be agreed January 2011 (Adie Shepherd involved in discussions)
231	Simulators (Programme machine replacement simulator; Met/Jub/Bakerloo simulator (at Baker Street))	**~~5001~~**	**1410**	Asset Group responsible to be agreed January 2011 (Adie Shepherd involved in discussions)
240	**Power**	**~~15000~~**	**2700**	
241	High Integrity Supplies (UPS; Dual LUL/CEGB supplies)	**~~15001~~**	**2710**	Agreed on 15001 mapping
300	**Processing**	**~~4000~~**	**1300**	Should heading be amended to Management Information? NO it already is on the new ACR Standard
310	**Centre Functions (elements)**	**~~2000~~**	**1100**	What should this heading be - Centralised Signalling Control or signalling Control Servers? Centralised Signalling Contro
311	Processors (ATR (Central Line); LICC)	**~~2002~~**	**1120**	Agreed on 2002 mapping
312	Programme Machine Centre Logic	**~~9001 & 2002~~**	**2110**	Agreed on 9001 and 2002 mapping
320	**Site Functions (elements)**	**~~9000~~**	**2100**	Should heading be amended to 9000 Train Control system?
321	Site Intelligence (LSCs; LNPs; PLCs)	**~~9001~~**	**2110**	Agreed on 9001 and 2002 mapping
322	Programme Machine	**~~9001 & 9002~~**	**2110/2120**	Agreed on 9001 and 2002 mapping
323	Programme Machine Logic Systems (Card; Relay; Lever Operation Boards)	**~~9002 & 9002~~**	**2110/2120**	Agreed on 9001 and 2002 mapping
330	**~~Software~~**		**Removed**	REMOVE as software part of System - Obsolescence covered within System assessment
331	~~Proprietary~~ ~~(Windows NT; Operating systems; COTS components; UNIX)~~		**Removed**	REMOVE as software part of System - Obsolescence covered within System assessment
332	~~Bespoke~~ ~~(North end of the Picc; Met/Jub control systems; Baker Street control systems; Programme Machine replacement; VME systems)~~		**Removed**	REMOVE as software part of System - Obsolescence covered within System assessment
340	**~~Data Production Facility~~**	**~~REMOVE~~**	**Removed**	
341	~~LUL CARTT~~ ~~(Programme machine roll punch; processors; interfaces)~~	**~~REMOVE~~**	**Removed**	Kunal I wrote 5002 - Asset Specific Test/Development equipment mapping which I think is a mistake???? YES, It should be removed all together

350	**Development Facilities**	**~~5000~~**	**1400**	What Heading should this be?? Training Systems or Simulators & Development Facilities
351	Software Development Systems	**~~5002~~**	**1420**	Agreed on 5002 mapping
352	Control System Data Generation Systems	**~~5002~~**	**1420**	Agreed on 5002 mapping
400	**~~Memory~~**	**~~REMOVE~~**	**Removed**	Agreed to REMOVE this item
500	**Transmission**	**~~7000~~**	**1600**	I did not note any mapping for this item ... None really required only bottom level required!
510	**Networks**	**~~REMOVE HEADING~~**	**Removed**	
511	Local area networks (Ethernet (Neasden Control Centre))	**~~7001~~**	**1610**	Agreed on 7001 mapping
512	Wide area networks (Supervisory Cables; Multi Drops; Fibre Optics)	**~~7001~~**	**1610**	Agreed on 7001 mapping
520	**~~Dedicated links~~** ~~(Telstar House backup control system links)~~		**Removed**	Agreed to REMOVE these items
600	**~~Decision~~**		**Removed**	Agreed to REMOVE these items
610	**~~Warnings~~**		**Removed**	Agreed to REMOVE these items
620	**~~Critical human decision making and actions~~** ~~(Presentation formats, clarity, quality and volume of information with potential to adversely affect operator decision making.)~~		**Removed**	Agreed to REMOVE these items
700	**~~Power Supply to Control Systems~~ Signals/C&I Power**	**~~15000~~**	**Removed**	Agreed to amend heading to Signals/C&I Power
710	**Electrical**	**~~15001~~**	**2710**	Should this heading be amended to Power Supply? No, ACR Standard is already Power supply
711	Normal supplies (Mains; CEGB/LUL; batteries)	**~~15001~~**	**2710**	Agreed on 15001 mapping
712	High Integrity Supplies (UPS; Dual LUL/CEGB supplies)	**~~15001~~**	**2710**	Agreed on 15001 mapping
713	Standby supply (Generators; auto switching etc.)	**~~15001~~**	**2710**	Agreed on 15001 mapping
720	**Air** (Programme machine supply; air pressure monitoring)	**~~15002~~**	**2720**	I crossed out 15002 from C&I but may have made a mistake as the air monitoring equip is C&I? It is as shown
800	**Support systems**	**~~21000~~**	**4000**	
810	**O&M Manuals**	**~~21001~~**	**4100**	
811	Operational Information	**~~21001~~**	**4100**	Agreed on 21001 mapping
812	Engineering Information	**~~21001~~**	**4100**	Agreed on 21001 mapping
820	**~~LUL Ops Strategy~~**		**Removed**	Agreed to REMOVE these items
821	~~Required duty (e.g. operating in degraded condition)~~		**Removed**	Agreed to REMOVE these items
822	~~Operating philosophy~~		**Removed**	Agreed to REMOVE these items
830	**Drawings & Manuals**	**~~21001~~**	**4100**	Agreed on 21001 mapping and to ADD Manuals to heading
840	**Training manuals**	**~~21001~~**	**4100**	Agreed on 21001 mapping

Asset Definition : Signalling

No	Definition Groups	Interfaces With			
The asset is attributed to an Infraco and Line on the basis of stewardship with assets leased to external organisations			~~Old ACR mapping~~	ACR mapping	Comments from meeting
1000	**Input Sub Systems**				
1100	**Man/machine interface - system inputs**				
1110	**Signal Operators and Shunters**				
1111	Power frame levers		~~13000/1/2~~	2500/2510/2520	Agreed on 13000/1/2 mapping
1112	Signalman's handscrew emergency release		~~13001/2~~	2510/2520	Agreed on 13001/2 mapping
1113	Signalman's route push buttons		~~2000 & 9000~~	1100/2100	Agreed on 2000 & 9000 mapping
~~1114~~	~~Depot Point Switches~~		~~Not Signals~~	Not a Signalling Asset	Agreed not a signals asset
1115	Ground frame levers		~~13001~~	2510	Agreed on 13001 mapping
1116	Williams toggle point levers		~~PWAY asset~~	Not a Signalling Asset	Agreed a PWAY Asset
1117	Shunter's plungers		~~12002~~	2410	Agreed on 12002 mapping
1118	Switchlock plungers		~~12002~~	2410	Agreed on 12002 mapping
1120	**Train Operators**				
1121	Driver's plungers		~~12002~~	2410	Agreed on 12002 mapping
1130	**Maintainers**				
1131	Interlocking machine levers		~~13001~~	2510	
~~1132~~	~~SER route push controls~~			Removed	Agreed to REMOVE these items
~~1133~~	~~SER point switches~~			Removed	Agreed to REMOVE these items
~~1134~~	~~Temporary speed restriction switches~~			Removed	Agreed to REMOVE these items
1135	SER Westrace Maintenance PC		~~9001~~	2110	
1136	SER Westrace emergency release keyswitches		~~12002~~	2410	
1137	Special keyswitches (leaf fall control, p/m local control)		~~12002~~	2410	
1140	**Others**				
1141	Staff protection keyswitches		~~12002~~	2410	
1141	Fog signal switches		~~12002~~	2410	
1142	Passenger emergency plungers		~~12002~~	2410	
1200	**Train status, position and speed detection (trackside)**		~~10000~~		
1201	Capacitor fed AC track circuits (33.3Hz, 125Hz - Glass enclosed relays)		~~10001~~	2210	
1202	Capacitor fed AC track circuits (50Hz - VT1 relays)		~~10001~~	2210	
1203	Jointless Track Circuits		~~10001~~	2210	
1204	Victoria Line coded track circuits		~~10001~~	2210	
1205	1978 coded track circuits		~~10001~~	2210	

1206	Depot semi-vital track circuits		~~10001~~	2210	
1207	10Hz overlay rail circuits		~~10001~~	2210	
1208	Blockjointed rail circuits		~~10001~~	2210	
1209	SEL position detectors		~~10001~~	2210	
1210	Axle counter systems		~~10001~~	2210	
1211	Track circuit interruptors		~~10001~~	2210	
1212	Train speed inductors		~~12000~~	2400	
1213	Tripcock Detector		~~10005~~	2250	Agreed to rename as Tripcock Detector
1214	Surface stock detectors (U-tubes)		~~10005~~	2250	
1215	Low negative shoe detectors	Rolling Stock	~~10005~~	2250	
~~1216~~	~~Faulty train detectors~~			Removed	Agreed to REMOVE this item
1300	**Point and lock detection**		~~11000~~	2300	
1301	4-foot		~~11001~~	2310	
1302	6-foot		~~11001~~	2310	
1303	Chairlock		~~11001~~	2310	
1304	Clamplock		~~11001~~	2310	
1305	M63		~~11001~~	2310	
1306	HW1000		~~11001~~	2310	
1307	Detached circuit breaker boxes		~~11001~~	2310	
1308	Contactless depot points		~~11001~~	2310	
1309	Pneumatic detectors for supplementary drive control		~~11001~~	2310	
1310	Switchlock detection		~~11001~~	2310	
1400	**Signal and trainstop state detection (and other train movement authority devices)**		~~12000~~	2400	
1401	EP disc signals (with standard or non-standard contact arrangements)		~~12001~~	2410	
1402	Colour light lamp proving (Met main, Waterloo & City)		~~12001~~	2410	
1402	Position light lamp proving (Waterloo & City)		~~12001~~	2410	
1404	Junction indicator proving (tunnel and open)		~~12001~~	2410	
1405	Trainstop detection (J, K, KC, HO, HT, CLR, DR, LER, with standard or non standard contact arrangements)		~~12001~~	2410	
1500	**Infrastructure, environment or other miscellaneous detectors and actuators**		~~10000~~	2200	
1501	Air-off/low air pressure detectors		~~10006~~	2240	~~Kunal to confirm 10006 not on hierarchy - DONE~~
1502	Low/high voltage detectors		~~10006~~	2240	~~Kunal to confirm 10006 not on hierarchy - DONE~~
1503	Floodgate detectors		~~10006~~	2240	~~Kunal to confirm 10006 not on hierarchy - DONE~~
1504	Rainfall detectors (track circuit boosting)		~~10006~~	2240	~~Kunal to confirm 10006 not on hierarchy - DONE~~

1505	Point heater thermostats		~~10006~~	2240	~~Kunal to confirm 10006 not on hierarchy - DONE~~
1506	Traction earth detectors		~~10006~~	2240	~~Kunal to confirm 10006 not on hierarchy - DONE~~
1507	AC-on-DC detectors		~~10006~~	2240	~~Kunal to confirm 10006 not on hierarchy - DONE~~
1600	**Train borne interface/input devices (including train status, position and speed detection)**		~~17000~~	3000	
2000	**Vital Logic processing sub-systems**		~~13000~~	2500	
2100	**Mechanical logic elements**				
2101	Interlocking frames (B, K, N, N2, V)		~~13001~~	2510	
~~2200~~	~~**Electromechanical logic elements**~~			Combined with the system that it services	Agreed to combine with the system that it services
~~2201~~	~~Plug in electrical relays - BR930 all types (e.g. QN1, QMT3 (50Hz, 125Hz, 33.3Hz etc)) (excluding latched relays)~~			Combined with the system that it services	Agreed to combine with the system that it services
~~2202~~	~~Screw in electrical relays - Q (track); Q (line)~~			Combined with the system that it services	Agreed to combine with the system that it services
~~2203~~	~~Detachable top electrical relays - DEV (track, line); SEV; 3-POS DEV; BG~~			Combined with the system that it services	Agreed to combine with the system that it services
~~2204~~	~~Route indicator relays (1-5, 6-10); LT (4.5sec, 15sec); N (1min, 2min) – 33.3Hz/125Hz~~			Combined with the system that it services	Agreed to combine with the system that it services
~~2205~~	~~Frequency relays (20, 25, 30mph); F3 (6v, 12v, 60v) - DC Hard wired - C, D~~			Combined with the system that it services	Agreed to combine with the system that it services
~~2300~~	~~**Solid state non-microprocessor logic elements**~~			Combined with the system that it services	Agreed to REMOVE this item
~~2301~~	~~Magnetic amplifier elements~~			Combined with the system that it services	Agreed to REMOVE this item
~~2302~~	~~Electronic elements (e.g. Northumberland Park depot sub-systems.~~			Combined with the system that it services	Agreed to REMOVE this item
2400	**Microprocessor based logic elements**		~~13000~~	2500	
2401	Westrace		~~13003~~	2530	
2402	VPI		~~13003~~	2530	
2403	Diverse Monitoring Unit (PLC)		~~13003~~	2530	
2404	CBI		~~13003~~	2530	
~~2500~~	~~**Critical human decision making and actions**~~			Removed	Agreed to REMOVE this item
~~3000~~	~~**Vital Memory Elements**~~			Removed	Agreed to REMOVE this item
~~3100~~	~~**Mechanical**~~			Removed	Agreed to REMOVE this item
~~3101~~	~~Levers~~			Removed	Agreed to REMOVE this item
~~3200~~	~~**Electromechanical**~~			Removed	Agreed to REMOVE this item
~~3201~~	~~Gravity bias relays~~			Removed	Agreed to REMOVE this item
~~3300~~	~~**Electromagnetic**~~			Removed	Agreed to REMOVE this item
~~3301~~	~~Latched relays~~			Removed	Agreed to REMOVE this item
~~3400~~	~~**Solid state**~~			Removed	Agreed to REMOVE this item

4000	**Vital Data Transmission Sub Systems**		~~16000~~	2800	
4100	**Electrical**		~~16001~~	2810	Kunal/Mick to develop suitable wording to cover these items
4101	Lead covered cable			2810	Kunal/Mick to develop suitable wording to cover these items
4102	Fault screened concentric cable			2810	Kunal/Mick to develop suitable wording to cover these items
4103	Non fault screened concentric cable			2810	Kunal/Mick to develop suitable wording to cover these items
4104	Vital multicore cable (with overall outer screen)			2810	Kunal/Mick to develop suitable wording to cover these items
4105	Vital multicore cable (unscreened)			2810	Kunal/Mick to develop suitable wording to cover these items
4106	Track crossing cable (various types/lengths, F.S. or non-F.S)			2810	Kunal/Mick to develop suitable wording to cover these items
4107	Clamplock tail cables (Litton connector)			2810	Kunal/Mick to develop suitable wording to cover these items
4108	Track circuit tails			2810	Kunal/Mick to develop suitable wording to cover these items
4109	Relay room wire - various conductor sizes and types			2810	Kunal/Mick to develop suitable wording to cover these items
~~4200~~	~~**Mechanical**~~			Removed	Agreed to REMOVE this item as deemed part of system
~~4201~~	~~Air hose (trainstop, point cylinder, ground lock)~~			Removed	Agreed to REMOVE this item as deemed part of system
~~4202~~	~~Air slug (pneumatic delay line in trainstop feed)~~			Removed	Agreed to REMOVE this item as deemed part of system
4300	**Optical**				
4400	**Electromagnetic (e.g.radio; microwave; inductive coupling etc.).**		~~16003~~	2830	
5000	**Power Supply Sub Systems**		~~6001~~	1510	
5100	**Electrical**		~~15000~~	2700	
5101	Transformers (for correct frequency, voltage, inrush current, load current, resistance to saturation)		~~15001/6001~~	2710/1510	
5102	Rectifier units		~~15001/6001~~	2710/1510	
5103	DC power units (regulated/unregulated)		~~15001/6001~~	2710/1510	
5104	Earthing bonds		~~15001/6001~~	2710/1510	
5105	UPS units		~~15001/6001~~	2710/1510	
5106	Power cables		~~part of system~~	Part of system	Kunal/Mick to develop suitable wording to cover these items
5107	Isolating switches and links		~~15000~~	2700	
5108	Circuit breakers and MCBs (time/current characteristics)		~~part of system~~	Part of system	Kunal/Mick to develop suitable wording to cover these items
5109	Cartridge fuses/links - HRC, Zed, Weekes, Westinghouse, Ericson, Feraz		~~part of system~~	Part of system	Kunal/Mick to develop suitable wording to cover these items
5200	**Pneumatic**		~~15002~~	2720	
5201	Mains (various sizes)		~~15002~~	2720	
5202	Isolating cocks		~~15002~~	2720	
5203	Drain Taps		~~15002~~	2720	
5204	Compensators		~~15002~~	2720	
6000	**Output Sub Systems**		~~2000~~	1100	

6100	**Man/machine interface - system outputs (Visual (vital signal displays, CRTs etc); Audible)**		~~2001~~	1110	
6110	**Signal Operators and Shunters**		~~13000~~	2500	
6111	Lever plate visuals		~~13001~~	2510	
6112	Lever locks		~~13001~~	2510	
6113	Bells/buzzers		~~13001~~	2510	
6120	**Train Operators**		~~12000~~	2400	
6121	Light signals (colour light, position light, COL - lenses, lamps, transformers)		~~12001~~	2410	
6122	Internally illuminated legends (A, T, speed, RS, shunt signal repeater, junction indicator repeater, etc)		~~12001~~	2410	
6123	Disc signal (with detachable plates for shunt, call on, warning, banner repeater or distant)		~~12001~~	2410	
6130	**Maintainers**				
6131	Illuminated diagrams (fixed, mosaic tile, normally lit, normally unlit, VDU)		~~9001/2001~~	1110/2110/	
6132	Interlocking machine lever locks		~~13001~~	2510	
6133	Air off' indicators		~~13001~~	2510	
~~6134~~	~~Coincidence flap indicators~~			Removed	Agreed to REMOVE this item
~~6135~~	~~Audible output devices~~			Removed	Agreed to REMOVE this item
~~6136~~	~~Cable and terminal identifications~~			Removed	Agreed to REMOVE this item
6140	**Others**				
6141	Cross now' signs		~~12001~~	2410	
6142	Road traffic lights (depots)		~~12001~~	2410	
6200	**Point operating sub-systems**		~~11000~~	2300	
6201	4-foot		~~11001~~	2310	
6202	6-foot		~~11001~~	2310	
6203	Chairlock		~~11001~~	2310	
6204	Clamplock		~~11001~~	2310	
6205	M63		~~11002~~	2320	
6206	HW1000		~~11002~~	2320	
6207	Unlocked powered points (trailing layouts, depot points)		~~11001~~	2310	
6208	Spring trailing/power facing		~~11001~~	2310	
6209	Supplementary drive systems (mechanical/pneumatic)		~~11001~~	2310	
6210	Switchlocks		~~11001~~	2310	
6211	EP valves (universal, fixed frequency, GE, SA, various voltages)		~~11001~~	2310	
6212	Point auxiliary valves		~~11001~~	2310	
~~6213~~	~~Point heaters (oil, pad, strip, cartridge)~~			Removed	Agreed to REMOVE this item

~~6214~~	~~Point clips and other accessories~~	~~Safety interlock; interfaces with track.~~		Removed	Agreed to REMOVE this item
6300	**Signal and trainstop operating sub-systems (including sighting)**		~~12000~~	2400	
6301	EP valves (universal, fixed frequency, GE, SA, various voltages)		~~12003~~	2420	
6302	Trainstops		~~12003~~	2420	
6303	Fixed trainstops		~~12003~~	2420	
6304	Tripcock testers		~~12001~~	2410	
6400	**Automatic train command sub-systems**		~~18000/16003~~	2830/3100	
6401	Code generators and receivers/Code acceptance units		~~18000/16003~~	2830/3100	
6402	Transmitters/Track feed sets		~~18000/16003~~	2830/3100	
6403	ATP Controller (Train safety boxes; Vic line, Central line)	Rolling Stock	~~18000/16003~~	2830/3100	
6404	Spot generators (Vic line, Central line)		~~18000/16003~~	2830/3100	
6500	**Train borne output devices**		~~18000/16003~~	2830/3100	
6600	**Other miscellaneous output sub-systems**		~~18000/16003~~	2830/3100	
6601	EP activators (levers, derailers, remote circuit breaker resets)		~~18000/16003~~	2830/3100	
6602	PED output interface	E&M	~~18000/16004~~	2830/3100	Electrical and Mechanical
7000	**Support Sub Systems**		~~21000~~	4000	
7100	**Equipment operating and maintenance manuals**		~~21001~~	4100	
7200	**Drawings**		~~21001~~	4100	
7300	**Essential diagnostic systems**		~~4000~~	1300	
7301	Diagnostic PCs (including Westrace)		~~4000~~	1300	
7400	**Operating rules**			Agreed to assess against asset/system	Agreed to assess against asset/system
~~7401~~	~~Working manual~~			Removed	Agreed to REMOVE this item
7500	**Electronic and magnetic data.**			Agreed to assess against asset/system	Agreed to assess against asset/system
7600	**Logging systems**			Agreed to assess against asset/system	Agreed to assess against asset/system
7700	**Design rules**			Agreed to assess against asset/system	Agreed to assess against asset/system
7800	**Maintenance rules**			Agreed to assess against asset/system	Agreed to assess against asset/system
7900	**Asset Information Systems**			Agreed to assess against asset/system	Agreed to assess against asset/system
8000	**Point heaters**		~~11002~~	2320	
8001	Oil		~~11002~~	2320	
8002	Pad		~~11002~~	2320	
8003	Strip		~~11002~~	2320	
8004	Cartridge		~~11002~~	2320	
~~8100~~	~~**Equipment room cooling units**~~	~~**E&M**~~		Removed	Agreed to REMOVE this item

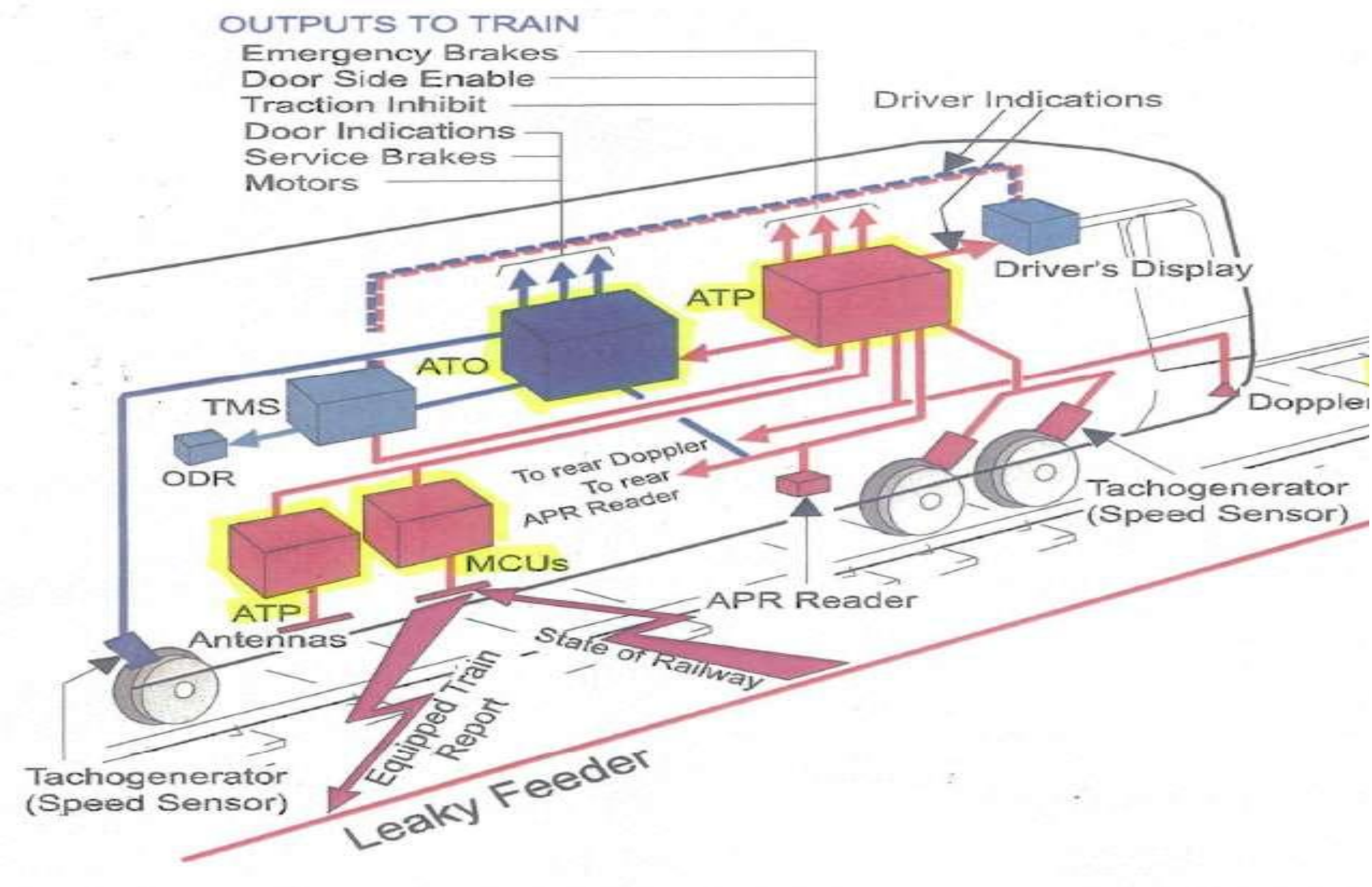
Asset Condition Reporting - Home for Train borne ATO / ATP equipment

The highlighted sections in the ATO/ATP Diagram below will be under the Signals and C&I and the rest will be Rolling Stock equipment for ACR purposes only. This is to ensure that the concerns are captured and are in one place for the ATO/ATP equipment.

The defining factors on train-borne signal equipment are around them being replaceable units and having inbuilt logic (i.e. not passive). Therefore all cabling between, racks, mounts and brackets will remain under Rolling Stock. Obviously this applies for the software attached to these components as well as the hardware.

Please Note It will not affect Ellipse, day to day management, or on the ground work; it is only for ACR purposes

ATO/ATP Diagram (based on VLU but generally applicable to all lines):



In ellipse (so for ex-MR only) this means that the following will be reported (for ACR purposes only) under Signalling and C&I (a few of these need to be resolved)

E2 Asset Group	E4 Asset Sub -Group	E6 Asset System	E8 Asset Sub-System	E10 Functional Location/Equipment	Comment
Rolling Stock	Rolling Stock Unit	Rolling Stock Car	Blank	Auto Train Op Cntllr	
				Auto Train Prot Ctlr	
			RS Cab	ATC Box 7	67? kit then Fleet
				ATP Control Unit	
				Mobile Communications Unit	VLU? then Signals
				Mobile Communications Unit Unlinked	
			Zone24 Auto Trn Ctrl	<Tx/Rx> Antenna	67? kit then Fleet
				Auto Drive Box	
				Safety Box	

UNDERGROUND

S1042 Asset Condition Reporting (ACR)

Electrical and Mechanical

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Business Objective

The purpose scope and requirements of the ACR is defined in the Cat 1 Standard 5-042.

In addition the Sponsor requires the ACR to provide a systematic process for the evaluation of the condition of our assets supporting the preparation of the annual asset management plan and longer term business planning. This will:

- Achieve a balance between capital and maintenance funds
- Demonstrate functional suitability and performance
- Demonstrate physical and operational condition

1 Purpose

This document sets out the specific requirements for condition reporting for electrical assets and forms an appendix to standard 5-042. This provides visibility by which London Underground can understand:

- Whether the electrical infrastructure and the use to which it is being put is in accordance with its approval and design.
- How the asset condition is performing with regard to its age and environmental conditions
- How to plan the timely and most cost effective renewal of the asset
- Whether the maintenance regimes are robust enough to deliver the anticipated life expectancy

2 Scope of Condition Reporting

All electrical systems, and equipment, that is owned or leased by London Underground excluding those forming part of PFI or secondary revenue contracts. The asset hierarchy for electrical assets is detailed in standard 5-042 Asset Condition Reporting.

The review is a “Desk Top” exercise drawing on information from asset inspections and routine assessment / maintenance activities requiring the assessor to co-ordinate the information and draw final conclusions on the condition and performance of the assets.

A flow diagram in Appendix A details the ACR process and linkage to the asset work bank and risk register.

If the asset is declared as a concern in the preceding ACA / ACR a re-assessment shall be undertaken yearly until it is renewed.

In addition to pre-existing concerns, the assets and locations covered in each annual review will be detailed in the Sponsors requirement document issued to compliment the standard and to assist the preparation and completion on the assessment.

Due to the volume of electrical assets and variety of age and condition in the estate it is neither necessary nor efficient to survey the whole asset base in each year. Therefore the scope of the yearly assessment shall be determined by asset age. For the purposes of determining the review programme, the nominal equipment life spans shall be used as detailed in Standard 5-042.

For an asset having a **10 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 5th and 6th anniversary of it's commissioning
- and then in the year between its 7th and 8th anniversary of it's commissioning

For an asset having a **15 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 7th and 8th anniversary of it's commissioning
- and then in the year between its 12th and 13th anniversary of it's commissioning

For an asset having a **20 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 10th and 11th anniversary of it's commissioning
- and then in the year between its 17th and 18th anniversary of it's commissioning

For an asset having a **25 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 12th and 13th anniversary of it's commissioning
- and then in the year between its 22nd and 23rd anniversary of its commissioning

For an asset having a **30 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 10th and 11th anniversary of its commissioning
- and then in the years between its 18th and 19th and 27th and 28th anniversaries of its commissioning

Where an assets renewal is deferred beyond its nominal life span then it shall be subject to the following asset condition assessment regime:

- in the year of expiry of nominal life, as applicable
- Then in each of the years after the passage of a further two anniversaries until it is renewed.

For cables an asset condition assessment shall be undertaken:

- when the cable reaches an approximate point halfway through its nominal lifespan i.e. after 15 years from its commissioning
- then every 3 years until its replacement.

In addition to the programme of assessments detailed above, the Stations Maintenance Sponsor requires the following to be taken into account:

a. Statutory Electrical Testing

A Statutory Electrical Test (SET) is required to be completed every three years. The concerns arising from the assessment shall be included in the ACR for the following year i.e. SET completed in 2010, concerns included in ACR 2011. Where there is no evidence of a test having been completed a functional condition Code 1 concern shall be raised against the asset concerned.

Where a Statutory Electrical Test has been completed and safety related remedial actions have been raised a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

b. Earthing Management Plan

An earthing management plan is required to be in place for each complex earthing installation. Where there is no evidence of an earthing management plan a functional condition Code 2 concern shall be raised if the lack of a plan presents a safety risk.

The frequency of condition assessment shall be as determined in the individual earthing management plan or as a minimum every three years. The concerns arising from the assessment shall be included in the following years ACR.

c. Emergency Power Supplies

Emergency power supplies are vital to the continued operation of the railway and are regularly inspected through a cycle of visual inspection, functional and discharge testing. The outstanding concerns registered from these tests shall be included as concerns in the ACR each year.

d. Lighting

Lighting systems are subjected to regular inspection by LU Operations and subject to an illumination test during the three yearly SET. The concerns arising from the assessment shall be included in the ACR for the following year i.e. SET completed in 2010, concerns included in ACR 2011. Where there is no evidence of a test having been completed the asset a functional condition Code 2 concern shall be raised.

e. Outstanding Defects

Asset information is gathered through other means such as Planned General Inspections or through planned or reactive maintenance. Concerns raised through these routes shall be recorded in the annual ACR if they have not been rectified by three months from the date of inspection as Code 1 or 2 conditions if a legislation of safety concern exists.

3 Responsibilities

It is the joint responsibility of the Maintenance Sponsor, Client Engineer, Head of Profession and engineering representatives of CMO to compile concerns from asset data and information, convert the concerns to specific ACR condition codes and provide necessary supporting information to validate the coding.

It is important that the person(s) undertaking the assessment have the ability to determine whether the electrical infrastructure and the use to which it is currently being put still retains conformity with the condition of its approval and design.

The responsibilities through the cycle of reporting shall be as follows:

Description of Activity	CMO	Client Engineer	Maintenance Sponsor	Head of Profession	Asset Management
Confirmation of asset base and hierarchy	C	R	A	C	C
Confirmation of Legislation changes for review	C	C	A	R	I
Confirmation of Obsolescence issues for review	R	C	A	R	I
Asset concern reporting requirements	I	C	R, A	C	C
Asset data collection methodology	I	R	A	C	C
Develop review content and delivery programme	R	C	A	I	I
Generation of Initial concerns for ACR and Sponsors Work Bank	R, A	C	C	I	I
Determination of ACR concerns list	R	C	A	I	I
Codifying asset condition:					
Physical condition (A – D)	R, A	R	C	C	I
Functional Condition (Legislation and Safety Code 1 & 2))	C	R	A	R	I
Functional Condition (Extraordinary maintenance / operation Code 3)	R	C	R, A	I	I
Functional Condition (Performance Code 4)	C	C	R, A	I	I
Concern table compilation	R	C	A	I	I
ACR report production	R	C	A	I	I
ACR Review	C	C	C	R, A	I
ACR output to AAMP and work bank	C	R	A	I	I
ACR output to Sponsors Asset Risk Register	I	C	R, A	C	I

Responsible: The person who does the work to achieve the task.

Accountable: The person who is accountable for the correct completion of the task.

Consulted: The people who provide information for the Review and with whom there is two-way communication.

Informed: The people who are kept informed about progress and with whom there is one-way communication.

4 Source Information

In order to generate the initial list of physical condition concerns it will be necessary to review information from a number of different sources. The expected source of information shall be from (but not limited to) the list detailed below:

- Records and information from preceding ACA / ACR
- Periodic maintenance records including other survey data and records of condition of the asset (e.g. PGI's and EPGI's)
- The asset register (Ellipse)
- Statutory Inspections
- Contractors work orders and details of any maintenance backlog
- Changes in legislation detailed in the Sponsors requirements
- Obsolescence issues detailed in the Sponsors requirements

Details of pre-existing concerns shall be provided by the Maintenance Sponsor and Client Engineer at the commencement meeting with the CMO Assessors to ensure both physical and functional concerns are considered as part of the initial review.

5 Generation of Initial condition concerns

The assessor is to provide an initial listing of concerns for review by the Client Engineer prior to the formal codifying of each concern. This is to:

- Validate coverage and content of the review
- Determine the concerns that may impact on physical and functional condition of an asset which may result in an adjustment to remaining asset life.
- Determine concerns that are not valid for ACR but need to be considered for inclusion in the Sponsor's work bank.

Where asset information is available a visual inspection of the asset shall not be undertaken but shall be recorded as an initial concern so the issue can be addressed by CMO by agreement with the Maintenance Sponsor.

The checklists shown in Appendix B shall be used to give guidance on the specific issues of concern to the Sponsor and Client Engineer and to assist the CMO assessor in determining asset specific issues. The list is not exhaustive and the assessor shall use engineering judgement in determining the set of concerns.

A record of information used or not available needs to be collated to assist the Sponsor in future improvement plans.

Any defects noted during the assessment shall be reported to the relevant fault report centre. Faults of a transitory nature are not required to be recorded in the initial or final ACR concerns table.

6 Codifying physical condition concerns

Assets are codified for their physical condition based on their remaining life taken against the nominal life detailed in the standard (Codes A-D). This is the default position for each asset when reporting condition

The condition code applied to the asset can be modified following review by the Assessor where it is considered that the asset has deteriorated faster than expected or that work completed has extended the life of the asset.

To determine if the remaining asset life requires adjustment and hence the condition code, the assessor needs to consider:

- Generic and location specific degradation of the asset under review considering both hardware and software issues
- Overall system condition if the asset under review forms part of a larger system
- Physical and environmental impact of the surrounding area and related assets
- Improvements completed by Maintenance that return the asset to the expected deterioration curve or extends life through component replacement

Where significant change in asset condition has taken place the asset shall be re-graded. Changes to asset grading shall be validated by the Client Engineer who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance to the assessor and Client Engineer in determining the changes to the physical condition of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list.

7 Codifying functional condition concerns

The codifying of functional condition concerns will be determined as follows:

- Concerns relating to statutory compliance and safe operation (Codes 1-2) are determined from joint review by the Client Engineer and Head of Profession.
- Concerns relating to extraordinary maintenance and or operation and asset performance (Codes 3 & 4) are determined by Joint review by CMO and the Maintenance Sponsor.

Functional condition concerns can be derived from both physical condition concerns and independently where operation or maintenance issues exist. The assessment needs to consider:

- The exact breach of statutory legislation validated by the relevant SQE advisor
- Generic and location specific safety issues relating to the asset under review considering physical, maintenance and operational issues
- Overall system condition if the asset under review forms part of a larger system

Asset grading shall be validated by the Sponsor who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance in determining the Functional Condition (Concerns Code1-4) of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list. In order to codify the identified functional condition concerns other source information is required to be reviewed:

- Performance data held in CuPid and Ellipse including outputs to FRACAS and other analysis tools
- Performance and function concerns identified in reliability growth plans
- Improvement plans that may impact the asset

8 Output to asset work bank

The Maintenance Sponsor shall be responsible for the generation of issues to be taken from the initial concerns list that are not valid for ACR into the Work Bank. To populate the additional issues in the work bank the Maintenance Sponsor in conjunction with the Client Engineer determine:

- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work

- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

9 Output from ACR to AAMP and Business Plan

The Client Engineer shall be responsible for the generation of issues to be taken from the Concerns List to the Stations Forward Maintenance work bank.

In order to add any additional issues in the work bank the Client Engineer and the Maintenance Sponsor shall determine:

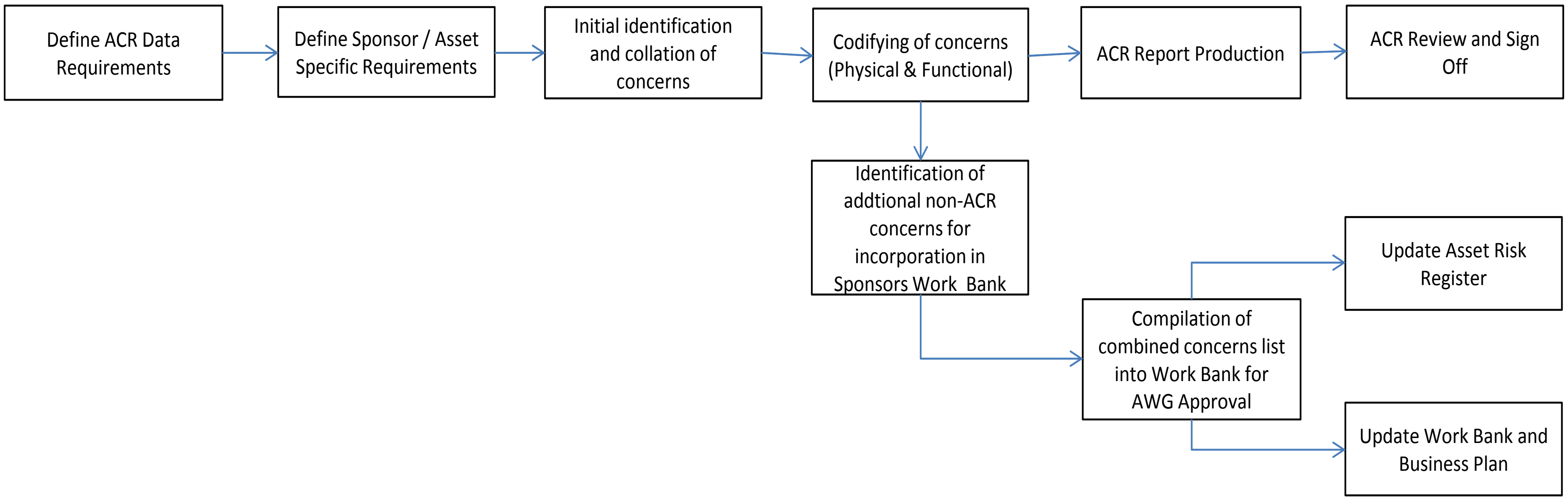
- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work
- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

10 Output to Local Asset Risk Register

The Maintenance Sponsor is responsible for ensuring an effective local asset risk register is used to inform the corporate asset register (ARM). One of the sources of information for the risk register is the ACR.

Concerns generated from the review that are not included in the work bank will be reviewed for inclusion in the local asset risk register.

Appendix A – Assessment Flow Diagram



<u>Asset Condtion Reporting - Flow Diagram</u>

Appendix B – Asset Condition Checklists

CHECK LIST TO ASSISTCOMPILATION OF INITIAL LIST OF ASSET CONCERNS BY CMO

Issue	Asset Concern	Checklist	Action
Failure Modes (Functional lighting)	What failure modes are affecting system reliability?	1. Lamp failure 2. Control gear failure 3. Loss of mains input 4. Environmental problems 5. No failure modes 6. Other factors	Correlate against other asset information and revise concerns list accordingly
Failure Modes (OLBI and UPS Systems)	What failure modes are affecting system reliability?	1. Loss of mains input 2. Input isolation, circuit breaker tripped 3. Rectifier failure 4. Batteries unable to support the load for the required time 5. Inverter failure 6. Environmental problems (e.g. Overheating and water ingress) 7. No failure modes	Correlate against other asset information and revise concerns list accordingly
Failure Modes (power supplies)	What failure modes are affecting system reliability?	1. Failure of incoming power supplies 2. Failure of downstream equipment 3. Degraded operation due to environmental factors 4. Vandalism 5. No failure modes 6. Other factors	Correlate against other asset information and revise concerns list accordingly
Maintenance costs	Are the costs of maintenance of the asset in line with budget?	1. As expected 2. Maintenance cost has increased but is now steady 3. Increasing at an unacceptable rate	No action Review increased costs to establish if a safety concern exists Review increased costs to establish if a safety concern exists
User ergonomics	Does the use have any difficulties in operating the asset?	1. No negative feedback from user 2. Some negative feedback from user which can be modified as part of maintenance regime 3. Some negative feedback from user which can be modified at small additional cost 4. Some negative feedback which can be modified at significant Additional cost 5. User unpleased with equipment and modifications cannot be carried out	No action No action Sponsor to review business case for improvement Review if this will impact on safe operation of the system Review if this will impact on safe operation of the system

CHECK LIST TO CODIFY PHYSICAL CONDITION OF ASSETS (CODE A TO D) BY CMO & CLIENT ENGINEER

Issue	Asset Concern	Checklist	Action
Cabling	What is the general condition of the cable installation and terminations?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No adjustment to residual life No adjustment to residual life Assess impact and reassess residual life or TTNEI
Cabling	Are there signs of insulation degradation (brittle / softened insulation)?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No adjustment to residual life No adjustment to residual life Assess impact and reassess residual life or TTNEI
Earthing systems	What is the general condition of earthing system? (Earth rods, tapes and air termination network etc.)	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No adjustment to residual life No adjustment to residual life Assess impact and reassess residual life or TTNEI
Emergency power supplies	What is the condition of the rectifier / inverter? (signs of damage or overheating etc.)	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No adjustment to residual life Assess impact and reassess residual life or TTNEI Assess impact and reassess residual life or TTNEI
Emergency power supplies	What is the condition of the supporting batteries? (signs of corrosion, bulging and overheating etc.)	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No adjustment to residual life Assess impact and reassess residual life or TTNEI Assess impact and reassess residual life or TTNEI
Emergency power supplies	What is the condition of any by pass / mains isolation switches?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No adjustment to residual life Assess impact and reassess residual life or TTNEI Assess impact and reassess residual life or TTNEI

Environmental condition (External)	What is the operating environment of the switchgear? (consider physical conditions, temperature and security)	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment 2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset 3. Unacceptable environmental conditions which may significantly effect the reliability of the asset	No adjustment to residual life No adjustment to residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Environmental condition (Physical)	Has the asset degraded as a result of any environmental effects?	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment 2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset 3. Unacceptable environmental conditions which may significantly effect the reliability of the asset	No adjustment to residual life No adjustment to residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Operations requirements	Does the asset function and perform to meet Line / Network requirements?	1. Equipment more than meets operational requirement 2. Equipment meets operational requirement 3. Equipment does not meet operational requirement but can be modified at small cost 4. Equipment does not meet operational requirements but can be modified at large cost 5. Equipment does not meet operational needs and cannot be modified	No adjustment to residual life No adjustment to residual life Code D Concern Code D Concern Code D Concern
Physical condition	What is the condition of the asset?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No adjustment to residual life No adjustment to residual life Assess impact and reassess residual life or TTNEI
Reparability of component parts	Can all components be repaired and are they readily available to procure?	1. All system parts are repairable 2. Some parts are non-repairable, but parts can be replaced with equivalent 3. Equipment becoming less repairable, parts difficult to source and likely issue with expected life of equipment 4. Equipment becoming less repairable, parts difficult to source and costs are excessive 5. Equipment not repairable	No adjustment to residual life No adjustment to residual life Assess adjustment to residual life Assess adjustment to residual life Concern Code D
Specialist tools availability	Does the maintainer have the required tools for completion of any repair or access equipment?	1. Equipment does not require nay specialist tools to carry out routine or reactive maintenance 2. Specialist tools required and maintainer has sufficient 3. Specialist tools required, maintainer does not have sufficient quantities, but they are readily available 4. Specialist tools required, maintainer does not have sufficient quantities, and difficult / expensive to source	No adjustment to residual life No adjustment to residual life Assess adjustment to residual life Assess adjustment to residual life

		5. Specialist tools required and are unavailable	Concern Code D
Supportability (Spares)	Can spares be sourced when required?	1. Abundance of spares. More than sufficient to support asset during its life 2. Sufficient spares to support asset during its life across network 3. Limited spares available 4. No spares available, mitigation in place 5. No spares available, no mitigation possible	No adjustment to residual life No adjustment to residual life Assess adjustment to residual life Assess adjustment to residual life Concern Code D
Supportability (System supplier)	Can manufacturer support be sourced when required?	1. Equipment fully supported for period longer than remaining life 2. Equipment supported for remaining life 3. Equipment not supported but equipment can easily be replaced or repaired 4. Equipment not supported high risk of critical failure	No adjustment to residual life No adjustment to residual life Assess adjustment to residual life Concern Code D

CHECK LIST TO CODIFY FUNCTIONAL CONDITION OF ASSETS (1 TO 4) BY HEAD OF PROFESSION, CLIENT ENGINEER AND SPONSOR

Issue	Asset Concern	Checklist	Action
Appropriate manuals and records	Are manuals available, accurate and accessible?	1. Records exist, are comprehensive and up to date 2. Records exist but require minor revisions to be up to date 3. Records exist but have not been kept up to date with major changes 4. No records exist	No action No action Code 2 concern if maintenance may result in unsafe practice Code 2 concern if maintenance may result in unsafe practice
Cabling	Are the cables properly segregated?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No Action Code 2 Concern and record mitigation Code 2 Concern
Control of lighting	Can the installed artificial lighting be effectively controlled and enabling the work function or operational use to be undertaken?	1. Lighting can be effectively controlled by switches or automatic controls 2. No control other than by switching of MCB	No action Code 2 concern
Earthing Systems (including lightning protection systems and supplementary earth bonding)	Is an earthing management plan in place for the installation? Is it supported by updated local records?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete but plan not implemented 3. No - Records and remedial work not completed	No action Code 2 concern Code 1 concern
Emergency Equipment and Statutory Notices	Is there adequate availability of emergency equipment in switch rooms and equipments rooms? (e.g. Alarms emergency telephones, panic buttons, emergency isolation devices etc.)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Ergonomic issues with maintenance	Is the asset in a position where it can be maintained correctly?	1. Equipment easy to maintain, no manual handling 2. Minor manual handling issues. No ladders required 3. Minor manual handling requirements, more than 1 person required 4. Difficult manual handling issues, more than 1 person required 5. Equipment un-maintainable	No action No action No action No action Code 2 concern if no mitigation plan in place
Labelling and identification	Does the asset have sufficient labelling and identification for safe operation and maintenance?	1. Excellent - all labelling in place with no unambiguous identification or description of assets served or operation 2. Acceptable - maintenance and operation can be safely undertaken 3. Unacceptable - labelling and identification missing or unclear	No action No action Code 2 concern
Lighting	Are the luminaires provided for artificial lighting appropriate to the type of work carried out, e.g. Suitability for working with VDU's	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
LU Standards	Is the asset compliant with current standards?	1. No standard applicable to asset	Assess if legislation or safety issues exist due to no LU standard existing

		2. System fully compliant to current standard 3. Non-compliant, compliance is not retrospective 4. Non-compliant, derogation and action plan in place 5. Non-compliant, standard forcing renewal	No Action Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern
Maintenance Plan	Is the asset in the current maintenance plan?	1. Asset is maintained under a maintenance plan compliant with LU standards or specifications and or work instructions 2. Asset does not need maintenance 3. Asset is maintained through special arrangements outside of a maintenance plan 4. Asset is not under any maintenance arrangement or has not been maintained and this is causing the renewal to be brought forward	No action Determine how statutory compliance is assured Assess plan ensures statutory compliance is maintained Code 1 concern if non compliant with legislation, Code 2 if safety concern
Safe accessibility Physical Hazards	Are there physical obstacles which may prevent safe access / egress for inspection, testing or maintenance?	1. No additional hazards identified 2. Low risk, known hazards identified 3. Medium risk, known hazards identified 4. High Risk, Known hazards identified 5. Unacceptable risk, known hazards identified	No action No action No action No action Code 2 concern if no mitigation plan in place
Safe Operation	Is there adequate means of isolation? (including isolation for mechanical isolation)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Safe Operation	Are there adequate barriers or enclosures against direct contact? Are those barriers or enclosures compromised, e.g. Due to damage?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Safety Signage	Is there adequate display of safety signs and posters relating to the asset installation?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are plant and equipment rooms adequately secured to prevent undue health and safety risks? (e.g. Unauthorised operation or isolation of equipment)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are plant areas used as storage areas?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern

Statutory Testing of Electrical Equipment	Has the statutory inspection been undertaken at the prescribed interval? Has remedial work completed where required?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and essential remedial work undertaken 3. Yes – Records fully complete but safety related issues incomplete 4. No - Records and remedial work not completed	No action No action Code 2 concern Code 1 concern
Temporary installations	Are there temporary supplies and resulting safety hazards such as trailing cables?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Testing of earthing systems (including Lightning Protection)	Has the inspection been undertaken at the prescribed interval and remedial work completed where required	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and safety related work not undertaken 3. No - Records and remedial work not completed	No action Code 2 concern Code 1 concern
Uninterruptable power supplies, Off Line Battery Inverters OLBI (Non PFI assets) and self contained emergency lighting systems	Has the system installed been regularly tested for integrity of operation, discharge and duration?	1. Meets the required discharge requirements (load and duration) evidenced from partial and full load tests 2. Meets the minimum requirement for duration and improvement plan in place for remedial works 3. Incomplete testing records 4. No records	No action No action unless safety concern exists Code 2 concern Code 1 concern

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Business Objectives

The purpose scope and requirements of the ACR is defined in the Cat 1 Standard 5-042.

In addition the Sponsor requires the ACR to provide a systematic process for the evaluation of the condition of our assets supporting the preparation of the annual asset management plan and longer term business planning. This will:

- Achieve a balance between capital and maintenance funds
- Demonstrate functional suitability and performance
- Demonstrate physical and operational condition

1 Purpose

This document sets out the specific requirements for condition reporting for mechanical assets and forms an appendix to standard 5-042. This provides visibility by which London Underground can understand:

- Whether the mechanical systems and assets and the use to which they are being put is in accordance with its approval and design.
- How the asset condition is performing with regard to its age and environmental conditions
- How to plan the timely and most cost effective renewal of the asset
- Whether the maintenance regimes are robust enough to deliver the anticipated life expectancy

2 Scope

All piped services cooling and ventilation systems, and equipment, which is owned or leased by London Underground excluding those forming part of PFI contracts. The asset hierarchy for mechanical assets is detailed in standard 5-042 Asset Condition Reporting.

The review is a “Desk Top” exercise drawing on information from asset inspections and routine assessment / maintenance activities requiring the assessor to co-ordinate the information and draw final conclusions on the condition and performance of the assets.

A flow diagram in Appendix A details the ACR process and linkage to the asset work bank and risk register.

If the asset is declared as a concern in the preceding ACA / ACR a re-assessment shall be undertaken yearly until it is renewed.

In addition to pre-existing concerns, the assets and locations covered in each annual review will be detailed in the Sponsors requirement document issued to compliment the standard and to assist the preparation and completion on the assessment.

Due to the volume of mechanical assets and variety of age and condition in the estate it is neither necessary nor efficient to survey the whole asset base in each year. Therefore the scope of survey shall be determined by asset age. For the purposes of determining the review programme, the nominal equipment life spans shall be used as detailed in Standard 5-042:

If the asset is declared as a concern in the preceding ACA / ACR an assessment shall be undertaken yearly until it is renewed.

For an asset having a **7 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 3rd and 4th anniversary of it's commissioning
- and then in the year between its 5th and 6th anniversary of it's commissioning

For an asset having a **10 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 5th and 6th anniversary of it's commissioning
- and then in the year between its 7th and 8th anniversary of it's commissioning

For an asset having a **12 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 5th and 6th anniversary of it's commissioning
- and then in the year between its 9th and 10th anniversary of its commissioning

For an asset having a **15 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 7th and 8th anniversary of its commissioning
- and then in the year between its 12th and 13th anniversary of its commissioning

For an asset having a **20 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 10th and 11th anniversary of its commissioning
- and then in the year between its 17th and 18th anniversary of its commissioning

For an asset having a **25 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 12th and 13th anniversary of its commissioning
- and then in the year between its 22nd and 23rd anniversary of its commissioning

For an asset having a **30 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 10th and 11th anniversary of its commissioning
- and then in the years between its 18th and 19th and 27th and 28th anniversaries of its commissioning

For an asset having a **50 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 10th and 11th anniversary of its commissioning
- and then in the years between its 18th and 19th, 27th and 28^{th,} , 37th and 38th and 47th and 48th anniversaries of its commissioning

Where an assets renewal is deferred beyond its nominal life span then it shall be subject to the following asset condition assessment regime:

- in the year of expiry of nominal life, as applicable
- Then in each of the years after the passage of a further two anniversaries until it is renewed.

For cables an asset condition assessment shall be undertaken:

- when the cable reaches an approximate point halfway through its nominal lifespan i.e. after 10 years from its commissioning
- then every 3 years until its replacement.

In addition to the programme of assessments detailed above, the Maintenance Sponsor requires the following to be taken into account:

a. Statutory Testing

Statutory testing is required for a number of mechanical systems. These include:

- Legionella risk assessment and risk management to cover stored water, showers, evaporative coolers and general water hygiene
- Electrical earthing and insulation test records (Electricity at Work Regulations)
- Gas safety inspection records
- Smoke extract system test records
- Records of maintenance and servicing of equipment containing refrigerants (F-gas regulations)

The concerns arising from the assessment shall be included in the ACR for the following year i.e. test completed in 2010, concerns included in ACR 2011. Where there is no evidence of a test having been completed a functional condition Code 1 concern shall be raised against the asset concerned.

Where a Statutory Test has been completed and safety related remedial actions have been raised a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

b. Tunnel Ventilation Systems

The correct operation of tunnel ventilation systems is vital to maintain air quality in running tunnels and provide the correct functionality i.e. supply or extract and / or speed control. The assessor shall ensure that operational and functional tests have been completed for each system at the agreed interval. Any concerns arising from the review shall be included in the ACR. Where there is no evidence of a test having been completed a functional condition Code 1 concern shall be raised against the asset concerned.

Where a Test has been completed and safety related remedial actions have been raised a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

c. Outstanding Defects

Asset information is gathered through other means such as Planned General Inspections or through planned or reactive maintenance. Concerns raised through these routes shall be recorded in the annual ACR if they have not been rectified by three months from the date of inspection as Code 1 or 2 conditions if a legislation of safety concern exists.

3 Responsibilities

It is the joint responsibility of the Maintenance Sponsor, Client Engineer, Head of Profession and engineering representatives of CMO to compile concerns from asset data and information, convert the concerns to specific ACR condition codes and provide necessary supporting information to validate the coding.

It is important that the person(s) undertaking the assessment have the ability to determine whether the mechanical infrastructure and the use to which it is currently being put still retains conformity with the condition of its approval and design. The responsibilities through the cycle of reporting shall be as follows:

Description of Activity	CMO	Client Engineer	Maintenance Sponsor	Head of Profession	Asset Management
Confirmation of asset base and hierarchy	C	R	A	C	C
Confirmation of Legislation changes for review	C	C	A	R	I
Confirmation of Obsolescence issues for review	R	C	A	R	I
Asset concern reporting requirements	I	C	R, A	C	C
Asset data collection methodology	I	R	A	C	C
Develop review content and delivery programme	R	C	A	I	I
Generation of Initial concerns for ACR and Sponsors Work Bank	R, A	C	C	I	I
Determination of ACR concerns list	R	C	A	I	I
Codifying asset condition:					
Physical condition (A – D)	R, A	R	C	C	I
Functional Condition (Legislation and Safety Code 1 & 2))	C	R	A	R	I
Functional Condition (Extraordinary maintenance / operation Code 3)	R	C	R, A	I	I
Functional Condition (Performance Code 4)	C	C	R, A	I	I
Concern table compilation	R	C	A	I	I
ACR report production	R	C	A	I	I
ACR Review	C	C	C	R, A	I
ACR output to AAMP and work bank	C	R	A	I	I
ACR output to Sponsors Asset Risk Register	I	C	R, A	C	I

Responsible: The person who does the work to achieve the task.

Accountable: The person who is accountable for the correct completion of the task.

Consulted: The people who provide information for the Review and with whom there is two-way communication.

Informed: The people who are kept informed about progress and with whom there is one-way communication.

4 Source Information

In order to generate the initial list of physical condition concerns it will be necessary to review information from a number of different sources. The expected source of information shall be from (but not limited to) the list detailed below:

- Records and information from preceding ACA / ACR
- Periodic maintenance records including other survey data and records of condition of the asset (e.g. PGI's and EPGI's)
- The asset register (Ellipse)
- Statutory Inspections
- Contractors work orders and details of any maintenance backlog
- Changes in legislation detailed in the Sponsors requirements
- Obsolescence issues detailed in the Sponsors requirements

Details of pre-existing concerns shall be provided by the Maintenance Sponsor and Client Engineer at the commencement meeting with the CMO Assessors to ensure both physical and functional concerns are considered as part of the initial review.

5 Generation of Initial condition concerns

The assessor is to provide an initial listing of concerns for review by the Client Engineer prior to the formal codifying of each concern. This is to:

- Validate coverage and content of the review
- Determine the concerns that may impact on physical and functional condition of an asset which may result in an adjustment to remaining asset life.
- Determine concerns that are not valid for ACR but need to be considered for inclusion in the Sponsor's work bank.

Where asset information is available a visual inspection of the asset shall not be undertaken but shall be recorded as an initial concern so the issue can be addressed by CMO by agreement with the Maintenance Sponsor.

The checklists shown in Appendix B shall be used to give guidance on the specific issues of concern to the Sponsor and Client Engineer and to assist the CMO assessor in determining asset specific issues. The list is not exhaustive and the assessor shall use engineering judgement in determining the set of concerns.

A record of information used or not available needs to be collated to assist the Sponsor in future improvement plans.

Any defects noted during the assessment shall be reported to the relevant fault report centre. Faults of a transitory nature are not required to be recorded in the initial or final ACR concerns table.

6 Codifying physical condition concerns

Assets are codified for their physical condition based on their remaining life taken against the nominal life detailed in the standard (Codes A-D). This is the default position for each asset when reporting condition

The condition code applied to the asset can be modified following review by the Assessor where it is considered that the asset has deteriorated faster than expected or that work completed has extended the life of the asset.

To determine if the remaining asset life requires adjustment and hence the condition code, the assessor needs to consider:

- Generic and location specific degradation of the asset under review considering both hardware and software issues
- Overall system condition if the asset under review forms part of a larger system
- Physical and environmental impact of the surrounding area and related assets
- Improvements completed by Maintenance that return the asset to the expected deterioration curve or extends life through component replacement

Where significant change in asset condition has taken place the asset shall be re-graded. Changes to asset grading shall be validated by the Client Engineer who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance to the assessor and Client Engineer in determining the changes to the physical condition of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list.

7 Codifying functional condition concerns

The codifying of functional condition concerns will be determined as follows:

- Concerns relating to statutory compliance and safe operation (Codes 1-2) are determined from joint review by the Client Engineer and Head of Profession.
- Concerns relating to extraordinary maintenance and or operation and asset performance (Codes 3 & 4) are determined by Joint review by CMO and the Maintenance Sponsor.

Functional condition concerns can be derived from both physical condition concerns and independently where operation or maintenance issues exist. The assessment needs to consider:

- The exact breach of statutory legislation validated by the relevant SQE advisor
- Generic and location specific safety issues relating to the asset under review considering physical, maintenance and operational issues
- Overall system condition if the asset under review forms part of a larger system

Asset grading shall be validated by the Sponsor who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance in determining the Functional Condition (Concerns Code1-4) of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list. In order to codify the identified functional condition concerns other source information is required to be reviewed:

- Performance data held in CuPid and Ellipse including outputs to FRACAS and other analysis tools
- Performance and function concerns identified in reliability growth plans
- Improvement plans that may impact the asset

8 Output to asset work bank

The Maintenance Sponsor shall be responsible for the generation of issues to be taken from the initial concerns list that are not valid for ACR into the Work Bank. To populate the additional issues in the work bank the Maintenance Sponsor in conjunction with the Client Engineer determine:

- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work
- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

9 Output from ACR to AAMP and Business Plan

The Client Engineer shall be responsible for the generation of issues to be taken from the Concerns List to the Stations Forward Maintenance work bank.

In order to add any additional issues in the work bank the Client Engineer and the Maintenance Sponsor shall determine:

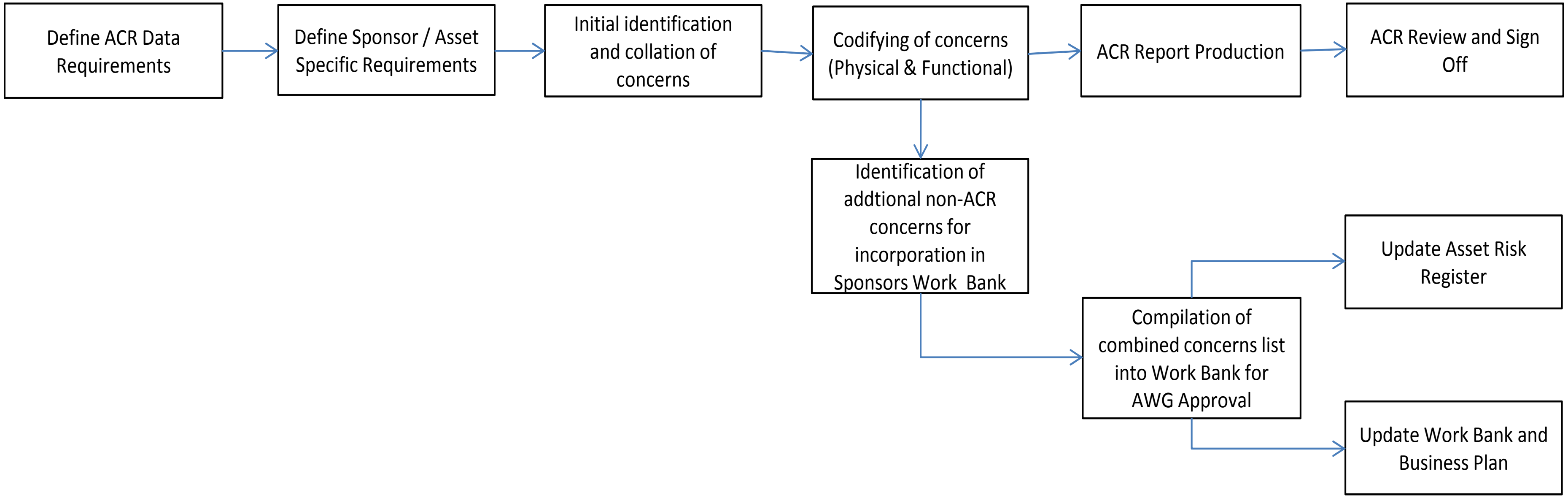
- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work
- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

10 Output to Local Asset Risk Register

The Maintenance Sponsor is responsible for ensuring an effective local asset risk register is used to inform the corporate asset register (ARM). One of the sources of information for the risk register is the ACR.

Concerns generated from the review that are not included in the work bank will be reviewed for inclusion in the local asset risk register.

Appendix A – Assessment Flow Diagram



<u>Asset Condtion Reporting - Flow Diagram</u>

Appendix B – Asset Condition Checklist

CHECK LIST TO ASSISTCOMPILATION OF INITIAL LIST OF ASSET CONCERNS

Issue	Definitions	Checklist	Action
Failure Modes (heating and hot water systems)	What failure modes are affecting system reliability?	1. Failure of incoming gas / oil supplies 2. Failure of boiler / storage 3. Degraded operation due to environmental factors 4. Vandalism 5. No failure modes 6. Other factors	Correlate against other asset information and revise concerns list accordingly
Failure Modes (Ventilation and other cooling systems)	What failure modes are affecting system reliability?	1. Loss of power supply 2. Input isolation, circuit breaker tripped 3. Fan failure 4. Condenser failure 5. Pipe work failure 6. Environmental problems (e.g. Overheating and water ingress) 7. No failure modes 8. Other factors	Correlate against other asset information and revise concerns list accordingly
Future expansion	How easy is the system to expand to meet future capacity requirements?	1. Modular design, no limit to capacity 2. System can be expanded within limits 3. System incapable or difficult to expand	1. Asset Records 2. Planned General Inspections 3. Asset Specific Inspections
Heating Quality	Are there obstructions to heat distribution from heat emitters and fan coil units e.g. Radiators obstructed by furniture?	1. Yes 2. No	No action Review if this will impact on safe operation of the system
Maintenance costs	Are the costs of maintenance of the asset in line with budget?	1. As expected 2. Maintenance cost has increased but is now steady 3. Increasing at an unacceptable rate	No action Review increased costs to establish if a safety concern exists Review increased costs to establish if a safety concern exists

User ergonomics	Does the use have any difficulties in operating the asset?	1. No negative feedback from user	No action
		2. Some negative feedback from user which can be modified as part of maintenance regime	No action
		3. Some negative feedback from user which can be modified at small additional cost	Sponsor to review business case for improvement
		4. Some negative feedback which can be modified at significant Additional cost	Review if this will impact on safe operation of the system
		5. User unpleased with equipment and modifications cannot be carried out	Review if this will impact on safe operation of the system

CHECK LIST TO CODIFY PHYSICAL CONDITION OF ASSETS (CODE A TO D)

Condition	Definitions	Checklist	Action
Environmental condition (External)	What is the operating environment of the switchgear? (consider physical conditions, temperature and security)	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment	No impact on residual life
		2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset	No impact on residual life
		3. Unacceptable environmental conditions which may significantly affect the reliability of the asset	Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Environmental condition (Physical)	Has the asset degraded as a result of any environmental effects?	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment	No impact on residual life
		2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset	No impact on residual life
		3. Unacceptable environmental conditions which may significantly affect the reliability of the asset	Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Operations requirements	Does the asset function and perform to meet Line / Network requirements?	1. Equipment more than meets operational requirement	No adjustment to residual life
		2. Equipment meets operational requirement	No adjustment to residual life
		3. Equipment does not meet operational requirement but can be modified at small cost	Code D Concern
		4. Equipment does not meet operational requirements but can be modified at large cost	Code D Concern
		5. Equipment does not meet operational needs and cannot be modified	Code d Concern
Physical condition	What is the condition of the asset?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset	No impact on residual life
		2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset	No impact on residual life
		3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	Assess impact and reassess residual life or TTNEI
Redundant Equipment	Are there any redundant plant and pipe work systems?	1. Yes	Code D Concern
		2. No	No adjustment to residual life
Reparability of component parts	Can all components be repaired and are they readily available to procure?	1. All system parts are repairable	No impact on residual life
		2. Some parts are non-repairable, but parts can be replaced with equivalent	No impact on residual life
		3. Equipment becoming less repairable, parts difficult to source and likely issue with expected life of equipment	Assess impact on residual life
		4. Equipment becoming less repairable, parts difficult to source and costs are excessive	Assess impact on residual life
		5. Equipment not repairable	Concern Code D

Specialist tools availability	Does the maintainer have the required tools for completion of any repair or access equipment?	1. Equipment does not require nay specialist tools to carry out routine or reactive maintenance 2. Specialist tools required and maintainer has sufficient 3. Specialist tools required, maintainer does not have sufficient quantities, but they are readily available 4. Specialist tools required, maintainer does not have sufficient quantities, and difficult / expensive to source 5. Specialist tools required and are unavailable	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D
Supportability (Spares)	Can spares be sourced when required?	1. Abundance of spares. More than sufficient to support asset during its life 2. Sufficient spares to support asset during its life across network 3. Limited spares available 4. No spares available, mitigation in place 5. No spares available, no mitigation possible	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D
Supportability (System supplier)	Can manufacturer support be sourced when required?	1. Equipment fully supported for period longer than remaining life 2. Equipment supported for remaining life 3. Equipment not supported but equipment can easily be replaced or repaired 4. Equipment not supported high risk of critical failure	No impact on residual life No impact on residual life Assess impact on residual life Concern Code D

CHECK LIST TO CODIFY FUNCTIONAL CONDITION OF ASSETS (1 TO 4)

Operability	Definitions	Checklist	Action
Appropriate manuals and records	Are manuals available, accurate and accessible?	1. Records exist, are comprehensive and up to date 2. Records exist but require minor revisions to be up to date 3. Records exist but have not been kept up to date with major changes 4. No records exist	No action No action Code 2 concern if maintenance may result in unsafe practice Code 2 concern if maintenance may result in unsafe practice
Cabling	Are the cables properly segregated?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No Action Code 2 Concern and record mitigation Code 2 Concern
Cold water capacity	Is there adequate cold water storage to meet the demand of the installation?	1. Yes 2. No	No action Code 3 concern
Emergency Equipment and Statutory Notices	Is there adequate availability of emergency equipment in switch rooms and equipments rooms? (e.g. Alarms emergency telephones, panic buttons, emergency isolation devices etc.)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Ergonomic issues with maintenance	Is the asset in a position where it can be maintained correctly?	1. Equipment easy to maintain, no manual handling 2. Minor manual handling issues. No ladders required 3. Minor manual handling requirements, more than 1 person required 4. Difficult manual handling issues, more than 1 person required 5. Equipment un-maintainable	No action No action No action No action Code 2 concern if no mitigation plan in place
Heating Quality	Are the correct type of heat emitters installed and safe surface temperatures achieved for the occupancy of the space?	1. Yes 2. No	No action Code 2 concern if no mitigation in place
Heating Quality	Is the hot water system able to achieve hot water storage and supply temperature requirements stated in HS(G) 70?	1. Yes 2. No	No Action Code 1 concern if no mitigation in place, Code 2 if mitigation in place
Hot water configuration	Are there dead legs in the domestic hot water configuration?	1. Yes 2. No	Code 2 concern No action

Hot water quality	Is there un-lagged pipe work causing undue heat emission in specific areas or causing danger to occupants?	1. Yes 2. No	Code 2 concern if safety concern No action
Labelling and identification	Does the asset have sufficient labelling and identification for safe operation and maintenance?	1. Excellent - all labelling in place with no unambiguous identification or description of assets served or operation 2. Acceptable - maintenance and operation can be safely undertaken 3. Unacceptable - labelling and identification missing or unclear	No action No action Code 2 concern
LU Standards	Is the asset compliant with current standards?	1. No standard applicable to asset 2. System fully compliant to current standard 3. Non-compliant, compliance is not retrospective 4. Non-compliant, derogation and action plan in place 5. Non-compliant, standard forcing renewal	Assess if legislation or safety issues exist due to no LU standard existing No Action Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern
Maintenance Plan	Is the asset in the current maintenance plan?	1. Asset is maintained under a maintenance plan compliant with LU standards or specifications and or work instructions 2. Asset does not need maintenance 3. Asset is maintained through special arrangements outside of a maintenance plan 4. Asset is not under any maintenance arrangement or has not been maintained and this is causing the renewal to be brought forward	No action Determine how statutory compliance is assured Assess plan ensures statutory compliance is maintained Code 1 concern if non compliant with legislation, Code 2 if safety concern
Safe accessibility Physical Hazards	Are there physical obstacles which may prevent safe access / egress for inspection, testing or maintenance?	1. No additional hazards identified 2. Low risk, known hazards identified 3. Medium risk, known hazards identified 4. High Risk, Known hazards identified 5. Unacceptable risk, known hazards identified	No action No action No action No action Code 2 concern if no mitigation plan in place
Safe Operation	Is there adequate means of isolation? (including isolation for mechanical isolation)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern

Safe Operation	Are there adequate barriers or enclosures against direct contact? Are those barriers or enclosures compromised, e.g. Due to damage?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Safety Signage	Is there adequate display of safety signs and posters relating to the asset installation?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are plant and equipment rooms adequately secured to prevent undue health and safety risks? (e.g. Unauthorised operation or isolation of equipment)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are plant and equipment rooms adequately secured to prevent undue health and safety risks? (e.g. Unauthorised operation or isolation of equipment)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are plant areas used as storage areas?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Statutory Testing of Equipment	Has the statutory inspection been undertaken at the prescribed interval? Has remedial work completed where required?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and essential remedial work undertaken 3. Yes – Records fully complete but safety related issues incomplete 4. No - Records and remedial work not completed	No action No action Code 2 concern Code 1 concern
Temporary installations	Are there temporary supplies and resulting safety hazards such as trailing cables?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern

7.1.1 Basis of Condition Reporting for Electrical and Mechanical

ACR No.	FD* No.	Asset Description	RAV (k)	Unit	Nominal Life	Source of Nominal Life
Electrical						
1000	**150**	**Distribution system and switchgear -low voltage AC**				Data source: CIBSE Guide M - Appendix 13.A1: Indicative Life Expectancy factors
1100	151	Cable	0.01	metre	30	(O) Electrical installations, mains cables, thermoplastic / other
1200	152	Switchgear	5	unit	25	(O) Electrical installations, mains power supplies, LV switchgear
1300	153	Protection systems (relays)	0.4	system	35	(O) Electrical & protective installatns, earth bonding / lightning protn
1400	154	Cable support and management system	0.2	system	35	Professional judgement
1500	156	Fixed electrical appliances	1	set	5	(T) Miscellaneous electrical equipment & plant, various
1600	159	Sub Metering	0.3	unit	20	Professional judgement
1700	160	Local Distribution Board	0.5	unit	25	(O) Electrical Installation, sub-main distribution, distribution boards
1800	161	Transformer	1	unit	30	(O) electrical installations, mains power supplies, transformers
2000	**200**	**Earthing and bonding**				
2100	202	Earth System (cabling, connections, terminals etc)	1.25	set (usually 2)	25	(O) Electrical & protective installatns, earth bonding / lightning protn
2200	203	Lightning protection	10	station	25	(T) Miscellaneous electrical equipment & plant, Lightning Protection
2300	204	Supplementary bonding	1	station	25	(T) Miscellaneous electrical equipment & plant, Lightning Protection
3000	**250**	**Emergency Power Systems**				
3100	252	Non PFI Maintained OLBIs - Offline Battery Inverters	100	unit	30	Professional judgement
3200	251	UPS - Uninterruptable Power Supply (Stations)	50	unit	10	PSC Schedule 5.1 part 5 “LEPS”
4000	**300**	**Lighting**				
4100	301 / 302	Functional lighting/Ambient lighting (full lighting; partial lighting; OPO etc). Note: This entry refers to fittings and not internal consumables	0.4	fitting	15	(P) Lighting systems, lighting and luminaires (external/internal)
4200	303	Emergency lighting	0.4	fitting	15	(P) Lighting Systems, emergency lighting
4300	304	Tunnel lighting	0.5	fitting	15	(P) Lighting systems, lighting and luminaires (external/internal)
4400	305	External lighting (station, footpath, car pk etc)	0.7	fitting	15	(P) Lighting Systems, emergency lighting
Mechanical						
5000	**550**	**Mechanical Control Systems**				
5100	551	Tunnel ventilation control system	50 (JLE Only) 15 (elsewhere)	system	20	(S) protection systems, smoke ventilation systems
5200	552	Energy management (BMES)	50	system	10	(N) Controls, Building management Systems, various
5300	553	HVAC controls	5	Unit	10	(L) air handling & ventilation, air conditioning & terminal units, various
6000	**600**	**Tunnel and Public Area Ventilation**				
6100	601	Internal (Non JLE) Station ventilation systems (Staff Ventilation, Public Ventalation, Staff Toilet Extract, Public Toilet)	100 - 250	system	20	(L) air handling & ventilation, air conditioning & terminal units, various
6200	601	External & JLE Station ventilation systems (Staff Ventilation, Public Ventilation, Staff Toilet Extract, Public Toilet)	101 - 250	system	25	(L) air handling & ventilation, air conditioning & terminal units, various
6300	n/a	Tunnel ventilation systems - Non JLE	Non JLE 704	system	20	Professional judgement
6400	602	Tunnel ventilation systems - JLE	JLE 704	system	25	(L) air handling & ventilation, air conditioning & terminal / fan coil units
7000	**n/a**	**JLE Substation ventilation system**	10	system	20	Professional judgement
8000	**650**	**Environmental Control**				
8100	654	Cooling (human comfort, plant protection)	7	Each system split	10	(L) air handling & ventilation, air conditioning & terminal / fan coil units
8200	n/a	JLE Cooling (human comfort, plant protection)	250	Each system split	10	Professional judgement
8300	n/a	Chilled Water	50	Unit	15	Professional judgement
8400	n/a	VRF/VRV	50	Unit	15	Professional judgement
9000	**700**	**Smoke Control**				
9100	701	Smoke Control Ventillation (Pressurisation systems, fan, ductwork and cable)	70	system	15	Professional judgement
10000	**750**	**Water Services**				
10100	751	Mains water supply	3	station	35	(H) Pipe work systems & components, pipe work systems
10200	752	Cold water storage and distribution	25	station	35	(C) Water & fuel installations, water cisterns (galvanised/cast iron)
10300	753	Hot water storage and distribution	25	station	10	(C) Water & fuel installations, water cisterns (galvanised/cast iron)
10400	755	Boilers	10	station	20	(A) heating sources, boiler plant, water tube boilers
11000	**800**	**Fuel Services**				
11100	801	Gas supply and utilisation plant and equipment.	50	station	35	(A) Distribution Main
11200	802	Oil receipt, storage, distribution and utilisation plant and equipment. (Depots)	20	station/depot	15	Professional judgement
12000	**500**	**Compressed Air ****				
12100	501	Pressure vessels (JLE Sewage Ejection System only)	10	station	25	Governed by legislation. Yearly tests reqd. Can be maint. Indefinitely
12200	502	Distribution pipework and fittings (JLE Sewage Ejection System and pipework to supply compressed air to non-electric gates across network)	0.1	station	35	Governed by legislation. Yearly tests reqd. Can be maint. Indefinitely
12300	503	Compression plant (JLE Sewage Ejection System only)	15	station	10	(M) miscellaneous mechanical equipment and plant, air compressor
12400	504	Drying equipment (JLE Sewage Ejection System only)	5	station	15	(M) miscellaneous mechanical equipment and plant, laundries
12500	505	Control Panel (JLE Sewage Ejection System only)	5	station	10	Professional judgement

* FD No. To provide cross reference to ACAC Foundation document reference numbering

** PFI Power Contractor is responsible for all Compressed Air assets except:
1) JLE Sewage Ejection System (maintained by TLL);
2) Pipework to supply compressed air to non-electric gates (maintained by Mechanical (LU + TLL))
3) Depots Compressed Air systems (maintained by Rolling Stock);
4) Air main assets outside the substation boundary (maintained by Signalling);

7.1.2 Asset Definition Electrical & Mechanical

ACR No	FD No	Definition Groups	Comments
3100	252	Non PFI Maintained OLBIs - Offline Battery Inverters	Most OLBIs are a Power asset but there is a specific subset of “Non PFI Maintained OLBI’s” which are shown as an E&M asset.
12000	500	Compressed Air	PFI Power Contractor is responsible for all Compressed Air assets except: 1) JLE Sewage Ejection System (maintained by TLL); 2) Pipework to supply compressed air to non-electric gates (maintained by Mechanical (LU + TLL)) 3) Depots Compressed Air systems (maintained by Rolling Stock); 4) Air main assets outside the substation boundary (maintained by Signalling);
n/a	Fire 120	Smoke and fire dampers	Now included in Fire ACR hierarchy
13100		Platform edge doors (JLE only)	Maintained by Signals
3200	251	UPS - Uninterruptable Power Supply (Stations)	UPSs have moved from Power to E&M as agreed between Heads of Profession Jan 2010

7.1.3 Reporting Requirements for Electrical

7.1.3.1 Electrical ACR - all Lines

ACR No.	FD* No.	Electrical – all Lines	Physical Condition				Functional Condition			
		Actuals:	Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
ACR No.	FD* No.		% RAV	% RAV	% RAV	% RAV	Statutory non compliant Quantity	Residual safety risk £ Risk	uneconomic/ unsustainable £ Risk	Risk of Performance Loss £ Risk
Electrical										
1000	150	**Distribution system and switchgear - low voltage AC:**								
1100	151	Cable								
1200	152	Switchgear								
1300	13th	Protection systems (relays)								
1400	154	Cable support and management system								
1500	156	Fixed electrical appliances								
1600	159	Metering								
1700	160	Local Distribution Board								
1800	161	Transformer								
2000	200	**Earthing and bonding:**								
2100	202	Earth System (cabling, connections, terminals etc)								
2200	203	Lightning protection								
2300	204	Supplementary bonding								
3000	250	**Emergency Power Systems:**								
3100	252	Non PFI Maintained OLBIs - Offline Battery Inverters								
3200	251	UPS - Uninterruptable Power Supply (Stations)								
4000	300	**Lighting:**								
4100	301 / 302	Functional lighting/Ambient lighting (full lighting; partial lighting; OPO etc). Note: This entry refers to fittings and not internal consumables								
4200	303	Emergency lighting								
4300	304	Tunnel lighting								
4400	305	External lighting (station, footpath, car pk etc)								
		Electrical:								
		Previous								
		Actual								
		Variance								

7.1.3 Reporting Requirements for Electrical

7.1.3.2 Electrical ACR - by Line

ACR No.	FD* No.	Electrical – Summary Report for xxx Line								
		Actuals:	**Physical Condition**				**Functional Condition**			
			Code A	**Code B**	**Code C**	**Code D**	**Code 1**	**Code 2**	**Code 3**	**Code 4**
ACR No.	**FD* No.**		**% RAV**	**% RAV**	**% RAV**	**% RAV**	**Statutory non compliant**	**Residual safety risk**	**uneconomic/ unsustainable**	**Risk of Performance Loss**
Electrical							**Quantity**	**£ Risk**	**£ Risk**	**£ Risk**
1000	150	**Distribution system and switchgear - low voltage AC:**								
1100	151	Cable								
1200	152	Switchgear								
1300	13th	Protection systems (relays)								
1400	154	Cable support and management system								
1500	156	Fixed electrical appliances								
1600	159	Metering								
1700	160	Local Distribution Board								
1800	161	Transformer								
2000	200	**Earthing and bonding:**								
2100	202	Earth System (cabling, connections, terminals etc)								
2200	203	Lightning protection								
2300	204	Supplementary bonding								
3000	250	**Emergency Power Systems:**								
3100	252	Non PFI Maintained OLBIs - Offline Battery Inverters								
3200	251	UPS - Uninterruptable Power Supply (Stations)								
4000	300	**Lighting:**								
4100	301 / 302	Functional lighting/Ambient lighting (full lighting; partial lighting; OPO etc). Note: This entry refers to fittings and not internal consumables								
4200	303	Emergency lighting								
4300	304	Tunnel lighting								
4400	305	External lighting (station, footpath, car pk etc)								
		Electrical:								
		Previous								
		Actual								
		Variance								
		Cable								
		Commentary on Variances:	A brief explanation of any significant variances of planned v. actual condition states and of any resultant backlog and including details of							
		The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.								

7.1.4 Reporting Requirements for Mechanical

7.1.4.1 Mechanical ACR - all Lines

		Mechanical – all Lines								
		Actuals:	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
ACR No.	FD* No.		% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
Mechanical							Quantity	£ Risk	£ Risk	£ Risk
5000	550	**Mechanical Control Systems**								
5100	551	Tunnel ventilation control system								
5200	552	Energy management (BMES)								
5300	553	HVAC controls								
6000	600	**Tunnel and Public Area Ventilation**								
6100	601	Internal (Non JLE) Station ventilation systems (Staff Ventilation, Public Ventalation, Staff Toilet Extract, Public Toilet)								
6200	601	External & JLE Station ventilation systems (Staff Ventilation, Public Ventilation, Staff Toilet Extract, Public Toilet)								
6300	n/a	Tunnel ventilation systems - Non JLE								
6400	602	Tunnel ventilation systems - JLE								
7000	n/a	**JLE Substation ventilation system**								
8000	650	**Environmental Control**								
8100	654	Cooling (human comfort, plant protection)								
8200	n/a	JLE Cooling (human comfort, plant protection)								
8300	n/a	Chilled Water								
8400	n/a	VRF/VRV								
9000	700	**Smoke Control**								
9100	701	Smoke Control Ventillation (Pressurisation systems,								
10000	750	**Water Services**								
10100	751	Mains water supply								
10200	752	Cold water storage and distribution								
10300	753	Hot water storage and distribution								
10400	755	Boilers								
11000	800	**Fuel Services**								
11100	801	Gas supply and utilisation plant and equipment.								
11200	802	Oil receipt, storage, distribution and utilisation plant								
12000	500	**Compressed Air ****								
12100	501	Pressure vessels (JLE Sewage Ejection System only)								
12200	502	Distribution pipework and fittings (JLE Sewage Ejection System and pipework to supply compressed air to non-electric gates across network)								
12300	503	Compression plant (JLE Sewage Ejection System only)								
12400	504	Drying equipment (JLE Sewage Ejection System only)								
12500	505	Control Panel (JLE Sewage Ejection System only)								
		Mechanical:								
		Previous								
		Actual								
		Variance								

7.1.4 Reporting Requirements for Mechanical

7.1.4.2 Mechanical ACR - by Line

Mechanical – Summary Report for xxx Line

ACR No.	FD* No.		Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
Mechanical		Actuals:					Quantity	£ Risk	£ Risk	£ Risk
5000	550	**Mechanical Control Systems**								
5100	551	Tunnel ventilation control system								
5200	552	Energy management (BMES)								
5300	553	HVAC controls								
6000	600	**Tunnel and Public Area Ventilation**								
6100	601	Internal (Non JLE) Station ventilation systems (Staff Ventilation, Public Ventalation, Staff Toilet Extract, Public Toilet)								
6200	601	External & JLE Station ventilation systems (Staff Ventilation, Public Ventilation, Staff Toilet Extract, Public Toilet)								
6300	n/a	Tunnel ventilation systems - Non JLE								
6400	602	Tunnel ventilation systems - JLE								
7000	n/a	**JLE Substation ventilation system**								
8000	650	**Environmental Control**								
8100	654	Cooling (human comfort, plant protection)								
8200	n/a	JLE Cooling (human comfort, plant protection)								
8300	n/a	Chilled Water								
8400	n/a	VRF/VRV								
9000	700	**Smoke Control**								
9100	701	Smoke Control Ventillation (Pressurisation systems,								
10000	750	**Water Services**								
10100	751	Mains water supply								
10200	752	Cold water storage and distribution								
10300	753	Hot water storage and distribution								
10400	755	Boilers								
11000	800	**Fuel Services**								
11100	801	Gas supply and utilisation plant and equipment.								
11200	802	Oil receipt, storage, distribution and utilisation plant								
12000	500	**Compressed Air ****								
12100	501	Pressure vessels (JLE Sewage Ejection System only)								
12200	502	Distribution pipework and fittings (JLE Sewage Ejection System and pipework to supply compressed air to non-electric gates across network)								
12300	503	Compression plant (JLE Sewage Ejection System only)								
12400	504	Drying equipment (JLE Sewage Ejection System only)								
12500	505	Control Panel (JLE Sewage Ejection System only)								
		Mechanical:								
		Previous								
		Actual								
		Variance								
		Commentary on Variances:	A brief explanation of any significant variances of planned v. actual condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >							

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

S1042 Asset Condition Reporting (ACR)

Lifts & Escalators

Residual Life: Lifts & Escalators (L&E)

a) L&E ACR Working Group determined that only key subassets listed in the L&E Hierarchy would be assessed for Residual Life;

b) '*RL(M+N) Subassests to Assess*' worksheet lists:
i) The subassets to be assessed for each L&E Hierarchy grouping;
ii) Whether Residual Life Measured or Nominal should be used to determine the A-D Classification (with a reference to the relevant section of the methodologies worksheet if appropriate); and;
iii) The updated RAV values, which were produced by redistributing the RAVs of L&E assets that do not drive Residual Life amongst those that do;

c) '*RL(M) Methodologies (Esc. Only)*' worksheet sets down the methodologies for subassets to be assessed using Residual Life Measured.
Note: Only a number of key Escalator & Passenger Conveyor subassets are currently assessed through Measurement (rather than Nominal Life);

d) CMO's Escalator Inspection Teams will incorporate the agreed methodologies into the Escalator Inspection Regime;

e) Information held in ELLIPSE and other databases managed by CMO will be used to determine Residual Life Nominal (desktop exercise);

f) For the avoidance of doubt the full L&E hierarchy is still to be used for reporting Concerns - the condensed version is intended for assessing Residual Life only.

1000	Escalator					
ACR Hierarchy Ref.	**Asset Description**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
1100	Shaft					
1170	Tracking Guidance System	14	14%	14	Measured (E1+E2)	Engineers professional
1200	Step Band					
1210	Step Chain	14	14%	14	Measured (E3)	Engineers professional
1220	Steps	10	10%	14	Nominal	Engineers professional
1300	Drive Machine					
1320	Motor	7	7%	28	Nominal - 2011 Measured (E5) - 2012	Engineers professional
1330	Gear Box	7	7%	40	Nominal - 2011 Measured (E5) - 2013	Engineers professional
1400	Drive Transmission System					
1410	Main Drive Top Shaft	6	6%	40	Measured (E6)	Engineers professional
1420	Lower Carriage Idler Shaft	3	3%	40	Measured (E6)	Engineers professional
1500	Handrail System					
1520	Drive, tracking & tension system	5	5%	7	Nominal	Engineers professional
1600	Tension Carriage					
1610	Half tracks & tension system	2	2%	14	Measured (E4)	Engineers professional
1700	Braking Systems*					
1710	Operational Brake	2	2%	14	Nominal*	Engineers professional
1720	Auxiliary Brake	3	3%	14	Nominal*	Engineers professional
1800	Balustrade					
1810	Panels & structural support	8	8%	40	Nominal	Engineers professional
1900	Power and Control					
1920	Controller	11	11%	20	Measured (E7)	Engineers professional
1930	Safety Circuit	4	4%	20	Measured (E7)	Engineers professional
1940	Field Wiring	4	4%	20	Measured (E7)	Engineers professional

*** Residual Life (Nominal) is used for Escalator braking systems; however, operational brakes will continue to be tested by deceleration. For safety reasons braking performance must remain within Cat 1 specified threshold and escalators must be taken out of service if not considered safe.**

1000A	**Compact Escalator**					
ACR Hierarchy Ref.	**Sub-asset**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
1100A	Shaft					
1170A	Tracking Guidance System	14	14%	14	Measured (E1+E2)	Engineers professional
1200A	Step Band					
1210A	Step Chain	14	14%	14	Measured (E3)	Engineers professional
1220A	Steps	10	10%	14	Nominal	Engineers professional
1300A	Drive Machine					
1320A	Motor	7	7%	28	Nominal - 2011 Measured (E5) - 2012	Engineers professional
1330A	Gear Box	7	7%	40	Nominal - 2011 Measured (E5) - 2012	Engineers professional
1400A	Drive Transmission System					
1410A	Main Drive Top Shaft	6	6%	40	Measured (E6)	Engineers professional
1420A	Lower Carriage Idler Shaft	3	3%	40	Measured (E6)	Engineers professional
1500A	Handrail System					
1520A	Drive, tracking & tension system	5	5%	7	Nominal	Engineers professional
1600A	Tension Carriage					
1610A	Half tracks & tension system	2	2%	14	Measured (E4)	Engineers professional
1700A	Braking Systems*					
1710A	Operational Brake	2	2%	14	Nominal*	Engineers professional
1720A	Auxiliary Brake	3	3%	14	Nominal*	Engineers professional
1800A	Balustrade					
1810A	Panels & structural support	8	8%	40	Nominal	Engineers professional
1900A	Power and Control					
1920A	Controller	11	11%	20	Measured (E7)	Engineers professional
1930A	Safety Circuit	4	4%	20	Measured (E7)	Engineers professional
1940A	Field Wiring	4	4%	20	Measured (E7)	Engineers professional

*** Residual Life (Nominal) is used for Escalator braking systems; however, operational brakes will continue to be tested by deceleration. For safety reasons braking performance must remain within Cat 1 specified threshold and escalators must be taken out of service if not considered safe.**

2000	Passenger Conveyor					
ACR Hierarchy Ref.	**Sub-asset**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
2100	Truss and Tracking					
2170	Tracking Guidance System	14	14%	14	Measured (E1+E2)	Engineers professional
2200	Pallet Band					
2210	Pallet Chain	14	14%	14	Measured	Engineers professional
2220	Pallets	10	10%	14	Nominal	Engineers professional
2300	Drive Machine					
2320	Motor	7	7%	28	Nominal (2011) Measured (2012+)	Engineers professional
2330	Gear Box	7	7%	40	Nominal (2011) Measured (2012+)	Engineers professional
2400	Drive Transmission System					
2410	Main Drive Top Shaft	6	6%	40	Measured (E6)	Engineers professional
2420	Lower Carriage Idler Shaft	3	3%	40	Measured (E6)	Engineers professional
2500	Handrail System					
2520	Drive, tracking & tension system	5	5%	7	Nominal	Engineers professional
2600	Tension Carriage					
2610	Half tracks & tension system	2	2%	14	Measured (E4)	Engineers professional
2700	Braking Systems*					
2710	Operational Brake	2	2%	14	Nominal*	Engineers professional
2720	Auxiliary Brake	3	3%	14	Nominal*	Engineers professional
2800	Balustrade					
2810	Panels & structural support	8	8%	40	Nominal	Engineers professional
2900	Power and Control					
2920	Controller	11	11%	20	Measured (E7)	Engineers professional
2930	Safety Circuit	4	4%	20	Measured (E7)	Engineers professional
2940	Field Wiring	4	4%	20	Measured (E7)	Engineers professional

*** Residual Life (Nominal) is used for Escalator braking systems; however, operational brakes will continue to be tested by deceleration. For safety reasons braking performance must remain within Cat 1 specified threshold and escalators must be taken out of service if not considered safe.**

3000	Traction Lift PMVT (Heavy Duty Station)					
ACR Hierarchy Ref.	**Sub-asset**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
3100	Shaft					
3140	Guide Rails & Fixings	15	15%	40	Nominal	Engineers professional
3160	Shaft Lighting	1	1%	20	Nominal	Engineers professional
3400	Drive Machine					
3420	Motor	10	10%	40	Nominal	Engineers professional
3430	Gear Box/Gearless	15	15%	40	Nominal	Engineers professional
3500	Car & Counterweight					
3510	Car	15	15%	40	Nominal	Engineers professional
3520	Car Frame/Sling/Structure	10	10%	40	Nominal	Engineers professional
3530	Doors	5	5%	20	Nominal	Engineers professional
3600	Landings and Doors					
3610	Sills	1	1%	20	Nominal	Engineers professional
3630	Landing Doors/Locks	4	4%	20	Nominal	Engineers professional
3700	Electrical System					
3710	Drive (Power) Control System	2	2%	20	Nominal	Engineers professional
3720	Operational Control System	2	2%	20	Nominal	Engineers professional
3750	Controller & Associated equipment.	10	10%	20	Nominal	Engineers professional
3780	Field Wiring	10	10%	20	Nominal	Engineers professional

3000A	Traction Lift SMVT (MRL)					
ACR Hierarchy Ref.	**Sub-asset**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
3100A	Shaft					
3140A	Guide Rails & Fixings	15	15%	20	Nominal	Engineers professional
3160A	Shaft Lighting	1	1%	20	Nominal	Engineers professional
3400A	Drive Machine	25	25%	20		
3420A	Motor / MRL Drive Machine	10	10%	20	Nominal	Engineers professional
3430A	Gear Box or Gearless / MRL Drive Machine	15	15%	20	Nominal	Engineers professional
3500A	Car & Counterweight					
3510A	Car	15	15%	20	Nominal	Engineers professional
3520A	Car Frame/Sling	10	10%	20	Nominal	Engineers professional
3530A	Doors	5	5%	20	Nominal	Engineers professional
3600A	Landings and Doors					
3610A	Sills	1	1%	20	Nominal	Engineers professional
3630A	Landing Doors/Locks	4	4%	20	Nominal	Engineers professional
3700A	Electrical System					
3710A	Drive (Power) Control System	2	2%	20	Nominal	Engineers professional
3720A	Operational Control System	2	2%	20	Nominal	Engineers professional
3750A	Controller & Associated equipment.	10	10%	20	Nominal	Engineers professional
3780A	Field Wiring	10	10%	20	Nominal	Engineers professional

4000	Hydraulic Lift (SMVT)					
ACR Hierarchy Ref.	**Sub-asset**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
4100	Shaft					
4140	Guide Rails & Fixings	15	15%	20	Nominal	Engineers professional
4170	Shaft Lighting	1	1%	20	Nominal	Engineers professional
4400	Hydraulic System					
4410	Pump, Drive Motor & Control Unit	15	15%		Nominal	Engineers professional
4420	Hydraulic Rams & Hoses	10	10%	20	Nominal	Engineers professional
4500	Car					
4510	Car	15	15%	20	Nominal	Engineers professional
4520	Car Frame/Sling	10	10%	20	Nominal	Engineers professional
4530	Doors	5	5%	20	Nominal	Engineers professional
4600	Landings and Doors					
4610	Sills	1	1%	20	Nominal	Engineers professional
4630	Landing Doors/Locks	4	4%	20	Nominal	Engineers professional
4700	Electrical System					
4710	Operational Control System	2	2%	20	Nominal	Engineers professional
4740	Controller & Associated equipment.	12	12%	20	Nominal	Engineers professional
4770	Field Wiring	10	10%	20	Nominal	Engineers professional

5000	Stair Lift					
ACR Hierarchy Ref.	**Sub-asset**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
5100	Platform	20	20%	10	Nominal	Engineers professional
5200	Guide Rails	20	20%	10	Nominal	Engineers professional
5300	Drive Mechanism and Hand Winding	40	40%	10	Nominal	Engineers professional
5400	Power Supply, Control and Safety Devices	20	20%	10	Nominal	Engineers professional

6000	Platform Lift					
ACR Hierarchy Ref.	**Sub-asset**	**Residual Life RAV**	**Residual Life RAV %**	**Nominal Life**	**Residual Life: Measured/Nominal**	**Source of Nominal Life**
6100	Cladding (tower Enclosure)	20	20%	10	Nominal	Engineers professional
6200	Platform	20	20%	10	Nominal	Engineers professional
6300	Guide Rails	20	20%	10	Nominal	Engineers professional
6400	Drive Mechanism and Hand Winding	20	20%	10	Nominal	Engineers professional
6500	Power Supply, Control and Safety Devices	20	20%	10	Nominal	Engineers professional

TRACKING GUIDANCE SYSTEM

To assess Residual Life of Tracking Guidance Systems assessors should use both methodologies set out below and record the results. If the methods lead to different results the 'worst' score (the one with the least remaining Residual Life) should be noted in the ACR detail sheet.

Table Ref	Link to Hierarchy	Nominal Life	Description	Year to be Introduced	CA Score	1	2	3	4 (Equivalent to 5B defect)	5 (Equivalent to 5A defect)
E1	Tracking Guidance System (ACR No. 1170)	14	Step skirt clearance (step frame & escalator guidance system wear)	2011	Measurement	5mm total but not greater than 3mm on one side	6mm total	6.5mm total but not greater than 3.5mm on one side	7mm total but not greater than 4mm on one side	>7mm
					Residual Life	A (100%)	B (66%)	C (33%)	D (0%)	D (0%)
E2	Tracking Guidance System (ACR No. 1170)	14	Wear on track running surfaces	2011	Description	0	1mm	1.5mm	2mm	>2mm
					ACR Code / Residual Life	A (100%)	B (66%)	C (33%)	D (0%)	D (0%)
				2012	*More refined wear and damage to running surface measurement to be developed for March 2012 ACR to replace current methodology set out above*					

STEP CHAIN

Table Ref	Link to Hierarchy	Nominal Life	Description	Year to be Introduced	CA Score	1	2	3	4 (Equivalent to 5B defect)	5 (Equivalent to 5A defect)
E3	Step Chain (ACR No. 1210)	14	Step gap (chain wear)	2011	Measurement	3mm	5mm	6mm	7mm	9mm
					ACR Code / Residual Life	A (100%)	B (66%)	C (33%)	D (0%)	D (0%)
				2012	Measurement	*Instructions about how to take passenger loadings into account to be developed for March 2012 ACR*				

HALF TRACKS & TENSION SYSTEM

Table Ref	Link to Hierarchy	Nominal Life	Description	Year to be Introduced	CA Score	1	2	3	4 (Equivalent to 5B defect)	5 (Equivalent to 5A defect)
E4	Half Tracks & tension system (ACR No.1610)	14	Relative carriage movement from installation (half track)	2011	Note	N = No. of Steps divided by 2				
					Measurement from installation point	0mm	N multiplied by (5mm-3mm)	N multiplied by (6mm-3mm)	N multiplied by (7mm-3mm)	N multiplied by (9mm-3mm)
					ACR Code / Residual Life	A (100%)	B (66%)	C (33%)	D (0%)	D (0%)

DRIVE MACHINE

A Residual Life Measured methodology is underdevelopment for 2012 ACR; Nominal Life to be used for 2011 ACR.

Table Ref	Link to Hierarchy	Nominal Life	Description	Year to be Introduced	CA Score	1	2	3	4 (Equivalent to 5B defect)	5 (Equivalent to 5A defect)
E5	Drive Machine (ACR No. 1300, 1320 & 1330)	28 - 40	Gear box / Motor	2012	Measurement	*Instructions to be developed to explain how vibration, oil and temperature measurements are assessed in conjunction to provide a useful measure of residual life for 2012 ACR. Nominal Life to be used in 2011.*				

DRIVE TRANSMISSION SYSTEM

Table Ref	Link to Hierarchy	Nominal Life	Description	Year to be Introduced	Head shaft and Idler Shaft				Sprockets	
E6	Drive Transmission System (ACR No. 1400)	40	Main Drive Top Shaft / Lower Carriage Idler Shaft	2011	**CA Score**	**1**	**4**	**5**	**1**	**5**
					Description	Running with no issues	Slight rouging, movement or noise; lack of lubrication	Scraping noise, discoloured grease or large movement	Rotation / alignment in sync; no rouging or movement	Rotation / alignment out of sync; rouging or movement
					ACR Code / Residual Life	A-C (As per remaining Nominal Life)	C (<1 yr)	D (0%)	A-C (As per remaining Nominal Life)	D (0%)
					Note	*NB Rouging refers to a form of corrosion found in steel resulting in evidence of a thin film, usually reddish-brown or golden in colour, of iron oxide or hydroxide*				

POWER & CONTROL

Table Ref	Link to Hierarchy	Nominal Life	Description	Year to be Introduced	CA Score	1	3	5
E7	Power & Control (ACR No. 1900)	20	Controller / Safety Circuit / Field Wiring	2011	Description	Current product with unknown end	End of Product Warning issued but adequate spares available and technical and/or software support available	Spares no longer available. Technical and/or Software support ceased
					ACR Code / Residual Life	A-C (As per remaining Nominal Life)	A-C (As per manufacturer advice)	D (0%)

8.1.1 Basis of Condition Reporting for Lifts and Escalators

Note: Residual Life is only reported for L&E subassets with a Residual Life RAV. See Residual Life Methodology for further information.

1000	Escalator							
ACR Hierarchy Ref.	FD. No	Asset Description	Concerns RAV	Concerns RAV %	Residual Life RAV	Residual Life RAV %	Nominal Life	Source of Nominal Life
1100	1100	Shaft						
1110	1110	Inclined Shaft	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	Engineers professional judgement
1120	1120	Machine Chambers	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
1130	1130	Shaft Lighting	1	1%	N/A	N/A	40	Engineers professional judgement
1140	1140	Guarding	3	3%	N/A	N/A	40	Engineers professional judgement
1150	1150	Fire Compartmentisation	1	1%	N/A	N/A	40	Engineers professional judgement
1160	1160	Truss Steel Work	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	Engineers professional judgement
1170	1170	Tracking Guidance System	7	7%	14	14%	14	Engineers professional judgement
1200	1200	Step Band						
1210	1210	Step Chain	12	12%	14	14%	14	Engineers professional judgement
1220	1220	Steps	12	12%	10	10%	14	Engineers professional judgement
1300	1300	Drive Machine						
1310	1310	Bed Plate	1	1%	N/A	N/A	40	Engineers professional judgement
1320	1320	Motor	2	2%	7	7%	28	Engineers professional judgement
1330	1330	Gear Box	2	2%	7	7%	40	Engineers professional judgement
1400	1400	Drive Transmission System						
1410	1410	Main Drive Top Shaft	4	4%	6	6%	40	Engineers professional judgement
1420	1420	Lower Carriage Idler Shaft	2	2%	3	3%	40	Engineers professional judgement
1430	1430	Main drive chain	1	1%	N/A	N/A	7	Engineers professional judgement
1440	1440	Auxilliary Shafts, Chains & Sprockets	2	2%	N/A	N/A	7	Engineers professional judgement
1450	1450	Lubrication System	1	1%	N/A	N/A	28	Engineers professional judgement
1500	1500	Handrail System						
1510	1510	Handrails	2	2%	N/A	N/A	7	Engineers professional judgement
1520	1520	Drive, tracking & tension system.	2	2%	5	5%	7	Engineers professional judgement
1600	1600	Tension Carriage						
1610	N/A	Half tracks & tension system	2	2%	2	2%	14	Engineers professional judgement
1700	1700	Braking Systems						
1710	1710	Operational Brake	2	2%	2	2%	14	Engineers professional judgement
1720	1720	Auxiliary Brake	2	2%	3	3%	14	Engineers professional judgement
1800	1800	Balustrade						
1810	1810	Panels & structural support	9	9%	8	8%	40	Engineers professional judgement
1820	1820	Comb Plates	1	1%	N/A	N/A	N/A	Engineers professional judgement
1900	1900	Power and Control						
1910	1910	Switch Board	1	1%	N/A	N/A	20	Engineers professional judgement
1920	1920	Controller	3	3%	11	11%	20	Engineers professional judgement
1930	1930	Safety Circuit	5	5%	4	4%	20	Engineers professional judgement
1940	1940	Field Wiring	5	5%	4	4%	20	Engineers professional judgement

1000A	Compact Escalator							
ACR Hierarchy Ref.	**FD. No**	**Asset Description**	**Concerns RAV**	**Concerns RAV %**	**Residual Life RAV %**	**Residual Life RAV**	**Nominal Life**	**Source of Nominal Life**
1100A	1100	Shaft						
1110A	1110	Inclined Shaft	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	Engineers professional judgement
1120A	1120	Machine Chambers	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
1130A	1130	Shaft Lighting	1	1%	N/A	N/A	40	Engineers professional judgement
1140A	1140	Guarding	3	3%	N/A	N/A	40	Engineers professional judgement
1150A	1150	Fire Compartmentisation	1	1%	N/A	N/A	40	Engineers professional judgement
1160A	1160	Truss Steel Work	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	Engineers professional judgement
1170A	1170	Tracking Guidance System	7	7%	14	14%	14	Engineers professional judgement
1200A	1200	Step Band						
1210A	1210	Step Chain	12	12%	14	14%	14	Engineers professional judgement
1220A	1220	Steps	12	12%	10	10%	14	Engineers professional judgement
1300A	1300	Drive Machine						
1310A	1310	Bed Plate	1	1%	N/A	N/A	40	Engineers professional judgement
1320A	1320	Motor	2	2%	7	7%	28	Engineers professional judgement
1330A	1330	Gear Box	2	2%	7	7%	40	Engineers professional judgement
1400A	1400	Drive Transmission System						
1410A	1410	Main Drive Top Shaft	4	4%	6	6%	40	Engineers professional judgement
1420A	1420	Lower Carriage Idler Shaft	2	2%	3	3%	40	Engineers professional judgement
1430A	1430	Main drive chain	1	1%	N/A	N/A	7	Engineers professional judgement
1440A	1440	Auxilliary Shafts, Chains & Sprockets	2	2%	N/A	N/A	7	Engineers professional judgement
1450A	1450	Lubrication System	1	1%	N/A	N/A	28	Engineers professional judgement
1500A	1500	Handrail System						
1510A	1510	Handrails	2	2%	N/A	N/A	7	Engineers professional judgement
1520A	1520	Drive, tracking & tension system.	2	2%	5	5%	7	Engineers professional judgement
1600A	1600	Tension Carriage						
1610A	N/A	Half tracks & tension system	2	2%	2	2%	14	Engineers professional judgement
1700A	1700	Braking Systems				5%		
1710A	1710	Operational Brake	2	2%	2	2%	14	Engineers professional judgement
1720A	1720	Auxiliary Brake	2	2%	3	3%	14	Engineers professional judgement
1800A	1800	Balustrade						
1810A	1810	Panels & structural support	9	9%	8	8%	40	Engineers professional judgement
1820A	1820	Comb Plates	1	1%	N/A	N/A	N/A	Engineers professional judgement
1900A	1900	Power and Control						
1910A	1910	Switch Board	1	1%	N/A	N/A	20	Engineers professional judgement
1920A	1920	Controller	3	3%	11	11%	20	Engineers professional judgement
1930A	1930	Safety Circuit	5	5%	4	4%	20	Engineers professional judgement
1940A	1940	Field Wiring	5	5%	4	4%	20	Engineers professional judgement

2000	Passenger Conveyor							
ACR Hierarchy Ref.	**FD. No**	**Asset Description**	**Concerns RAV**	**Concerns RAV %**	**Residual Life RAV %**	**Residual Life RAV**	**Nominal Life**	**Source of Nominal Life**
2100	2100	Truss and Tracking						
2110	2110	Inclined Shaft	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	Engineers professional judgement
2120	2120	Machine Chambers	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
2130	2130	Shaft Lighting	1	1%	N/A	N/A	40	Engineers professional judgement
2140	2140	Guarding	3	3%	N/A	N/A	40	Engineers professional judgement
2150	2150	Fire Compartmentisation	1	1%	N/A	N/A	40	Engineers professional judgement
2160	2160	Truss Steel Work	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	N/A Civils Asset	Engineers professional judgement
2170	2170	Tracking Guidance System	7	7%	14	14%	14	Engineers professional judgement
2200	2200	Pallet Band						
2210	2210	Pallet Chain	12	12%	14	14%	14	Engineers professional judgement
2220	2220	Pallets	12	12%	10	10%	14	Engineers professional judgement
2300	2300	Drive Machine						
2310	2310	Bed Plate	1	1%	N/A	N/A	40	Engineers professional judgement
2320	2320	Motor	2	2%	7	7%	28	Engineers professional judgement
2330	2330	Gear Box	2	2%	7	7%	40	Engineers professional judgement
2400	2400	Drive Transmission System						
2410	2410	Main Drive Top Shaft	4	4%	6	6%	40	Engineers professional judgement
2420	2420	Lower Carriage Idler Shaft	2	2%	3	3%	40	Engineers professional judgement
2430	2430	Main drive chain	1	1%	N/A	N/A	7	Engineers professional judgement
2440	2440	Auxilliary Shafts, Chains & Sprockets	2	2%	N/A	N/A	7	Engineers professional judgement
2450	2450	Lubrication System	1	1%	N/A	N/A	28	Engineers professional judgement
2500	2500	Handrail System						
2510	2510	Handrails	2	2%	N/A	N/A	7	Engineers professional judgement
2520	2520	Drive, tracking & tension system.	2	2%	5	5%	7	Engineers professional judgement
2600	2600	Tension Carriage						
2610	2610	Half tracks & tension system	2	2%	2	2%	14	Engineers professional judgement
2700	2700	Braking Systems				5%		
2710	2710	Operational Brake	2	2%	2	2%	14	Engineers professional judgement
2720	2720	Auxiliary Brake	2	2%	3	3%	14	Engineers professional judgement
2800	2800	Balustrade						
2810	2810	Panels & structural support	9	9%	8	8%	40	Engineers professional judgement
2820	2820	Comb Plates	1	1%	N/A	N/A	N/A	Engineers professional judgement
2900	2900	Power and Control						
2910	2910	Switch Board	1	1%	N/A	N/A	20	Engineers professional judgement
2920	2920	Controller	3	3%	11	11%	20	Engineers professional judgement
2930	2930	Safety Circuit	5	5%	4	4%	20	Engineers professional judgement
2940	2940	Field Wiring	5	5%	4	4%	20	Engineers professional judgement

Exclusions
The following are excluded from the Lifts & Escalators Asset Definition:
- Truss work, floor support work and finishes - Civils/Premises assets
- Lifting beams in machine rooms - Civils assets
- Lighting for Escalators and Passenger Conveyors - E&M assets but relamped by L&E
- Drainage Pumps - Civils Assets

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

8.1.1 Basis of Condition Reporting for Lifts and Escalators

Note: Residual Life is only reported for L&E subassets with a Residual Life RAV. See Residual Life Methodology for further information.

3000	Traction Lift PMVT (Heavy Duty Station)							
ACR Hierarchy Ref.	FD. No	Asset Description	Concerns RAV	Concerns RAV %	Residual Life RAV %	Residual Life RAV	Nominal Life	Source of Nominal Life
3100	3100	Shaft						
3110	3110	Shaft Walls/Tower	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	Engineers professional judgement
3120	3120	Machine Room Floor & Overhead Steelwork	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
3130	3130	Pit Floor	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
3140	3140	Guide Rails & Fixings	10	10%	15	15%	40	Engineers professional judgement
3150	3150	Guarding	1	1%	N/A	N/A	40	Engineers professional judgement
3160	3160	Shaft Lighting	1	1%	1	1%	20	Engineers professional judgement
3170	3170	Shaft Transfer Door	6	6%	N/A	N/A	40	Engineers professional judgement
3180	3180	Fire Compartmentation	3	3%	N/A	N/A	40	Engineers professional judgement
3200	3200	Safety Equipment						
3210	3210	Buffers	2	2%	N/A	N/A	40	Engineers professional judgement
3220	3220	Speed Governors	2	2%	N/A	N/A	20	Engineers professional judgement
3230	3230	Brakes	2	2%	N/A	N/A	40	Engineers professional judgement
3240	3240	Safety Gears	2	2%	N/A	N/A	20	Engineers professional judgement
3250	3250	Unintentional Movement device	N/A	N/A	N/A	N/A	20	Engineers professional judgement
3300	3300	Roping System						
3310	3310	Ropes	4	4%	N/A	N/A	5	Engineers professional judgement
3320	3320	Attachments	2	2%	N/A	N/A	10	Engineers professional judgement
3400	3400	Drive Machine						
3410	3410	Bed Plate	1	1%	N/A	N/A	40	Engineers professional judgement
3420	3420	Motor	4	4%	10	10%	40	Engineers professional judgement
3430	3430	Gear Box/Gearless	3	3%	15	15%	40	Engineers professional judgement
3440	3440	Drive Sheave	1	1%	N/A	N/A	10	Engineers professional judgement
3450	3450	Other Pulleys & Sheaves	2	2%	N/A	N/A	20	Engineers professional judgement
3460	3460	Auxiliary Winding System (Power Wind)	2	2%	N/A	N/A	40	Engineers professional judgement
3500	3500	Car & Counterweight						
3510	3510	Car	8	8%	15	15%	40	Engineers professional judgement
3520	3520	Car Frame/Sling/Structure	4	4%	10	10%	40	Engineers professional judgement
3530	3530	Doors/Door Panel/Door Operator & Equipment	3	3%	5	5%	20	Engineers professional judgement
3540	3540	Counterweight	3	3%	N/A	N/A	40	Engineers professional judgement
3550	3550	Auxiliary Equipment	1	1%	N/A	N/A	20	Engineers professional judgement
3600	3600	Landings and Doors						
3610	3610	Sills	1	1%	1	1%	20	Engineers professional judgement
3620	3620	Architrave	3	3%	N/A	N/A	40	Engineers professional judgement
3630	3630	Landing Doors/Locks	4	4%	4	4%	20	Engineers professional judgement
3700	3700	Electrical System						
3710	3710	Drive (Power) Control System	2	2%	2	2%	20	Engineers professional judgement
3720	3720	Operational Control System	3	3%	2	2%	20	Engineers professional judgement
3730	3730	Communications System	1	1%	N/A	N/A	10	Engineers professional judgement
3740	3740	Safety Circuit	3	3%	N/A	N/A	20	Engineers professional judgement
3750	3750	Controller & Associated equipment.	7	7%	10	10%	20	Engineers professional judgement
3760	3760	Switch Board	1	1%	N/A	N/A	20	Engineers professional judgement
3770	3770	Distribution Board	1	1%	N/A	N/A	20	Engineers professional judgement
3780	3780	Field Wiring	7	7%	10	10%	20	Engineers professional judgement

3000A	Traction Lift SMVT (MRL)							
ACR Hierarchy Ref.	FD. No	Asset Description	Concerns RAV	Concerns RAV %	Residual Life RAV %	Residual Life RAV	Nominal Life	Source of Nominal Life
3100A	3100	Shaft						
3110A	3110	Shaft Walls/Tower	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	Engineers professional judgement
3120A	3120	Machine Room Floor & Overhead Steelwork	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement

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3130A	3130	Pit Floor	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
3140A	3140	Guide Rails & Fixings	10	10%	15	15%	20	Engineers professional judgement
3150A	3150	Guarding	1	1%	N/A	N/A	20	Engineers professional judgement
3160A	3160	Shaft Lighting	1	1%	1	1%	20	Engineers professional judgement
3170A	3170	Shaft Transfer Door	6	6%	N/A	N/A	20	Engineers professional judgement
3180A	3180	Fire Compartmentation	3	3%	N/A	N/A	20	Engineers professional judgement
3200A	3200	Safety Equipment						
3210A	3210	Buffers	2	2%	N/A	N/A	20	Engineers professional judgement
3220A	3220	Speed Governors	2	2%	N/A	N/A	20	Engineers professional judgement
3230A	3230	Brakes	2	2%	N/A	N/A	20	Engineers professional judgement
3240A	3240	Safety Gears	2	2%	N/A	N/A	20	Engineers professional judgement
3300A	3300	Roping System						
3310A	3310	Ropes	4	4%	N/A	N/A	5	Engineers professional judgement
3320A	3320	Attachments	2	2%	N/A	N/A	10	Engineers professional judgement
3400A	3400	Drive Machine						
3410A	3410	Bed Plate	1	1%	N/A	N/A	20	Engineers professional judgement
3420A	3420	Motor / MRL Drive Machine	4	4%	10	10%	20	Engineers professional judgement
3430A	3430	Gear Box or Gearless / MRL Drive Machine	3	3%	15	15%	20	Engineers professional judgement
3440A	3440	Drive Sheave	1	1%	N/A	N/A	10	Engineers professional judgement
3450A	3450	Other Pulleys & Sheaves	2	2%	N/A	N/A	20	Engineers professional judgement
3460A	3460	Auxiliary Winding System	2	2%	N/A	N/A	20	Engineers professional judgement
3500A	3500	Car & Counterweight						
3510A	3510	Car	8	8%	15	15%	20	Engineers professional judgement
3520A	3520	Car Frame/Sling	4	4%	10	10%	20	Engineers professional judgement
3530A	3530	Doors	3	3%	5	5%	20	Engineers professional judgement
3540A	3540	Counterweight	3	3%	N/A	N/A	20	Engineers professional judgement
3550A	3550	Auxiliary Equipment	1	1%	N/A	N/A	20	Engineers professional judgement
3600A	3600	Landings and Doors						
3610A	3610	Sills	1	1%	1	1%	20	Engineers professional judgement
3620A	3620	Architrave	3	3%	N/A	N/A	20	Engineers professional judgement
3630A	3630	Landing Doors/Locks	4	4%	4	4%	20	Engineers professional judgement
3700A	3700	Electrical System						
3710A	3710	Drive (Power) Control System	2	2%	2	2%	20	Engineers professional judgement
3720A	3720	Operational Control System	3	3%	2	2%	20	Engineers professional judgement
3730A	3730	Communications System	1	1%	N/A	N/A	10	Engineers professional judgement
3740A	3740	Safety Circuit	3	3%	N/A	N/A	20	Engineers professional judgement
3750A	3750	Controller & Associated equipment. (UPS)	7	7%	10	10%	20	Engineers professional judgement
3760A	3760	Switch Board	1	1%	N/A	N/A	20	Engineers professional judgement
3770A	3770	Distribution Board	1	1%	N/A	N/A	20	Engineers professional judgement
3780A	3780	Field Wiring	7	7%	10	10%	20	Engineers professional judgement

4000	**Hydraulic Lift SMVT**							
ACR Hierarchy Ref.	**FD. No**	**Asset Description**	**Concerns RAV**	**Concerns RAV %**	**Residual Life RAV %**	**Residual Life RAV**	**Nominal Life**	**Source of Nominal Life**
4100	4100	Shaft						
4110	4110	Shaft Walls/Tower	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	N/A Tunnel Asset	Engineers professional judgement
4120	4120	Machine Room Floor & Overhead Steelwork	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
4130	4130	Pit Floor	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	N/A Structures Asset	Engineers professional judgement
4140	4140	Guide Rails & Fixings	10	10%	15	15%	20	Engineers professional judgement
4150	4150	Guarding	1	1%	N/A	N/A	20	Engineers professional judgement
4160	4160	Shaft Lighting	1	1%	1	1%	20	Engineers professional judgement
4170	4170	Shaft Transfer Door	7	7%	N/A	N/A	20	Engineers professional judgement
4180	4180	Fire Compartmentation	3	3%	N/A	N/A	20	Engineers professional judgement

4200	4200	Safety Equipment						
4210	4210	Buffers	2	2%	N/A	N/A	20	Engineers professional judgement
4220	4220	Speed Governors	2	2%	N/A	N/A	20	Engineers professional judgement
4230	4230	Brakes	2	2%	N/A	N/A	20	Engineers professional judgement
4240	4240	Safety Gears	2	2%	N/A	N/A	20	Engineers professional judgement
4300	4300	Roping System						
4310	4310	Ropes	4	1%	N/A	N/A	5	Engineers professional judgement
4320	4320	Attachments	2	1%	N/A	N/A	10	Engineers professional judgement
4400	4400	Hydraulic System						
4410	4410	Pump, Drive Motor & Control Unit	7	7%	15	15%	10	Engineers professional judgement
4420	4420	Hydraulic Rams & Hoses	8	8%	10	10%	20	Engineers professional judgement
4430	4430	Other Pulleys & Sheaves	1	1%	N/A	N/A	20	Engineers professional judgement
4440	4440	Auxiliary Pumping System	3	3%	N/A	N/A	10	Engineers professional judgement
4450	4450	Heat Extraction Plant (Oil Cooler)	1	1%	N/A	N/A	15	Engineers professional judgement
4500	4500	Car						
4510	4510	Car	6	6%	15	15%	20	Engineers professional judgement
4520	4520	Car Frame/Sling	4	4%	10	10%	20	Engineers professional judgement
4530	4530	Doors	4	4%	5	5%	20	Engineers professional judgement
4540	4540	Auxiliary Equipment	3	3%	N/A	N/A	20	Engineers professional judgement
4600	4600	Landings and Doors						
4610	4610	Sills	1	1%	1	1%	20	Engineers professional judgement
4620	4620	Architrave	3	3%	N/A	N/A	20	Engineers professional judgement
4630	4630	Landing Doors/Locks	4	4%	4	4%	20	Engineers professional judgement
4700	4700	Electrical System						
4710	4710	Operational Control System	3	3%	2	2%	20	Engineers professional judgement
4720	4720	Communications System	1	1%	N/A	N/A	10	Engineers professional judgement
4730	4730	Safety Circuit	3	3%	N/A	N/A	20	Engineers professional judgement
4740	4740	Controller & Associated equipment. (Power Raising)	7	7%	12	12%	20	Engineers professional judgement
4750	4750	Switch Board	1	1%	N/A	N/A	20	Engineers professional judgement
4760	4760	Distribution Board	1	1%	N/A	N/A	20	Engineers professional judgement
4770	4770	Field Wiring	7	7%	10	10%	20	Engineers professional judgement

5000	**Stair Lift**							
ACR Hierarchy Ref.	**FD. No**	**Asset Description**	**Concerns RAV**	**Concerns RAV %**	**Residual Life RAV %**	**Residual Life RAV**	**Nominal Life**	**Source of Nominal Life**
5100	5100	Platform	20	20%	20	20%	10	Engineers professional judgement
5200	5200	Guide Rails	20	20%	20	20%	10	Engineers professional judgement
5300	5300	Drive Mechanism and Hand Winding	40	40%	40	40%	10	Engineers professional judgement
5400	5400	Power Supply, Control and Safety Devices	20	20%	20	20%	10	Engineers professional judgement

6000	**Platform Lift**							
ACR Hierarchy Ref.	**FD. No**	**Asset Description**	**Concerns RAV**	**Concerns RAV %**	**Residual Life RAV %**	**Residual Life RAV**	**Nominal Life**	**Source of Nominal Life**
6100	N/A	Platform	20	20%	20	20%	10	Engineers professional judgement
6200	N/A	Guide Rails	20	20%	20	20%	10	Engineers professional judgement
6300	6400	Drive Mechanism and Hand Winding	20	20%	20	20%	10	Engineers professional judgement
6400	6500	Power Supply, Control and Safety Devices	20	20%	20	20%	10	Engineers professional judgement
6500	6200	Cladding (tower Enclosure)	20	20%	20	20%	10	Engineers professional judgement

Exclusions
The following are excluded from the Lifts & Escalators Asset Definition:
- Truss work, floor support work and finishes - Civils/Premises assets
- Lifting beams in machine rooms - Civils assets
- Lighting for Escalators and Passenger Conveyors - E&M assets but relamped by L&E
- Drainage Pumps - Civils Assets

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

8.1.2 Asset Definition : Escalators

ACR No.	FD No.	Asset Definition	Interfaces with
1000	**1000**	**Escalator**	
1100	**1100**	**Shaft**	
1110	1110	Inclined Shaft	Civil - Structures - includes maintenance access stairways
1120	1120	Machine Chambers	Civil - Structures
1130	1130	Shaft Lighting	E&M - Asset
1140	1140	Guarding	Includes dust trays and chutes
1150	1150	Fire Compartmentalisation	Fire Protection Asset
1160	1160	Truss Steel Work	Civils - Structures - including floor support steel work, plinths, floor tray supports and floor trays
1170	1170	Tracking System	L&E - Includes brackets, main and return tracking system, D tracks
1200	**1200**	**Step Band**	
1210	1210	Step Chain	Securing devices, links, pins, bushes and rollers
1220	1220	Steps	Chain wheels, axles, step frame, trailer wheels, bearings, treads and risers
1300	**1300**	**Drive Machine**	
1310	1310	Bed Plate	
1320	1320	Motor	Including coupling & hand winding arrangements
1330	1330	Gear Box	
1400	**1400**	**Drive Transmission System**	
1410	1410	Main Drive Top Shaft	Includes handrail drive and main drive sprockets
1420	1420	Lower Carriage Idler Shaft	
1430	1430	Main drive chain	
1440	1440	Auxilliary Shafts, Chains & Sprockets	
1450	1450	Lubrication System	
1500	**1500**	**Handrail System**	
1510	1510	Handrails	
1520	1520	Drive, tracking & tension system	
1600	**1600**	**Tension Carriage**	**Including frame, guidance and tensioning system**
1610	N/A	Half tracks & tension system	
1700	**1700**	**Braking Systems**	
1710	1710	Operational Brake	
1720	1720	Auxiliary Brake	
1800	**1800**	**Balustrade**	**Including signage**
1810	1810	Panels & structural support	Includes side panels, decking, mouldings, cabinet ends, advert panels and frames, skirt panels, brush guards, handrail entry guards and lights
1820	1820	Comb Plates	
1900	**1900**	**Power and Control**	
1910	1910	Switch Board	Includes circuit breakers, busbar system up to isolator system on incoming supply
1920	1920	Controller	
1930	1930	Safety Circuit	Includes all safety switches and speed governor
1940	1940	Field Wiring	Power & control wiring, auxiliary swiches, condition monitoring devices

1000A	**1000**	**Compact Escalator**	
1100A	**1100**	**Shaft**	
1110A	1110	Inclined Shaft	Civil - Structures - includes maintenance access stairways
1120A	1120	Machine Chambers	Civil - Structures
1130A	1130	Shaft Lighting	E&M - Asset
1140A	1140	Guarding	Includes dust trays and chutes
1150A	1150	Fire Compartmentalisation	Fire Protection Asset
1160A	1160	Truss Steel Work	Civils - Structures - including floor support steel work, plinths, floor tray supports and floor trays
1170A	1170	Tracking System	L&E - Includes brackets, main and return tracking system, D tracks
1200A	**1200**	**Step Band**	
1210A	1210	Step Chain	Securing devices, links, pins, bushes and rollers
1220A	1220	Steps	Chain wheels, axles, step frame, trailer wheels, bearings, treads and risers
1300A	**1300**	**Drive Machine**	
1310A	1310	Bed Plate	
1320A	1320	Motor	Including coupling & hand winding arrangements
1330A	1330	Gear Box	
1400A	**1400**	**Drive Transmission System**	
1410A	1410	Main Drive Top Shaft	Includes handrail drive and main drive sprockets
1420A	1420	Lower Carriage Idler Shaft	
1430A	1430	Main drive chain	
1440A	1440	Auxilliary Shafts, Chains & Sprockets	
1450A	1450	Lubrication System	
1500A	**1500**	**Handrail System**	
1510A	1510	Handrails	
1520A	1520	Drive, tracking & tension system	
1600A	**1600**	**Tension Carriage**	**Including frame, guidance and tensioning system**
1610A	N/A	Half tracks & tension system	
1700A	**1700**	**Braking Systems**	
1710A	1710	Operational Brake	
1720A	1720	Auxiliary Brake	
1800A	**1800**	**Balustrade**	**Including signage**
1810A	1810	Panels & structural support	Includes side panels, decking, mouldings, cabinet ends, advert panels and frames, skirt panels, brush guards, handrail entry guards and lights
1820A	1820	Comb Plates	
1900A	**1900**	**Power and Control**	
1910A	1910	Switch Board	Includes circuit breakers, busbar system up to isolator system on incoming supply
1920A	1920	Controller	
1930A	1930	Safety Circuit	Includes all safety switches and speed governor
1940A	1940	Field Wiring	Power & control wiring, auxiliary swiches, condition monitoring devices

2000	**2000**	**Passenger Conveyor**	
2100	**2100**	**Truss and Tracking**	**Civil - Structures - includes maintenance access stairways**
2110	2110	Shaft	Civil - Structures
2120	2120	Machine Chambers	Civil - Structures
2130	2130	Shaft Lighting	E&M - Asset
2140	2140	Guarding	Includes dust trays and chutes
2150	2150	Fire Compartmentalisation	Fire Protection Asset
2160	2160	Truss Steel Work	Civils - Structures - including floor support steel work, plinths, floor tray supports and floor trays
2170	2170	Tracking System	L&E - Includes brackets, main and return tracking system, D tracks
2200	**2200**	**Pallet Band**	
2210	2210	Pallet Chain	Securing devices, links, pins, bushes and rollers
2220	2220	Pallets	Chain wheels, axles, pallet frame, trailer wheels, bearings and treads.C26
2300	**2300**	**Drive Machine**	
2310	2310	Bed Plate	
2320	2320	Motor	Including coupling & hand winding arrangements
2330	2330	Gear Box	
2400	**2400**	**Drive Transmission System**	**Includes handrail drive and main drive sprockets**
2410	2410	Main Drive Shaft	
2420	2420	Tension Carriage Idler Shaft	
2430	2430	Main drive chain	
2440	2440	Auxilliary Shafts, Chains & Sprockets	
2450	2450	Lubrication System	
2500	**2500**	**Handrail System**	
2510	2510	Handrails	
2520	2520	Drive, tracking & tension system	
2600	**2600**	**Tension Carriage**	**Including frame, guidance and tensioning system**
2700	**2700**	**Braking Systems**	
2710	2710	Operational Brake	
2720	2720	Auxiliary Brake	
2800	**2800**	**Balustrade**	Including signage
2810	2810	Panels & structural support	Includes side panels, decking, mouldings, cabinet ends, advert panels and frames, skirt panels, brush guards, handrail entry guards and lights
2820	2820	Comb Plates	
2900	**2900**	**Power and Control**	
2910	2910	Switch Board	Includes circuit breakers, busbar system up to isolator system on incoming supply
2920	2920	Controller	
2930	2930	Safety Circuit	Includes all safety switches and speed governor
2940	2940	Field Wiring	Power & control wiring, auxiliary swiches, condition monitoring devices

8.1.2 Asset Definition: Lifts

ACR No.	FD No.	Asset Definition	Interfaces With
5000	**3000**	**Traction Lift PMVT (Heavy Duty Station)**	
5100	**3100**	**Shaft**	**Lift tower (tower and shaft screens) including signage**
5120	3110	Shaft Walls/Tower	Civil Structures - note guide rails & fixings are L&E assets
5130	3120	Machine Room Floor & Overhead Steelwork	Civil Structures
5140	3130	Pit Floor	Civil Structures - solid or suspended
5150	3140	Guide Rails & Fixings	
5160	3150	Guarding	
5170	3160	Shaft Lighting	
5180	3170	Shaft Transfer Door	
5190	3180	Fire Compartmentation	Fire Protection asset
5200	**3200**	**Safety Equipment**	
5210	3210	Buffers	
5220	3220	Speed Governors	
5230	3230	Brakes	
5240	3240	Safety Gears	
5300	**3300**	**Roping System**	**Including governor ropes**
5310	3310	Ropes	
5320	3320	Attachments	
5400	**3400**	**Drive Machine**	**Including drive, divertor sheaves & pulleys**
5410	3410	Bed Plate	
5420	3420	Motor	
5430	3430	Gear Box/Gearless	Including coupling
5440	3440	Drive Sheave	
5450	3450	Other Pulleys & Sheaves	
5460	3460	Auxiliary Winding System	Including back-up power supplies
5500	**3500**	**Car & Counterweight**	
5510	3510	Car	Including interior finish, signage, transfer door & roof hatch
5520	3520	Car Frame/Sling	Including guidance system
5530	3530	Doors	Including door operating equipment, mechanical locking mechanism, door tracks & guides
5540	3540	Counterweight	Including filler weights & guidance system
5550	3550	Auxiliary Equipment	Heating, lighting & ventilation
5600	**3600**	**Landings and Doors**	**Including signage**
5610	3610	Sills	
5620	3620	Architrave	
5630	3630	Landing Doors/Locks	Includes landing door tracks, guides & engineers' gates
5700	**3700**	**Electrical System**	
5710	3710	Drive (Power) Control System	Includes motor generator systems & solid state systems
5720	3720	Operational Control System	Switches, cabling, push buttons, lighting, indicators, control stations and indications
5730	3730	Communications System	a) No Interfaces b) Interfaces to CCTV monitors and recording equipment via half way box in machine room c) Interface with comms in operations room to permanently manned location.
5740	3740	Safety Circuit	Includes safety circuit wiring & all safety switches
5750	3750	Controller & Associated equipment.	Includes lighting, ventilation, machine room and on landing.
5760	3760	Switch Board	
5770	3770	Distribution Board	
5780	3780	Field Wiring	Looms, travelling cables, switches, interlocks and halfway boxes

3000A	**3000**	**Traction Lift - SMVT**	
3100A	**3100**	**Shaft**	**Lift tower (tower and shaft screens) including signage**
3110A	3110	Shaft Walls/Tower	Civil Structures - note guide rails & fixings are L&E assets
3120A	3120	Machine Room Floor & Overhead Steelwork	Civil Structures
3130A	3130	Pit Floor	Civil Structures - solid or suspended
3140A	3140	Guide Rails & Fixings	
3150A	3150	Guarding	
3160A	3160	Shaft Lighting	
3170A	3170	Shaft Transfer Door	
3180A	3180	Fire Compartmentation	Fire Protection asset
3200A	**3200**	**Safety Equipment**	
3210A	3210	Buffers	
3220A	3220	Speed Governors	
3230A	3230	Brakes	
3240A	3240	Safety Gears	
3300A	**3300**	**Roping System**	**Including governor ropes**
3310A	3310	Ropes	
3320A	3320	Attachments	
3400A	**3400**	**Drive Machine**	**Including drive, divertor sheaves & pulleys**
3410A	3410	Bed Plate	
3420A	3420	Motor	
3430A	3430	Gear Box/Gearless	Including coupling
3440A	3440	Drive Sheave	
3450A	3450	Other Pulleys & Sheaves	
3460A	3460	Auxiliary Winding System	Including back-up power supplies
3500A	**3500**	**Car & Counterweight**	
3510A	3510	Car	Including interior finish, signage, transfer door & roof hatch
3520A	3520	Car Frame/Sling	Including guidance system
3530A	3530	Doors	Including door operating equipment, mechanical locking mechanism, door tracks & guides
3540A	3540	Counterweight	Including filler weights & guidance system
3550A	3550	Auxiliary Equipment	Heating, lighting & ventilation
3600A	**3600**	**Landings and Doors**	**Including signage**
3610A	3610	Sills	
3620A	3620	Architrave	
3630A	3630	Landing Doors/Locks	Includes landing door tracks, guides & engineers' gates
3700A	**3700**	**Electrical System**	
3710A	3710	Drive (Power) Control System	Includes motor generator systems & solid state systems
3720A	3720	Operational Control System	Switches, cabling, push buttons, lighting, indicators, control stations and indications
3730A	3730	Communications System including:- a) automatic lift generated voice announcements b) CCTV c) lift emergency / maintenance communiations	a) No Interfaces b) Interfaces to CCTV monitors and recording equipment via half way box in machine room c) Interface with comms in operations room to permanently manned location.
3740A	3740	Safety Circuit	Includes safety circuit wiring & all safety switches
3750A	3750	Controller & Associated equipment.	Includes lighting, ventilation, machine room and on landing.
3760A	3760	Switch Board	
3770A	3770	Distribution Board	
3780A	3780	Field Wiring	Looms, travelling cables, switches, interlocks and halfway boxes

8.1.2 Asset Definition: Lifts

ACR No.	FD No.	Asset Definition	Interfaces With
4000	**4000**	**Hydraulic Lift - SMVT**	
4100	**4100**	**Shaft**	**lift tower (tower and shaft screens) including signage**
4110	4110	Shaft Walls/Tower	Civil - Structures - note guide rails & fixings are L&E assets
4120	4120	Machine Room Floor & Overhead Steelwork	Civil - Structures
4130	4130	Pit Floor	Civil - Structures - may be solid or suspended
4140	4140	Guide Rails & Fixings	
4150	4150	Guarding	
4160	4160	Shaft Lighting	
4170	4170	Shaft Transfer Door	
4180	4180	Fire Compartmentation	Fire Protection asset
4200	**4200**	**Safety Equipment**	
4210	4210	Buffers	
4220	4220	Speed Governor	
4230	4230	Safety Gear	
4240	4240	Anti-rupture Protection	
4300	**4300**	**Roping System**	**Including governor ropes**
4310	4310	Ropes	Could include chains
4320	4320	Attachments	
4400	**4400**	**Hydraulic System**	Including drive, divertor sheaves & pulleys
4410	4410	Pump, Drive Motor & Control Unit (including reservoir and spillage containment)	
4420	4420	Hydraulic Rams & Hoses	
4430	4430	Other Pulleys & Sheaves	
4440	4440	Auxiliary Pumping System	Including back-up power supplies
4450	4450	Heat Extraction Plant (Oil Cooler)	Room cooling system
4500	**4500**	**Car**	
4510	4510	Car	Including interior finish, signage, transfer door & roof hatch
4520	4520	Car Frame/Sling	Including guidance system
4530	4530	Doors	Including door operating equipment, mechanical locking mechanism, door tracks & guides
4540	4540	Auxiliary Equipment	Heating, lighting & ventilation
4600	**4600**	**Landings and Doors**	**Including signage**
4610	4610	Sills	
4620	4620	Architrave	
4630	4630	Landing Doors/Locks	Includes landing door tracks, guides & engineers' gates
4700	**4700**	**Electrical System**	
4710	4710	Operational Control System	Switches, cabling, push buttons, lighting, indicators, control stations and indications
4720	4720	Communications System including:- a) automatic lift generated voice announcements b) CCTV c) lift emergency / maintenance communiations	a) No Interfaces b) Interfaces to CCTV monitors and recording equipment via half way box in machine room c) Interface with comms in operations room to permanently manned location.
4730	4730	Safety Circuit	Includes safety circuit wiring & all safety switches
4740	4740	Controller & Associated equipment.	Includes lighting, ventilation, machine room and on landing.
4750	4750	Switch Board	
4760	4760	Distribution Board	
4770	4770	Field Wiring	Looms, travelling cables, switches, interlocks and halfway boxes

5000	**5000**	**Stair Lift**	
5100	5100	Platform	
5200	5200	Guide Rails	
5300	5300	Drive Mechanism and Hand Winding	
5400	5400	Power Supply, Control and Safety Devices	

6000	**6000**	**Lifting Platform**	
6100	N/A	Platform	
6200	N/A	Guide Rails	
6300	6400	Drive Mechanism and Hand Winding	
6400	6500	Power Supply, Control and Safety Devices	
6500	6200	Cladding (tower Enclosure)	

8.1.3 Reporting Requirements for Escalators

8.1.3.1 Escalator ACR - all Lines

Escalators – all

ACR No.	FD No.	Actuals:	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			%RAV	%RAV	%RAV	%RAV	Statutory non compliant Quantity	Residual safety risk £ Risk	uneconomic/ unsustainable £ Risk	Risk of Performance Loss £ Risk
1000	**1000**	**Escalator**								
1100	1100	Shaft								
1110	1110	Inclined Shaft								
1120	1120	Machine Chambers								
1130	1130	Shaft Lighting								
1140	1140	Guarding								
1150	1150	Fire Compartmentisation								
1160	1160	Truss Steel Work								
1170	1170	Tracking Guidance System								
1200	1200	Step Band								
1210	1210	Step Chain								
1220	1220	Steps								
1300	1300	Drive Machine								
1310	1310	Bed Plate								
1320	1320	Motor								
1330	1330	Gear Box								
1400	1400	Drive Transmission System								
1410	1410	Main Drive Top Shaft								
1420	1420	Lower Carriage Idler Shaft								
1430	1430	Main drive chain								
1440	1440	Auxilliary Shafts, Chains & Sprockets								
1450	1450	Lubrication System								
1500	1500	Handrail System								
1510	1510	Handrails								
1520	1520	Drive, tracking & tension system.								
1600	1600	Tension Carriage								
1610	N/A	Half tracks & tension system								
1700	1700	Braking Systems								
1710	1710	Operational Brake								
1720	1720	Auxiliary Brake								
1800	1800	Balustrade								
1810	1810	Panels & structural support								
1820	1820	Comb Plates								
1900	1900	Power and Control								
1910	1910	Switch Board								
1920	1920	Controller								
1930	1930	Safety Circuit								
1940	1940	Field Wiring								

1000A	**1000**	**Compact Escalator**								
1100A	1100	Shaft								
1110A	1110	Inclined Shaft								
1120A	1120	Machine Chambers								
1130A	1130	Shaft Lighting								
1140A	1140	Guarding								
1150A	1150	Fire Compartmentisation								
1160A	1160	Truss Steel Work								
1170A	1170	Tracking Guidance System								
1200A	1200	Step Band								
1210A	1210	Step Chain								
1220A	1220	Steps								
1300A	1300	Drive Machine								
1310A	1310	Bed Plate								
1320A	1320	Motor								
1330A	1330	Gear Box								
1400A	1400	Drive Transmission System								
1410A	1410	Main Drive Top Shaft								
1420A	1420	Lower Carriage Idler Shaft								
1430A	1430	Main drive chain								
1440A	1440	Auxilliary Shafts, Chains & Sprockets								
1450A	1450	Lubrication System								
1500A	1500	Handrail System								
1510A	1510	Handrails								
1520A	1520	Drive, tracking & tension system.								
1600A	1600	Tension Carriage								
1610A	N/A	Half tracks & tension system								
1700A	1700	Braking Systems								
1710A	1710	Operational Brake								
1720A	1720	Auxiliary Brake								
1800A	1800	Balustrade								
1810A	1810	Panels & structural support								
1820A	1820	Comb Plates								
1900A	1900	Power and Control								
1910A	1910	Switch Board								
1920A	1920	Controller								
1930A	1930	Safety Circuit								
1940A	1940	Field Wiring								

2100	**2100**	**Passenger Conveyor**								
2100	2100	Truss and Tracking								
2110	2110	Inclined Shaft	[redacted]							
2120	2120	Machine Chambers	[redacted]							
2130	2130	Shaft Lighting	[redacted]							
2140	2140	Guarding	[redacted]							
2150	2150	Fire Compartmentisation	[redacted]							
2160	2160	Truss Steel Work	[redacted]							
2170	2170	Tracking Guidance System								
2200	2200	Pallet Band								
2210	2210	Pallet Chain								
2220	2220	Pallets								
2300	2300	Drive Machine								
2310	2310	Bed Plate	[redacted]							
2320	2320	Motor								
2330	2330	Gear Box								
2400	2400	Drive Transmission System								
2410	2410	Main Drive Top Shaft								
2420	2420	Lower Carriage Idler Shaft								
2430	2430	Main drive chain	[redacted]							
2440	2440	Auxilliary Shafts, Chains & Sprockets	[redacted]							
2450	2450	Lubrication System	[redacted]							
2500	2500	Handrail System								
2510	2510	Handrails	[redacted]							
2520	2520	Drive, tracking & tension system.								
2600	2600	Tension Carriage								
2610	2610	Half tracks & tension system								
2700	2700	Braking Systems								
2710	2710	Operational Brake								
2720	2720	Auxiliary Brake								
2800	2800	Balustrade								
2810	2810	Panels & structural support								
2820	2820	Comb Plates	[redacted]							
2900	2900	Power and Control								
2910	2910	Switch Board	[redacted]							
2920	2920	Controller								
2930	2930	Safety Circuit								
2940	2940	Field Wiring								

Escalators :								
Previous								
Actual								
Variance								

8.1.3 Reporting Requirements for Escalators

8.1.3.2 Escalator ACR - by Line

Escalators – all Lines

ACR No.	FD No.	Actuals:	Physical Condition Code A % RAV	Code B % RAV	Code C % RAV	Code D % RAV	Functional Condition Code 1 Statutory non compliant Quantity	Code 2 Residual safety risk £ Risk	Code 3 uneconomic/ unsustainable £ Risk	Code 4 Risk of Performance Loss £ Risk
1000	**1000**	**Escalator**								
1100	1100	Shaft								
1110	1110	Inclined Shaft								
1120	1120	Machine Chambers								
1130	1130	Shaft Lighting								
1140	1140	Guarding								
1150	1150	Fire Compartmentisation								
1160	1160	Truss Steel Work								
1170	1170	Tracking Guidance System								
1200	1200	Step Band								
1210	1210	Step Chain								
1220	1220	Steps								
1300	1300	Drive Machine								
1310	1310	Bed Plate								
1320	1320	Motor								
1330	1330	Gear Box								
1400	1400	Drive Transmission System								
1410	1410	Main Drive Top Shaft								
1420	1420	Lower Carriage Idler Shaft								
1430	1430	Main drive chain								
1440	1440	Auxilliary Shafts, Chains & Sprockets								
1450	1450	Lubrication System								
1500	1500	Handrail System								
1510	1510	Handrails								
1520	1520	Drive, tracking & tension system.								
1600	1600	Tension Carriage								
1610	N/A	Half tracks & tension system								
1700	1700	Braking Systems								
1710	1710	Operational Brake								
1720	1720	Auxiliary Brake								
1800	1800	Balustrade								
1810	1810	Panels & structural support								
1820	1820	Comb Plates								
1900	1900	Power and Control								
1910	1910	Switch Board								
1920	1920	Controller								
1930	1930	Safety Circuit								
1940	1940	Field Wiring								
1000A	**1000**	**Compact Escalator**								
1100A	1100	Shaft								
1110A	1110	Inclined Shaft								
1120A	1120	Machine Chambers								
1130A	1130	Shaft Lighting								
1140A	1140	Guarding								
1150A	1150	Fire Compartmentisation								
1160A	1160	Truss Steel Work								
1170A	1170	Tracking Guidance System								
1200A	1200	Step Band								
1210A	1210	Step Chain								
1220A	1220	Steps								
1300A	1300	Drive Machine								
1310A	1310	Bed Plate								
1320A	1320	Motor								
1330A	1330	Gear Box								
1400A	1400	Drive Transmission System								
1410A	1410	Main Drive Top Shaft								
1420A	1420	Lower Carriage Idler Shaft								
1430A	1430	Main drive chain								
1440A	1440	Auxilliary Shafts, Chains & Sprockets								
1450A	1450	Lubrication System								
1500A	1500	Handrail System								
1510A	1510	Handrails								
1520A	1520	Drive, tracking & tension system.								
1600A	1600	Tension Carriage								
1610A	N/A	Half tracks & tension system								
1700A	1700	Braking Systems								
1710A	1710	Operational Brake								
1720A	1720	Auxiliary Brake								
1800A	1800	Balustrade								

1810A	1810	Panels & structural support								
1820A	1820	Comb Plates								
1900A	1900	Power and Control								
1910A	1910	Switch Board								
1920A	1920	Controller								
1930A	1930	Safety Circuit								
1940A	1940	Field Wiring								
2100	**2100**	**Passenger Conveyor**								
2100	2100	Truss and Tracking								
2110	2110	Inclined Shaft								
2120	2120	Machine Chambers								
2130	2130	Shaft Lighting								
2140	2140	Guarding								
2150	2150	Fire Compartmentisation								
2160	2160	Truss Steel Work								
2170	2170	Tracking Guidance System								
2200	2200	Pallet Band								
2210	2210	Pallet Chain								
2220	2220	Pallets								
2300	2300	Drive Machine								
2310	2310	Bed Plate								
2320	2320	Motor								
2330	2330	Gear Box								
2400	2400	Drive Transmission System								
2410	2410	Main Drive Top Shaft								
2420	2420	Lower Carriage Idler Shaft								
2430	2430	Main drive chain								
2440	2440	Auxilliary Shafts, Chains & Sprockets								
2450	2450	Lubrication System								
2500	2500	Handrail System								
2510	2510	Handrails								
2520	2520	Drive, tracking & tension system.								
2600	2600	Tension Carriage								
2610	2610	Half tracks & tension system								
2700	2700	Braking Systems								
2710	2710	Operational Brake								
2720	2720	Auxiliary Brake								
2800	2800	Balustrade								
2810	2810	Panels & structural support								
2820	2820	Comb Plates								
2900	2900	Power and Control								
2910	2910	Switch Board								
2920	2920	Controller								
2930	2930	Safety Circuit								
2940	2940	Field Wiring								

Escalators :								
Previous								
Actual								
Variance								
Commentary on								
A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >								
The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.								

8.1.4 Reporting Requirements for Lifts

8.1.4.1 Lift ACR - all Lines

ACR No.	FD No.	Actuals:	Physical Condition Code A % RAV	Code B % RAV	Code C % RAV	Code D % RAV	Functional Condition Code 1 Statutory non compliant Quantity	Code 2 Residual safety risk £ Risk	Code 3 uneconomic/ unsustainable £ Risk	Code 4 Risk of Performance Loss £ Risk
		Lifts – all Lines								
3000	**3000**	**Traction Lift PMVT (Heavy Duty Station)**								
3100	3100	Shaft								
3110	3110	Shaft Walls/Tower								
3120	3120	Machine Room Floor & Overhead Steelwork								
3130	3130	Pit Floor								
3140	3140	Guide Rails & Fixings								
3150	3150	Guarding								
3160	3160	Shaft Lighting								
3170	3170	Shaft Transfer Door								
3180	3180	Fire Compartmentation								
3200	3200	Safety Equipment								
3210	3210	Buffers								
3220	3220	Speed Governors								
3230	3230	Brakes								
3240	3240	Safety Gears								
3250	3250	Unintentional Movement device								
3300	3300	Roping System								
3310	3310	Ropes								
3320	3320	Attachments								
3400	3400	Drive Machine								
3410	3410	Bed Plate								
3420	3420	Motor								
3430	3430	Gear Box/Gearless								
3440	3440	Drive Sheave								
3450	3450	Other Pulleys & Sheaves								
3460	3460	Auxiliary Winding System (Power Wind)								
3500	3500	Car & Counterweight								
3510	3510	Car								
3520	3520	Car Frame/Sling/Structure								
3530	3530	Doors/Door Panel/Door Operator & Equipment								
3540	3540	Counterweight								
3550	3550	Auxiliary Equipment								
3600	3600	Landings and Doors								
3610	3610	Sills								
3620	3620	Architrave								
3630	3630	Landing Doors/Locks								
3700	3700	Electrical System								
3710	3710	Drive (Power) Control System								
3720	3720	Operational Control System								
3730	3730	Communications System								
3740	3740	Safety Circuit								
3750	3750	Controller & Associated equipment.								
3760	3760	Switch Board								
3770	3770	Distribution Board								
3780	3780	Field Wiring								
3000A	**3000**	**Traction Lift SMVT (MRL)**								
3100A	3100	Shaft								
3110A	3110	Shaft Walls/Tower								
3120A	3120	Machine Room Floor & Overhead Steelwork								
3130A	3130	Pit Floor								
3140A	3140	Guide Rails & Fixings								
3150A	3150	Guarding								
3160A	3160	Shaft Lighting								
3170A	3170	Shaft Transfer Door								
3180A	3180	Fire Compartmentation								
3200A	3200	Safety Equipment								
3210A	3210	Buffers								
3220A	3220	Speed Governors								
3230A	3230	Brakes								
3240A	3240	Safety Gears								
3300A	3300	Roping System								
3310A	3310	Ropes								
3320A	3320	Attachments								
3400A	3400	Drive Machine								
3410A	3410	Bed Plate								
3420A	3420	Motor / MRL Drive Machine								
3430A	3430	Gear Box or Gearless / MRL Drive Machine								
3440A	3440	Drive Sheave								
3450A	3450	Other Pulleys & Sheaves								
3460A	3460	Auxiliary Winding System								
3500A	3500	Car & Counterweight								
3510A	3510	Car								
3520A	3520	Car Frame/Sling								
3530A	3530	Doors								
3540A	3540	Counterweight								
3550A	3550	Auxiliary Equipment								
3600A	3600	Landings and Doors								
3610A	3610	Sills								
3620A	3620	Architrave								
3630A	3630	Landing Doors/Locks								
3700A	3700	Electrical System								
3710A	3710	Drive (Power) Control System								
3720A	3720	Operational Control System								
3730A	3730	Communications System								
3740A	3740	Safety Circuit								
3750A	3750	Controller & Associated equipment. (UPS)								
3760A	3760	Switch Board								
3770A	3770	Distribution Board								
3780A	3780	Field Wiring								

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4000	**4000**	**Hydraulic Lift SMVT**								
4100	4100	Shaft								
4110	4110	Shaft Walls/Tower								
4120	4120	Machine Room Floor & Overhead Steelwork								
4130	4130	Pit Floor								
4140	4140	Guide Rails & Fixings								
4150	4150	Guarding								
4160	4160	Shaft Lighting								
4170	4170	Shaft Transfer Door								
4180	4180	Fire Compartmentation								
4200	4200	Safety Equipment								
4210	4210	Buffers								
4220	4220	Speed Governors								
4230	4230	Brakes								
4240	4240	Safety Gears								
4300	4300	Roping System								
4310	4310	Ropes								
4320	4320	Attachments								
4400	4400	Hydraulic System								
4410	4410	Pump, Drive Motor & Control Unit								
4420	4420	Hydraulic Rams & Hoses								
4430	4430	Other Pulleys & Sheaves								
4440	4440	Auxiliary Pumping System								
4450	4450	Heat Extraction Plant (Oil Cooler)								
4500	4500	Car								
4510	4510	Car								
4520	4520	Car Frame/Sling								
4530	4530	Doors								
4540	4540	Auxiliary Equipment								
4600	4600	Landings and Doors								
4610	4610	Sills								
4620	4620	Architrave								
4630	4630	Landing Doors/Locks								
4700	4700	Electrical System								
4710	4710	Operational Control System								
4720	4720	Communications System								
4730	4730	Safety Circuit								
4740	4740	Controller & Associated equipment. (Power Raising)								
4750	4750	Switch Board								
4760	4760	Distribution Board								
4770	4770	Field Wiring								

5000	**5000**	**Stair Lift**								
5100	5100	Platform								
5200	5200	Guide Rails								
5300	5300	Drive Mechanism and Hand Winding								
5400	5400	Power Supply, Control and Safety Devices								

6000	**6000**	**Platform Lift**								
6100	N/A	Platform								
6200	N/A	Guide Rails								
6300	6400	Drive Mechanism and Hand Winding								
6400	6500	Power Supply, Control and Safety Devices								
6500	6200	Cladding (tower Enclosure)								

Lifts:								
Previous								
Actual								
Variance								

8.1.4 Reporting Requirements for Lifts

8.1.4.2 Lifts Reports - by Line

Lifts – Summary Report for xxx Line

ACR No.	FD No.	Actuals:	Physical Condition Code A %RAV	Code B %RAV	Code C %RAV	Code D %RAV	Functional Condition Code 1 Statutory non compliant Quantity	Code 2 Residual safety risk £ Risk	Code 3 uneconomic/ unsustainable £ Risk	Code 4 Risk of Performance Loss £ Risk
3000	3000	Traction Lift PMVT (Heavy Duty Station)								
3100	3100	Shaft								
3110	3110	Shaft Walls/Tower								
3120	3120	Machine Room Floor & Overhead Steelwork								
3130	3130	Pit Floor								
3140	3140	Guide Rails & Fixings								
3150	3150	Guarding								
3160	3160	Shaft Lighting								
3170	3170	Shaft Transfer Door								
3180	3180	Fire Compartmentation								
3200	3200	Safety Equipment								
3210	3210	Buffers								
3220	3220	Speed Governors								
3230	3230	Brakes								
3240	3240	Safety Gears								
3250	3250	Unintentional Movement device								
3300	3300	Roping System								
3310	3310	Ropes								
3320	3320	Attachments								
3400	3400	Drive Machine								
3410	3410	Bed Plate								
3420	3420	Motor								
3430	3430	Gear Box/Gearless								
3440	3440	Drive Sheave								
3450	3450	Other Pulleys & Sheaves								
3460	3460	Auxiliary Winding System (Power Wind)								
3500	3500	Car & Counterweight								
3510	3510	Car								
3520	3520	Car Frame/Sling/Structure								
3530	3530	Doors/Door Panel/Door Operator & Equipment								
3540	3540	Counterweight								
3550	3550	Auxiliary Equipment								
3600	3600	Landings and Doors								
3610	3610	Sills								
3620	3620	Architrave								
3630	3630	Landing Doors/Locks								
3700	3700	Electrical System								
3710	3710	Drive (Power) Control System								
3720	3720	Operational Control System								
3730	3730	Communications System								
3740	3740	Safety Circuit								
3750	3750	Controller & Associated equipment.								
3760	3760	Switch Board								
3770	3770	Distribution Board								
3780	3780	Field Wiring								

ACR No.	FD No.	Actuals:	Code A %RAV	Code B %RAV	Code C %RAV	Code D %RAV	Code 1 Quantity	Code 2 £ Risk	Code 3 £ Risk	Code 4 £ Risk
3000A	3000	Traction Lift SMVT (MRL)								
3100A	3100	Shaft								
3110A	3110	Shaft Walls/Tower								
3120A	3120	Machine Room Floor & Overhead Steelwork								
3130A	3130	Pit Floor								
3140A	3140	Guide Rails & Fixings								
3150A	3150	Guarding								
3160A	3160	Shaft Lighting								
3170A	3170	Shaft Transfer Door								
3180A	3180	Fire Compartmentation								
3200A	3200	Safety Equipment								
3210A	3210	Buffers								
3220A	3220	Speed Governors								
3230A	3230	Brakes								
3240A	3240	Safety Gears								
3300A	3300	Roping System								
3310A	3310	Ropes								
3320A	3320	Attachments								
3400A	3400	Drive Machine								
3410A	3410	Bed Plate								
3420A	3420	Motor /								
3430A	3430	Gear Box or Gearless /								
3440A	3440	Drive Sheave								
3450A	3450	Other Pulleys & Sheaves								
3460A	3460	Auxiliary Winding System								
3500A	3500	Car & Counterweight								
3510A	3510	Car								
3520A	3520	Car Frame/Sling								
3530A	3530	Doors								
3540A	3540	Counterweight								
3550A	3550	Auxiliary Equipment								
3600A	3600	Landings and Doors								
3610A	3610	Sills								
3620A	3620	Architrave								
3630A	3630	Landing Doors/Locks								
3700A	3700	Electrical System								
3710A	3710	Drive (Power) Control System								
3720A	3720	Operational Control System								
3730A	3730	Communications System								
3740A	3740	Safety Circuit								
3750A	3750	Controller & Associated equipment. (UPS)								
3760A	3760	Switch Board								
3770A	3770	Distribution Board								
3780A	3780	Field Wiring								

ACR No.	FD No.	Actuals:	Code A %RAV	Code B %RAV	Code C %RAV	Code D %RAV	Code 1 Quantity	Code 2 £ Risk	Code 3 £ Risk	Code 4 £ Risk
4000	4000	Hydraulic Lift SMVT								
4100	4100	Shaft								
4110	4110	Shaft Walls/Tower								
4120	4120	Machine Room Floor & Overhead Steelwork								
4130	4130	Pit Floor								
4140	4140	Guide Rails & Fixings								
4150	4150	Guarding								
4160	4160	Shaft Lighting								
4170	4170	Shaft Transfer Door								
4180	4180	Fire Compartmentation								
4200	4200	Safety Equipment								
4210	4210	Buffers								
4220	4220	Speed Governors								
4230	4230	Brakes								
4240	4240	Safety Gears								
4300	4300	Roping System								
4310	4310	Ropes								
4320	4320	Attachments								
4400	4400	Hydraulic System								

4410	4410	Pump, Drive Motor & Control Unit								
4420	4420	Hydraulic Rams & Hoses								
4430	4430	Other Pulleys & Sheaves								
4440	4440	Auxiliary Pumping System								
4450	4450	Heat Extraction Plant (Oil Cooler)								
4500	4500	Car								
4510	4510	Car								
4520	4520	Car Frame/Sling								
4530	4530	Doors								
4540	4540	Auxiliary Equipment								
4600	4600	Landings and Doors								
4610	4610	Sills								
4620	4620	Architrave								
4630	4630	Landing Doors/Locks								
4700	4700	Electrical System								
4710	4710	Operational Control System								
4720	4720	Communications System								
4730	4730	Safety Circuit								
4740	4740	Controller & Associated equipment. (Power Raising)								
4750	4750	Switch Board								
4760	4760	Distribution Board								
4770	4770	Field Wiring								

5000	**5000**	**Stair Lift**								
5100	5100	Platform								
5200	5200	Guide Rails								
5300	5300	Drive Mechanism and Hand Winding								
5400	5400	Power Supply, Control and Safety Devices								

6000	**6000**	**Platform Lift**								
6100	N/A	Platform								
6200	N/A	Guide Rails								
6300	6400	Drive Mechanism and Hand Winding								
6400	6500	Power Supply, Control and Safety Devices								
6500	6200	Cladding (tower Enclosure)								

Lifts:								
Previous								
Actual								
Variance								
Commentary on Variances:								

A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

S1042 Asset Condition Reporting (ACR)

Fire

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Business Objectives

The purpose scope and requirements of the ACR is defined in the Cat 1 Standard 5-042.

In addition the Sponsor requires the ACR to provide a systematic process for the evaluation of the condition of our assets supporting the preparation of the annual asset management plan and longer term business planning. This will:

- Achieve a balance between capital and maintenance funds
- Demonstrate functional suitability and performance
- Demonstrate physical and operational condition

1 Purpose

This document sets out the specific requirements for fire assets and forms an appendix to standard 5-042. Fire Safety Legislation requires certain fire precautions to be undertaken. These include:

- Measures to reduce the risk of fire on the premises and risk of spread of fire on the premises
- Measures in relation to the means of escape from the premises
- Measures for securing that, at all material times, the means of escape can be safely and effectively used
- Measures in relation to the means of fighting fire on the premises
- Measures in relation to means for detecting fire on the premises and giving warning in the case of fire on the premises
- Measures in relation to means of suppressing a fire on premises and giving a warning in the event of fire on the premises
- Measure to mitigate the effects of fire

The ACR forms part of the process to demonstrate that the systems and equipment installed meet these requirements. This also provides visibility by which London Underground can understand:

- Whether the Fire systems and assets and the use to which they are being put is in accordance with its approval and design, and meets the industry “good practice” standards applicable at the time of installation.
- How the asset condition is performing with regard to its age and environmental conditions
- How to plan the timely and most cost effective renewal of the asset
- Whether the maintenance regimes are robust enough to deliver the anticipated life expectancy and the legal and standards minimum requirements are being met.

2 Scope

All fire assets, including detection, suppression and fire fighting assets as well as passive fire assets such as compartmentation and fire doors / shutters which is owned or leased by London Underground excluding those forming part of PFI contracts.

The asset hierarchy is as detailed in standard 5-042 Asset Condition Reporting. The assets and locations covered in each annual review are detailed in the Sponsors requirement document issued to compliment the standard and to assist the preparation and completion on the assessment.

The review is a “Desk Top” exercise drawing on information from asset inspections and routine assessment / maintenance activities requiring the assessor to co-ordinate the information and draw final conclusions on the condition and performance of the assets.

A flow diagram in Appendix A details the ACR process and linkage to the asset work bank and risk register.

Due to the nature of regulation of fire assets an ongoing condition and performance assessment is made as part of the established maintenance programme. The output of this inspection and assessment programme shall be used as the basis for the annual review.

In addition to the routine programme of assessments detailed above, the Maintenance Sponsor requires the following to be taken into account:

a. Statutory Electrical Testing

A Statutory Electrical Test (SET) is required to be completed every three years for all wiring systems. The concerns arising from the assessment shall be included in the ACR for the following year i.e. SET completed in 2010, concerns included in ACR 2011.

Where there is no evidence of a test having been completed the asset will be considered a functional condition Code 1 concern.

Where a Statutory Electrical Test has been completed and safety related remedial actions have been raised a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

b. The Regulatory Reform (Fire Safety) Order 2005

By virtue of the Regulatory Reform (Fire Safety) Order 2005, London Underground is required to carry out a fire risk assessment of each station or building. The significant findings of the fire risk assessment, the control measures put in place to address the significant findings of the assessment as being especially at risk must all be recorded.

Where there is no evidence of an assessment having been completed for the building a functional condition Code 1 concern shall be raised accordingly. Where an assessment has been completed and safety related remedial actions have been raised a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

c. Testing of Fire Detection and Alarm Systems

Demonstration of effective fire suppression and fire fighting system by testing and inspection is required on a cyclical basis detailed in legislation and standards. This is to confirm that an effective system is available at all times.

Where there is no evidence of the required testing and inspection having been completed a functional condition Code 1 shall be concern raised accordingly. Where an inspection has been completed and safety related remedial actions have been identified a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

d. Testing of Fire Suppression and Fire Fighting Systems

Demonstration of effective fire suppression and fire fighting system by testing and inspection is required on a cyclical basis detailed in legislation and standards. This is to confirm that an effective system is available in the event of fire.

Where there is no evidence of the required testing and inspection having been completed a functional condition Code 1 concern shall be raised accordingly. Where an inspection has been completed and safety related remedial actions have been identified a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

e. Compartmentation

Demonstration of effective fire compartmentation is required annually. This is to confirm that fire and smoke spread within a station or other building can be limited by the provision of effective subdivision, thereby creating fire compartments, to maintain compliance with the Fire Compliance/ Fire Precautions/ Fire Risk Assessments applicable to the building.

Where there is no evidence of an annual check having been completed the building a functional condition Code 1 concern shall be raised accordingly. Where an annual check has been completed and safety related remedial actions have been identified a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

f. Outstanding Defects

Asset information is gathered through other means such as Planned General Inspections or through planned or reactive maintenance. Concerns raised through these routes shall be recorded in the annual ACR if they have not been rectified by three months from the date of inspection as Code 1 or 2 conditions if a legislation of safety concern exists.

3 Responsibilities

It is the joint responsibility of the Maintenance Sponsor, Client Engineer, Head of Profession and engineering representatives of CMO to compile concerns from asset data and information, convert the concerns to specific ACR condition codes and provide necessary supporting information to validate the coding.

It is important that the person(s) undertaking the assessment have the ability to determine whether the fire infrastructure and the use to which it is currently being put still retains conformity with the condition of its approval and design.

The responsibilities through the cycle of reporting shall be as follows:

Description of Activity	CMO	Client Engineer	Maintenance Sponsor	Head of Profession	Asset Management
Confirmation of asset base and hierarchy	C	R	A	C	C
Confirmation of Legislation changes for review	C	C	A	R	I
Confirmation of Obsolescence issues for review	R	C	A	R	I
Asset concern reporting requirements	I	C	R, A	C	C
Asset data collection methodology	I	R	A	C	C
Develop review content and delivery programme	R	C	A	I	I
Generation of Initial concerns for ACR and Sponsors Work Bank	R, A	C	C	I	I
Determination of ACR concerns list	R	C	A	I	I
Codifying asset condition:					
Physical condition (A – D)	R, A	R	C	C	I
Functional Condition (Legislation and Safety Code 1 & 2))	C	R	A	R	I
Functional Condition (Extraordinary maintenance / operation Code 3)	R	C	R, A	I	I
Functional Condition (Performance Code 4)	C	C	R, A	I	I
Concern table compilation	R	C	A	I	I
ACR report production	R	C	A	I	I
ACR Review	C	C	C	R, A	I
ACR output to AAMP and work bank	C	R	A	I	I
ACR output to Sponsors Asset Risk Register	I	C	R, A	C	I

Responsible: The person who does the work to achieve the task.

Accountable: The person who is accountable for the correct completion of the task.

Consulted: The people who provide information for the Review and with whom there is two-way communication.

Informed: The people who are kept informed about progress and with whom there is one-way communication.

4 Source Information

In order to generate the initial list of physical condition concerns it will be necessary to review information from a number of different sources. The expected source of information shall be from (but not limited to) the list detailed below:

- Records and information from preceding ACA / ACR
- Periodic maintenance records including other survey data and records of condition of the asset (e.g. PGI's and EPGI's)
- The asset register (Ellipse)
- Statutory Inspections
- Contractors work orders and details of any maintenance backlog
- Changes in legislation detailed in the Sponsors requirements
- Obsolescence issues detailed in the Sponsors requirements

Details of pre-existing concerns shall be provided by the Maintenance Sponsor and Client Engineer at the commencement meeting with the CMO Assessors to ensure both physical and functional concerns are considered as part of the initial review.

5 Generation of Initial condition concerns

The assessor is to provide an initial listing of concerns for review by the Client Engineer prior to the formal codifying of each concern. This is to:

- Validate coverage and content of the review
- Determine the concerns that may impact on physical and functional condition of an asset which may result in an adjustment to remaining asset life.
- Determine concerns that are not valid for ACR but need to be considered for inclusion in the Sponsor's work bank.

Where asset information is available a visual inspection of the asset shall not be undertaken but shall be recorded as an initial concern so the issue can be addressed by CMO by agreement with the Maintenance Sponsor.

The checklists shown in Appendix B shall be used to give guidance on the specific issues of concern to the Sponsor and Client Engineer and to assist the CMO assessor in determining asset specific issues. The list is not exhaustive and the assessor shall use engineering judgement in determining the set of concerns.

A record of information used or not available needs to be collated to assist the Sponsor in future improvement plans.

Any defects noted during the assessment shall be reported to the relevant fault report centre. Faults of a transitory nature are not required to be recorded in the initial or final ACR concerns table.

6 Codifying physical condition concerns

Assets are codified for their physical condition based on their remaining life taken against the nominal life detailed in the standard (Codes A-D). This is the default position for each asset when reporting condition

The condition code applied to the asset can be modified following review by the Assessor where it is considered that the asset has deteriorated faster than expected or that work completed has extended the life of the asset.

To determine if the remaining asset life requires adjustment and hence the condition code, the assessor needs to consider:

- Generic and location specific degradation of the asset under review considering both hardware and software issues
- Overall system condition if the asset under review forms part of a larger system
- Physical and environmental impact of the surrounding area and related assets
- Improvements completed by Maintenance that return the asset to the expected deterioration curve or extends life through component replacement

Where significant change in asset condition has taken place the asset shall be re-graded. Changes to asset grading shall be validated by the Client Engineer who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance to the assessor and Client Engineer in determining the changes to the physical condition of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list.

7 Codifying functional condition concerns

The codifying of functional condition concerns will be determined as follows:

- Concerns relating to statutory compliance and safe operation (Codes 1-2) are determined from joint review by the Client Engineer and Head of Profession.
- Concerns relating to extraordinary maintenance and or operation and asset performance (Codes 3 & 4) are determined by Joint review by CMO and the Maintenance Sponsor.

Functional condition concerns can be derived from both physical condition concerns and independently where operation or maintenance issues exist. The assessment needs to consider:

- The exact breach of statutory legislation validated by the relevant SQE advisor
- Generic and location specific safety issues relating to the asset under review considering physical, maintenance and operational issues
- Overall system condition if the asset under review forms part of a larger system

Asset grading shall be validated by the Sponsor who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance in determining the Functional Condition (Concerns Code1-4) of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list. In order to codify the identified functional condition concerns other source information is required to be reviewed:

- Performance data held in CuPid and Ellipse including outputs to FRACAS and other analysis tools
- Performance and function concerns identified in reliability growth plans
- Improvement plans that may impact the asset

8 Output to asset work bank

The Maintenance Sponsor shall be responsible for the generation of issues to be taken from the initial concerns list that are not valid for ACR into the Work Bank. To populate the additional issues in the work bank the Maintenance Sponsor in conjunction with the Client Engineer determine:

- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work

- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

9 Output from ACR to AAMP and Business Plan

The Client Engineer shall be responsible for the generation of issues to be taken from the Concerns List to the Stations Forward Maintenance work bank.

In order to add any additional issues in the work bank the Client Engineer and the Maintenance Sponsor shall determine:

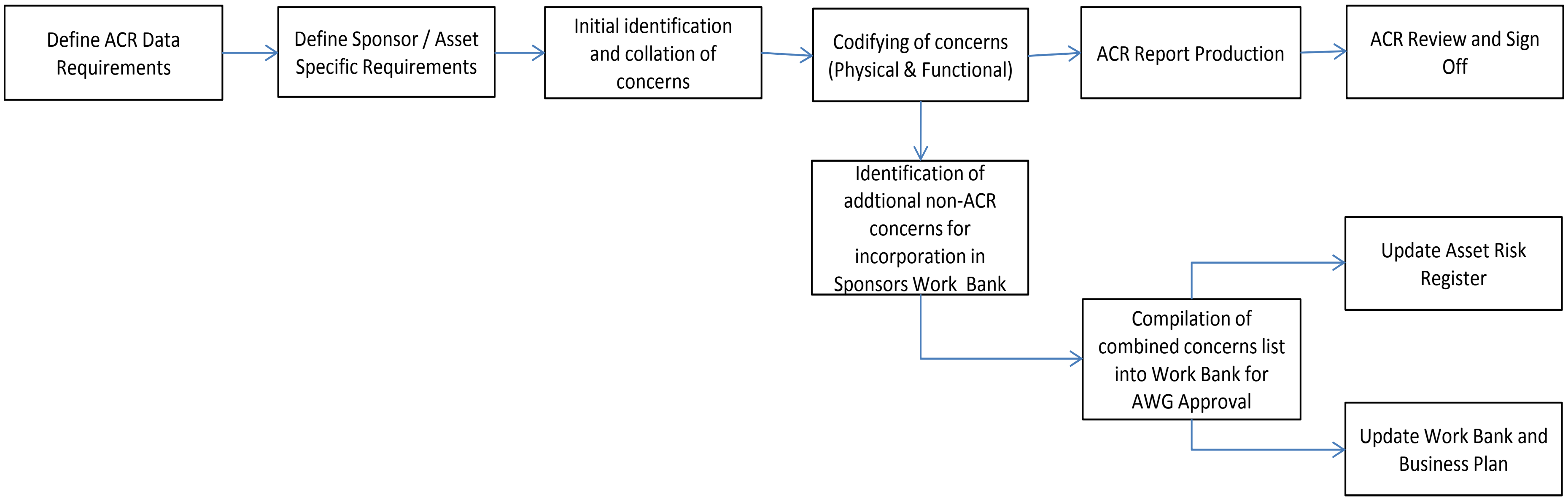
- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work
- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

10 Output to Local Asset Risk Register

The Maintenance Sponsor is responsible for ensuring an effective local asset risk register is used to inform the corporate asset register (ARM). One of the sources of information for the risk register is the ACR.

Concerns generated from the review that are not included in the work bank will be reviewed for inclusion in the local asset risk register.

Appendix A – Assessment Flow Diagram



<u>Asset Condtion Reporting - Flow Diagram</u>

Appendix B – Asset Condition Checklist

CHECK LIST TO ASSISTCOMPILATION OF INITIAL LIST OF ASSET CONCERNS BY CMO

Issue	Asset Concern	Checklist	Action
Maintenance costs	Are the costs of maintenance of the asset in line with budget?	1. As expected 2. Maintenance cost has increased but is now steady 3. Increasing at an unacceptable rate	No action Review increased costs to establish if a safety concern exists Review increased costs to establish if a safety concern exists
User ergonomics	Does the use have any difficulties in operating the asset?	1. No negative feedback from user 2. Some negative feedback from user which can be modified as part of maintenance regime 3. Some negative feedback from user which can be modified at small additional cost 4. Some negative feedback which can be modified at significant Additional cost 5. User unpleased with equipment and modifications cannot be carried out	No action No action Sponsor to review business case for improvement Review if this will impact on safe operation of the system Review if this will impact on safe operation of the system
Failure Modes (Detection systems)	What failure modes are affecting system reliability?	1. Failure of incoming power supply 2. Failure of control panel 3. Failure of detection devices (smoke or heat detection) 4. Failure of manual call points 5. Degraded operation due to environmental factors 6. Vandalism 7. No failure modes 8. Other factors	Correlate against other asset information and revise concerns list accordingly
Failure Modes (Suppression systems)	What failure modes are affecting system reliability?	1. Failure of incoming water supply 2. Failure of valves 3. Failure of pipe work 4. Failure of interface to MFCP 5. Degraded operation due to environmental factors 6. Vandalism 7. No failure modes 8. Other factors	Correlate against other asset information and revise concerns list accordingly
Approved Product	What is the current product approval status for the system?	1. System has product or materials approval 2. System has safety case product or materials approval 3. Currently in service with no product or materials approval 4. Currently in service, subject of a concession, and concession still valid.	No action No action Review if this will impact on safe operation of the system No action

Future expansion	How easy is the system to expand to meet future capacity requirements?	1. Modular design, no limit to capacity 2. System can be expanded within limits 3. System incapable or difficult to expand	No action Assess if this will impact on usable life of the asset

CHECK LIST TO CODIFY PHYSICAL CONDITION OF ASSETS (CODE A TO D) BY CMO & CLIENT ENGINEER

Issue	Asset Concern	Checklist	Action
Operations requirements	Does the asset function and perform to meet Line / Network requirements?	1. Equipment more than meets operational requirement 2. Equipment meets operational requirement 3. Equipment does not meet operational requirement but can be modified at small cost 4. Equipment does not meet operational requirements but can be modified at large cost 5. Equipment does not meet operational needs and cannot be modified	No adjustment to residual life No adjustment to residual life Code D Concern Code D Concern Code D Concern
Physical condition	What is the condition of the asset?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Environmental condition (Physical)	Has the asset degraded as a result of any environmental effects?	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment 2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset 3. Unacceptable environmental conditions which may significantly affect the reliability of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Environmental condition (External)	What is the operating environment of the switchgear? (consider physical conditions, temperature and security)	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment 2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset 3. Unacceptable environmental conditions which may significantly affect the reliability of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Redundant Equipment	Are there any redundant plant and pipe work systems?	1. Yes 2. No	Condition Code D No adjustment to residual life
Cabling	What is the general condition of the cable installation and their terminations?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls	No impact on residual life No impact on residual life

		3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	Assess impact and reassess residual life or TTNEI
Cabling	Are there signs of insulation degradation (brittle / softened insulation / water ingress to mineral insulated cables)?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Emergency power supplies	What is the condition of the supporting batteries? (signs of corrosion, bulging and overheating etc.) Have the batteries passed the annual test?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset 4. Failed annual testing	No impact on residual life Assess impact and reassess residual life or TTNEI Assess impact and reassess residual life or TTNEI Concern Code D
Environmental conditions	What is the operating environment of the detection system? (consider physical conditions, temperature and security) Has the location been compromised by addition of other assets to the detriment of its operating capabilities?	1. Excellent - e.g. excellent condition with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable condition with minor shortfalls to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. unacceptable asset condition with significant shortfalls to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Environmental conditions	What is the operating environment of the suppression system? (consider physical conditions, temperature and security) Has the location been compromised by addition of other assets to the detriment of its operating capabilities?	1. Excellent - e.g. excellent condition with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable condition with minor shortfalls to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. unacceptable asset condition with significant shortfalls to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Supportability (Spares)	Can spares be sourced when required?	1. Abundance of spares. More than sufficient to support asset during its life 2. Sufficient spares to support asset during its life across network 3. Limited spares available 4. No spares available, mitigation in place 5. No spares available, no mitigation possible	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D

Supportability (System supplier)	Can manufacturer support be sourced when required?	1. Equipment fully supported for period longer than remaining life 2. Equipment supported for remaining life 3. Equipment not supported but equipment can easily be replaced or repaired 4. Equipment not supported high risk of critical failure	No impact on residual life No impact on residual life Assess impact on residual life Concern Code D
Reparability of component parts	Can all components be repaired and are they readily available to procure?	1. All system parts are repairable 2. Some parts are non-repairable, but parts can be replaced with equivalent 3. Equipment becoming less repairable, parts difficult to source and likely issue with expected life of equipment 4. Equipment becoming less repairable, parts difficult to source and costs are excessive 5. Equipment not repairable	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D
Specialist tools availability	Does the maintainer have the required tools for completion of any repair or access equipment?	1. Equipment does not require nay specialist tools to carry out routine or reactive maintenance 2. Specialist tools required and maintainer has sufficient 3. Specialist tools required, maintainer does not have sufficient quantities, but they are readily available 4. Specialist tools required, maintainer does not have sufficient quantities, and difficult / expensive to source 5. Specialist tools required and are unavailable	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D
Pipe work	What is the general condition of the pipe work?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Pipe work	What is the general condition of pipe work joints? What is the general condition of pipe work supports?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Power Supplies	What is the condition of the power supplies serving the system? Is it compliant with standards?	1. Excellent - e.g. excellent condition with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable condition with minor shortfalls to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. unacceptable asset condition with significant shortfalls to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI

CHECK LIST TO CODIFY FUNCTIONAL CONDITION OF ASSETS (CODES 1 TO 4) BY HEAD OF PROFESSION, CLIENT ENGINEER AND SPONSOR

Issue	Asset Concern	Checklist	Action
Appropriate manuals and records	Are manuals available, accurate and accessible?	1. Records exist, are comprehensive and up to date 2. Records exist but require minor revisions to be up to date 3. Records exist but have not been kept up to date with major changes 4. No records exist	No action No action Code 2 concern if maintenance may result in unsafe practice Code 2 concern if maintenance may result in unsafe practice
Cabling	Are the cables properly segregated, clearly identified and labelled?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No Action Code 2 Concern and record mitigation Code 2 Concern
Compartmentation	Are any holes or gaps in walls, ceilings and floors properly sealed, e.g. Where services such as ventilation ducts and electrical cables pass through them?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Condition Code 2 if safety related issues remain Condition code 1
Compliance	Has a fire risk assessment been completed for the building and recommendations implemented?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and essential remedial work undertaken 3. No - Records and remedial work not completed	No action Condition Code 2 if safety related issues remain Condition code 1
Compliance	Where necessary, are escape routes and exits, the locations of fire fighting equipment indicated by appropriate signs, and detailed on Fire Plans?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Condition Code 2 if safety related issues remain Condition code 1
Compliance	Are notices provided such as those giving information on how to operate security devices on exit doors, those indicating doors enclosing fire hazards that must be kept shut and fire action notices for staff and other people?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action No action Condition Code 2
Compliance	Are all the necessary signs and notices correct, legible and understood?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Condition Code 2 if safety related issues remain Condition code 1
Compliance	Have there been any substantial changes to the building including the internal layout, furniture and fittings that may impact on the operation and effectiveness of the installed fire systems?	1. Yes - Installation remains compliant 2. Yes - Essential remedial work undertaken 3. Yes - Remedial work not completed 4. No - No change to compliance	No action Condition Code 2 if safety related issues remain No action

Ergonomic issues with maintenance	Is the asset in a position where it can be maintained correctly?	1. Equipment easy to maintain, no manual handling 2. Minor manual handling issues. No ladders required 3. Minor manual handling requirements, more than 1 person required 4. Difficult manual handling issues, more than 1 person required 5. Equipment un-maintainable	No action No action No action No action Code 2 concern if no mitigation plan
Fire Doors	Do the final doors on escape routes open in the direction of escape, and are all doors on the escape routes unhindered?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Condition Code 2 if safety related issues remain Condition Code 1
Fire Doors	Are fire door seals, and self-closing devices (where required) in good condition? Is the door furniture undamaged and in good condition?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Condition Code 2 if safety related issues remain Condition Code 1
Fire Doors	Do all roller shutters provided for fire compartmentation work correctly?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Condition Code 2 if safety related issues remain Condition Code 1
Fire Doors	Have the release and closing mechanisms of any fire-resisting compartment doors and shutters been tested and any remedial works identified and completed?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Condition Code 2 if safety related issues remain Condition Code 1
Labelling and identification	Does the asset have sufficient labelling and identification for safe operation and maintenance?	1. Excellent - all labelling in place with no unambiguous identification or description of assets served or operation 2. Acceptable - maintenance and operation can be safely undertaken 3. Unacceptable - labelling and identification missing or unclear	No action No action Code 2 concern
LU Standards	Is the asset compliant with current standards?	1. No standard applicable to asset 2. System fully compliant to current standard 3. Non-compliant, compliance is not retrospective 4. Non-compliant, derogation and action plan in place 5. Non-compliant, standard forcing renewal	Assess if legislation or safety issues exist due to no LU standard existing No Action Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern

Maintenance Plan	Is the asset in the current maintenance plan?	1. Asset is maintained under a maintenance plan compliant with LU standards or specifications and or work instructions 2. Asset does not need maintenance 3. Asset is maintained through special arrangements outside of a maintenance plan 4. Asset is not under any maintenance arrangement or has not been maintained and this is causing the renewal to be brought forward	No action Determine how statutory compliance is assured Assess plan ensures statutory compliance is maintained Code 1 concern if non compliant with legislation, Code 2 if safety concern
Maintenance Plan	Is the asset in the current maintenance plan?	1. Asset is maintained under a maintenance plan compliant with LU standards or specifications and or work instructions 2. Asset does not need maintenance 3. Asset is maintained through special arrangements outside of a maintenance plan 4. Asset is not under any maintenance arrangement or has not been maintained and this is causing the renewal to be brought forward	No action Determine how statutory compliance is assured Assess plan ensures statutory compliance is maintained Code 1 concern if non compliant with legislation, Code 2 if safety concern
Portable fire extinguishers	Are the portable fire extinguishers or any fixed fire fighting equipment provided suitable for controlling the risks identified?	1. Yes 2. No	No action Condition Code 2
Portable fire extinguishers	Are the right types of extinguishers located close to the fire hazards and can users get to them without exposing themselves to risk?	1. Yes 2. No	No action Condition Code 1
Portable fire extinguishers	Are there enough extinguishers sited throughout the premises at appropriate locations?	1. Yes 2. No	No action Condition Code 1
Portable fire extinguishers	Are the extinguishers visible or does their position need indicating?	1. Yes 2. No	No action Condition Code 1
Safe accessibility Physical Hazards	Are there physical obstacles which may prevent safe access / egress for inspection, testing or maintenance?	1. No additional hazards identified 2. Low risk, known hazards identified 3. Medium risk, known hazards identified 4. High Risk, Known hazards identified 5. Unacceptable risk, known hazards identified	No action No action No action No action Code 2 concern if no mitigation plan in place
Safe Operation	Is there adequate means of isolation? (including isolation for mechanical isolation)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are there adequate barriers against unauthorised tampering and operation, e.g. Lockable panels?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern

Statutory Testing of Electrical Equipment	Has the statutory inspection been undertaken at the prescribed interval? Has remedial work completed where required?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and essential remedial work undertaken 3. Yes – Records fully complete but safety related issues incomplete 4. No - Records and remedial work not completed	No action No action Code 2 concern Code 1 concern
Statutory Testing of fire mains	Has the statutory inspection been undertaken at the prescribed interval? Has remedial work completed where required?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and essential remedial work undertaken 3. No - Records and remedial work not completed	No action No action Code 2 concern
Statutory Testing of suppression systems	Has the statutory inspection been undertaken at the prescribed interval? Has remedial work completed where required?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and essential remedial work undertaken 3. No - Records and remedial work not completed	No action No action Code 2 concern
Testing of detection and alarm systems	Has the statutory inspection been undertaken at the prescribed interval? Has remedial work completed where required?	1. Yes - Records fully complete and remedial work undertaken 2. Yes - Records fully complete and essential remedial work undertaken 3. No - Records and remedial work not completed	No action Concern Code 2 if safety related work has not been completed Concern Code 1
Testing of detection and alarm systems	Are the detectors of the right type and in the appropriate locations?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Concern Code 2 if safety related work has not been completed Concern Code 1
Testing of detection and alarm systems	Are there provisions for people in locations where the alarm cannot be heard?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Concern Code 2 if safety related work has not been completed Concern Code 1
Testing of detection and alarm systems	Is there evidence of vandalism or incorrect use of manual call points?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Concern Code 2 if safety related work has not been completed Concern Code 2
Testing of detection and alarm systems	Is there evidence of false operation of detection devices due to environmental factors?	1. Yes 2. No	Concern Code 2 if improvements have not been made No action
Voice Alarm Systems	Is the installed voice alarm system, where required compliant with BS5839 Parts 8 * 9?	1. Yes 2. Yes - essential remedial work undertaken 3. No - Remedial work not completed	No action Concern Code 2 if safety related work has not been completed Concern Code 2

Water Fog systems	Has the system installed been regularly tested for integrity of operation, discharge and duration?	1. Meets the required discharge requirements (load and duration) evidenced from partial and full load tests 2. Meets the minimum requirement for duration and improvement plan in place for remedial works 3. Incomplete testing records 4. No records	No action Concern Code 2 if safety related work has not been completed Concern Code 2 Concern Code 1

9.1.1 Basis of Condition Reporting for Fire Protection

ACR No.	FD No.	Asset Description	RAV (k)	Unit	Nominal Life	Source of Nominal Life
1000	**n/a**	**Fire Control Panels**				
1100	310	Fire Control Panel Main	1.68	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1200	381	Fire control panel radio controlled	1.97	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1300	312	Repeater panels	1.26	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1400	311	Fire panel used for Damper control	0.48	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1500	n/a	Gaseous system fire panel	0.50	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1600	431	ESPS control panel (fibre optic)	7.37	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1700	431	ESPS control panel (linear)	0.66	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1800	431	ESPS control panel (Listec Detection)	0.66	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
1900	n/a	Waterfog panel	0.50	panel	15	Professional judgement
2000	**n/a**	**Fire Interface Panel**				
2100	n/a	PA / UTS Interface fire panel	0.42	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
2200	360	HSSD interface panel	0.70	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
2300	360	VESDA/HART Interface panel	0.70	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
2400	315	modem link interface panel	0.48	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
2500	311	Damper control interface panel	0.48	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
2600	n/a	EDNE sign interface panel	0.42	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
2700	390	RAVDU interface panel	0.50	panel	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3000	**n/a**	**Devices**				
3100	320	Call points (Manual)	0.03	unit excl wiring & junction box	10	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3200	330	Heat/ Smoke detectors	0.02	unit excl wiring & junction box	10	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3300	314	Relay units	0.03	unit excl wiring & junction box	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3400	314	Switches (incl. CHQ, short circuit isolators etc)	0.02	unit excl wiring & junction box	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3500	340	Sounders	0.01	unit excl wiring & junction box	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3600	330/320	Strobes	0.01	unit excl wiring & junction box	10	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3700	n/a	Voice Alarm	0.09	unit excl wiring & junction box	15	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
3800	380	Radio Alarm	0.12	unit excl wiring & junction box	10	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
4000	**n/a**	**Wiring & Junction Boxes**				
4100	n/a	Wiring	3.07	loop	20	Professional judgement
4200	n/a	Junction Boxes	0.01	unit	20	Professional judgement
5000	**n/a**	**HSSD Apparatus (Pipework)**	0.01	**metre**	**25**	Professional judgement
6000	**430**	**Sprinkler (Escalator)**				
6100	n/a	Sprinkler Valve set	0.41	system	25	Professional judgement
6200	n/a	Sprinkler Pipe work	3.04	system	50	Professional judgement
6300	n/a	Sprinkler heads	0.00	unit	25	Professional judgement
6400	n/a	Deluge Control Valves (Multi Jet Controllers, Deluge valves) incl. Solenoid / Detonator	0.30	unit	25	Professional judgement
7000	**410**	**Sprinkler (General)**				
7100	n/a	Sprinkler Valve set (including inline valves)	0.41	system	25	Professional judgement
7110	n/a	Monitored Valve	0.20	unit	25	Professional judgement
7120	n/a	Unmonitored Valve	0.03	unit	25	Professional judgement
7130	n/a	Non-return Valve	0.12	unit	25	Professional judgement
7140	n/a	Pressure Gauges	0.09	unit	15	Professional judgement
7150	n/a	Pressure Switch	0.11	unit	15	Professional judgement
7160	n/a	Flow Switch	0.05	unit	15	Professional judgement
7170	n/a	Clack Valve	0.15	unit	25	Professional judgement
7180	n/a	Compressor	0.40	unit	10	Professional judgement
7190	n/a	Gap Meter	0.36	unit	15	Professional judgement
7200	n/a	Sprinkler Pipe work	3.04	system	50	Professional judgement
7300	n/a	Sprinkler heads	0.00	system	15	Professional judgement
8000	**510**	**Hydrant (dry & wet)**				
8010	n/a	Hydrant (dry)	7.75	system	50	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
8020	n/a	Hydrant (wet)	6.48	system	50	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
8030	n/a	Hydrant (charged)	10.99	system	50	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
8040	n/a	Tunnel Fire main (dry , wet or charged) station - station	31.76	system	50	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
8050	n/a	Monitored Valve	0.20	unit	25	CIBSE Guide M Appendix 13.A1: Indicative Life Expectancy factors
8060	n/a	Unmonitored Valve	0.03	unit	25	Professional judgement
8070	n/a	Non-return Valve	0.12	unit	25	Professional judgement
8080	n/a	Breaching Inlet 4 / 2 way	0.11	unit	25	Professional judgement
8090	n/a	Landing Valve 1/ 2 Way	0.05	unit	25	Professional judgement
8100	n/a	Presure Reducing Valve in line	1.14	unit	25	Professional judgement
8110	n/a	Presure Reducing landing Valve 1/ 2 Way	0.13	unit	25	Professional judgement
8120	n/a	Pressure Gauges	0.09	unit	15	Professional judgement
8130	540	Hydrant Pipework	6.63	system	50	Professional judgement
9000	**520**	**Hose Reels**				
9100	n/a	Hose	0.05	system	15	Professional judgement
9200	n/a	Reel	0.12	system	25	Professional judgement
9300	n/a	Valves	0.00	system	15	Professional judgement
10000	**440**	**Waterfogs/mists**				
10100	n/a	cylinders and valves	2.95	system	25	Professional judgement
10200	n/a	pipework	1.33	system	50	Professional judgement
10300	n/a	spray heads	0.29	system	25	Professional judgement
11000	**n/a**	**Water Tanks**				
11100	n/a	Tank (including brake tanks)	3.24	tank	25	Professional judgement
11200	n/a	pumps	2.53	tank	25	Professional judgement
11300	n/a	pipework	1.33	system	50	Professional judgement
12000	**450**	**Gaseous supression system**				
12100	n/a	cylinders	2.80	system	20	Professional judgement
12200	n/a	pipework	1.33	system	20	Professional judgement
12300	n/a	spray heads	0.15	system	25	Professional judgement
13000	**530**	**Fire extingushers (including stands)**	0.04	**unit**	**20**	Professional judgement
14000	**530**	**Fire blankets**	0.01	**unit**	**8**	Professional judgement
15000	**n/a**	**Illuminated**				
15100	230	EDNE/DNE	1.96	sign	15	M.J.Quinn
16000	**n/a**	**Automatic Door Holder**	0.04	**door holder**	**10**	Professional judgement
17000	**120**	**Damper**	0.53	**unit**	**25**	Professional judgement
17100	n/a	Damper motor	0.15	system	10	M.J.Quinn
18000	**112**	**Magnetic Door Retainers**	0.12	**door closer**	**10**	Professional judgement
19000	**110**	**Fire Doors Timber (Door, fittings (locks/hinges) and frame)**	0.17	**unit**	**20**	Professional judgement
20000	**110**	**Fire Doors Steel (Door, fittings (locks/hinges) and frame)**	0.24	**unit**	**25**	Professional judgement
21000	**112**	**Fire Doors Closers**	0.06	**door closer**	**10**	Professional judgement
22000	**170**	**Fire resisting shutter curtains**	0.28	**sq m**	**25**	Professional judgement
23000	**170**	**Fire Resisting Glazing**	0.60	**sq m**	**30**	Professional judgement
24000	**160**	**Firestopping**	N/A**	**sq m**	**25**	Professional judgement
25000	**n/a**	**Cavity Barriers**	N/A**	**sq m**	**20**	Professional judgement
26000	**150**	**Fire Rated False ceilings / Floors**	N/A**	**sq m**	**20**	Professional judgement

* FD No. To provide cross reference to ACAC Foundation document reference numbering
** The Physical Condition (A-D) of these assets will be assessed by Premises; Fire will report any applicable Functional Codes (1-4)
N/A not applicable

9.1.3 Reporting Requirements for Fire Protection

9.1.3.1 Fire Protection ACR - all Lines

Fire Protection – all Lines

ACR No.	FD No.	Actuals	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant Quantity	Residual safety risk £ Risk	uneconomic/ unsustainable £ Risk	Risk of Performance Loss £ Risk
1000	**n/a**	**Fire Control Panels**								
1100	310	Fire Control Panel Main								
1200	381	Fire control panel radio controlled								
1300	312	Repeater panels								
1400	311	Fire panel used for Damper control								
1500	n/a	Gaseous system fire panel								
1600	431	ESPS control panel (fibre optic)								
1700	431	ESPS control panel (linear)								
1800	n/a	ESPS control panel (Listec Detection)								
1900	n/a	Waterfog panel								
2000	**n/a**	**Fire Interface Panel**								
2100	360	PA / UTS Interface fire panel								
2200	360	HSSD interface panel								
2300	315	VESDA/HART Interface panel								
2400	311	modem link interface panel								
2500	n/a	Damper control interface panel								
2600	390	EDNE sign interface panel								
2700	n/a	RAVDU interface panel								
3000	**320**	**Devices**								
3100	330	Call points (Manual)								
3200	314	Heat/ Smoke detectors								
3300	314	Relay units								
3400	340	Switches (incl. CHQ, short circuit isolators etc)								
3500	330/320	Sounders								
3600	n/a	Strobes								
3700	380	Voice Alarm								
3800	n/a	Radio Alarm								
4000	**n/a**	**Wiring & Junction Boxes**								
4100	n/a	Wiring								
4200	n/a	Junction Boxes								
5000	**430**	**HSSD Apparatus (Pipework)**								
6000	**n/a**	**Sprinkler (Escalator)**								
6100	n/a	Sprinkler Valve set								
6200	n/a	Sprinkler Pipe work								
6300	n/a	Sprinkler heads								
6400	410	Deluge Control Valves (Multi Jet Controllers, Deluge valves) incl. Solenoid / Detonator								
7000	**n/a**	**Sprinkler (General)**								
7100	n/a	Sprinkler Valve set (including inline valves)								
7110	n/a	Monitored Valve								
7120	n/a	Unmonitored Valve								
7130	n/a	Non-return Valve								
7140	n/a	Pressure Gauges								
7150	n/a	Pressure Switch								
7160	n/a	Flow Switch								
7170	n/a	Clack Valve								
7180	n/a	Compressor								
7190	n/a	Gap Meter								
7200	n/a	Sprinkler Pipe work								
7300	510	Sprinkler heads								
8000	**n/a**	**Hydrant (dry & wet)**								
8010	n/a	Hydrant (dry)								
8020	n/a	Hydrant (wet)								
8030	n/a	Hydrant (charged)								
8040	n/a	Tunnel Fire main (dry, wet or charged) station - station								
8050	n/a	Monitored Valve								
8060	n/a	Unmonitored Valve								
8070	n/a	Non-return Valve								
8080	n/a	Breaching Inlet 4 / 2 way								
8090	n/a	Landing Valve 1/ 2 Way								
8100	540	Presure Reducing Valve in line								
8110	520	Presure Reducing landing Valve 1/ 2 Way								
8120	n/a	Pressure Gauges								
8130	n/a	Hydrant Pipework								
9000	**n/a**	**Hose Reels**								
9100	440	Hose								
9200	n/a	Reel								
9300	n/a	Valves								
10000	**n/a**	**Waterfogs/mists**								
10100	n/a	cylinders and valves								
10200	n/a	pipework								
10300	n/a	spray heads								
11000	**n/a**	**Water Tanks**								
11100	450	Tank (including brake tanks)								
11200	n/a	pumps								
11300	n/a	pipework								
12000	**n/a**	**Gaseous supression system**								
12100	530	cylinders								
12200	530	pipework								
12300	n/a	spray heads								
13000	**230**	**Fire extingushers (including stands)**								
14000	**n/a**	**Fire blankets**								
15000	**120**	**Illuminated**								
15100	n/a	EDNE/DNE								
16000	**112**	**Automatic Door Holder**								
17000	**110**	**Damper**								
17100	110	Damper motor								
18000	**112**	**Magnetic Door Retainers**								
19000	**170**	**Fire Doors Timber (Door, fittings (locks/hinges) and frame)**								
20000	**170**	**Fire Doors Steel (Door, fittings (locks/hinges) and frame)**								
21000	**160**	**Fire Doors Closers**								
22000	**n/a**	**Fire resisting shutter curtains**								
23000	**150**	**Fire Resisting Glazing**								
24000	**160**	**Firestopping**								
25000	**n/a**	**Cavity Barriers**								
26000	**150**	**Fire Rated False ceilings / Floors**								
		Fire								
		Previous								
		Actual								
		Variance								

9.1.3 Reporting Requirements for Fire Protection

9.1.3.2 Fire Protection ACR - by Line

Fire Protection – XXX Line

ACR No.	FD No.	Actuals	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	FD No.						Quantity	£ Risk	£ Risk	£ Risk
1000	**n/a**	**Fire Control Panels**								
1100	310	Fire Control Panel Main								
1200	381	Fire control panel radio controlled								
1300	312	Repeater panels								
1400	311	Fire panel used for Damper control								
1500	n/a	Gaseous system fire panel								
1600	431	ESPS control panel (fibre optic)								
1700	431	ESPS control panel (linear)								
1800	n/a	ESPS control panel (Listec Detection)								
1900	n/a	Waterfog panel								
2000	**n/a**	**Fire Interface Panel**								
2100	360	PA / UTS Interface fire panel								
2200	360	HSSD interface panel								
2300	315	VESDA/HART Interface panel								
2400	311	modem link interface panel								
2500	n/a	Damper control interface panel								
2600	390	EDNE sign interface panel								
2700	n/a	RAVDU interface panel								
3000	**320**	**Devices**								
3100	330	Call points (Manual)								
3200	314	Heat/ Smoke detectors								
3300	314	Relay units								
3400	340	Switches (incl. CHQ, short circuit isolators etc)								
3500	330/320	Sounders								
3600	n/a	Strobes								
3700	380	Voice Alarm								
3800	n/a	Radio Alarm								
4000	**n/a**	**Wiring & Junction Boxes**								
4100	n/a	Wiring								
4200	n/a	Junction Boxes								
5000	**430**	**HSSD Apparatus (Pipework)**								
6000	**n/a**	**Sprinkler (Escalator)**								
6100	n/a	Sprinkler Valve set								
6200	n/a	Sprinkler Pipe work								
6300	n/a	Sprinkler heads								
6400	410	Deluge Control Valves (Multi Jet Controllers, Deluge valves) incl. Solenoid / Detonator								
7000	**n/a**	**Sprinkler (General)**								
7100	n/a	Sprinkler Valve set (including inline valves)								
7110	n/a	Monitored Valve								
7120	n/a	Unmonitored Valve								
7130	n/a	Non-return Valve								
7140	n/a	Pressure Gauges								
7150	n/a	Pressure Switch								
7160	n/a	Flow Switch								
7170	n/a	Clack Valve								
7180	n/a	Compressor								
7190	n/a	Gap Meter								
7200	n/a	Sprinkler Pipe work								
7300	510	Sprinkler heads								
8000	**n/a**	**Hydrant (dry & wet)**								
8010	n/a	Hydrant (dry)								
8020	n/a	Hydrant (wet)								
8030	n/a	Hydrant (charged)								
8040	n/a	Tunnel Fire main (dry , wet or charged) station - station								
8050	n/a	Monitored Valve								
8060	n/a	Unmonitored Valve								
8070	n/a	Non-return Valve								
8080	n/a	Breaching Inlet 4 / 2 way								
8090	n/a	Landing Valve 1/ 2 Way								
8100	540	Presure Reducing Valve in line								
8110	520	Presure Reducing landing Valve 1/ 2 Way								
8120	n/a	Pressure Gauges								
8130	n/a	Hydrant Pipework								
9000	**n/a**	**Hose Reels**								
9100	440	Hose								
9200	n/a	Reel								
9300	n/a	Valves								
10000	**n/a**	**Waterfogs/mists**								
10100	n/a	cylinders and valves								
10200	n/a	pipework								
10300	n/a	spray heads								
11000	**n/a**	**Water Tanks**								
11100	450	Tank (including brake tanks)								
11200	n/a	pumps								
11300	n/a	pipework								
12000	**n/a**	**Gaseous supression system**								
12100	530	cylinders								
12200	530	pipework								
12300	n/a	spray heads								
13000	**230**	**Fire extingushers (including stands)**								
14000	**n/a**	**Fire blankets**								
15000	**120**	**Illuminated**								
15100	n/a	EDNE/DNE								
16000	**112**	**Automatic Door Holder**								
17000	**110**	**Damper**								
17100	110	Damper motor								
18000	**112**	**Magnetic Door Retainers**								
19000	**170**	**Fire Doors Timber (Door, fittings (locks/hinges) and frame)**								
20000	**170**	**Fire Doors Steel (Door, fittings (locks/hinges) and frame)**								
21000	**160**	**Fire Doors Closers**								
22000	**n/a**	**Fire resisting shutter curtains**								
23000	**150**	**Fire Resisting Glazing**								
24000	**160**	**Firestopping**								
25000	**n/a**	**Cavity Barriers**								
26000	**150**	**Fire Rated False ceilings / Floors**								
		Fire								
		Previous								
		Actual								
		Variance								

Commentary on Variances:

A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

S1042 Asset Condition Reporting (ACR)

Communications

TABLE OF CONTENTS

Business Objectives

The purpose scope and requirements of the ACR is defined in the Cat 1 Standard 5-042.

In addition the Sponsor requires the ACR to provide a systematic process for the evaluation of the condition of our assets supporting the preparation of the annual asset management plan and longer term business planning. This will:

- Achieve a balance between capital and maintenance funds
- Demonstrate functional suitability and performance
- Demonstrate physical and operational condition

1 Purpose

This document sets out the specific requirements for communications assets and forms an appendix to standard 5-042. This provides visibility by which London Underground can understand:

- Whether the communications systems and assets and the use to which they are being put is in accordance with its approval and design.
- How the asset condition is performing with regard to its age and environmental conditions
- How to plan the timely and most cost effective renewal of the asset
- Whether the maintenance regimes are robust enough to deliver the anticipated life expectancy

2 Scope

All security, customer information and telecommunication systems, and equipment, that is owned or leased by London Underground excluding those forming part of PFI contracts.

The review is a “Desk Top” exercise drawing on information from asset inspections and routine assessment / maintenance activities requiring the assessor to co-ordinate the information and draw final conclusions on the condition and performance of the assets.

A flow diagram in Appendix A details the ACR process and linkage to the asset work bank and risk register.

If the asset is declared as an asset at risk in the preceding ACA / ACR an assessment shall be undertaken yearly until it is renewed.

In addition to pre-existing concerns, the assets and locations covered in each annual review will be detailed in the Sponsors requirement document issued to compliment the standard and to assist the preparation and completion on the assessment.

Due to the volume of communications assets and variety of age and condition in the estate it is neither necessary nor efficient to survey the whole asset base in each year. Therefore the scope of survey shall be determined by asset age. For the purposes of determining the review programme, the nominal equipment life spans shall be used as detailed in Standard 5-042

For an asset having a **10 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 5th and 6th anniversary of it's commissioning
- and then in the year between its 7th and 8th anniversary of it's commissioning

For an asset having a **15 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 7th and 8th anniversary of it's commissioning
- and then in the year between its 12th and 13th anniversary of it's commissioning

For an asset having a **20 year life span** the asset condition assessments shall be planned to take place:

- in the year between its 10th and 11th anniversary of it's commissioning
- and then in the year between its 17th and 18th anniversary of it's commissioning

Where an assets renewal is deferred beyond its nominal life span then it shall be subject to the following asset condition assessment regime:

- in the 15th or 20th anniversary of commissioning, as applicable
- Then in each of the years after the passage of a further two anniversaries until it is renewed.

For cables an asset condition assessment shall be undertaken:

- when the cable reaches an approximate point halfway through its nominal lifespan i.e. after 8 or 10 years from its commissioning
- then every 3 years until its replacement.

In addition to the programme of assessments detailed above, the Maintenance Sponsor requires the following to be taken into account:

a. Public Address System

A sound pressure test is required to be completed every six months to demonstrate the effectiveness of the public address system. The concerns arising from the assessment shall be included in the ACR for the following year. Where there is no evidence of a test having been completed a functional condition Code 1 concern shall be raised accordingly.

Where a test has been completed and safety related remedial actions have been raised a functional condition Code 2 concern shall be raised if there is no evidence of the action being completed.

b. Signal Post Telephones

Signal post telephones (SPT's) located on the BCV / SSL network are operated subject to a concession. On the surface areas of the network SPT's are being withdrawn from service, with the exception of areas of dual running with Chiltern Railways. The telephones are being covered and indicated out of use. To meet the requirements of the concession the assets are to be recorded as redundant and requiring removal and recorded as asset condition D.

c. Platform OPO and Track to Train CCTV systems

Both the Victoria Line and SSR are currently in transition from a platform based OPO CCTV system to a track to train system for train operation. Whist both systems are in operation the condition and performance needs to be assessed. For the purpose of residual life, the legacy OPO systems will be removed on completion of each line upgrade.

d. Outstanding Defects

Asset information is gathered through other means such as Planned General Inspections or through planned or reactive maintenance. Concerns raised through these routes shall be recorded in the annual ACR if they have not been rectified by three months from the date of inspection as Code 1 or 2 conditions if a legislation of safety concern exists.

3 Responsibilities

It is the joint responsibility of the Maintenance Sponsor, Client Engineer, Head of Profession and engineering representatives of CMO to compile concerns from asset data and information, convert the concerns to specific ACR condition codes and provide necessary supporting information to validate the coding.

It is important that the person(s) undertaking the assessment have the ability to determine whether the communications infrastructure and the use to which it is currently being put still retains conformity with the condition of its approval and design.

The responsibilities through the cycle of reporting shall be as follows:

Description of Activity	CMO	Client Engineer	Maintenance Sponsor	Head of Profession	Asset Management
Confirmation of asset base and hierarchy	C	R	A	C	C
Confirmation of Legislation changes for review	C	C	A	R	I
Confirmation of Obsolescence issues for review	R	C	A	R	I
Asset concern reporting requirements	I	C	R, A	C	C
Asset data collection methodology	I	R	A	C	C
Develop review content and delivery programme	R	C	A	I	I
Generation of Initial concerns for ACR and Sponsors Work Bank	R, A	C	C	I	I
Determination of ACR concerns list	R	C	A	I	I
Codifying asset condition:					
Physical condition (A – D)	R, A	R	C	C	I
Functional Condition (Legislation and Safety Code 1 & 2))	C	R	A	R	I
Functional Condition (Extraordinary maintenance / operation Code 3)	R	C	R, A	I	I
Functional Condition (Performance Code 4)	C	C	R, A	I	I
Concern table compilation	R	C	A	I	I
ACR report production	R	C	A	I	I
ACR Review	C	C	C	R, A	I
ACR output to AAMP and work bank	C	R	A	I	I
ACR output to Sponsors Asset Risk Register	I	C	R, A	C	I

Responsible: The person who does the work to achieve the task.

Accountable: The person who is accountable for the correct completion of the task.

Consulted: The people who provide information for the Review and with whom there is two-way communication.

Informed: The people who are kept informed about progress and with whom there is one-way communication.

4 Source Information

In order to generate the initial list of physical condition concerns it will be necessary to review information from a number of different sources. The expected source of information shall be from (but not limited to) the list detailed below:

- Records and information from preceding ACA / ACR
- Periodic maintenance records including other survey data and records of condition of the asset (e.g. PGI's and EPGI's)
- The asset register (Ellipse)
- Statutory Inspections
- Contractors work orders and details of any maintenance backlog
- Changes in legislation detailed in the Sponsors requirements
- Obsolescence issues detailed in the Sponsors requirements

Details of pre-existing concerns shall be provided by the Maintenance Sponsor and Client Engineer at the commencement meeting with the CMO Assessors to ensure both physical and functional concerns are considered as part of the initial review.

5 Generation of Initial condition concerns

The assessor is to provide an initial listing of concerns for review by the Client Engineer prior to the formal codifying of each concern. This is to:

- Validate coverage and content of the review
- Determine the concerns that may impact on physical and functional condition of an asset which may result in an adjustment to remaining asset life.
- Determine concerns that are not valid for ACR but need to be considered for inclusion in the Sponsor's work bank.

Where asset information is available a visual inspection of the asset shall not be undertaken but shall be recorded as an initial concern so the issue can be addressed by CMO by agreement with the Maintenance Sponsor.

The checklists shown in Appendix B shall be used to give guidance on the specific issues of concern to the Sponsor and Client Engineer and to assist the CMO assessor in determining asset specific issues. The list is not exhaustive and the assessor shall use engineering judgement in determining the set of concerns.

A record of information used or not available needs to be collated to assist the Sponsor in future improvement plans.

Any defects noted during the assessment shall be reported to the relevant fault report centre. Faults of a transitory nature are not required to be recorded in the initial or final ACR concerns table.

6 Codifying physical condition concerns

Assets are codified for their physical condition based on their remaining life taken against the nominal life detailed in the standard (Codes A-D). This is the default position for each asset when reporting condition

The condition code applied to the asset can be modified following review by the Assessor where it is considered that the asset has deteriorated faster than expected or that work completed has extended the life of the asset.

To determine if the remaining asset life requires adjustment and hence the condition code, the assessor needs to consider:

- Generic and location specific degradation of the asset under review considering both hardware and software issues
- Overall system condition if the asset under review forms part of a larger system
- Physical and environmental impact of the surrounding area and related assets
- Improvements completed by Maintenance that return the asset to the expected deterioration curve or extends life through component replacement

Where significant change in asset condition has taken place the asset shall be re-graded. Changes to asset grading shall be validated by the Client Engineer who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance to the assessor and Client Engineer in determining the changes to the physical condition of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list.

7 Codifying functional condition concerns

The codifying of functional condition concerns will be determined as follows:

- Concerns relating to statutory compliance and safe operation (Codes 1-2) are determined from joint review by the Client Engineer and Head of Profession.
- Concerns relating to extraordinary maintenance and or operation and asset performance (Codes 3 & 4) are determined by Joint review by CMO and the Maintenance Sponsor.

Functional condition concerns can be derived from both physical condition concerns and independently where operation or maintenance issues exist. The assessment needs to consider:

- The exact breach of statutory legislation validated by the relevant SQE advisor
- Generic and location specific safety issues relating to the asset under review considering physical, maintenance and operational issues
- Overall system condition if the asset under review forms part of a larger system

Asset grading shall be validated by the Sponsor who shall be provided with all supporting information and data used in determining the change in asset condition.

The checklist shown in Appendix B shall be used to give guidance in determining the Functional Condition (Concerns Code1-4) of the asset concerned. The list is not exhaustive and engineering judgement shall be applied in codifying the initial list. In order to codify the identified functional condition concerns other source information is required to be reviewed:

- Performance data held in CuPid and Ellipse including outputs to FRACAS and other analysis tools
- Performance and function concerns identified in reliability growth plans
- Improvement plans that may impact the asset

8 Output to asset work bank

The Maintenance Sponsor shall be responsible for the generation of issues to be taken from the initial concerns list that are not valid for ACR into the Work Bank. To populate the additional issues in the work bank the Maintenance Sponsor in conjunction with the Client Engineer determine:

- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work

- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

9 Output from ACR to AAMP and Business Plan

The Client Engineer shall be responsible for the generation of issues to be taken from the Concerns List to the Stations Forward Maintenance work bank.

In order to add any additional issues in the work bank the Client Engineer and the Maintenance Sponsor shall determine:

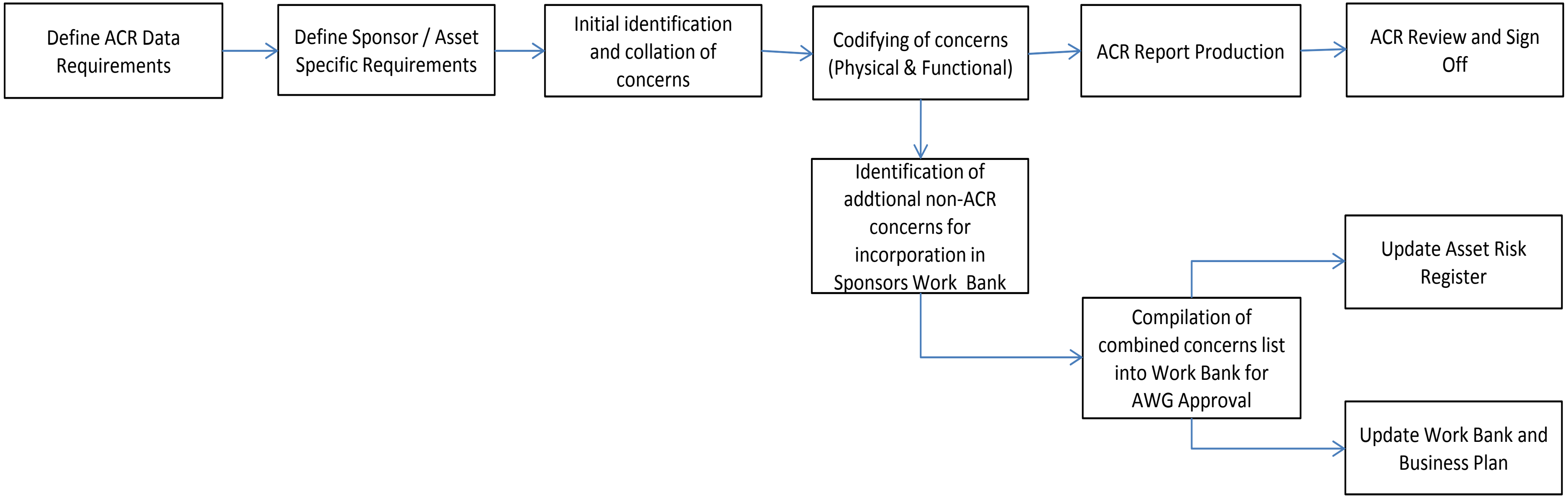
- Severity of the concern (assessing the consequence of and the likelihood of asset failure) together with date for completion of remedial work
- The likely solution such as asset replacement, enhancement or refurbishment
- Issues requiring further investigate to determine severity or solution to the identified concern.

10 Output to Local Asset Risk Register

The Maintenance Sponsor is responsible for ensuring an effective local asset risk register is used to inform the corporate asset register (ARM). One of the sources of information for the risk register is the ACR.

Concerns generated from the review that are not included in the work bank will be reviewed for inclusion in the local asset risk register.

Appendix A – Assessment Flow Diagram



Asset Condtion Reporting - Flow Diagram

Appendix B – Asset Condition Checklists

CHECK LIST TO ASSISTCOMPILATION OF INITIAL LIST OF ASSET CONCERNS BY CMO

Issue	Asset Concern	Checklist	Action
Approved Product	What is the current product approval status for the system?	1. System has product or materials approval 2. System has safety case product or materials approval 3. Currently in service with no product or materials approval 4. Currently in service, subject of a concession, and concession still valid.	No action No action Review if this will impact on safe operation of the system No action
Cabling	What failure modes are affecting system reliability?	1. Open circuit on conductors 2. Short Circuit on Conductors 3. Insulation fault to earth 4. Audio path degradation including cross talk 5. Video path degradation 6. Environmental problems 7. Vandalism 8. Theft 9. No failure modes 10. Other	Correlate against other asset information and revise concerns list accordingly
Failure Modes	What failure modes are affecting system reliability	1. Monitor picture failure 2. Monitor picture quality 3. Failure of video recording facilities 4. Failure of power supplies 5. Degraded operation due to environmental factors 6. Vandalism 7. No failure modes 8. other factors	Correlate against other asset information and revise concerns list accordingly
Failure rate	Which equipment is exhibiting high failure rates within the system?	1. Camera 2. Camera Lens (focus, image) 3. Monitor 4. Recording Facilities 5. Speaker 6. DVA 7. Clock 8. No equipment exhibiting high failure rate	Correlate against other asset information and revise concerns list accordingly
Failure rate (asset)	Does the asset perform as expected within company documentation?	1. No incidence of the asset becoming un-maintainable 2. Low incidence of <2 events per year 3. Low to medium, between 3-5 events per year 4. Medium to high, between 6-10 events per year 5. High incidence > 10 events per annum	Correlate against other asset information and revise concerns list accordingly

Failure rate (System)	Does the system perform as expected within company documentation?	1. Less than expected 2. Expected failure rate 3. More than expected	Correlate against other asset information and revise concerns list accordingly
Future expansion	How easy is the system to expand to meet future capacity requirements?	1. Modular design, no limit to capacity 2. System can be expanded within limits 3. System incapable or difficult to expand	No action Assess if this will impact on usable life of the asset
Maintenance costs	Are the costs of maintenance of the asset in line with budget?	1. As expected 2. Maintenance cost has increased but is now steady 3. Increasing at an unacceptable rate	No action Review increased costs to establish if a safety concern exists Review increased costs to establish if a safety concern exists
User ergonomics	Does the use have any difficulties in operating the asset?	1. No negative feedback from user 2. Some negative feedback from user which can be modified as part of maintenance regime 3. Some negative feedback from user which can be modified at small additional cost 4. Some negative feedback which can be modified at significant Additional cost 5. User unpleased with equipment and modifications cannot be carried out	No action No action Sponsor to review business case for improvement Review if this will impact on safe operation of the system Review if this will impact on safe operation of the system

CHECK LIST TO CODIFY PHYSICAL CONDITION OF ASSETS (CODE A TO D) BY CMO & CLIENT ENGINEER

Issue	Asset Concern	Checklist	Action
Operations requirements	Does the asset function and perform to meet Line / Network requirements?	1. Equipment more than meets operational requirement 2. Equipment meets operational requirement 3. Equipment does not meet operational requirement but can be modified at small cost 4. Equipment does not meet operational requirements but can be modified at large cost 5. Equipment does not meet operational needs and cannot be modified	No adjustment to residual life No adjustment to residual life Code D Concern Code D Concern Code D Concern
Physical condition	What is the condition of the asset?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Environmental condition (Physical)	Has the asset degraded as a result of any environmental effects?	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment 2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset 3. Unacceptable environmental conditions which may significantly affect the reliability of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Environmental condition (External)	What is the operating environment of the switchgear? (consider physical conditions, temperature and security)	1. Excellent - e.g. Excellent environmental conditions with no obvious concerns affecting the reliability of the equipment 2. Acceptable - e.g. Acceptable environmental conditions with minor shortfalls that do not significantly affect the reliability of the asset 3. Unacceptable environmental conditions which may significantly affect the reliability of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or recommend improvements to environmental condition to prevent degradation
Redundant Equipment	Are there any redundant plant and cabling systems?	1. Yes 2. No	Condition Code D No adjustment to residual life
Cabling	What is the general condition of the cable installation and terminations?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI

Cabling	Are there signs of insulation degradation (brittle / softened insulation)?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Cabling	What is the condition of the connectivity between control equipment and peripherals (containment, cables and connectors)?	1. Excellent - e.g. excellent condition with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable condition with minor shortfalls to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. unacceptable asset condition with significant shortfalls to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Cabling	What is the condition of the connectivity between control equipment and Connect PFI and other data / audio system providers	1. Excellent - e.g. excellent condition with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable condition with minor shortfalls to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. unacceptable asset condition with significant shortfalls to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Cameras	What is the condition of the CCTV cameras? (Cameras, housings, cable connections)	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Cameras	What is the condition of the camera support structures?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
CCTV Recording	What is the condition of the CCTV recording facilities? (DVR or VCR, BTP playback facilities)	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Clocks	What is the condition of the Clocks?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI

Digital Voice Announcers (DVA)	What is the condition of the DVA?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Environmental conditions	What is the operating environment of the control equipment? (consider physical conditions, temperature and security)	1. Excellent - e.g. excellent condition with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable condition with minor shortfalls to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. unacceptable asset condition with significant shortfalls to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or recommend improvements to en
Monitors	What is the condition of the CCTV Monitors?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Operation	What is the condition of the Operators control Desk? (microphones, switching systems, touch screens)	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Overall condition	What is the general condition of the control equipment?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Power Supplies	What is the condition of the power supplies serving the system?	1. Excellent - e.g. excellent condition with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable condition with minor shortfalls to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. unacceptable asset condition with significant shortfalls to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Supportability (Spares)	Can spares be sourced when required?	1. Abundance of spares. More than sufficient to support asset during its life 2. Sufficient spares to support asset during its life across network 3. Limited spares available 4. No spares available, mitigation in place 5. No spares available, no mitigation possible	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D

Supportability (System supplier)	Can manufacturer support be sourced when required?	1. Equipment fully supported for period longer than remaining life 2. Equipment supported for remaining life 3. Equipment not supported but equipment can easily be replaced or repaired 4. Equipment not supported high risk of critical failure	No impact on residual life No impact on residual life Assess impact on residual life Concern Code D
Reparability of component parts	Can all components be repaired and are they readily available to procure?	1. All system parts are repairable 2. Some parts are non-repairable, but parts can be replaced with equivalent 3. Equipment becoming less repairable, parts difficult to source and likely issue with expected life of equipment 4. Equipment becoming less repairable, parts difficult to source and costs are excessive 5. Equipment not repairable	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D
Specialist tools availability	Does the maintainer have the required tools for completion of any repair or access equipment?	1. Equipment does not require nay specialist tools to carry out routine or reactive maintenance 2. Specialist tools required and maintainer has sufficient 3. Specialist tools required, maintainer does not have sufficient quantities, but they are readily available 4. Specialist tools required, maintainer does not have sufficient quantities, and difficult / expensive to source 5. Specialist tools required and are unavailable	No impact on residual life No impact on residual life Assess impact on residual life Assess impact on residual life Concern Code D
Public Address Speakers	What is the condition of the Public Address Speakers?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI
Remote PA microphones and transmission system	What is the condition of the RPA?	1. Excellent - e.g. as new no physical damage with no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. Minor damage to asset without impairing operation or performance of the asset 3. Unacceptable - e.g. damage to asset impairs operation or performance of the asset	No impact on residual life No impact on residual life Assess impact and reassess residual life or TTNEI

CHECK LIST TO CODIFY FUNCTIONAL CONDITION OF ASSETS (CODES 1 TO 4) BY HEAD OF PROFESSION, CLIENT ENGINEER AND SPONSOR

Issue	Asset Concern	Checklist	Action
Appropriate manuals and records	Are manuals available, accurate and accessible?	1. Records exist, are comprehensive and up to date 2. Records exist but require minor revisions to be up to date 3. Records exist but have not been kept up to date with major changes 4. No records exist	No action No action Code 2 concern if maintenance may result in unsafe practice Code 2 concern if maintenance may result in unsafe practice
Ergonomic issues with maintenance	Is the asset in a position where it can be maintained correctly?	1. Equipment easy to maintain, no manual handling 2. Minor manual handling issues. No ladders required 3. Minor manual handling requirements, more than 1 person required 4. Difficult manual handling issues, more than 1 person required 5. Equipment un-maintainable	No action No action No action No action Code 2 concern if no mitigation plan
LU Standards	Is the asset compliant with current standards?	1. No standard applicable to asset 2. System fully compliant to current standard 3. Non-compliant, compliance is not retrospective 4. Non-compliant, derogation and action plan in place 5. Non-compliant, standard forcing renewal	Assess if legislation or safety issues exist due to no LU standard existing No Action Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern Code 1 concern if non compliant with legislation, Code 2 if safety concern
Quality (CCTV)	Is there evidence of variable picture quality caused by variations in natural lighting?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No action No action Code 2 concern
Quality (CCTV)	Is there evidence of glare on monitor screens caused by direct sunlight?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No action No action Code 2 concern
Quality (CCTV)	Is there evidence of poor image quality from DVR / VCR systems?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs	No action No action Code 2 concern

		operation or performance of the asset	
Quality (PA)	Is there evidence of poor audibility or intelligibility of PA systems?	1. Excellent - e.g. no obvious concerns affecting the reliability of the asset 2. Acceptable - e.g. acceptable asset condition with minor shortfalls 3. Unacceptable - e.g. unacceptable asset condition impairs operation or performance of the asset	No action No action Code 2 concern
Safe accessibility Physical Hazards	Are there physical obstacles which may prevent safe access / egress for inspection, testing or maintenance?	1. No additional hazards identified 2. Low risk, known hazards identified 3. Medium risk, known hazards identified 4. High Risk, Known hazards identified 5. Unacceptable risk, known hazards identified	No action No action No action No action Code 2 concern if no mitigation plan in place
Safety barriers	Are there adequate guards and rails against falling? (e.g. From roof areas, access gantries and platforms)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Safety Signage	Is there adequate display of safety signs and posters relating to the asset installation?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are plant and equipment rooms adequately secured to prevent undue health and safety risks? (e.g. Unauthorised operation or isolation of equipment)	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Security	Are plant areas used as storage areas?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern
Statutory Notices	Is there adequate display of warning and danger notices?	1. Yes 2. No - Issues identified and mitigation plan in place 3. No	No action No action Code 2 concern

10.1.1 Basis of Condition Reporting for Communications						
ACR No.	FD* No.	Asset Description	RAV (k)	Unit	Nominal Life	Source of Nominal Life
1000	**3020**	**Station - CCTV**				
1100	3060	CCTV Camera	2	camera	10	ST24 Restated Terms
1200	3010	CCTV Transmission System (Intra-Station)	30	station system	10	ST24 Restated Terms
1300	n/a	CCTV Control System	40	per station	10	ST24 Restated Terms
1400	n/a	CCTV Operator Interface	30	per station	10	ST24 Restated Terms
2000	**3040**	**OPO System**	**40**	**platform system**		
2100	n/a	OPO Camera Assembly	included in value for system		10	ST24 Restated Terms
2200	n/a	OPO Monitor Assembly	included in value for system		10	ST24 Restated Terms
3000	**3050**	**Track to Train CCTV**	**50**	**platform system**		
3100	n/a	Track to Train Camera Assembly	included in value for system		10	ST24 Restated Terms
3200	n/a	Track to Train Image Processing Sub-system	included in value for system		10	ST24 Restated Terms
3300	n/a	Track to Train Trackside Equipment	included in value for system		10	ST24 Restated Terms
4000	**n/a**	**Dwell Time / RPTI CCTV**	**50**	**platform system**		
4100	n/a	CCTV Camera Assembly	included in value for system		15	LU Standard ST-0015
4200	n/a	CCTV Control System	included in value for system		15	LU Standard ST-0015
4300	n/a	CCTV Operator Interface	included in value for system		15	LU Standard ST-0015
5000	**3030**	**Depot/Sidings - CCTV**				
5100	n/a	CCTV Camera	2	camera	10	Based on best professional judgement
5200	n/a	CCTV Control System	40	depot system	15	Based on best professional judgement
5300	3010	CCTV Transmission System (Intra-Station)	30	depot system	15	Based on best professional judgement
5400	n/a	CCTV Operator Interface	20	depot system	15	Based on best professional judgement
6000	**1030**	**Station PA – Surface**				
6100	n/a	Control Rack	30	Unit	15	Based on best professional judgement
6200	n/a	PA Zones	20	zone	15	Based on best professional judgement
6300	n/a	Operator Interfaces	50	system	15	Based on best professional judgement
7000	**1020**	**Station PA – Sub-Surface**				
7100	n/a	Control Rack	35	Unit	15	Based on best professional judgement
7200	n/a	PA Zones	30	zone	15	Based on best professional judgement
7300	n/a	Operator Interfaces	50	system	15	Based on best professional judgement
8000	**1050**	**Ticket Window Audio Systems**				
8100	n/a	Operator and Customer Interface	4	system	10	Based on best professional judgement
9000	**1040**	**Depot PA**				
9100	n/a	Control Equipment & Operator Interfaces	25	per depot	20	LU Standard S&CSE-ST0037-A2
10000	**1010**	**Long Line PA**				
10100	n/a	Operator Interface	150	per Service Control Centre	15	Based on best professional judgement
10200	n/a	Station Interface	15	per station	15	Based on best professional judgement
11000	**6240**	**Voice Recording Systems**	**40**	**system**	**10**	Based on best professional judgement
12000	**4040**	**Passenger Help Point**				
12100	n/a	Control Equipment , PHP and Operator Interface	120	per station	10	Based on best professional judgement
13000	**4010**	**Access Control System - Depots**				
13100	n/a	Access Control System	45	system	10	Based on best professional judgement
14000		**Alarm Systems (Stations)**				
14100	4030	Gate Alarms	5	station	10	Based on best professional judgement
14200	n/a	Personal Protection	2	unit	10	Based on best professional judgement
14300	n/a	Secure Room Alarm	3	unit	10	Based on best professional judgement
14400	n/a	Gate Line Attendance Point (GLAP)	2	unit	10	Based on best professional judgement
14500	n/a	Ticket Office Duress	3	unit	10	Based on best professional judgement
14600	6230	Door Entry System	6	unit	10	Based on best professional judgement
15000	**4050**	**Depot/Sidings Security**				
15100	n/a	Intruder Detection	95	depot	10	Based on best professional judgement
16000	**6040**	**Direct Line Telephones**				
16100	n/a	Direct Lines	1	per Station/Depot	10	LU Standard 1-145
17000	**6050**	**Station to Station Telephones**				
17100	n/a	Station to Station	1	per Station/Substation	10	LU Standard 1-145
18000	**6010**	**Tunnel Telephone System**				
18100	n/a	ETCDS (TT) Sub-Station Section	37	total including sub-stn control circuitry	20	Based on best professional judgement
18200	n/a	TT Control Panel	RAV included in value for Control Rack		20	Based on best professional judgement
18300	n/a	TT Control Rack	25	per TT section	20	Based on best professional judgement
19000	**n/a**	**Signal Post Telephones**	**10**	**per signalling controlled area**		
19100	n/a	SPT Control Panel	RAV included in value for whole system		15	Based on best professional judgement
19200	n/a	SPT Control Rack	RAV included in value for whole system		15	Based on best professional judgement
19300	n/a	SPT Telephones	RAV included in value for whole system		15	Based on best professional judgement
20000	**7010**	**SCADA**				
20100	n/a	Tube Lines only	TBC		TBC	Based on best professional judgement
21000	**5040**	**Customer Displays**				
21100	n/a	VEIDS/VIDS/PIDS/	25	based on 3 per station	15	Based on best professional judgement
21200	n/a	ESUB	6	system	10	Based on best professional judgement
22000	**5020**	**Clock Systems**				
22100	n/a	Clock Systems	15	per station	15	Based on best professional judgement
23000	**5010**	**Breakdown Broadcast Messaging System (BBMS)**				
23100	n/a	Operator Interface	1	per Station/Depot	15	Based on best professional judgement
24000	**5050**	**Station Control Systems**	**200**	**system**		
24100	n/a	SMS/MICA/SIMS Control System	RAV included in value for whole system		10	Based on best professional judgement
24200	n/a	SMS Operator Interface	RAV included in value for whole system		10	Based on best professional judgement
25000		**Service Control System**	**4000**	**system**		
25100	n/a	CIMS/ Operational Workstation + Control Equip	included in value for system		15	No LU Standard, based on best professional judgement
25200	n/a	Control Equipment	included in value for system		15	No LU Standard, based on best professional judgement

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

10.1.3 Reporting Requirements for Communications

10.1.3.1 Communications ACR - all Lines

ACR No.	FD* No.	Communications – all Lines	Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			%RAV	%RAV	%RAV	%RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
		Actuals:					Quantity	£ Risk	£ Risk	£ Risk
1000	**3020**	**Station - CCTV:**								
1100	3060	CCTV Camera								
1200	3010	CCTV Transmission System (Intra-Station)								
1300	n/a	CCTV Camera Systems								
1400	n/a	CCTV Operator Interface								
2000	**3040**	**OPO System:**								
2100	n/a	OPO Camera Assembly								
2200	n/a	OPO Monitor Assembly								
3000	**3050**	**Track to Train CCTV:**								
3100	n/a	Track to Train Camera Assembly								
3200	n/a	Track to Train Image Processing Sub-system								
3300	n/a	Track to Train Trackside Equipment								
4000	**n/a**	**Dwell Time / RTPI / CCTV:**								
4100	n/a	CCTV Camera Assembly								
4200	n/a	CCTV Control System								
4300	n/a	CCTV Operator Interface								
5000	**3030**	**Depot - CCTV:**								
5100	n/a	CCTV Camera								
5200	n/a	CCTV Control System								
5300	3010	CCTV Transmission System (Intra-Station)								
5400	n/a	CCTV Operator Interface								
6000	**1030**	**Station PA – Surface:**								
6100	n/a	Control Rack								
6200	n/a	PA Zones								
6300	n/a	Operator Interfaces								
7000	**1020**	**Station PA – Sub-Surface:**								
7100	n/a	Control Rack								
7200	n/a	PA Zones								
7300	n/a	Operator Interfaces								
8000	**1050**	**Ticket Window Audio Systems:**								
8100	n/a	Operator and Customer Interface								
9000	**1040**	**Depot PA:**								
9100	n/a	Control Equipment & Operator Interfaces								
10000	**1010**	**Long Line PA:**								
10100	n/a	Operator Interface								
10200	n/a	Station Interface								
11000	**6240**	**Voice Recording Systems:**								
12000	**4040**	**Passenger Help Point:**								
12100	n/a	Control Equipment , PHP and Operator Interface								
13000	**4010**	**Access Control System - Depots**								
13100	n/a	Access Control System								
14000		**Alarm Systems (Stations):**								
14100	4030	Gate Alarms								
14200	n/a	Personal Protection								
14300	n/a	Secure Room Alarm								
14400	n/a	Gate Line Attendance Point (GLAP)								
14500	n/a	Ticket Office Duress								
14600	6230	Door Entry System								
15000	**4050**	**Depot/Sidings Security:**								
15100	n/a	Intruder Detection								
16000	**6040**	**Direct Line Telephones:**								
16100	n/a	Direct Lines								
17000	**6050**	**Station to Station Telephones:**								
17100	n/a	Station to Station								
18000	**6010**	**Tunnel Telephone System:**								
18100	n/a	ETCDS (TT) Sub-Station Section								
18200	n/a	TT Control Panel								
18300	n/a	TT Control Rack								
19000	**n/a**	**Signal Post Telephones:**								
19100	n/a	SPT Control Panel								
19200	n/a	SPT Control Panel								
19300	n/a	SPT Telephones								
20000	**7010**	**SCADA:**								
20100	n/a	Tube Lines only								
21000	**5040**	**Customer Displays:**								
21100	n/a	VEIDS/VIDS/PIDS								
22000	**5020**	**Clock Systems:**								
22100	n/a	Clock Systems								
23000	**5010**	**Breakdown Broadcast Messaging System (BBMS):**								
23100	n/a	Operator Interface								
24000	**5050**	**Station Control Systems:**								
24100	n/a	SMS/MICA/SIMS Control System								
24200	n/a	SMS Operator Interface								
25000		**Service Control System:**								
25100	n/a	CIMS/ Operational Workstation + Control Equip								
25200	n/a	Control Equipment								
		Communications								
		Previous								
		Actual								
		Variance								

10.1.3 Reporting Requirements for Communications

10.1.3.2 Communications ACR - by Line

Communications – Summary Report for xxx Line

	Physical Condition				Functional Condition			
	Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
	% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
Actuals:					Quantity	£ Risk	£ Risk	£ Risk
Station - CCTV:								
CCTV Camera								
CCTV Transmission System (Intra-Station)								
CCTV Camera Systems								
CCTV Operator Interface								
OPO System:								
OPO Camera Assembly								
OPO Monitor Assembly								
Track to Train CCTV:								
Track to Train Camera Assembly								
Track to Train Image Processing Sub-system								
Track to Train Trackside Equipment								
Dwell Time / RTPI / CCTV:								
CCTV Camera Assembly								
CCTV Control System								
CCTV Operator Interface								
Depot - CCTV:								
CCTV Camera								
CCTV Control System								
CCTV Transmission System (Intra-Station)								
CCTV Operator Interface								
Station PA – Surface:								
Control Rack								
PA Zones								
Operator Interfaces								
Station PA – Sub-Surface:								
Control Rack								
PA Zones								
Operator Interfaces								
Ticket Window Audio Systems:								
Operator and Customer Interface								
Depot PA:								
Control Equipment & Operator Interfaces								
Long Line PA:								
Operator Interface								
Station Interface								
Voice Recording Systems:								
Passenger Help Point:								
Control Equipment , PHP and Operator Interface								
Access Control System - Depots								
Access Control System								
Alarm Systems (Stations):								
Gate Alarms								
Personal Protection								
Secure Room Alarm								
Gate Line Attendance Point (GLAP)								
Ticket Office Duress								
Door Entry System								
Depot/Sidings Security:								
Intruder Detection								
Direct Line Telephones:								
Direct Lines								
Station to Station Telephones:								
Station to Station								
Tunnel Telephone System:								
ETCDS (TT) Sub-Station Section								
TT Control Panel								
TT Control Rack								
Signal Post Telephones:								
SPT Control Panel								
SPT Control Panel								
SPT Telephones								
SCADA:								
Tube Lines only								
Customer Displays:								
VEIDS/VIDS/PIDS								
Clock Systems:								
Clock Systems								
Breakdown Broadcast Messaging System (BBMS):								
Operator Interface								
Station Control Systems:								
SMS/MICA/SIMS Control System								
SMS Operator Interface								
Service Control System:								
CIMS/ Operational Workstation + Control Equip								
Control Equipment								
Communications								
Previous								
Actual								
Variance								
Commentary on Variances:	A brief explanation of any significant variances of planned v. actual condition states and of any resultant backlog and including							

The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.

10.1.6 Basis for RAV Communications

Station Categories

	Station	Owner	Infraco	Line	Urban/ Suburban	Counts 2008 Entries/ exits (m)	Category (Based on Foundation Stations model)	Surface/ Cut and Cover/ Deep Tube
1	Acton Town	LUL	TLL	Piccadilly	Suburban	5.82	Medium	Surface
2	Aldgate	LUL	SSL	Metropolitan	Urban	6.24	Medium	Cut and Cover
3	Aldgate East	LUL	SSL	District	Urban	8.15	Medium	Cut and Cover
4	Alperton	LUL	TLL	Piccadilly	Suburban	3.07	Small	Surface
5	Amersham	LUL	SSL	Metropolitan	Suburban	2.17	Medium	Surface
6	Angel	LUL	TLL	Northern	Urban	17.82	Medium	Deep Tube
7	Archway	LUL	TLL	Northern	Suburban	8.24	Medium	Deep Tube
8	Arnos Grove	LUL	TLL	Piccadilly	Suburban	4.25	Medium	Surface
9	Arsenal	LUL	TLL	Piccadilly	Suburban	3.21	Medium	Deep Tube
10	Baker Street	LUL	SSL	Metropolitan	Urban	24.61	Mega	Deep Tube
11	Balham	LUL	TLL	Northern	Suburban	11.56	Medium	Deep Tube
12	Bank/Monument	LUL	BCV	Central	Urban	42.82	Mega	Deep Tube
13	Barbican	LUL	SSL	Metropolitan	Urban	10.03	Medium	Surface
14	Barking	LTSR	SSL	District	Not required	11.68	Not required	Not required
15	Barkingside	LUL	BCV	Central	Suburban	0.95	Small	Surface
16	Barons Court	LUL	SSL	District	Urban	6.78	Medium	Surface
17	Bayswater	LUL	SSL	Metropolitan	Urban	5.98	Medium	Cut and Cover
18	Becontree	LUL	SSL	District	Suburban	2.55	Small	Surface
19	Belsize Park	LUL	TLL	Northern	Suburban	6.14	Medium	Deep Tube
20	Bermondsey	LUL	TLL	Jubilee	Suburban	6.65	Medium	Deep Tube
21	Bethnal Green	LUL	BCV	Central	Suburban	14.27	Medium	Deep Tube
22	Blackfriars Station Closed	LUL	SSL	District	Urban	13.14	Medium	Cut and Cover
23	Blackhorse Road	LUL	BCV	Victoria	Suburban	6.09	Medium	Deep Tube
24	Bond Street	LUL	BCV	Central	Urban	36.41	Large	Deep Tube
25	Borough	LUL	TLL	Northern	Suburban	4.14	Medium	Deep Tube
26	Boston Manor	LUL	TLL	Piccadilly	Suburban	1.98	Small	Surface
27	Bounds Green	LUL	TLL	Piccadilly	Suburban	5.78	Medium	Deep Tube
28	Bow Road	LUL	SSL	District	Urban	5.32	Medium	Cut and Cover
29	Brent Cross	LUL	TLL	Northern	Suburban	2.19	Small	Surface
30	Brixton	LUL	BCV	Victoria	Suburban	20.93	Medium	Deep Tube
31	Bromley-by-Bow	LUL	SSL	District	Suburban	2.75	Small	Surface
32	Buckhurst Hill	LUL	BCV	Central	Suburban	1.60	Small	Surface
33	Burnt Oak	LUL	TLL	Northern	Suburban	3.51	Small	Surface
34	Caledonian Road	LUL	TLL	Piccadilly	Suburban	4.93	Medium	Deep Tube
35	Camden Town	LUL	TLL	Northern	Suburban	19.64	Large	Deep Tube
36	Canada Water	LUL	TLL	Jubilee	Urban	11.43	Large	Deep Tube
37	Canary Wharf	LUL	TLL	Jubilee	Urban	43.51	Large	Deep Tube
38	Canning Town	LUL	TLL	Jubilee	Suburban	7.98	Large	Surface
39	Cannon Street	LUL	SSL	District	Urban	4.54	Medium	Cut and Cover
40	Canons Park	LUL	TLL	Jubilee	Suburban	1.56	Small	Surface
41	Chalfont & Latimer	LUL	SSL	Metropolitan	Suburban	1.19	Medium	Surface
42	Chalk Farm	LUL	TLL	Northern	Suburban	4.85	Medium	Deep Tube
43	Chancery Lane	LUL	BCV	Central	Urban	15.39	Medium	Deep Tube
44	Charing Cross	LUL	BCV	Bakerloo	Urban	23.39	Large	Deep Tube
45	Chesham	LUL	SSL	Metropolitan	Suburban	0.45	Small	Surface
46	Chigwell	LUL	BCV	Central	Suburban	0.41	Small	Surface
47	Chiswick Park	LUL	SSL	District	Suburban	2.05	Small	Surface
48	Chorleywood	LUL	SSL	Metropolitan	Suburban	0.86	Small	Surface
49	Clapham Common	LUL	TLL	Northern	Suburban	9.05	Medium	Deep Tube
50	Clapham North	LUL	TLL	Northern	Suburban	5.85	Medium	Deep Tube
51	Clapham South	LUL	TLL	Northern	Suburban	7.60	Medium	Deep Tube
52	Cockfosters	LUL	TLL	Piccadilly	Suburban	1.76	Medium	Surface
53	Colindale	LUL	TLL	Northern	Suburban	4.10	Small	Surface
54	Colliers Wood	LUL	TLL	Northern	Suburban	5.48	Medium	Deep Tube
55	Covent Garden	LUL	TLL	Piccadilly	Suburban	17.51	Medium	Deep Tube
56	Croxley	LUL	SSL	Metropolitan	Suburban	0.75	Small	Surface
57	Dagenham East	LUL	SSL	District	Suburban	2.14	Small	Surface
58	Dagenham Heathway	LUL	SSL	District	Suburban	4.08	Small	Surface
59	Debden	LUL	BCV	Central	Suburban	1.76	Small	Surface
60	Dollis Hill	LUL	TLL	Jubilee	Suburban	3.66	Small	Surface
61	Ealing Broadway	Thames	BCV	Central	Suburban	17.86	Medium	Surface
62	Ealing Common	LUL	TLL	Piccadilly	Suburban	3.40	Small	Surface
63	Earl's Court	LUL	SSL	District	Urban	20.43	Large	Deep Tube
64	East Acton	LUL	BCV	Central	Suburban	3.90	Small	Surface
65	East Finchley	LUL	TLL	Northern	Suburban	5.95	Medium	Surface
66	East Ham	LUL	SSL	District	Suburban	12.67	Small	Surface
67	East Putney	LUL	SSL	District	Suburban	5.81	Small	Surface
68	Eastcote	LUL	SSL	Metropolitan	Suburban	2.46	Small	Surface
69	Edgware	LUL	TLL	Northern	Suburban	3.72	Medium	Surface
70	Edgware Road (Bakerloo)	LUL	BCV	Bakerloo	Urban	3.70	Medium	Deep Tube
71	Edgware Road (H&C)	LUL	SSL	Metropolitan	Urban	6.04	Medium	Surface
72	Elephant & Castle	LUL	BCV	Bakerloo	Urban	18.54	Large	Deep Tube
73	Elm Park	LUL	SSL	District	Suburban	2.40	Small	Surface
74	Embankment	LUL	SSL	District	Urban	20.85	Mega	Deep Tube
75	Epping	LUL	BCV	Central	Suburban	2.48	Small	Surface
76	Euston	LUL	TLL	Northern	Urban	28.13	Mega	Deep Tube
77	Euston Square	LUL	SSL	Metropolitan	Urban	10.58	Medium	Cut and Cover
78	Fairlop	LUL	BCV	Central	Suburban	0.80	Small	Surface
79	Farringdon	LUL	SSL	Metropolitan	Urban	18.84	Medium	Surface
80	Finchley Central	LUL	TLL	Northern	Suburban	5.05	Medium	Surface
81	Finchley Road	LUL	TLL	Jubilee	Suburban	10.18	Medium	Surface
82	Finsbury Park	LUL	TLL	Piccadilly	Suburban	26.30	Large	Deep Tube
83	Fulham Broadway	LUL	SSL	District	Urban	9.63	Small	Cut and Cover
84	Gants Hill	LUL	BCV	Central	Suburban	4.69	Medium	Deep Tube
85	Gloucester Road	LUL	SSL	District	Urban	13.52	Medium	Deep Tube
86	Golders Green	LUL	TLL	Northern	Suburban	7.67	Medium	Surface
87	Goldhawk Road	LUL	SSL	Metropolitan	Suburban	1.77	Small	Surface
88	Goodge Street	LUL	TLL	Northern	Urban	8.49	Medium	Deep Tube
89	Grange Hill	LUL	BCV	Central	Suburban	0.46	Small	Surface
90	Great Portland Street	LUL	SSL	Metropolitan	Urban	6.96	Medium	Cut and Cover
91	Green Park	LUL	TLL	Piccadilly	Urban	29.62	Mega	Deep Tube
92	Greenford	LUL	BCV	Central	Suburban	3.53	Medium	Surface
93	Gunnersbury	STS	SSL	District	Not required	3.67	Not required	Not required
94	Hainault	LUL	BCV	Central	Suburban	2.38	Medium	Surface
95	Hammersmith (D&P)	LUL	SSL	District	Suburban	28.98	Medium	Surface
96	Hammersmith (H&C)	LUL	SSL	Metropolitan	Suburban	9.17	Medium	Surface

10.1.6 Basis for RAV Communications

Station Categories

	Station	Owner	Infraco	Line	Urban/ Suburban	Counts 2008 Entries/ exits (m)	Category (Based on Foundation Stations model)	Surface/ Cut and Cover/ Deep Tube
100	Harrow & Wealdstone	STS	BCV	Bakerloo	Not required	4.31	Not required	Not required
101	Harrow-on-the-Hill	LUL	SSL	Metropolitan	Suburban	9.36	Medium	Surface
102	Hatton Cross	LUL	TLL	Piccadilly	Suburban	2.74	Medium	Cut and Cover
103	Heathrow Terminal 4	LUL	TLL	Piccadilly	Suburban	1.17	Medium	Deep Tube
104	Heathrow Terminals 1,2,3	LUL	TLL	Piccadilly	Suburban	8.09	Medium	Deep Tube
105	Heathrow Terminal 5	LUL	TLL	Piccadilly	Suburban	3.14	Medium	Deep Tube
106	Hendon Central	LUL	TLL	Northern	Suburban	5.91	Small	Surface
107	High Barnet	LUL	TLL	Northern	Suburban	2.73	Medium	Surface
108	High Street Kensington	LUL	SSL	District	Urban	13.26	Medium	Cut and Cover
109	Highbury & Islington	LUL	BCV	Victoria	Suburban	13.73	Medium	Deep Tube
110	Highgate	LUL	TLL	Northern	Suburban	4.85	Medium	Deep Tube
111	Hillingdon	LUL	SSL	Metropolitan	Suburban	1.39	Small	Surface
112	Holborn	LUL	BCV	Central	Urban	30.18	Large	Deep Tube
113	Holland Park	LUL	BCV	Central	Suburban	3.88	Medium	Deep Tube
114	Holloway Road	LUL	TLL	Piccadilly	Suburban	7.67	Medium	Deep Tube
115	Hornchurch	LUL	SSL	District	Suburban	1.96	Small	Surface
116	Hounslow Central	LUL	TLL	Piccadilly	Suburban	3.63	Medium	Surface
117	Hounslow East	LUL	TLL	Piccadilly	Suburban	3.86	Medium	Surface
118	Hounslow West	LUL	TLL	Piccadilly	Suburban	2.95	Medium	Cut and Cover
119	Hyde Park Corner	LUL	TLL	Piccadilly	Urban	6.42	Medium	Deep Tube
120	Ickenham	LUL	SSL	Metropolitan	Suburban	1.03	Small	Surface
121	Kennington	LUL	TLL	Northern	Suburban	4.18	Medium	Deep Tube
122	Kensal Green	STS	BCV	Bakerloo	Not required	2.63	Not required	Not required
123	Kentish Town	LUL	TLL	Northern	Suburban	7.10	Medium	Deep Tube
124	Kenton	STS	BCV	Bakerloo	Not required	1.47	Not required	Not required
125	Kew Gardens	STS	SSL	District	Not required	3.17	Not required	Not required
126	Kilburn	LUL	TLL	Jubilee	Suburban	8.56	Small	Surface
127	Kilburn Park	LUL	BCV	Bakerloo	Suburban	3.62	Medium	Deep Tube
128	King's Cross St. Pancras	LUL	SSL	Metropolitan	Urban	67.07	Mega	Deep Tube
129	Kingsbury	LUL	TLL	Jubilee	Suburban	3.32	Medium	Surface
130	Knightsbridge	LUL	TLL	Piccadilly	Urban	19.64	Medium	Deep Tube
131	Ladbroke Grove	LUL	SSL	Metropolitan	Suburban	5.44	Medium	Surface
132	Lambeth North	LUL	BCV	Bakerloo	Urban	3.20	Medium	Deep Tube
133	Lancaster Gate	LUL	BCV	Central	Urban	5.97	Medium	Deep Tube
134	Latimer Road	LUL	SSL	Metropolitan	Suburban	2.15	Small	Surface
135	Leicester Square	LUL	TLL	Piccadilly	Urban	33.87	Interchange	Deep Tube
136	Leyton	LUL	BCV	Central	Suburban	12.65	Small	Surface
137	Leytonstone	LUL	BCV	Central	Suburban	9.86	Medium	Surface
138	Liverpool Street	LUL	SSL	Metropolitan	Urban	64.16	Large	Deep Tube
139	London Bridge	LUL	TLL	Jubilee	Urban	60.55	Mega	Deep Tube
140	Loughton	LUL	BCV	Central	Suburban	2.66	Medium	Surface
141	Maida Vale	LUL	BCV	Bakerloo	Suburban	3.21	Medium	Deep Tube
142	Manor House	LUL	TLL	Piccadilly	Suburban	8.65	Medium	Deep Tube
143	Mansion House	LUL	SSL	District	Urban	5.32	Medium	Cut and Cover
144	Marble Arch	LUL	BCV	Central	Urban	16.30	Medium	Deep Tube
145	Marylebone	LUL	BCV	Bakerloo	Urban	11.38	Medium	Deep Tube
146	Mile End	LUL	BCV	Central	Suburban	13.30	Medium	Cut and Cover
147	Mill Hill East	LUL	TLL	Northern	Suburban	1.00	Small	Surface
148	~~Monument~~	~~LUL~~	~~BCV~~	~~Central~~	~~Urban~~	N/A	~~Major Interchange~~	~~Deep Tube~~
149	Moor Park	LUL	SSL	Metropolitan	Suburban	0.76	Small	Surface
150	Moorgate	LUL	SSL	Metropolitan	Urban	22.22	Large	Deep Tube
151	Morden	LUL	TLL	Northern	Suburban	6.65	Medium	Surface
152	Mornington Crescent	LUL	TLL	Northern	Suburban	4.29	Medium	Deep Tube
153	Neasden	LUL	TLL	Jubilee	Suburban	2.99	Small	Surface
156	Newbury Park	LUL	BCV	Central	Suburban	3.59	Small	Surface
157	North Acton	LUL	BCV	Central	Suburban	5.10	Small	Surface
158	North Ealing	LUL	TLL	Piccadilly	Suburban	0.92	Small	Surface
159	North Greenwich	LUL	TLL	Jubilee	Urban	17.76	Interchange	Deep Tube
160	North Harrow	LUL	SSL	Metropolitan	Suburban	1.48	Small	Surface
161	North Wembley	STS	BCV	Bakerloo	Not required	1.40	Not required	Not required
162	Northfields	LUL	TLL	Piccadilly	Suburban	4.06	Small	Surface
163	Northolt	LUL	BCV	Central	Suburban	3.52	Small	Surface
164	Northwick Park	LUL	SSL	Metropolitan	Suburban	3.74	Small	Surface
165	Northwood	LUL	SSL	Metropolitan	Suburban	1.94	Small	Surface
166	Northwood Hills	LUL	SSL	Metropolitan	Suburban	1.38	Small	Surface
167	Notting Hill Gate	LUL	BCV	Central	Suburban	16.85	Large	Deep Tube
168	Oakwood	LUL	TLL	Piccadilly	Suburban	2.84	Small	Surface
169	Old Street	LUL	TLL	Northern	Urban	19.24	Medium	Deep Tube
170	Kensington (Olympia)	STS	SSL	District	Not required	1.32	Not required	Not required
171	Osterley	LUL	TLL	Piccadilly	Suburban	2.06	Small	Surface
172	Oval	LUL	TLL	Northern	Suburban	5.92	Medium	Deep Tube
173	Oxford Circus	LUL	BCV	Bakerloo	Urban	72.91	Mega	Deep Tube
174	Paddington (Main)	LUL	SSL	Metropolitan	Urban	33.80	Large	Deep Tube
175	Paddington (Suburban)	LUL	SSL	Metropolitan	Urban	6.9	Small	Surface
176	Park Royal	LUL	TLL	Piccadilly	Suburban	1.59	Small	Surface
177	Parsons Green	LUL	SSL	District	Suburban	5.13	Small	Surface
178	Perivale	LUL	BCV	Central	Suburban	2.09	Small	Surface
179	Piccadilly Circus	LUL	BCV	Bakerloo	Urban	38.85	Large	Deep Tube
180	Pimlico	LUL	BCV	Victoria	Urban	8.41	Medium	Deep Tube
181	Pinner	LUL	SSL	Metropolitan	Suburban	2.31	Small	Surface
182	Plaistow	LUL	SSL	District	Suburban	6.31	Small	Surface
183	Preston Road	LUL	SSL	Metropolitan	Suburban	3.10	Small	Surface
184	Putney Bridge	LUL	SSL	District	Suburban	5.51	Small	Surface
185	Queen's Park	STS	BCV	Bakerloo	Not required	5.66	Not required	Not required
186	Queensbury	LUL	TLL	Jubilee	Suburban	3.21	Small	Surface
187	Queensway	LUL	BCV	Central	Urban	8.48	Medium	Deep Tube
188	Ravenscourt Park	LUL	SSL	District	Suburban	2.62	Small	Surface
189	Rayners Lane	LUL	SSL	Metropolitan	Suburban	3.85	Small	Surface
190	Redbridge	LUL	BCV	Central	Suburban	2.36	Medium	Cut and Cover
191	Regent's Park	LUL	BCV	Bakerloo	Urban	3.34	Medium	Deep Tube
192	Richmond	SWT	SSL	District	Not required	7.30	Not required	Not required
193	Rickmansworth	LUL	SSL	Metropolitan	Suburban	1.90	Small	Surface
194	Roding Valley	LUL	BCV	Central	Suburban	0.21	Small	Surface
196	Royal Oak	LUL	SSL	Metropolitan	Suburban	1.83	Small	Surface
197	Ruislip	LUL	SSL	Metropolitan	Suburban	1.59	Small	Surface
198	Ruislip Gardens	LUL	BCV	Central	Suburban	0.88	Small	Surface
199	Ruislip Manor	LUL	SSL	Metropolitan	Suburban	1.55	Small	Surface

10.1.6 Basis for RAV Communications

Station Categories

	Station	Owner	Infraco	Line	Urban/ Suburban	Counts 2008 Entries/ exits (m)	Category (Based on Foundation Stations model)	Surface/ Cut and Cover/ Deep Tube
200	Russell Square	LUL	TLL	Piccadilly	Urban	13.59	Medium	Deep Tube
201	Seven Sisters	LUL	BCV	Victoria	Suburban	13.34	Large	Deep Tube
203	Shepherd's Bush (Central)	LUL	BCV	Central	Suburban	20.73	Medium	Deep Tube
204	Shepherd's Bush Market (H&C)	LUL	SSL	Metropolitan	Suburban	3.58	Small	Surface
206	Sloane Square	LUL	SSL	District	Urban	14.79	Medium	Cut and Cover
207	Snaresbrook	LUL	BCV	Central	Suburban	2.22	Small	Surface
208	South Ealing	LUL	TLL	Piccadilly	Suburban	3.36	Small	Surface
209	South Harrow	LUL	TLL	Piccadilly	Suburban	2.19	Small	Surface
210	South Kensington	LUL	SSL	District	Urban	28.48	Large	Deep Tube
211	South Kenton	STS	BCV	Bakerloo	Not required	0.82	Not required	Not required
212	South Ruislip	LUL	BCV	Central	Suburban	1.61	Small	Surface
213	South Wimbledon	LUL	TLL	Northern	Suburban	3.68	Medium	Deep Tube
214	South Woodford	LUL	BCV	Central	Suburban	3.84	Small	Surface
215	Southfields	LUL	SSL	District	Suburban	5.63	Small	Surface
216	Southgate	LUL	TLL	Piccadilly	Suburban	5.05	Small	Deep Tube
217	Southwark	LUL	TLL	Jubilee	Urban	9.66	Large	Deep Tube
218	St. Paul's	LUL	BCV	Central	Urban	13.19	Medium	Deep Tube
219	St. James's Park	LUL	SSL	District	Urban	6.66	Medium	Cut and Cover
220	St. John's Wood	LUL	TLL	Jubilee	Suburban	12.95	Medium	Deep Tube
221	Stamford Brook	LUL	SSL	District	Suburban	2.64	Small	Surface
222	Stanmore	LUL	TLL	Jubilee	Suburban	2.78	Medium	Surface
223	Stepney Green	LUL	SSL	District	Urban	4.40	Medium	Cut and Cover
224	Stockwell	LUL	TLL	Northern	Suburban	8.36	Large	Deep Tube
225	Stonebridge Park	STS	BCV	Bakerloo	Not required	2.13	Not required	Not required
226	Stratford	LUL	TLL	Jubilee	Suburban	27.23	Large	Surface
227	Sudbury Hill	LUL	TLL	Piccadilly	Suburban	2.11	Small	Surface
228	Sudbury Town	LUL	TLL	Piccadilly	Suburban	2.24	Small	Surface
230	Swiss Cottage	LUL	TLL	Jubilee	Suburban	7.06	Medium	Deep Tube
231	Temple	LUL	SSL	District	Urban	6.77	Medium	Cut and Cover
232	Theydon Bois	LUL	BCV	Central	Suburban	0.65	Small	Surface
233	Tooting Bec	LUL	TLL	Northern	Suburban	6.99	Medium	Deep Tube
234	Tooting Broadway	LUL	TLL	Northern	Suburban	13.00	Medium	Deep Tube
235	Tottenham Court Road	LUL	TLL	Northern	Urban	36.57	Large	Deep Tube
236	Tottenham Hale	LUL	BCV	Victoria	Suburban	8.35	Medium	Deep Tube
237	Totteridge & Whetstone	LUL	TLL	Northern	Suburban	1.81	Small	Surface
238	Tower Hill	LUL	SSL	District	Urban	20.31	Medium	Cut and Cover
239	Tufnell Park	LUL	TLL	Northern	Suburban	3.35	Medium	Deep Tube
240	Turnham Green	LUL	SSL	District	Suburban	5.99	Medium	Surface
241	Turnpike Lane	LUL	TLL	Piccadilly	Suburban	9.87	Small	Deep Tube
242	Upminster	LTSR	SSL	District	Not required	4.39	Not required	Not required
243	Upminster Bridge	LUL	SSL	District	Suburban	0.93	Small	Surface
244	Upney	LUL	SSL	District	Suburban	1.84	Small	Surface
245	Upton Park	LUL	SSL	District	Suburban	9.59	Small	Surface
246	Uxbridge	LUL	SSL	Metropolitan	Suburban	6.93	Medium	Surface
247	Vauxhall	LUL	BCV	Victoria	Urban	18.56	Medium	Deep Tube
248	Victoria	LUL	BCV	Victoria	Urban	78.41	Mega	Deep Tube
249	Walthamstow Central	WAGN	BCV	Victoria	Suburban	14.16	Medium	Deep Tube
250	Wanstead	LUL	BCV	Central	Suburban	2.26	Medium	Deep Tube
252	Warren Street	LUL	BCV	Victoria	Urban	14.38	Large	Deep Tube
253	Warwick Avenue	LUL	BCV	Bakerloo	Suburban	4.26	Medium	Deep Tube
254	Waterloo	LUL	TLL	Jubilee	Urban	77.20	Mega	Deep Tube
255	Watford	LUL	SSL	Metropolitan	Suburban	1.62	Medium	Surface
256	Wembley Central	STS	BCV	Bakerloo	Not required	3.50	Not required	Not required
257	Wembley Park	LUL	TLL	Jubilee	Suburban	10.75	Large	Surface
258	West Acton	LUL	BCV	Central	Suburban	1.65	Small	Surface
259	West Brompton	LUL	SSL	District	Urban	3.71	Small	Surface
260	West Finchley	LUL	TLL	Northern	Suburban	1.22	Small	Surface
261	West Ham	LUL	TLL	Jubilee	Suburban	3.05	Large	Surface
262	West Hampstead	LUL	TLL	Jubilee	Suburban	7.36	Small	Surface
263	West Harrow	LUL	SSL	Metropolitan	Suburban	1.19	Small	Surface
264	West Kensington	LUL	SSL	District	Urban	4.72	Small	Surface
265	West Ruislip	LUL	BCV	Central	Suburban	1.30	Medium	Surface
266	Westbourne Park	LUL	SSL	Metropolitan	Suburban	3.11	Small	Surface
267	Westminster	LUL	TLL	Jubilee	Urban	19.05	Large	Deep Tube
268	White City	LUL	BCV	Central	Suburban	9.33	Medium	Surface
269	Whitechapel	LUL	SSL	District	Suburban	11.55	Medium	Surface
270	Willesden Green	LUL	TLL	Jubilee	Suburban	8.14	Small	Surface
271	Willesden Junction	STS	BCV	Bakerloo	Not required	3.50	Not required	Not required
272	Wimbledon	SWT	SSL	District	Not required	15.06	Not required	Not required
273	Wimbledon Park	LUL	SSL	District	Suburban	2.08	Small	Surface
274	Wood Green	LUL	TLL	Piccadilly	Suburban	10.89	Medium	Deep Tube
275	Wood Lane	LUL	SSL	Metropolitan	Suburban	3.82	Small	
276	Woodford	LUL	BCV	Central	Suburban	4.35	Small	Surface
277	Woodside Park	LUL	TLL	Northern	Suburban	2.31	Small	Surface

Key

(green)	Typical 2 Platform Station (Surface)	Small
(yellow)	2 platforms or more and/or 2 booking halls (Sub Surface)	Medium
(orange)	Interchange or NR terminus station	Large
(red)	Largest Stations	Mega

(pink)	Asset Stabilisation
(blue)	Stations Delivery DIS granted
	Stations on site

10.1.6 Basis of RAVs for Communications

10.1.6.2 Depot Categories

	Station	Owner	Infraco	Line	No. of CCTV Cameras in Depot / Sidings	Category (Based on Foundation Stations model)
1	Stonebridge Park Depot	LUL	BCV	Bakerloo	9	Large
2	London Road Depot	LUL	BCV	Bakerloo	8	Medium
3	Queens Park North & South Sheds	LUL	BCV	Bakerloo		Small
4	Elephant & Castle Sidings	LUL	BCV	Bakerloo		Small
5	Hainault Depot	LUL	BCV	Central	11	Large
6	White City Sidings	LUL	BCV	Central	64	Mega
7	Ruislip Depot	LUL	BCV	Central		Mega
8	Loughton Sidings	LUL	BCV	Central		Small
9	Woodford Sidings	LUL	BCV	Central		Small
10	Waterloo Depot	LUL	BCV	Waterloo & City	12	Small
11	Brixton Sidings	LUL	BCV	Victoria		Small
12	Walthamstow Sidings	LUL	BCV	Victoria		Small
13	Northumberland Park Depot	LUL	BCV	Victoria	14	Large
15	Watford Sidings	LUL	SSL	Metropolitan		Small
16	Neasden Depot	LUL	SSL	Metropolitan	56	Mega
17	Uxbridge Sidings	LUL	SSL	Metropolitan		Small
18	Rickmansworth North Sidings	LUL	SSL	Metropolitan		Small
19	Rickmansworth South Sidings	LUL	SSL	Metropolitan		Small
20	Upminster Depot	LUL	SSL	District	8	Large
21	Lillie Bridge Depot	LUL	SSL	District	24	Medium
22	Ealing Common Depot	LUL	SSL	District	6	Large
23	Triangle Sidings	LUL	SSL	District		Medium
24	Parsons Green Sidings	LUL	SSL	District		Small
25	Barking Sidings	LUL	SSL	District		Medium
14	Hammersmith Depot	LUL	SSL	Hammersmith & City		Medium
26	Farringdon Sidings	LUL	SSL	Hammersmith & City		Small
27	Edgware Road Sidings	LUL	SSL	Hammersmith & City		Small
28	Stanmore Sidings	TfL	JNP	Jubilee		Medium
29	Wembley Park Sidings	TfL	JNP	Jubilee		Small
30	Stratford Market Depot	TfL	JNP	Jubilee		Mega
31	Edgware Depot	TfL	JNP	Northern		Medium
32	Golders Green Depot	TfL	JNP	Northern		Mega
33	Morden Depot	TfL	JNP	Northern		Large
34	Hign Barnet Sidings	TfL	JNP	Northern		Medium
35	Highgate Depot	TfL	JNP	Northern		Small
36	South Harrow Sidings	TfL	JNP	Piccadilly		Small
37	Northfields Depot	TfL	JNP	Piccadilly		Medium
38	Arnos Grove Sidings	TfL	JNP	Piccadilly		Small
39	Cockfosters Depot	TfL	JNP	Piccadilly		Mega

S1042 Asset Condition Reporting (ACR)

Power Non-PFI

Power Performance – MAINTENANCE	UNDERGROUND

POWER ACR RE-LIFING EXERCISE GROUPING RATIONALE
April 2010

1.0 Background

The new Asset Condition Reporting (ACR) Standard 5-042 requires that all assets are assessed to establish their Residual Life. Within the ACR Manual of Good Practice Residual Life is described as ‘The remaining life of an asset at the reporting date, in terms of the estimated time required before the next intervention, taking into account physical degradation to date, agreed changes to the maintenance regime, obsolescence and any other relevant factors’. This measure is arrived at in the following ways:

- By taking the commissioning date and adding the known nominal life and subtracting the time the asset has spent in service and adding any known condition factors
- If the commissioning date is not known a re-lifing exercise must be undertaken to establish the remaining Residual Life of the asset using a matrix published as an appendix to the Standard
- If the Residual Life of an asset has reached ten years, and will therefore automatically turn from an A category to a B category asset, a re-lifing exercise should be undertaken to establish if it is appropriate to extend the Residual Life of the asset to a maximum of fifteen years

All information concerning Power assets is held within Ellipse but an area of data weakness is the number of missing commissioning dates against the individual asset records. In order to deliver a compliant Power ACR a re-lifing exercise will need to be undertaken on large numbers of assets which, if undertaken on an asset by asset basis, would be time consuming and unreasonably costly. A route to reducing the burden of the assessments is to bundle similar assets together by type.

2.0 Rationale for Grouping

A number of Power assets are of identical design and when located in similar environments and subject to the same maintenance regime they can reasonably be expected to have very similar operational lives. Where no installation or commissioning date is known the re-lifing process can give an asset a maximum Residual Life of fifteen years. If no specific concern arises against the asset it will again be assessed at ten years and again at five; when the asset class changes from an A to a B and thence to a C. This process means that all re-lifed assets, regardless of condition, will be re-assessed as a minimum every five years. This gives a high level of assurance that the Residual Life is correct and greatly reduces the risk of grouping together similar assets within any given category.

3.0 Grouping Assessment

All asset types are allocated numbers within the ACR Standard and further grouped into five categories. The Power Performance team have reviewed these and made recommendations where grouping is believed to be appropriate giving a brief explanation as to the rationale for the grouping. The table on page 2 gives the listing of Power asset types, additional information including Nominal Life and the recommended groupings.

4.0 Recommendation and Output

The Power Performance team recommend that the groupings listed on page 2 are formally accepted by the Power Asset Sponsor and the Head of Power Engineering. The approval should then be confirmed and documented in the minutes of the Power Asset Working Group.

Power Performance – MAINTENANCE

ACR Number	Asset Description	RAV (k)	Unit	Nom' Life	Recommendations for Re-lifing Groupings
1000	**Electrical Protection**				
1001	Permanent Current Rail Indicator Device (P-CRID)	5.0	Unit	7	Only on Tube Lines
1002	Traction Earth Detection System	18.0	Section	7	I Due to low numbers of system failures it is reasonable to re-life as a group
1003	Earth Electrodes	18.0	Farm	20	None identified
1004	HEX Earth Monitoring system	1.0	System	40	Only one system so not applicable
1005	Main Depot Earthing Conductors	30.0	Metre	40	None on Ellipse
1006	TBTC Earthing System	0.1	Metre	40	Only on Tube Lines
2000	**DC Traction Supply (Electric Track Equipment)**				
2001	DC traction substation feeder cable	0.1	Metre	40	DC traction substation feeder cables will be divided into metal/non metal sheathed; smoky/non-smoky; Section 12/not. Within these categorisations all cables will be grouped
2002	DC continuity traction cable or conductor rail bond	0.1	Metre	40	These assets are not individually recorded within Ellipse and so will be grouped
2003	Emergency gap Jumper cables and boxes	2.0	Unit	40	These will be grouped due to their imminent design change and replacement
2004	Manually Operated Exposed Copperwork Main Line TIS	1.0	Pair	40	These will be grouped due to their constant upgrade through annual maintenance
2005	Manually Operated off-load tunnel TIS	15.0	Pair	40	New assets; residual life known
2006	Remotely Operated off-load Tunnel TIS	20.0	Pair	40	New assets; residual life known
2007	Manually Operated Exposed Copperwork Depot TIS	1.0	Pair	40	These will be grouped due to their constant upgrade through annual maintenance
2008	Manually Operated on-load Depot TIS	20 .0	Pair	40	New assets; residual life known
2009	Remotely Operated on-load Depot TIS	25.0	Pair	40	New assets; residual life known
2010	Manually Operated on-load Depot Changeover TIS	30 .0	Pair	40	New assets; residual life known
2011	Remotely Operated on-load Depot Changeover TIS	35.0	Pair	40	New assets; residual life known

Power Performance – MAINTENANCE

2012	DC Siding circuit breakers	30.0	Unit	40	These will be grouped as all are in similar locations and condition
2013	DC Siding contactors	30.0	Unit	40	These will be grouped as all are in similar locations and condition
2014	Disconnection panels	1.0	Unit	40	These will be grouped as all are very basic in design and similar condition
2015	Mini bleed resistor	1.0	Unit	20	These will be grouped as all are in similar locations and condition
2016	Depot Bleed resistor	1.0	Unit	20	These will be grouped as all are in similar locations and condition
2017	Train Entering Terminal Station devices (TETs)	1.0	Unit	40	Only on Tube Lines
3000	**Non Traction DC Supply**				
3001	DC non-traction cables	0.026	Metre	40	Non-traction main cables will be divided into metal/non metal sheathed; smoky/non-smoky; Section12/not. Within these categorisations all cables will be grouped
3002	DC non-traction switch	0.5	Unit	40	These will be grouped as all are in similar locations and condition
3003	DC non-traction changeover contactor	5.0	Unit	40	There is only one at Piccadilly so not applicable
4000	**LVAC Supply**				
4001	LVAC cable mains	0.026	Metre	40	LVAC main cables will be divided into metal/non metal sheathed; smoky/non-smoky; Section12/not. Within these categorisations all cables will be grouped
4002	LVAC trunk/main switch	0.5	Unit	40	These will be grouped as we have no data that would suggest that any will have a residual life of less than 15 years
4004	LVAC Voltage stabiliser systems	100.0	Each	7	Only on Tube Lines
5000	**Depot Shed**				
5001	Main Depot DC circuit Breakers (including protection)	30.0	Unit	40	Installation dates known
5002	DC link boxes (with MCCB)	3.0	Unit	30	Installation dates known
5003	DC Shore Supply Pedestals system	18.0	Unit	30	Installation dates known
5005	Contactor Panels System	18.0	Road	30	Installation dates known

Power Performance – MAINTENANCE	UNDERGROUND

5006	BCV and Tube Lines Trolleys	10.0	Unit	30	Installation dates known
5007	SSL Smart Switchable Trolleys	5.0	Unit	30	Installation dates known
5008	W&C Festoon	30.0	Unit	30	Installation dates known
5009	Overhead System Control Panels	4.0	Shed	30	Installation dates known
5010	Shed Board Isolators	18.0	Shed	30	Installation dates known
5011	Mimic Panel	30.0	Panel	30	Installation dates known
5012	Depot Shed Power UPS (supporting the shore supply system)	5.0	Unit	20	Installation dates known
5013	Emergency trip system	1.0	Shed	30	Installation dates known
5014	Overhead Status Indicators	12.0	Shed	30	Installation dates known
5015	Shore supply fused contactor (Northern Line)	1.0	Unit	30	Only on Tube Lines
5016	Depot overhead busbars and feeder cables	5.0	Road	40	Installation dates known

Power Performance – MAINTENANCE	UNDERGROUND

POWER ACR RE-LIFING; ASSET SCORING RATIONALE

1.0 Background

The new Asset Condition Reporting (ACR) Standard 5-042 requires that all assets are assessed to establish their Residual Life, if it is not known. Within the ACR Manual of Good Practice Residual Life is described as 'The remaining life of an asset at the reporting date, in terms of the estimated time required before the next intervention, taking into account physical degradation to date, agreed changes to the maintenance regime, obsolescence and any other relevant factors'. Most Power assets installed on the railway in the last fifteen years have installation dates recorded within Ellipse. These dates, together with the Nominal Life of each asset type as recorded in Attachment 11 to Standard 5-042, are used to calculate the asset Residual Life. Where the Residual Life of an asset is not known a re-lifting exercise must be undertaken to provide a calculated Residual Life which will then be used to update Ellipse. The re-lifting of assets can in certain circumstances be undertaken in groups and this is detailed within the Power ACR Re-lifting Exercise; Grouping Rationale document.

2.0 Rationale for Scoring

The Power re-lifting matrix assesses assets under the headings of Reliability, Condition, Environment, Obsolescence, Design, Maintenance and Stressing. Each asset, or asset group, under each of these headings is scored and the total score determines the length of Residual Life given to the asset; a low score resulting in high Residual Life. The longest Residual Life this process can give an asset is fifteen years, that is the minimum life for Category A assets (ten years) plus five years. When the re-lifting process is used to assess if an asset should move from a Category A to B because it's Residual Life has reduced to ten years the greatest extension the re-lifting process can ascribe to an asset is five years.

In an attempt to reduce 'Engineering Judgment' to a minimum, the scoring of each asset type within each assessment category has been specified using unambiguous, quantitative criteria. This means that the re-lifting process, for Power assets, is both methodical and accurately repeatable. The rationale for each assessment category is detailed below:
Note, a zero score is in all cases good or acceptable, a score of one or more will contribute to a less than optimal Residual Life or re-life. Some categories score higher than others due to their relative impact upon the asset's long term life expectancy.

Reliability

0 = one or no failures in the past year.
1 = more than one failure in the past year.

Condition

For assets which are subject to annual testing:
0 = met test MAC as described within the relevant Standard or maintenance return document.
1 = failed to meet the test MAC.
For assets which are not subject to annual testing:
0 = no condition concerns identified at or since last maintenance visit.
1 = a condition concern has been identified and documented.
Continuity cables are defaulted to 0 as they are changed upon routine inspection maintenance if their condition deteriorates unacceptably.

Environment

0 = a Section 12 location for all cables and exposed copperwork switches
1 = a non-Section 12 location for all cables and exposed copperwork switches
All externally located assets which are not housed in IP rated enclosures are defaulted to 1

Power Performance – MAINTENANCE	UNDERGROUND

For all assets housed within IP rated enclosures
0 = no environmental concerns identified at or since last maintenance visit.
1 = an environmental concern has been identified and documented.

Obsolescence

0 = the asset is not obsolete.
3 = the asset is obsolete.

Design

0 = there is no known design deficiency.
1 = there is a known design deficiency.

Maintenance

0 = the asset is not subject to an extraordinary maintenance regime as documented within the Power Maintenance Regime.
2 = the asset is subject to an extraordinary maintenance regime.

Stressing

0 = the asset is not operating above its design capability.
2 = the asset is known and documented to be operating above its design capability.

3.0 Scoring Output

The asset scoring rationale, detailed within the following ACR Re-lifting Scoring Rationale table, is output in the re-lifting matrix which is built into the ACR 'Detail' worksheet which is one of the formal ACR deliverable documents.

ACR RE-LIFING SCORING RATIONALE

ACR Numbers	ACR Asset Groups	Reliability	Condition	Environment	Obsolescence	Design	Maintenance	Stressing
		Failure rate over past year - Acceptable 0 / Unacceptable 1	Inspection results Good 0 / Bad 1	Is the environment in which this asset is operating Good 0 / Bad 1	Are spares available for this asset Yes 0 / No 3	Good 0 / Poor 1	Is asset subject to standard maintenance Yes 0 / No 2	Asset is stressed Yes 1 / No 0
2001	**DC traction substation feeder cable**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = Section 12 location	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2002	**DC continuity traction cable or conductor rail bond**	Acceptable ≤ 1 failure per asset	Default to 0 as any continuity cable or bond found to be in poor condition would be replaced through routine maintenance	Good = Section 12 location	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2003	**Emergency gap Jumper cables and boxes**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Default to 1 as all are in external locations within enclosures which are not IP rated	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2004	**Manually Operated Exposed Copperwork Main Line TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = Section 12 location	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2005	**Manually Operated off-load tunnel TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity

2006	**Remotely Operated off-load Tunnel TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2007	**Manually Operated Exposed Copperwork Depot TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Default to 1 as all are in external locations within enclosures which are not IP rated	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2008	**Manually Operated on-load Depot TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2009	**Remotely Operated on-load Depot TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2010	**Manually Operated on-load Depot Changeover TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2011	**Remotely Operated on-load Depot Changeover TIS**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2012	**DC Siding circuit breakers**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity

2013	**DC Siding contactors**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Default to 1 as all are in external locations within enclosures which are not IP rated	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2014	**Disconnection panels**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Default to 1 as all are in external locations within enclosures which are not IP rated	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2015	**Mini bleed resistor**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Default to 1 as all are in external locations within enclosures which are not IP rated	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2016	**Depot Bleed resistor**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Default to 1 as all are in external locations within enclosures which are not IP rated	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
2017	**Train Entering Terminal Station devices (TETs)**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3001	**DC non-traction cables**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = Section 12 location	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
3002	**DC non-traction switch**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity

3003	**DC non-traction changeover contactor**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
4001	**LVAC cable mains**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = Section 12 location	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
4002	**LVAC trunk/main switch**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
4003	**Uninterruptible Power Supply Units**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
4004	**LVAC Voltage stabiliser systems**	Tube Lines only	Tube Lines only	Tube Lines only	Tube Lines only	Tube Lines only	Tube Lines only	Tube Lines only
5001	**Main Depot DC circuit Breakers (including protection)**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5002	**DC link boxes (with MCCB)**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity

5003	**DC Shore Supply Pedestals system**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5004	**DC Shore Supply Wall Units**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5005	**Overhead Road Contactor Panels System**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5006	**BCV and Tube Lines Trolleys**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5007	**SSL Smart Switchable Trolleys**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5008	**W&C Overhead Festoon**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5009	**Overhead System Control Panels**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity

5010	**Shed Board Isolators**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5011	**Mimic Panel**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5012	**Depot Shed Power UPS**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5013	**Emergency trip system**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5014	**Overhead Status Indicators**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
5015	**Shore supply fused contactor (Northern Line)**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5016	**Depot overhead busbars and feeder cables**	Acceptable ≤ 1 failure per asset	Good = met relevant testing MAC or MACs	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity

1001	**Permanent Current Rail Indicator Device (P-CRID)**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1002	**Traction Earth Detection System**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
1003	**Earth Electrodes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1004	**HEX Earth Monitoring system**	Acceptable ≤ 1 failure per asset	Good = no identified condition concerns identified at or since last maintenance visit	Good = no environmental concerns identified at or since last maintenance visit	Yes = Spares Available	Good = No known design issues	No = any increase to the standard maintenance (Maintenance Regime Document)	Yes = Asset operating over its design capacity
1005	**Main Depot Earthing Conductors**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1006	**TBTC Earthing System**	N/A	N/A	N/A	N/A	N/A	N/A	N/A

11.1.1 Basis of Condition Reporting for Power Non PFI

ACR No.	FD* No.	Asset Description	RAV (k)	Unit	Nominal Life	Source of Nominal Life
1000	**300**	**Electrical Protection**				
1001	309	Permanent Current Rail Indicator Device (P-CRID)	5.0	unit	7	Manufacturers Recommendations
1002	516	Traction Earth Detection System	18.0	Section	25	Mercury Design Recommendations
1003	401	Earth Electrodes	18.0	Farm	40	Standard 1-106 Earthing and Bonding of LU Electrical Networks
1004	402	HEX Earth Monitoring system	1.0	System	tbc	
1005	n/a	Main Depot Earthing Conductors	30.0	metre	40	Standard 1-109 Switchgear and Ancillary Equipment
1006	n/a	TBTC Earthing System	0.1	metre	40	Standard 1-106 Earthing and Bonding of LU Electrical Networks
2000	**510**	**DC Traction Supply (Electric Track Equipment)**				
2001	554	DC traction substation feeder cable	0.1	Metre	40	Standard 1-108 DC Traction Feeder Cables
2002	n/a	DC continuity traction cable or conductor rail bond	0.1	Metre	40	Standard 1-108 DC Traction Feeder Cables
2003	517	Emergency gap Jumper cables and boxes	2.0	Unit	40	Standard 1-108 DC Traction Feeder Cables
2004	514 a.)	Manually Operated Exposed Copperwork Main Line TIS	1.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2005	514 b.)	Manually Operated off-load tunnel TIS	15.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2006	514 c.)	Remotely Operated off-load Tunnel TIS	20.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2007	903 a.)	Manually Operated Exposed Copperwork Depot TIS	1.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2008	903 b.)	Manually Operated on-load Depot TIS	20.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2009	903 c.)	Remotely Operated on-load Depot TIS	25.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2010	903 d.)	Manually Operated on-load Depot Changeover TIS	30.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2011	903 e.)	Remotely Operated on-load Depot Changeover TIS	35.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2012	512	DC Siding circuit breakers	30.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2013	513	DC Siding contactors	30.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
2014	511	Disconnection panels	1.0	Unit	40	Standard 1-108 DC Traction Feeder Cables
2015	515	Mini bleed resistor	1.0	Unit	20	Manufacturers Recommendations
2016	515	Depot Bleed resistor	1.0	Unit	20	Manufacturers Recommendations
2017	n/a	Train Entering Terminal Station devices (TETs)	1.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
3000	**530**	**Non Traction DC Supply**				
3001	555	DC non-traction cables	0.026	Metre	40	Standard 1-108 DC Traction Feeder Cables
3002	533	DC non-traction switch	0.5	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
3003	n/a	DC non-traction changeover contactor	5.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
4000	**540**	**LVAC Supply**				
4001	556	LVAC cable mains	0.026	Metre	40	Standard 1-108 DC Traction Feeder Cables
4002	543	LVAC trunk/main switch	0.5	unit	40	Standard 1-109 Switchgear and Ancillary Equipment
4003		LVAC circuit breaker	20.0	unit	40	
4004	545/546	LVAC Voltage stabiliser systems	100.0	Installation	7	Manufacturers Recommendations
5000	**900**	**Depot Shed**				
5001	901	Main Depot DC circuit Breakers (including protection)	30.0	Unit	40	Standard 1-109 Switchgear and Ancillary Equipment
5002	951	DC link boxes (with MCCB)	3.0	Unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5003	955	DC Shore Supply Pedestals system	18.0	Unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5004	954	DC Shore Supply Wall Units	16.0	Unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5005	957	Contactor Panels System	18.0	road	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5006	952 a.)	BCV Overhead Switchable Trolleys	10.0	Unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5007	952 b.)	SSL and Tube Lines Smart Switchable Trolleys	5.0	Unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5008	952 c.)	W&C Festoon	30.0	Unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5009		Northern Line Drop Leads	1.0	Unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5010	958	Overhead System Control Panels	4.0	Shed	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5011	959	Shed Board Isolators	18.0	Shed	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5012	960	Mimic Panel	30.0	Panel	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5013	961	Depot Shed Power UPS (supporting the shore supply system)	5.0	Unit	7-10 for batteries. 20 for rest	Manufacturers Recommendations
5014	953	Emergency trip system	1.0	Shed	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5015	956	Overhead Status Indicators	12.0	Shed	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5016	n/a	Shore supply fused contactor (Northern Line)	1.0	unit	30	RSE-ST-01902 “Shed traction supply to trains in depots”. Clause 9.1
5017	n/a	Depot overhead busbars and feeder cables	5.0	Road	40	Manufacturers Recommendations

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

11.1.2 Asset Definition: Power

ACR No.	FD No.	Definition Groups	Comment
4003	580	UPS	UPSs have moved from Power to E&M as agreed between Heads of Profession Jan 2010

11.1.3 Reporting Requirements for Power Non PFI

11.1.3.1 Power Non PFI ACR - all Lines

			Power Non PFI – all Lines							
			Physical Condition				Functional Condition			
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			%RAV	%RAV	%RAV	%RAV	Statutory non compliant %RAV	Residual safety risk %RAV	uneconomic/ unsustainable %RAV	Risk of Performance Loss %RAV
ACR No.	FD* No.	Asset Description					Quantity	£ Risk	£ Risk	£ Risk
1000	300	Electrical Protection								
1001	309	Permanent Current Rail Indicator Device (P-CRID)								
1002	516	Traction Earth Detection System								
1003	401	Earth Electrodes								
1004	402	HEX Earth Monitoring system								
1005	n/a	Main Depot Earthing Conductors								
1006	n/a	TBTC Earthing System								
2000	510	DC Traction Supply (Electric Track Equipment)								
2001	554	DC traction substation feeder cable								
2002	n/a	DC continuity traction cable or conductor rail bond								
2003	517	Emergency gap Jumper cables and boxes								
2004	514 a.)	Manually Operated Exposed Copperwork Main Line TIS								
2005	514 b.)	Manually Operated off-load tunnel TIS								
2006	514 c.)	Remotely Operated off-load Tunnel TIS								
2007	903 a.)	Manually Operated Exposed Copperwork Depot TIS								
2008	903 b.)	Manually Operated on-load Depot TIS								
2009	903 c.)	Remotely Operated on-load Depot TIS								
2010	903 d.)	Manually Operated on-load Depot Changeover TIS								
2011	903 e.)	Remotely Operated on-load Depot Changeover TIS								
2012	512	DC Siding circuit breakers								
2013	513	DC Siding contactors								
2014	511	Disconnection panels								
2015	515	Mini bleed resistor								
2016	515	Depot Bleed resistor								
2017	n/a	Train Entering Terminal Station devices (TETs)								
3000	530	Non Traction DC Supply								
3001	555	DC non-traction cables								
3002	533	DC non-traction switch								
3003	n/a	DC non-traction changeover contactor								
4000	540	LVAC Supply								
4001	556	LVAC cable mains								
4002	543	LVAC trunk/main switch								
4003	n/a	LVAC circuit breaker								
4004	545/546	LVAC Voltage stabiliser systems								
5000	900	Depot Shed								
5001	901	Main Depot DC circuit Breakers (including protection)								
5002	951	DC link boxes (with MCCB)								
5003	955	DC Shore Supply Pedestals system								
5004	954	DC Shore Supply Wall Units								
5005	957	Contactor Panels System								
5006	952 a.)	BCV Overhead Switchable Trolleys								
5007	952 b.)	SSL and Tube Lines Smart Switchable Trolleys								
5008	952 c.)	W&C Festoon								
5009	n/a	Northern Line Drop Leads								
5010	958	Overhead System Control Panels								
5011	959	Shed Board Isolators								
5012	960	Mimic Panel								
5013	961	Depot Shed Power UPS (supporting the shore supply								
5014	953	Emergency trip system								
5015	956	Overhead Status Indicators								
5016	n/a	Shore supply fused contactor (Northern Line)								
5017	n/a	Depot overhead busbars and feeder cables								
Power Non PFI										
Previous										
Actual										
Variance										

11.1.3.2 Power Non PFI ACR - by Line

ACR No.	FD* No.	Asset Description	Physical Condition				Functional Condition			
			Power Non PFI – Summary Report for xxx Line							
			Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
			%RAV	%RAV	%RAV	%RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance
							%RAV	%RAV	%RAV	%RAV
							Quantity	£ Risk	£ Risk	£ Risk
1000	300	Electrical Protection								
1001	309	Permanent Current Rail Indicator Device (P-CRID)								
1002	516	Traction Earth Detection System								
1003	401	Earth Electrodes								
1004	402	HEX Earth Monitoring system								
1005	n/a	Main Depot Earthing Conductors								
1006	n/a	TBTC Earthing System								
2000	510	DC Traction Supply (Electric Track Equipment)								
2001	554	DC traction substation feeder cable								
2002	n/a	DC continuity traction cable or conductor rail bond								
2003	517	Emergency gap Jumper cables and boxes								
2004	514 a.)	Manually Operated Exposed Copperwork Main Line TIS								
2005	514 b.)	Manually Operated off-load tunnel TIS								
2006	514 c.)	Remotely Operated off-load Tunnel TIS								
2007	903 a.)	Manually Operated Exposed Copperwork Depot TIS								
2008	903 b.)	Manually Operated on-load Depot TIS								
2009	903 c.)	Remotely Operated on-load Depot TIS								
2010	903 d.)	Manually Operated on-load Depot Changeover TIS								
2011	903 e.)	Remotely Operated on-load Depot Changeover TIS								
2012	512	DC Siding circuit breakers								
2013	513	DC Siding contactors								
2014	511	Disconnection panels								
2015	515	Mini bleed resistor								
2016	515	Depot Bleed resistor								
2017	n/a	Train Entering Terminal Station devices (TETs)								
3000	530	Non Traction DC Supply								
3001	555	DC non-traction cables								
3002	533	DC non-traction switch								
3003	n/a	DC non-traction changeover contactor								
4000	540	LVAC Supply								
4001	556	LVAC cable mains								
4002	543	LVAC trunk/main switch								
4003	n/a	LVAC circuit breaker								
4004	545/546	LVAC Voltage stabiliser systems								
5000	900	Depot Shed								
5001	901	Main Depot DC circuit Breakers (including protection)								
5002	951	DC link boxes (with MCCB)								
5003	955	DC Shore Supply Pedestals system								
5004	954	DC Shore Supply Wall Units								
5005	957	Contactor Panels System								
5006	952 a.)	BCV Overhead Switchable Trolleys								
5007	952 b.)	SSL and Tube Lines Smart Switchable Trolleys								
5008	952 c.)	W&C Festoon								
5009	n/a	Northern Line Drop Leads								
5010	958	Overhead System Control Panels								
5011	959	Shed Board Isolators								
5012	960	Mimic Panel								
5013	961	Depot Shed Power UPS (supporting the shore supply system)								
5014	953	Emergency trip system								
5015	956	Overhead Status Indicators								
5016	n/a	Shore supply fused contactor (Northern Line)								
5017	n/a	Depot overhead busbars and feeder cables								
Power Non PFI										
Previous										
Actual										
Variance										

11.1.6 Residual Life Model

	Reliability	Condition	Environment	Obsolescence	Design	Maintenance	Stressing	Total	Physical condition
	Failure rate over past year - Acceptable / Unacceptable	Inspection results - Good / Bad	Is the environemt in which this asset is operating Good / Bad	Are spares available for this asset Yes / No	Good/ Bad	Is asset subject to standard maintance - Yes / No	Asset is stressed Yes / No		
Min	0	0	0	0	0	0	0		
Max	1	1	1	3	1	2	1	**10.00**	
DC traction substation feeder cable								**0.00**	**A**
DC continuity traction cable or conductor rail bond								**0.00**	**A**
Emergency gap Jumper cables and boxes								**0.00**	**A**
Manually Operated Exposed Copperwork Main Line TIS								**0.00**	**A**
Manually Operated off-load tunnel TIS								**0.00**	**A**
Remotely Operated off-load Tunnel TIS								**0.00**	**A**
Manually Operated Exposed Copperwork Depot TIS								**0.00**	**A**
Manually Operated on-load Depot TIS								**0.00**	**A**
Remotely Operated on-load Depot TIS								**0.00**	**A**
Manually Operated on-load Depot Changeover TIS								**0.00**	**A**
Remotely Operated on-load Depot Changeover TIS								**0.00**	**A**
DC Siding circuit breakers								**0.00**	**A**
DC Siding contactors								**0.00**	**A**
Disconnection panels								**0.00**	**A**
Mini bleed resistor								**0.00**	**A**
Depot Bleed resistor								**0.00**	**A**
Train Entering Terminal Station devices (TETs)								**0.00**	**A**
DC non-traction cables								**0.00**	**A**
DC non-traction switch								**0.00**	**A**
DC non-traction changeover contactor								**0.00**	**A**
LVAC cable mains								**0.00**	**A**
LVAC trunk/main switch								**0.00**	**A**
Uninterruptible Power Supply Units								**0.00**	**A**
LVAC Voltage stabiliser systems								**0.00**	**A**
Main Depot DC circuit Breakers (including protection)								**0.00**	**A**
DC link boxes (with MCCB)								**0.00**	**A**
DC Shore Supply Pedestals system								**0.00**	**A**
DC Shore Supply Wall Units								**0.00**	**A**
Contactor Panels System								**0.00**	**A**
BCV and Tube Lines Trolleys								**0.00**	**A**
SSL Smart Switchable Trolleys								**0.00**	**A**
W&C Festoon								**0.00**	**A**
Overhead System Control Panels								**0.00**	**A**
Shed Board Isolators								**0.00**	**A**
Mimic Panel								**0.00**	**A**
Depot Shed Power UPS								**0.00**	**A**
Emergency trip system								**0.00**	**A**
Overhead Status Indicators								**0.00**	**A**
Shore supply fused contactor (Northern Line)								**0.00**	**A**
Depot overhead busbars and feeder cables								**0.00**	**A**
Permanent Current Rail Indicator Device (P-CRID)								**0.00**	**A**
Traction Earth Detection System								**0.00**	**A**
Earth Electrodes								**0.00**	**A**
HEX Earth Monitoring system								**0.00**	**A**
Main Depot Earthing Conductors								**0.00**	**A**
TBTC Earthing System								**0.00**	**A**

11.1.6.1 Residual Life Model Assumptions

Process	The residual life assessment is to be undertaken where assets: a) are within 10 years of their nominal life expiry including those that are life-expired b) do not have a known installation date and therefore remaining nominal life is unknown c) have previously been assessed using the model and have reached the time limit for next assessment as per the lookup table in the Residual life model
Responsibilities	The maintenance engineer completing the ACR assessment is reponsible for undertaking the assessment The assessment shall be reviewed and signed off by the Head of Profession
Residual Life factors	Each factor within the model is deemed to impact the residual life of the asset. A score is given for each factor, with a score of 0 being positive and 1,2 or 3 being negative Factors which have a greater impact on residual life are weighted accordingly through the scoring mechanism
Reliability	Whether or not the number of failures in the past year is acceptable, is dependant upon the asset itself. It is not practical to define the parameters of accepability for every non-PFI power asset and this element is therefore scored based on engineering judgement
Condition	Condition scores are derived from the inspetion results (which uses a Minimum Acceptable Condition scale)
Environment	Whether or not an asset's environment is positive or negative for its operation is dependent upon the asset itself
Obsolescence	Obsolescence is given a greater weighting than the majority of the other factors because if an asset becomes obsolete this will have a greater impact on the residual life
Design	Some design features are preferable over others eg the material of the sheath of a cable.
Maintenance	If an asset is subject to maintenance over and above that prescribed in a Standard, then this should be recorded as a Code 3 concern in ACR.

S1042 Asset Condition Reporting (ACR)

Transplant (Non-Passenger Rolling Stock)

9.1.1 Basis of Condition Reporting for Non Passenger Rolling Stock (Transplant)

ACR No.	FD No.	Asset Description	RAV (k)	quantity as at	Nominal Life	Source of Nominal Life	Comments
	3010	Battery Locomotives	2.00	29	35	Professional judgement	
	3020	Pilot Motor Cars	1.25	0	35	Professional judgement	
	3030	Weedkilling Train	2.50	2	30	Professional judgement	
	3040	Tunnel Cleaning Train	1.20	5	30	Professional judgement	
	3050	Tamping Machines	2.00	3	25	Professional judgement	
	3060	Track Recording Vehicle	3.00	1	35	Professional judgement	
	3070	Flat Wagons	0.800 (rounded)	18	40	Professional judgement	
	3080	Hopper Wagons	0.08	50	40	Professional judgement	
	3090	Spoil & Ballast Wagons	0.08	60	40	Professional judgement	
	3100	Rail Wagons	0.080 (rounded)	28	40	Professional judgement	
	3110	Long Welded Rail Train Wagons	0.080 (rounded)	6	40	Professional judgement	
	3120	Winch Wagons	0.10	0	40	Professional judgement	
	3140	7.5 tonne Cranes (self-propelled)	1.00	6	35	Professional judgement	
	3150	10 tonne Twin Jib Track Laying Machines (self-propelled)	2.00	2	35	Professional judgement	
	3160	General Purpose Wagons	0.080 (rounded)	41	40	Professional judgement	
	3170	Cement Mixer/Match Wagons	0.080 (rounded)	12	40	Professional judgement	
	3180	Cable Drum Wagons	0.070 (rounded)	7	40	Professional judgement	
	3190	Schoma Diesel Locomotives (ex JLE)	0.700 (rounded)	14	35	Professional judgement	
	3200	Well Wagons (ex JLE)	0.08	4	40	Professional judgement	
	3210	High Deck Wagons	0.08	6	40	Professional judgement	
	3220	Road/Rail Vehicles (e.g. Unimogs etc.)	0.25	2	20	Professional judgement	

* FD No. To provide cross reference to ACAC Foundation document reference numbering
N/A not applicable

9.1.3 Reporting Requirements for Non Passenger Rolling Stock (Transplant)

9.1.3.1 Non Passenger Rolling Stock (Transplant) ACR - all Lines

Non Passenger Rolling Stock (Transplant) – all Lines

		Actuals:		Physical Condition				Functional Condition			
				Code A	Code B	Code C	Code D	Code 1	Code 2	Code 3	Code 4
				% RAV	% RAV	% RAV	% RAV	Statutory non compliant	Residual safety risk	uneconomic/ unsustainable	Risk of Performance Loss
ACR No.	FD No.							Quantity	£ Risk	£ Risk	£ Risk
	3010	Battery Locomotives									
	3020	Pilot Motor Cars									
	3030	Weedkilling Train									
	3040	Tunnel Cleaning Train									
	3050	Tamping Machines									
	3060	Track Recording Vehicle									
	3070	Flat Wagons									
	3080	Hopper Wagons									
	3090	Spoil & Ballast Wagons									
	3100	Rail Wagons									
	3110	Long Welded Rail Train Wagons									
	3120	Winch Wagons									
	3140	7.5 tonne Cranes (self-propelled)									
	3150	10 tonne Twin Jib Track Laying Machines (self-propelled)									
	3160	General Purpose Wagons									
	3170	Cement Mixer/Match Wagons									
	3180	Cable Drum Wagons									
	3190	Schoma Diesel Locomotives (ex JLE)									
	3200	Well Wagons (ex JLE)									
	3210	High Deck Wagons									
	3220	Road/Rail Vehicles (e.g. Unimogs etc.)									

9.1.3 Reporting Requirements for Non Passenger Rolling Stock (Transplant)

9.1.3.2 Non Passenger Rolling Stock (Transplant) ACR - by Line

		Non Passenger Rolling Stock (Transplant) – Summary Report for xxx Line								
		Actuals:	**Physical**				**Functional**			
			Code A	**Code B**	**Code C**	**Code D**	**Code 1**	**Code 2**	**Code 3**	**Code 4**
			% RAV	**% RAV**	**% RAV**	**% RAV**	**Statutory non compliant**	**Residual safety risk**	**uneconomic/ unsustainable**	**Risk of Performance Loss**
ACR No.	**FD No.**						**Quantity**	**£ Risk**	**£ Risk**	**£ Risk**
	3010	Battery Locomotives								
	3020	Pilot Motor Cars								
	3030	Weedkilling Train								
	3040	Tunnel Cleaning Train								
	3050	Tamping Machines								
	3060	Track Recording Vehicle								
	3070	Flat Wagons								
	3080	Hopper Wagons								
	3090	Spoil & Ballast Wagons								
	3100	Rail Wagons								
	3110	Long Welded Rail Train Wagons								
	3120	Winch Wagons								
	3140	7.5 tonne Cranes (self-propelled)								
	3150	10 tonne Twin Jib Track Laying Machines (self-propelled)								
	3160	General Purpose Wagons								
	3170	Cement Mixer/Match Wagons								
	3180	Cable Drum Wagons								
	3190	Schoma Diesel Locomotives (ex JLE)								
	3200	Well Wagons (ex JLE)								
	3210	High Deck Wagons								
	3220	Road/Rail Vehicles (e.g. Unimogs etc.)								
		Fire								
		Previous								
		Actual								
		Variance								
		Commentary on Variances:								
		A brief explanation of any significant variances of previous vs. current condition states and of any resultant backlog and including details of obsolescence. List assets of unknown condition >								
		The Nominee Company shall complete and submit one of these summary reports for each of the lines for which it is responsible.								

Transport for London

London Underground

Written Notice	LU Ref. No.: LU-WN-01313
	Suppliers Ref. No.:

1	**Written Notice Completed By**	
	Person Accountable	Richard Moore
	Directorate	CPD
	Date Issued	18/12/2014
2	**Details of the standard Requiring Clarification**	
	Title:	Asset Condition Reporting (ACR)
	Standard Reference No.	S1042
	Issue No.	A11
	Clause/Paragraph No.:	Various
3	**Details of Definitive LU Interpretation of Requirements**	
	Title of Written Notice	Group Station Manager change to Area Manager
	Due to a title change as a result of Fit For the Future - Stations, from 11th January 2015, wherever the term ‘Group Station Manager’ / GSM is used; it should be taken to read, ‘Area Manager’.	

Transport for London

London Underground

Guidance Document

G042 Asset Condition Reporting (ACR)

		Issue date:	July 2015
Issue No.	A4	**Review date:**	July 2020

MAYOR OF LONDON

Contents

1 Purpose

1.1 The purpose of this Guidance Document is to:

a) Explain the principles of Asset Condition Reporting (ACR);
b) Provide instructions and guidelines to support the accurate and timely production, submission and review of the annual Asset Condition Report and Asset Safety and Management Certificates in compliance with Category 1 ACR Standard S1042.

2 Scope

2.1 The Standard applies to engineering Assets listed in the Attachments to the ACR Standard, S1042.

2.2 The scope of reporting is limited to:

a) Residual Life of the Asset base;
b) Failures to meet Required Duty that result in Functional Condition Concerns:
   - Statutory non-compliance; and/or
   - Safety risks that may result in customer or staff fatalities and/or injuries, which require either control or mitigation to achieve risk levels of ALARP or better; and/or
   - Extraordinary maintenance and/or operational activities, outside of the maintenance regime, which are uneconomic and/or unsustainable; and/or
   - Performance Risks of £250k or more per year;
c) Degradation Concerns.

2.3 The scope of reporting includes software and firmware, but excludes:

a) Information and documentation used to support management of a physical Asset;
b) Any aspect of failure to meet Required Duty that does not result in any of the business impacts covered by 2.2 above (i.e. transient defects).

Notes
Any exceptions to 2.3 are explicitly listed in the Attachments to the Standard.

For simplicity the term “engineering Asset” is shortened to “Asset” within the Standard and accompanying Guidance Document. Similarly the term "Asset" shall be interpreted to include "Asset systems", "Asset sub-systems" or "part of an Asset" as appropriate.

3. Guidance

3.1 Overview

3.1.1 Physical and Functional condition are assessed separately through ACR and categorised as follows:

a) Residual Life is reported for 100% of the Asset base using Physical Condition Codes (A-D) and any specific Degradation Concerns are also recorded.
b) Functional Condition Concerns (1-4) are used to report Assets with a residual risk that is a direct result of the physical condition of the Asset.

3.1.2 For ACR Reporting 100% of the total Relative Asset Value (RAV) for each Asset group must be allocated to Physical Condition Codes A-D.

3.1.3 The scope of ACR is limited to non-transient defects; i.e. it excludes defects rectified under the Asset's normal and budgeted maintenance regime or through maintenance deemed economic in comparison to renewal or replacement over the life of the Asset.

3.2 Physical Condition (Residual Life)

3.2.1 The Standard requires Physical Condition to be assessed using Residual Life (Nominal), Residual Life (Measured) or Time To Next Economic Intervention (TTNEI).

3.2.2 **Nominal Lives**

3.2.3 Nominal Lives have been specified for all Assets, where appropriate, in the Attachments to ACR Standard. These represent the Asset's design life, taking account of any duty or environmental considerations, and have been determined in the majority of Asset groups as either: manufacturer's design life; design life prescribed by Standards, good industry practice or engineering professional judgement.

3.2.4 Upon nominal life expiry the Asset must be replaced unless, a), there is justification to re-life it or, b), the business is prepared to accept the risk of the Asset being unable to fulfil its Required Duty ('run to fail'). An Asset can only be re-lifed following a suitable assessment, and with the agreement of the Sponsor/Asset Manager (following consultation with the Head of Technical Discipline). A record must be retained of all instances where an Asset's life has been extended beyond its Nominal Life for audit purposes.

3.2.3 Residual Life (Nominal)

3.2.3.1 Residual Life (Nominal), RL(N), assumes straight line degradation. The nominal life may be stated to reflect the duty and environment that an Asset operates in. RL(N) is therefore calculated as:

RL(N) = (nominal life) – (time in service)

3.2.3.2 This method of measurement requires the date of installation of the Asset to be known and recorded, where this information is available. Where this date is not known, an assessment of its estimated installation date will be made, if possible. Any estimate should be supported by evidence and will only be accepted once approved by the Sponsor/Asset Manager.

3.2.3.3 Example: Electrical Cabling

Nominal life is 35 yrs. If installed in 1978 then in 2010 service life of Asset is 32 yrs hence RL(N) is 35yrs - 32yrs = 3yrs (Code C)

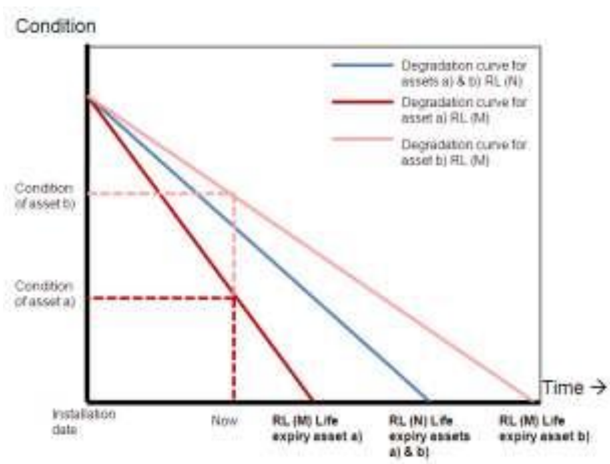
3.2.4 Residual Life (Measured)

3.2.4.1 Where practical approaches to measuring Asset degradation have been developed, and the agreed methods detailed in the Attachments to the Standard, these shall be used to determine the Residual Life (Measured), RL(M).

3.2.4.2 The calculation of RL(M) will ideally be determined using a physical measure that can be correlated with residual life. RL(M) may also take into account other factors, which indicate the amount of remaining residual life. These may include, but are not limited to: obsolescence (see Appendix 1) and reliability.

3.2.4.3 Nominal Lives and installation dates (known or estimated) need to be recorded, where this information is available, alongside the RL(N) and RL(M) in the Detailed Report with the agreement of the Sponsor Asset Manager .

3.2.4.4 The diagram below illustrates the relationship between RL(N) and RL(M). Assets a) and b) both have the same RL(N), but Asset a) is experiencing quicker than expected degradation such that its RL(M) is less than its RL(N). Asset b) is shown to be degrading slower and if the degradation rates remained the same, intervention on Asset a) would be required first



3.2.4.5 Example: Sewage Pump

If Nominal Life 20yrs and installed in 1997, and reported in 2010, the life expired to date would be 2010 – 1997 = 13yrs. Hence RL(N) = 20yrs -13yrs = 7yrs (Code B)
However, a more accurate approach, based upon actual usage, would be:
Nominal life is 15,000 hrs. Pump runs an average of 1.5 hrs per day, 550 hrs per yr.
Hence Nominal Life = 15,000/550 = 27yrs.RL(M) = 27yrs – 13yrs = 14yrs (Code A)

3.2.4.6 Time To Next Economic Intervention (TTNEI)

3.2.4.7 Time To Next Economic Intervention (TTNEI) is used for Assets which are managed to provide a nominally infinite life and for which Residual Life is therefore not meaningful. TTNEI is the interval between interventions required to manage the degradation of an Asset. For simplicity, the term Residual Life will include TTNEI within this Guidance Document, unless otherwise stated.

3.3 Physical Condition Coding

3.3.1 Once the Residual Life is calculated using either RL(M), RL(N) or TTNEI the Asset is assigned to one of four physical codes A, B, C & D:

Code A	• An expected residual life of at least 10 years; or • Where TTNEI is applicable an intervention is not required for at least 10 years.
Code B	• An expected residual life of between five and 10 years; or • Where TTNEI is applicable an intervention is required between five and 10 years.
Code C	• An expected residual life of less than five years; or • Where TTNEI is applicable an intervention in less than five years.
Code D	• Beyond nominal life. Note: An Asset in this category can be reassessed to determine if it has further residual life if the relevant Asset group has an agreed method and approval process in place.

3.3.2 The physical condition codes for each Asset should be recorded at the level defined in the appropriate Attachment.

3.4 Degradation Concerns

3.4.1 Where Asset groups have no Residual Life methodology then Asset degradation will be reported in the Concerns Workbook.

3.4.2 A Degradation Concern should be formatted in the Concern Description of the Concerns Workbook as: <Asset><objective defect with measure and threshold><rationale for revised physical Condition code><source of concern>.

3.5 Functional Condition Concerns

3.5.1 The Concerns Workbook

3.5.1.1 All Functional Condition Codes should be reported and the required details recorded, in the Concerns Workbook.

3.5.1.2 The Concerns Workbook is used to report issues arising as a result of the condition of an Asset. A guide to completing the Functional Condition Concerns worksheet is provided in Appendix 6.4.check reference

3.5.1.3 The Concerns Workbook should be populated by reviewing:

a) The previous year's ACR Concerns;
b) The risk registers prepared in accordance with the requirements of the Asset Risk Standard S5044 (to identify any condition related risks that may have arisen during the past year);
c) Any other appropriate data sources.

3.5.1.4 Where a concern is common to multiple similar assets, in one or more locations, this should be reported on the ASMC as a single concern, with the number of instances stated.

3.5.1.5 Each Concern should be reported in the Concerns Workbook with, optionally, all the line(s) and location(s) with the affected Assets entered in the designated columns. It is preferable to have each location on a separate row so that archiving is made easier. This method will also remove some of the counting anomalies that have been found in the past which affect the calculations further across the row.

3.5.2 Reporting Concerns with two or more Functional Condition Codes

3.5.2.1 The Concerns Workbook allows all applicable Functional Condition Codes to be reported.

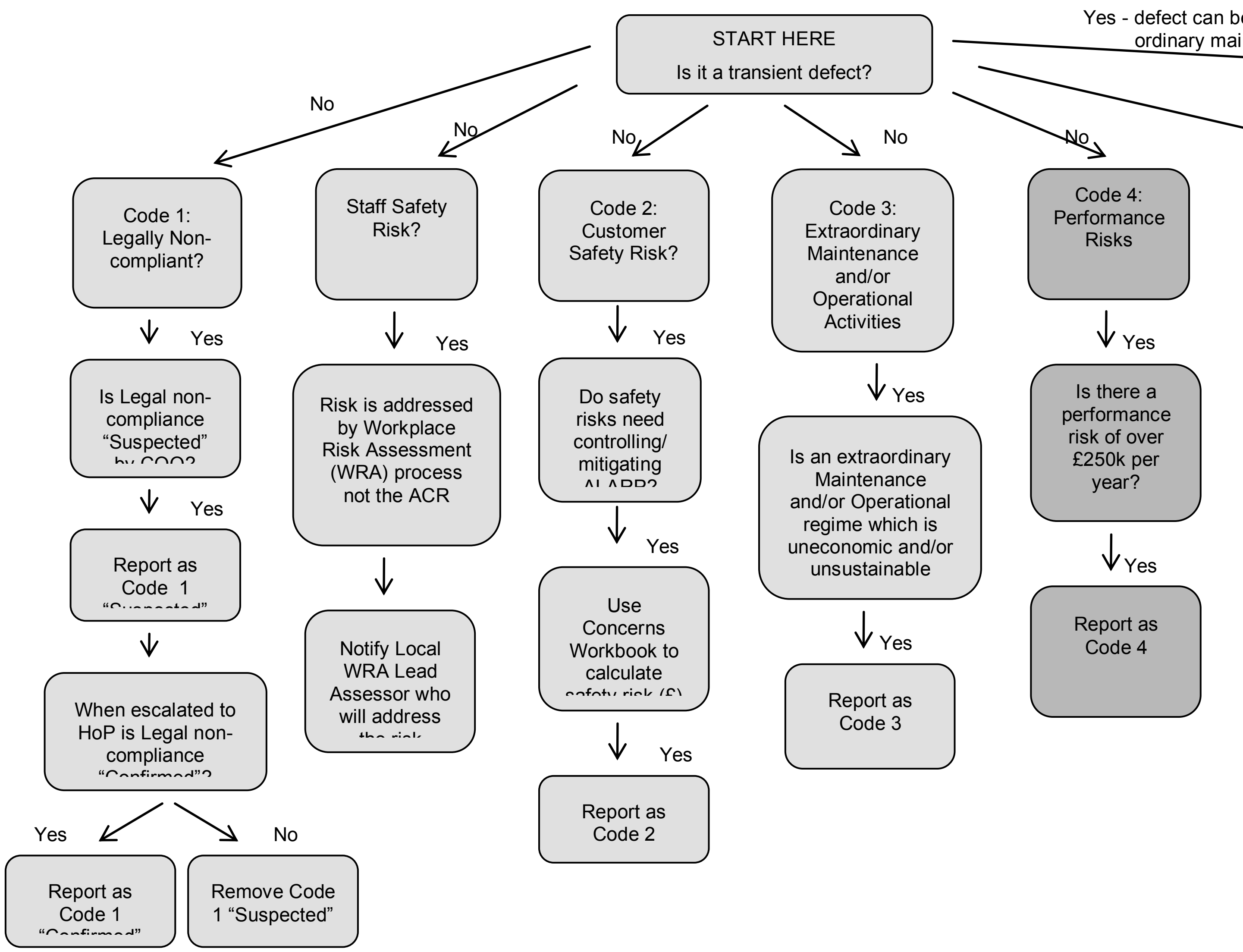
3.5.2.2 In the ‘Concerns Description’ cell all the information required for the applicable Functional Condition Codes must be entered in the required format which is set out in the section on each Functional Condition Code below.

3.5.2.3 Information required for all Functional Condition Concerns - <Asset><objective defect with measure and threshold>...<source of concern> - needs to only be entered once.

3.5.3 Flow Chart: Functional Condition Concerns and Physical Condition Concerns.

Notes

1) All of the Functional Codes and the Degradation Concerns need to be considered separately and all that are reported in the Concerns Workbook or the ACR Detailed Report.
2) If you cannot answer "Yes" move onto the next Concern type.
3) COO/TLL Equivalent are responsible for identifying & reporting Codes 1, 2 & 3 and Degradation Concerns.
4) Client Sponsors/TLL equivalent are responsible for identifying & reporting Code 4 Concerns.



3.5.4 Code 1: Statutory Non-Compliance

3.5.4.1 Code 1 - Condition Concern that states an Asset is statutorily non-compliant.

3.5.4.2 In the Concerns Description cell in the Concerns Workbook a Code 1 Concern should be formatted as: <Asset><objective defect with measure and threshold><how Asset breaches specific part(s) of legislation><reference to action plan proposed / agreed with the enforcing authority><source of concern>

3.5.4.3 The purpose of the Concern description for this Functional Condition Code is to clearly and concisely detail the issue and how it is in breach of particular legislation.

3.5.4.4 Example Code 1: Concern for Rolling Stock

Concern: <Colour of floor in the vestibule (area around the doors) on xxx Stock> has <inadequate contrast with the colour of the floor in the saloon.><Breach of Rail Vehicle Accessibility Regulations 1998; clause 4(i).><Identified by Accessibility Working Group when reviewing Assets against legislation>

3.5.4.5 In the Concerns Workbook the assessor records a ‘Suspected’ Code 1 and then updates this to “Confirmed” or removes the entry depending upon the decision taken by the Head of Technical Discipline.

3.5.4.6 For any confirmed Code 1 Concerns the Head of Technical Discipline shall, act as the principle point of contact for the regulatory authority, lead engagement and notify HSE. If not the principle point of contact then the Head of Technical Discipline shall notify the appropriate team in HSE and work with them to agree a plan for engaging the relevant regulatory authority.

3.5.4.7 If the Concern has customer and/or staff safety implications it also needs to be reported as a Code 2.

3.5.5 Code 2: Safety Risks to Customers and Staff

3.5.5.1 Condition Concern that may cause an event with a potential safety consequence, fatalities and/or injuries, for customers and staff, that requires either control or mitigation to achieve a risk level of ALARP or better by either: Withdrawal of the Asset from full duty; or Risk reduction by either control or mitigation measures not required by the original design of the Asset.

3.5.5.2 In the Concerns Workbook a Code 2 Concern should be formatted as: <Asset><objective defect with measure and threshold><most probable failure mode/behaviour> and the potential <outcome/consequence – Note: number of fatalities and/or injuries will be calculated by the Concerns Workbook using data from the LUQRA models. If the relevant Top Event or Base Event is not quantified in LUQRA then no estimate of the number of potential fatalities and/or injuries should be made><source of concern>

3.5.5.3 The purpose of the Concern description is to clearly and concisely detail the issue with the Asset, the safety related hazard and the potential consequence. Risk described should be the situation post mitigation or post control measures having been implemented.

3.5.5.4 Example Code 2: Concern for Rolling Stock

<Primary load bearing components responsible for whole vehicle support, braking or guidance><suffering fatigue cracks within the critical crack length>. <Structural failure> leading to <derailment/trackside structure strike/uncoupled vehicles with consequential risk of injury or loss of life><Asset Risk Register Reference>

3.5.5.5 The risk is quantified in financial terms in the Concerns Workbook using data from the LUQRA models.

3.5.6 Quantifying Safety Risks for Code 2

3.5.6.1 Assessors are required to quantify the annual risk in financial terms for Code 2 concerns reported in the ACR.

3.5.6.2 To enable assessors to complete this task the Concerns Workbook was developed to include safety consequence and probability data from the LUQRA models managed by HSE. Details on completing the Concerns Workbook, including this section, are available in Appendix 4, and descriptions of each Top Event are in Appendix 2.

3.5.6.3 The LUQRA estimates the number of Fatalities & Weighted Injuries (FWIs) –a fatality equates to 1, Major Injury to 0.10 and minor injury to 0.005.

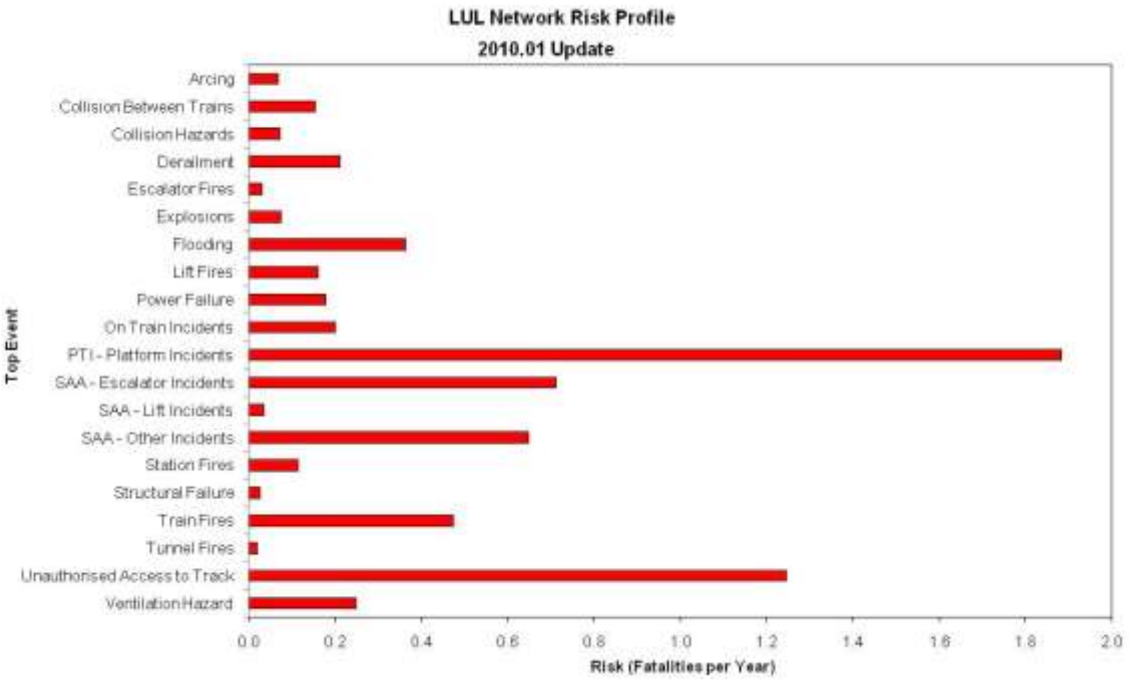
3.5.6.4 The current value for Preventing a Fatality (VPF) is defined by Cat 1 standard ‘Safety Decision Making’ S1521.

3.5.6.5 If it is not possible to calculate the Safety Risk (£) using the Concerns Workbook no estimate of the number of potential fatalities and/or injuries should be made. Heads of Technical Discipline will continue to review all concerns (including those which are not quantified) to ensure the railway is safe to operate and Sponsors/Asset Managers will consider them all when developing and prioritising the investment plan.

3.5.6.6 HSE will note any Code 2 concerns that cannot be quantified and take these into account when the model for the relevant Top Event/Asset group is reviewed.

3.5.6.7 The chart below breaks down the 2010.01 LU Network Risk Profile of seven FWIs per year by Top Event and shows that the risk of fatalities and injuries from customer or operational incidents is far greater than that from Asset failures.

3.5.7 LUL Network Risk Profile (2010.01 Update)



Note;	The most up-to-date version of this chart can be found on the LU Intranet.

3.5.8 Code 3: Extraordinary Maintenance and/or Operational Activities

3.5.8.1 A Condition Concern that requires extraordinary maintenance and/or operational activities, which are outside the maintenance regime and considered to be uneconomic and/or unsustainable. Unsustainable can be applied to Assets where it is economic to provide additional maintenance for a planned period before total or part replacement.

3.5.8.2 In the Concerns Workbook a Code 3 Concern should be formatted as: <Asset><objective defect with measure and threshold><uneconomic because...> and/or <unsustainable because...> and <quantified description of the extraordinary maintenance and/or operation regime that has been adopted><source of concern>

3.5.8.3 The purpose of the Concern description is to clearly and concisely detail the issue with the Asset, the activity additional to the normal regime and the consequence to the business.

3.5.8.4 The annual additional cost recorded in the Concerns Workbook for Code 3 Concerns, which will either be: the actual costs where these are recorded or an estimate of the additional cost, including, but not limited, to plant, labour, materials for the total population of Assets described in the Concerns Workbook. The cost of routine maintenance undertaken on the Asset population will not be included.

3.5.8.5 As part of the joint working process the ACR assessor will review with the Sponsor/Asset Manager the issues proposed as Code 3 to determine whether the activity is uneconomic or unsustainable. Where this cannot be determined prior to submission of the ACR report, then the issue will be included within the Concerns Workbook and reviewed with the Sponsor/Asset Manager post submission. Where the activity is agreed to be economic or sustainable these are no longer Code 3 Concerns and should be removed from the Concerns Workbook

3.5.8.6 Example Code 3: Concern Track Drains

Maintenance Regime:

The condition of a track drain is measured in terms of structural strength and serviceability (i.e. the ability to pass its designed flow), both of which are measured using WRc objective criteria and grading systems.

Structural defects are an ACR issue as their rectification is outside the maintenance regime.

Serviceability defects are usually rectified as part of the maintenance regime and so will not normally be covered by ACR.

However if the drain suffers exceptional serviceability problems – typically tree root ingress at joints – then the level of cleaning required is likely to move from “normal” to “extraordinary”. Permanent rectification would usually mean the introduction of a polypropylene liner.

It is anticipated that the Track Drainage Strategy will address this issue and will have set a threshold at which the whole-life cost of extraordinary cleaning will exceed the whole-life cost of rectification. The cost estimates should allow for the fact that excessive cleaning accelerates physical degradation, therefore, assume that more than two tree root cuttings/cleanings per year are uneconomic.

Generic Concern: <Track drain> that <suffers tree root ingress producing WRc serviceability scores in excess of 3>. <Uneconomic because it requires a cleaning frequency greater than twice per year><Asset Risk Register Reference>

The total number of instances of this defect will be reported in the Concerns Workbook, together with the annual extra-over cost.

3.5.9 Code 4: Performance Risks

3.5.9.1 A Condition Concern that presents a Lost Customer Hours (LCH) performance risk on the Underground Network of £250k or more per year.

3.5.9.2 In the Concerns Workbook a Code 4 Concern should be formatted as: <Asset><objective defect with measure and threshold><most probable failure mode/behaviour> and the ongoing/potential <outcome/consequence of><source of concern>

3.5.9.3 The Sponsor/Asset Manager is responsible for identifying and quantifying Code 4 concerns, based upon their analysis of CuPID and other data sources, and sharing these with the Assessor, for inclusion in the Concerns Workbook, at least three weeks prior to submission of the final draft ACR to the Asset Development Manager.

3.5.9.4 The Sponsor/Asset Manager should also review any Code 1, 2 & 3 Concerns reported in the Concerns Workbook for their Asset group and quantify any that are likely to have a performance risk of £250k or more per year.

3.5.9.5 The consequence of future performance risks can be estimated using the Nominally Accumulated Customer Hours (NACHs) calculator if sufficient data is available. See Appendix 3 for a guide to using the NACHs calculator.

3.5.9.6 To ensure consistency, the value of a Lost Customer Hour (LCH) given in the latest version of the Business Case Development Manual (BCDM) should be used.

3.5.9.7 This data will be used to provide a profile of the risk to service, based upon the underlying condition of the Assets.

3.6 Relative Asset Values (RAVs)

3.6.1 Relative Asset Values (RAVs) for each Asset group, except Signalling, C&I and Premises are Modern Equivalent Asset Values (MEAVs) from the 1997 re-pricing exercise minus the pound sign. For ACR reporting 100% of the total RAV for an Asset group must be allocated to the A, B, C and D classifications.

3.6.2 Any RAVs required for new Assets, or amendments to existing values, must be agreed by the Sponsor/Asset Manager and submitted to the Asset Development Manager. To ensure consistency RAVs for new Assets should be calculated by deflating the cost of the Asset to 1997 values and removing the pound sign (£).

3.6.3 No MEAVs were available for Signalling and C&I since these Assets were not repriced as part of the 1997 exercise. In the absence of MEAVs Signalling and C&I engineers have used the impact of Asset failure to derive RAVs for their Asset group.

3.7 The Summary Report

3.7.1 Each Asset group will provide a Summary Report representing the Physical Condition (A-D) and Functional Concerns (1-4), the report will compare the previous year's ACR figures; see the template in Appendix 5.

3.7.2 Additionally the report will identify and explain all changes/variations that have a significant business impact in the commentary section.

3.8 The Reporting Process

3.8.1 All proposed amendments to improve or update the Standard, Attachments to the Standard and the Guidance Document, including updated LUQRA data, must be submitted to the Asset Development Manager on or before 1st October.

3.8.2 Any revision to the Standard and associated Attachments shall be published via the Management System by the Asset Development Manager no later than 1st February.

3.8.3 The Asset Condition Report shall describe the condition of the Asset base at the reporting date of the reporting year. All Asset condition data shall be fully evidenced by auditable information.

3.8.4 The Asset Condition Report (ACR), Asset Safety and Management Certificate (ASMC) and ACR Summary Report will be prepared by Assessors working jointly with the relevant Heads of Technical Discipline and Sponsors / Asset Managers. Regular meetings should take place to ensure all parties are aware of the Physical Condition (A-D) of the Asset base and any Functional Condition and Degradation Concerns.

3.8.? A draft version of the documents will be submitted to the Asset Development Manager on or before the 23rd of June of the reporting year. The Asset Development Manager then has two weeks to return any observations to the relevant Asset Manager via the ACR Manager.

3.8.5 Heads of Technical Discipline and Sponsors / Asset Managers, will determine if the ASMC for their Asset Group is:

a) Accepted; or

b) Accepted with caveats.

3.8.6 The completed ACR and signed off ASMC shall be submitted by the Assessors to their relevant ACR Managers for logging and onward transmission to the Asset Development Manager on or before 31st July in the reporting year.

3.8.7 After reviewing these documents the Asset Development Manager shall submit a report to the LU Executive summarising the findings of the ACR and highlighting any critical risks to the business.

4 Responsibilities

4.1 The responsibilities for Sponsors/Asset Managers and Heads Technical Discipline are set out in Section 4 of the ACR Standard, S1042

5 References

5.1 Abbreviations

The following abbreviations are created:
a) within London Underground's Glossary of Terms (S1622) (a Category 1 Standard);
b) from published sources that are clearly identified.

Abbreviation	Definition	Source
ACR	Asset Condition Reporting	
AGS	Asset Group Strategy	
ALARP	As Low As Reasonably Practicable	
ASMC	Asset Safety and Management Certificate	
BCDM	Business Case Development Manual	
COO	Chief Operating Office	
CPD	See Document History 1	
FWI	Fatalities & Weighted Injuries	
HSE	Health, Safety and Environment	
LU	London Underground	
LUQRA	London Underground Quantified Risk Assessment	
RAV	Relative Asset Value	
S&C	See Document History 1	
TTNEI	Time To Next Economic Intervention	
WRA	Workplace Risk Assessment	

5.2 Definitions

The following topic specific definitions are created:
a) within London Underground's Glossary of Terms (S1622) (a Category 1 Standard);
b) from published sources that are clearly identified.

Term	Definition	Source
Asset group	Set of assets that interact and/or are inter-related so as to deliver a required business function or service.	a

Term	Definition	Source
Concern	In relation to Asset condition, a defect in the Asset that will need to be addressed outside of the agreed maintenance regime. A Concern may describe: a) Failure to meet Required Duty; and/or b) State of degradation; and/or c) Failure to reach the expected Residual Life.	a
Condition	The state of an Asset in terms of its continued ability to meet its Required Duty on account of its physical and functional attributes.	a
Defect	A fault or shortcoming.	a
Degradation Concern	Where the Asset group has no Residual Life methodology Asset degradation will be reported in the Concerns Workbook.	a
Economic Intervention	Any work required to address an Asset Condition Concern which is outside the agreed maintenance regime. Typically includes replacement or refurbishment.	a
Extraordinary Maintenance	Maintenance activities which are either outside the maintenance schedule determined during design, construction and commissioning of an operational Asset and included in an agreed Asset Management Regime or in addition to the maintenance regime agreed or carried out with appropriate approvals, and in existence prior to the year in which the ACR is carried out.	a
Fatalities & Weighted Injuries	Fatality equates to 1, Major Injury to 0.10 and minor injury to 0.005.	a
Firmware	Permanent software programmed into a read-only memory.	a
Functional Condition Concern	One of the following: Code 1: Statutory Compliance;; Code 2: Safety Risks to Customers and Staff; Code 3: Extraordinary Maintenance and/or Operational Activities; Code 4: Performance Risks	a
Intervention	Any work required to address an Asset Condition Concern which is outside the agreed maintenance regime.	a
Maintenance Regime	All maintenance activities identified in the Asset maintenance regime within the AGS or Asset Maintenance Plan. The combination of all technical and administrative actions, including supervision actions, intended to retain an Asset in, or restore it to, a state in which it can perform its Required Duty.	a
Major Injury	Reportable occurrence under the requirements set out in RIDDOR Regulations.	a
Nominal Life	The period of time after commissioning for which an engineering Asset, subject to an agreed maintenance regime, is expected to meet or exceed its Required Duty. Where usage dictates the nominal life of the Asset its capability will need to be converted into a time equivalent.	a
Relative Asset Value	Relative Asset Values (RAVs) for each Asset group, except Signalling and C&I, are Modern Equivalent Asset Values (MEAVs) from the 1997 re-pricing exercise minus the pound sign. For ACR reporting 100% of the total RAV for an Asset group must be allocated to the A, B, C and D classifications.	A
Residual Life	The remaining life of an Asset at the reporting date, in terms of the estimated time required before the next Intervention, taking into account physical degradation to date, agreed changes to the maintenance regime, obsolescence and any other relevant factors (but not any planned changes to Required Duty).	A

Term	Definition	Source
Required Duty	A statement of the requirements placed on an engineering Asset in order to deliver satisfactory service to the railway and supporting services in accordance with LU Cat 1 Standards, British Standards, International Standards and associated codes of practice, or other contractual obligations.	A
Routine Maintenance	All maintenance activities identified in the Asset maintenance regime within the AGS or Asset Management Plan.	A
Safety Implication	Any Concern which has potential to result in serious injury or death to any person or persons.	A
Software	Intellectual creation comprising the programs, procedures, rules and any associated documentation pertaining to the operation of a system.	A
Concern	Concern (1): A concern developed by an Asset group as a statement of how a particular operational Asset type, operational Asset type element or individual operational Asset fails to meet Required Duty. Concern (2): A concern developed by a Supplier as a statement of how a particular Operational Asset type, Operational Asset type Element or individual Operational Asset fails to meet Required Duty.	A
Staff	All TfL employees including those in subsidiary companies, and any contractors, consultants or other 3rd parties working on the Underground Network.	A
Sub-Asset	Component part of an Asset as defined in the Asset Hierarchies within the Attachments to the ACR Standard E.g. emergency lighting is a Sub-Asset of lighting within the Electrical Asset hierarchy.	A
Supplier	Supplier to London Underground, the primary organisation or individual that is selected to deliver a product, service or facility to London Underground and contracting directly to London Underground. This includes Consultants, Contractors, Entities and PFI Contractors and excludes organisations or individuals selected by and contracting directly to these Suppliers.	A
Time To Next Economic Intervention (TTNEI)	TTNEI is used for Assets which are managed to provide a nominally infinite life and therefore residual life is not meaningful. The TTNEI will be the time until the next intervention is required to stem the degradation of the Asset and increase its life.	A
Transient Defect	A defect which can be rectified either under the Asset's normal and budgeted maintenance regime or through maintenance which is deemed economic in comparison to renewal or replacement over the life of the Asset.	A
Underground Network	The stations and depots (wherever situated), Assets, systems, track, and other buildings which are used in the maintenance and provision of the underground service known as 'London Underground.'	A

5.3 Subject Matter Expert

ACR Subject Matter Expert
Asset Development Manager

5.4 Document history

Issue no	Date	Changes	Author
A1	March 2011	Original Cat 5 Standard revised following extensive consultation with APD (now COO), CPD, S&C and TLL prior to update to Cat 1.	Elliot Simmons
A2	February 2012	Updated as per DRACCT No. 01115. References to Code 2 (Staff Only) concerns removed since these are addressed through the Workplace Risk Assessment process. Role of Head of Technical Discipline in contacting the Regulatory authority clarified, Appendix on using the NACHS calculator added. Appendix on using Concerns Workbook updated to reflect changes to the Workbook.	Marc Sims
A3	April 2015	Ensure that the Guidance Document is “in line” with the Standard.	Joe Crow

6 Appendix

6.1 Appendix 1: Obsolescence Paper

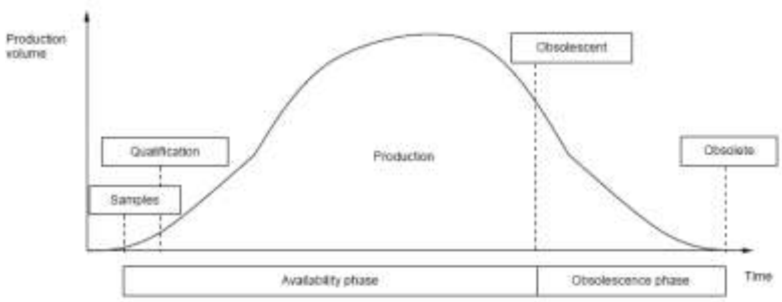
Reporting obsolescence in the ACR
(Obsolescence Manager, 21/12/10, 1EA2E739)

Purpose
This paper proposes the principle for reporting obsolescence concerns in the Asset Condition Report (ACR).

Introduction
'Obsolescence' refers to a phase in a product's availability. At some stage, its manufacturer will decide a future date to end production; the product is then considered to be 'obsolescent'.

BS EN 624202 Obsolescence Management defines the following terms:

- 'obsolescence' as the "*transition from availability from the original manufacturer*[1] *to unavailability*"
- 'obsolete' as "*no longer available*"
- 'obsolescent' as "*subject to an announced future end"* (of production)



Product availability phases

Reporting

Definition
To clarify the meaning of obsolescence and emphasise its association with product availability, the following definition is proposed for use when reporting obsolescence concerns on the ACR:

> **Equipment is either obsolete, in that replacements, components or in-service support are no longer available, or obsolescent, in that the supplier has announced a future date at which replacements, components or in-service support will become unavailable**

Discrete reports
An Asset may have another reportable condition, such as degradation or loss of integrity, as well as being obsolete or obsolescent. In such cases, discrete reports are required; each condition to be reported separately. In that way all known obsolescence concerns will be reported and LU will be informed of any latent risk.

Quantification

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[1] *Note the emphasis on the 'original manufacturer'; this is because the sourcing of alternatives and substitutes from other manufacturers is considered a mitigating activity.*

Residual life

Unmitigated obsolescence will have a direct impact on Residual Life and Physical Condition Codes A-D (Residual Life) and may be used to indicate obsolescence timescales. Effective mitigation may extend Residual Life, though not necessarily in excess of 10 years (i.e. condition Code A).

The current definitions and timescales for physical condition codes are sufficient but the following interpretation is proposed for obsolescence assessment:

Code A	Either It is expected that replacements, significant components and in-service support will remain available for at least 10years, or It is expected that action taken to mitigate the effects of obsolescence will be effective for at least 10years
Code B	Either It is expected that replacements, significant components and in-service support will remain available for at least 5years but reported that replacements or significant components or in-service support will become unavailable in less than 10years or It is expected that action taken to mitigate the effects of obsolescence will be effective for at least 5years but will become ineffective in less than 10years
Code C	Either It is reported that replacements or significant components or in-service support will become unavailable in less than 5years or It is expected that action taken to mitigate the effects of obsolescence will become ineffective in less than 5years
Code D	Replacements or significant components or in-service support are no longer available and no action has been taken to mitigate the effects of obsolescence

Risk and Functional Condition

The occurrence of obsolescence itself is not a risk. Obsolescence is inevitable. Risk realisation will occur after the product has become obsolete and stocks are exhausted.

The risk to be assessed is the event which will follow if:

1. A product becomes obsolete before the Asset is decommissioned, and
2. Product procurement is subsequently required, i.e. for repair or maintenance activity (e.g. failure, damage, planned periodic replacement etc.)

The most likely impact is a loss of function. A Functional Condition Code 1-4 should be awarded as appropriate. The expectation is a risk of service loss (Code 4) which can be quantified in financial terms based on the value of the potential lost customer hours (LCH). It is possible that there will be no significant impact from obsolescence and that an Asset may be Code D without any functional risk.

6.2 Appendix 2: Descriptions of LUQRA Top Events

Note: The descriptions in this section are those used for the 2010.01 version of the LUQRA and are subject to change. The latest descriptions are available on the LU Intranet.

Arcing
The Arcing Top Event models the risk of fatality arising from electric burning from a short circuit or electrical fault on the traction supply, limited only by the resistance of the fault path and protected electrically only by sub-station circuit breakers.

Collision Hazard
The Collision Hazard Top Event models the risk of fatality from incidents resulting from an impact between a train and a fixed obstruction. This includes floodgates, line side structures (including tunnel walls), platform edges and terminal platforms.

Collision between Trains
The Collision between Trains Top Event models the risk of fatality arising from an incident where there is an impact between two trains. This includes:

- End on, side on and side swipe collisions between LU passenger trains on LU and Network Rail infrastructure,
- Collisions between runaway engineering trains and LU passenger trains, and
- Collisions between derailed/collided trains that initially did not involve an LU passenger train, but where there was a subsequent collision with an LU passenger train

Derailment
The Derailment Top Event models the risk of fatality arising from an incident where a train comes off the rails due to an unplanned event. This includes trains striking obstructions on the track (including objects fallen from trains) or that infringe the structure gauge.

Escalator Fires
The Escalator Fire Top Event models the risk of fatality associated with an incident involving fires in both the public and non-public areas of the station including disused areas and tenancies.

Escalator Incidents
Escalator Incidents are defined as any incident or accident which occurs on an escalator, be it moving or stationary.

Explosion
The Explosion Top Event models the risk of fatality associated with any incident resulting from either deliberate action, or from the accidental ignition or pressure build up of flammable material/gases.

Flooding
The Flooding Top Event models the risk of fatality from any major incident resulting from an overflow of the River Thames, failure of the Thames Barrier or as a result of broken pipes and sewers belonging to water utilities with the potential for loss of life.

Lift Fires
The Lift Fire Top Event models risk of fatality arising from an incident involving fire in lift cars, shafts, pits and machine rooms.

Lift Incidents
The Lift Incidents Top Event models the risk of fatality associated with any incident or accident which occurs in or around the lift.

On-Train Incidents
The On Train Incidents Top Event models risk of fatality once a passenger has boarded a train. The On Train Incident Top Event includes items within station limits, such as unauthorised use of inter-car doors, which up to 2003 had been included in the PTI Top Event.

Platform Train Interface
The Platform Train Interface (PTI) Top Event models risk of fatality arising from the platform edge where it interfaces with trains and is normally accessible to passengers.

Power Failure
The Power Failure Top Event models the risk of fatality from any incident associated with major system wide power loss which affects, in particular, trains and stations.

Station Area Accidents
The Station Area Accidents Top Event models risk of fatality arising from any incident or accident which occurs within the station boundary that is not included in another Top Event e.g. Escalator Incident, Lift Incident.

Station Fires
The Station Fire Top Event models the risk of fatality associated with an incident involving fires in both the public and non-public areas of the station; including disused areas and tenancies.

Structural Failures
The Structural Failure Top Event models the risk of fatality arising from any incident associated with civil infrastructure collapse/failure with the potential to directly result in customer fatality.

Train Fires
The Train Fire Top Event models risk of fatality arising from an incident involving fire on any part of a train or its contents.

Tunnel Fires
The Tunnel Fire Top Event models the risk of fatality arising from an incident involving fire in subsurface or tube sections or open sections but not within the confines of the station head and tail walls.

Unauthorised Access To Track
The Unauthorised Access to Track Top Event models the risk of fatality arising from an unauthorised persons being on or around the track, who are not in the vicinity of a station/platform.

Ventilation Hazard
The Ventilation Hazard Top Event models the risk to customers trapped on immobilised trains in sections (i.e. not at platforms) due to all causes except power failure, since this is included in the LUQRA power failure model. The conditions within the carriages are assumed to deteriorate by a combination of heat / humidity and the build up of carbon dioxide. There is also a risk of fatality from self detrainment and authorised detrainment without protection.

6.3 Appendix 3: Quantifying Code 4 with the NACHs Calculator

BACKGROUND
The Asset Condition Reporting (ACR) Standard separates the assessment of Physical and Functional Condition.

Assessors report Functional Condition by noting any specific issues in the ACR Concerns Table and entering information against the applicable Functional Codes.

Concerns which cause service affecting failures are covered under Code 4: Performance.

The Sponsor / Asset Manager may use the NACHs Calculator to quantify Performance Risk in financial terms.

INTRODUCTION
The NACHs (Nominally Accumulated Customer Hours) were developed by the LUL Transport Planning Team to return the Lost Customer Hour (LCH) impact of a range of disruption types on particular sections of the network.

Advantages of using the NACHs Calculator:
1) Consistency: results are repeatable and auditable;
2) Speed: fast and easy to use with appropriate training and guidance;
3) Accuracy: robust means of forecasting impact of service affecting failures.

CUPID ACCESS
The NACHs calculator is available through Cupid. For instructions see *NACHs 2014 Calculator Access – Step by Step Guide*.

DISTRUPTION TYPES
On opening the NACHS Calculator the Assessor first needs to select a Disruption Type.

For the purposes of the ACR a number of options are not valid because their impact would be better measured using another option. For instance, Signal Failures should be assessed using Partial Line Suspension and Depot Late Start Up using Train Cancellations.

The Assessor must choose the most likely disruption type based upon professional judgment.

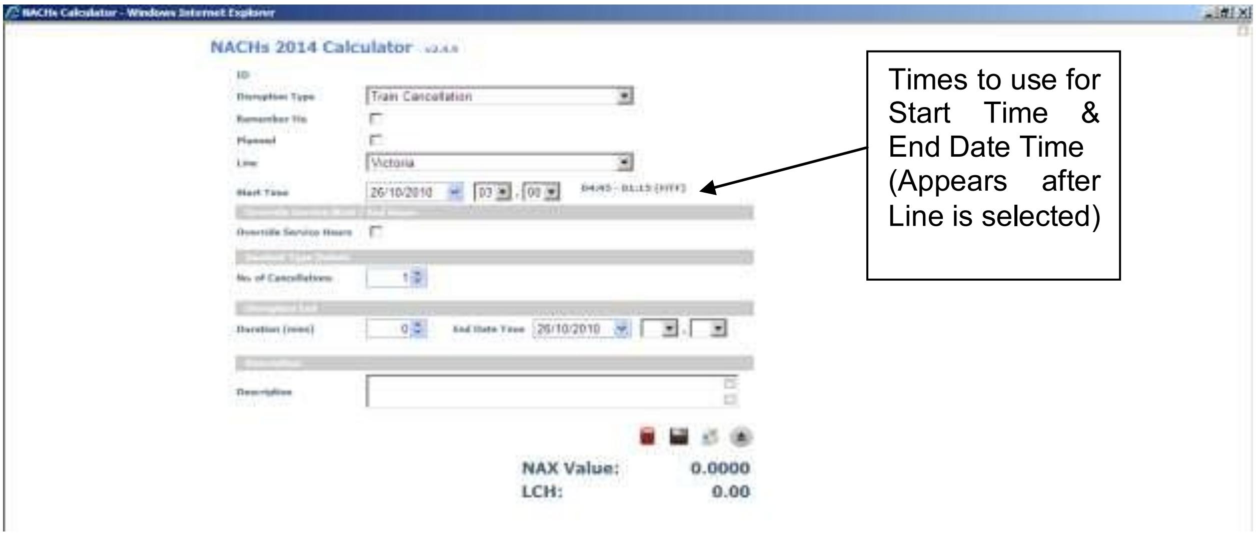
ACR Options	Non-ACR Options
Train Cancellations	Train Withdrawal (Cancel)
Speed Restrictions	Train Delay
Partial Line Suspension	Train Degradation
Lift Downtime	Signal Failure(s)
Full Station Closures	Platform Closures
Full Line Suspension	Passenger Conveyor Downtime
Escalator Downtime	Partial Station Closure
	Partial Line Degradation
	Loss of Route
	Depot Late Start Up

GENERAL PROCESS

Detailed instructions for using the NACHs Calculator after selecting valid Disruption Types are set out below; however, the general process is:

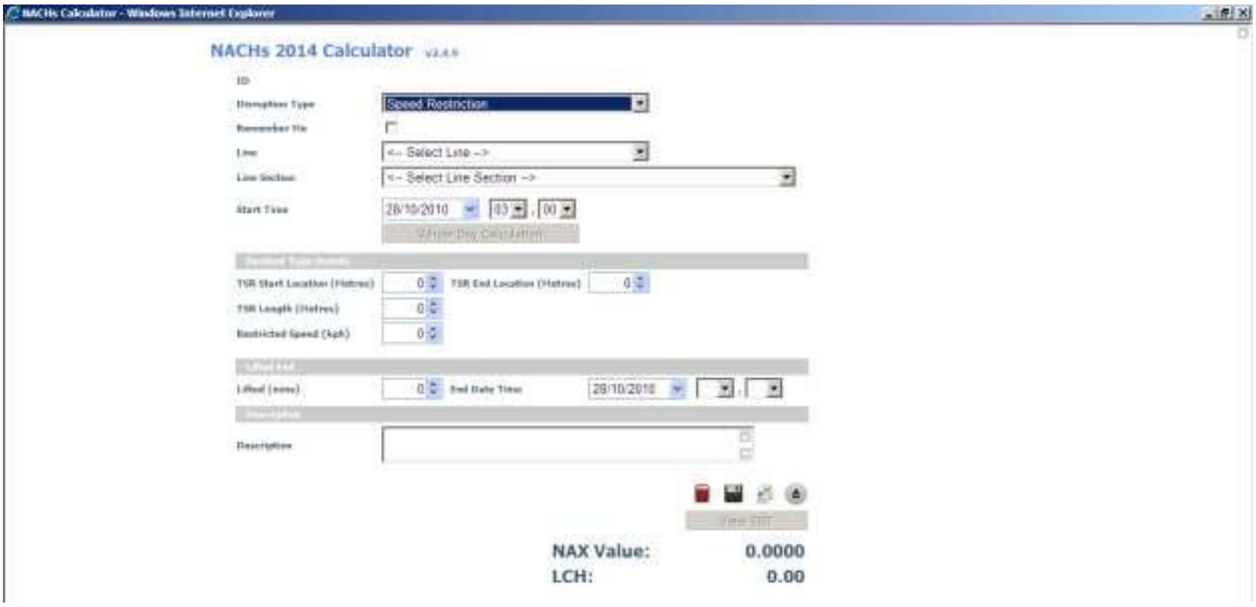
1	Choose disruption type
2	Decide if location specific or generic
3	Calculate NACHs value using the detailed instructions for ONE day only. Note for 'Group Faults', where than one Asset has the concern, additional instructions are provided where appropriate.
4	Enter the total LCH in the 'Total ONE Day LCH Impact for ALL Assets with Concern' in the Concerns Workbook
5	The Concerns Workbook will then use the LCH figure to calculate the Annual Performance Risk in £ with reference to: the average duration of disruption (when the Concern materialises occurs), the annual frequency for the Concern and the current Value of Time

TRAIN CANCELLATIONS



Step	**Field**	**Guidance**
1	Disruption Type	Select 'Train Cancellations'
2	Remember Me	Leave blank
3	Planned	Leave blank
4	Line	Select Line from drop down menu
5	Start Time [Date]	Enter: 31/03/2011
6	Start Time [Time]	Enter start time that appears in blue text after a Line is selected (see text to the right of 'Start Time' fields in screenshot above)
7	Override Service Hours	Leave blank
8	No. of Cancellations	Select No. of trains that are likely to be cancelled if the risk identified materialises
Note: There is a list of the number of trains in service in the peak for each line in Appendix 2		
9	Duration	Leave blank
10	End Date Time [Date]	Enter: 01/04/2011
11	End Date Time [Time]	Enter end time that appears in blue text after a Line is selected (see text to the right of 'Start Time' fields in screenshot above)
12	Description	Leave blank
13	Red Calculator	Click on symbol to generate LCH
Outside NACHS Calculator		
14	Record LCH Value	Enter the LCH value in the Concerns Workbook in the 'Total ONE Day LCH Impact for ALL Assets with Concern' column

SPEED RESTRICTIONS (SR)



Step	Field	Guidance
1	Disruption Type	Select 'Speed Restrictions'
2	Remember Me	Leave blank
3	Line	Select Line from drop down menu
4	Line Section	All options are for the section between adjacent platforms in one direction. If the Speed Restriction is longer than this the LCH for all the individual sections needs to be entered and then added together outside the NACHs Calculator
5	Start Time	Enter 31/03/2011 and leave Time fields blank. Select 'Whole Day Calculation'
6	TSR Start Location (M)	Enter Start of SR from the 1st platform in meters
7	TSR End Location (M) OR TSR Length (M)	Enter meters from the 1st platform the SR ends OR Enter length of the SR in meters
8	Restricted Speed	Enter estimated Restricted Speed for the Section
9	Lifted End	Leave blank
10	Description	Leave blank
11	Red Calculator	Click on symbol to generate LCH
Outside NACHS Calculator		
12	Record LCH Value	Enter the LCH value in the Concerns Workbook in the 'Total ONE Day LCH Impact for ALL Assets with Concern' column

Partial Line Suspension (PLS)

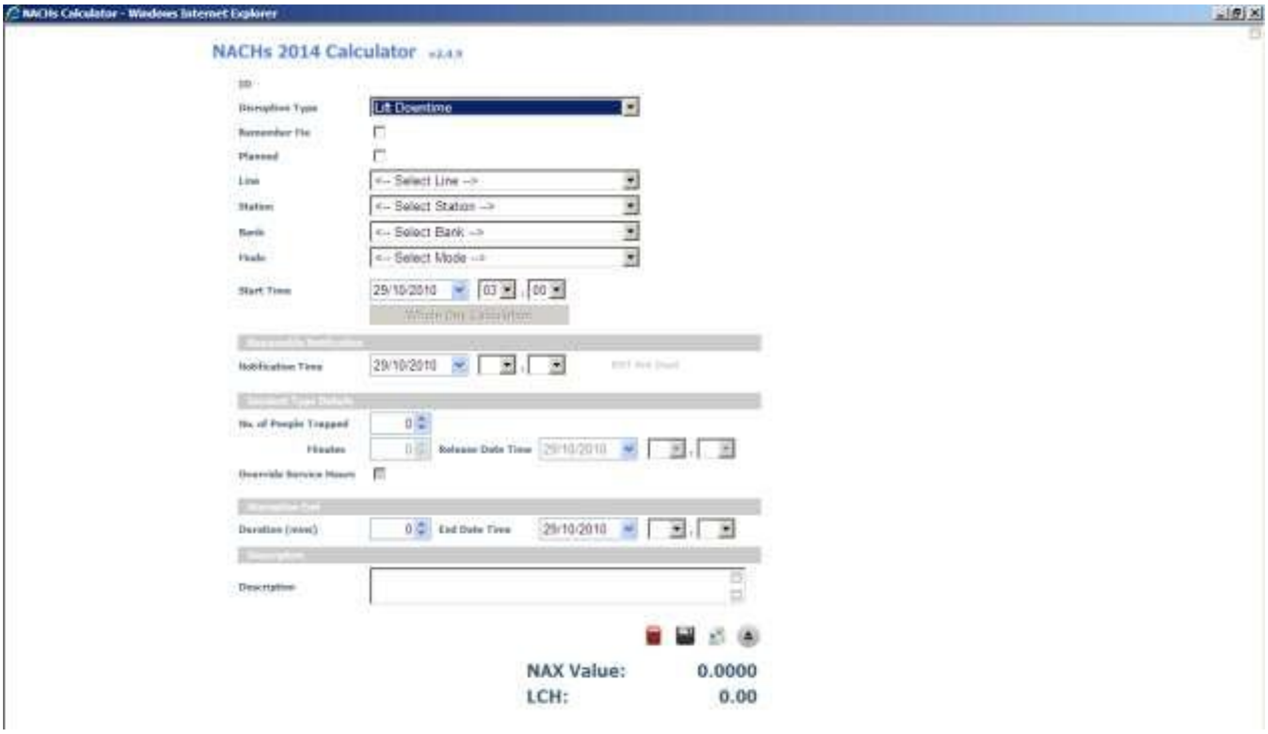
Step	Field	Guidance
1	Disruption Type	Select 'Partial Line Suspension'
2	Remember Me	Leave blank
3	Line	Select Line and then press green '+' symbol
NOTE: Code 4 Appendix 3 below provides a list of potential PLS for consideration		
4	From Station	Although the line will be suspended in both directions the Calculator is set such that you should always first pick the nearest station to the **east/south** that will not be affected by the suspension (see Table 1 below). Select Station and then press green '+' symbol
5	End Station	Following Step 4, pick the nearest station to the **west/north** that will not be affected by the suspension (see table below). Select Station and then press green '+' symbol
6	Via	If applicable the Calculator will offer a Via Option
7	Matches	If applicable the Calculator will offer a selection of options that match the requirements entered. Select the closest match.
8	Start Time	Enter 31/03/2011 and leave Time fields blank. Select 'Whole Day Calculation'
9	Lifted End	Leave blank
10	Override Service Hours	Leave blank
11	Reasonable Notification	Leave blank
12	Disruption End	Leave blank
13	Description	Leave blank
14	Red Calculator	Click on symbol to generate LCH
Outside NACHS Calculator		
15	Record LCH Value	Enter the LCH value in the Concerns Workbook in the 'Total ONE Day

		LCH Impact for ALL Assets with Concern' column

Table 1: Selecting From and To Stations for PLS

Line	From Station	To Station	Comment
Bakerloo	Furthest SB	Furthest NB	
Central	Furthest EB	Furthest WB	Rule does not hold on the Hainault loop. Assessors need to try both directions. Does the Rule hold when the Line splits after North Acton?
District	Furthest EB	Furthest WB	
Circle	Furthest EB	Furthest WB	Rule generally holds but check around Aldgate, Gloucester Road & High Street Ken.
Jubilee	Furthest EB	Furthest WB	
Met	Furthest EB/SB	Furthest WB/NB	There are many branches at the west end – anything "special"?
Northern	Furthest SB	Furthest NB	Does the Rule hold whether you use the City or Charing Cross branch and then go onward to High Barnet or Edgware?
Piccadilly	Furthest EB	Furthest WB	Does the Rule hold for both the west end branches – to Uxbridge and the various Heathrows?
Victoria	Furthest SB	Furthest NB	
W&C	N/A	N/A	No PLS

Lift Downtime



Individual Fault

Step	Field	Guidance
1	Disruption Type	Select 'Lift Downtime'
2	Remember Me	Leave blank
3	Planned	Leave blank
4	Line	Select Line from drop down menu
5	Station	Select Station from drop down menu
6	Bank	Select Lift Bank from drop down menu
7	Mode	Select the appropriate number of lifts Out of Service (O). O=1 OO=2
8	Start Time	Enter 31/03/2011 and leave Time fields blank. Select 'Whole Day Calculation'
9	Incident Details	Leave blank
10	Disruption End	Leave blank
11	Description	Leave blank
12	Red Calculator	Click on symbol to generate LCH
Outside NACHS Calculator		
13	Record LCH Value	Enter the LCH value in the Concerns Workbook in the 'Total ONE Day LCH Impact for ALL Assets with Concern' column

Group Fault
If the same Concern is common to a number of Assets either repeat the process outlined above for all locations to reach the total OR consult Code 4 Appendix 1: Generic Disruption Priority List. Select the highest entry which has the Concern recorded in the Concerns Table and use this lift for the steps outlined for an Individual fault. Multiply the answer by 0.7 (for an average LCH impact for the affected group) and then multiply by the number of lifts with the same Concern.

Full Station Closure

Individual Fault

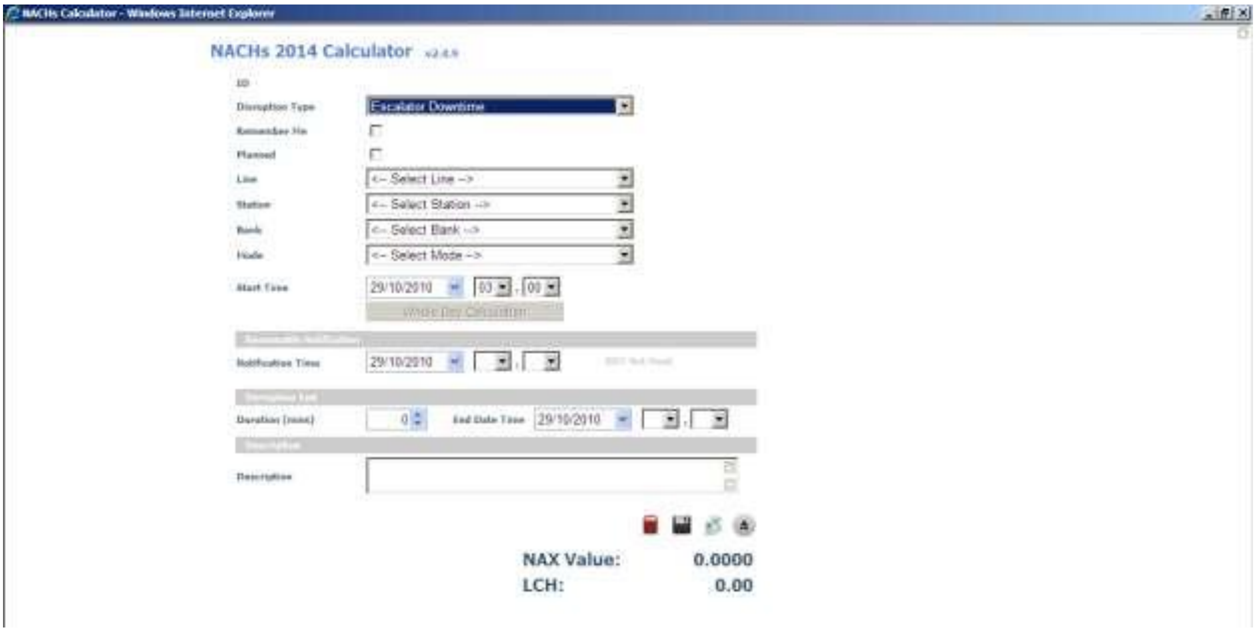
Step	Field	Guidance
1	Disruption Type	Select ‘Full Station Closure’
2	Remember Me	Leave blank
3	Planned	Leave blank
4	Line	Select Line from drop down menu
5	Station	Select Station from drop down menu
6	Start Time	Enter 31/03/2011 and leave Time fields blank. Select ‘Whole Day Calculation’
7	Override Service Hours	Leave blank
8	Reasonable Notification	Leave blank
9	Disruption End	Leave blank
10	Description	Leave blank
11	Red Calculator	Click on symbol to generate LCH
Outside NACHS Calculator		
12	Record LCH Value	Enter the LCH value in the Concerns Workbook in the ‘Total ONE Day LCH Impact for ALL Assets with Concern’ column

Group Fault
If the same Concern is common to a number of Assets either repeat the process outlined above for all locations to reach the total OR consult Code 4 Appendix 1: Generic Disruption Priority List. Select the highest entry which has the Concern recorded in the Concerns Table and use this lift for the steps outlined for an Individual fault. Multiply the answer by 0.7 (for an average LCH impact for the affected group) and then multiply by the number of lifts with the same Concern.

Full Line Suspension (FLS)

Step	Field	Guidance
1	Disruption Type	Select 'Full Line Suspension'
2	Remember Me	Leave blank
3	Planned	Leave blank
4	Line	Select Line from drop down menu
5	Start Time	Enter 31/03/2011 and leave Time fields blank. Select 'Whole Day Calculation'
6	Override Service Hours	Leave blank
7	Reasonable Notification	Leave blank
8	Disruption End	Leave blank
9	Description	Leave blank
10	Red Calculator	Click on symbol to generate LCH
Outside NACHS Calculator		
11	Record LCH Value	Enter the LCH value in the Concerns Workbook in the 'Total ONE Day LCH Impact for ALL Assets with Concern' column

Escalators Downtime



Individual Fault

Step	Field	Guidance
1	Disruption Type	Select ‘Escalator Downtime’
2	Remember Me	Leave blank
3	Planned	Leave blank
4	Line	Select Line from drop down menu
5	Station	Select Station from drop down menu
6	Bank	Select Esc. Bank from drop down menu
7	Mode	Select the appropriate number of Escalators which are Fixed Stair (F) or Out of Service (O). I.E. OF = 1 Esc. Out of Service & 1 Esc. Fixed Stair
8	Start Time	Enter 31/03/2011 and leave Time fields blank. Select ‘Whole Day Calculation’
9	Disruption End	Leave blank
10	Description	Leave blank
11	Red Calculator	Click on symbol to generate LCH
Outside NACHS Calculator		
12	Record LCH Value	Enter the LCH value in the Concerns Workbook in the ‘Total ONE Day LCH Impact for ALL Assets with Concern’ column

Group Fault
If the same Concern is common to a number of Assets either repeat the process outlined above for all locations to reach the total OR consult Code 4 Appendix 1: Generic Disruption Priority List. Select the highest entry which has the Concern recorded in the Concerns Table and use this lift for the steps outlined for an Individual fault. Multiply the answer by 0.7 (for an average LCH impact for the affected group) and then multiply by the number of lifts with the same Concern.

6.4 Code 4 Appendix 1: Generic Disruption Priority List

No.	Station
1	Waterloo
2	Canary Wharf
3	Bank / Monument
4	Oxford Circus
5	King's Cross
6	Green Park
7	Victoria
8	Paddington
9	London Bridge
10	Liverpool Street
11	Tottenham Court Road
12	Finsbury Park
13	Euston
14	Baker Street
15	Stratford
16	Holborn
17	North Greenwich
18	Bond Street
19	Moorgate
20	Mile End
21	Stockwell
22	Westminster
23	Leicester Square
24	Highbury & Islington
25	South Kensington
26	Piccadilly Circus
27	Farringdon
28	Embankment
29	Euston Square
30	Ealing Broadway
31	East Ham
32	Earl's Court
33	Warren Street
34	Bethnal Green
35	Brixton
36	Hammersmith (Dis)
37	Finchley Road
38	Uxbridge
39	Wimbledon
40	Canada Water
41	Wembley Park
42	Seven Sisters
43	Leytonstone
44	Hammersmith (H&C)
45	West Ham

No.	Station
46	Tooting Broadway
47	Vauxhall
48	St. James's Park
49	Notting Hill Gate
50	Canning Town
51	Blackhorse Road
52	Old Street
53	Charing Cross
54	Chancery Lane
55	Walthamstow Central
56	Elephant & Castle
57	Leyton
58	Barking
59	Barons Court
60	Bermondsey
61	Marble Arch
62	Russell Square
63	Angel
64	Shepherd's Bush
65	White City
66	East Finchley
67	Knightsbridge
68	Sloane Square
69	Acton Town
70	Blackfriars
71	Camden Town
72	St. Paul's
73	Tooting Bec
74	Goodge Street
75	Queen's Park
76	Highgate
77	Gunnersbury
78	Gloucester Road
79	Finchley Central
80	Kilburn
81	Tower Hill
82	Morden
83	Golders Green
84	Fulham Broadway
85	Heathrow Terminals 123
86	High Street Kensington
87	Barbican
88	Woodford
89	Turnpike Lane
90	Balham

No.	Station
91	Richmond
92	Willesden Junction
93	Covent Garden
94	Pimlico
95	Northolt
96	Willesden Green
97	East Putney
98	Clapham South
99	Wood Lane
100	Southwark
101	Marylebone
102	Hendon Central
103	Great Portland Street
104	Holloway Road
105	Colliers Wood
106	Harrow & Wealdstone
107	Queensbury
108	Archway
109	Tottenham Hale
110	Whitechapel
111	Harrow-on-the-Hill
112	Parsons Green
113	Queensway
114	Upton Park
115	Dagenham Heathway
116	Epping
117	St. John's Wood
118	Clapham Common
119	North Acton
120	Manor House
121	Elm Park
122	Hounslow West
123	Stepney Green
124	Aldgate East
125	Swiss Cottage
126	Loughton
127	Harlesden
128	Rickmansworth
129	Bromley-by-Bow
130	Lancaster Gate
131	Eastcote
132	Edgware Road (Bak)
133	Clapham North
134	Southfields
135	Putney Bridge

No.	Station	No.	Station	No.	Station

136	East Acton
137	Aldgate
138	Hampstead
139	Upminster
140	Borough
141	Mornington Crescent
142	Belsize Park
143	Debden
144	Plaistow
145	Watford
146	Edgware
147	Pinner
148	Kentish Town
149	Holland Park
150	Shepherd's Bush Market
151	Alperton
152	Hillingdon
153	Wood Green
154	Hatton Cross
155	West Kensington
156	Caledonian Road
157	Northwood
158	Temple
159	Bow Road
160	Hyde Park Corner
161	Kensal Green
162	Kew Gardens
163	Hainault
164	Gants Hill
165	Oval
166	West Hampstead
167	Edgware Road (H&C/Dis)
168	Southgate
169	Osterley
170	Kingsbury
171	Rayners Lane
172	Sudbury Hill
173	Ravenscourt Park
174	South Woodford
175	West Brompton
176	Neasden
177	Perivale
178	Chorleywood
179	Royal Oak
180	Bayswater

181	Buckhurst Hill
182	Ladbroke Grove
183	Regent's Park
184	Canons Park
185	Warwick Avenue
186	Kenton
187	Arsenal
188	Stanmore
189	Hanger Lane
190	Hornchurch
191	Redbridge
192	Becontree
193	Dollis Hill
194	Cannon Street
195	Brent Cross
196	Northwick Park
197	Turnham Green
198	West Acton
199	Wembley Central
200	South Ruislip
201	High Barnet
202	Mansion House
203	Newbury Park
204	South Wimbledon
205	Ealing Common
206	South Harrow
207	Snaresbrook
208	Sudbury Town
209	Colindale
210	West Finchley
211	Chalk Farm
212	Hounslow East
213	Goldhawk Road
214	Tufnell Park
215	Bounds Green
216	Greenford
217	Hounslow Central
218	Ruislip
219	Woodside Park
220	Kennington
221	Northfields
222	South Ealing
223	Latimer Road
224	Arnos Grove
225	Heathrow Terminal 5

226	Upminster Bridge
227	Moor Park
228	Westbourne Park
229	Chiswick Park
230	North Wembley
231	Ickenham
232	Kensington (Olympia)
233	Preston Road
234	Dagenham East
235	Croxley
236	Wanstead
237	Boston Manor
238	Stonebridge Park
239	Ruislip Gardens
240	Oakwood
241	Wimbledon Park
242	North Harrow
243	Park Royal
244	Totteridge & Whetstone
245	Lambeth North
246	Theydon Bois
247	Stamford Brook
248	Burnt Oak
249	Chalfont & Latimer
250	Ruislip Manor
251	Amersham
252	Maida Vale
253	Heathrow Terminal 4
254	Barkingside
255	South Kenton
256	Chesham
257	West Harrow
258	Kilburn Park
259	Northwood Hills
260	Fairlop
261	West Ruislip
262	Upney
263	Grange Hill
264	Cockfosters
265	Chigwell
266	North Ealing
267	Roding Valley
268	Mill Hill East

6.5 Code 4 Appendix 2: Number of Trains in Service in the Peak for each Line

The number of trains cancelled which would currently mean 100% of the service was cancelled

Please note that the most up-to-date Working Timetables can be found on the LU Intranet.

Code 4 Appendix 3: Partial Line Suspension (PLS)
The table below provides a list of potential Partial Line Suspensions.

Line	Line Section
VIC	Highbury & Islington to Walthamstow
VIC	Victoria to Highbury & Islington
VIC	Brixton to Victoria
DIS	Upminster to Barking (District)
DIS	Barking to Aldgate East (District & H&C)
DIS	Whitechapel to Embankment (District) and Aldgate to Embankment (Circle)
DIS	Embankment to Earls Court (District) AND Embankment to High Street Kensington (Circle)
DIS	Earls Court to Richmond & Wimbledon & Acton Town (District only)
DIS	Earls Court to Gunnersbury & Ealing Broadway (District only)
H&C	Liverpool Street to Kings Cross (Metropolitan, H&C, Circle)
H&C	Aldgate to Baker Street (Metropolitan) AND Kings Cross to Edgware Road (H&C, Circle)
H&C	Edgware Road to Hammersmith (H&C and Extended Circle)
MET	Baker Street to Wembley Park (Metropolitan only)
MET	Wembley Park to Northwood/Harrow-on-the-Hill (Metropolitan only)
MET	Northwood to Watford (Local) (Metropolitan)
MET	Moor Park to Amersham/Chesham (Fast) (Metropolitan)
CEN	Epping to Woodford
CEN	Loughton to Leytonstone AND Hainault to Woodford AND Hainault to Leytonstone
CEN	Leytonstone to Liverpool Street
CEN	Liverpool Street to Holborn
CEN	Holborn to Marble Arch
CEN	Marble Arch to White City
CEN	White City to West Ruislip & Ealing Broadway
BAK	Elephant & Castle to Piccadilly Circus
BAK	Piccadilly Circus to Paddington
BAK	Paddington to Queens Park
BAK	Queens Park to Harrow & Wealdstone
JUB	Stratford to West Ham
JUB	Stratford to North Greenwich
JUB	North Greenwich to Canary Wharf

JUB	Canary Wharf to London Bridge
JUB	London Bridge to Waterloo
JUB	Waterloo to Green Park
JUB	Waterloo to Finchley Road
JUB	Finchley Road to West Hampstead
JUB	West Hampstead to Willesden Green
JUB	Willesden Green to Neasden
JUB	Neasden to Wembley Park
JUB	Wembley Park to Stanmore
NOR	Morden to Tooting Broadway
NOR	Tooting Broadway to Stockwell
NOR	Morden to Tooting Broadway
NOR	Tooting Broadway to Stockwell
NOR	Stockwell to Kennington
NOR	Kennington to Moorgate
NOR	Moorgate to Euston (City)
NOR	Euston (City) to Camden Town
NOR	Kennington to Charing Cross
NOR	Charing Cross to Mornington Crescent
NOR	Mornington Crescent to Camden Town
NOR	Camden Town to Archway
NOR	Archway to East Finchley
NOR	East Finchley to Finchley Central
NOR	Finchley Central to Mill Hill East
NOR	Finchley Central to Totteridge & Whetstone
NOR	Totteridge & Whetstone to High Barnet
NOR	Camden Town to Hampstead
NOR	Hampstead to Golders Green
NOR	Golders Green to Colindale
NOR	Colindale to Edgware
PIC	Cockfosters to Oakwood
PIC	Cockfosters to Arnos Grove
PIC	Arnos Grove to Wood Green
PIC	Wood Green to Kings Cross
PIC	Wood Green to Hyde Park Corner
PIC	Green Park to Hyde Park Corner
PIC	Hyde Park Corner to Barons Court
PIC	Barons Court to Hammersmith (Piccadilly only)
PIC	Hammersmith to Acton Town (Piccadilly only)
PIC	Acton Town to Ealing Common (Piccadilly only)
PIC	Ealing Common to South Harrow
PIC	South Harrow to Uxbridge (Piccadilly only)
PIC	Acton Town to Northfields

PIC	Northfields to Boston Manor
PIC	Boston Manor to Heathrow
PIC	Hounslow Central to Heathrow
PIC	Hatton Cross to Heathrow
W&C	There cannot be a Partial Closure of the W&C

6.6 Appendix 4: Concerns Workbook Guide

- Guide to Functional Condition Concerns and Degradation Concerns worksheets.
- [FT] = Free Text (user enters number(s) or text) / [DDL] = Drop Down List (user selects from) / [AC] = Automated Cell (no user action).

Asset Group [Top Left]	[DDL] Select the group responsible for the Asset(s) in this Concerns Workbook. **Note: If no selection is made then the drop down field will not work in the Sub-Asset Group or the entire workbook.**
Company [Top Left]	[DDL] Select the business unit (APBCV/APSSL/APJNP) responsible for the Asset(s) in this Concerns Workbook. **Note: If no selection is made then the drop down field will not work in the Sub-Asset Group or the entire workbook.**
Reference	Concern No. (divided into three parts) as per the Coding System in Appendix 1, ACR Standard S1042.
Group	[AC] Single character that identifies the 'Asset Group' responsible for the Asset(s) in this Concerns Workbook. Note: The cell will auto populate once the 'Sub-Asset Group' is selected.
Company	[AC] Two digit code that identifies the business unit (APBCV/APSSL/APJNP) responsible for the Asset(s) in this Concerns Workbook. Note: The cell will auto populate once the 'Sub-Asset Group' is selected.
Unique Reference Number	[FT] User to enter the unique identifier used by the Asset Group in the responsible business unit (APBCV/APSSL/APJNP) which will refer to the Concern.
Location(s)	[FT] Enter the location(s) where there are Assets with the Concern. Include Asset ID(s) if appropriate.
BCV/JNP/SSL	[DDL] Select line(s) where there are Assets with the Concern.
Sub-Asset Group	[DDL] Select the Sub-Asset Group (taken from the Asset Group Hierarchy) which includes the Asset with the concern. Note: Only Sub-Asset Groups for the selected 'Asset Group' will be displayed. If the sub-Assets for a particular 'Asset Group' are not divided into Sub-Asset Groups please select '[Asset Group Name] Sub-Assets' option from the drop down menu. Note: 'Group' and 'Company' columns will auto populate once the Sub-Asset Group is selected in this cell.
Sub-Asset Affected	[DDL] Select the sub-Asset (taken from the relevant Asset Group Hierarchy) with the concern. Note: Only sub-Assets in the 'Sub-Asset Group' for the chosen 'Asset Group' will be displayed.

ACR No.	[AC] ACR Hierarchy Reference Number of the 'Sub-Asset Affected' for the Asset Group selected.
Concern Description	[FT] Details of all the applicable Functional Condition Codes need to be entered as formatted below. Information required for all Functional Condition Concerns - <Asset><objective defect with measure and threshold>...need only be entered once Code 1 (Legislation) - Reported by Assessors / Reviewed by Head of Technical Discipline. <Asset><objective defect with measure and threshold><how Asset breaches specific part(s) of legislation><reference to action plan proposed to/agreed with the enforcing authority><source of concern> Code 2 (Safety Risks to Customers and Staff) - Reported by COO / Reviewed by Head of Technical Discipline. <Asset><objective defect with measure and threshold><most probable failure mode/behaviour> and the potential <outcome/consequence - Note: number of fatalities and/or injuries will be calculated by the Concerns Workbook using data from the LUQRA Models. If the relevant Top Event or Base Event is not quantified in LUQRA then no estimate of the number of potential fatalities and/or injuries should be made>< source of concern> Code 3 (Extraordinary Maintenance/Operation) - Reported by COO / Reviewed by Sponsor / Asset Manager. <Asset><objective defect with measure and threshold><uneconomic because...> and/or <unsustainable because...> and <quantified description of the extraordinary maintenance and/or operation regime that has been adopted><source of concern> Code 4 (Performance Risk) - Reported & Reviewed by Sponsor . Asset Manager. <objective defect with measure and threshold><most probable failure mode/behaviour> and the ongoing/potential <outcome/consequence of><source of concern> Degradation Concern - Reported by COO / Reviewed by Sponsor / Asset Manager. <Asset><objective defect with measure and threshold><rationale for revised Physical Condition Code><source of concern>
Control or Mitigation	[FT] The Control and/or Mitigation associated with the Concern.
Plan to Ensure Future Compliance	[FT] Enter the proposed Plan to Ensure Future Compliance for the Concern. If there is no plan, then an explanation should be provided of why this is the case.
No. of Assets with Concern	[FT] Enter the number of Assets with the Concern on the line(s) selected. If the number is unknown an estimate must be made using professional judgement.

Total Asset Population on Selected Line(s)	[[FT] Enter the total number of Assets of this type on line(s) selected. If the number is unknown an estimate should be made.
% of Asset Population Affected	[AC] No. of Assets with the Concern' divided by 'Asset Population on Selected Line(s)', if known, expressed as % of total Asset population for the line(s). If user enters a higher 'No. of Assets with Concern than the 'Asset Population on Selected Line(s)'. The cell background turns red to alert the user.
No. of Base Events per Asset (i.e. for ONE Asset with the Concern)	[FT] Part 1 of 3: Enter the number of times the Base Event would be expected to materialise (Not the 'Top Event' which may occur as a consequence of it) for ONE Asset with the concern over the chosen time period - Part 2 ('Every') & 3 ('Unit of Time'). Example: "Base Event expected to occur 2 (Part 1: 'No. of Base Events Per Asset') times every 10 (Part 2: 'Every') year(s) (Part 3: 'Unit of Time')
Every	[FT] Part 2 of 3: Enter the number of 'Units of Time' (Part 3) that the 'No. of Base Events per Asset' would be expected to occur over for ONE Asset with the Concern.
Unit of Time	[DDL] Part 3 of 3: Select the unit of time – Day(s), Week(s), Month(s), Year(s) – for the chosen time period over which the 'No. of Base Events per Asset' are expected to occur.
Annual Frequency of Concern per Asset	[AC] The Annual Frequency the 'Base Event' may occur based upon the user input into columns 'No. of Events Per Asset', 'Every' & 'Unit of Time'.

Code 1	[DDL] **Code 1: Legislation** Condition Concern that states an Asset is non-compliant with statute. In this context 'statutory compliance' refers to requirements set out in law. "Statutory compliance" does not include the following unless they have been incorporated into law: • European Standards • British Standards • London Underground Standards • Codes of Practice and all other similar documents If statutory non-compliance is suspected an assessor must alert the appropriate internal authority (Head of Technical Discipline) who will confirm or deny the existence of a Code 1 after examining the Concern and consulting the LU Statutory Instrument Register. In this column of the Concerns Table the Assessor selects 'Suspected' (if applicable) and then either removes it or updates it to 'Confirmed' based upon the decision taken by the Head of Technical Discipline.
Code 2	[DDL] Code 2: Safety Risks to Customers and Staff Condition Concern that may cause an event with a potential safety consequence, fatalities and/or injuries, for customers and staff, that require either control or mitigation to achieve a risk level of ALARP or better by either: a) Withdrawal of the Asset from full duty; or b) Risk reduction by either control or mitigation measures not required by the original design of the Asset.
Top Event	[DDL] For Code 2 (Safety Risk to Customers and Staff) Concerns select the most likely, or closet match, Top Event (safety consequence) that may occur if the Concern materialises (Note: Only Top Events modelled in the LUQRA for the chosen 'Asset Group' will be displayed). If there is no good match select: 'Top Event not Quantified in LUQRA' - HSE will note these and take them into account when the relevant LUQRA model is next reviewed. The definitions and main scenarios detailed for each Top Event are listed in an Appendix 2 of the ACR Guidance Document.

Base Event	[DDL] Select the Base Event that most closely matches what may occur if the Concern materialises, potentially causing the 'Top Event' previously selected (Note: Only Base Events which can cause the pre-selected 'Top Event' for the chosen 'Asset Group' will be displayed). If there is no good match select: 'Base Event not Quantified in LUQRA' - HSE will note these and take them into account when the relevant LUQRA model is next reviewed.
Safety Consequence Probability [Hidden on User Version]	[AC] Returns the probability of the 'Base Event' causing the 'Top Event' for the line(s) selected using data from the LUQRA Model.
Annual Frequency of Top Event Occurring due to Concern per Asset [Hidden on User Version]	[AC] 'Annual Frequency of Concern per Asset' multiplied by 'Safety Consequence Probability'.
Average Consequence per Top Event (FWIs) [Hidden on User Version]	[AC] Returns the average annual FWIs for the chosen 'Top Event' for the line(s) selected.
Value of Average Consequence per Top Event (£) [Hidden on User Version]	[AC] Average Consequence per Top Event (FWIs)' multiplied by the Equivalent Fatality Cost (2011: £1.6m)
Annual Safety Risk per Asset (£) [Hidden on User Version]	[AC] 'Value of Average Consequence per Top Event (£)' multiplied by 'Annual Frequency of Top Event Occurring due to Concern per Asset'
Total Annual Safety Risk (£) (Top 20 Events Only)	[AC] 'Annual Safety Risk per Asset (£)' multiplied by 'No. of Assets with Concern'.
Code 3	[DDL] **Code 3: Extraordinary Maintenance and/or Operation Activities** Condition Concern that requires extraordinary operational and/or maintenance activities which are outside of the maintenance regime and considered to be uneconomic and/or unsustainable.

Total Annual Uneconomic and/or Unsustainable Cost (£)	[FT] If 'Yes' selected under 'Code 3' then, in this column, enter the annual cost of adopting the uneconomic and/or unsustainable maintenance/operation regime set out in the 'Concern Description' NOT the cost of rectification/replacement
VoT	[AC] The Value of Time (£) used by TfL in the reporting year
Code 4	[DDL] Code 4: Performance Condition Concern with an annual Lost Customer Hours (LCH) performance risk on the Underground Network of £250k or more a year. The Sponsor / Asset Manager are responsible for identifying and quantifying Code 4 concerns, based upon their analysis of CuPID and other data sources, and sharing these with the Assessor respectively, for inclusion in the Concerns Workbook, at least three weeks prior to the submission of the final draft ACR to the Asset Development Manager. The Sponsor / Asset Manager should also review any Code 1, 2 & 3 Concerns reported in the Concerns Workbook for their Asset group and quantify any that are likely to have a performance impact above £250k per year. A guide to using the NACHs Calculator is included in Appendix 3.
Type of Consequence	[DDL] Select the Type of Consequence that is most likely to occur if the Concern materialises.
Total ONE Day LCH Impact for ALL Assets with Concern	[FT] Enter the total ONE day LCH impact for ALL Assets with the Concern. This can be calculated using the NACHs calculator (refer to Appendix 3).
Average Estimated Duration (Days)	[FT] Enter the average estimated duration (in days) the Performance Impact would last if the risk materialised.
Total Annual Performance Risk (£)	[AC] 'Total ONE Day LCH Impact for ALL Assets with Concern' multiplied by 'Average Estimated Duration (Days)' multiplied by 'VoT' multiplied by 'Annual Frequency of Concern per Asset.'
Physical Condition Code	[DDL] Select a Physical Condition Code (A-D) to reflect the estimated Residual Life at the time of reporting.

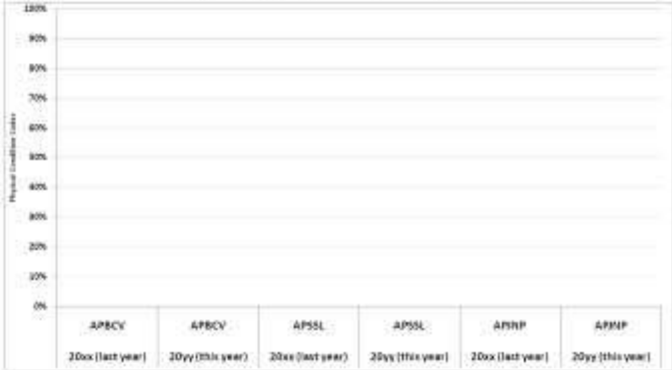
6.7 Appendix 5: The Summary Report

Do we need to consider the size of the font on the next two pages and provide some form of explanation?

Asset Group

ACR Physical Condition

		A	B	C	D
20xx (last year)	APBCV				
20yy (this year)	APBCV				
20xx (last year)	APSSL				
20yy (this year)	APSSL				
20xx (last year)	APJNP				
20yy (this year)	APJNP				



APBCV Physical Condition Commentary
Insert commentary here describing reasons for any significant changes to physical condition profile, compared to previous year.

APSSL Physical Condition Commentary
Insert commentary here describing reasons for any significant changes to physical condition profile, compared to previous year.

APJNP Physical Condition Commentary
Insert commentary here describing reasons for any significant changes to physical condition profile, compared to previous year.

Asset Group

ACR Functional Concerns (1-4): APBCV, APSSL & APJNP

		No
		Code 1
20xx (last year)	APBCV	
20yy (this year)	APBCV	
20xx (last year)	APSSL	
20xx (last year)	APSSL	
20xx (last year)	APJNP	
20yy (this year)	APJNP	

		Annual Risk £k		
		Code 2	Code 3	Code 4
20xx (last year)	APBCV			
20yy (this year)	APBCV			
20xx (last year)	APSSL			
20yy (this year)	APSSL			
20xx (last year)	APJNP			
20yy (this year)	APJNP			

Graph: ACR Codes 2, 3 & 4

APBCV Functional Concerns Commentary

Code 1	Insert commentary here describing the most significant Code 1 concerns. Comment on the reasons for any significant changes to the quantity of Code 1 concerns compared to the previous year.
Code 2	Insert commentary here describing the most significant Code 2 concerns. Comment on the reasons for any significant changes to the total annual value of Code 2 concerns compared to the previous year.
Code 3	Insert commentary here describing the most significant Code 3 concerns. Comment on the reasons for any significant changes to the total annual value of Code 3 concerns compared to the previous year.
Code 4	Insert commentary here describing the most significant Code 4 concerns. Comment on the reasons for any significant changes to the total annual value of Code 4 concerns compared to the previous year.

APSSL Functional Concerns Commentary

Code 1	Insert commentary here describing the most significant Code 1 concerns. Comment on the reasons for any significant changes to the quantity of Code 1 concerns compared to the previous year.
Code 2	Insert commentary here describing the most significant Code 2 concerns. Comment on the reasons for any significant changes to the total annual value of Code 2 concerns compared to the previous year.
Code 3	Insert commentary here describing the most significant Code 3 concerns. Comment on the reasons for any significant changes to the total annual value of Code 3 concerns compared to the previous year.
Code 4	Insert commentary here describing the most significant Code 4 concerns. Comment on the reasons for any significant changes to the total annual value of Code 4 concerns compared to the previous year.

APJNP Functional Concerns Commentary

Code 1	Insert commentary here describing the most significant Code 1 concerns. Comment on the reasons for any significant changes to the quantity of Code 1 concerns compared to the previous year.
Code 2	Insert commentary here describing the most significant Code 2 concerns. Comment on the reasons for any significant changes to the total annual value of Code 2 concerns compared to the previous year.
Code 3	Insert commentary here describing the most significant Code 3 concerns. Comment on the reasons for any significant changes to the total annual value of Code 3 concerns compared to the previous year.
Code 4	Insert commentary here describing the most significant Code 4 concerns. Comment on the reasons for any significant changes to the total annual value of Code 4 concerns compared to the previous year.

Asset Management Policy

		Issue date:	20 May 2014
Issue No.:	1	**Review date:**	March 2015

Policy Statement

TfL will use co-ordinated asset management activities to select, inspect, maintain, renew, improve and dispose of our assets in order to maximise customer satisfaction, maintain high levels of safety, manage risks, minimise whole life costs and enable delivery of our outcomes and priorities.

Strategic Objectives

To support and deliver the Policy Statement TfL shall:

- Establish, maintain and review asset management objectives, strategies and plans
- Engage with customers to understand their requirements and take account of these in the asset management objectives, strategies and plans
- Establish, maintain and review the organisation structure, roles and responsibilities for controlling, directing and delivering asset management
- Establish, maintain and review the activities (including people, processes, data and technology) that deliver the asset management policy, objectives and strategy
- Identify and manage asset related risks
- Consider Whole Life Value (including capital and operating costs) when making decisions at each stage of the asset lifecycle, and embed practices that support and inform consistent decision making and prioritisation
- Identify, manage and continually improve the information that supports decisions, ensuring it is accessible and of the required quality
- Develop and implement asset performance measures that inform decisions, monitor the delivery and effectiveness of strategies and plans, and support benchmarking
- Measure and continually improve asset management maturity including the training and competence of our people
- Share, develop and implement asset management practices to be consistent across TfL's portfolio of infrastructure assets
- Regularly review asset management practices to assess their appropriateness to the business and to identify areas for change and/or improvement

Lead Directors

TfL's Commissioner and Managing Directors are committed to this policy and are accountable for its provision, application and delivery. This policy shall be available to all employees and be publicly available.

Signed: TfL Commissioner

LU Asset Management Strategy

\June 2014

Head of Asset Strategy & Investment (S&SD)
Palestra
LONDON
SE1 8NJ

Contents

1. Foreword

London is at the heart of the UK economy and continues to grow with forecast population levels predicted to increase to just under 10million by 2031.

For the last 150 years we have kept London moving and grown with the changing times and customer needs. We must continue to do so, and our response to growing demand is investment in new trains and signalling systems, increasing the capacity of our stations and ensuring that the underlying infrastructure is 'fit for purpose', both today and in the future.

We have already upgraded the capacity on Jubilee and Victoria lines, and the Northern, Sub Surface (Metropolitan, District, Hammersmith & City and Circle) lines are well under way. This over the next ten years will constitute a £17bn programme of improvements to the network with plans in place beyond that period to introduce further investment by providing a 'New Tube for London' to ensure that the Piccadilly, Central and Bakerloo lines are also upgraded.

Customers are at the centre of our Vision for the Tube – 'To be world class'. Therefore a consistent and coherent approach to managing our assets is key to ensuring that this is achieved. We need to meet our customer expectations through ensuring that our investment is suitably prioritised, performance continues to improve, and our financial efficiency is increased.

This Asset Management Strategy has been developed to provide an overall view of the challenges and opportunities that our network faces and how our assets provide a key contribution to ongoing success of this iconic railway system.

The document is aimed at internal and external stakeholders alike as well as industry peers and suppliers to communicate how the assets will play a significant role in meeting our corporate vision for the railway and hence provide a strategic focal point to align and develop appropriate technical strategies (in order to exploit future technology) and to enable us to build effective and efficient medium and long term delivery plans.

2. Background

This **LU Asset Strategy** sets out the long-term direction for our key physical assets, notably: **Train Systems (i.e. Fleet, Signalling and Control, and Cooling assets), Power, Track, Civils, Stations, Lifts & Escalators and Communication Systems**. The strategy outlines the role and contribution of our assets and how, through LU's Asset Management Policy & Framework, we will manage them in order to assist the delivery of our **Vision**, **Strategy** and **Priorities**.

2.1 Our Vision, Strategy & Priorities

London is a growing city, not only in terms of its population (forecast to grow over the next decade by the equivalent of two full tube trains every week), but also in terms of its reputation on the world stage and its importance to UK economic recovery.

Rail & Underground (R&U) as part of an integrated Transport for London (TfL), must play its part in *'keeping London working, growing and making life in London better'*, by providing more services at better value, whilst offering an improving customer experience. Our response to this is to offer a Vision for the future of our network which sets a strong direction and imperative for change:

Vision

To be world class

Our understanding of 'world class' is framed by the context within which we operate – with the challenges of an aging network, accelerated demand growth, and economic constraints. As such this requires us to:

- Run a reliable service every day, safely and with high standards of customer care;
- Deliver new assets and introduce technology on time and to budget, minimising the disruption to customers, changing the way we work to make R&U more efficient and able to get the most from the new equipment;
- Harness the skills, talents and energies of our people, ensuring we can continue to improve as one team; and
- Deliver everything we do at a sustainable cost that London can afford, and derive value from it;

This is what world class means: world class **customer** service; world class **delivery**; world class **people**; and world class efficiency, and therefore **value**.

Our **Strategy**, to reach our Vision is therefore:

Strategy

To deliver a reliable train service with high standards of customer care, efficiently, through our people and technology

This is our guide in helping us determine the right path to take. It can be broken down, like the **Vision**, into four pillars – **Customer**, **Value**, **People** and **Delivery**:

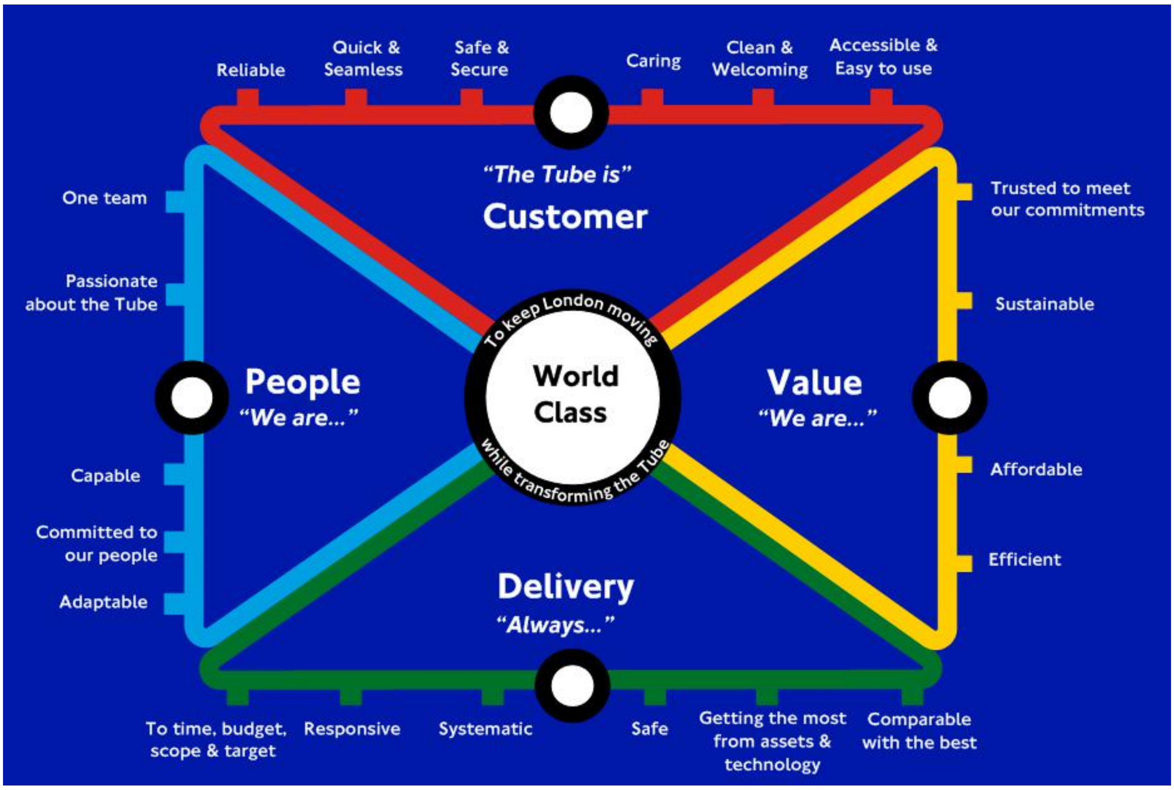


Figure 1: The R&U Strategic Framework

These four pillars lie at the heart of our Strategic Framework and ensure that our plans for the future do not focus solely on one objective without acknowledging how this will affect the whole. Our transformation is long term – we are just part way through it, and we have recognised that we cannot expect to achieve everything all at once. We have therefore set out four key, immediate priorities:

Our Priorities

Figure 2: The R&U Priorities

Reliability & Safety: A reliable and safe service is the bedrock of our organisation. Without this, we cannot deliver improvements to capacity or improved customer service. Since 2000 there has been a 20 fold improvement in safety and our reliability has doubled. We need to continue this trend, ensuring all customers see the benefit and that we meet our target to reduce Tube delays by a further 30% by 2015.

Capacity from the current network: The Tube is one of the largest metro systems in the world and with the reach of the other TfL modes, we truly do encompass all parts of London. Investing in our network to maximise capacity and reliability will help us manage the crowding we experience in the face of rising demand. This means not only upgrading lines which have yet to be renewed, but further maximising capacity from the investment which has already been made.

Capacity from growing the network: London is growing and the existing network cannot meet the demand which will be placed on it in the future. Expanding the R&U network through projects like the Northern Line Extension will reduce crowding and increase capacity; as well as providing better transport accessibility to key parts of London.

Customer Service: Changing customer expectations (including 24hr running) means we must move away from a 'one size fits all' approach and deliver a personalised and consistent service. Ensuring that we have skilled and capable staff in the right roles, supported by cutting edge technology is crucial to providing a modern, cost-efficient service.

In summary, our **Vision**, **Strategy** and **Priorities** set a clear direction for the business, and it is within this context that LU's Asset Strategies have been developed.

3. The Role of our Assets

So what are our assets, how will they contribute to the delivery of our **Vision**, **Strategy** and **Priorities**, and how are they managed?

3.1 Our Assets – In Numbers

We manage an extensive and varied asset base that requires high quality stewardship. In 2012, LU operated 76m train km, enabling 1229.3 bn Passenger Journeys. An operation of this magnitude is only made possible by the effective management of our:

600	Trains
4	Major signalling systems (soon to be 5)
1,000+	Kilometres of track
1,000+	Points & Crossing units
272	Stations
430	Escalators
184	Lifts
4	Passenger conveyors
500+	Kilometres of drainage
16,000	Bridges & Structures
350	Kilometres of Deep Tube Tunnels
235	Kilometres of Earth Structures
Plus	Numerous other communication, fire, electrical, mechanical and power systems

The cost of maintaining and renewing these assets is approximately £2.4bn per annum, which represents around 65% of LU's total budget:

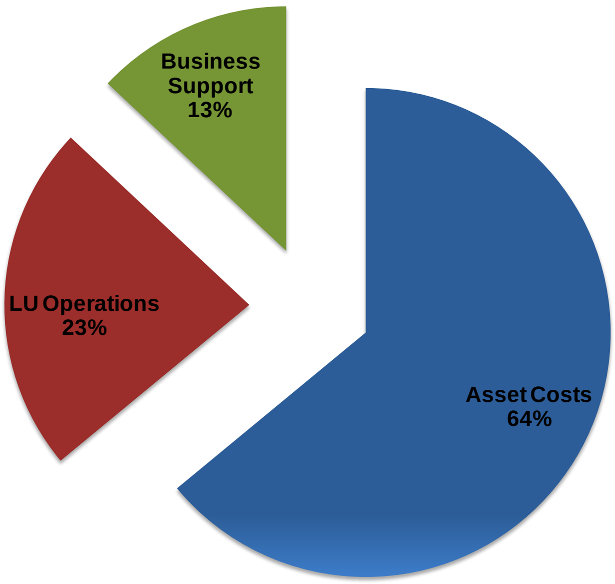


Figure 3: Breakdown of LU budget (TfL Business Plan 2013/14)

Approximately 60% of the investment in assets focuses on upgrade and renewal projects, with 40% supporting day-to-day maintenance:

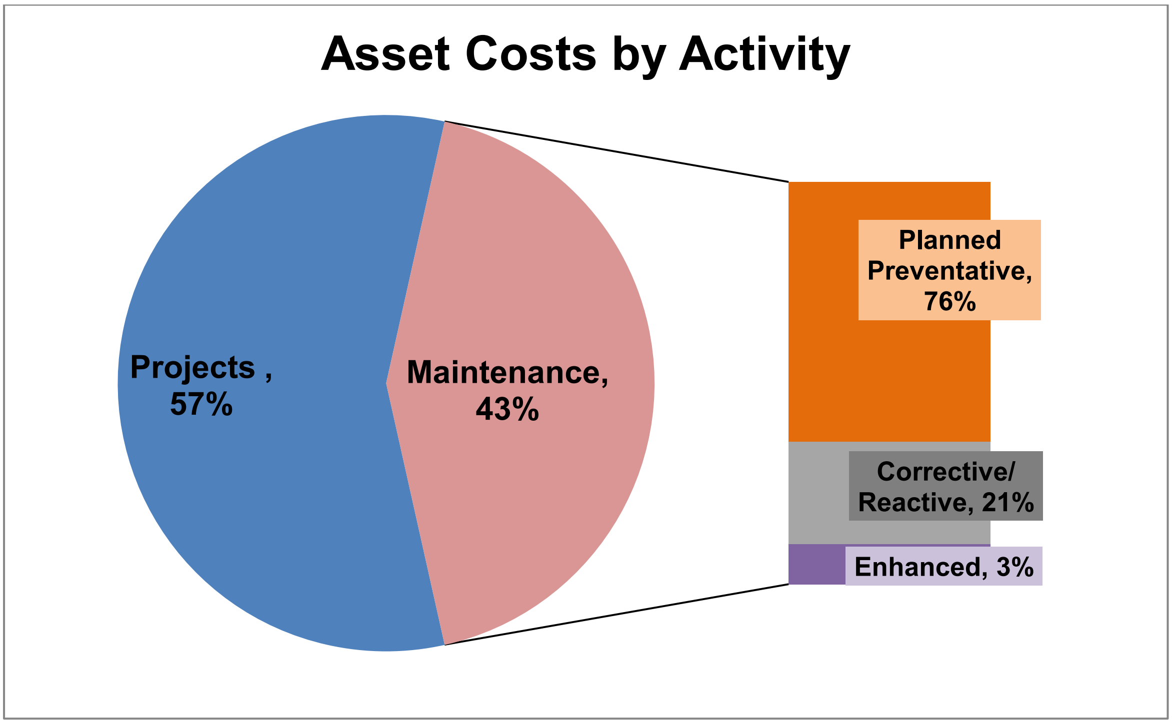


Figure 4: Breakdown of LU asset spend by type of spend (TfL Business Plan 2013/14)

With 80% of the investment focusing on trains systems, track and stations:

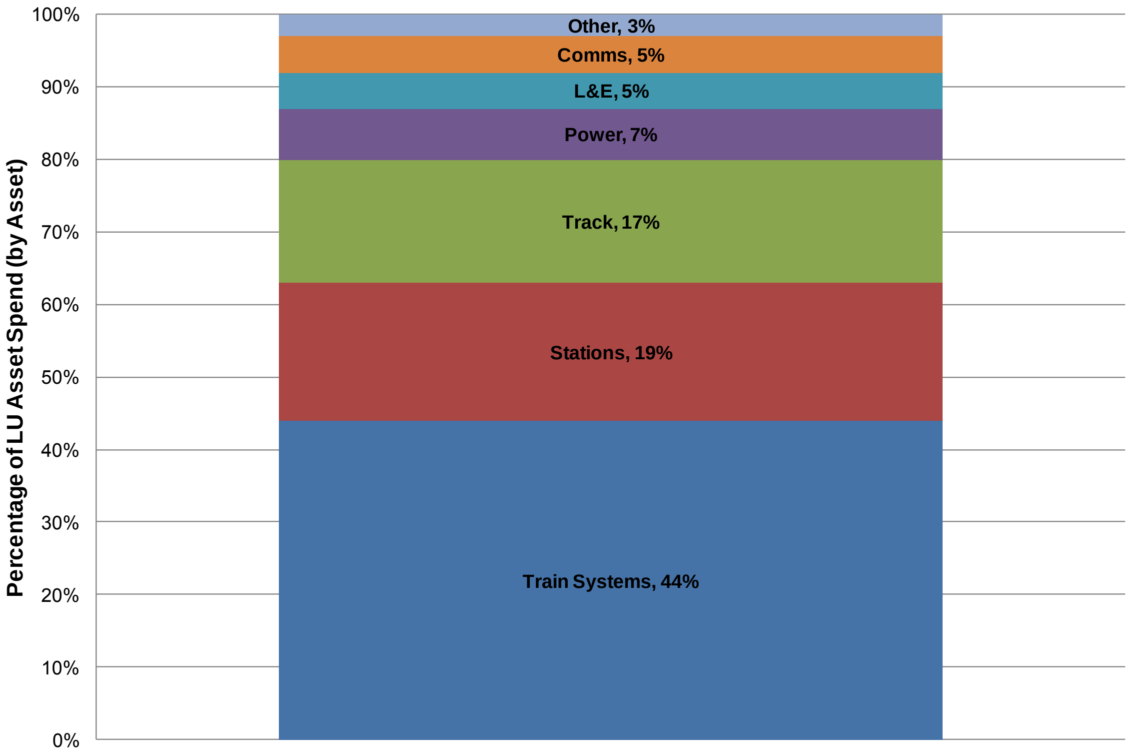


Figure 5: Breakdown of LU asset spend by asset (TfL Business Plan 2013/14)

Tube reliability has doubled since 2000, and enhancements to our assets have played in big role in reducing delays:

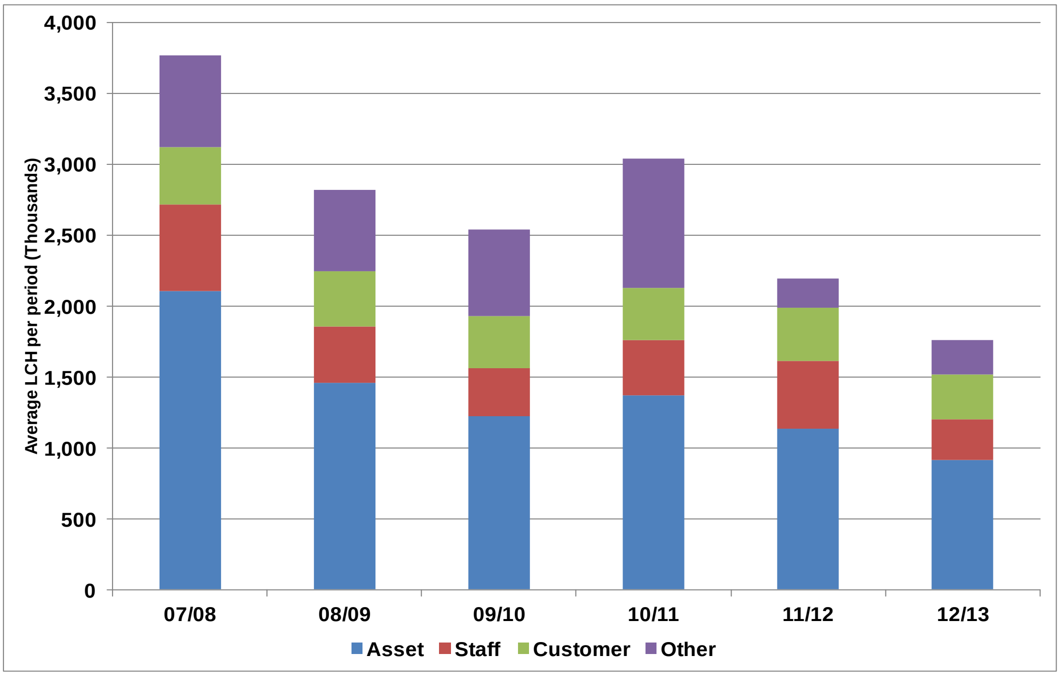


Figure 6: LU Reliability (Lost Customer Hours; 2007/8 to 2012/13)

But asset related failures still account for 50% of the total delays on the network, and we must continue to support the drive for improved reliability, focusing on those assets which offer us the greatest opportunities (or risks):

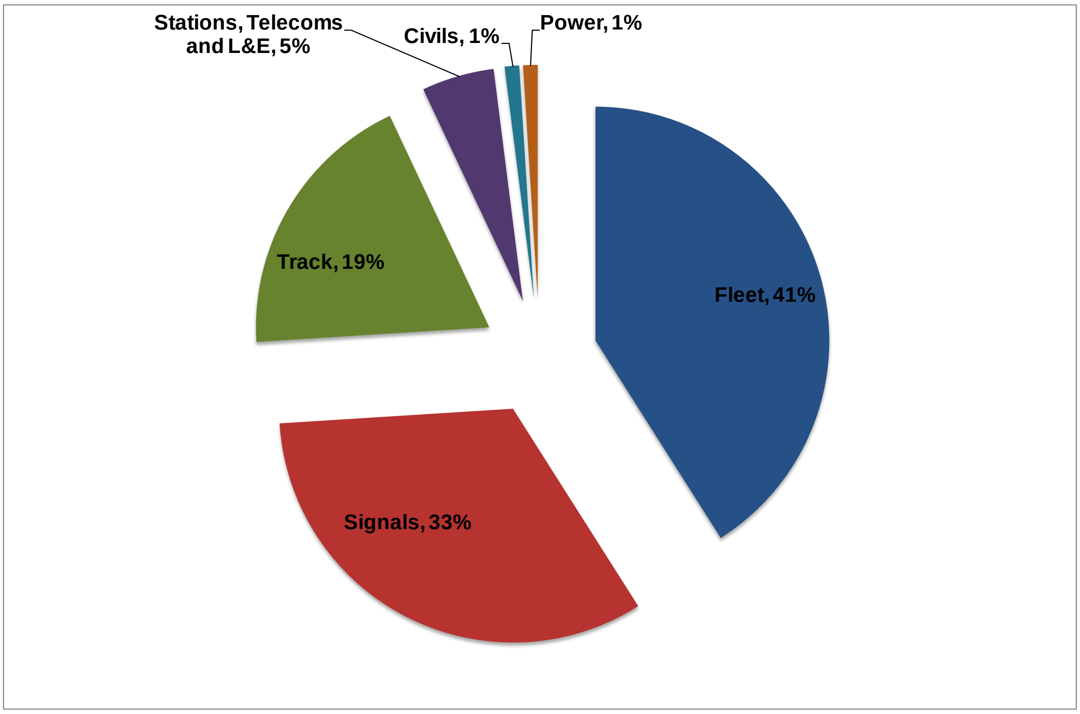


Figure 7: Breakdown of Total Lost Customer Hours for Assets (by Asset)

4. LU's Asset Management Policy

4.1 Asset Management Policy Statement

TfL will use co-ordinated asset management activities to select, inspect, maintain, renew, improve and dispose of our assets in order to maximise customer satisfaction, maintain high levels of safety, manage risks, minimise whole life costs and enable delivery of our outcomes and priorities.

4.2 Asset Management Strategic Objectives

To support and deliver the Policy Statement TfL shall:

- Establish, maintain and review asset management objectives, strategies and plans
- Engage with customers to understand their requirements and take account of these in the asset management objectives, strategies and plans
- Establish, maintain and review the organisation structure, roles and responsibilities for controlling, directing and delivering asset management
- Establish, maintain and review the activities (including people, processes, data and technology) that deliver the asset management policy, objectives and strategy
- Identify and manage asset related risks
- Consider Whole Life Value (including capital and operating costs) when making decisions at each stage of the asset lifecycle, and embed practices that support and inform consistent decision making and prioritisation
- Identify, manage and continually improve the information that supports decisions, ensuring it is accessible and of the required quality
- Develop and implement asset performance measures that inform decisions, monitor the delivery and effectiveness of strategies and plans, and support benchmarking
- Measure and continually improve asset management maturity including the training and competence of our people
- Share, develop and implement asset management practices to be consistent across TfL's portfolio of infrastructure assets
- Regularly review asset management practices to assess their appropriateness to the business and to identify areas for change and/or improvement

4.3 Lead Director & Policy Champion

The TfL Board, Commissioner and Managing Directors are committed to asset management and accountable for its provision, application and delivery. This policy shall be communicated to all employees and be publicly available.

5. Asset Management Framework

5.1 The Asset Management Framework: An Overview

Integration of activity and decision making across an organisation is one of the key principles of effective asset management. LU's approach to asset management is structured around the AM framework in fig 8. The AM framework sets out the clear conceptual view of how all the elements of LU's business are integrated in a single integrated approach. This provides the line of sight between the R&U strategy, overall business objectives, and delivery of maintenance, and project activities.

The LU AM Framework identifies the following key elements:

- This Asset Management Policy & Strategy (AMS)
- The Asset Strategies
- The Asset Plans (a component of the Line, Asset and Network Plan)
- Asset management enablers
- Implementation of the asset management plan through integrated delivery processes across the entire asset lifecycle.
- Performance measurement and continuous improvement
- Management review

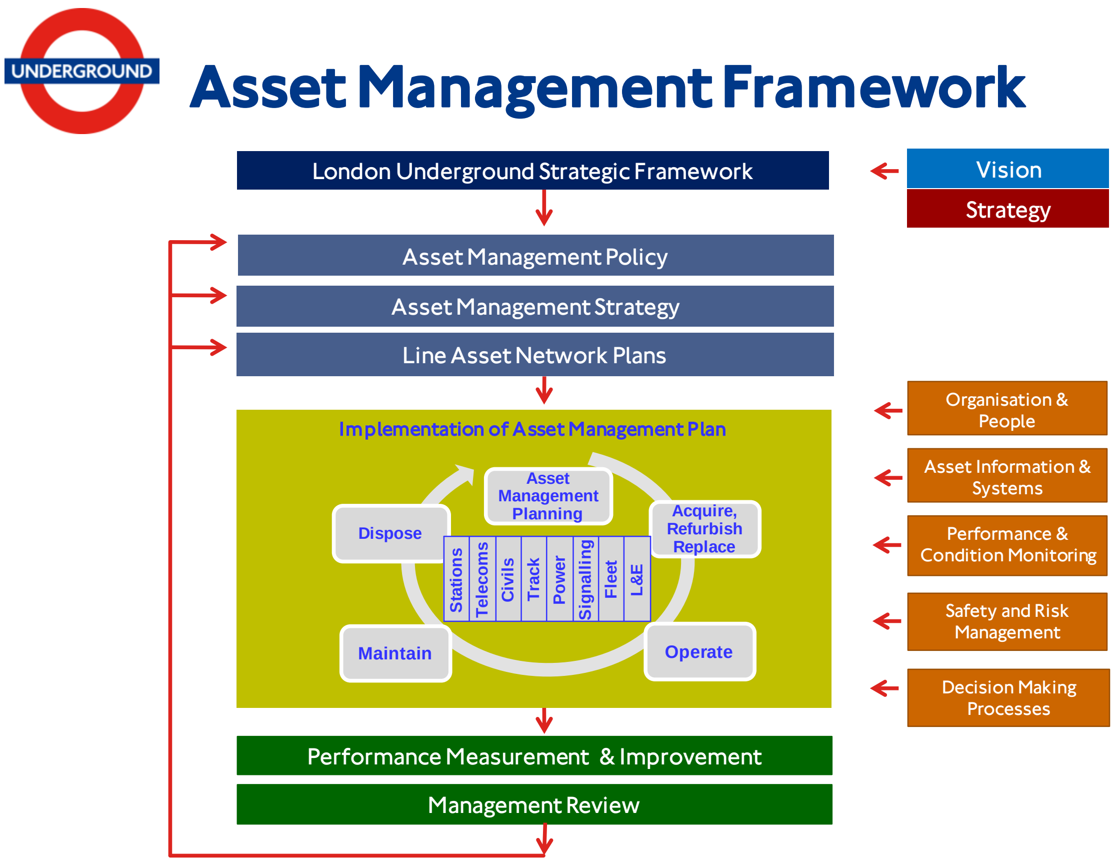


Figure 6: Asset Management Framework

5.2 Key Components of the Asset Management Framework

5.2.1 *Asset Management Strategy*

The AMS covers the AM Policy and Strategy and provides the fundamental guidance within which asset management is to be conducted, together with the high level approach to be taken across the whole lifecycle to ensure assets support progression to the R&U Vision for R&U. The AMS also provides detail of how to achieve the AM Policy.

The AMS includes the asset the Asset Strategies for each asset group which provide the detailed approach and strategies to manage the assets, including specific approaches that apply only to an individual asset group. Together, the AMS and Asset Strategies address the overall approach to be taken to achieve LU's asset management objectives.

In addition the Asset Strategies:

- Provide internal stakeholders with a clear view of the asset's contribution to strategic priorities, and the rationale for the chosen strategy
- Demonstrate due diligence to external stakeholders, providing confidence in our overall approach to managing assets and supporting the case for investment.

5.2.2 *Line and Asset Network Plans*

The LU Asset Plans set out R&U's plans to deliver its Asset Strategies, within a Line, Asset and Network (LAN) Plan package. The LAN package is produced annually by S&SD at the end of the business planning cycle and includes (by asset group) the project and maintenance activity (incorporating the Annual Maintenance Plans) that is funded within the latest approved R&U Business Plan together with the forecasted performance outcomes of that investment. The outputs of the LAN set the baseline for the R&U scorecard target setting process and future Business Planning rounds.

5.2.3 *Enabling activities*

The enabling activities support the delivery of the overall strategy and are essential to ensure a consistent and effective approach. These cover:

Organisation, and people : ensuring people in the organisation have the competences, are available in sufficient numbers and are organised to effectively deliver their tasks and manage organisational interfaces.

Asset Information management: Information is the life blood of asset management and having the appropriate level and quality of information to support decision making is essential.

Decision making processes: optimising risk, performance and cost are at the heart of LU's approach to decision making and LU are continually refining the decision making processes to improve decision making throughout the asset lifecycle including maintenance vs renewals decisions.

Performance & Condition monitoring: an understanding of the interrelationship between performance, asset condition and the mechanism by which an asset degrades across its life is central to effective investment decision making.

Safety, and risk management: ensuring that our assets are safe is a t the core of our approach to asset management together with a full understanding and effective control of asset risks.

5.3 How we are Organised

LU is set up as a sponsor/deliverer organisation. The sponsor acts as an internal client to make sure that the needs of the business are being addressed at every stage of the asset lifecycle. Work is delivered by the project and maintenance teams and the support functions work with both the sponsor and the deliverers and provide consistent services to all parts of the organisation.

Each group of assets has a strategy which details the asset goals and how these goals will be achieved. These strategies are detailed further in this document.

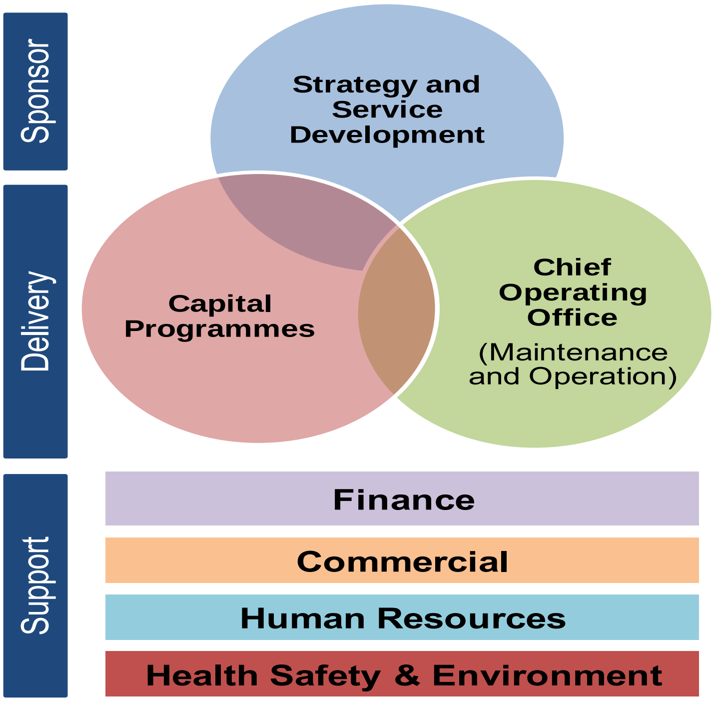


Figure 9: the Sponsor and Deliverer organisation

6. Asset Strategy

6.1 Context

London Underground is the oldest metro in the world and its asset base is both large and diverse. Annual passenger journeys are forecast to increase by 22% by 2021. Parts of the system are already operating at full capacity during morning and evening peak hours, resulting in train and platform overcrowding, most prevalent in central London areas. Morning peak service crowding severity is illustrated by orange, brown and black on the crowding map. Whilst the introduction of Crossrail in 2018 will relieve some pressure, London Undergrounds strategic challenge is to find new capacity.

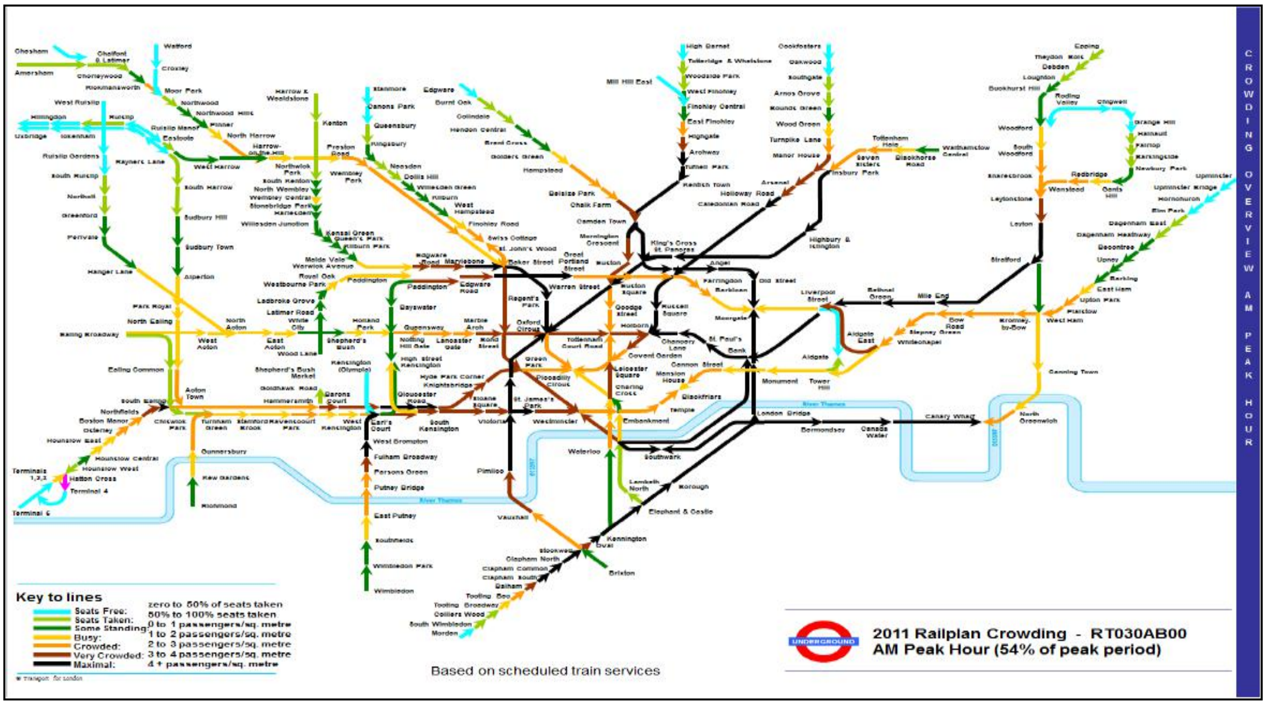


Figure 10: Peak Crowding Summary

6.2 Our Asset Management Goals

- ***Ensure good performance from our existing assets***, by:
  - Having the right information on our assets at our disposal.
  - Utilising technology where we can to detect faults before they occur.
  - Persistent attention to detail, focused on minimising root causes of failures.
  - Maintaining assets based on criticality/ need - this removes the potential for human error from unnecessary and costly time interval maintenance.
  - Making the right whole life cost decision for our assets.
- ***Harness the potential of new technology***, designing reliability in upfront and making the most of innovative solutions offered by the supply chain
- ***Seamlessly integrating new and legacy assets***, and ensuring we exploit the full performance capability of the system.
- ***Drive down the costs of energy consumption***, improving not only financial but also environmental sustainability.
- ***Strike the right balance on access*** – efficiently use access and eliminating instances of frustrated access, so that we are able to make the best decision between closing the network for work and keeping the service running.
- ***Embed the drive for greater efficiency in the business, utilising benchmarking intelligently and routinely*** to identify and implement best practices and thus realise significant productivity and process savings.
- ***Buy new assets at the right price*** and being more commercially astute as we enter contracts, dismantling barriers and working practices that prevent us getting better value from our suppliers.
- ***Have a proven track record of safe delivery*** – we will put the principle of 'Zero Harm' at the heart of everything that we do for our customers, staff and contractors.
- ***Maximise the value obtained from our assets throughout their life, where affordable -*** We will use lifecycle costing and value optimisation techniques and models to support our asset management decision making.

- ***Improve the quality of our asset information –*** by establishing a strategy and ensuring an integrated approach to Asset Information within LU.
- ***Develop the competence of our people –*** we will develop our staff ensuring that they understand and can apply the principles of asset management.

6.3 The role of the Assets

The network serves 11 lines over a total route length of 402km, 350km operating underground. Our 600 trains are controlled by four signalling systems (soon to be five) consuming £129m of power each year. The network is served by 272 stations, operating 430 escalators, 184 lifts, 4 passenger conveyors, telecommunications, fire, electrical and mechanical assets.

We operate our service across 866kms of track (with over 1000 sets of points and crossings), 500kms of drainage and 181kms of track in our 14 depots. We have over 16,000 bridges and structures, 350km of deep tube tunnels and 235km earth structures.

The cost of maintaining and renewing these assets is £2.4bn per year, which represents 64% of LU's total budget, with the cost of operating the assets 23%.

Our assets are fundamental to the delivery of our objectives and have an enormous impact on the customer experience if they perform poorly. Assets therefore need to be maintained in a reliable condition and life-expired assets replaced to further improve asset performance and delivery efficiency.

The **Train System** assets comprise **trains, depots, signalling and control and information and cooling**. These assets will maximise service capacity through new line upgrades, and moving block signalling technology. Newly upgraded lines will be enhanced to deliver the maximum service capacity, striving to operate up to 36 trains per hour to deliver a 'world class' service. The maintenance approach will be transformed to facilitate 24 hour weekend service operation whilst continuously improving asset reliability.

Power assets must to renewed and enhanced to provide sufficient power to operate the more intense service enabled by the line upgrades, ensuring a sustainable and energy efficient approach is adopted.

Our **Infrastructure** assets, including **track** and **civil** assets must support increasing levels of traffic, travelling at greater speeds with heavier rolling stock whilst preventing any adverse impact to service. The approach to both maintenance and renewal must change to meet reduced access levels, achieved though component standardisation, move to a predict and prevent condition based maintenance approach, more mechanised maintenance to increase the volume of work delivered with existing resources, and the exploitation of new technologies such as new track forms with lower implementation and maintenance costs.

Our **Stations** will be attractive, spacious, light, clean, reflect our heritage, and will be more accessible through increased levels of step free access. Stations assets together with our **lifts** and **escalators** are critical to managing congestion and improving the service we provide to our customers. Additional station capacity needs to be provided at key locations to meet the capacity brought about through the planned line upgrades, national rail developments and rising passenger demand.

7. Train Systems

7.1 Strategic Summary

LU delivered 1.23bn trips in 2012/13, the greatest in its history. Adding DLR, Croydon Tramlink and London Overground, TfL R&U is now close in annual passenger journeys to the entire national rail system. Extra capacity to meet ever-growing demand has been delivered incrementally every year for many years, and, based on capital projects and programmes already authorised and underway, will be into the future. Despite this, demand remains unsatisfied. The VLU was completed in January 2013 delivering more than 20% capacity increase and yet the Victoria line remains crowded.

Except for rare additions such as the Jubilee Line Extension, the Northern Line Extension and the Croxley Link, LU's infrastructure is essentially fixed. The Train Systems Assets (trains, signalling, communications and information, power and cooling) by contrast are more readily scalable. The asset management challenge is to bring the capability of the train system assets up to the full potential of the fixed infrastructure and maximise the capacity of the LU system as a whole, at an affordable cost,.

The train system assets have therefore typically renewed to increase capacity, and not because of their condition,. This reflects their nature: there is no concept of like-for-like renewal as with say a station, a bridge, a kilometre of track, or a set of points. At the time of renewal (trains and signalling assets have a 'typical' lifespan in the order of 40 - 60 years). Changing technology and growing demand means the need to renew is in practice an opportunity to upgrade.

Renewal of train system assets is extremely capital-intensive and must be carefully coordinated on a line basis: a 'line upgrade'. New capacity typically requires renewal of all trains and signalling, new or upgraded power and cooling. Line upgrades dominate LU's capital spending and due to constraints of funding, access and engineering resource purposes, only one or two can be physically underway simultaneously. At times there have been no line upgrades in progress which inevitably leads one or two decades later to an investment backlog. The line upgrade cycle – from conception through planning and funding to implementation and completion – can be up to 20 years..

Between renewals the assets are subject to maintenance regimes to keep them in a stable, serviceable and safe condition, primarily through the replacement of worn components with new or refurbished at set intervals or on inspection. In addition train system assets require capital interventions between renewals varying from small (sub £1m) to large (train overhauls and refurbishments can be valued up to £100m). These projects must be carefully scoped and coordinated with the renewal/upgrade cycle. Sometimes they take the form of life-extension works and towards asset end-of-life the choice between investing in existing or new assets becomes complex influenced by cost, asset condition, stakeholder, capacity, maintenance and operating costs and legislation.

The train system assets are responsible for the overwhelming majority of system unreliability; are intensely safety-critical; and are subject to many 'network' issues, spanning across several asset groups, such as wheel-rail interface, tunnel heating, tunnel dust, platform train interface and rail adhesion. The challenges that LU faces in these areas are amongst the most difficult in the worldwide railway industry.

The train systems assets are also discrete on a line-by-line basis. LU operates 11 different lines, although several of these interoperate and share assets. In general, though, the fleets and signalling systems on each line are self-contained and, because of the 40-60 year renewal cycle, at any time there will be train system assets from different technological eras. For example, there are 'legacy' train fleets (72TS, 73TS, C and D Stock) with electro-mechanical traction packages, fabricated aluminium bodies and steel frames; 'middle-aged' fleets (92TS, 95TS and 96TS) with extruded aluminium body shells and early electronic traction and control systems; and new fleets (09TS and S-Stock) with modern, fully computerised traction and control systems. LU thus has some of the oldest trains (C Stock) and the newest (S-Stock) in the country. A similar situation pertains for signalling, with traditional electro-pneumatic and mechanical fixed block signalling increasingly being replaced by new computer based signalling systems (SSL ATC, JNUP TBTC, Victoria Line DTG-R) which comprises of wayside, train borne and central control assets.

LU's train system assets are extremely large and intensively used. With over 600 trains it has nearly three times as many vehicles as the largest UK mainline train operating company. The purpose of this document is to describe, on a line-by-line basis, the strategies that LU will deploy to manage its Train Systems assets against the business objectives and priorities.

Train system asset management strategies have delivered sustained lowered unit costs; increased capacity; excellent safety; and best-ever reliability. This document describes how LU plans to further improve these trends into the future.

Train systems covers rolling stock, depots and signalling assets across the London Underground (LU) network. There are over 600 passenger trains (as well as additional engineering trains and support vehicles) operating on 11 lines over a distance of 402km. The fleets are maintained at several depots and controlled by 4 different types of signalling and control systems (soon to be five). The frequency of trains is such that over 75 million kilometres was travelled in 2012/13.

Train systems assets will provide reliable, secure, quick and seamless daily train service while ensuring that customers feel safe, secure and cared for whilst using our services. The delivery of line upgrades will be efficient and systematic to ensure objectives are achieved to time, budget, scope and target with minimum disruption to passenger services. We will deliver environmentally sustainable and affordable solutions, and will be regarded as a good steward of public funds. Structural cost improvement within the maintenance and operational organisations will be achieved through delivering a robust programme of efficiencies that seek to optimise maintenance and incident response and improve productivity. In doing so, LU will improve maintenance quality, optimise frequency and improve efficiency without compromising safety.

The primary challenge for train systems assets is to meet the increasing passenger demand on the network whilst accommodating increased service including 24hr running at weekends.

7.2 Our Goal

Our overall goal for Train Systems is to:

Deliver a safe, comfortable and reliable train service that unlocks the full capacity of our assets against the potential of the fixed infrastructure

To deliver our goals for our Train Systems assets we will:

Deliver a programme of line upgrades to grow the capacity of the existing network which exploits the capability of modern signalling and control systems, prioritises upgrades where most needed and enables the transformation to a more reliable and cost effective maintenance regime.

Maximise the benefit of newly upgraded assets (such as the Jubilee, Northern and Victoria lines) to maximise the line potential, striving to operate world class capacity of up to 36 trains per hour, achieved by identifying and eliminating infrastructure pinch points and, in the case of Jubilee and Northern, procuring additional trains to expand the fleet stock to operate full service capacity.

Develop a ***'New Tube for London'*** *which sets out the plans for a co-ordinated approach of next generation line upgrades* focused on upgrading the 'deep tube' train systems on the Bakerloo, Central and Piccadilly lines with modern technology enabled assets which improves safety, capacity and automation.

Support the delivery of R&U's extension programmes by ensuring that major schemes such as Croxley Rail Link and Northern Line Extension adopt assets that meet the capacity needs of the network, relieve congestion, provide better transport accessibility, integration for customers and promote growth.

Look to minimise passenger disruption during upgrades by utilising off-site fleet and software testing to reduce the need for closures.

New fleets designs will consider the future needs of our customers and staff including their impact on the environment, maintainability, operability (including the option of driverless trains), security and safety, accessibility, ambience and provision of real-time customer information etc.

Standardise systems and new assets to reduce variability, improve system interoperability and reduce whole life maintenance and renewal costs.

Provide maintenance regimes and life-extension renewal works that prioritise safety, reliability, meet legislative and passenger comfort requirements and evolve to changing needs. Initiatives will be assessed against criteria such as reliability, stakeholder needs, operating costs and legislation to transition our service to an increasingly **'**world class**'** position.

Promote an environment of continuous improvement to deliver world class performance by identifying what is possible for each system and line through the use of benchmarking, both internal and external, coupled with a commitment to work with industry peers and our supply chain to implement the advantages offered by technology.

Adopt a 'predict and prevent' asset stewardship approach; as signalling systems are upgraded to transmission/communication based systems, in built diagnostic and condition monitoring will improve fault detection and maintenance response, and may provide some self or remote restoration revolutionising the approach to maintenance.

Transfer fleet maintenance from a service hours approach to a condition and usage basis to focus interventions on criticality, exploiting our knowledge of the assets with remote condition monitoring technology integrated with our maintenance management system whilst exploiting the use of hand held devices.

7.3 Contribution to key Rail and Underground priorities

7.3.1 Reliability & Safety

Reliability

Train systems have the largest contribution to availability and therefore targeting these assets provides the greatest benefit. We need to continue to improve reliability to achieve fewer service disruptions achieved by;

- Implement life extension works on the Piccadilly, Bakerloo, Central and Waterloo & City lines to provide serviceable, reliable and safe operation until assets are upgraded.
- Change fleet maintenance, moving from service hours to condition or usage based, exploiting our knowledge of the assets and technology integrated with our maintenance management systems.
- Adapt signal maintenance regimes following upgrade by optimising frequencies through risk based maintenance and multi skilled staff, continually reviewing maintenance practices
- Improved monitoring and diagnostics, including real time monitoring and automated trackside monitoring of components to capture deterioration in train systems performance and adoption of predict and prevent strategy based maintenance regimes

- Invest in our staff to develop their competency, adapt to changing technology and drive high quality maintenance.
- Use of redundancy and commercial off-the-shelf (COTS) components in system design to minimise the impact of obsolescence.
- Understand the 'wheel-rail' interface following upgrade to inform and maximise the effect of track and fleet maintenance to reduce whole life asset costs.
- Continuously improve rail adhesion management, considering 'predictive systems' to facilitate breaking under increased service intensity.
- Case by case investment in component renewals to address failures funded through capital interventions or business as usual activities such as RAMS

Safety

Safety is at the heart of everything we do and means taking an uncompromising approach to health, safety and the environment. There has been a 20% improvement in safety since 2000. We will continue to improve the safety of the network by;

- Maintenance mechanisation and improved signalling and fleet working practices, measured by safety performance KPI's
- Ensuring we systematically and rigorously follow the maintenance regime and the work arising instructions to maintain safety risks as ALARP.
- Implementing modifications and projects to ensure that the safety integrity of our assets is maintained.
- Deploying information technology and our professional engineering expertise to better understand the relationships between asset degradation, performance, cost and risk, giving better control of the emergent properties of the railway.
- Exploiting innovation to improve safety such as the use of new type of tools and equipment to maintain and upgrade assets
- Deliver into service new trains with improved crashworthiness, through gangways and saloon CCTV to provide a safer passenger environment.
- Deliver comprehensive Automatic Train Protection (ATP) throughout the network with continuous speed supervision providing increased passenger protection compared to traditional (trainstop-protected) systems.
- Improved depot security through CCTV and guarding

7.3.2 Capacity from the current network

The central areas of the LU network are intensely crowded, as shown in Figure 1. Service disruptions in central areas cause major delays and passenger congestion. Failure reduction/avoidance and reduction in failure response times is a key priority as a more reliable service allows greater capacity to be regularly achieved.

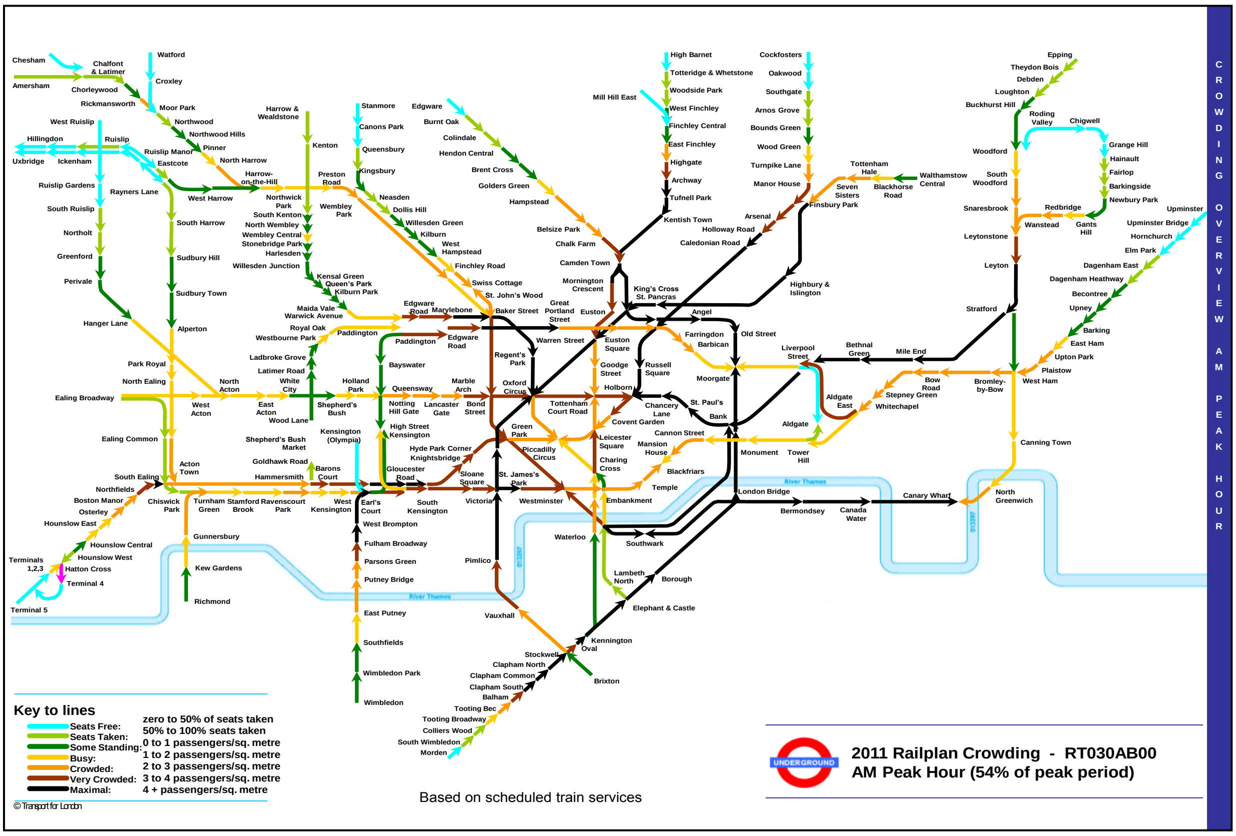


Figure 11: Overcrowding map

Extracting greater capacity from the existing network is a core objective. In the context of train systems this will be achieved by a combination of line upgrades, capacity improvements and improved utilisation of existing assets. The timely delivery of the SSR, Northern Line and “New Tube for London” upgrades and exploiting the spare capacity provided by the recent Victoria and Jubilee Line Upgrades is the primary focus and dominates our capital expenditure.

We will continuously refine existing timetables to provide improved peak services, longer operating hours (e.g. all night running) and improved weekend services. This will increase fleet utilisation e.g. increase in kilometres run and number of trains in service. All decisions to amend timetables are done in accordance with business case methodology.

The core measures of capacity are system based and include trains per hour (tph) and the Journey Time Metric (JTM).

7.3.3 Capacity from growing the network

The existing network is already overcrowded and cannot meet the future demand without enhancement. Expanding the R&U network through projects like Crossrail, Northern line Extension and Croxley Link will relieve congestion as well as providing better transport accessibility to key parts of London. The devolution of rail services to TfL will also provide the opportunity to improve customer service and create a more integrated transport service for Londoners.

In the context of train systems assets growing the network means the acquisition of new rolling stock and/or signalling to provide greater capacity. For example additional trains will be required to provide the required services envisaged as part of the Northern Line Extension.

7.3.4 Customer Service

World class customer service is a core aspect of our vision. To achieve high standards of customer care, we will:

- Improve the accessibility and safety of the platform train interface, enabling greater ease of access for all customers. Accessibility will be enhanced by achieving the requirements of the Rail Vehicle Accessibility Regulations (RVAR) 2010.
- Design trains that are easier to clean and maintain in an acceptable condition, measured through customer satisfaction and mystery shopper measures.
- Deploy improved customer information systems, giving better, more accurate and, where possible, real time audible and visual information.
- Deploy cooling infrastructure improvements across the network to improve passenger comfort and reduce the risk of heat strain.
- Provide modern fleets with wide doors and through gangways to reduce platform overcrowding.
- Improve the accessibility and safety of the Platform Train Interface, addressing the Rail Vehicle Accessibility Regulations (RVAR) 2010, enabling greater ease of access for all customers.
- Install train CCTV, viewable in real time from the service control centre to improve customer safety.
- Minimise passenger disruption during delivery of the line upgrades through use of fewer closures and off site fleet and software testing.
- 24 hour weekend night tube operation

7.4 Key Assumptions

The following are key assumptions that underpin the Train Systems strategy, i.e. if they change, then the strategy would have to change accordingly:

- 2013/14 business plan funding levels are maintained.
- The majority of capability (capacity) and train performance and condition uplift objectives will be achieved by line upgrades in the timescales set out

by the programmes.

- Changes to train services (e.g. timetables) have an impact on maintenance activities and cost. When known these are included in the business plan. Proposed changes are notional and are subject to detailed analysis closer to the implementation date.
- There will be no significant amendment to the existing procurement contracts for the provision of the Northern line and SSR network upgrades
- Northern line fleet maintenance will continue to be delivered through Alstom and additional maintenance due to upgrades will be absorbed through contract variations.
- S Stock and 09TS fleet maintenance will continue to be delivered using permanent labour, supplemented by the Technical Support and Spares Supply Arrangement (TSSSA) until March 2018.
- Trains Division (REW/TMU) continues as a 'going concern' and will adjust its operations according to future work load.

7.5 SSR Network Strategy

7.5.1 Operating Context

Asset Overview

The Sub Surface Railway (SSR) comprises the Metropolitan, District, Hammersmith & City and Circle lines and carries approximately 390 million passengers per year. The main contributor is the District line which is the third most used line, carrying approximately 208 million passenger journeys per year.

The lines are served by both legacy and new rolling stock. At time of writing the Metropolitan Line is served by 58 x 8-car S Stock. C Stock will be replaced during 2014 and all D Stock will be replaced by 2016 with 133 x 7-car S Stock. The fleets are being maintained by the direct labour organisation (DLO) at Neasden, Ealing Common, Upminster and Hammersmith (being converted to sidings) depots. There are numerous sidings across the entire network.

A traditional fixed block, trainstop protected, colour light based signalling system is employed on the SSR network with a mixture of local signal cabin control and centralised control facilities. This is being replaced with the new SSR ATC. Control centres are currently located at Earls Court and Baker Street but will be consolidated at the new Hammersmith Control Centre as part of the Upgrade.

Demand Overview

The SSR is the most complex part of the LU network and the largest, accounting for around 40% of both network and passenger kilometres. The four SSR lines interoperate with each other, with other LU lines and with National Rail and London Overground services. In particular, west of Barons Court, SSR has an integral relationship with the Piccadilly line. Taking them together as one system they constitute around 60% of the LU network.

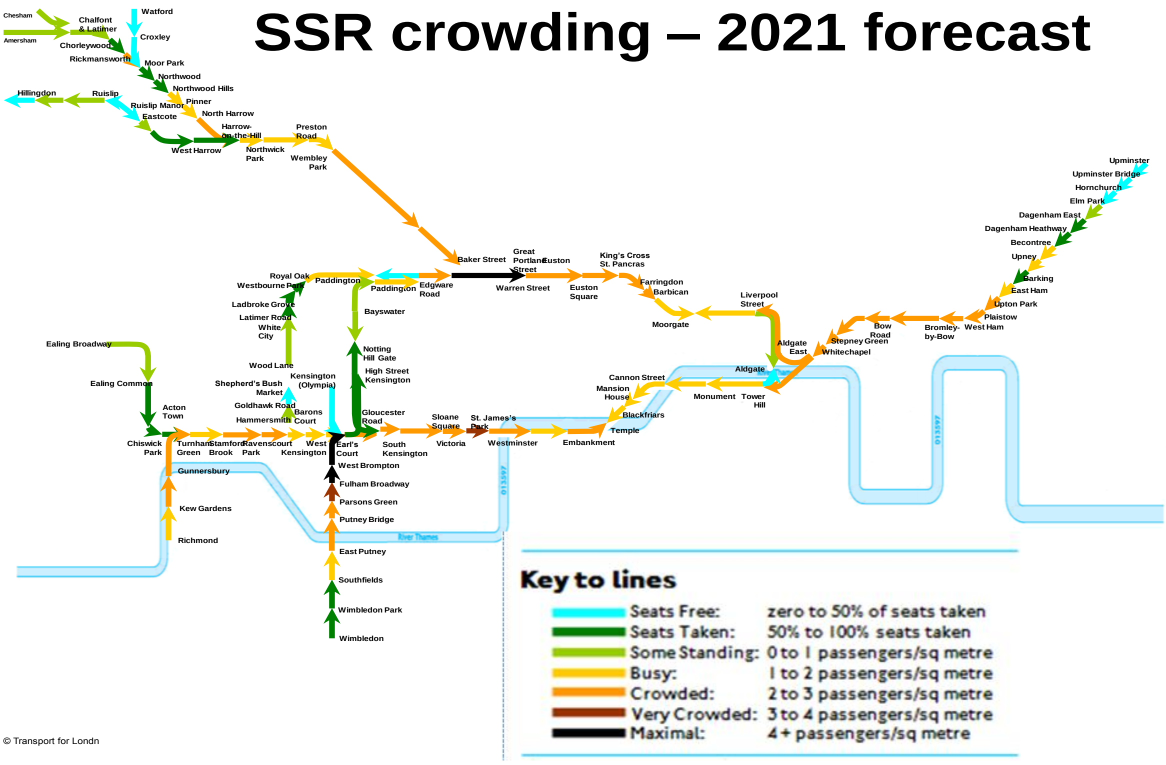


Figure 13: SSR 2021 Overcrowding map

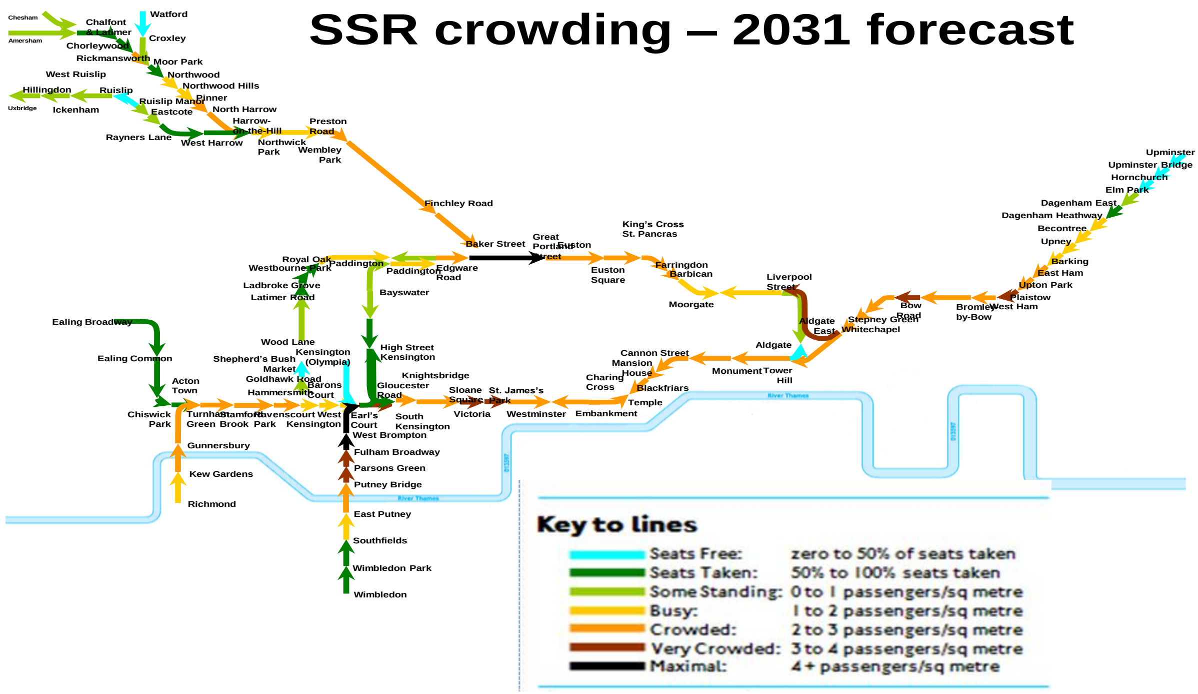


Figure 14: SSR 2031 Overcrowding map

Demand on the SSR has tended to grow by equal to or less than the overall network demand growth rate. The Metropolitan line has the strongest demand growth relative to the SSR network, whilst the Circle and C&H lines have the slowest rate of demand growth. For the District and Metropolitan lines, off-peak demand is rising at a faster rate than peak demand. For the Circle and C&H lines, peak and off-peak demand are following a similar pattern.

Currently areas of high demand on the SSR lines are the busy Wimbledon branch of the District line and WB services from Victoria and Baker Street. By 2021, Crossrail 1 is expected to reduce crowding in the central section of the District line, and also around Paddington and Edgware Road and from Aldgate East to Liverpool Street by diverting some passengers from the Tube network. By 2021, the SSR upgrade will help prevent increased crowding on the SSR lines although the Wimbledon branch of the District line is expected to remain crowded despite an extra train per hour in each direction. By 2031 the SSR lines experience increased crowding in a number of sections. The progression of Crossrail 2 offers the prospect of helping to reduce the crowding forecast on the Wimbledon branch in the long term.

Several stations in East London on the C&H and District line are likely to be most affected by Opportunity Area development: Aldgate East, West Ham and Barking. Increased passenger flows at Earls Court and Victoria will be challenging at these already-busy areas. Further developments are also expected at Wembley Park, Kings Cross, Euston, the City Fringe and Paddington. Therefore, multiple parts of the SSR network can expect to see increasing demand for the long term

7.5.2 Reliability & Safety

The focus on the SSR network comprises:

- Continue to improve train reliability. S Stock trains are generally performing well and reliability growth is acceptable (see R&U Asset & Network Plan, page 16), SUP has a ”Lessons Learnt” from the S8s, which will be applied to the S7s as appropriate. The trains are being cycled through Bombardier Derby to address build quality issue and implement many modifications.
- Implement a Platform Train Interface strategy. Incidents have occurred at a limited number of locations on the Metropolitan line and similar problems are expected emerge at other SSR stations as S7 roll-out progresses. The increased prevalence of falls between the train and platform at curved platforms results from the lower floor of S-Stock trains which gives rise to greater stepping gaps. A dual strategy is being implemented. Within SUP a special project has been established to investigate and implement a wide range of non-infrastructural mitigations, such as enhanced lighting and signage. Outwith SUP a longer-term study of infrastructural solutions, such as reconfiguring track and platforms and Platform Edge Doors (PEDs) will

also be established. Infrastructure solutions will be both expensive and have a long implementation timescale and it is not yet clear whether they will be necessary. The study, and also the results of the SUP's own mitigations, will clarify the PTI strategy on SSR over the next year or two.

- Achieve ATC operation without restriction throughout the year. During leaf fall a single 5-car A Stock (RAT or Rail Adhesion Train) currently services the line but this will be insufficient post ATC so additional mitigation capability is required. D Stock conversion is the preferred solution. In addition the existing Metropolitan Line ACCAT will be replaced by an SSR Network ACCAT, which will provide required ATO brake rate changes based on predicted and prevailing conditions. The S Stock will be fitted with sanders and SUP has developed facilities at Neasden to support the S Stock and the rail adhesion trains. Also the speed restriction on the southbound and sequential signalling are both part of current leaf fall measures which will cease to be necessary after ATC implementation.

7.5.3 Capacity from current network

- The SSR network is presently being upgraded and is the overriding challenge for the SSR Upgrade Programme (SUP). The upgrade provides a step-change in the capacity, safety, reliability and operability of the railway. ATC implementation is the critical short-term focus for SSR, whilst ensuring that any critical asset condition concerns are appropriately managed to ensure that operational risk remains ALARP. Specifically the strategy is to, replace the existing signalling systems with a moving block system (CityFlo 650 manufactured by Bombardier) providing Automatic Train Operation, Automatic Train Regulation and continuous Automatic Train Protection, all controlled from the new SUP Service Control Centre (SCC) at Hammersmith. Install SELCAB signalling equipment in the interoperable areas, allowing Chiltern trains to cease reliance upon the current tripcock-based ATP system currently employed.
- Fit ATC to the S Stock trains, which involves an equipment installation programme, undertaken by Bombardier at Ruislip from 2014.
- By May 2018, provide an end-state peak service of 28tph on the Metropolitan Line north of Baker Street, a 32tph peak service on the Circle Line and Aldgate East to Barking section and a 16tph on the Hammersmith branch and outer sections of the District Line.
- Complete the redevelopment of Neasden, Ealing Common and Upminster Depots. Although the main maintenance facilities and signalling at Neasden is largely complete, there remains the delivery of the Heavy Maintenance Facilities (HMF) (comprising additional lifting road, roads for door, gangway, coupler and HVAC maintenance and enhanced stores and accommodation) to facilitate the delivery of planned heavy maintenance. The strategy is to centralise planned heavy maintenance for the 191 S-Stock trains, including S7s, at Neasden. The timing of the HMF is under

review and it will likely be delayed against earlier plans since heavy maintenance is not anticipated until 2017 at the earliest, but will be in place to ensure maintenance delivery.

- Implement a track rationalisation programme, End State Track Layout (ESTL). Along with the ATC system which provides for a degree of bi-directional working, this provides substantial medium-term potential for greater service resilience and reduced maintenance costs.

The SSR's complete train systems renewal in the 2010s means that the long-term strategy is clear.~~,~~ S-Stock trains and CityFlo 650 ATC will provide a robust, effective, reliable and efficient asset base.. The creation of an SSR "world class" capacity improvement programme to maximise the number of tph may be considered following completion of the ATC upgrade.

7.5.4 Capacity from growing the network

An extra S8 train will be purchased as part of the Croxley link programme, externally funded by Hertfordshire County Council.

7.5.5 Customer Service

The new train contains features that enhance accessibility and customer experience, such as RVAR compliance, through gangways and improved customer information. There are no other significant fleet modifications planned in the next 10 years. A fleet refurbishment will be necessary in the late 2020's to refresh the train to improve passenger comfort and experience.

7.6 Bakerloo Line Strategy

7.6.1 Operating Context

Asset Overview

The Bakerloo line covers 23.2 km (14.42 miles) and serves 25 stations. North of Queen's Park, Bakerloo line trains run over tracks owned and signalled by Network Rail (DC Line). The line carries approximately 111 million passenger journeys per year.

The line operates a fleet of 36 7-car trains (1972 Tube Stock). The fleet is maintained through DLO at Stonebridge Park. There is a small depot at London Road (largely for stabling) and sidings at Queens Park. 33 trains are required for weekday peak service.

The line utilises a fixed block 2-aspect trainstop protected signalling system with a single signalling control centre remotely controlling all interlocking areas. The line is controlled from the Baker Street control centre.

Demand Overview

The Bakerloo line has experienced modest growth, slightly lower than the network average. The introduction of TfL Overground services has provided an attractive alternative on the northern part of the line, suppressing Bakerloo line growth.

The Bakerloo line is not without heavy crowding, but it is short-lived and does not pose a long term strategic challenge, with planned upgrade as a part of DTP, services helping to lower crowding in the long term.

The line is successfully operated close to its full schedule, but is susceptible to asset failures on the DC line. Although the impact on train kilometres can be significant, the impact on passenger journeys is relatively low, with the majority making journeys in central London on the line and Overground services providing a competitive alternative between Harrow & Wealdstone and Central London.

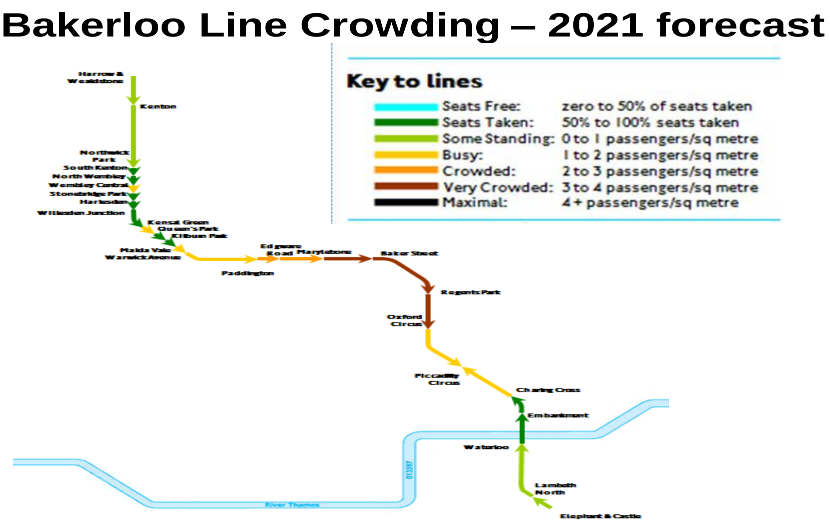


Figure 15: Bakerloo 2021 Overcrowding map

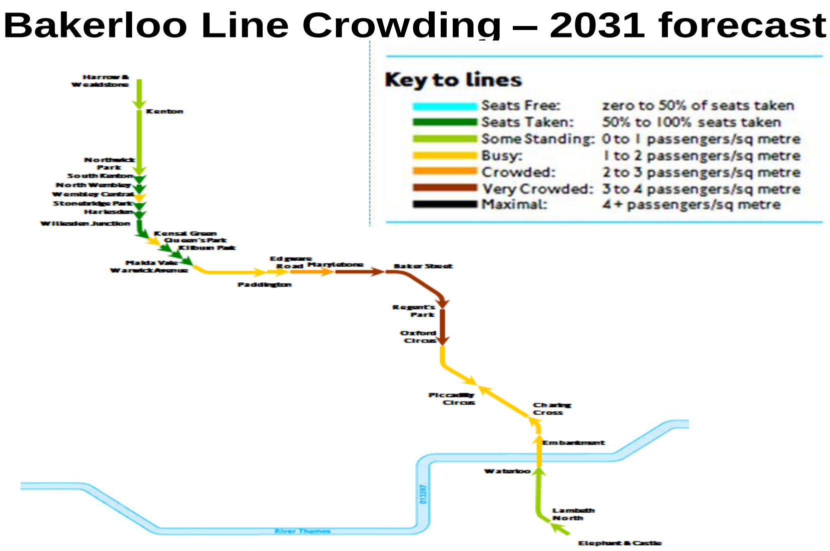


Figure 16: Bakerloo 2031 Overcrowding map

Demand is forecast to fall on the line around 2020/2021, as other upgrades, Crossrail, SSR and Overground improvements are implemented, further decreasing the attractiveness of the line. Future demand forecasts to 2031 see demand increase to levels significantly beyond 2021.

There are no significant forecast demand drivers due to new development or changes in land use that are expected to place demand pressure solely on the line.. This contributes towards the relatively low growth forecast long term for the line.

7.6.2 Reliability & Safety

Originally planned to be replaced by 2020, 72TS will now remain in operation until the early 2030's, which is beyond is nominal design life of 40 years. This delay will create challenges, as LU has limited recent experience of operating trains of this age. However, the rolling stock systems are relatively simple, comprising electro-pneumatic components, DC motors and little in the way of electronics. Structurally the vehicle exhibits many age related failures which is largely caused by the curvature of the Bakerloo Line. The strategy is to firstly sustain and then improve safety and performance:

- Undertake a programme of train life extension activities. A review has been undertaken of the current, known state of the fleet based on current internal professional knowledge and existing documented studies. This has identified areas of the fleet at system, sub-system or component level that are known or suspected to be in an advanced state of deterioration. By the start of 2015 a package of works designed to reinstate the structural integrity of the fleet is planned to commence.
- Following this a more extensive life extension and refurbishment package will be scoped and delivered to ensure that all train systems will be safe and operable through to the planned disposal date.
- Conduct a root and branch review of the train maintenance regime to apply best practice for the maintenance of legacy rolling stock assets and lessons learned from recent experience with Piccadilly line 73TS fleet.
- Undertake a programme of Signalling and Control Systems life extension activities by replacing / upgrading certain sub-systems such as control systems computer equipment and track circuits in order to manage obsolescence and reliability risks.

7.6.3 Capacity from existing network

The short term strategy is to build an additional 2 trains from retired 67TS passenger cars currently in storage. The Bakerloo Line operates a 22tph railway, offering 33 trains out of 36; the creation of two additional trains could increase this to 24tph. The works also involves changes to power infrastructure (conductor rail) and provision of cooling at Edgware Road.

The longer term strategy is to deliver the Deep Tube line upgrades in a priority sequence which reflects the relative capacity needs and business case for the lines. The Bakerloo line upgrade is planned to follow on from the Piccadilly and Central lines, which are more urgent business priorities. The Deep Tube Programmes objectives are to upgrade the fleet and signalling systems to:

- Re-signal the line with a modern CBTC system, which will enable capacity improvement to be realised in conjunction with new rolling stock introduction to meet rising demand in the 2020's and 2030's. Service levels of c27tph are expected to be required with improved reversing capacity (e.g. at Queens

Park), achieved through layout improvements and auto-reversing. Installed capability for a final capacity of 30tph is expected in view of the long term possibility of a Southern extension.

- Design, procure, build and commission a fleet of new generation trains by 2034. The new trains will have improved energy efficiency, through gangways and saloon cooling.
- Minimise tunnel temperatures increases. Waste heat will be minimised through regenerative braking and coasting, thus reducing the number of station cooling and ventilation fan upgrade projects. If the temperatures are forecast to exceed 30-32°C in some parts of the line, cooling interventions will be considered. Station cooling will be delivered as part of major stations projects where possible to reduce capital costs.
- Cooling interventions currently under consideration include station cooling schemes at Edgware Road, Maida Vale, Charing Cross, Paddington and Baker Street and ventilation fan upgrades at London Road Depot

7.6.4 Capacity from growing the network

There is no strategy for extending the Bakerloo Line.

7.6.5 Customer Service

Fleet ambience levels are forecast to deteriorate more quickly than new fleets due to the fleet age and condition. The deterioration rate will be mitigated by the refurbishment mentioned above.

The Bakerloo line is one of the warmest lines on the network, with average platform temperatures reaching 29 – 31°C in July in the afternoon peak. The strategy is to maintain the existing ventilation capacity through a programme of fan renewals, increase the capacity by reinstating out-of-service fans (such as Baker Street and Waterloo station fans) and enhance the cooling where there is the opportunity, such as Oxford Circus station cooling.

Since the train will be in operation after 1 January 2020, LU will implement RVAR improvements and will refresh the passenger environment, including the provision of new customer information systems and saloon CCTV. The final scope will be agreed with DfT and may include exemptions.

7.7 Central Line Strategy

7.7.1 Operating Context

Asset Overview

The Central line covers 74 km (46.5 miles) and serves 49 stations making it the longest line on the LU network. The line carries approximately 261 million passenger journeys per year.

The line operates a fleet of 85 8-car trains (1992 Tube Stock). The fleet is maintained by the DLO at Ruislip and Hainault Depots. There are stabling facilities at White City, Loughton and Woodford. 79 trains are required for weekday peak service making the utilisation of the fleet one of the highest.

The line's signalling control system provides full ATO, and jointless track circuits provide train detection. The system was commissioned between 1995 and 2000. The line is controlled from the Wood Lane Signalling Control Centre.

Demand Overview

In the last 10 years the Central line has seen growth at a rate far above the network average, driven particularly by growth from major developments at Stratford and Shepherd's Bush. Off peak demand has grown most - increasing by 60% in the last decade.

This high rise in demand has made the line the busiest on the network, and keeping Excess Journey Time constant or achieving a reduction has consequently been very challenging.

Demand on the line should continue to rise as financial services in the City recover and the major shopping and leisure districts on the line grow in popularity.

Central Line Crowding – 2021 forecast

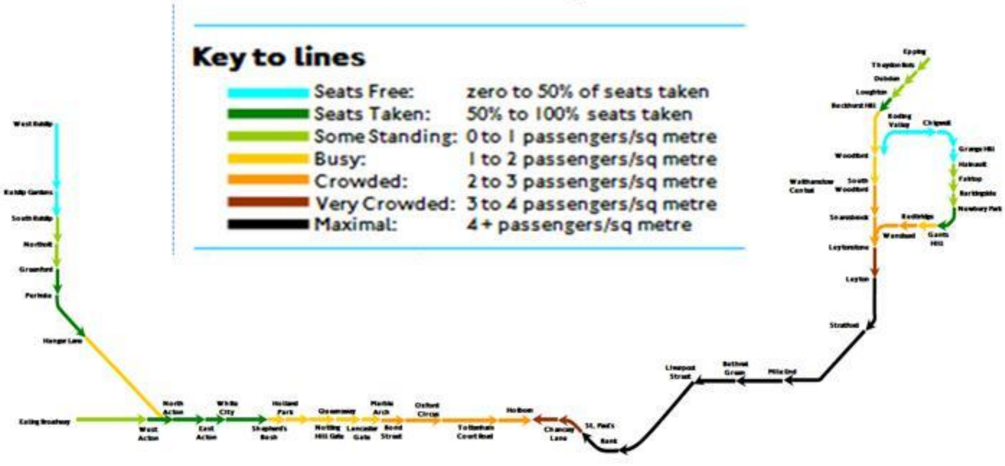


Figure 17: Central Line 2021 Overcrowding map

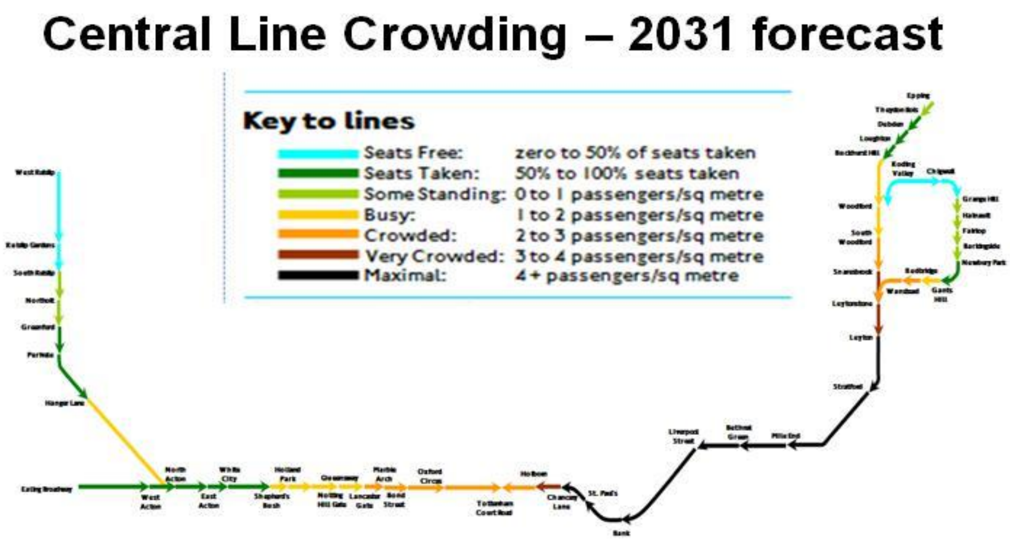


Figure 18: Central Line 2031 Overcrowding map

Post-Crossrail, congestion on the line in the west will fall significantly, but on the eastern section into Central London, the respite is forecast to be short-lived due to the split in Crossrail's service meaning where it parallels through Stratford, the train frequency is far below that of the Central line.

7.7.2 Reliability & Safety

The 92TS represents a transitional phase when railway technology was changing from traditional, long established electro-mechanical systems to modern microprocessor controlled systems. Whilst it is a comparatively modern train it contains technology that is now superseded and difficult to maintain. Main areas of unreliability are traction systems and ATO/ATP systems. Due to the high utilisation of the fleet, many of these issues on 92TS can have considerable impact upon the train service and peak availability. Equally the signalling and control & information assets are suffering from obsolescence and age-related failures. To sustain and improve reliability and safety the strategy is to:

- Ensure that the scoping of the next cycle of heavy maintenance comprising programme lift and heavy overhaul (2015-17) and door overhaul (2018-2020) is comprehensive to “reset” the condition of mechanical components and systems
- Establish a dedicated programme management function within CPD, responsible for the delivery of the comprehensive refurbishment activities proposed for fleet, signalling and control integrated and seamless with routine maintenance, and ensuring all asset issues are dealt with in a coordinated and systematic manner. This is will ensure focus on the many issues that are system based involving track, train, signalling and power assets and that span both capital and operational delivery functions.
- Develop and implement a programme of comprehensive component and system replacement or renewal (Mid Life Repair/Refurbishment) following completion of the heavy overhaul in 2015-17 (or sooner if possible but need to consider the impact upon the timetable).
- Develop and implement selective upgrades and renewals of wayside and train borne signalling equipment by 2017. Many of the issues are obsolescence-based and have the potential to cause a significant risk to the performance of the Central Line. This should ensure that signalling systems will reliably last until 2035.
- Replace life-expired and obsolete computer based equipment in the Wood Lane Signalling Control Centre by 2018. This enables the equipment to be supported for the remaining required operational life of the system. It is proposed that this work will take place before the signalling life extension as the need to replace the Control System is deemed to be more urgent.
- Re-examine the case for AC Traction. When previously examined, the case was marginal and was not pursued. However it may be possible to justify replacement of parts of the system in conjunction with the mid-life refurbishment. To be viable, the fleet replacement may have to be mid to late 2030’s.

7.7.3 Capacity from existing network

- The current timetable, WTT67, requires the use of 79 trains of out a fleet size of 85 for peak service; the scheduled kilometres will increase by 8%. The short-term strategy for further enhancement of the service will include, establishing the feasibility of increasing line speed back to 100kph. This would offer significant benefits to the timetable, but investigation is needed to ascertain the likely impact on train system performance and life expectancy.
- Explore the feasibility for cascading Waterloo & City 92TS on to the Central Line, providing an additional 2 x Central Line trains. The existing fleet is proposed to be replaced with retired 67TS passenger cars currently in storage. The power infrastructure on the Central will need to be strengthened.
- Enable ATC operation without restriction throughout the year by improving the rail adhesion trains. During leaf fall LU operates two 62TS rail adhesion trains. Although these vehicles operate for only a few months each autumn they are suffering from age related issues. The strategy is to implement packages of work to improve condition, build a float of strategic spares and to restore spare 62TS cars to improve the performance of the existing trains. Fortunately the vehicles are relatively basic (lacking any electronic components), so solutions are possible for most engineering issues. However skills and domain knowledge could become an increasingly challenging area. Thus the strategy is to establish the Trains Modification Unit as the maintainer of the vehicles.
- The longer-term strategy is to undertake the deep tube line upgrades in a priority sequence which reflects the relative capacity needs and business case for the lines. The Central Line is planned to follow on from that of the Piccadilly, which is a more urgent business priority. The Deep Tube Programme’s objectives are to upgrade the fleet and signalling systems to;
- Re-signal the line with a modern CBTC system by 2025-28, which will enable capacity improvement to be realised in conjunction with new rolling stock introduction to meet rising demand in the 2020’s and 2030’s. Peak service levels of c33-36tph are expected to be achieved through higher levels of automation.
- Design, procure, build and commission a fleet of new generation trains by 2028-32. The new trains will have improved energy efficiency, through gangways and saloon cooling.
- Minimise tunnel temperature increases. Waste heat will be minimised through regenerative braking (already deployed on existing line) and coasting, thus reducing the number of station cooling and ventilation fan upgrade projects. If the temperatures are forecast to exceed 30-32°C in some parts of the line, cooling interventions will be considered. Station

cooling will be delivered as part of major stations projects where possible to reduce capital costs.

7.7.4 Capacity from growing the network

There is no strategy for extending the Central Line

7.7.5 Customer Service

LU will enhance accessibility in line with RVAR 2010 where possible. However the train poses a unique set of engineering challenges.

- It does not have multi purposes areas (such as those on Northern and Jubilee Lines) so it would necessitate the removal of existing seat bays which house vital train equipment.
- The saloon doors do not have an external sill plate which means that providing a compliant level access to platform will also be difficult to achieve without use of manual boarding ramps.

The Central line is one of the warmest lines on the network, with average platform temperatures reaching 29 – 31°C in July in the afternoon peak. The strategy is to maintain the existing ventilation capacity through a programme of station fan renewals, increase the capacity by reinstating out-of-service fans (such as Old Ford Road, Redbridge Lane and Carlton Square) and enhance the cooling where there is the opportunity, such as Oxford Circus station cooling, Bond Street and Bank station cooling (to be delivered as part station capacity projects).

7.8 Waterloo & City Line

7.8.1 Operating Context

Asset Overview

The Waterloo & City Line is 2.37km and links Bank and Waterloo stations without any intermediate stations. The line carries approximately 16 million passenger journeys per year.

The line operates a fleet of 5 x 4-car trains (1992 Tube Stock). The fleet is essentially the same as that operating on the Central Line, except that it is manually driven and has traditional fixed block signalling with trainstop protection. The fleet is maintained by the DLO at Waterloo Depot.

The line is reaching capacity and since it is mainly a tidal commuting line; growth will be driven primarily by rises from weekend operations and off peak traffic.

7.8.2 Reliability & Safety

Although the fleet is similar to the Central Line, it does not exhibit the same problems. This is regarded as being a function of the operating environment, mileage and the lack of ATO/ATP train borne equipment. For most intents and purposes the train is treated in the same way as the Central Line, so reliability and safety improvements will be deployed as applicable. In particular the fleet will receive the next cycle of heavy maintenance comprising programme lift, heavy overhaul and door overhaul from 2015-2020, which will ‘reset’ the condition of mechanical components and systems. It will also be subject to a programme of comprehensive component and system replacement or renewal (Mid Life Repair) following completion of the heavy overhaul in 2015-17. There are no specific strategies for the signalling and control of the W&C line.

7.8.3 Capacity from existing network

The line already operates all 5 trains in service, so the short-term strategy is to offer increased weekend operation and longer operating hours. The strategy to cascade Waterloo & City 92TS on to the Central Line, providing an additional 2 x Central Line trains which will result in a reduction in capacity on the W&C. This is because the retired 67/72TS passenger cars currently in storage have a lower performance and capacity than the 92TS. However this loss is more than offset by the improvement on the Central Line.

The longer-term strategy is to undertake the deep tube line upgrades in a priority sequence which reflects the relative capacity needs and business case for the lines. The W&C line will follow the Central Line. The Deep Tube Programme objective is to re-signal the line with a modern CBTC system by 2032, which will enable capacity improvement to be realised in conjunction with new rolling stock. Peak service levels of c30tph are expected to be achieved through higher levels of automation. It is currently intended to deliver the upgrade via a line blockade, including platform edge doors and track remodelling.

7.8.4 Capacity from growing the network

There is no strategy for line extension of the W&C line. However, extending the tunnel so that it is inter-connected with the Bakerloo Line could be explored.

7.8.5 Customer Service

There is no strategy for improving the ambience of the W&C line. However should the W&C fleet be cascaded to the Central Line, the replacement stock will be completely refurbished and Innovative passenger information and advertising solutions will be explored.

7.9 Victoria Line

7.9.1 Operating Context

Asset Overview

The Victoria Line covers 21kms and serves 16 stations. The whole line is below ground, except for Northumberland Park Depot and the track leading to it. The line carries approximately 200 million passenger journeys per year.

The line operates a fleet of 47 x 8 car trains (2009 Tube Stock). The fleet is maintained by the DLO staff at Northumberland Park Depot. There are sidings at Brixton, Walthamstow Central, Victoria and Kings Cross St Pancras. 39 trains are required to operate the weekday peak service.

The line uses a modern radio based Distance-To-Go Radio (DTG-R) ATC system providing fully automatic train operation and control. Train detection is provided by the latest generation of jointless track circuits. The line is controlled from Osborne House Signalling Control Centre, located in Northumberland Park Depot.

Demand Overview

The line's growth has been sharp in the last 2 years – increasing by over 20 million passenger journeys a year, as 09TS entered service and the recovery from the economic downturn began. In general, the rate of growth and has been close to the network average.

The upgrade benefits are now enabling the line to realise reductions in passenger journey time whilst simultaneously providing the capacity for many more journeys. Off-peak growth has seen the sharpest rise in the last 2 years– up almost 35% since 2000.

The line is forecast to experience continual growth over the next 20 years (total AM peak period passenger forecast to increase a further 20%) slowing by 2031, The popularity of the line and other developments, increasing demand ,means that capacity increases provide relatively short-lived relief, and heavy congestion on the line returns in the medium to long term.

Given the spatial development and other potential drivers of demand such as High Speed 2, the focus remains on exploiting the full potential of the line following the upgrade. It has been clear in forecasts that the Victoria line, in all scenarios, remains heavily crowded due to the normal traffic and therefore serving any HS2 demand will be a challenge.

Victoria Line Crowding – 2021 forecast

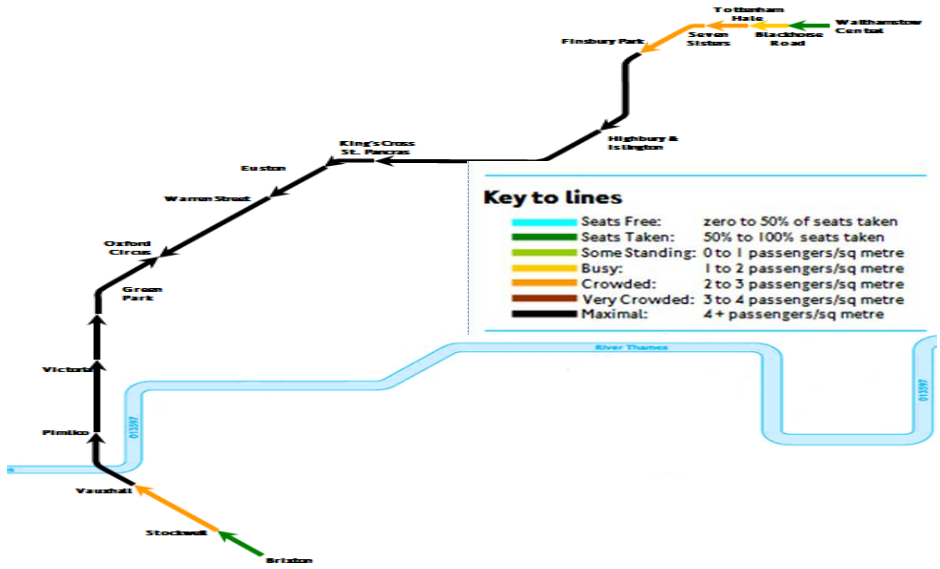


Figure 19: Victoria Line 2021 Overcrowding map

Victoria Line Crowding – 2031 forecast

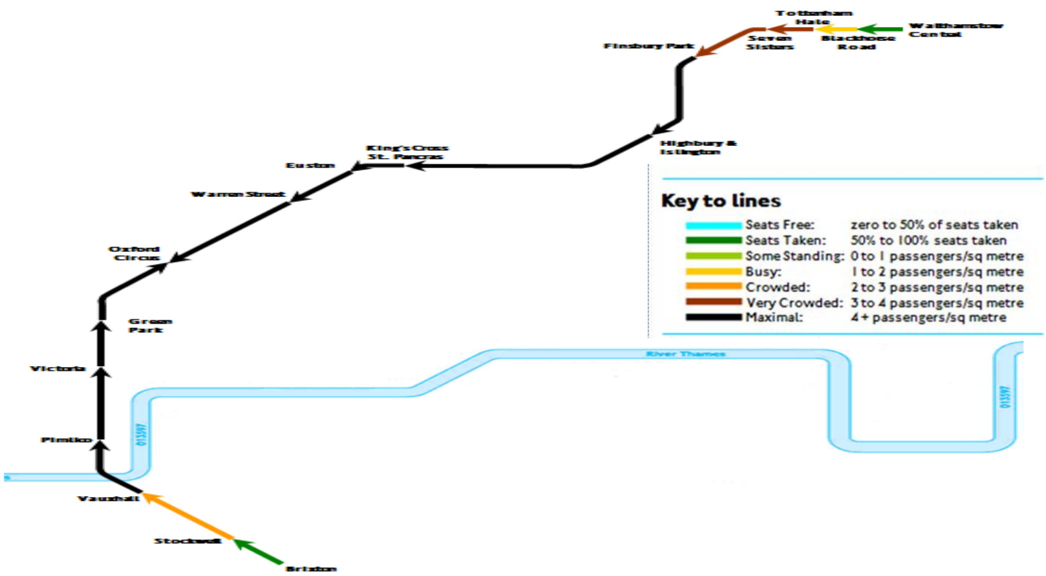


Figure 20: Victoria Line 2031 Overcrowding map

In the long term, to meet demand Crossrail 2 is necessary. Strategic Consultation has taken place on a new route for the scheme, to accompany the consultation on a revision to the scheme's safeguarding .

7.9.2 Reliability & Safety

The Victoria Line Upgrade was completed in 2012, so the strategy focuses on continuous improvement of asset reliability and performance. For 09TS and the signalling the emphasis is on exploiting the 'built-in' level of train system performance to deliver rolling stock and signal maintenance at a long term economic and efficient cost.

Northumberland Park Depot signalling will be renewed from 2014, the exact degree of functionality & automation required is yet to be determined and a feasibility study is currently underway. The drivers for this are based on asset condition and reliability.

7.9.3 Capacity from existing network

Working Timetable 36 will increase the peak service to 34tph, expanding the period of 33tph operation and increasing the number of trains extended to Walthamstow from 18 to 24.

In the medium term LU will pursue a range of "World Class" improvements to support a regular timetabled service of 43 out of 47 trains (c33-36tph). This will include a review of signalling capacity pinch points, Platform Edge Doors (PEDs), real time train data and diagnostics, including remote condition monitoring of track circuits, cooling and traction power improvements. The business case will also make the link with the track programme both for capacity and reliability (bullhead rail replacement and upgrade of P&C). The target date for enhancement is April 2016.

The Victoria line upgrade means that long-term strategy is clear. Although service patterns may alter at the margins 09TS trains and DTG-R will provide a robust, effective, reliable and efficient asset base. It is anticipated that the assets can be continually optimised through the years and potential for long-term excellence is high.

7.9.4 Capacity from growing the network

There is no strategy for line extension of the Victoria Line.

7.9.5 Customer Service

There are no significant fleet modifications planned in the next 10 years. A half life fleet refurbishment will be necessary in the late 2020's to refresh the train exterior and interior to improve passenger comfort and experience. Depending on the nature of these works and their timing other improvements will be considered, subject to normal business case principles.

Temperatures on the Victoria line have slightly decreased compared to the pre-upgrade state, despite the predicted temperature increases as a result of the line upgrade. Regenerative braking, the upgrade of thirteen mid-tunnel ventilation shafts and the installation of station cooling schemes at Green Park and Oxford Circus stations have all contributed to the mitigation of the predicted line upgrade temperature increases. Station cooling at Victoria Station is being delivered as part of the Victoria Station Upgrade project.

7.10 Jubilee Line

7.10.1 Operating context

Asset Overview

The Jubilee line covers 36.2kms and serves 27 stations between Stanmore and Stratford. The line carries approximately 213 million passenger journeys per year.

The line operates a fleet of 63 x 7 car trains (1996 Tube Stock), manufactured by Alstom and maintained at Stratford Market Depot by LU Staff. The line was extended between Green Park and Stratford, commissioned in 1999. A 7th car and 4 additional trains were introduced in 2005 to increase line capacity by 17%. 57 out of 63 trains (90.4%) are used for daily service.

The signalling and control system has recently been upgraded with the Thales Transmission Based Train Control (TBTC) to increase line capacity by 33% and train service is increased from 24tph to 30tph from March 2012. The line is controlled from the Signalling Control Centre at Neasden.

The system has the potential to provide a further increase in train service frequency whilst the existing rolling stock is utilised to full capacity. The increase in number of trains is being considered under the world class capacity *programme.*

Demand Overview

The Jubilee line has seen growth at a rate exceeding the network average in the last 10 years, driven particularly by demand on the extended section of the line due to significant regeneration and employment growth in East London and the legacy of the Olympics & Paralympics. Further growth in employment is forecast in the West End, City and Docklands along the route of the Jubilee line.

Between now and Crossrail, the capacity delivered by the upgrade in the peak will begin to be fully utilised, with only marginal further peak service increases planned due to fleet constraints. As a result journey time reductions will begin to plateau and then increase over time.

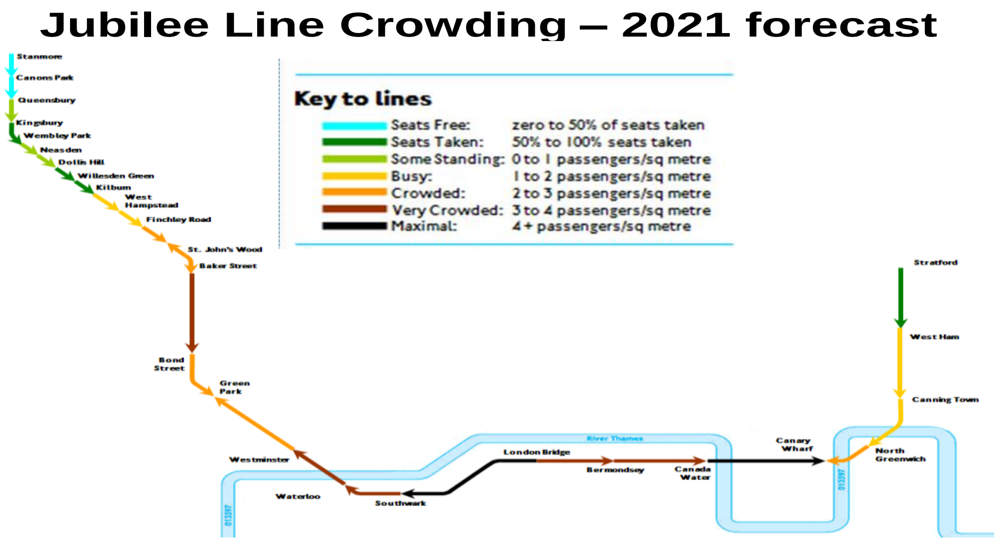


Figure 21: Jubilee Line 2021 Overcrowding map

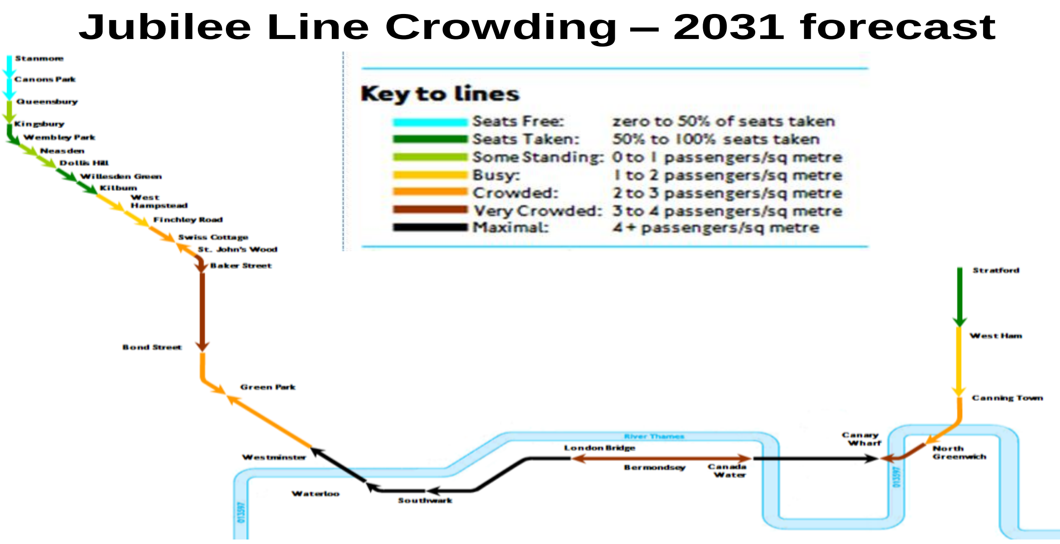


Figure 22: Jubilee Line 2031 Overcrowding map

By 2021, crowding would have been relieved on many parts of the line, though some stretches of heavy crowding would remain and benefit from additional capacity the line can offer in addition to the decongestive effect of Crossrail.

By 2031, crowding would remain severe between Westminster and Canary Wharf, due in part to the growth in National Rail passenger arriving at Waterloo and London Bridge.

Post Crossrail, the highest demand section between Waterloo and Canary Wharf will increase in the peak by 15% to 20%. Provision of additional capacity by releasing the line from its fleet constraint is therefore a priority and has a good case for implementation prior to Crossrail.

7.10.2 Reliability & Safety

The Jubilee Line Upgrade was completed in 2010, so the strategy focuses on continuous improvement of asset reliability and performance. The strategy is to;

- Improve operator functionality, reliability and remove performance constraints through Jubilee line strengthening work.
- Work closely with the Train System manufacturers (e-g Alstom, Thales etc) to improve diagnostics and condition monitoring of the systems to improve reliability and longevity of the train system equipment.
- Assess gradual migration from inductive loop to radio (Wi-Fi) train to wayside communications system. Removing the ‘loop’ will eliminate a vulnerable signalling asset and remove many challenges faced by Track Engineers during track works and P&C renewal activities.
- Extend TBTC into the depots, reduce axle counters and replace air driven points with electric point machines to standardise equipment types and gradually remove the air main.
- Address obsolescence issues and needs of the train system’s asset particularly TBTC system and fleet electronics.
- Improve Rail adhesion forecasts in the ACCAT system to allow improved braking in open sections to reduce fleet brake wear and reduce safety risk.

7.10.3 Capacity from the current network

The short term strategy is to exploit the benefits offered by the recent upgrade of signalling system. The introduction of WTT 13 will expand the 30tph peak service from 40 to 90 minutes and increase off peak service to 24tph. This will require a number of trains reversing at Wembley Park, Willesden Green and North Greenwich, one more train in service and reducing the number of trains reversing at Stanmore to fully utilise the capability delivered by JLU1. New PEDs will also be required to facilitate auto reversing at these locations.

In the medium term LU will deliver the world class capacity programme to increase frequency of the trains in the range of 33-36 tph peak and 24-27 tph off peak by 2018. The TBTC signalling system has the potential to provide a further increase in train service frequency whilst the existing rolling stock is fully utilised to provide the current level of peak train service. Signalling and infrastructure (e.g. P&C) constraints will preclude the operation of a higher level of train service above a range of approx. 30-32 tph . The elimination of these infrastructure constraints such as auto reversing capability at various stations together with the procurement of approx. 5-14 additional trains would enable the Jubilee line peak train service to be further increased to 36 tph . This will also require infrastructure modifications (e-g stabling to stable additional trains, PEDS to enable auto reversing and resources to support this increase in service).

7.10.4 Capacity from growing the network

There is a business case to extend the line to Harrow-on-the-Hill (via the Metropolitan all stations service). The feasibility study to assess that business case is in The Plan.

7.10.5 Customer Service

Accessibility will be improved to enable greater ease of access through the provision of wheel chair spaces as part of the fleet mid-life refurbishment. The refurbishment scope will be subject to value engineering to improve both the ambience and condition of the fleet subject to business needs and affordability; the core refurbishment will be completed by 2020 to comply with RVAR legislation.

Additional clone trains will be procured to top up the fleet to ensure world class capacity is achieved from the upgrade (up to 36 Trains per hour)

7.11 Northern Line

7.11.1 Operating Context

Asset Overview

The Northern line covers 58 kms and serves 50 stations between Morden and Edgware, Mill Hill East or High Barnet, with two central London branches via Bank or Charing Cross. It carries 252 million passenger journeys per.

The line operates a fleet of 106 x 6 car trains (1995 Tube Stock) manufactured and maintained by Alstom under a PFI agreement. There are two maintenance depots at Golders Green and Morden. There are also additional minor maintenance / stabling facilities at Highgate, Edgware and High Barnet. The Alstom's NLTSC contract will continue until at least October 2017 and two years notice would be required to terminate the contract.

The Northern line is being upgraded with a Thales' transmission based train control (TBTC) system, which will replace the existing fixed block trainstop protected colour light signalling system. The system will provide Automatic Train Protection (ATP) and allow Automatic Train Operation (ATO) for the first time on the Northern line. ATO is already running on the High Barnet branch migrating to other line sections during 2014.

The upgrade will move control from Cobourg Street to a new service control centre at Highgate in stages. The Northern line upgrade follows directly on from the completion of the Jubilee line upgrade to maintain continuity of expertise.

Demand Overview

Growth on the Northern line is equal to network average in the last 10 years, driven by demand for the Bank branch. Off peak demand has also been strong, rising by 40%.

There is little change in crowding relief as a result of the increased upgrade capacity. The capacity on the Charing Cross branch provides the opportunity for the extension to Battersea. Demand continues to increase to 2031, demonstrating a need to deliver further increases in capacity and service reliability concentrated on the Morden-Bank-High Barnet branch. As with the Victoria line, HS2 would increase flows on both branches of the Northern line. Projects such as Crossrail 2 and other options for addressing HS2 would potentially assist to reduce overcrowding.

Between now and 2021, Crossrail will open, adding further demand to interchange traffic on the Bank and Charing Cross branches. Demand in 2021 is forecast to have utilised the upgrade capacity.

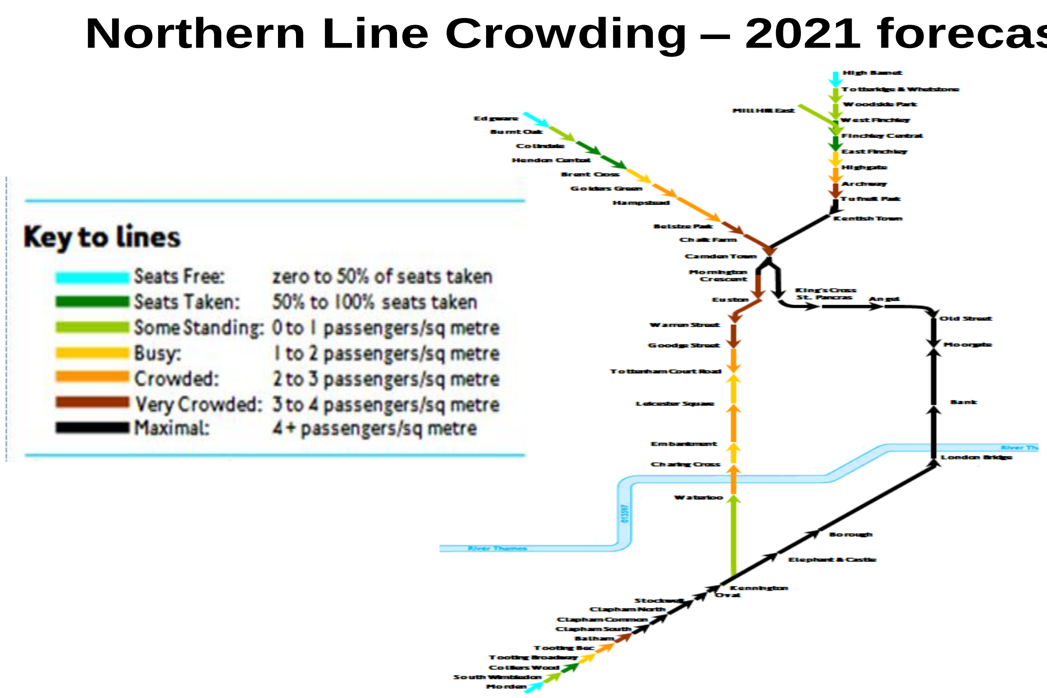


Figure 23: Northern Line 2021 Overcrowding map

Northern Line Crowding – 2031 forecast

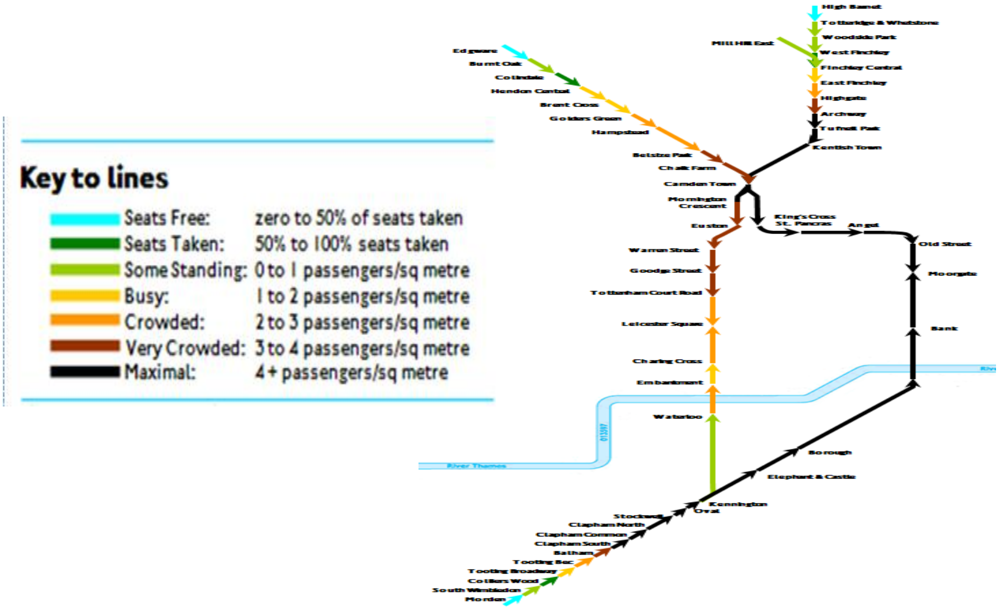


Figure 24: Northern Line 2031 Overcrowding map

Post 2021, congestion on the line in the current crowding hotspots, remains very high, with continued demand growth forecast across the whole line to 2031.

HS2 adds significantly to the line's future demand growth, with increased traffic above the current 2031 forecast possible.

7.11.2 Reliability & Safety

Demand has been supported by a strong improvement in reliability, and despite no rise in scheduled service kilometres, the line achieves 99% of schedule on a regular basis, meaning scheduled capacity is now consistently delivered. The Northern line train system's reliability will be impacted as TBTC goes live in 2014 and introduction of the new time table increasing the number of trains required for service from 91 to 96. The strategy is to;

- Improve reliability of the fleet and signalling through resolution of upgrade infant failures and the elimination of 46% of conventional signalling asset failures.
- Work as a 'one team' (*JNP, LU, Thales, Alstom all working together towards one goal)* to improve line performance and learn lesson from the Jubilee line upgrade.
- Establish a service level agreement with Alstom and technical support contract with Thales that offers more trains for service, maintains TBTC equipment and improves performance. Commence a feasibility study for future adhesion management to improve train braking and journey times.

7.11.3 Capacity from the current network

The Northern Line Upgrade (NLU1) will enable a trunk frequency of up to 24 trains per hour (currently 20 trains per hour) to be run on the central (Bank and Charing Cross) and northern (Edgware and Mill Hill East / High Barnet) sections of the line. For the Morden branch, the upgrade will provide the capacity to operate up to 32 trains per hour on the Morden Branch. The increased frequency of service will result in a 20% increase in line capacity.

The medium term strategy is to deliver further capacity improvements as part of a second line upgrade (NLU2) by 2021/22. This will provide an additional 20% increase in capacity by delivering a peak service of up to 33 trains per hour on both the Bank and Charing Cross branches of the Northern line. This will require approximately 21 additional 'clone trains' (95 Tube Stock) and additional train stabling to remove fleet constrains and number of enabling works.

7.11.4 Capacity from growing the network

Northern Line Extension (NLE) programme will deliver the signalling works associated with extending the railway to Battersea by 2020. The extension from the Kennington Loop travels southbound to Battersea via an intermediate station at Nine Elms providing increased operational flexibility. The addition of the NLE will require 5 additional 95 tube stock trains and stabling capacity (this is additional to the NLU2 trains above).

7.11.5 Customers

The ambience and condition of the trains will be improved by 2015, through the mid-life refurbishment project. As part of this project, accessibility is also being improved, providing new features for disabled passengers such as dedicated wheelchair bays, and will be largely compliant with RVAR 2010 (some minor exemptions are proposed and will be agreed with the DfT).

7.12 Piccadilly Line

7.12.1 Operating Context

Asset Overview

The Piccadilly line covers 71kms and serves 52 stations between Cockfosters and Heathrow or Uxbridge. It is the fourth most used line on the network carrying approximately 210 million passenger journeys per year

The line operates a fleet of 86 x 6 car trains (1973 Tube Stock). The fleet is maintained by in house (DLO) staff at Cockfosters and Northfields depots. There are sidings at Oakwood, South Harrow, Arnos Grove, Rayners Lane, Down Street, Wood Green, Acton Town, Ruislip and Uxbridge. 79 trains are required to operate the morning and evening peak period service

A fixed block 2-aspect trainstop protected signalling system with a single signalling control centre remotely controlling all interlocking areas was installed between the 1930's and 1960's. The Heathrow Terminal 5 extension completed in 2008 introducing free wired relay interlocking signalling interfacing with the existing systems. The line is controlled from the control centre at Earl's Court.

By 2018, Piccadilly line trains will operate manually under automatic train protection on the inter-operable SSR areas using the SSR ATC system

Demand Overview

The Piccadilly line provides key transport links between west and north west London, the west-end, Heathrow Airport and the north London suburbs. The line experiences very high all-day demand, particularly off-peak evenings and weekends due to the destinations served including the west-end shopping area, museums, exhibition centres and hotel districts.

Growth on the line has been very close to the network average. Like many lines, the rate of growth in the off peak has been higher than the peak. Customer satisfaction on the line has been steady, and a sustained reduction in journey time has been achieved in the last five years through the introduction of improvements such as Variable Dwell Time Indication to regulate the service.

The Piccadilly line has experienced continued demand growth, which is forecast to increase into the 2020's. The line is operating well below optimum capacity owing to both fleet size and signalling constraints. Current peak service levels of 24tph are well below the 30+tph levels required not only to meet current demand but also to meet future growth projections.

The central and trunk section extends in the west to Acton Town, which provides a key junction for the two western branches to Heathrow and Rayners Lane/Uxbridge. Between Baron's Court and Hanger Lane junction, infrastructure is shared by the Piccadilly line with SSR District line services and between Rayners Lane and Uxbridge with SSR Metropolitan line trains.

Piccadilly Line Crowding – 2021 forecast

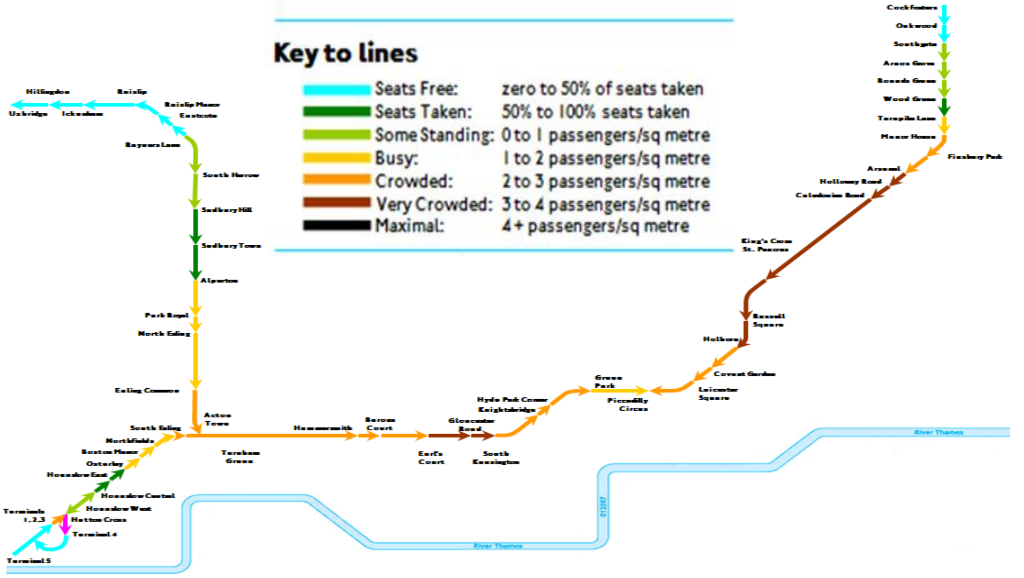


Figure 25: Piccadilly Line 2021 Overcrowding map

Piccadilly Line Crowding – 2031 forecast

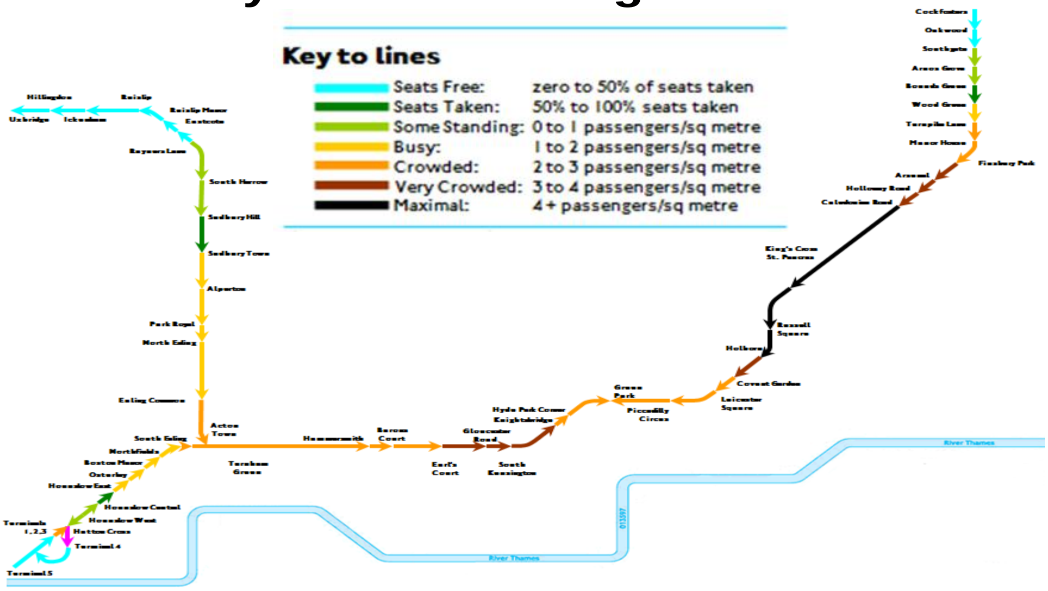


Figure 26: Piccadilly Line 2031 Overcrowding map

By 2031 demand increases mean that much of the extra capacity provided by the line upgrade is occupied, with the WB stretch into central London returned to "Maximal" levels. This reflects the long term problem on the north-east capacity corridor. Crowding on the EB section into London is not forecast to return to 2011 levels, reflecting the east-west extra capacity that Crossrail will introduce from 2019.

The northeast end of the line is forecast to return to very crowded conditions following the line upgrades, that drive the company's priority of Crossrail 2.,.

7.12.2 Reliability & Safety

The current asset performance is outstanding despite the fact that the fleet and signalling assets are both operating beyond their design life of 40 years. Fleet performance is forecast to continue to be the best of all LU fleets however there are certain obsolescence and life expiry issues, which require significant life extension, works for safe train operation. The current plans include life extension up to 2018 and review of asset condition is required to extend life further to ensure train system assets are safe and operable until their planned renewal by 2024/25. The strategy is to,

- Utilise and grow REW capability and work with other suppliers to re-engineer obsolete equipment to ensure consistency in performance.
- Maintain signalling reliability through enhanced maintenance and limited renewals such as trainstops, wayside equipment, poor condition sections of air main and AC main to extend their life by a further 10 years.
- Transfer signalling control SCADA system from Earl's Court to Hammersmith Service Control Centre by 2018 as a precursor to line upgrade re-signalling in order to improve reliability and realise operating efficiencies.
- Replace east end computer system, which controls the area between Wood Green to Cockfosters early as part of an interim SCADA installation or as an interim project dependent on the SUP programme.
- Review rail adhesion strategies as part of a feasibility study to improve the wheel rail interface in areas such as Rayners Lane that are vulnerable to leaf fall.

7.12.3 Capacity from current network

The line will be upgraded by 2026 as a part of the new tube for London programme. The strategy is to undertake this in a priority sequence, which reflects the relative capacity needs and business case for the lines. The Piccadilly line has the most urgent business priority and is therefore the first line to be upgraded. The strategy is to upgrade the fleet and signalling systems by 2024/25. This will achieve Automatic Train Operation (ATO) at between 33-36tph through new CBTC system, PEDs, walk through gangways, increased capacity, provision of saloon cooling and improved customer information.

7.12.4 Capacity from growing the network

There is no strategy for extending the Piccadilly line.

7.12.5 Customer Service

Fleet ambience levels are forecast to deteriorate more quickly than new fleets due to the fleet age and condition. The deterioration rate will be mitigated by an enhanced cleaning regime in the short term.

The feasibility of complying with RVAR 2010 will be assessed based on cost and benefits noting that the train will be replaced only 5-6 years after the 2020 deadline. Exemptions will necessitate discussions with the DfT.

Introduction of the new fleet will provide enhanced accessibility, improved customer information, walk through gangways, wider doors, and air conditioning to improve customer experience.

7.13 Delivery Strategy

7.13.1 Maintenance Strategy

Maintenance is delivered by the Asset Performance Teams within COO, who are responsible for the achievement of safety, performance, ambience and condition targets whilst increasing productivity to deliver cost targets.

The main objective of the maintenance strategy is to ensure a safe and reliable train service with minimum disruption. This is achieved through delivery of effective maintenance regimes, incident response, root cause analysis and reliability improvement activities.

The maintenance regimes will be subject to continuous reviews. The key objective of these reviews is to increase the efficiency of maintenance - by improving its quality and optimising its quantity - without compromising safety. While this will give lower costs, over time there will be several further important benefits including the release of staff to address maintenance backlog, reliability improvement, training, fault investigation and other performance-enhancing activities.

Furthermore, predictive maintenance regimes will be developed and implemented through greater use of automated, and intelligent condition monitoring systems

7.13.2 People Strategy

The delivery of train system maintenance is labour intensive. Therefore this strategy cannot be achieved solely through new technology and assets. To be successful LU must also address a range of matters regarding its people and their competencies. In particular:

- Deploying new technology, such as remote condition monitoring, will result in new ways of working.

- New assets have different maintenance needs resulting in different skill sets and competencies.
- Changing the methods and frequency in which we deliver maintenance requires consultation with our staff and Trade Unions.
- Identification of high potential, development of succession plan for key positions and structured training and development plans are key to delivering consistent performance.

7.13.3 Fleet Maintenance Strategy

The fleet maintenance strategy is to deliver core maintenance (e.g. the train maintenance regime (TMR), including corrective and reactive maintenance and call points) using internal resources, supplemented by external resources for non-core work (e.g. train cleaning, site security, depot plant maintenance etc). This strategy will be subject to ad-hoc reviews, particularly with fleet upgrade activities to ensure that appropriate contracting strategies are deployed to give the best long term value to LU (i.e. risk, cost, performance).

The TMR covers planned preventative maintenance activities and their periodicities which are based, in most instances on the calendar days or service hours/days. The delivery of TMR ensures compliance with standards & legislation, train safety and to preserve condition of the asset. Activities also include opex funded reliability improvement initiatives.

The approach to in-service faults, including the ability to restore normal service following an equipment failure on a train in service, is three-fold.

- Provision of well-trained rolling stock technicians who can assist Line Controllers to properly diagnose and assess whether faults can be remedied to allow the train to continue in service or to withdraw the train safely and efficiently from service.
- Provision of mobile rolling stock technicians at core locations to assist in the repair of trains where possible. The locations where rolling stock technicians are deployed will be reviewed continuously to maximise their impact on reducing lost customer hours. Additionally the review & implementation of Defective in Service Instructions (DISI) will ensure the consistency of train service.
- Access to a well-resourced and competent engineering organisation along with appropriate root cause analysis processes to eliminate or mitigate the event from occurring in the future.

The capacity improvement on most lines requires increased numbers of trains to be offered in peak service and thus reduces the window for the train maintenance. This will require a number of maintenance activities to be performed at weekends and duty rosters to be changed.

Benchmarking will continue to be used to compare unit rates, maintenance processes and key performance indicators to share best practices with international metros and organisations from other industries. We will consistently monitor trends to gain a better understanding of cost & performance drivers.

09TS and S Stock TSSSA

All 09TS and S-Stock trains are covered by a Technical Support and Spares Supply Arrangement (TSSSA) with manufacturer Bombardier until 2018. This renders train maintenance cost artificially high both through its high cost (relative to the value of similar goods and service acquired for trains maintenance under business as usual arrangements) and because it makes changes to the train maintenance regime more difficult. LU and Bombardier have endeavoured to renegotiate the TSSSA, with only moderate success, and this will continue. LU will also prepare to take over the TSSSA responsibilities itself at the earliest possible date.

Despite the TSSSA, the maintenance regime will undergo continual development as experience with the fleet grows. For S Stock the train-mounted tripcocks will be removed when ATC is implemented, providing an opportunity to redefine the expensive and logistically difficult daily ‘train prep’ inspection. Overall fleet maintenance economics is strongly influenced by the scope and periodicity of heavy maintenance. At present the manufacturer’s maintenance documentation calls for this work at more frequent periodicities than has been shown to be possible on fleets such as 95 and 96TS. Careful engineering analysis of the oldest trains in the fleet will be undertaken to optimise heavy maintenance periodicities.

Northern Line 95TS

The Northern Line fleet is being maintained through Alstom Northern Line Train Service contract (NLTSC). The strategy is to continue and manage the NLTSC until Oct 2017 in line with service performance targets and negotiate to add maintenance of additional TBTC equipment to the existing contract.

7.14 Depot Strategy

The role of depots is to provide sufficient, safe and reliable facilities to support the maintenance and stabling of rolling stock (passenger and engineering vehicles). This includes premises, systems, track, signalling, power and depot plant & equipment.

The core maintenance depots are supplemented by a number of geographically dispersed designated sidings to provide stabling and lower levels of maintenance tasks, e.g. train preparation and litter picking. Centralised workshop facilities also exist to undertake some of the heavier maintenance activities and component overhauls, e.g. REW & TMU.

7.14.1 Approach to Maintenance & Minor Renewals

The approach that LU adopts for maintaining depots and designated sidings is that planned maintenance, as defined by the Depot Maintenance Regime (DMR) is supplemented by a risk based approach to asset replacement.

The rationale underpinning the DMR is slightly different for the two sub asset groups; Depot, Plant & Equipment (DP&E) and facilities assets (premises, mechanical, electrical and comms etc).

- For DP&E assets a whole-life cost approach is followed to provide the lowest cost solution for the business. This approach is taken because a high proportion of DP&E assets are rolling stock specific, i.e. they are designed specifically for use for a particular train, as such major intervention points are aligned to train upgrades.
- The rationale is to maintain facilities assets at a broadly constant condition / slow degradation rate with asset replacement or upgrade at the end of the working life or as requirements on the depot change. This approach is adopted because the requirement for facilities assets is a long life, i.e. LU depots are used for decades (typically >50 years) and normally have a life greater than one rolling stock variant.
- We need to ensure that the DP&E assets are fit for purpose to maintain the relative fleets. This may require capital interventions are different points in time. Because of this varying time period for interventions a risk based approach is adopted. This provides the business with an approach that keeps the railway safe and capital expenditure is minimised.

7.14.2 Approach to Major Upgrade / Intervention

Depot upgrades are a key consideration when LU embarks on a Line Upgrade (i.e. new trains and signalling system) due to train maintenance and stabling being fundamental aspects to operating a railway. When upgrading a depot for a new train fleet, the overarching principles to follow are:

- Where appropriate the design and configuration of the train should be cognisant of existing depot constraints (e.g. size and location) and facilities (e.g. maintenance and stabling roads) to minimise capital investment and disruption during fleet migration.
- The train maintenance concept needs to be defined at an early stage so that decisions on the number of maintenance roads required and their utility (i.e. flat, pitted, lifting, platform) can be determined together with other requirements such as fork lift access, HVAC storage etc.
- Where a line or network comprises multiple depots, LU should seek to consolidate as many activities as possible at one location, thereby improving productivity.
- Depot design should consider human factors to facilitate the ease of maintenance, minimise non-productive time (e.g. walking between trains and tools) and exploit greater mechanisation where credible (e.g. wheel lathes, bogie drops, etc)
- Depot signalling/control will be considered as an integral part of the depot redevelopment so that opportunities for auto-routing of trains to stabling

and station platforms can be exploited and also risks to staff will be reduced where possible

- Depots and sidings shall be enabled to ensure all levels of maintenance and stabling can be achieved during the migration phase and for the end-state.
- Undertake asset condition surveys (intrusive where necessary) to establish the expected life of all depot assets in the early stage of the project.
- All assets (the main building infrastructure excluded) should have an expected life greater than 5 years from completion of works – to reduce the likelihood of further works soon after the intervention to allow working practises and procedures to embed before any further disruption.
- Where synergies and/or business benefits exist to replace assets with an expected life greater than 5 years (from project completion) each option should be evaluated on an individual bases and a cost-benefit analysis undertaken to determine the whole-life cost. The best whole-life cost approach should be adopted, assuming it is within affordability limits.

7.15 Signals Maintenance strategy

The Signal maintenance regimes set the planned, corrective, reactive and routine change maintenance requirements and frequencies for the various asset types across the network. The delivery of the regime ensures compliance with standards and legislation to ensure safety and to preserve asset condition. The regimes are reviewed annually to ensure their continued effectiveness based on performance, reliability trends, and recommendations resulting from internal and external audits.

Signalling maintenance workforce is subject to specific safety-critical assessments and licensing . LU employs an in-house workforce to carry out core maintenance and to support projects (particularly where there is an interface with the existing signalling system). Staff demonstrate their competence via the IRSE licensing scheme for which it is assessed by approved workplace competence assessors. Skills will be maintained and extended as new equipment types are introduced through the upgrades though in house training, with support from the key supplier as required.

Core maintenance will be supplemented with contracts and agreements with external suppliers to facilitate efficient and effective delivery based on a range of considerations including capability, cost and capacity.

7.15.1 Northern and Jubilee TBTC

TBTC assets on Jubilee and Northern line are initially being maintained in accordance with the manufacturer's recommendations under Thales warranty. The strategy is to develop preventative maintenance regimes with increased emphasis on remote diagnostics and to optimise the frequency of the routine change programme

7.15.2 SSR Network ATC

The concept for the maintenance of the new SSR signalling and signalling control system requires the system to have improved reliability to minimise the on-going cost of maintenance, renewals, upgrades and failure rectification. The design will have a high level of availability and will be controlled from a single control centre at Hammersmith. All first line maintenance will be performed 'in-house' and there is a requirement that LU resource will acquire sufficient knowledge to perform second line maintenance. It is a requirement that LU acquire expertise in the system and the supplier will be required to support this initiative. The intention being that LU will develop an 'in house' capability to undertake limited modifications to the system. Training will be in the form of 'train-the-trainer' training. New equipment, where possible, will include condition monitoring, diagnostics and event recording capability. The Metropolitan line will be a 'pathfinder' for the CityFlo 650 system. Maintenance practices for it will be evolved from other ATO lines with different systems and with the manufacturer and these will be rolled out in time to the other SSR lines as they are re-signalled.

7.16 Programme/Project Strategy

A portfolio of feasible renewal/enhancement projects is developed on an on-going basis as part of normal business planning process. The proposed projects are prioritised through value management techniques considering various criteria such as safety risk, service impact risk, direct cost, whole life cost, access and resource constraints, synergies with other schemes etc.

Projects are delivered via CPD on behalf of the Sponsor, using internal and external suppliers based on the requirements of the individual programme or project. In addition to core delivery roles, the CPD organisation supports the delivery of LU's asset management obligations by engaging in various activities, including:

- Development and review of asset technical strategies and plans
- Application of the project management methodologies (e.g. Pathway)
- Development and delivery of project milestones in support of asset objectives
- Participation in reviews such as programme/project reviews and risk reviews

7.16.1 Access

An efficient access process is essential to the delivery of line upgrades and other engineering projects as well as extensive asset renewal and maintenance activities, without compromising either train or customer service. The Access Transformation Programme is underway to identify and implement improvements to the way the LU plans and controls access to its key assets.

LU will be operating 24 hour weekend Tube service by 2015 and there is ever greater need to change the way we work, plan and use access efficiently. The strategy is to implement;

- Modular design based point machines to reduce replacement time
- Track side storage / zone based arrangement of spares
- Delivery of line upgrades with minimum closures through extensive off site testing and majority of work to be completed in engineering hours

7.17 Asset Management Capability & Development

Our asset management capability development improves the delivery of our plans in a sustainable way to improve reliability and capacity with good customer care at the lowest whole life cost.

Benchmarking comparison has confirmed that we demonstrate many best practices which has already reduced our unit costs by 11 % and 7% for rolling stock and signalling assets respectively from 2012/13 to 2014/15 and our costs compare favourably with other world metros. Performance has also improved significantly but with increased service intensity, improving performance remains a priority. The strategy is to develop the following;

- **Remote monitoring and automatic inspection**. LU is currently undergoing a major strategic transformation in the way it carries out maintenance activities, shifting from a “find and fix” to a “predict and prevent” approach.
- **Improved asset data management**. Developing a Condition Monitoring Data Management Tool will integrate condition, reliability and maintenance scheduling data in a single place, enabling root-cause analysis and better targeted maintenance activity to areas of greatest performance risk.

  Mobile handheld devices will allow staff to access technical documents on the move and to support data acquisition from the ground.
- **Improve working methods and productivity**. Maintenance frequencies are being reduced to against the associated level of risk. Lean Six Sigma deployment across LU will help to improve our processes and productivity.
- **Improve workforce flexibility**. LU’s drive towards greater standardisation of assets will provide the opportunity to improve workforce flexibility, as does an increased focus on multi-skilling.
- **Benchmarking**. LU is committed to growing its AM capability through benchmarking of maintenance and project costs to identify good practice within the fleet and signalling environment and also with international metros. The experiences of other Metros is to be shared to drive continual improvement through CoMET, NOVA, UITP and UK national rail. For example remote condition monitoring, fleet overhauls, CBTC signalling systems will all be benchmarked to share and learn how to best manage these assets.
- **Whole life cost modelling.** LU will develop whole life cost models where possible by balancing maintenance, renewals and enhancement work on

assets by taking into account condition, performance, deterioration, costs and risks. This will facilitate informed asset investment decision for strategic reasons.

- **Upgrade Maximo / Ellipse.** To support improved asset information quality and increase asset management functionality. Other opportunities include:
    - Use of mobile devices e-g handhelds integrated with MAXIMO/ Ellipse to access work orders, work instructions, drawings, stock/spare information and close work orders remotely in real time.
    - Establish automatic analysis based on algorithms to convert data to useful information by flagging up failures and raising work orders in the Asset Management System.
    - Enhance asset register and integration with work management, inventory, stores management and procurement, plan and schedule work, track equipment status, resource management, and cost and performance analysis and automated reporting.

7.17.1 Technology

LU's experience of permanent condition monitoring installations (e.g. wheel profile measuring equipment) has not been entirely positive. Thus lessons on optimal location, maintenance support, calibration and integration with depot processes and systems (e.g. IT) have been learnt. LU will continue to explore opportunities for static condition monitoring systems (as well as train borne monitoring) where they are perceived but a more conservative assessment of the benefit, moderated by our experience will be taken. The deployment of intelligent handheld systems (such as laser wheel profile gauges) may, in some cases, be the better operational option than fixed infrastructure.

7.17.2 Remote Condition Monitoring

There have been huge advancements in technology in the last couple of years. The Wi-Fi system is available across several stations on the London Underground network which makes data transmission and real time monitoring of the asset a lot easier than ever before. This provides an opportunity to review our current maintenance strategies across train system assets and adopt real time remote condition monitoring and automated performance analysis where possible to facilitate predict and prevent failures to improve asset performance.

7.17.3 Energy and Environmental Sustainability

Our policy is to be compliant at all times with the requirements of current legislation, LU's Environmental Policy, BS EN ISO 14001 Environmental Management Standard and QUENSH Contract Conditions.

Our environmental management system (EMS), certified to the International ISO 14001 Standard, environmental policy and supporting objectives, targets and programmes, commits us to continuously strive to improve our environmental performance and to support our customers' and the Mayor of London's environmental strategies. Periodic surveillance audits are undertaken by external suppliers to verify compliance. We will focus to;

- Reduce the environmental impact, considering the whole life cycle of the assets through use of lightweight materials commonly used in other industries (aeronautical, etc.) and the exploration of more efficient power delivery, saving and energy recovery and energy monitoring systems in collaboration with the Power Engineer.
- Lower the ambient temperature on board and on platforms, helping to improve the overall customer experience through introducing regenerative braking on all LU rolling stock (where not already achieved and is practicable to do so) and collaborating with our power engineers to optimise the traction power supply system to improve the efficiency of the system receptivity.
- Design and procure low weight rolling stock to reduce energy consumption and less wear and tear of the wheels

7.18 Other Enabling Strategies

7.18.1 Technical Strategies

Technical strategies has been developed separately and owned by Heads of Profession (HoPs). The objective of technical strategies is to facilitate delivery of the train system strategy through provision of technical knowledge base of the assets.

7.18.2 Cooling Strategy

The current thermal situation on the deep tube (Bakerloo, Central, Victoria, Jubilee, Northern and Piccadilly lines) is widely regarded as uncomfortable for passengers for much of the year. The temperatures in the summer are significantly higher than the ambient temperatures:

The temperature in the tunnels is rising and is predicted to continue to rise with line upgrades, new timetables, speed/distance profiles and the effects of climate change. This results in the need for cooling infrastructure to maintain temperature at acceptable levels for passengers and operational staff

Rising temperatures on the network have the following impacts:

- Increased potential for heat strain illness in crowded warm trains and during stalled train events, leading to safety incidents and delays to journeys.
- Increased dissatisfaction with the thermal ambience.
- Negative impact on LU's reputation.

An increase of 1°C in the deep tube tunnels equates to a whole life loss of thermal ambience benefit and safety disbenefits of around £240m. However, reducing the temperature at one platform by 1°C can take more than £3m in capital expenditure and more than £1m (PV) of on-going operational costs. Reducing waste heat so that temperature mitigation is minimised is essential for an efficient railway system that can meet and deliver our future service demand.

To manage the heat on the network, thereby limiting heat strain risk and thermal discomfort, there are four strategic objectives:

- Minimise source of heat on deep tube where possible: Support line upgrades to make trade-offs between energy, heat & upgrade benefits to minimise the extent of cooling works required.
- Support Line Upgrades: Continue to improve the cooling capacity to meet service demands, in particular from line upgrades, through station cooling and ventilation fan projects.
- Maximise opportunities to reduce cooling costs: Reduce the cost of improvements by including cooling as part of station capacity projects or enhancing existing assets where practicable and beneficial. Support the business in considering cooling as part of other projects through modelling and provision of temperature data.
- Optimise existing cooling assets: Safeguard the current cooling capacity by ensuring ventilation fans and future PAHUs are well maintained. Enhance the capacity where there is the opportunity and a strong business case.

All projects are subject to a business case analysis, which includes an assessment of the whole life cost of the project. The strategic objectives have been endorsed by the Cooling Strategy Group and are documented in the Cooling Plan.

The Sub-Surface lines do not generally suffer from the same high temperatures as the deep tube network due to the ‘cut and cover’ method of construction which allowed for natural unforced ventilation. The S-Stock trains are air-conditioned to improve the thermal comfort of customers.

7.18.3 Point Machine Strategy

LU employs a variety of point machine types across the network. The majority are operated via the air main and the strategy is to replace theses with electric points at part of the Track Points and Crossing renewal programme. Over time this will reduce the number point types, standardising equipment, reduce training costs and eventually remove the requirement for air main.

A Cat 1 standard issued in 1994 specified a requirement for a flangeway clearance of 50mm. This clearance cannot be achieved with the current 4 foot Point Machines in a Flat-Bottom Rail configuration. The Surelock Points Machine has been approved for use on the network, selected as the optimum compliant point machine for to improve reliability and maintainability (component/modular machine).

The intention is to replace M63’s with the modern equivalent Surelock to reduce machines types on the network.

An alternative compliant machine is the hydraulic In-bearer Clamplock machine (used extensively on Network Rail) which is currently being installed and trialled. The intention is to develop an electric power pack to replace the hydraulic system before the mechanism is installed anywhere on the main-line.

7.18.4 Trains Division

Trains Division provides a specialised service for the overhaul and repair of rolling stock and signalling assets that cannot in all cases be easily replicated on the external market. LU's strategy is to develop internal strategic competencies to support its maintenance operations, as experience shows that the external market cannot always match LU in terms of competiveness and turn-around times.

This limits LU's risk exposure to external market factors and gives it a degree of control in how it responds to emerging issues within the fleet and signalling assets. The most recent development is the creation of the Train Systems Electronics Repair Strategy.

Decisions on sourcing from Trains Division, the original equipment manufacturer (OEM) or elsewhere have typically been on a case-by-case basis and often conclude that Trains Division is the best solution (e.g. Jubilee Line Heavy Overhaul, 92TS Refresh, 72TS Life Extension). These individual "make or buy" assessments are wasteful and create uncertainty. To eliminate this, LU will set out a long term strategic plan that is settled and agreed for a definitive period of time. This will be supplemented with an assessment of recent experience and internal and external capabilities and capacity. In particular the plan will identify, acquire and enhance specific skills that are lacking such as project management, engineering, procurement and quality control. The strategy is to maintain and enhance our internal capability for supporting all assets for as long as it is operationally and financially advantageous to do so.

7.18.5 RVAR and Platform Train Interface

The strategy is to comply with the requirements of RVAR 2010 subject to consideration of the technical and financial implications of compliance. In principle all fleets will comply with RVAR by 1 January 2020, except that where complete compliance cannot be achieved exemptions through parliament shall be sought. Delivery shall be through the most economic means possible with due consideration of internal competencies (such as Trains Modification Unit), scope and complexity and synergies with other fleet based activities (e.g. heavy maintenance and projects).

In the relation to the platform train interface, RVAR specifies the maximum tolerable stepping distances that must be achieved at the wheelchair doors. These stepping distances (75mm horizontal, 50mm vertical) present a unique set of challenges on some lines and stations owing to current design of the platform train interface (e.g. door sills, oversailing, platform/track curvature, etc). The strategy is to provide permanent compliant level access at Cat 1, 2 and 3 stations (in accordance with "Pimlico Principle") through provision of humps and/or track lifting/slewing and modification of nosing stones. Where permanent compliance cannot be achieved (due to infrastructure geometry) then manual boarding ramps (MBRs) will be deployed where possible (narrow platforms may prohibit MBRs). Delivery shall be through the most economic means possible and will consider synergies with other projects requiring access.

7.18.6 Adhesion Management System Strategy

Adhesion management systems comprise the suite of assets, processes, activities and IT systems that are implemented to enable safe and reliable rail adhesion whilst delivering the required service performance.

Traditionally, ensuring safe levels of adhesion on manually driven lines is primarily achieved through defensive driving techniques. As service requirements increase (e.g. through the introduction of new trains and automatic train control and operation or significant changes to the timetable), the extent of the required adhesion management assessment and measures becomes both more extensive and more critical. The entire suite of measures comprises the Adhesion Management System.

LU's strategy is to implement an appropriate line or network based AMS so that service requirements can be achieved irrespective of the prevailing and predicted conditions. In practice this can require some adjustment to the service under severe conditions (e.g. heavy leaf fall or freezing conditions).

The adhesion requirements, and the requirements of the AMS, shall be considered at the outset of:

- future line upgrades
- significant timetable changes
- rolling stock or ATC asset replacement
- mitigation train replacement

For this reason LU will publish a category 1 standard which will dictate the requirements for an acceptable Adhesion Management System (AMS).

For ATO lines, the AMS shall consider the following:

- Rolling stock low adhesion brake performance consistent with the ATO brake rates and the possible range of adhesion conditions
- Existing and new trains fitted with standard precautionary measures such as de-icing, anti-icing, wheel spin correction (motoring), wheel slide protection (braking) and sanders.
- ATC system traction and brake rates are set consistent with the possible range of adhesion conditions and the rolling stock low adhesion performance
- Condition Assessment System (CAS) provided which will identify, in advance, when adverse conditions will exist and require the ATO brake rate to be changed and the leaf fall mitigation trains to be operated to

counter low adhesion conditions. (The system currently deployed on LU is known as the Adhesion Condition Controllers Assessment Tool or ACCAT, which is a generic application which can be configured for different lines. Note that the CAS is sometimes referred to as the Adhesion Prediction System.)

- ATO control system provides the means to quickly and easily change traction and braking rates for both individual sites and defined groups of sites
- On-going provision of line specific leaf fall and weather forecasts to the adhesion prediction system
- Leaf fall mitigation trains provided to clean and treat the railhead in leaf fall vulnerable zones.
- Track side mitigation devices (e.g. traction gel lubricators) installed to treat the railhead at specific sites.
- On-going vegetation surveys, assessment and management
- Deployment of track side equipment to provide site specific environmental data
- Real time feedback of data from the RS to the CAS concerning the operation of the WSP and sanders
- Real time feedback from ATO to the CAS concerning the currently applied ATO brake rate at each site and the occurrence of any overruns
- Real time feedback of data from the leaf fall mitigation trains to the CAS concerning the application of mitigation
- ATP train borne equipment installed so as to minimise the occurrence of emergency brake interventions due to spin or slip during motoring or service braking (ATP tachogenerators)
- Autumn site inspection, leaf collection and removal (especially P&Cs)
- Adhesion Controller to manage day to day mitigation measures
- Adequate budget and resource commitments for both day to day implementation and on-going review and development
- Clearly identified leadership with appropriate authority

8. Power

8.1.1 Strategic Summary

This strategy sets out the vision and objectives for the power supply and distribution system for the next 40 years which is broadly in line with the design life of these assets.

LU's Power assets are managed in accordance with the whole life cost principles where appropriate through the optimisation of network capacity, energy consumption, renewals and maintenance activities, taking into account cost, risk, performance, asset condition and statutory compliance concerns. Upgrades to existing assets, or construction of new ones, will continue to adopt cost effective designs that consider future maintenance costs and network sustainability.

One of the key challenges for the Power systems going forward is the increase in energy consumption costs which are primarily driven by major train service upgrades and the rising cost of energy. This cost forms the majority of the Power expenditure and therefore optimising and stabilising our energy consumption is key in ensuring this issue is managed effectively.

In light of the above, technological advances in the power area will be pursued, evaluated and where there is a positive business case, implemented in order to improve our existing Power Supply and Distribution system and move towards a more energy efficient and sustainable railway. The Power community will also be key in influencing the Train, Signalling and Station systems approach to optimising energy consumption.

This Strategy Covers:

- A description of the assets which comprise LU's power & distribution system.
- The strategic safety, business and performance objectives and core assumptions currently influencing power asset delivery.
- The long-term approach to developing and delivering power operations, maintenance, renewals and upgrades activities in support of these strategic objectives.
- How the Power Asset Group intends to further develop its asset management capability through the management of strategic risks and opportunities.

8.2 Our Goal

Ensure that there is sufficient power capacity for existing and future train service requirements, maintaining high asset resilience, reliability and safety whilst optimising and stabilising our energy consumption and contributing to energy sustainability

To deliver our goals for our Power assets we will:

Upgrade the power network to ensure that there is sufficient power capacity to cope with future demands on the network; this will be achieved through step changes in the network power supply and distribution capacity by upgrading existing and adding additional assets (such as substations) to ensure that sufficient power is in place to support the line upgrades and major schemes such as the Northern Line Extension and Croxley Rail Link. This includes the use of energy efficient components and interaction with other asset groups, such as the introduction by Track assets of Extra Low Loss Conductor Rail which has material properties leading to less power loss from point of entry of the system to the train.

Use the opportunity of the line upgrade to enhance the power capacity network and resolve key residual asset condition, obsolescence and compliance concerns at a significantly reduced cost.

Ensure that the power system is designed with inbuilt redundancy and resilience to minimise reliability issues. Any system deficiencies will be dealt with on a risk basis. Minor works will be dealt with through the maintenance regime and where substantive intervention is required this will either be incorporated in forthcoming network capacity upgrades (the most cost effective intervention point) or as part of an asset renewal programme.

Look to optimise network traction energy efficiency whilst ensuring the consequential benefits of limiting tunnel temperature rises are delivered, working closely with the other train system assets (fleet, signalling, depots).

8.3 Contribution to Key Rail and Underground Priorities:

R&U Priority	Strategy
Reliability & Safety	• The Power system is designed with inbuilt redundancy and resilience. • Where existing or future deficiencies have been identified (for example, reliability, obsolescence, statutory compliance) these will be evaluated to determine the risk to the business. • Where these cannot be dealt with under the maintenance regime and substantive intervention is deemed necessary, in the first instance opportunities will be explored to incorporate them as part of forthcoming network capacity upgrades (the most cost effective intervention point).

R&U Priority	Strategy
	• Otherwise they will be included in future prioritised asset renewal programmes.
Capacity from the current Network	• Train service increases through major line upgrades, necessitate step changes in Power supply and distribution capacity, presenting significant challenges to its configuration and design. • By 2023, the system is expected to have grown in the order of 28% (since 2006). This growth presents a once in 40 – 50 year opportunity to: ○ Incorporate residual asset condition, obsolescence and compliance concerns at a significantly reduced cost as opposed to undertaking these works on an ad hoc condition driven basis. • Working closely with the other Train system assets (fleet, signalling, depots), optimise the network energy efficiency, with consequential benefits to tunnel temperatures.
Capacity from growing the Network	• This will be achieved by expanding the Power network and introducing additional HV/Network assets such as substations to ensure sufficient power capacity is in place to support major schemes such as the Northern Line Extension and Croxley Rail Link. This includes the use of energy efficient components and interaction with other asset groups, such as Extra Low Loss Conductor Rail which has material properties that leads to far less power loss from point of entry of the system to the train.
Customer Service	• Whilst the Power system has no direct customer facing assets, failures most definitely result in substantive indirect impacts through the loss of customer facing train system and station system assets. • Asset resilience and capacity are critical features of the Power Supply and Distribution system to maintain world class performance. • LU separately purchases a small amount of its power from Distribution Network Operators, primarily for stations assets. These are outside the direct control of this Power strategy and are subject to agreed commercial terms.

8.4 The London Underground Power System

The London Underground power system can be broadly classified into 2 parts:

- **The High Voltage / Network Power Assets**
  Incorporating Bulk Supply Points, Switch Houses for HV Distribution, Substations, Compressed Air Supplies, Power SCADA, Central Emergency Power Supply and some Low Voltage switchgear.

- **The Low Voltage Power Assets**
  Incorporating Electrical Traction Equipment (ETE - Feeder Cables, traction switches, depot overhead supplies), 400v Low Voltage AC (LVAC – distribution), essentially all assets downstream of the substations and transformer rooms.

HV supply assets upstream of the LU Power system are provided by National Grid and respective Distribution Network Operators. LV electrical assets downstream of the power system are managed by their respective user asset (e.g. stations, signals, depots etc.).

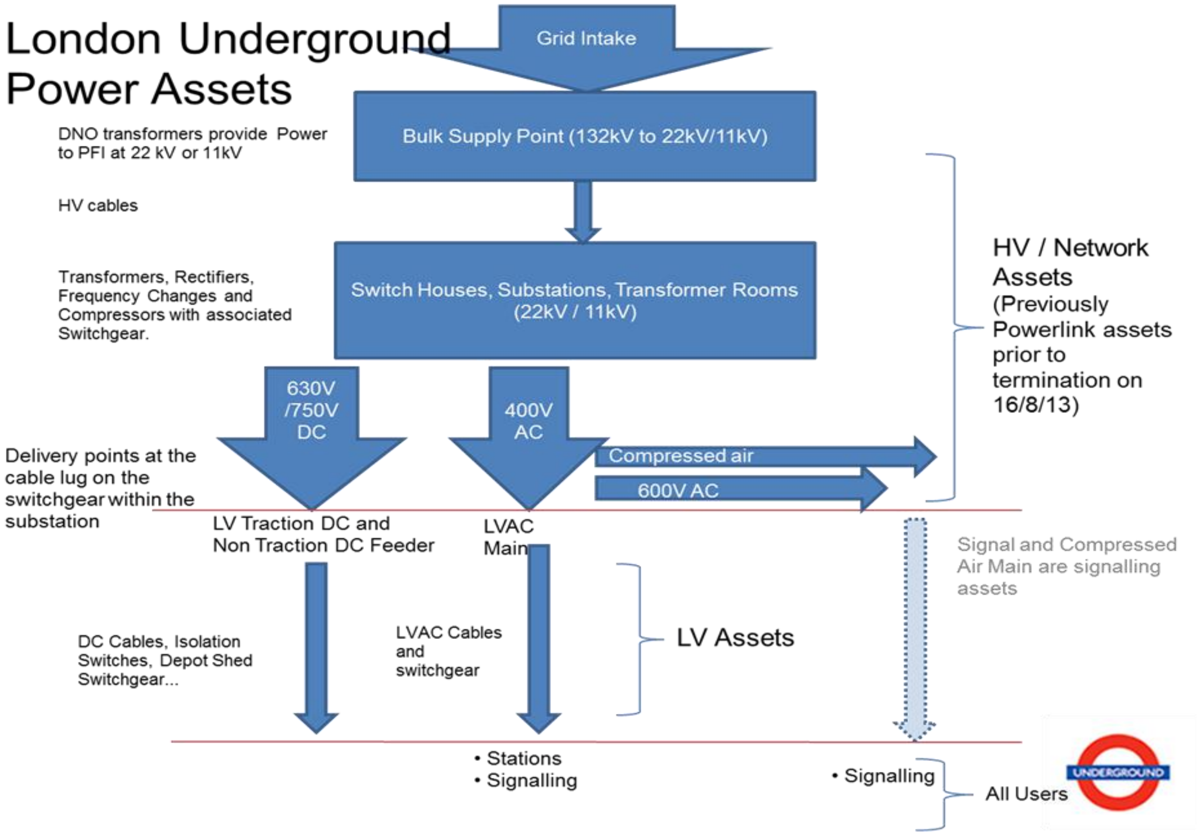


Figure 27: Simplified Power Infrastructure

Figure 28 provides a strategic overview of the LU HV power distribution. There are six main 132 kV fed bulk supply points (BSP) located at Neasden, Lots Road, Mansell Street, Manor House, Griffith House and West Ham. In addition, there are two smaller BSPs at Acton Lane (22kV) and Finchley (11kV). Each BSP takes a direct feed from the National Grid to supply the LU network and are strategically located providing resilience against outages. In the event of a BSP outage, the system would be reconfigured so that the affected area of the network can still receive a supply from the remaining operational BSPs. However, there are usually significant service impacts whilst the system is reconfigured highlighting the criticality of a BSP. LU has an overarching 22kV network ring which is then transformed down to 11kV to feed the substations for the majority of infrastructure.

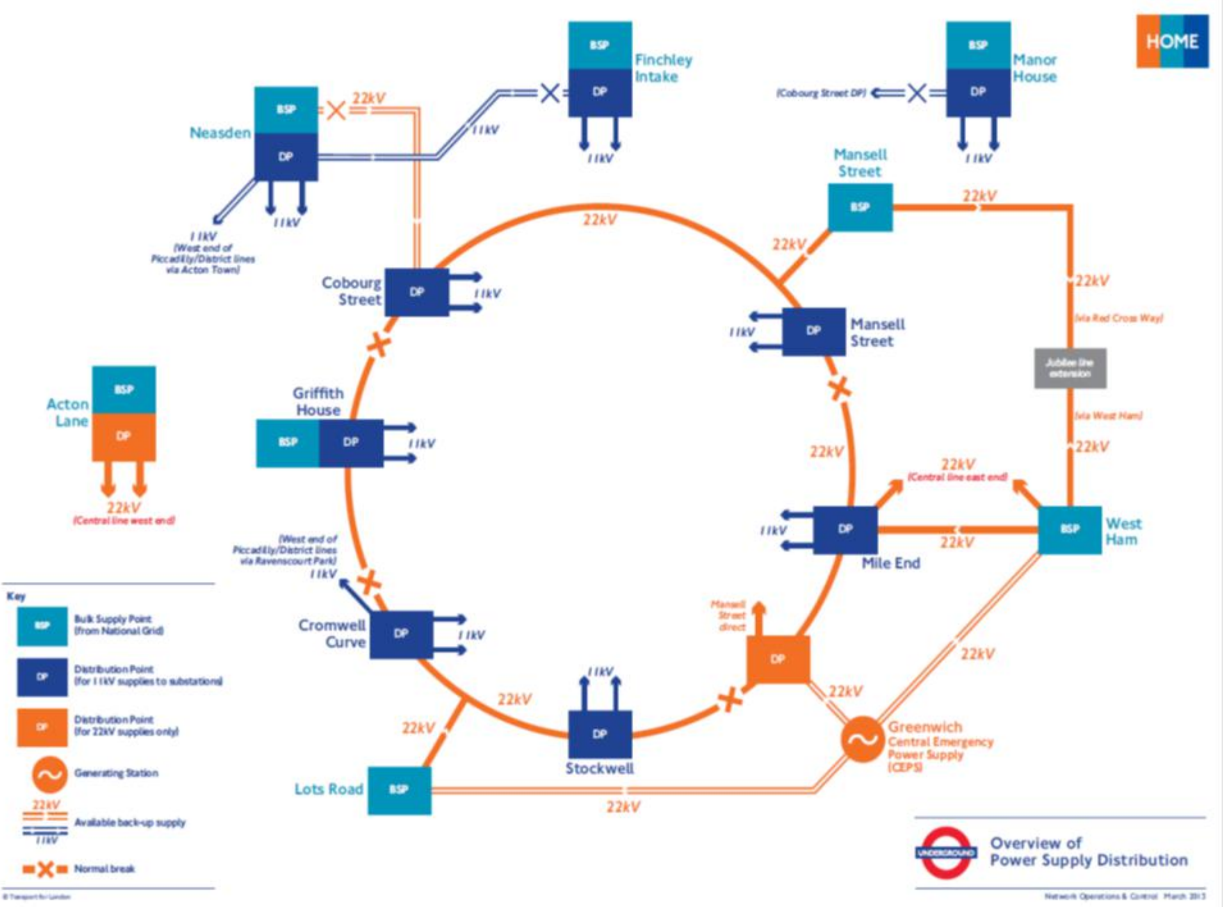


Figure 28: Overview of LU Power Supply HV Distribution

8.4.1 Distribution Network Operators (DNO)

In addition to the major BSPs and LU's power supply system, LU also separately receives many small LV power supplies from local Distribution Network Operators (DNO) and Network Rail. LU procures these supplies from the DNOs but has limited control and influence over the reliability of these supplies, providing they meet the minimum statutory requirements set by OFGEM.

Where other assets derive their power from these DNOs, this associated distribution equipment is not considered as part of the Power Supply and Distribution system as defined in this strategy.

However, as a number of safety-critical assets (such as escalators/lifts/platform lighting) are currently powered through DNO supplies, some DNO failures lead to disruption in service and sometimes station closures in the more extreme circumstances. LU's LVAC power supply is unable to cope with all the load demands that are currently being served by the DNOs. A key reason for the popular use of DNO supplies is the relative ease, quickness and cheapness of obtaining a DNO power source.

In light of these concerns, LU introduced a Category 1 standard (1-123) in relation to power supply requirements which has restricted the future opportunity to use DNO supplies for safety-critical assets. This standard will be gradually applied as and when upgrades of the assets using power are undertaken. The responsibility for resilience of loss in DNO power lies with the affected end user asset areas and is not specifically part of this Power Asset strategy.

In practice however, LU COO Power Operational team are generally the first point of call by the business in the event of DNO power failures, who then liaise with respective suppliers for suitable resolution.

8.5 Key Changes since Last Strategy

Termination of the Power Service Contract

Asset management, maintenance and renewals of HV/Network power assets previously undertaken by UK Power Networks Services Powerlink Limited, under the 30 year Power Service Contract PFI was terminated in August 2013, with the assets fully reverting back to TfL ownership.

Therefore this strategy reflects the increased responsibilities on TfL, post termination. In principle it is expected that the general undertaking will remain the same with the re-integration of Powerlink's function and staff within the LU and TfL organisations. This has the following organisational impacts:

HV Power Control Room operation and management of the Central Emergency Power Supply moving to COO under the Head of Network Operations & Control.

Maintenance and performance responsibility and adoption of new assets moving to COO Asset Performance under the Head of Asset Support.

Management and delivery of future renewal and upgrade activities plus management of variations requiring power works on behalf of other projects moving to CPD under the Head of Power, Cooling and Communications Team.

Engineering responsibility for these assets and accountability for preparation of future renewal and upgrade assessments, which recognise TfL's business case methodology moving to CPD under the Professional Head of Power.

Integration of JNP assets into LU

With the recent integration of JNP assets into LU, the long-term strategy across BCV, SSL and JNP is to have one common and consistent approach for asset management activities including the reporting of asset condition. This will also consider the use of a single asset management system to manage day-to-day maintenance activities, faults and performance data.

8.5.1 Key Assumptions

The following are core assumptions, which underpin the power strategy, i.e. if they change, then the strategy would have to change accordingly:

- Changes to TfL's Business Plan - Any changes to revenue, government funding and mayoral policies are likely to impact on these objectives being achieved.

- There are no changes to the overall amount of engineering hours available for undertaking maintenance and project activities.

- There are sufficient and capable resources within the AP and CPD delivery teams to deliver the plans as set out in this strategy.

- There are no catastrophic climate events that could impact operational services, maintenance or project delivery activities .e.g. Flood ingress within deep tube tunnels.
- Minor changes to train services (e.g. timetable changes) can have an impact on power maintenance and capacity. When known these are included in the business plan. Proposed changes are notional and are subject to detailed analysis closer to the implementation date.
- The potential effect of all night running of the railway has not yet been considered from a power perspective. It may impact on capacity and therefore this would need to be evaluated and modelled on a line by line basis.
- Train service capacity - The tables below describe the outline service level and timing assumed for future major train service capacity upgrades. As the underlying assumptions and LU's future funding stream become clearer these assumptions will be modified, therefore influencing the timing, delivery and scope of the power solutions.

Upgrade	**Financial Status**	**Completion Date**	**Trains per Hour**
Northern Line Upgrade 1	Approved	2014	24 N of Kennington 32 S of Kennington
Jubilee Line Upgrade 2	Budgeted	Mar 2018	33 and 36
Victoria Line Upgrade 2	Budgeted	April 2016	36
Northern Line Extension	Budgeted	2020	28
Northern Line Upgrade 2	Budgeted	2022	*3 Bank branch 30 Charing Cross Branch 33 Morden Branch

Table 1: World Class Programme - Post Upgrade Train Service Enhancements

Upgrade	Financial Status	Completion Date	Trains per Hour
Waterloo and City	Budgeted	2021/22	25
Bakerloo	*Budgeted	2023/24	25-27
Piccadilly	*Budgeted	2026/27	33 (36 may be considered)
Central	Beyond 10 year plan	2029/30	33

Table 2: New Tube for London

- **Energy & Environmental Sustainability** - The power asset has a fundamental part to play in supporting mayoral emissions targets in a number of ways:

- Through investment in sufficient capacity and resilience it helps support higher predicted levels of train service, thus promoting modal shift away from more carbon intensive forms of transport within London.

- Through greater system integration with the newer train systems assets being installed, opportunities for increased energy efficiency can be realised. For example, enhanced train regenerative braking, potentially contributing between 25% and 40% energy efficiencies and consequential tunnel temperature improvements.

- Opportunities for reduced transmission losses should also be exploited, for example through changes in energy sourcing strategy and use of more localised 'greener' generation.

8.6 Asset Strategy

The Power Asset Group aims to deliver the following high-level objectives at the optimum whole life cost to London Underground:

- ***Sufficient power capacity*** to fully support London Underground's existing and future train service and operational requirements.

- ***High asset resilience, reliability and safety*** to prevent unplanned outages and failures manifesting themselves in service disruption and safety impacts to staff and passengers.

Power operations, maintenance, renewals and upgrades are integral to supporting the wider objectives of fast, safe, reliable and comfortable journeys for all customers. The following power related business goals apply for LU to achieve its overall objectives:

	Objective	Measures and Impacts
1	Power system Capacity	• Meeting power capacity requirements for current and future train service timetables. • Supporting Line Upgrade Business Case for SSR. • Supporting the New Tube for London as it develops. • Supporting the World Class Programme as it develops. • Supporting Station Upgrades, Modernisations and Redevelopments. • Optimising the power solution using the most efficient combination of HV and LV power assets.
2	Power System Availability	• Minimising Lost Customer Hours impacts and ensuring that they do not exceed agreed levels. • Maintaining current standards of system and asset resilience. • Contribute towards Mayoral policy to achieve 30% improvement in reliability. • Identifying any underlying fault trends and condition data to determine if any intervention is required.
3	Safety and Compliance	• Robust earth fault reporting. • Compliance with Cat 1 standards where justified. • Statutory Compliance (e.g. Electricity at Work Regulations). • Managing safety issues to ALARP.
4	Environment	• Supporting Mayoral Energy Policy • Optimising Energy Consumption. • Supporting more efficient train system solutions (e.g enhanced regenerative braking). • Challenging other assets' load growth requirements • Responding to changes to the energy sourcing strategy. • Managing the impacts of climate change on the operation of LU's power supply system.
5	Optimum Whole Life Cost	• Ensuring the above objectives are met at least whole life cost. • Ensure the most energy efficient approach is adopted and new technologies pursued. • Exploiting Operational and Maintenance efficiency opportunities. • Optimising the balance between asset maintenance, renewals and upgrade interventions. • Understanding maintenance, renewal and upgrade activities at unit cost level to assess and exploit further efficiencies. • Benchmarking unit costs with other similar power providers • Challenging inappropriate standards. • Good understanding of asset trends, condition and lifecycle in order to be proactive when responding to emerging concerns. • Robust asset condition reporting to prioritise maintenance / renewals work activities for addressing any concerns.

Table 3: Summary of strategic objectives

8.7 Delivery Strategy

The delivery strategy outlined below is in line with our vision and long-term objectives for the Power asset area to increase capacity to accommodate primarily train and station systems assets, optimise our energy consumption and contribute towards a sustainable future. To achieve maximum value from the power assets, we adopt a whole-life approach which is underlined by capture of management information that includes:

- Operational and maintenance cost data
- Capacity and load growth projections
- Asset performance and failure trends
- Asset condition data
- Whole life business case appraisals
- Unit cost data

All this information ultimately influences the asset intervention regimes and delivery scopes to maintain and improve the performance of the assets against the strategic objectives set out in table 3. This approach applies to:

- Operations: To ensure the power distribution network and its assets are managed and configured on a day to day basis in an efficient and effective manner that supports a reliable and safe rail network.
- Maintenance: To ensure both new and old assets continue to perform to their required function within lifecycle.
- Renewals: To prolong the life cycle and functionality of existing power assets and to replace those assets where there is sufficient reliability, condition, safety or statutory concerns resulting in disproportionate cost or risk.
- Upgrades: To increase the capacity or functionality of the power supply system, primarily in response to major line upgrades and major station developments.
- The approach to achieving the Power Supply & Distribution System strategic aims is illustrated below in figure 29 as a roadmap over the life of the asset systems and represents the asset management approach to maintenance, renewals and upgrades.

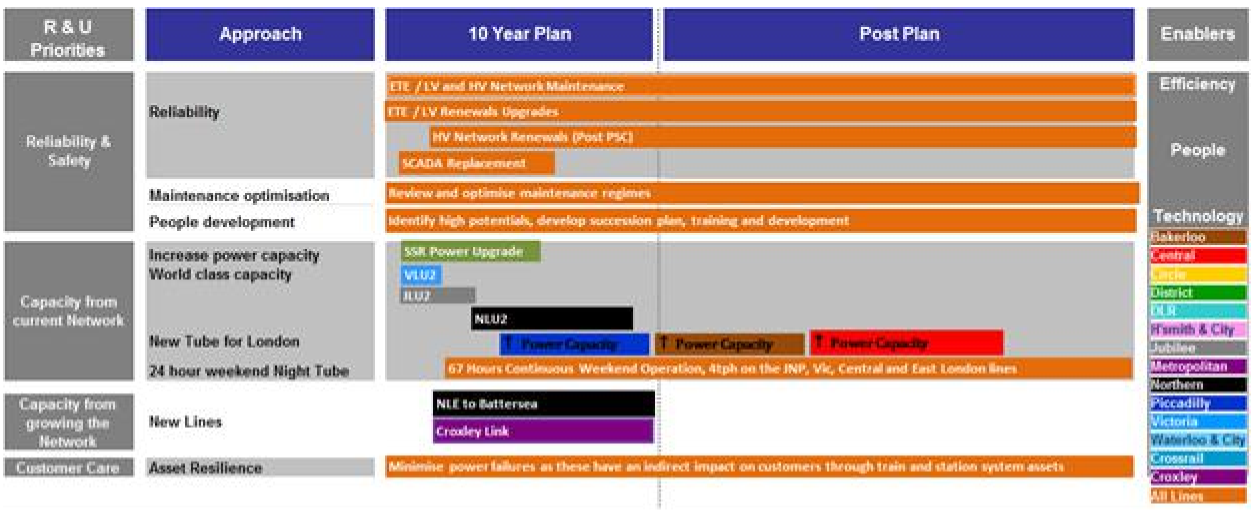


Figure 29: Power Roadmap

8.8 Power Operations and Maintenance

8.8.1 Power System asset Objective

The power system is designed with inbuilt redundancy and resilience, thus reliability issues tend to be significantly lower compared to other asset areas. However, when failures do occur they generally result in substantive indirect impacts through the loss of availability of train system and station system assets. Therefore, our objective is to detect issues through our maintenance regime and address these before they cause an impact on the network and improve asset resilience to reach and maintain 'world class' performance levels.

As can be seen from the graph below (figure 30), the key issue is the electricity consumption costs which are significant and forecasted to increase. This is mainly due to the impact of train service capacity increases following a line upgrade and the expected increases in energy costs. Therefore, our long-term objective and strategy is to manage this increase by pursuing the most energy efficient and sustainable approach to managing the power system optimisation and where necessary implement a new or advanced technology.

The efficient management of our energy consumption will not solely rely on the Power supply and distribution system community but also on other asset areas such as stations and train systems. An example of this would be maximising the regenerative breaking capability of our passenger rolling stock.

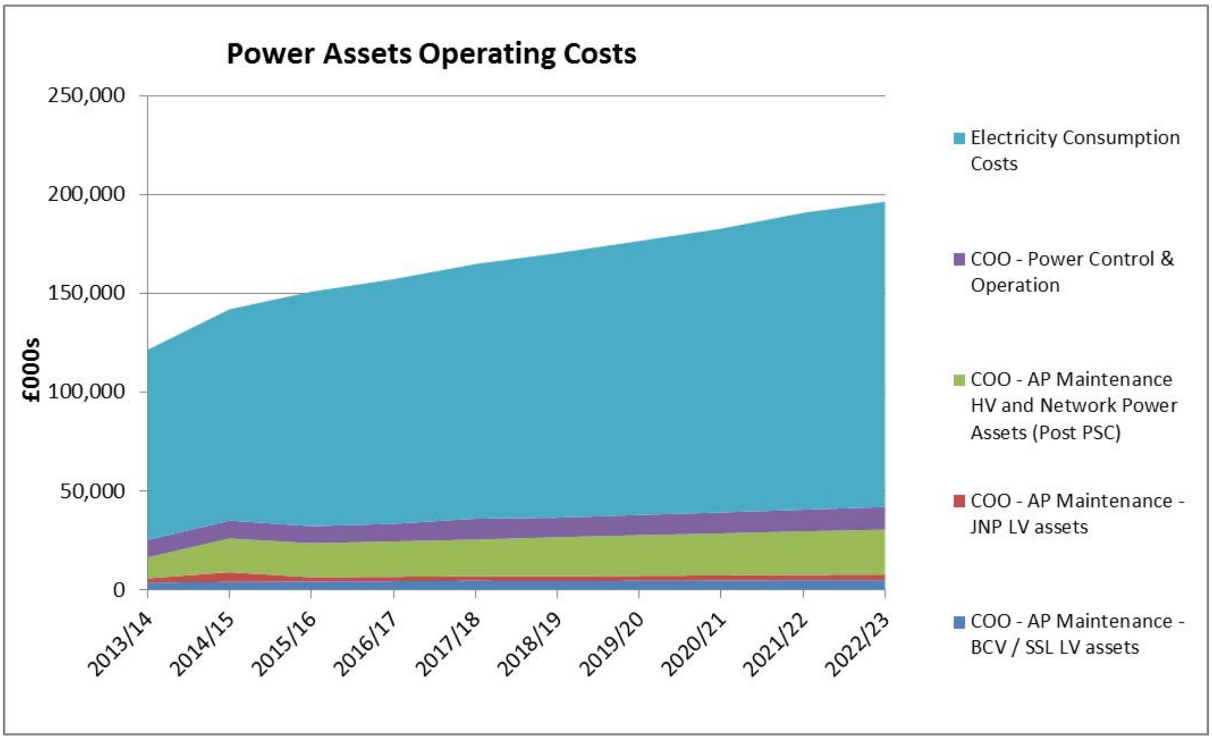


Figure 30: Power COO Planned Budget profile

8.8.2 Power Operations

Our Approach

- Power operations under the COO comprise the following:
- Network Power Control
- Operation and Management of Central Emergency Power Supplies

8.8.3 Network Power Control

Power operation and control is carried out in the LU Control Centre located in Central London. It is responsible for the day to day management and configuration of the complete power distribution system, plus communication and coordination with the Distribution Network Operators (UK Power Network Services and Scottish & Southern Energy) and the National Grid. At present, power control is separated into two discrete functions:

- HV supply and distribution executive control.
- HV and LV power control (incorporates HV, LVAC, signals, traction and compressed air supplies).

8.8.4 Operation & Management of Central Emergency Power Supplies

The primary function of generating station based in Greenwich is management of LU's Central Emergency Power Supply (in the event of a major grid outage) and management of the Energy Cost Saving (ECS) service to help optimise our energy consumption unit cost tariffs. Training, planning, consumable stores and site security arrangements are provided by AP Power.

The future of CEPS (Central Emergency Power Supply) will have to be considered within the life of this strategy. The redevelopment plans for Greenwich will begin to consider the future of CEPS and the opportunities around centralised or distributed power supply.

8.8.5 Power Maintenance Approach

Maintenance of HV/Network and BCV/SSL LV power assets is carried out by LU's COO Asset Performance organisation via the Head of Asset Support (BCV & SSL). Currently separate maintenance functions and arrangements are in place for HV/Network assets and LV Assets. This reflects the asset demarcations pre power supply contract termination and also the substantial differing competences / access issues necessitated between these asset groups.

The long-term strategy is to have consistent reporting of asset condition across BCV, SSL and JNP HV and LV assets so the outcomes can be interpreted and compared and the highest risk items can be prioritised and addressed first.

Maintenance activity incorporates:

- Inspections
- Preventative Planned Interventions
- Reactive Fault rectification

The current maintenance regimes are based predominately on; compliance with LU engineering standards, responding to any other underlying asset concerns which necessitate extraordinary maintenance interventions, and minor renewals activity. Our maintenance approach will be reviewed on an ongoing basis and where necessary changes introduced to improve our maintenance regime and drive further efficiencies.

8.9 Power Renewals

The long-term strategy for power renewals is to incorporate these into the major upgrade intervention programmes. However, any items which are unable to be incorporated will be scheduled in an annual separate renewals programme to ensure these assets do not adversely impact on performance. The requirementsr these works are driven by a number of issues including:

- Existing performance concerns (e.g. assets incurring Lost Customer Hours, changes in asset failure trends).
- Loss avoidance issues (identified through predicted/risk based assessment around future deterioration, driven by a combination of condition, performance, increasing maintenance commitment).
- Obsolescence (e.g. inability to remanufacture critical spares, unsupportable software/hardware systems etc.)
- Quantified safety concerns or statutory compliance issues.
- Small scale capacity issues and minor upgrade requirements.

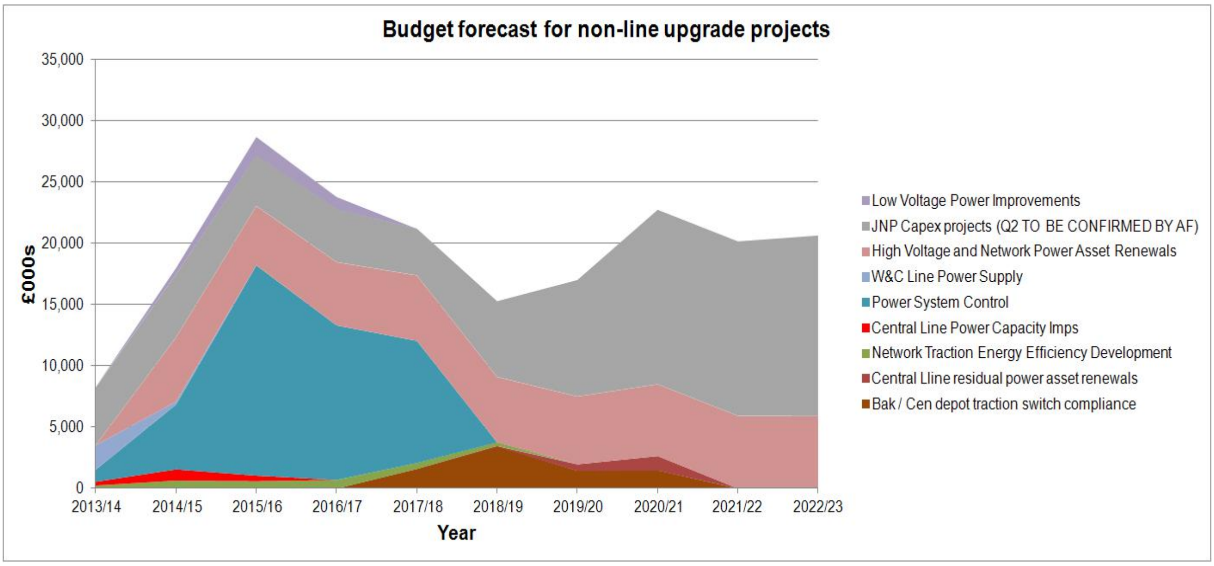


Figure 31: Power Capital Planned Budget profile for non line upgrade projects (including

SCADA and R&U)

It is important to note that the JNP budget post 2018/19 is likely to change significantly as there is currently an exercise underway to reduce this budget.

Power renewals and minor upgrades will be predominantly delivered through the Power Cooling and Communications Delivery Team (PCCT - CPD). Some existing LV/ETE renewals works are currently delivered through the line upgrade programmes. This demarcation reflects the original PPP arrangements. In addition, Infrastructure JNP is presently delivering some LV works on JNP lines. However, the long-term strategy is for one delivery team to be responsible for all LV renewal works across BCV, SSL and JNP in order for a consistent approach to be adopted.

Access planning and booking are undertaken through the LU Access Planning team, there are currently no major constraints with regards to access for these works.

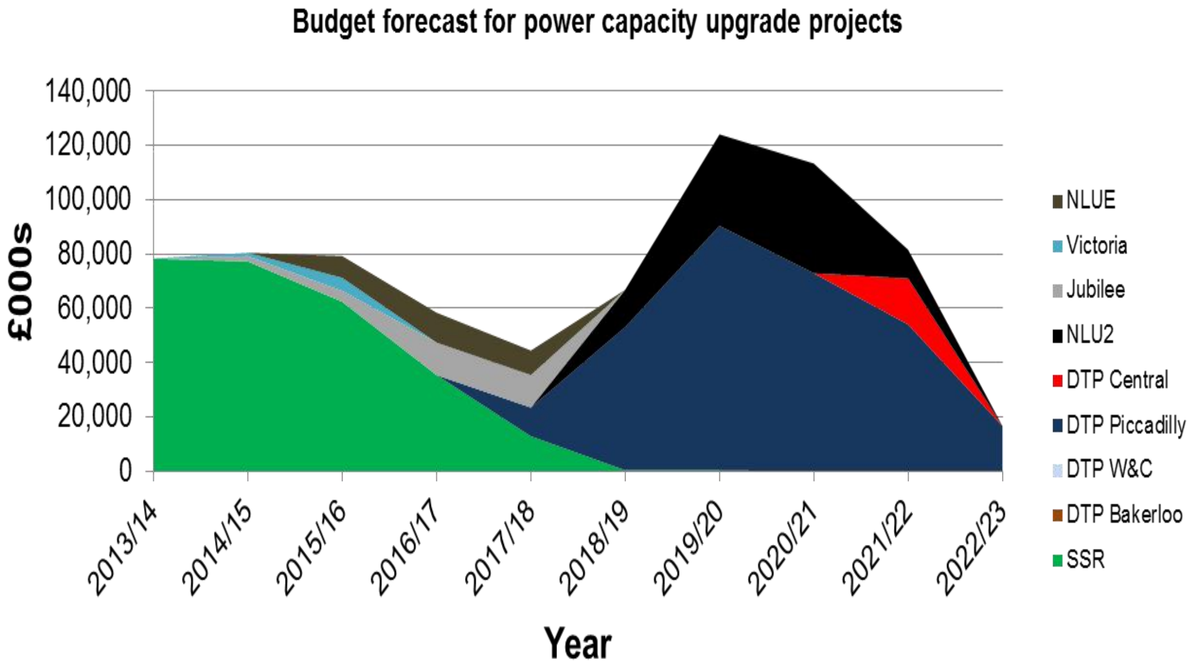
The PCCT manage its resource requirements on a periodic basis, the only significant scarce resource are commissioning engineers. PCCT is currently developing a strategy to address this issue over the next 6 to 12 months.

Major works are contracted in accordance with existing procurement strategies appropriate to the work type. PCCT currently has a work stream to optimise future supply chain delivery and efficiencies to meet the business planning targets. New procurement frameworks are being developed to support this.

8.10 Power Upgrades

The key goal is to ensure sufficient power capacity can be provided to accommodate major train service upgrades in a safe, timely and efficient manner. With customer expectations changing and 24 hour weekend running of the network becoming a reality over the next few years, this will be even more crucial. Therefore, the primary challenge for the Power Supply and Distribution system will be to ensure enough power capacity is in place for train services, stations and signalling assets to operate safely in the future which will enable the delivery of a 'new tube for London'.

The graph below shows the capital expenditure on the network power assets in support of train service capacity driven upgrades. The dominant characteristic of the profile is the lack of stability from year to year, which from a power delivery perspective is not optimised for efficient implementation. However, flexibility exists to change this profile so long as the capacity is installed ahead of the demand from the upgrade projects. Therefore, the goal is to smooth this profile to enable the more efficient delivery of these works.



Note: SSR expenditure is for PCCT works only

Figure 32: Power Capital Planned Budget profile for line upgrade projects

Our Approach:

- Major (HV) power upgrades are delivered through the Power Cooling and Communications Delivery Team (PCCT - CPD). Some existing LV/ETE works are currently delivered through Line Upgrade projects. This demarcation reflects the original PPP arrangements. For future upgrades however, it is assumed that the majority of this LV work will also reside with PCCT.
- There are a number of challenges which require careful management in the planning and delivery of major power asset upgrades. These include:

- The forecast spending on power to support the future line upgrades shows significant difference from year to year. This presents a challenge to the deliverer in terms of matching the required resource to a spending profile which is not stable. The most efficient way to deliver the planned works is to smooth the profile to provide a repeatable resource requirement.
- Any major intervention at a substation is difficult and, hence, expensive therefore it makes good economic sense to minimise the frequency of major interventions.
- Ideally, upgrades should be achieved by building a new substation adjacent to the old substation and then decommissioning the old one following switchover. This is rarely practical, because of land constraints but remains a good guiding principle.
- There is strong public demand to minimise the amount of access required to deliver line upgrades. The majority of power works can be carried out without the need to close the railway to passengers. When trackside access is required (for example in ELLCCR installation) where possible the work will be combined with possessions required for other work or carried out in engineering hours.
- Each major intervention should consider encompassing all the work foreseeable at the site, even if this involves a degree of purchasing materials/resources significantly in advance of need. The upgrade works create practical and cost effective opportunity to deal with long-standing, low-level, asset condition concerns and statutory compliance issues at reduced cost.
- Power equipment upgrades have quite long lead times, 2+ years from inception to order, and 2+ years from order to commissioning and need to be very closely integrated with train and signalling delivery and major train service enhancements.
- Given that a very large proportion of power upgrade costs are on-site, there are almost certainly opportunities to reduce costs by moving the boundary between factory and on-site activity.
- Maintaining capacity and security of power supplies during the process of upgrading is difficult and, hence, expensive. Therefore, if any reduction in capacity or security of supply can be tolerated, the opportunity should be utilised.

Commissioning Engineer resource to support HV asset upgrades has historically struggled to meet demand which has led to delays to substation works. This has been managed by allowing additional time in delivery schedules for commissioning, however this does lead to additional costs when the resource is withdrawn at short notice. The integration of this resource fully back into LU will enable greater strategic prioritisation of this issue.

8.10.1.1 Train Service Driven Power Capacity Upgrades

The vast majority of upgrades are driven by the need for enhanced power capacity to support the respective train service enhancements and line upgrade programmes already underway and planned for delivery by the Capital Programme Directorate. The scope of these major power upgrades is determined using a well-developed methodology whereby conceptual designs are developed in-house and outline / detailed design & build is delivered by contractors selected through competitive procurement.

Two key planning documents underpin the development of the Power conceptual designs; namely the *Power Sizing Guidance (ref. PE-TR-390)*, which sets out the way in which solutions to traction power capacity and train shoe voltage issues should be addressed and the *Security Planning Criteria (ref. SP81802)* which defines the levels of redundancy to be applied at different points on the power distribution network.

The conceptual design process follows a 'bottom up' approach, starting with multi-train simulation (MTS) modelling of each line to determine the electrical demand on traction substations arising from the operation of new rolling stock at enhanced frequencies.

A recent enhancement to this methodology has been the consideration of opportunities to improve Traction energy efficiency as part of the MTS modelling process. This necessitates a systems approach as invariably it impacts the design of the train, the power infrastructure and ultimately service regulation strategies and systems. The justification for incorporating this is as follows:

- To mitigate some of the predicted increases in absolute traction energy consumption to support the upgraded train service (faster station to station runtimes, increased train frequency, increased auxiliary loads).
- Predicted increases in energy unit costs over the next few years
- Limiting the rising levels of waste heat in deep tube tunnels and associated mitigations (tunnel ventilation, station cooling etc.) resulting from the enhanced train services.
- Maximising this infrequent major upgrade intervention to deliver these energy efficiency improvements at marginal cost (upgrades usually occur once every 40 – 50 years).

Major (HV) power works are typically design and build contracts. However Power stakeholders are working closely with the Line Upgrade programmes to develop a more stable, long term, lower annual spending profile for future Power upgrade works. Initial evaluation suggests this would enable delivery efficiencies in the order of 10% - 15%, through a combination of more in-house design and a move further down the supply chain to limit the requirement of external management contracting.

The Sub-Surface Railway Upgrade, and to a lesser extent station upgrade programmes, have resulted in step increases in energy and power (i.e. instantaneous load) demands. In order to support these changes, while maintaining the required levels of security of supply, significant new power assets (5 new substations) have been installed and a large proportion of the existing power assets in relevant areas have been replaced with assets of greater capacity (40 substation upgrades).

The New Tube for London (NTfL) and 'World Class Initiatives' will require a capacity increase of comparable magnitude to the Sub-Surface Railway Upgrade. The emerging scope will contain new or upgraded substations and ETE.

Figure 33 shows the projected 'Installed Capacity' by line resulting from the substation upgrades which indicates the network capacity available within LU to run the much enhanced train services.

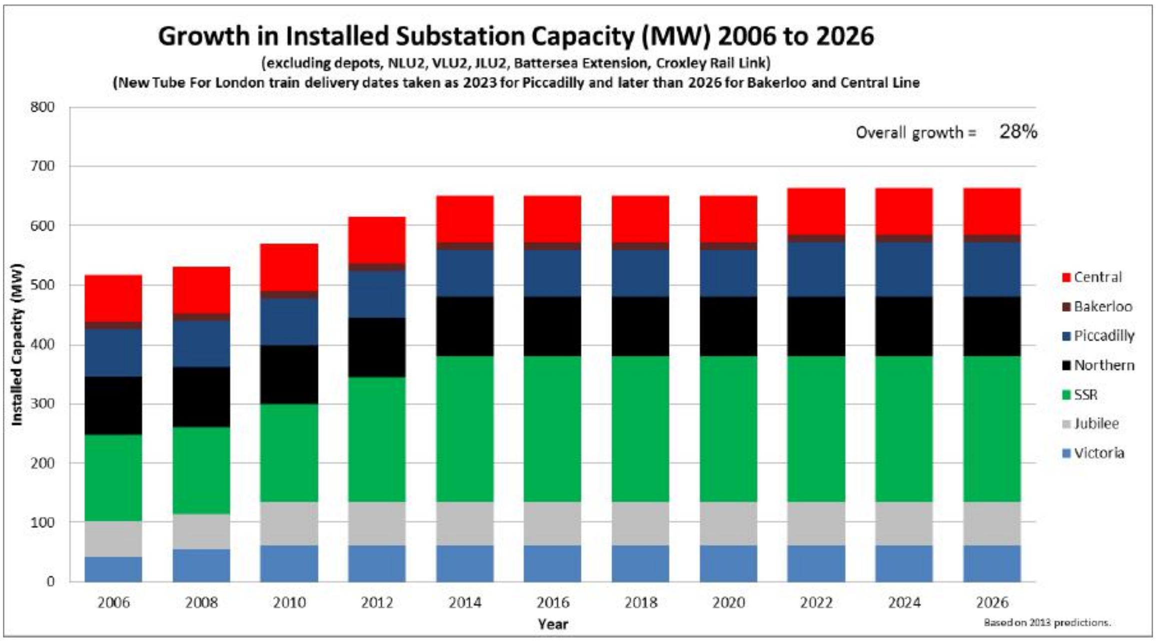


Figure 33: Installed capacity by line

The graph includes the major line upgrades (VLU, SUP and NTfL) which make the most significant contribution to the growth in capacity. The World Class upgrades (NLU2, VLU2, JLU2), Battersea Extension and Croxley Rail Link are under development and will have a relatively minor impact by comparison.

8.10.2 Station / 3rd Party Power Capacity Increases

In addition there are power capacity increases to support major station upgrades and 3rd party developments. These are funded by the project requiring the additional capacity, but in many cases delivered via the PCCT (since the demise of the PSC). Current examples include:

- **Crossrail** – The relocation of existing traction substation at Liverpool Street with higher rated transformers.
- **Tottenham Court Road Station Upgrade** – A new transformer room to meet additional power requirements.
- **Victoria Station Upgrade** – Additional transformer room.
- **Bank Station Upgrade** – The Walbrook Square entrance project (DNO supply) and the Bank Northern Line station congestion relief project involves relocation of the existing transformer room plus additional transformers. Station Upgrades Sponsor has been advised that the Power Sponsor would like to reserve space for a future traction substation to support the Northern Line at Bank.
- **Paddington** – Proposal for new transformer room for Bakerloo Line and consideration of space for future traction supply to Bakerloo Line.
- **Holborn** – Proposal for replacement traction substation.

8.10.3 Access

The Power asset area aims to deliver its works with minimal access requirements and least disruption to the public. Access planning and booking are undertaken through the LU Access Planning team. There are currently no major constraints with regards to access for LV maintenance.

Our approach to developing renewal programmes is to exploit opportunities to deliver them in the most cost effective fashion, in particular looking for synergies with other major works, to limit project on-costs and incremental access requirements. We do this by:

- Including them where possible in major power capacity upgrades.
- Combining them into manageable packages.

Where possible, power upgrades will be delivered during possessions required for other works (e.g. Track) or carried out in engineering hours to reduce the requirement to close the railway and thus minimising disruption to the public and ‘keep London moving’.

8.11 Asset Management Capability & Development

This section sets out how the Power asset area will continue to increase its asset management knowledge and capability through maximising its opportunities whilst making full potential of the enablers and minimising the risks.

Increasing Asset Management Knowledge and Capability

Opportunities	• Commence exploring opportunities for further efficiencies post Power Service Contract termination.
	• Gain greater consistency in approach to LV Asset condition evaluation and renewals between BCV/SSR and JNP.
	• Increased contribution to Mayoral Carbon Emission Targets through:
	  o Power's contribution to managing traction energy efficiency.
	  o Exploring localised energy sourcing / combined heat & power generation opportunities.
	• Moving down the Supply Chain for future Capacity Upgrade Works:
	  o Potential 10 – 15% unit cost reduction on substation upgrades.
	• JNP Renewals expenditure Opportunities:
	  o Currently significant expenditure for future renewals.
	  o Opportunity for greater alignment with the rest of LU's LV assets.

Risks	• Residual risks following Power Service Contract Termination:
	  o Loss of continuity
	  o Emergent asset concerns not previously visible to TfL
	  o Reputational issues now TfL's responsibility.
	• Increase in future risk of National Grid Blackouts and Brownouts:
	  o Reduction in national generating capacity over the next few years.
	  o Potential increased reliance on emergency supplies.

Enablers

Efficiency	• Future development of LU's Power Command and Control structure, supported through the new SCADA systems. • Continued development of a range of simulation tools to optimise the Power system design and total train system (trains, signals, power) capacity and energy efficiency. • Whole life asset management, where appropriate that identifies the optimal interventions for maintenance, renewals and upgrade activities based on capacity, risk, condition, degradation and cost. • Smoothing future major power capacity upgrades activities over a longer term to exploit the potential to change supply chain arrangements in order to reduce substation upgrade unit costs. • Enabling a singular approach to LV asset maintenance and renewals with the recent integration of JNP assets.

	• Benchmarking where viable to identify best practice for our network power assets and to improve cost, performance and efficiency.
People	• Provide training and development to ensure existing staff are competent and are prepared to adapt to change where required.

Technology	• Better understanding of asset condition capture techniques previously managed through the Power Service Contract.
	• Influencing future train system parameters to exploit traction energy efficiencies including:
	  ○ Software enhancements to Passenger Rolling Stock Regenerative braking systems,
	  ○ Automatic Train Regulation Systems configured to support coasting,
	  ○ Power Infrastructure changes to enhance system receptivity
	• Modern Power SCADA systems facilitate more efficient control of the railway, whilst providing better power status, condition and consumption data.

8.12 Benchmarking and Efficiency

The Power Supply and Distribution System will explore best practice identified through benchmarking studies and where feasible adopt these to deliver works more efficiently, improve performance and reduce costs.

It is an aspiration to undertake further benchmarking studies in the Power community across BCV, SSL and JNP and also with other metro organisations worldwide to understand best practice and introduce more efficient ways of maintaining, renewing and upgrading our Power Supply and Distribution System.

8.13 Strategic Risk & Opportunities

This section sets out identified strategic risks and opportunities to further develop and enhance our power strategic asset management capability.

Progress against these opportunities and risks will be tracked at the quarterly Power Asset Strategy Group, along with the identification of any new items.

The **Power Asset Strategy Group** provides the vehicle for review, update and delivery of this strategy as well as more detailed development of the annual Asset Plan. It comprises the following key stakeholders or their representatives:

- Power & Cooling Sponsor (S&SD)
- Head of Power, Cooling & Communications (CPD)
- Power Supply Manager (COO)
- Professional Head of Power (CPD)
- Head of Asset Support (COO – AP) (which incorporates power maintenance delivery)

- Power Delivery Manager (JNP)
- Climate Change Strategy Manager (S&SD)

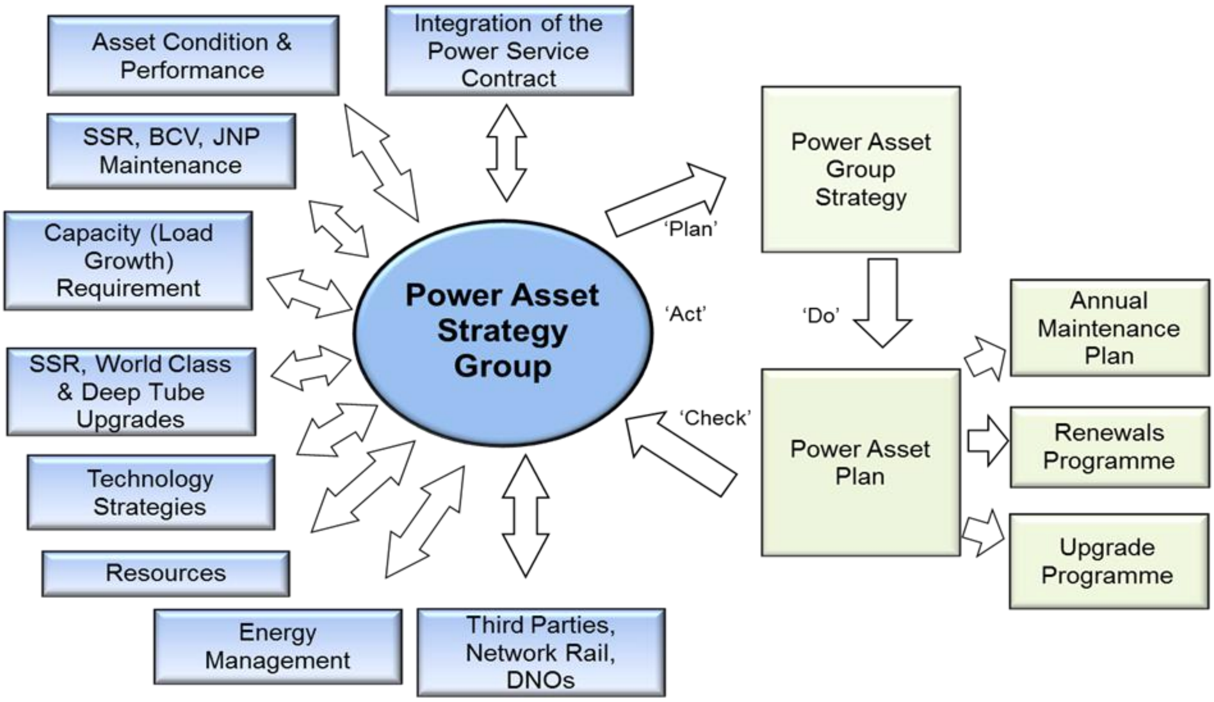


Figure 34: Power Whole Life Asset Management. Influential factors impacting the Power Asset Strategy Group.

8.14 Strategic Opportunities (Table 4)

	Opportunity	Action
1	Exploring post PSC, longer term efficiency opportunities	Following termination of the PSC, there exists an opportunity to investigate whether further efficiencies and synergies exist within both COO & CPD following better understanding of former Powerlink's maintenance/operation processes and procedures.

2	Consistency of Asset Condition reporting	Ensure consistency of asset condition reporting of all LV Power assets across BCV, SSL and JNP. This would ensure the same criteria and methodology when using asset condition in business case justifications. Furthermore, consideration should be given to how much alignment is necessary for the HV/Network Assets.
3	Determination of Asset boundaries	Identify if there are any synergies to be gained from expanding the LU infrastructure to include DLR, Overground and Crossrail. In the first instance, this is being investigated as part of the scope in the UIP1894 Power System Control Project.
4	Delivery against Mayoral carbon emission reduction target and delivering cost efficiencies through lower LU power consumption.	Develop LU Power's possible contribution to this Mayoral target without adversely impacting Power system resilience and security: Traction Energy Efficiency Opportunities (Synergies with Upgrades) Develop TfL's Energy Metering Strategy
5	Delivery against Mayoral decentralised energy target and delivering cost efficiencies through linking London's energy generation to LU's power network	Consider LU Power's possible contribution to this Mayoral target and cost efficiencies without adversely impacting Power system resilience and security: • Energy Sourcing Strategy (Renewables, Localised Generation, Linking with London Heat networks). • Impacts / Opportunities of GLA's heat network strategy. • Diversify the way we source energy and investigate the possibility to move some of it away from the grid.
6	Renewals Synergies within Future Line upgrades	As part of line upgrades to expand capacity on the network, there are opportunities to: • Take advantage of access on the infrastructure to address known Renewals priorities.
7	Moving down the supply chain within CPD	By working closely with the NTfL and World Class Programme, it may be possible to develop a smoothed, long term lower annual power Upgrade expenditure profile. An initial assessment has indicated that this could deliver 10% - 15% reductions in unit costs through more in-house design and moving further down the supply chain (possibly limiting the need for external principal contractors).
8	Benchmarking of Power Activities	The cost of power capacity upgrades is currently not well benchmarked. There is no agreed "common currency" to allow

		comparison of costs with Network Rail, other Metro systems or parallel industries.
9	Using validated CUPID data to capture all Power LCHs	To work with CUPID development team to improve the accuracy of LCH attribution due to Power unavailability.
10	Extracting greater value from existing JNP CAPEX projects in the plan horizon	The existing CAPEX provision for JNP LV assets seem out of proportion to the CAPEX provision for LV BCV / SSL assets. An investigation needs to be undertaken to better understand the drivers behind the JNP LV projects and whether the funds can be redistributed to higher priority projects.

8.15 Strategic Risks (Table 5)

	Risk	Action
1	Residual Strategic Risks following PSC Termination	Head of Network Operations / Power Supply manager capture any residual risks for consideration.
2	Increase in Future risk National Grid Outages	There is a need to consider whether LU's emergency plans are still appropriate under this increased risk Potentially enhances the benefits of LU's Energy Sourcing strategy to consider Localised generation.
3	Weekend All-night running may impact Power System Capacity	Undertake an evaluation of the associated impacts and potential solutions required for input into next years Asset Plan.

9 Track

9.1 Strategy Summary

The Track assets comprise over 866km of plain line track on the running lines and 181km of plain line track in Depots and sidings, over 1000 units of points & crossings (P&C) and over 500km of track drainage and associated catchpits etc.

The track & track drainage assets provide a safe and reliable surface on which to run the train services operated by London Underground. The plain line track provides a suitable geometry to guide trains around curves at the speed required to meet service expectations while providing separation between the vibration caused by the passage of a train and nearby residential properties. For lines with traditional signalling systems, the running rail conducts train detecting signals down its length between insulated rail joints. The third and fourth rails conduct the traction power to the rolling stock to provide the energy to operate the train. Points & Crossings (P&C) provide the service flexibility to send trains on different routes and provide reversing or stabling capability. Track drainage provides the capacity for water which has entered the track environment to be removed before it causes a problem to the operation of the railway.

Effective Track & Track Drainage assets are therefore key to London Underground's ability to operate a service each day and must be safe and reliable at all times. These assets represent a considerable financial investment in both maintenance and renewal each year and it is therefore important that the approach to asset management sees this investment made in the most value adding ways in line with a long term strategy to meet the demands of the railway both now and in the future while bringing overall costs down.

The demand and expectations on Track Assets is increasing with requirements to support greater levels of traffic travelling at greater speeds as rolling stock and signalling is progressively upgraded and the timetables increasingly make use of additional capacity within existing systems (the scale of this demand increase can be seen in the chart below). The track assets have to make these changes possible while preventing any adverse impacts on service reliability due to failure of track assets and indeed whilst improving the overall performance of the asset group. This has to be achieved within reducing levels of access as weekend 24 hour operation comes into effect, reducing maintenance access and necessitating robust assets which can support continuous operation without failure. There is also a need to reduce the number of weekend closures that are taken to undertake core asset renewal activities towards zero.

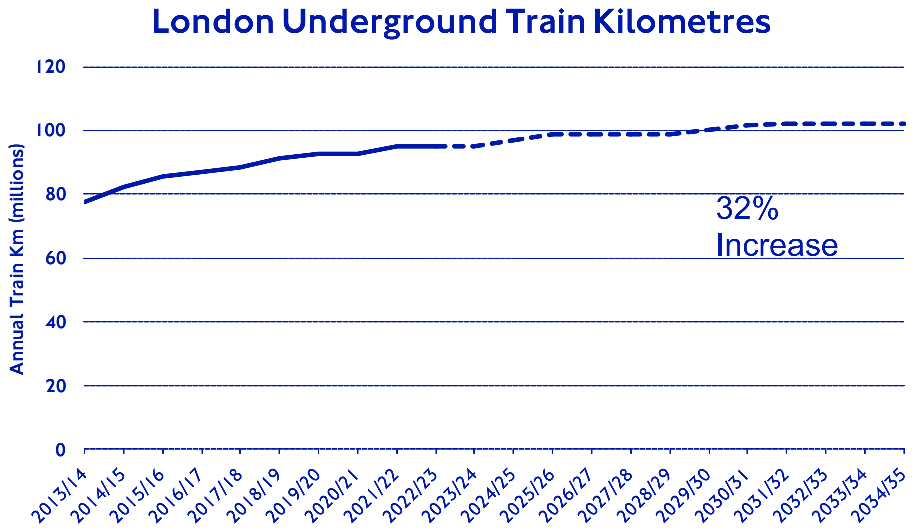


Figure 35: Forecast Growth (Train KM)

9.2 Our Goal

Our overall goal is to:

Provide a safe, highly reliable track asset base which meets future capacity demand whilst providing the ability to be efficiently maintained and replaced within short access windows

To achieve our goal we will:

The Track Asset Strategy can be summarised as a route map from the current position which is one where there is still a substantial volume of ‘traditional’ track assets (ballasted, bullhead rail on wooden sleepers) on the network through to a ‘World Class’ position with modern track form which meets the demands of the modern railway at lower cost.

This Strategy can be broken down into four strategic objectives which describe how the journey to ‘World Class’ track will be achieved. These are as follows:

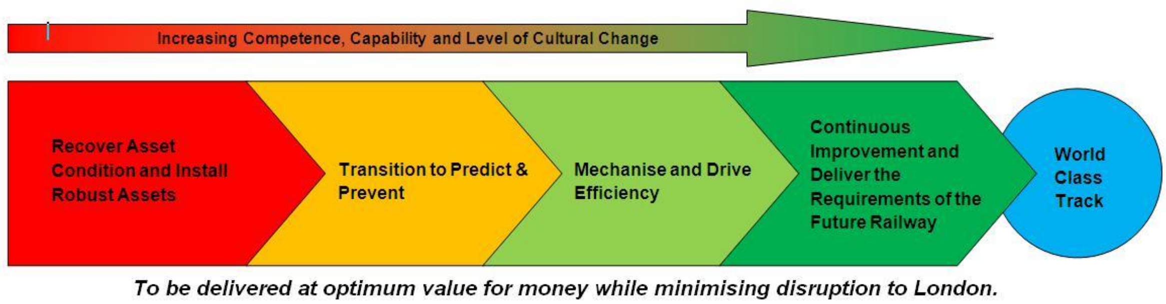


Figure 9: Track Strategy Roadmap

Recover the asset condition to a ‘steady state’ position whereby a lower level of annual renewal is required to sustain a consistent asset condition. Whilst delivering this, the opportunity will be taken to replace the more traditional track components with modern standardised designs which have a longer service life, fewer failure modes and are simpler to maintain.

Prioritise renewals based upon a best whole life cost (WLC) approach taking into account cost, risk capability, capacity and performance as well as constraints such as existing and future business priorities and delivery capability across the Network.

Develop changes in technology, process and skill sets to make a transition from the existing approach to maintenance which is largely 'fix on failure' to 'predict and prevent'. The transition to a 'predict and prevent' approach to maintenance requires significantly higher quantity and quality of data to inform decision making. The benefits of this approach include lower in service failure rate (as faults are identified before they fail), reduced correction cost (as defects are generally dealt with earlier when levels of severity are far less and hence corresponding lower levels of correction being required), increased labour utilisation efficiency (as work delivery deadlines become longer, resource planning becomes easier and therefore more work can be delivered by the same number of staff) and extension of asset life.

9.3 High Level Summary and Alignment with R&U Priorities

The Track Asset Strategy can be summarised as a route map from the current position which is one where there is still a substantial volume of 'traditional' track assets (ballasted, bullhead rail on wooden sleepers) on the network all the way through to a 'World Class' position where optimum whole life cost asset management is carried out on modern track form which meet the demands and expectations of a high capacity modern railway at lower cost.

The timing and choice of asset to install as part of condition based renewals will be based upon a best whole life cost (WLC) approach which takes account of constraints, business priorities and forecasts and delivery capability across the Network. Reliability forms a key part of this WLC assessment. In support of this WLC approach, significant work is being undertaken to move to a 'predict and prevent' approach to asset stewardship which utilises optimum levels of mechanisation to efficiently deliver work. These changes in maintenance approach and cost will be continuously fed back into the Whole Life Cycle Cost assessment along with future forecasts for track utilisation and capacity expectations to ensure that timing of renewals remains optimised.

The long term vision for Track & Track Drainage Assets is to provide a safe, highly reliable asset which can be maintained and replaced within short access windows. Delivery of maintenance and renewals works will be highly mechanised to allow high quality of work to be delivered and more efficient use of resources. Maintenance works will be planned using predictive techniques drawing on information from high quality condition monitoring equipment and utilisation of resources will be maximised through works planning against a long term workbank prioritised by rate of degradation and optimum intervention point.

9.3.1 Contribution to Key Rail and Underground Priorities

The **reliability and safety** of the track will be improved through the removal of points of failure delivered through replacement of assets with more robust modern alternatives. This will be accomplished through condition based renewal and campaign replacement. Through an optimised asset management approach, assets may be replaced earlier in the lifecycle to reduce risk of service affecting failure where the benefit justifies the sacrifice of residual asset life. Preventative maintenance activities such as rail re-profiling and tamping will be delivered across the network at an optimised frequency to reduce the number of faults and defects which have an impact on timetabled services. The relative criticality of track assets in terms of how quickly Lost Customer Hours (LCH) accumulates following a service affecting incident is shown below:

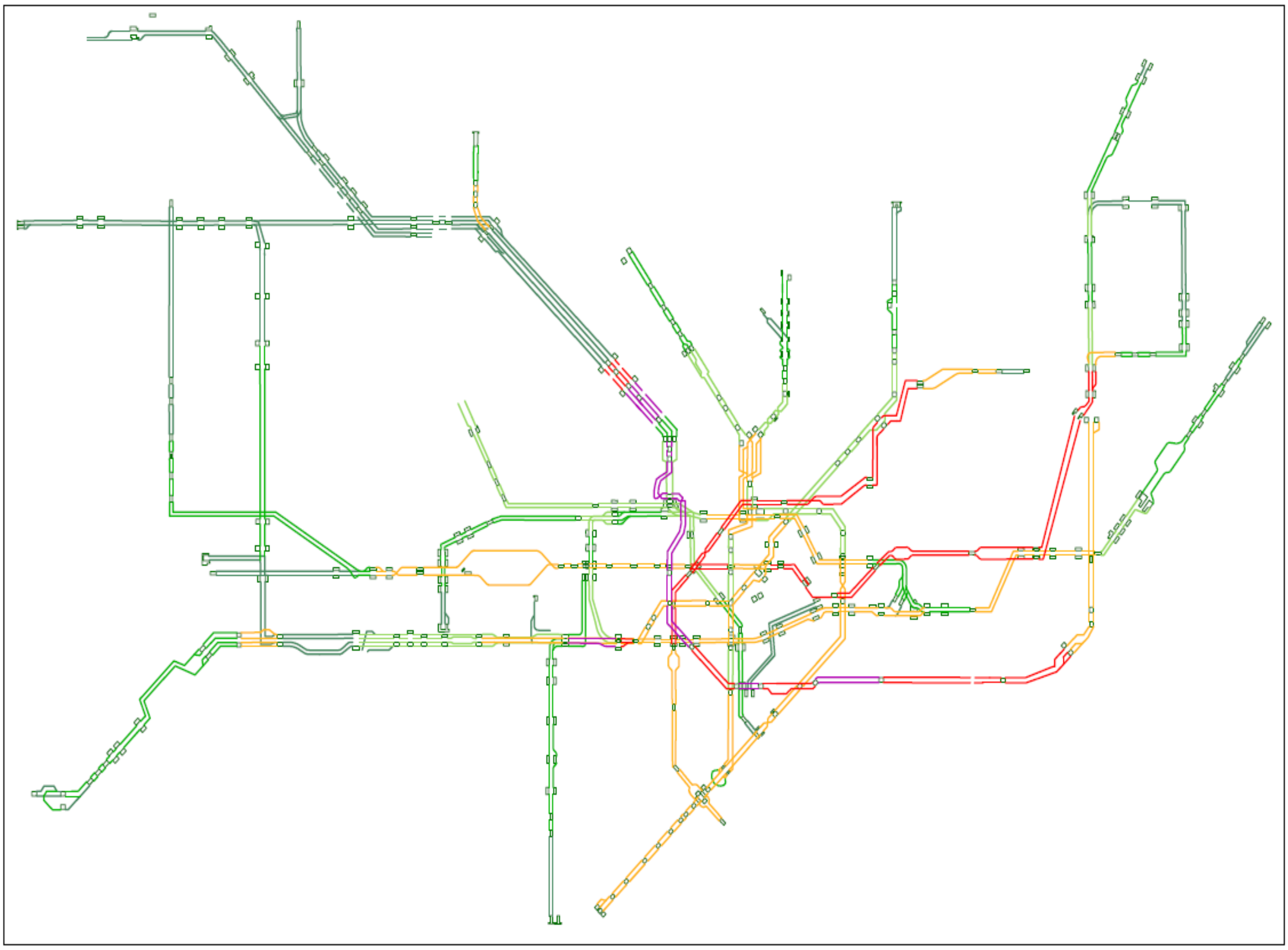


Figure 36: LCH Criticality

Getting further **capacity from the current network** is reliant on having suitable track assets and geometry. The speed capability of the track and the limitations of other infrastructure assets ultimately provides the upper limit for the additional capacity that can be delivered through 'line upgrades' and timetable changes. Therefore, where track either is or is predicted to become the limiting factor to capacity, work will be undertaken to lift the speed capability where possible.

Track renewals will be kept aligned with line upgrades to ensure that speed capability and condition remains consistent with service aspirations and delivery is synergised with upgrade works. For line upgrades in the future such as 'New Tube for London' this will include the acceleration of track works to ensure that track quality and speed improvements are delivered before the rolling stock and fleet upgrade where possible to avoid access conflicts during the upgrade and the need to carry out significant works on the track immediately after the upgrade.

The aspirational upgrade rolling stock speed will be used for the track designs and, given the lifespan of many track assets, this speed will be used in designs as soon as it has been defined as long as the impact of this change up to the date of upgrade does not exceed the value of the speed increase post upgrade. This will be assessed in detail using Vampire modelling. To mitigate the impact of significant increases in both speed and annual throughput on asset cost and performance, management of rail defects, wheel/rail friction is being changed to become more preventative and adaptive to the changing requirements of the railway.

Power requirements for line upgrades will be supported through the optimisation of the power rail and conversion to ELLCCR. This will reduce the requirement for additional sub-stations to meet the increasing power demand of new rolling stock. It will also reduce the traction power losses on the network due to conductor rail resistance.

Conversion to modern P&C assets will create additional speed capability and capacity. A long term timetable look ahead is included in work forecasting and WLC modelling to ensure maintenance and renewal plans create sufficient capacity to support increased service running without adverse impact on performance. Further capacity will be unlocked through targeted asset renewals, the designs of which will lift the speed capability of the track where this offers a potential journey time benefit. Ability to reduce inter-station run times in critical areas will be incorporated into the whole life cost tool for track as an additional benefit upon which to base its workbank optimisation. These sites and priorities are provided by Transport Planning based on run time limitations and the capacity in the signalling and rolling stock to utilise a higher speed. The maintenance and renewal of track will be altered to allow weekend 24 hour operation to be possible on existing lines without an adverse impact on safety and reliability.

To manage the impact of driving further capacity from the network without a resulting adverse impact on asset reliability, the wheel/rail interface will continue to be actively managed to mitigate the additional energy being put into the interface. This management will form a fundamental element of maintenance plans and will inform choice of materials and designs during renewals. The approach to managing this interface and others will continually evolve in line with developments in thinking and technology throughout the industry.

When getting additional **capacity from growing the network**, new track installed as part of line extensions etc. will be the preferred trackform identified through Future Trackform Development Project and will give lower WLC while better meeting the demands of the future railway and the service provision this represents.

Future stations developments will give consideration to track access for staff and materials to deliver greater efficiency for maintenance and renewals of these sections in the future and reduce service impacts of future works.

While not a passenger facing asset, track assets do contribute to the overall passenger experience and **customer service** beyond service reliability. The quality of the track drives ride comfort for passengers and the degree of rail roughness contributes to in-car and on-platform noise. To this end the condition and quality of the track will be lifted through asset renewal and improved asset management processes (e.g. rail grinding and track tamping) to improve the customer experience.

Customers are also inconvenienced by track closures for which track renewals are a significant driver. This will be reduced through the installation of more robust, longer life assets which allow longer intervals between renewals. When undertaking renewals this will be carried out in normal engineering hours wherever possible and new access methods such as materials hoists and road/rail access points will be used to reduce time to get materials to site and hence closure requirements.

Greater levels of mechanisation will be introduced across the network to drive improved quality and cost of delivery for asset renewals and maintenance. This in turn will alter the optimum WLC intervention point and will subsequently provide further justification to renew assets earlier to realise further performance improvements.

Safety of staff will be improved through the reduction in heavy manual works delivered through the predict and prevent maintenance regime (fixing the fault earlier while the works are lighter) and the greater levels of mechanisation.

9.4 Key Assumptions

The introduction of whole lifecycle cost techniques to asset decision making means that plans can be optimised within different levels of available budget, resulting in the strategy taking different amounts of time to deliver. Reducing budget, changes the optimum WLC, generally increase and this increase the overall cost, and resulting in a worsening of performance etc. This informs the business planning decision as to whether the budget should be reduced.

However, if the available budget were to be reduced by very significant levels, the requirement to manage safety and a minimum level of reliability would force the optimised WLC solution towards a largely 'patch and repair' approach to the management of track. This scenario would make this Asset Strategy impossible to deliver over any reasonable timescale and hence would trigger the need to re-write this document. It is therefore assumed that the budget for managing the track assets remains above the critical 'tipping point' at which a 'patch and repair' approach to asset management becomes the only option financially available.

It is also assumed that the delivery of the People Strategy which supports this Asset Strategy delivers the changes in organisational skills, approach and cost which are required to deliver the benefits of the changes brought about by this Asset Strategy. If these changes become impossible to deliver, or significantly diluted, then the Strategy will need to be re-assessed based on a reduced benefits case and altered to what would then become the new optimum WLC approach.

9.5 Asset Strategy

The Track Asset Strategy can be summarised as a route map from the current position which is one where there is still a substantial volume of 'traditional' track assets on the network which require high levels of inspection and maintenance effort and where recovery from previous underinvestment is still underway all the way through to a 'World Class' position where optimum whole life cost asset management is carried out on modern assets which meet the demands and expectations of a modern railway. These 'traditional' track assets cannot meet the demands of future service and cannot perform at the level we wish to achieve and therefore their replacement is essential to LU's long term Strategy. Significant progress has been made towards this goal to date but there is much more still to be done. This route map is articulated in the diagram below:

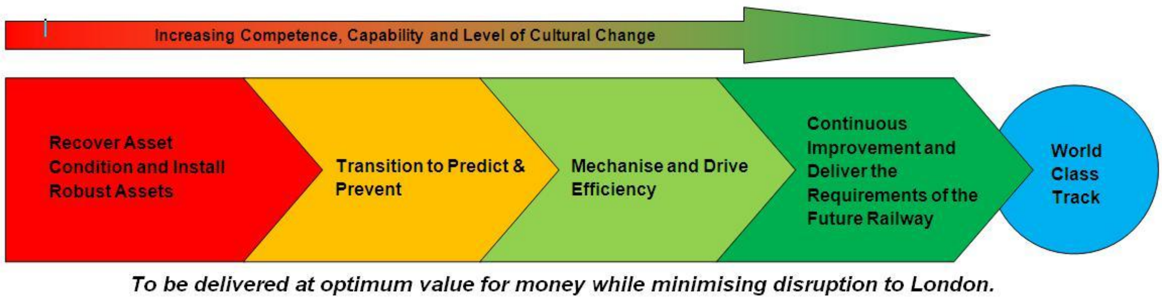


Figure 37: Track Routemap

The four headings in the coloured chevrons are the four key objectives of this Asset Strategy. These are depicted in this way to show how the approach to management of track assets will develop over time and the inter-dependency of these objectives. For instance, it would be impossible to effectively make the transition to a predict and prevent approach if the condition of the assets had not been recovered to a suitable position as delivery resources would be too tied up managing asset failures to be able to analyse measurement data, clear workbanks and push out planning horizons. Similarly it would not be cost effective to try to mechanise processes until the predict and prevent regime has identified the optimum work types and timings.

That said, it is not necessary for the preceding objective to be completely met before works supporting later objectives are undertaken as long as the works delivered fit with the overall strategic direction. It is, however, true to say that the journey to 'World Class' for the Track & Track Drainage Assets will not be complete until all four objectives are fully met.

It is also important to note that this 'journey' has to be undertaken on assets which are in service every day and within a cost which LU can afford.

As part of the development of the 10 year asset plan in the LAN, a set of maturity measures will be defined against these objectives to allow an assessment of how effectively and how quickly the asset plan delivers this strategy. To develop these measures, work will be carried out looking at information from benchmarking studies to ascertain what 'World Class' is for track assets by looking at examples of best performance, cost, risk and delivered service around the world and adjusting for London Underground track using structural factors. This will then form the benchmark against which subsequent asset management plan delivery is measured.

It is recognised that 'World Class' is itself a continuously moving target as technology progresses and other railways themselves strive towards being 'the best'. This Strategy therefore looks to make the journey towards 'World Class' at a rate which is faster than 'World Class' is itself improving.

9.5.1 Recover Asset Condition and Install Robust Assets:

Work will continue to be undertaken to reverse the impact of historic under investment in the track assets and restore the asset condition to a 'steady state' position whereby a lower level of annual renewal is required to sustain a consistent asset condition. Whilst delivering this, the opportunity will be taken to replace the more traditional track components with modern designs which have a longer service life and fewer failure modes. This will deliver a more cost efficient 'steady state' position than would be achieved through a direct like for like replacement of assets. The recovery of asset condition will provide a stable asset base upon which optimised maintenance approaches can be built based on best whole life cost. If these processes were fully implemented before recovering condition, they would naturally be scaled to meet the workload requirements of today and hence would be inefficiently sized to meet the needs of a 'steady state' asset. The delivery of this objective will be enabled by the following items:

- Continuing to deliver the Track and Track Drainage renewal Programme to improve asset residual life, lifting it to a 'steady state' level which can be sustained through continuous investment.
- Developing, trialling and installing new componentry such as cast crossings, premium rail steels, alternative keys for bull-head rail, channel drainage etc. to ensure that new assets are reliable, fit for the modern

railway and are chosen to ensure that the future 'steady state' lifecycle costs (i.e. asset renewal, maintenance, performance and risk) are lower than with previous components.

- Progressively removing 'points of failure' from the network, i.e. assets which have failure modes which are either regular, difficult to measure/monitor, have a rapid rate of deterioration or are difficult to predict. These will be replaced with more modern assets with more manageable deterioration properties.
- Deliver assets which are suitably reliable and robust to allow continuous services to be run 24 hours through the weekends without failure or maintenance intervention.

9.5.2 Transition to Predict & Prevent

Having recovered the condition of the track asset back to an acceptable state, changes in technology, process and skill sets will be developed to make a transition from the existing approach to maintenance which is largely 'fix on failure' to 'predict and prevent'. The 'predict and prevent' approach to maintenance requires significantly higher quantity and quality of data to inform decision making. The benefits of this approach include lower in service failure rate (as faults are identified before they fail), reduced correction cost (as defects are generally dealt with earlier when levels of severity are far less and hence corresponding lower levels of correction are required), increased labour utilisation efficiency (as work delivery deadlines become longer, resource planning becomes easier and therefore more work can be delivered by the same number of staff) and extension of asset life. This is enabled by the following items amongst others:

- Automated in service (passenger train based) monitoring of track geometry, noise and vibration and corresponding video imagery measured to high tolerances, frequency and repeatability. Information provided to maintenance staff through a data visualisation tool with built in decision support.
- 'Little & Often' rail re-profiling and ballast management to manage rail and geometry condition to a higher level and realise benefits in terms of improved performance, lengthened asset life and lower unit cost to sustain condition.
- Improved/mechanised rail defect measuring equipment to provide repeatable accurate data to allow planning for efficient correction of rail defects through monitoring of rate of degradation.
- Acoustic Surveying of track drainage to provide a repeatable measurement of pipe condition and allow works planning through monitoring rate of deterioration.

- Organisational training and development to create the skill sets necessary to manage data and information to make decisions on what work to carry out and when such that asset failures are avoided.

- Use of thermo-graphic imagery in conductor rails to provide an improved assessment of condition.

- Development of Reliability Centred Maintenance (RCM) for all areas of maintenance, applying a risk based approach to inspections and preventative maintenance activities and using techniques such as Failure Modes and Effects Analysis (FMEA) to identify risks to be managed through asset re-design or targeted predictive or preventative/risk based maintenance.
- Improved management of spares including optimisation of line side stock based on predicted rate of failure, required levels of incident response and asset criticality.

9.5.3 Mechanise and Drive Efficiency

Having recovered the condition of the track asset and made the transition to a ‘predict and prevent’ approach to maintenance to achieve a reduction in the cost of maintaining and renewing the track through its life, further efficiencies will be targeted through mechanising work activities or introducing new technologies which increase the volume of work which can be delivered by existing resources. If the ‘predict and prevent’ approach can be summarised as doing the right work at the right time, this objective can be summarised as delivering that work to high quality at least cost. This is enabled by the following items among others:

- New Grinding, Tamping and Ballast cleaning Machines which make the ‘Little & Often’ approach outlined under ‘Transition to Predict & Prevent’ more cost efficient to deliver

- Tunnel Cleaning Train to reduce the need for manual deep clean of the deep tube environment and deliver a greater level of material removal.

- Equipment to move towards modular installation of track such as points & crossings to reduce cost and time for installation.

- Flexible Maintenance and Renewals Vehicles to improve the cost of delivery of deep tube renewals and heavy maintenance activities.

- Installation of materials hoists and road/rail access points to reduce the amount of manual handling being carried out through stations, reducing damage to stations assets and allowing resources to focus on delivering work on the track. This will also reduce risk to staff.

- Clean traction and high performance battery technology to provide improved haulage capability for the deep tube.

- Track renewals trains and modern engineering haulage to deliver improved cost of delivery of renewals on ballasted track.

9.5.4 Continuous Improvement and Deliver the Requirements of the Future Railway

The final cornerstone objective in the Track Asset Strategy is about building upon the benefits of having robust assets maintained under an efficient maintenance regime with cost effective mechanised delivery and making further improvements in processes and approach to ensure that the management of track assets on the network is World Class. Alongside this is ensuring that the track assets continue to meet the requirements placed on them as London Underground as a whole becomes world class, particularly around asset reliability, ability to support increased train volumes and faster train operations following fleet and signalling upgrades. Continuous improvement in reliability, cost, risk and quality will continue to be undertaken on the asset. This is enabled by the following items among others:

- Use of Whole Life Cost tools to optimise Asset Management. This includes selection of optimum asset intervention type and timing based upon lifecycle cost, through life performance and risk and asset criticality. This will also include prioritisation of works to unlock additional benefits such as reduced asset inspection requirements and opportunities to increase capacity through improving line speed.

- Development of New Trackforms for the modern railway environment to deliver better Whole Life Cost than asset types currently in use.

- Development of new Track Maintenance Regime to support 24 hour operation which will require better monitoring and planning techniques and more robust assets with fewer rapid onset failure modes

- Continuous research and development of new products and processes to drive continuous improvement in cost, risk and performance.

- Benchmarking and knowledge share with peers and the rest of industry to identify best practice and 'world class' techniques which can be implemented within the London Underground environment.

- Asset Rationalisation. Continuous review of the ongoing benefit of assets such as P&C to the operational railway. As line upgrades and timetables change with time the requirements on where a service needs to reverse or stable changes. As such assets must be rationalised to remove flexibility which has a reduced benefit which is less than the cost of managing the asset and the performance risk that the asset represents. The corollary to this is locations where further flexibility is required to provide a more robust service or a greater passenger carrying capacity.

- Bi-directional operation. derive further benefits from bi-directional capability of modern signalling systems installed on the Network through provision of suitable crossover facilities to allow single line operation with adjacent line open working practices to allow renewals and maintenance works to be carried out in more efficient access windows and more efficient service recovery. This to be explored wherever there is sufficient economic benefit to justify the work to enable this and in locations where single line operation can be sustained for periods of time without adverse impact on the timetable and capacity of the Network.

This final objective is a sustained position where fresh opportunities and ideas continue to be identified, cultivated, tested and converted into changes in how the assets are managed with the aim of continuing to close the gap and eventually surpass London Underground's peers in terms of Track and Track Drainage asset management and the London Underground as a whole.

While Track Assets cannot by themselves directly create additional passenger carrying capacity (additional train capacity must be made available first), the future strategy for track is that wherever achievable track assets will not be the constraint on network capacity, i.e. track assets will be able to support the maximum speeds, train per hour and headways that the rolling stock and signalling systems are capable of delivering.

9.6 Delivery Strategy

9.6.1 Supply chain strategy

Whilst being one of the biggest metros in the world, London Underground is not a big railway in global terms and therefore often does not have sufficiently large order book to leverage significant discounts in the marketplace. For this reason opportunities will continue to be sought to maximise buying power either through aligning procurement activities with other modes within TfL or through alignment with Network Rail to increase buying power and hence reduce cost. This will naturally have some impact on choice of suppliers and materials which will be factored into the WLC decisions to ascertain whether it is worthwhile paying a less competitive price for an alternative product.

The mix of external and internal supply (of such things as long strings of rail, fabricated P&C etc.) will be kept under continuous review. As asset types develop towards more modern designs (such as cast crossings) or as alternative technologies get introduced (such as mobile flash-butt welding as opposed to supply of long welded rails) then the decision as to whether to move to outsourced supply or invest in internal manufacturing facilities will be made based on cost, risk and capacity. Where an internal supply arrangement is deemed to offer greater benefits the utilisation of these facilities and materials will be planned to ensure efficient utilisation.

9.6.2 Capital Programme Delivery

Within the current track renewals programme there is a significant volume of works being undertaken to replace ballasted track. The construction of this trackform is fundamentally the same as for ballasted track on most railways throughout the world and is less constrained by gauging than tube track. For this reason it is sensible to enter into contractual delivery relationships with outside suppliers to leverage on experience and innovations from outside the London Underground network. Over the last few years this has been achieved through a ‘partnership’ organisation centred around a contract between London Underground and an outside delivery organisation where London Underground provides staff and expertise around the unique LU specific aspects of delivery leaving the contractor to concentrate on the parts of the work which are more consistent with other railways.

Some capacity to deliver ballasted track will be retained internally to provide a healthy tension on cost and a suitable internal benchmark. This capacity will be based in the Track Delivery Unit (TDU) and will primarily be used to deliver works in depots and sidings along with works in more unique locations which prevent the normal mechanised approaches to the work being used.

Delivery of works on deep tube track is different to ballasted track in that the working environment is very space constrained and consequently plant requirements are bespoke. The slab track throughout the deep tube is also far less prevalent in other railways and work processes are very specific to the LU deep tube environment. For this reason the delivery approach will remain through an internal delivery function to maximise efficiency and internal competence/learning.

The delivery approach for both types of track may change subject to the outcome of the future trackforms work depending upon the trackforms selected to be installed in the future. If there is sufficient experience of these trackforms within the wider rail industry then options to realise the benefits of this experience through further contractual arrangements will be pursued. If, however, the optimum trackforms are relatively unique to the environment then an internal delivery approach will be taken to safeguard the skillsets and processes necessary to achieve an optimised installation.

9.6.3 Maintenance Delivery

Historically due to the volatility on the volumes of work being delivered day to day under a ‘find and fix’ approach, for track assets LU has retained a level of internal resources sufficient to meet the demands of the inspection regime and a small volume of corrective maintenance and then used externally contracted labour to ‘top up’ to meet resource requirements. This Strategy will deliver a reduced inspection requirement and longer term works and resource planning. Therefore the existing internal resources will be re-focussed on the delivery of the works identified through the predict and prevent maintenance processes. This will remove the reliance on externally contracted labour.

For track drainage assets maintenance work has historically been wholly outsourced through external contracts. Inspection and maintenance works for track drainage can be closely synergised with the surveying works required for the renewal programme. The strategy is therefore to align the delivery of maintenance and renewals of track drainage assets. Therefore, the resourcing strategy for these works (i.e. internal supply or external contract) will be aligned for both maintenance and renewals and will be based on cost, risk, capacity and synergies with the Track Renewals Programme. This delivery approach will naturally develop in line with new asset technologies that get introduced (i.e. channel drainage).

9.6.4 Incident Response

With the move to a around ‘Predict and Prevent’ maintenance approach which maximises resource utilisation in the longer term, in the shorter term there will remain a need to respond to incidents in a reactive way. While the number of such incidents will be lower, the need to respond quickly to minimise the service impact of failures will be greater due to the greater expectation on service provision and ever increasing numbers of passengers affected. A suitably sized, trained and equipped incident response team will therefore still be required and positioned to be able to respond to incidents within suitable timescales. The sizing and positioning of these teams will be based upon an assessments carried out using FMEA, Asset Risk and Asset Criticality approaches.

9.7 Configuration Management

Given the scale of the changes that this Strategy seeks to implement a Configuration Strategy and Configuration Plan will be produced to articulate how the asset will be managed at all stages during this transition.

This will include, on a line by line basis, all of the different combinations of assets that will be in place from specific dates (i.e. date that last of the ‘traditional assets’ will be removed, date that ATMS will be fully commissioned etc.). This will then inform what maintenance capabilities need to be in place and when.

9.8 Access

All works will be delivered whilst minimising the disruption to London. For maintenance this will mean continuing to deliver most works in mid week engineering hours whilst maximising usage of opportunities created by line closures for other works. The predict and prevent regime will increase the volumes of works identified to be undertaken in such situations. For maintenance activities which require longer to complete, or which represent a higher risk of works overrun, Saturday nights will continue to be utilised until the introduction of 24 hour weekend operation. After this, such works will be delivered under extended engineering hours in line with the business Access Strategy. In parallel the development of further mechanisation will reduce the number of activities requiring this approach.

The access approach for track renewals in the deep tube will remain within engineering hours as is the current approach. Access for ballasted track & track drainage renewals will change to a zonal approach based on level of disruption caused by closures and the relative cost benefit. In central London where the impact of closures is highest, closures will not be taken for track renewals unless essential. In such a situation the minimum possible access window will be taken whether that be extended engineering hours or partial line closure. In these cases options such as single line bi-directional operation will be explored to try to minimise disruption. Otherwise all ballasted track renewals will be undertaken in mid week engineering hours the same as deep tube renewals.

At the extremities of the network where the social impact of a closure is less, opportunities will be taken to deliver track renewals in closures or even blockades where sufficient cost efficiencies can be demonstrated to justify the disruption. Whenever such a closure is taken, the volume of works delivered within the closure will be maximised. For blockades, works will be planned such that the blockaded area is renewed to the extent that no further closures will be required in the location for a considerable period of time.

9.9 Asset Information

Information on asset type, date of installation and maintenance history will be stored and managed through the Ellipse (BCV/SSL) and Maximo (JNP) systems until a single Asset Information System is introduced across all asset areas. These systems will be updated following renewals works or significant maintenance intervention such that they represent the best view of the asset at any point in time. This information will be used to regularly update systems such as the Track WLC model to ensure that it is aligned with the Asset Information Systems.

As the management of the asset moves towards an increasingly data led and Lifecycle optimisation approach, the importance of keeping the asset information up to date increases. This will be reflected in the levels of effort and rigour applied in keeping this information up to date.

The introduction of the ATMS and AIT systems will create additional asset information databases containing track measurement information and video footage and will become an additional asset information source for use in managing track assets. As with Ellipse and Maximo, this system will be backed up and subject to content control to keep the information robust. The DataMap system will become the common portal for accessing this information and data from Ellipse/Maximo.

9.10 Asset Interfaces

Asset Area	Interface	Strategy
Fleet	Wheel Rail Interface (WRI)	Optimised approach to managing costs and impacts across the impact defined in the WRI Strategy Appendix. Based around managing and optimising quality and condition of the wheel and rail surfaces and the provision of friction management.
	Shoe/ Conductor Rail Interface	Optimise management of conductor rail position, ramp alignment and gaps based on cost of fleet rectification and service impact against cost of works. Gaps to be minimised, particularly in areas of vehicle acceleration. Shoe loss to also be improved through improving wheel/rail roughness (vibration) delivered through optimisation of the wheel /rail interface (above)
Fleet/ Stations	Platform Train Interface (PTI)	Opportunities taken to synergise track renewals and PTI works, lifting and slewing the track to reduce the need to works such as platform humps wherever this offers an economic benefit.
L&E/ Stations	Movement of Materials	Further installation of hoists to reduce the need to bring materials for deep tube renewals onto the track through stations, reducing the damage to lifts, escalators and station finishes. Implementation of Flexible Maintenance and Renewal Vehicles to further reduce the need to move materials through stations. Consideration to be given to providing alternative access routes to the track with materials handling equipment as part of the scoping of future major station upgrades.
Signals	Points & Crossings (P&C)	Synergising of works for converting P&C to modern designs and replacement of points machines with more reliable, faster equipment and improvements in wiring and

Asset Area	Interface	Strategy
		control.
	Insulated Block Joints (IBJ)	Remove IBJs through rail replacement activities once IBJs rendered redundant by introduction of modern signalling. Until that time maintain IBJs through predictive/ risk based techniques to a condition which prevents signal/ mechanical failures occurring.
Civils	Bridges	Align any changes in future track form weight with Civils workbank to ensure that new trackform can be supported. Progressively replace Long Timber Bridges (LTBs) with either Ballasted Decks or Concrete Beams to improve reliability and maintenance cost.
	Water ingress/ Pumped Outflows	Align repair of tunnel seepage with Deep Tube Renewals Programme to ensure that seepage is controlled before renewal and hence will not impact on long term life of concrete slab. Ensure pumped outflows have sufficient capacity to deal with predicted water flows from improved or changed track drainage layouts.
Power	Conductor Rail	As part of track condition renewals converting to Extra Low Loss Composite Conductor Rail (ELLCCR) to achieve a reduced resistance and hence lower system losses.

Table 6: Key Asset Interfaces

9.11 Asset Management Capability & Development

9.11.1 Opportunities to improve the Asset Strategy

Good asset information is key to making good asset management decisions. The existing asset management information systems (Ellipse and Maximo) are not effective in providing granular detail for performance of assets as they are set up as work management systems (i.e. they record the corrective work that is required in response to a fault, not the fault itself). While it is possible to infer a type of fault from the work carried out to correct it, this is often inaccurate as certain corrective works may be common to multiple fault types. For this reason, these work management systems need to be developed to allow defects and corrective works to be managed separately, creating two distinct but linked databases. This will allow for more in-depth analysis of fault trends and hence allow further refinement of asset management approach for individual areas. This will also aid with the 'predict and prevent' approach to maintenance as defects can be logged and monitored without requiring work to be raised against them, then a single work order could be used to remove multiple faults.

Wider use of Remote Condition Monitoring techniques will be made including catchpit water level monitoring and rail stress measurement. Data from these systems will be fed back and integrated with either DataMap or with a dashboard style user interface. The technology and opportunities with the field of remote condition monitoring will be continually reviewed to make beneficial use of new technologies and approaches.

Greater use will be made of hand-held devices to provide more accurate on-site information to staff and remove the necessity to manually enter information into work management systems in an office, after work is carried out. This will help improve data accuracy (information is entered while still fresh in the mind) and free up more working time on site. New systems will also allow additional information such as photos to be added to provide further information on faults or conditions and hence aid with work audit.

9.11.2 Development of Asset Management Capability

The logic behind the track and track drainage WLC models and their associated optimisation packages will continue to be developed. Benchmarking will continue to form a key input to these models since certain drivers for track deterioration will be consistent across all railways. To this end the logic and methodologies in use on other railways will continue to be reviewed and used to inform further developments of the model. As LU is currently involved in discussions with East London Line and New York City Metro around the use of the Track WLC model, consideration will be given to setting up a more formal Track Asset Management forum to allow a more efficient exchange of developments in theory and approach around WLC modelling for track. Also as more railways choose to use the WiLCO model for track asset management this creates opportunities for networks to share the cost of developing additional software functionality to meet future aspirations.

Other tools such as SALVO will be utilised for specific asset management assessments which sit outside the capability of the track WLC model.

Work will be undertaken to improve the way that Asset Risk is quantified and managed. This will move away from the current process which uses Ellipse Standard Job codes to attempt to assess how often a certain risk has been realised (for track) and converting ACA concern codes into risks. Both of these current methods are flawed in the way that they assess exposure to different types of risk (although until now they have been the best methods available). Systems will be developed to allow quantification of risks based on asset condition, asset loading and impact of failure and will also make it easier to forecast how these risks change with time, hence better informing WLC assessment. The developed systems will also be able to quantify compound risks, i.e. the extent to which the realisation of one risk changes exposure to other risks. This will produce a far more refined and accurate assessment of asset risk and hence will help drive better value decisions where asset risk is a significant contributor to the optimum decision.

This risk approach will be applied to passenger safety risks, extraordinary maintenance risks, performance risks and staff safety risks.

9.11.3 Benchmarking and Efficiency

Benchmarking will continue to be carried out for all activities carried out on Track and Track Drainage assets.

Continuous improvement forms part of the overall journey to ‘World Class’ and will be accomplished through review and adoption of new technologies, designs or techniques which will either be identified through benchmarking against the rest of industry, through direct involvement with suppliers (i.e. products being directly put forward for review and acceptance within the Approved Products Register), items identified through the Innovation Portal or through internal development of new approaches, methods or ideas.

9.12 Strategic Risks and Opportunities

9.12.1 Strategic Risks

The key Strategic risks are:

- Impact of changes in Rolling Stock design, operational speed a number of timetabled train passes brought about by line upgrades is larger than predicted within asset models. This would lead to a greater increase in rate of asset deterioration and hence long term pressures on maintenance and renewals budgets which will affect rate at which this Strategy is delivered.
- Future planned investment falls below the critical ‘tipping point’ level required to deliver this Strategy, resulting in a reversion to a ‘patch and repair’ approach to manage risk and performance.
- Failure to deliver the People Strategy which supports this Asset Strategy and which helps to deliver the necessary changes in organisational competence and approach necessary to deliver the benefits of the transition to ‘predict and prevent’. Failure to deliver this will result in the business case for the ‘predict and prevent’ approach needing to be re-assessed.

9.12.2 Opportunities

The key Strategic opportunities are:

- Increasing maturity of asset management tools such as the Track Whole Life Cost model identifies intervention types and timings which drive a lower WLC than currently forecast and hence creates budgetary headroom which can either be used to accelerate delivery of this Strategy or passed back to TfL for re-investment in other Programmes/Projects.
- As the Plant Investment Programme develops, further opportunities to reduce working cost or improve works quality are identified beyond those currently envisaged through mechanisation.

Delivery of working efficiencies, Remote Condition Monitoring systems and general asset management competence leads to a significant change in optimum WLC intervention point for assets leading to a reduction in overall budgets.

10 Civils

10.1 Strategic Summary

The Civils assets comprise over 16,000 bridges and structures, 350km of deep tube tunnels and 235km earth structures, which together represent the majority of the railway infrastructure and therefore its total asset value.

Track drainage (including off-track drainage), pumps and Station drainage are Civils assets, but are covered by the Track and Station AGS's, in line with responsibility for asset management and delivery of the maintenance and project works.

10.1.1 Strategic Context

The primary purpose of the Civils assets is to provide structural support and stability to the other assets and to carry the required live loading. Effective and reliable Civils assets are therefore critical to the safe and reliable operation of the railway.

Civils assets are long life assets and the vast majority are as old as the railway, with many in excess of 100 years old. Although these assets are approaching the end of their nominal design life, they are by nature slow degrading and residual life can usually be extended for the foreseeable future through the implementation of a sustainable maintenance regime.

Due to their age, many assets do not comply with modern day design standards. Major strengthening or renewal works will usually require huge civil engineering intervention, particularly for the larger bridges and tunnels assets, which is usually costly and likely to result in significant disruption to the railway. However, although many assets are non-compliant, risks are generally low and can usually be managed cost effectively through additional inspections or monitoring.

Due to these high intervention costs, the strategy is to adopt a sustainable preventative maintenance regime, which is economic and efficient and ensures that deterioration does not lead to major works being required. There may however be emerging requirements in the future to address unforeseen degradation associated with hidden defects, unknown failure mechanisms or where there is no appropriate preventative maintenance regime.

The strategy is to improve the condition of these assets, where it is economic and efficient to do so. This means that renewal works are generally limited to high risk non-compliant assets and / or assets with excessive maintenance costs. A robust prioritisation process is required to ensure projects deliver maximum value for the available budget.

The Civils assets will be managed in accordance with whole life cost principles by optimising maintenance, renewals and life extension works, taking into account cost, risk, performance and asset condition / degradation. All project work to upgrade existing assets, or to construct new ones, will adopt cost effective designs that consider future maintenance costs and sustainability.

Where funding constraints do not allow the adoption of the least WLC approach, the optimum solution for the funding available will be selected and long term financial impact of that decision understood and managed.

10.2 Civils asset Goal

Our overall goal for Civils is to:

Provide a safe, highly reliable Civils asset base which meets future capacity demand, which is risk-based and is delivered at the optimum whole life cost

Our goal will be achieved through:

Optimising maintenance, renewals and life extension works taking into account cost, risk, performance and asset condition/degradation. All project work to upgrade existing assets, or to construct new ones, will adopt cost effective designs that consider future maintenance costs.

Continued improvement in asset condition and development of our asset knowledge and asset management capability.

Maintain Civils assets at managed levels of degradation and mitigate against future major works. Targeted significant investment over the last 10 years has recovered a backlog of condition concerns to improve condition.

Extend planned preventative maintenance (PPM) to control major causes of asset degradation such as water ingress and vegetation / tree growth. Control of seepage through tunnels in particular will contribute to reliability by reducing the number of signal failures.

Civils assets will support capacity growth from the existing network by improving clearances when existing structures are upgraded or replaced e.g. to allow for new rolling stock configurations, or improved track alignments. The loading capacity of existing structures will be increased where required (e.g. to meet increased traffic levels as a result of new rolling stock configurations). Opportunities will also be explored for increasing the amount of work carried out in traffic hours e.g. by isolating of areas of stations, to support 24 hour weekend service.

Construct new line extensions. Development of new materials, processes and technologies will enable more cost effective construction methods and minimise future maintenance and access requirements. An example is 'build off site' methodology, which moves away from traditional in-situ construction to a process of factory based prefabrication, delivered to site and installed with minimum disruption. New infrastructure will introduce standardised designs and modular structures that can be scaled or expanded to allow for future passenger growth.

10.3 Approach

The diagram below shows the approach to achieving the vision for the Civils assets. These four stages represent the overarching objectives of this Asset Strategy and show how the management of Civils assets will develop over time.

However, it is not necessary for each preceding step to be completed before later objectives are started, providing progress fits with the overall strategic direction.

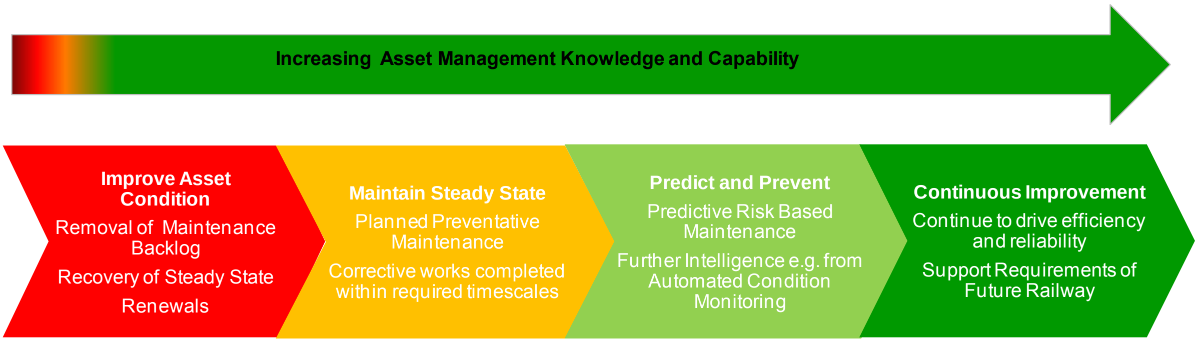


Figure 38: Civils Route Map

1. **Improve Asset Condition** so that all assets are in ACR condition ‘A’, in order to reduce risk, improve reliability and / or to reduce while life costs. (Note that for Civils assets, ACR Physical Code is not directly related to asset condition, as an intervention will only be carried out where it is economic to do so, as demonstrated through whole life cost principals.)

   The current position is that we are approaching the end of the Asset Condition Improvement phase, as the majority of the renewals programme will completed in the next few years. However, following the last spending review there has been a deferral of some bridges and structures renewals beyond the current plan, but this represents <1% of the overall asset base. There may be some asset degradation or increased asset risks, which may lead to additional condition improvements being required in the future. Further works may also be required in support of the line upgrades and capacity programmes.

   The backlog of maintenance is planned to be removed by March 2015 on BCV and JNP and by March 2017 on SSL.

2. **Maintain steady state** will be reached when there is no backlog of corrective maintenance works and new work orders are closed out within the required timescales.

   A planned preventative maintenance regime was introduced across BCV / SSL back in 2011 and on JNP in 2013, which has helped move towards steady state condition by slowing the rate of degradation. Due to the large number of assets involved and the backlog of existing corrective maintenance, it can take up to 4 years for preventative maintenance to impact on the overall asset condition and for steady state to be achieved.

3. Improve efficiencies by moving towards a ‘**Predict and Prevent**’ risk based maintenance approach. This will be achieved through a greater understanding of degradation rates, identification of optimum condition for intervention (by balancing risk, performance and cost) and the introduction of new technologies, such as automated condition monitoring and laser survey techniques.

A Knowledge and Development project commenced in 2013 to indentify a number of specific actions that will enable us to improve our understanding of asset degradation rates, where this can provide valuable support to reliability and optimisation. Due to the slow degradation rates of most Civils assets, this may take many years to reach a full understanding. We will however be working collaboratively with external peers to share existing information and predictive models where these are available.

4. **Continuous Improvement** to the asset base to further drive efficiencies and that support the future introduction of a 24 hour service.

   Due to the large costs involved, large scale improvement to the existing asset base is not an option. However, some improvement will be achieved through renewals (where cost effective and affordable) and the construction of new assets associated with the future growth of the network.

   Improvement will be achieved through the introduction of standardised designs, innovative materials and processes that minimise the number of closures and maximises the work that can be carried out in traffic hours.

Figure 10: Civils Strategy Roadmap

10.4 Contribution to Key Rail and Underground Priorities

10.4.1 Reliability and Safety

Although the risks associated with structural assets are currently low due to the low likelihood of structural failure occurring, most assets do not fail safe and consequences could be significant. Robust planned preventative, corrective and renewals programmes are therefore required to manage these risks and reduce the risk profile associated with the Civils assets.

The Civils assets will contribute to the overall 30% reliability improvement target through the improvement of asset condition, thereby improving performance, reducing future operating costs and increasing customer benefits as measured by Lost Customer Hours. This will be achieved through;

- Ensure the Civils assets remain available and meet the necessary loading requirements to allow the safe operation of the railway.
- Closure of the railway will be avoided, particularly in central London areas and on key suburban routes, unless absolutely essential. Maintenance and project work will be delivered in traffic or engineering hours, or in synergy with existing essential closures.
- Implement a projects programme that focuses on the highest risk assets and reduces the total asset risk to an appropriate level that can be managed safely and cost effectively.
- Implementation of an inspection and asset maintenance regime for cable posts that support critical signal and power cables, ensuring life-expired posts are replaced before failure.

- Implementation of planned preventative maintenance to address seepage through structures, particularly shallow brick tunnels, to reduce the number of performance affecting incidents. This will be supplemented, where required, by reactive maintenance, to address high priority water ingress affecting performance critical assets i.e. rails or signals.
- Addressing underlying seepages affecting station assets through the Station Stabilisation Programme, to prevent possible station closures.
- Where the Civils assets are required to provide structural support to other reliability projects and initiatives, such as the installation of platform edge doors, these will be maintained in sound condition. Where necessary and affordable, these structures will be strengthened to carry any additional loads required.

10.4.2 Capacity from the Current Network

- Support capacity upgrade projects such as the Deep Tube Programme by considering improving clearances when existing structures are renewed or replaced e.g. to allow for new rolling stock configurations, or improved track alignments.
- Consideration will be given to increasing loading capacity of existing structres where required to meet increased loading as a result of new rolling stock configurations (where cost effective and affordable to do so).
- Where strengthening or renewal works are required to existing assets, the strategy is to ensure that designs are cost efficient by considering future maintenance requirements.

10.4.3 Capacity from Growing the Network

- The methods, materials and specifications for Civils works will continue to be developed and improved to best practice to enable safe and more cost effective methods for construction.
- Introducing standardised designs and modular structures that could be scaled or expanded to allow for future passenger growth, thereby reducing project costs, timescales and standardising future maintenance requirements.
- All new Civils assets will be designed to meet passenger loading requirements required by specified capacity demands.
- New cable routes will be designed with spare capacity to allow for the addition of future cables.
- Design assets that are resilient to degradation from climate change and extreme weather conditions.
- Wherever possible, ensure new assets are sustainable by minimising waste, use of recycled materials and by considering noise and pollution reduction throughout the design and implementation phases.

10.4.4 Customer Service

- Civils assets supporting signage and customer information systems (e.g. Dot Matrix Indicators and Visual Electronic Information Displays) will be maintained in a structurally sound condition and be capable of supporting the loading from these systems.
- Works to platform structures will address any platform-train interface issues wherever practicable and affordable, enabling greater ease of access for all customers
- Ensure that seepages affecting the customer experience at stations are addressed through the Stations Asset Programme.
- Minimising disruption to customers during delivery of maintenance and projects works. This also includes disruption to TfL tenants and neighbours adjacent to the railway.
- The Civils assets will be maintained in a condition that is aesthetically acceptable to customers. This will include protecting heritage assets, adopting appropriate paint schemes and removing of offensive graffiti.

10.5 Key Assumptions

Key assumptions that underpin this strategy are:

- Adequate funding will be made available to protect against insidious decline.
- The strategy will successfully reduce the requirements for Engineering Hour working, in support of the introduction of all night services at weekends.
- The possible future automation of trains does not require significant changes to current strategy for managing risks associated with vehicle incursion.
- Upgrades projects will consider loading and clearance requirements for existing assets e.g. as a result of introduction of new rolling stock.
- There are sufficient capable resources to deliver the plans required by this strategy, both internally and across the wider industry.
- There are no unforeseen catastrophic events.

10.6 Maintenance Delivery Strategy

Maintenance works are delivered by the Asset Performance (AP) teams within COO to maintain the assets in a condition that minimises risks to safety and railway operations and to support the whole life cost management of the assets. This is achieved through;

- The early identification of defects through the inspection regime.

- Undertaking corrective maintenance at the optimum time, triggered by a prescribed extent or severity of a defect that reflects least whole life cost.
- The implementation of a planned preventative maintenance regime which minimises degradation and future corrective maintenance costs.
- Optimising through packaging of works that are similar or geographically close.
- Maximising opportunities from existing closures.

Asset stewardship, inspections and contract management activities are carried out by internal resources within COO/AP. Maintenance works are scoped internally by COO/AP engineers and delivered through contracts with external suppliers.

Ensuring that internal and external resources are sufficiently trained and competent to carry out maintenance activities is central to LU's ability to achieve its strategic objectives. A competency management system in place to ensure all staff are competent to undertake the tasks required of them. All staff involved in safety critical activities hold a safety critical licence.

The Sponsor will continue to work with AP to ensure that the delivery strategy remains aligned to business needs and continues to drive efficiency.

COO is split into 3 line-based business units, to ensure maintenance remains performance focused and to allow benchmarking of performance and cost. There are currently separate supply chain arrangements in place for BCV/SSL and JNP, the future of which is addressed in section 4.3.

10.6.1 Maintenance Delivery, BCV / SSL

A Service Contract with Skanska Infrastructure Services (SIS) (Lot A) was introduced in 2011 for the delivery of preventative, cyclical and reactive maintenance. This is a 4 year contract, with an option to extend up to 2 years. The use of this fixed-price performance specification has resulted in a significant reduction in unit costs.

Corrective maintenance is delivered through three framework contracts (Lot B) with SIS, Clancy Dowcra and Lanes / KN Joint Venture. These are also 4 year contracts, with option to extend up to 2 years. All work packages are competitively tendered between the two contractors.

Larger maintenance jobs outside the normal maintenance regime are under taken as enhanced maintenance. These works are generally delivered through the Lot B contracts, but can also be delivered through competitively tendered stand alone contracts.

10.6.2 Maintenance Delivery, JNP

All maintenance works are competitively tendered through mini competitions with framework suppliers. There are presently 3 framework contractors providing both planned and / or reactive maintenance works which are due to expire at the end of August 2013.

Four new framework contracts will be awarded from September 2013, with one contractor to be selected to undertake all fault rectification. The contracts will be for 2 years, with the option to extend for a further 2 years.

10.7 Project Delivery Strategy

Project works are carried out to reduce risks, extend asset life, reduce future maintenance costs and to provide economical and efficient whole life cost solutions.

A portfolio of renewal / refurbishment projects is developed by the Sponsor in consultation with COO/AP and the Capital Programme Directorate (CPD). The projects are prioritised through value management techniques that consider various criteria such as safety risk, performance, direct cost, whole life cost, access and resource constraints, synergies with other schemes etc.

The strategy is to carry out feasibility studies in advance in order to allow early scoping and packaging of works, leading to lower unit rates.

Projects are delivered through the CPD using external suppliers. Core project management activities are carried out by a combination of in-house permanent staff, supplemented with non-permanent labour where required to meet short term requirements. Design work is either carried out in-house or, where there is a shortfall in capability and/or availability of internal resources, delivered externally, through consultants or design and build contracts.

10.7.1 Projects Delivery, BCV / SSL

Civils projects are mainly delivered through the Civils Programme, although the Stations Works Improvement Programme (SWIP) is increasingly being used, particularly for projects which interface with station assets.

Earth Structures Projects are delivered through two five year Design and Build Framework Contracts with Cementation Skanska and Clancy Dowcra, with a one year option to extend. These Frameworks were awarded utilising the NEC3 Form of Contract (Option C Target Contract with Activity Schedule) and are based on standard TfL/LU terms and conditions. Cost-effective solutions are encouraged through share / gain share conditions that are built into the Contracts.

Bridges and Structures and Deep Tube Tunnel Projects are mainly delivered through competitively tendered stand alone Contracts. These are generally priced contracts, with activity schedule (fixed price with compensation events), based on the NEC3 Engineering and Construction Contract, Option A, or Option C where appropriate. The risk sharing approach using Option C will be explored fully when considering the individual project procurement strategies.

SWIP adopt more of a Construction Management approach, which has been shown through benchmarking to be more cost effective than the traditional Principal Contractor route. The Civils Programme has used Construction Management to deliver a small number of low value, non-complex projects, primarily on Earth Structures.

10.7.2 Projects Delivery, JNP

Civils Projects on JNP are currently delivered by the Specials Projects Team which is a multi-functional team responsible for delivering a range projects including Civils, Power, Stations, Signals and enabling works. Civils works are delivered using a combination of Construction Management and specialist Contractors as appropriate.

JNP have in the past made greater use of the Construction Management approach than SSL/BCV.

10.7.3 Future Delivery Strategy

The current procurement strategies for the delivery of both maintenance and project works will be reviewed at the earliest opportunity with a view to rationalising the supply chain contracts and category management to maximise commercial advantage across TfL. This will include a review of options for 'make or buy' and to identify risks and opportunities for using internal resources compared to outsourcing.

The future strategy is to increase the use of Construction Management, particularly on BCV/SSL in order to continue to drive down unit costs.

With the exception of a few large projects (e.g. Baker Street-Bond Street tunnel reconstruction and bridge replacement projects), the majority of Civils projects could be considered heavy maintenance, which may be delivered more cost effectively by Asset Performance. The future strategy is therefore to undertake a review of the projects workbank to determine whether certain projects could be more efficiently delivered by COO/AP as a result of synergies with maintenance work and minimising overheads. The review will need to consider the cost and complexity of each project and the resources and capabilities available within the COO/AP organisation.

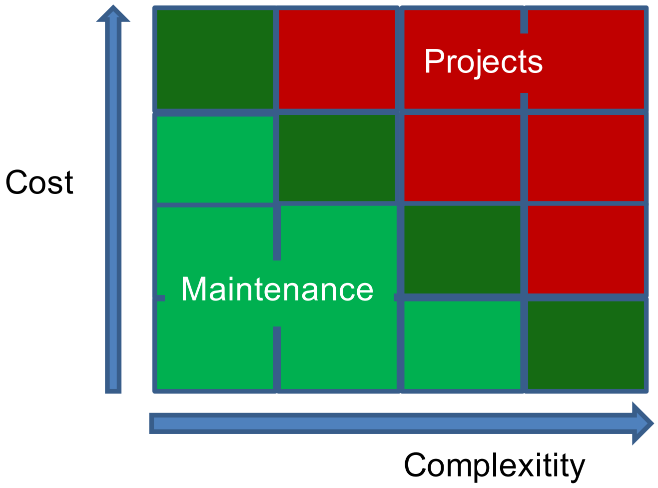


Figure 39: Workscope Delivery Matrix

Any projects not suitable for delivery through COO/AP would be delivered through another appropriate delivery team, removing the requirement for a separate Civils project team. The preference is for a multi-disciplined team that could deliver a range of projects and have the capability to manage project interfaces. This strategy would reduce the costs associated with a having dedicated Civils team and provide the capacity and flexibility to deliver the current programme along with any emerging works e.g. as a result of asset degradation or synergy opportunities.

The BCV/SSL Earth Structures renewals programme is nearing an end, with completion planned for March 2015. As this will only leave the Bridges and Structures programme, a significant proportion of which could be delivered through COO/AP, this may be a suitable time to shut down the Civils team.

10.8 Access

The access strategy is to maximise any synergy with planned line and station closures, which are considered during development of the Asset Plans. Closure of the railway will be avoided, particularly in Central London areas and on key suburban routes, unless absolutely essential. Opportunities will be explored for increasing the amount of work carried out in traffic hours e.g. by isolating of areas of stations.

Where closures are absolutely essential, these will be planned in accordance with LU access planning requirements and will ensure the passenger dis-benefit is balanced against programme and cost. The strategy is to plan any required line closures prior to 2016, as additional closures are unlikely to be approved after this time due to large number required by capacity projects.

With the exception of bridge replacements, the majority of Civils projects do not require a closure, as they can usually be delivered within Traffic or Engineering Hours. For bridge replacements, the strategy is to maximise the use of existing closures, which may mean deferring implementation, or bringing forward other bridges replacement projects.

There are a number of closures planned for tunnel strengthening works on the Jubilee Line between Baker Street and Bond Street, which is also being delivered partly in Engineering Hours. However, additional closures may be required, depending on the level of risk and success of Engineering Hour working.

Inspection, assessment and maintenance works are able to be performed over a short duration and can usually be carried out within Engineering Hours, but opportunities will be sought to work in existing possessions, where this is beneficial.

Where assets are adjacent to Network Rail overhead line equipment, consideration will be given to the installation of Faraday cages or protective screens to allow inspection, maintenance and project works to be carried out safely without the need for a NR possession.

10.9 Interface Strategy

The strategy is to cause least disruption as possible to interfacing assets whilst undertaking works to the Civils assets and to maximise opportunities through joint working. The implications of any interface issues are discussed with the relevant

Sponsor, to agree how these are managed. Where necessary, the Sponsor and/or COO will attend gate meetings and design reviews for projects, including major upgrades, where they have the potential to impact on existing Civils assets, or where new assets are being created.

Civils Projects generally have few interfaces and management of these are captured in the Project Execution Plan. Stakeholder Management and Communication Plans are produced for all Projects, which identify the interfaces and ensure the relevant interested parties (both internal and external) are consulted throughout the lifecycle of the Project.

A list of interfaces and strategies for managing these are given in Appendix A8.

10.10 Value and Benefits Management

The benefits associated with the Civils projects are predominantly reduction in asset risk (performance and safety) and/or whole life costs, usually by reducing ongoing maintenance costs. Total whole life benefits for each project are calculated using the Civils Value Management (VM) Tool. Benefit-cost ratios are also calculated, which are used to for the development and prioritisation of the asset plans (See Appendix A10 for details).

Benefits are assessed throughout the project lifecycle to verify that projects continue to deliver value, compared to its cost. This is done through the VM Tool and Projects Benefit Plans, either at Project or Delivery Portfolio level, as appropriate.

Value and benefits can usually be assessed using simple whole life cost calculations, but Value Assessments will be carried out where value and benefits are not straightforward. A project will be stopped if it does not deliver value for money.

At the end of the project, risk reduction benefit is captured through the STRATA risk model (see Appendix A9). Where benefit is a reduction in future maintenance costs, the Sponsor will ensure this is taken into account in the Opex Budget.

10.11 Asset Management Capability & Development

10.11.1 Whole Life Asset Management

Whole life costs are achieved through the implementation of an asset management regime that ensures asset deterioration does not lead to major interventions being required in the future. This strategy is achieved through a planned preventative maintenance regime, supported by optimised corrective works where appropriate.

Where asset risks are high or maintenance costs are excessive, whole life cost analysis is undertaken using the Value Management Tool to determine whether there is a business for undertaking renewal or strengthening work. Project interventions are also optimised for risk, cost and performance e.g. replacing bridge decks when longitudinal timbers are due for renewal, to maximise the life from the timbers and to reduce the number of closures.

Where funding constraints do not allow the adoption of the least WLC approach, the best WLC solution for the funding available will be selected and long term financial impact of that decision understood.

The diagram below shows how whole life cost management is undertaken for the Civils assets.

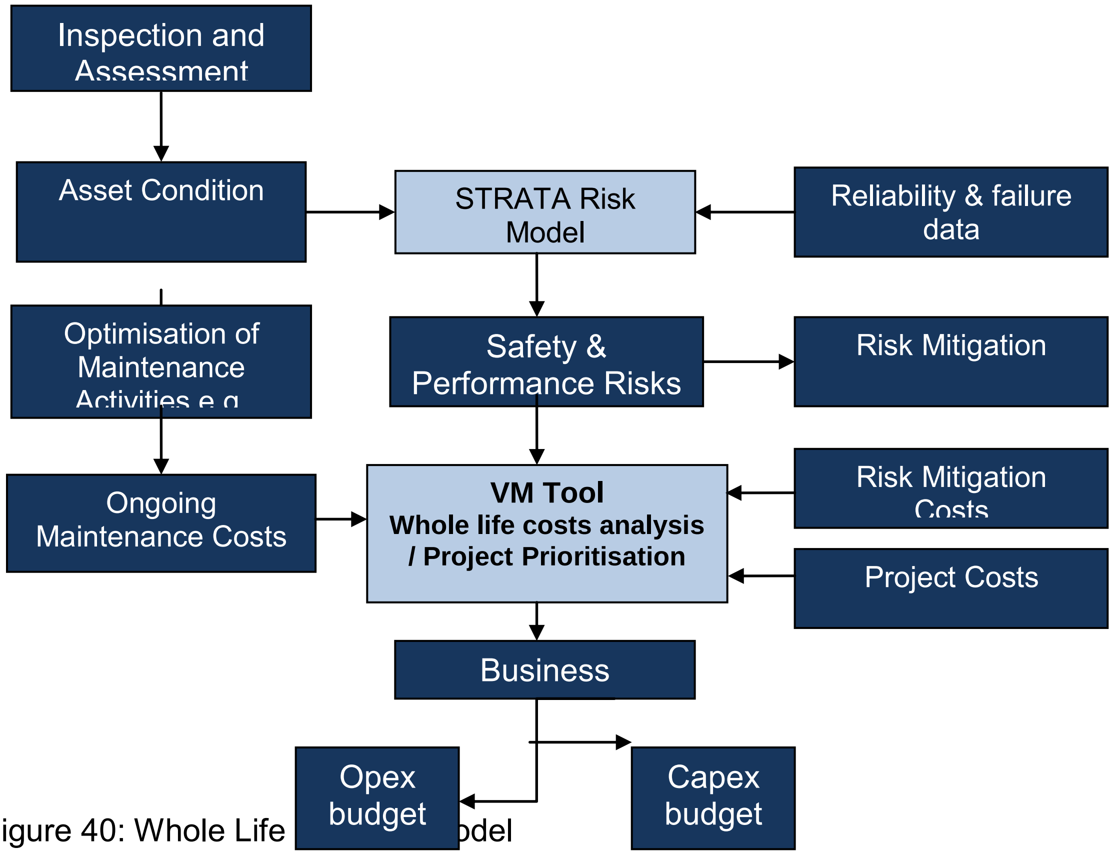


Figure 40: Whole Life ... odel

10.11.2 Benchmarking

The TfL Benchmarking programme is currently underway in order to provide cost comparisons and to identify best practice, prompt innovation, monitor trends and understand the drivers of cost and performance.

A benchmarking study was carried out for Civils maintenance in 2012 to compare unit costs across BCV, SSL and JNP. Although there were some difficulties in making meaningful comparisons due to the varied asset base and different intervention policies, there were a number of useful conclusions such as the reduction in unit rate on BCV/SSL following the introduction of new contracts for planned preventative maintenance in April 2011.

Benchmarking was also carried out recently for Earth Structures renewals, to compare unit rates internally across the operating units as well as externally with Network Rail. The study did highlight the cost effectiveness of the construction management approach used by JNP, which has since adopted more widely across BCV and SSL.

Bridges & Structures have a large variety of asset and intervention types and therefore can be difficult to benchmark. However, bridge painting is one a common repeatable activity that will be benchmarked.

10.11.3 Technology

Innovations in technology, materials and processes will support the move towards 'predict and prevent' risk based maintenance and continuous improvement. Innovative ideas may be sourced internally or externally through government or industry programmes or engagement with other infrastructure owners. Projects may be funded through external bodies, such as the Rail Innovation Fund, or internally through the Knowledge and Development (K&D) Programme (See Appendix A13 for the full list of current Civils K&D Projects).

10.11.4 Opportunities to Improve the Asset Strategy

Initiatives and opportunities to improve performance and efficiency include;

- Planned preventative maintenance (PPM) is key to improving performance and efficiency. A planned preventative maintenance is already in place across BCV and SSL and has started to be implemented across JNP. The strategy is to further extend the PPM regime, particularly to control water ingress and vegetation / tree growth, which are the main causes of asset degradation.
- The use of fibre reinforced plastics and composite materials for new structures and for replacement elements of existing structures. Although the design life of these materials are less than traditional steel and concrete, they can provide lower whole life cost solutions due to reduced construction and ongoing maintenance costs. Fibre reinforced plastics has recently been added to the Bridges and Structures Materials and Workmanship Technical Specification, so its use should now be considered during feasibility stage of all projects.
- The introduction of remote asset condition monitoring techniques, e.g. the use of train mounted monitoring systems, to predict the need for intervention and prevent failures. These techniques could reduce costs by ensuring capital intervention, particularly Earth Structure renewals, is targeted only where required. There is also the potential to reduce costs by reducing the need for site visits.
- The use of laser techniques to undertake detailed surveys of structures, to improve the accuracy of defect detection and measurement, which is currently carried recorded by visual inspections. The data collected will lead also lead to a better understanding of asset degradation. Visual inspections of tunnels are time consuming and the possibility of carry out surveys using equipment mounted on a track trolley could increase efficiency of the inspection process and reduced costs.
- Introduction of Risk Based Inspections on Bridges and Structures, to ensure the assets are managed in a safe and cost effective manner, taking

into account their criticality, condition and risk. A better understanding of asset degradation is likely to be required to enable fully optimised inspection frequencies, which is being addressed through a current K&D project. A Concession or Standard change would also be required, before inspection frequencies can be altered.

- The introduction of processes and technologies that minimise the number of closures required to maintain and upgrade existing assets and for the construction of new assets and maximises the amount of work done during engineering and traffic hours. One example that this can be achieved is through the use of build off-site modular components, which will allow a move away from traditional construction to a process of assembly.
- Sharing of knowledge, good practices and lessons learned with other infrastructure organisations, through conferences and working groups, such as the Bridge and Geotechnical Asset Owners forums.
- Industry sponsored research through Universities and other Research bodies e.g. CIRIA, TRL.

10.11.5 Development of Asset Management Capability

The following activities will support the development of our asset management capability and improve our understanding of life cycle costs and asset degradation mechanisms:

- Ongoing improvement of the Civils Risk Model (STRATA), by validation and review of input assumptions and results with Profession Heads. Inclusion of JNP assets, to ensure Civils asset risk is evaluated consistently across the Network.
- Further development of the Civils value management tool, for prioritising the projects workbank (see Appendix 9 for details). This will improve functionality and automate output for the creation of the projects workbank, risk profiles and ACR reporting. JNP projects to be included, ensuring projects are prioritised consistently and maximises value from investment.
- A K&D project is being undertaken to develop models for predicting asset degradation rates, for different asset types and materials. This will allow more efficient decision making and enable us to manage our assets more cost effectively by avoiding unnecessary renewal works and optimising maintenance interventions. It will also enable us to understand and better manage the risk associated with hidden defects e.g. on buried bridge girders or external faces of tunnels.
- Undertake life-cycle value optimisation through joint workshops with Asset Performance and Engineering, using SALVO (Strategic Assets: Life-Cycle Value Optimisation) asset management tool. The aim will be to use existing asset information and tacit knowledge to define the optimal point for maintenance activities based on risk, condition, degradation and cost. SALVO analyses were carried out in 2012 for bridge painting and this will now be extended to other maintenance activities.

- Further development of the GeoGraphical Information System (GIS) to include further data sets, to improve reliability and usability of critical information, leading to more efficient planning and data management.
- Investigate with COO the benefits of extending the asset hierarchy in Ellipse / Maximo to Maintainable Item level to allow Extent and Severity defect scores for all sub-components to be recorded and monitored through time. This will lead to an improved understanding of asset degradation, which is key in realising a risk based maintenance regime.
- Continue with the benchmarking programme, to identify best practice and to improve cost, performance and efficiency across the BCV, SSL and JNP, as well as TfL Rail and Surface.

10.12 Energy & Environmental Sustainability

Energy & environmental sustainability are supported by the following activities:

- Undertaking Carbon and Energy Impact Assessments for all projects, where applicable. The application of new materials and construction techniques will be considered for delivering reductions in embedded carbon.
- Reducing the quantity of construction waste by considering waste reduction opportunities throughout the Project lifecycle. Materials are recycled wherever possible, for example re-use of temporary fill on Earth Structures renewal projects on subsequent projects and contaminated ballast is washed and re-used on track drainage renewals.
- Incorporation of sustainable materials into construction methods wherever practicable e.g. the Ruglei system for stabilising embankment shoulders, geo-jute rather than plastic-based geotextiles.
- Undertaking of environmental assessments to identify biodiversity and the ecological value of a site. This will ensure controls are put in place to conserve ecology and wildlife and the appropriate licences and consents are applied for in advance of works starting on site.
- Undertaking of assessments to identify potential sources of pollution to ensure that control measures are put in place to adequately prevent pollution of waterways and drainage systems.
- Awareness to prevent the spread of invasive species which could damage the existing ecology.
- Safe disposal of asbestos and controlling risk of contamination.
- Due consideration is taken of adjoining residents and methods of working are put in place to control noise and dust during the works. All works are subject to an evaluation for Section 61 consent, under the Control of Pollution Act 1974.

10.12.1 Climate Change Adaptation

The strategy is to understand, manage and adapt to the impact of climate change, such as increased rainfall and temperature variations, on the Civils Assets. The risks associated with climate change have been identified through a number of risk workshops and risks are managed on ARM by the Infrastructure Protection Manager.

Key activities for managing the impact of climate change include:

- A Comprehensive Flood Review is being undertaken, which will identify all locations on the network that are vulnerable to flooding, provide direction on the future management of flooding risk and recommend where further mitigation measures are required.
- Management of Earth Structures at risk from inclement weather, including assessment of risk, vegetation management, measurement of rainfall and trigger levels for emergency response.
- Monitoring of track performance at locations of Earth Structures subject to shrink and swell effects.
- Assessment of structures at risk of scour, including the effects of rising water levels and installation of protective measures at high risk structures.

10.13 Strategic Risks and Opportunities

There is a risk that the current level of investment may need to substantially increase in the future as a result of hidden degradation or unforeseen failure mechanisms. A major structural failure, particularly of a deep tube tunnel, would also require lengthy line closures. This scenario may be another 100 years into the future but will remain uncertain until we have a better understanding of degradation.

Renewal works are currently limited to assets with risks that are particularly high and / or which have excessive maintenance costs. There is a risk that additional works will be required to strengthen or refurbish assets, to achieve the required capacity benefits associated with major upgrade projects.

Conversely, there may be opportunities to deliver Civils asset renewals cost effectively in conjunction with major programme works e.g. to renew a poor condition station platform during the installation of Platform Edge Doors.

11 Stations

11.1 Strategic Summary

London Underground is responsible for the operation and asset management of 272 stations of varying nature. In order to accurately reflect the different staff and customer needs at all stations London Underground have split them into four categories:

Gateway stations – stations that are the main visitor entry points to London, with a high proportion of people unfamiliar with the Tube network, such as Kings Cross/St. Pancras, and Heathrow 1, 2 & 3 stations.

Destination stations – are busy stations in Central London, which have high volumes of customers, and include commuter rail termini and tourist destinations, such as Embankment station.

Metro stations – stations that serve predominantly inner London communities, with many regular users, such as Clapham South station.

Local Stations – these smaller stations, in Outer London or beyond, have lower customer numbers and serve mainly regular customers, such as Rickmansworth station.

In addition to the station buildings London Underground has 1150 non stations premises which range from staff accommodation through to line side buildings that house critical operational equipment such as signalling systems. The stations assets aim to provide safe and welcoming environment for our customers to access, egress and interchange through the London Underground Network in an efficient and smooth manner.

The Station Asset portfolio consists of premises which provide the fabric of stations and non-station assets lighting, heating and cooling systems; fire detection and suppression systems, station drainage and pumping systems, as well as gas, water and electrical services.

11.1.2 Strategic Context

London's underground railway system is the oldest in the world and its architecture and other features reflect its development over 150 years. We are proud of this heritage and of the world-class buildings we own. There are currently 73 stations on the underground which have Grade I and II listed status and by law listed building consent must be achieved before we demolish, alter or extend any of these buildings. There are a further 48 properties that have a local listing designated by the local council or are situated in conservation areas. Therefore the challenge is to deliver and maintain a world-class metro in a way that respects the rich heritage of our underground railway system.

The construction of such varied station types over so many years' means there is a huge diversity of legacy assets that require managing and integration with other newer/different systems. The introduction of new technology, standardisation and centralisation has helped to reduce the variability, improve interoperability and reduce whole life costs. There are currently 117 stations that are deemed to be 'underground' which tend to be the more busy central stations and these are covered by Section 12 of the Regulatory Reform (Fire Safety) Order 2005, which places restrictions on the materials that can be used on the stations. This puts additional constraints on what assets can be used where.

There has previously been a "one size fits all" scaled model applied to station types, regardless of size, complexity or operational criticality of the station to the network. There are increasingly new demands being placed on our stations such as rising customer and other stakeholder expectations, rising demand and our plan to deliver a 24 hour railway during weekends in the central part of London by 2015. This creates additional challenges for the management of our stations assets and drives the need to review the standard model.

Each station type now has varying built environment and systems requirements to meet the particular operational model and customer needs including: technology which supports staff to be more visible within the station environment; improvements in customer information both train service and way finding to ensure all stations are easy and convenient for customers to navigate. In addition to this the growing customer and business need to increase secondary revenue opportunities by maximising the best use of available space for commercial opportunities whilst keeping true to the London Underground brand.

Currently there are over 1.3bn passenger journeys a year with customer demand expecting to increase by nearly 18% by 2022. It is essential to deliver investment to serve predicted demand. Stations need to meet this increasing demand in order to reduce congestion, increase capacity, and improve journey time whilst still delivering high standards of customer service.

11.2 Our Goal

Our overall goal for Stations is to:

Provide our customers with a functional, bright, clean and welcoming environment that is safe, accessible to all, whilst keeping in line with growth demands delivered through our line upgrades. Good station design will be applied that will be attractive, spacious, reflect out heritage, have a local identity whilst reinforcing the world famous LU brand

To deliver our goals for our Stations assets we will:

Increase the capacity at key stations to reduce customer crowding and improve interoperability.

Reduce congestion by prioritising capacity mitigations and by minimising the disruption caused by delivery programmes by combining delivery of different work programmes as well as utilising pre planned closures and blockades. The use of build off site methodology has already seen reduced programme times and closure requirements.

Improve accessibility by increasing levels of step-free access from street to train at a further 28 stations by solutions such as lifts, ramps and inclined lifts. In addition, small scale improvements can be made including installation of hearing loops, tactile and corduroy strips, improved lighting and contrasting finishes.

Improve interchange between transport modes through changes to the physical infrastructure, signage and customer information.

Address condition concerns at the remaining 71 stations which have not been upgraded through the Station Stabilisation Programme. For premises assets a targeted condition definition has been established to ensure that all relevant assets are returned to and maintained at a level that is described as 'fair', less than 10% defects experienced over a 10 year period. The stabilisation works will also include replacement of obsolete and end of life systems assets. The scope of works for each station is determined through a risk based assessment of asset concerns. The order of station delivery is determined based on overall asset condition, risk, fault levels and customer usage.

Implement targeted maintenance regimes to improve the performance of critical assets which could close a station, platform, track section or line. For example, cooling systems in critical areas such as station equipment rooms.

Improve our knowledge and information in relation to asset condition through physical inspection and the introduction of condition monitoring equipment to aid identification of areas of concern earlier and move towards a 'predict and prevent' regime where appropriate.

Deliver an improvement in the energy efficiency and reduction in carbon emissions (The stations assets account for approximately 15% of LU's energy usage) through utilisation of low energy/carbon technology. e.g. energy efficient technologies such as LED lighting, centralised heating and cooling systems and daylight controlled lighting.

Implement fit for the future stations, better utilising station space for commercial enterprise.

11.3 Strategic Overview

The stations assets strategy is to provide a safe, customer focused and reliable railway through continuing to improve the condition of the assets. Assets will therefore be managed in accordance with whole life cost principles by optimising maintenance and renewals taking into account cost, risk, performance and asset condition.

The level of risk associated with premises and systems assets is generally low; however there are a number of critical assets which, in the event of failure, could potentially close a station, platform, track section or line. For example fire systems and cooling systems in critical rooms such as Station Equipment and Computer Rooms. The maintenance regime will therefore be designed to focus on maintaining and improving performance of these critical assets. Improving our detailed knowledge of the assets through physical inspection and the introduction of condition monitoring equipment will ensure greater levels of intelligence will be achieved and help us understand where areas of concern can be addressed in a timely manner preventing unexpected failures and also ensuring more efficient use of resources.

Delivery of maintenance and planned renewals will continue to maximise the productivity and life of our existing assets through identifying and managing our risks to be as low as reasonably practicable whilst maintaining the design idiom that has been a key part of London Underground's history as well as ensuring that sustainability is at the heart of our future designs.

An increased focus on the root causes of faults will help us to develop an action plan to prevent future incidents. Delivery of new assets and introduction of new technology will improve efficiency and will be delivered on time and to budget, minimising the disruption to customers. Implementation of a 'predict and prevent' maintenance regime will optimise asset performance and minimise the need for reactive maintenance although it is worth noting that there are some non-critical assets where running to failure may be the best economic policy. Standardisation of assets and systems is vital in order to reduce the variability, improve interoperability and reduce whole life costs. This is a key part of driving the ability to leverage TfL buying power through the ongoing application of category management.

It is extremely important to develop our staff and to provide training such that staff are competent to support the multitude of assets and complex interfaces of systems on the network and are prepared to adapt to change where required.

All these actions will continue to deliver improved maintenance and a focused investment programme based on asset condition, performance, criticality and risk.

The increased customer demand forecast requires us to maximise the capacity of our existing assets. The Stations strategy will support this through maximising the availability of existing assets, prioritising performance of critical assets as described above. Improvement in the energy efficiency and reduction of our carbon footprint of stations assets will be achieved through utilisation of low energy/carbon technology within a whole life cost approach where practical. Examples of how this can be achieved by stations assets includes use of energy efficient technologies such as LED lighting, centralised heating and cooling systems and daylight controlled lighting.

Addressing long term capacity will be delivered through the Future Stations Capacity programme which will reduce congestion, increase capacity and improve journey time through effective use of existing space and expansion of stations where required. Prioritisation is determined through modelling future demand to understand capacity requirements. This will be delivered, where possible, utilising third party development and funding opportunities.

The strict application of the space management process will enable us to maximise the use of space on existing stations which will also be supported by the removal of clutter and redundant equipment. Application of improved wayfinding via station signage will improve the flow of passengers through stations improving capacity.

Congestion can also be addressed through minimising the disruption to the service and customers caused by delivery programmes. This can be achieved by combining delivery of different programmes of work, where possible, as well as utilising pre planned closures and blockades. The use of build off site methodology, rather than the traditional in situ construction method, has already seen reduced programme times and closure requirements, subsequently reducing the customer impact on stations. This methodology will be further developed with industry partners and utilised wherever possible.

Improved accessibility within stations will continue to be at the heart of our future strategy. Access from street to train will be achieved through the provision of growing levels of step-free access, via solutions such as lifts, ramps and inclined staircases. In addition to this, small scale improvements can be made including installation of hearing loops, tactile and corduroy strips, improved lighting and contrasting finishes.

London is growing and the existing network cannot meet the demand which will be placed on it in the future. Increasing Capacity from growing the network will be achieved through expanding the London Underground network through projects, like Crossrail, Croxley Rail Link and the Northern Line Extension, which will reduce crowding and increase capacity as well as providing better transport accessibility to key areas in and out of London. Management of interfaces with other modes of transport will also ensure seamless interchange through standardisation of technology and a joined up customer proposition including signage and customer information.

Customers sit at the heart of our vision of delivering a world class tube service for London. The stations asset portfolio is contributing to this through provision of better stations which are bright, clean and accessible environment for customers and staff. Stations will be spacious facilities that cope with peaks in customer demand and opening up the service to more customers through accessibility improvement and capacity works. Good station design and provision of the right assets will support the ability staff to be more visible and active in customer areas to provide world class customer service.

11.3.1 Key Assumptions

Key assumptions that underpin this strategy are:

- There are sufficient capable resources within Strategy & Service Development (S&SD), Chief Operating Office (COO) and Capital Projects (CPD) delivery teams to implement the plans required by this strategy.
- Funding is maintained at the level defined and agreed as part of the 2013/14 spending review process.
- Station closures will be avoided unless absolutely essential or supported by a robust business case.
- There is no significant change to overall amount of Engineering Hours available for undertaking maintenance and project activities. It is assumed that the possible introduction of all night service on Fridays and Saturdays will be offset by longer mid-week Engineering Hours, delivered through the Improved Access Programme.

11.4 Asset Strategies

11.4.1 Premises

The strategy is to achieve a steady state whereby all premises assets are at least in a condition of 'fair', that will require little or no work for ten years and to promote the standardisation of designs and materials so that whole life costs are minimised. The strategy will ensure, within the constraints of the current budget and access to the railway, that the assets:

- Comply with all applicable statutory requirements and laws
- Are maintained in a safe, secure, wind protected and watertight condition
- Are maintained to such levels of condition and to such specifications as are consistent with principles of good estate management applied to the Premises as a whole
- Are maintained in a manner which prevents deterioration of any part thereof

The strategy therefore aspires to:

- Provide a bright, clean and accessible environment for customers and staff;
- Provide spacious facilities that cope with peaks in customer demand;
- Provide durable finishes that can cope safely with large customer demand;
- Provide equipment rooms that make a positive contribution to the reliability of the assets they contain;

- Provide a steady reduction in maintenance liability and increase in reliability through the introduction of new technologies.
- Support the Stations Design Idiom
- Positively contribute to carbon reduction initiatives.

ESTEEM is a data collection and decision support tool that has been developed for premises assets. ESTEEM allows us to interrogate and review the data collected; produce standard reports for maintenance planning, business planning and Asset Condition Reporting (ACR); undertake degradation modelling considering whole life costs up to 100 years. A requirement has been built into the MAID that if any premises works are undertaken by projects then an updated survey will need to be done following the completion of the work in order to make sure the database is kept as up to date as possible. It will also allow cost information to be updated which will ensure improved estimating at a project outset.

A dashboard is being developed which, utilising the information from ESTEEM, will record the concerns, defects and condition issues which will identify i) the work required; ii) the cost of the work; iii) the delivery mechanism and iv) the timescales for implementation.

11.4.2 Asbestos

A draft strategy has been produced for the management of asbestos , 'Asbestos Strategy - a 20 year vision'. The legacy of asbestos in LU causes both planned and unexpected expenditure in day to day maintenance and projects. The strategy is to substantially reduce these risks, and ultimately remove all but the most deeply embedded asbestos. This strategy will require sustained investment over a long period of time. A road map is being developed and reviewed to determine the feasibility of this strategy.

Further Improvements / Aspirations

Following the ESTEEM premises stations surveys that have been carried out we now have an enhanced awareness of potential safety concerns which can be targeted. Also, work has recently been carried out in conjunction with CIRIA on safer stairs . As the work beds in, there will be an increasing knowledge about the improvements that can be made e.g. many existing stairs are uneven or have odd risers.

A programme will be put in place to review the realisable benefits of lean construction and BIM integration throughout the whole life cycle.

Going forward we can use ESTEEM to improve the strategy in line with the planned predictive maintenance regime strategy. This can be achieved through:

- Use of Bayesian statistics to predict the future condition of the assets which will lead to a greater period of time between principal condition inspections, thus reducing cost.
- Optimising interventions from a whole life cost prospective.
- Optimising interventions in synergy with other asset areas.

- Considering economies of scale by grouping tasks and/or locations for projects.

Other areas for further investigation include:

- Introduce robotic / mechanical cleaning devices.
- Investigate self cleaning materials.
- Investigate concealed fixings, and introduce programme to verify stability of all fixings, as part of a rolling programme of work.
- Building control automated.
- Design for minimum maintenance intervention and world class reliability.
- Build off site options.
- Further application of green roofs

11.4.3 Electrical & Mechanical

Station systems and associated power networks are of the highest criticality or impact and support the ALARP condition e.g. emergency lighting, fire alarms and associated power supplies.

The strategy for lighting and electrical assets is a step change of reduction to the current levels of reactive and corrective maintenance resulting in an increase of planned preventative maintenance based on clearly defined asset lifecycles. The consistent selection of the appropriate products (new or retrofit) suitable for the application and with respect to the operating environment is resulting in clear cost benefits in terms of the whole life cost ownership and reduced energy consumption.; with demonstrable savings evident through improved product performance and power supply monitoring. The strategy will ensure:

- Compliance with statutory legislation
- Maximum asset availability and reliability resilience
- Minimal service disruption
- Energy efficiency and whole life costs are integral in decisions to upgrade or replace lighting and associated wiring.

The strategy is targeted to deliver:

- A lighting policy and strategy that guides the phased development of the new lighting technologies. This focuses on:
- Obsolescence of T12 florescent tubes and other lamps impacted by the European directive regarding energy efficiency and use of cadmium in electrical components. T12 florescent lamps are replaced by more energy efficient lamps such as T8 fluorescents or LED. T10 LED retro fit conversions are being trialled at various locations and are approved for platform and over escalator locations with open Churchouse luminaires. The available technology is evolving and developments in the lighting market are closely monitored.
- Lighting in public areas which falls below acceptable levels

- Deficiencies in current emergency lighting installations in areas such as open section platforms and line side buildings
- Standardisation of luminaire designs.
- The evolving reliability strategy for CER & SER's to address overheating issues which are the primary cause of communications equipment failure. A design register will be developed which takes account of the room dimensions, building fabric gains and the equipment heat loads to determine the required cooling capacities. Space planning within the rooms will be better controlled in future and will incorporate the heat load assessments as an integral part of the approvals process, thereby reducing the risk of equipment failure and promoting critical design reviews where necessary.
- A policy of standardisation to reduce the proliferation of different types of electrical fittings and luminaires in order to optimise the opportunities for reducing spares holdings. Rationalisation of switch gear and sub-main circuits.
- Reducing energy consumption by employing daylight saving controls (DALI) and other energy management systems where appropriate.
- A policy of continuous reduction of the reactive power element, harmonics and the consequential associated heating of cables, light and electrical fittings.
- Sub mains energy metering – to measure the overall consumption and electrical quantities to determine the affect of the control measures.
- The expansion of broadband and Wi-Fi network connectivity for transmission of real time SCADA system information within the BMS to inform the contractors (internal or external) of the critical asset data.
- Centralised remote monitoring and BMS for consistent and coherent energy management reports.
- A reduction in the reliance on traditional split cooling systems (DX) and convection heaters for premises and utilisation of more efficient VRF/VRV systems where the opportunity within capital programmes arises.
- The utilisation of more heat recovery systems within premises facilitating a reduction in the reliance on traditional water heating methods.
- Procurement strategies for electrical and mechanical equipment that result in the standardisation of electrical fittings and the optimisation of energy consumption.
- Selection of low power and energy efficient equipment that optimises energy consumption .
- Statutory energy assessments for premises, acting as a driver for potential efficiency improvement projects.
- Systems reliability built in at the project design stage.

- Enhanced tunnel cooling by re-commissioning or modernisation of previously disused tunnel ventilation systems.
- Integrated automation of controls for a reduction of energy consumption for mechanical plant and equipment.
- A more comprehensive asset register, with a level of granularity down to individual units within the station areas that will enable the provision of better condition information.

11.4.4 Fire

LU faces unique challenges in operating a 21st Century railway with 19th and 20th century infrastructure whilst maintaining compliance with all current fire safety-related legislation. LU premises offer varying degrees of compliance with modern standards and guidance, and in many cases are non-compliant with both. The difficulty and expense of directly addressing these non-compliances in the short-to-medium term is accepted both by LU and the Regulators.

Various controls and the maintenance of existing fire protection arrangements ensure that fire risk is maintained to ALARP .

Over the next 10-20 years the key changes that are relevant to the fire protection engineering assets are considered to be:

- Improvement in compliance with standards (both national standards and railway-specific), as works across the LU network address existing non-compliances, either as stand-alone initiatives or as part of other works (e.g. congestion relief; major projects such as Crossrail etc).
- The approach of controlling fire load as the primary risk control measure will ensure that the current ALARP safety levels are maintained. Gradual improvements in compliance are expected as non-compliant materials are identified and removed – this may allow future reductions in the level of fire protection in certain areas.
- As passenger numbers continue to increase this can lead to increased congestion of a station impacting station escape route capacities. In locations where there are existing or emerging non compliances in escape route capacities the risk will be assessed to ensure that it is still tolerable and ALARP. This will form part of the future capacity works criteria.
- Fire detection technology will improve, such that sensitivity is enhanced with no resultant decrease in reliability or increase in unwanted fire alarms.
- Establishing the criteria to support the targeted, economic replacement of existing obsolete and life-expired fire-fighting water supplies (wet hydrants) with simpler, more reliable and easier to maintain falling mains.

The fire protection assets can, if they fail in service, cause disruption to the railway service. Improvement in reliability has, and will continue to be delivered through equipment modernisation and better maintenance, and by ensuring that only necessary fire protection is installed. Resilience may be delivered by considering whether asset protection from the risk of fire is a necessary requirement, especially during line upgrades. Further planned improvements include:

- To work with suppliers to investigate the usefulness and desirability of alternative human interfaces for our fire detection and alarm systems - e.g. intelligent 'Graphical Human Interfaces.

- To investigate alternative, potentially more efficient and cost-effective fire suppression technologies (e.g. water mist).

- To investigate whether the requirements for the design of means of escape from the public areas of stations can be altered to allow design using computer modelling – potentially using evacuation modelling and computational fluid dynamics to establish the required and available safe egress times, in case of fire. This may enable the design of means of escape to be done more efficiently & in accordance with 'best practice' as used for other building types (e.g. sports stadia; retail malls etc).

11.4.5 Stations Pumps and Drainage

The Strategy is to remove water and provide drainage to stations, track and depots, to prevent flooding and prevent closure or part closures as a result of flooding.

Station drainage renewals and improvements are required to address flooding problems, renew life expired drainage systems and replace incorrect connections, where grey and foul water is connected to track or surface water systems. Pumping assets, these are replaced before they become life expired due to their service criticality of. All critical pump sites are monitored and controlled by the Mactec system which is also used to inform the renewals programme. The Mactec system will be extended to include non-critical pump sites, as pump systems are renewed. Works are prioritised according to existing condition and life expectancy. All works are co-ordinated, wherever possible, with the Stations programme and the Depot Upgrade programme in order to minimise disruption.

Looking forward, feasibility studies will be undertaken on a risk basis to understand the root cause of flooding events and develop an action plan that prevents future incidents. Works to replace life-expired drainage assets will continue to be targeted on areas with high levels of faults or call-outs.

Further works will include:

- Existing life-expired GGG suction pumps to be replaced with Varisco and submersible pumps, which are more reliable and cost effective
- Renewal works will consider Sustainable Urban Drainage Systems (SUDS) principles such as local storage tanks / water holding areas, enlarging surface water systems and outfalls and the additional pumping facilities where appropriate.

11.5 Station Capacity & Upgrades

The capability of key stations and interchanges to accommodate passenger demand is assessed and figure 1 illustrates the peak hour crowding level at all LU stations against forecast 2031 demand. The analysis currently indicates that by 2031 a majority of zone 1 stations, as well as a significant number of stations outside zone 1 will suffer from capacity constraints at key points within the station during peak periods. Locations with significant and disruptive capacity shortfalls include key interchanges such as Holborn, Baker St, Paddington (Bakerloo) and Oxford Circus where station control protocols are already in place during peak hours.

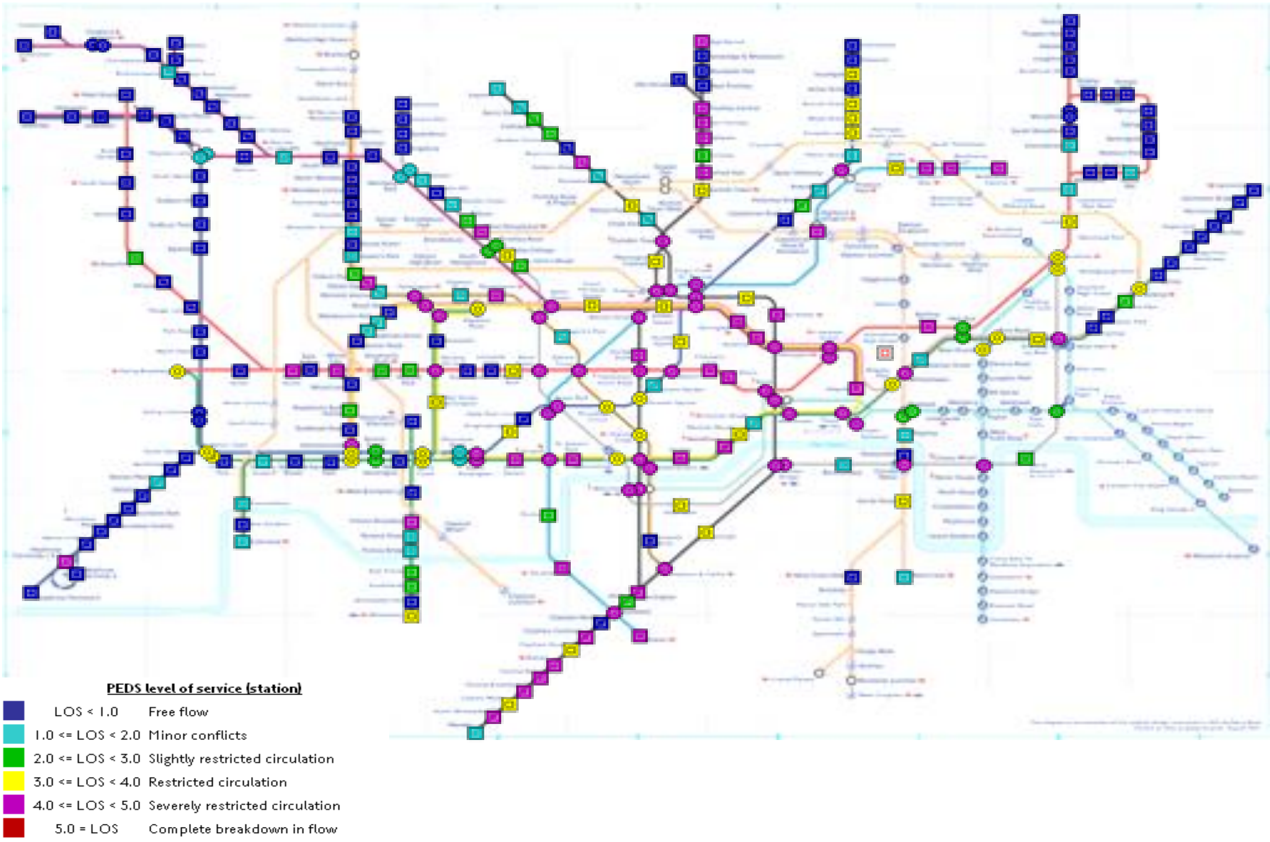


Figure 41: Station Crowding Map

There is neither the need nor the resource to tackle all of these capacity shortfalls as level of congestion can be anticipated, managed and tolerated without significantly impacting end to end journey times. However, congestion at certain locations can present a much greater strategic risk to the integrity of LU's service. A good example would be deep level platform and passageway congestion at a key interchange (e.g. Holborn). Also our capacity to implement change, critically, and the affordability of delivering complex and disruptive infrastructure means that there is a need to prioritise the most critical and/or opportune capacity mitigations which form the core of the Future Stations Capacity Plan (FSCP).

To carry out this assessment and prioritisation exercise, the FSCP developed a process to assess all of the identified station capacity constraints against a set of criteria, which are:

- Complexity of mitigation
- Strategic impact
- Journey time benefits
- Strategic benefits
- Third Party opportunity
- Risks

From this prioritised shortlist a number of locations were selected by the FSCP (endorsed by the Station Programme Board) for early feasibility development. From this initial tranche there are a number of stations that have been recommended for further design development and delivery as part of the next TfL Business plan. The stations chosen are critical to the success of the related line upgrades and to serve the growing demand from the Mayor's Opportunity areas.

Increasing capacity from growing the network will be achieved through expanding the LU network through projects, like Crossrail, High Speed 2 Railroute, Croxley Rail Link and the Northern Line Extension.

11.6.1 Northern Line extension

The primary aim of the Northern Line Extension (NLE) is to encourage economic growth in London and the wider UK economy by facilitating the sustainable regeneration of the Vauxhall Nine Elms Battersea (VNEB) Opportunity Area. This includes the creation of a major new residential, business and leisure district in London's Central Activities Zone.

The London Plan (2011) designates VNEB as an Opportunity Area with the potential for up to 16,000 new homes and up to 25,000 new jobs. This level of development cannot occur sustainably without the appropriate transport infrastructure.

The NLE will achieve this primary aim by extending the Northern line Charing Cross branch from Kennington to a new southern terminus within the Battersea Power Station site with an intermediate station within south Lambeth. This will improve access to the LU network in an area which is in part characterised by poor access to public transport, thereby benefiting both new and existing residential and business communities.

11.6.2 Croxley Rail Link

The Croxley Rail Link is a proposed project which will divert and extend the Metropolitan line from just north of Croxley to Watford Junction, with two new stations at Cassiobridge and Watford Vicarage Road. It will also serve existing stations at Watford High Street and Watford Junction, operated by LOROL and London Midland respectively. Both stations will have step-free access from street to train.

11.6.3 Crossrail

Crossrail is the new high frequency, high capacity railway for London and the South East. London Underground's role in Crossrail is that of Infrastructure Manager and Station Facilities Operator / Maintainer at five central London interchange stations (at Bond Street; Tottenham Court Road; Farringdon; Liverpool Street; Whitechapel). An integrated LU Crossrail team has been set up to progress and deliver the operational and customer synergies and strategies that are required to ensure that both networks can operate in the new environment.

LU will ensure Crossrail has designed the assets so that they can function effectively and be maintained in an economic and efficient manner in the LU environment. LU is working with Crossrail to ensure the specifications for new systems and equipment at the LU-Crossrail stations are compatible and where necessary integrated with existing systems. LU work with Crossrail in the development of the maintenance strategy for the new stations, assets and systems to ensure that appropriate maintenance and support resources are in place to deliver effective maintenance, post-commissioning. LU will work with Crossrail in the development of the relevant maintenance /operational cost models and supporting RAMS analysis for the Crossrail stations.

LU will operate the five central area interchange stations in accordance with LU's operational strategies and philosophy for management of its deep level underground stations. LU will ensure these stations will function safely and operate efficiently as an integrated whole (e.g. the combined LU-Thameslink-Crossrail interchange at Farringdon). Future LU cost/supply chain efficiencies will also be sought by early co-ordination of major Crossrail asset renewals with similar assets across the LU network.

11.6.4 High Speed 2 Railroute

High Speed 2 Railroute (HS2) is a planned high-speed railway between London Euston and the English Midlands, North West England, West Yorkshire, and potentially the central belt of Scotland. The project is at conception stage and TfL's role is that of a technical stakeholder. An integrated TfL HS2 team has been set up (including LU, LO and Surface) to assist HS2 and progress and deliver the operational and customer synergies and strategies that are required to ensure that HS2 deliver an integrated transport proposal for Euston and Old Oak Common stations.
At a local and network level, HS2 will increase interchange passenger flows on R&U lines and stations (in normal, degraded and emergency modes). LU will advise on the functionality, operational performance and capacity requirements which will be based on its planning, operational and engineering experience and the use of specialist modelling tools.

LU will be embedded in the HS2 and TfL team to ensure the acceptability of the station designs from a technical, service performance/capacity, operations and customer environment perspective, consistent with LUs requirements.

11.7 Accessibility

Improvement in station accessibility will be primarily achieved by providing a) Step-free access from street to platform and b) Level access from platform to train c) small scale accessibility measures

a) Step-free access from street to platform

The strategic approach to step-free access delivery is set out in the Mayor's Transport Strategy Accessibility Implementation Plan. Step-free access proposals need to deliver the greatest benefit to the largest number of users. Examples of high benefit schemes include:

- Central Interchange Stations (or Sub Surface Lines that link to major rail terminals)
- Gateways Points to the wider network (Bus Stations, NR, Overground, Crossrail, HS2)
- Locations where substantial 3rd party funding or implementation opportunities exist to deliver step free access

Increasing the number of step-free stations - 20 stations are currently planned during the plan period (to 2021) opening up access to 40% of the network stations.

Step-free access will be implemented where the highest benefits, best synergies or greatest opportunities exist. This includes:

- Where LU are comprehensively upgrading a station as part of the committed investment programme (e.g. capacity upgrades as at TCR, Victoria), these are often the best locations to unlock accessibility benefits by increasing access and connectivity at the busiest locations;
- Where LU are building new lines or extensions, with new accessible stations e.g. Crossrail or Croxley Rail line); or,
- Where there is a good opportunity to deliver step free access at low cost and where we are receiving substantial 3rd party contributions (e.g. Tower Hill and Bromley-by-Bow)

In this third 'opportunity' category, before committing to feasibility development, we have set a number of criteria against which the various opportunities will be assessed to ensure affordability, operability and a good strategic fit. It should be assumed that any 'opportunity' station would meet most if not all of these criteria.

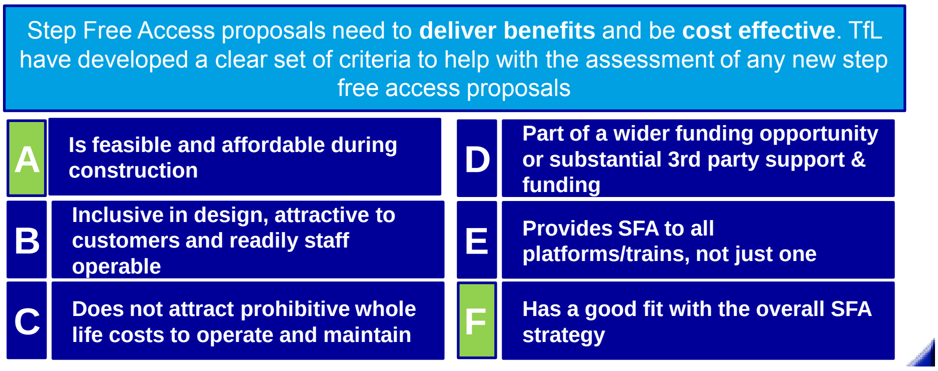


Figure 42: Step Free Access Opportunity Criteria

In addition, LU is undertaking a feasibility study to look at the delivery model for installing lifts, with a view to reducing the unit costs of delivery (Category A above).

b) Level access from platform to train

LU has an obligation to ensure that before new or modified rolling stock enters passenger service that the step and gap between the train and platform are compliant with the Rail Vehicle Accessibility Regulations (RVAR).

Provision of RVAR compliance requires a maximum vertical step of 50mm and a maximum horizontal gap of 75mm between the train and the platform at wheelchair compatible doorways to designated cars. This can be achieved by:

- Adjustment of track height and gap relative to the platform
- Repositioning of the platform nosing stones
- Construction of platform humps

LU is proposing to carry out level access work at those platforms which will give maximum benefit to disabled customers i.e. platforms with:

- Existing step-free access to street level,
- Planned step-free access
- Useful step-free interchange routes between services/lines

Where permanent compliance cannot be achieved, due to infrastructure geometry, manual boarding ramps will be deployed where possible.

c) Small scale accessibility measures. This includes measures such as:

- Provision of tactiles
- Provision of hearing loops
- Improved lighting

Our service to disabled customers is not limited to physical assets and will be improved in other aspects:

- Better engagement with a wide range of user groups
- More staff training
- Better and more targeted information (e.g. Apps) and signage

11.8 Maintenance Delivery Strategy

The strategy for stations assets is currently based on implementing a planned preventative and inspection based maintenance regime that optimises asset performance and asset life, thereby minimising the need for reactive maintenance.

This will be achieved through

- The early identification of defects and concerns through the inspection regime.
- Undertaking corrective maintenance at the optimum time identified through the annual Asset Condition Report (ACR)
- Maintenance of critical spares, through identification of failure rates assessment of availability and culling where the equipment is obsolete
- Optimising delivery of Capex and Opex through packaging of works
- Embedding COO Assets resource in projects to identify and understand the impact of future asset changes reduce duplication of works and maximise opportunities and enable a smooth transition at handover
- Utilisation of remote condition monitoring where appropriate.
- Carrying out work during traffic hours where possible to ensure optimum availability of assets.

Maintenance works are managed through COO Assets and are delivered through a combination of LU direct labour and external contracted work. Currently JNP and BCV/SSL operate separate contracts however the intention is to establish a joint approach as soon as the contracts allow. A review of the timings and therefore opportunities to synergise where possible will be undertaken.

LU takes a proactive approach in terms of managing obsolescence through spares management, with any issues generally identified prior to them impacting asset availability. The major refurbishment and renewal programmes will be used to replace components with modern equivalent or enhanced components, where possible. Critical spares are kept on behalf of LU by the maintenance contractors in accordance with the provision for stores set out in the contracts. The type and quantity of spares depends on:

- Criticality of component to operation of the railway
- Lead time to procure
- Risk of failure
- Urgency of replacement in the event of failure

11.9 Capital Programme Delivery

Projects works are carried out to reduce risks; extend asset life; reduce future maintenance costs and to provide economical and efficient whole life cost solutions.

11.9.1 Station Asset Projects

There are currently two asset condition focused capital programmes which are Asset Stabilisation and the Station Stabilisation Programme.

- **Asset Stabilisation**

Asset Stabilisation addresses risks and concerns where there is no station specific project planned or that the work is high priority to ensure stations remained safe and operational. The asset stabilisation scope is determined through risk assessment of emerging concerns and prioritisation based on asset condition, remaining life and specific asset concerns such as obsolescence, non-compliance or those assets which have a high risk of impacting service in the event of failure. This programme is typically based on like for like replacement, with modern equivalent. The approach will be to ensure the following; that the scope and timing reflects the needs and criticality of the assets; that the delivery strategy is one that considers the need to keep the stations and the associated assets in operational service; and that service disruption is minimised during the implementation of renewals. For BCV/SSL these works are delivered through CPD and for JNP through AP.

- **Station Stabilisation Programme**

The Station Stabilisation Programme was developed in order to address the concerns at the stations that remained untouched following the termination of the PPP. The strategy has been developed to ensure that these concerns are addressed in the most cost effective manner completing in 2018/19. A targeted condition definition has been established to ensure that all station assets are returned to and maintained at a level that is being described as ‘fair’ for a minimum for ten years and includes replacement of obsolete and end of life assets. Scope at each station is determined through a risk based assessment of emerging asset concerns. The order of station delivery was also determined based on overall asset condition, fault levels and customer usage.

The delivery and procurement model ’Stake’ will be utilised to deliver these and future programme of works. The approach is to provide packages by trade, across groups of stations, to enable predictable and continuous work-streams and drive resultant reductions in unit rate. The model is fully described in the Stations Stabilisation Programme Procurement Plan.

- **Future Delivery of Station Asset Projects**

Following the delivery of the asset programmes described above all stations will have either been through a modernisation, enhancement or stabilisation works. The future strategy is to maintain assets in a steady state across the network. In line with the current strategy, the investment will be focused on refurbishment and renewal of degraded, life expired and obsolete assets. As before, a risk based approach will be taken.

It is considered that through the ‘Stake’ procurement model the most value would be to take an asset based approach rather than delivery on a station by station basis. Opportunities that arise through other projects and access will be maximised.

Where assets works required are essentially Asset replacement these will be transferred to COO Assets where they can be delivered more cost effectively. Station asset works which are a greater complexity, higher value and require the application of Pathway will be delivered through CPD through one stations delivery team.

11.9.2 Station Capacity & Upgrades

Station Capacity projects are funded either through direct funding by TfL/R&U as part of the investment plan funding, or are part/fully externally funded. This third party funding is often in related to a development, or series of developments, at or around a specific location.

Feasibility and early design is undertaken 'in house' by CPD with engineering and design support procured from TfL frameworks. Detailed design and implementation phase contractors will vary according to project but will generally adopt a design and build approach.

The commercial model for design and delivery of major station capacity upgrades is being developed further with emphasis on earlier contractor engagement in the design process to drive innovation in design and to improve overall value from the project.

This model was applied at Bank and looks set to succeed in delivering a range of benefits across the commercial, engineering and project functions. In procuring a design and build partner, LU sought to access the expertise of the market by engaging early on in discussions which focussed on R&U's requirements over and above solely the mechanism of delivery or cost. By creating an environment in which innovation was protected, the process sought to encourage suppliers to be much more open about their innovation in pre-contract stages. Focusing primarily on achieving LU requirements, the approach is not focussed on lowest cost at the outset, but around whether this innovation would reduce costs, increase benefits, improve programme, reduce risks or ease stakeholder relations. The Bank project was able to enter into a contract with much greater confidence in the opportunity and ability to manage safety, efficiency and buildability throughout the supply chain than has previously been the case under traditional procurement models. The process delivered a 49% increase in value through reductions in forecast costs and an increase in whole life benefit.

This model will be adapted and developed across the development of the future station capacity programme.

Alternative funding models are also being developed. Working collaboratively across TfL and actively engaging with third parties, including Local Authorities and developers to investigate opportunities to deliver transport capacity improvements through third party funding. Recent examples include Cannon St and Bank (W&C) where there has been direct delivery of capacity assets by third parties, or at Tower Hill where a combination of direct third party asset provision, third party funding and TfL funding is delivering an integrated accessibility upgrade at a significantly lower cost than a previously TfL designed and funded scheme.

Further funding/asset delivery for capacity improvements is being pursued, as part of commercial development schemes at Earl's Court, White City, Elephant & Castle and South Kensington amongst others.

11.10 Access

A strategy is being developed to maximise daytime hours working on stations, such that activities could be completed in traffic hours. The stations access strategy employs the following principles:

- Where possible, stations maintenance activities and inspections will be re-scheduled in order to support any future requirements for 24 hour running of the railway over the weekend
- Reactive fault correction is required during Traffic hours where possible. Procedures are in place for the completion of normal activities such as litter picking and removal of spillages and to resolve service affecting failures such as fire detection system or OPO system failure.
- Procedures are in place and generic access codes agreed for traffic hours access for work that does not impact on the operation of the railway and does not increase safety risk to staff or passengers. This work includes cleaning, back of house maintenance, servicing of mechanical services and non-essential communications equipment.
- The default position is for routine maintenance in public areas that may affect the safety of staff or passengers or the operation of the railway, that activities will be completed in engineering hours. Opportunities will be explored for early access late completion to works public areas for maintenance during traffic hours may be agreed locally with GSM where it does not impact.
- Stations projects focused on asset stabilisation will be scheduled to maximise the benefits of closures from other work programmes. Opportunities will be explored for isolation of areas of stations to allow work to continue during traffic hours.
- For major station upgrade and capacity projects, the station will remain operational throughout the works though there may be some affect on the capacity through the station which will be agreed in advance. Where disruptive works or closures are required, they will be planned in accordance with LU access planning requirements. Any closure requests will carefully balance passenger dis-benefit against programme cost/delay of implementing within engineering or extended engineering hours.
- For outer London stations agreement will be sought for work to be delivered in extended engineering hours, or in traffic hours through local agreements with operational staff, where safety and operational controls are not compromised.

11.11 Asset Management Capability & Development

11.11.1 Data collection and analysis

The figure below demonstrates the information required supporting whole life asset management analysis.

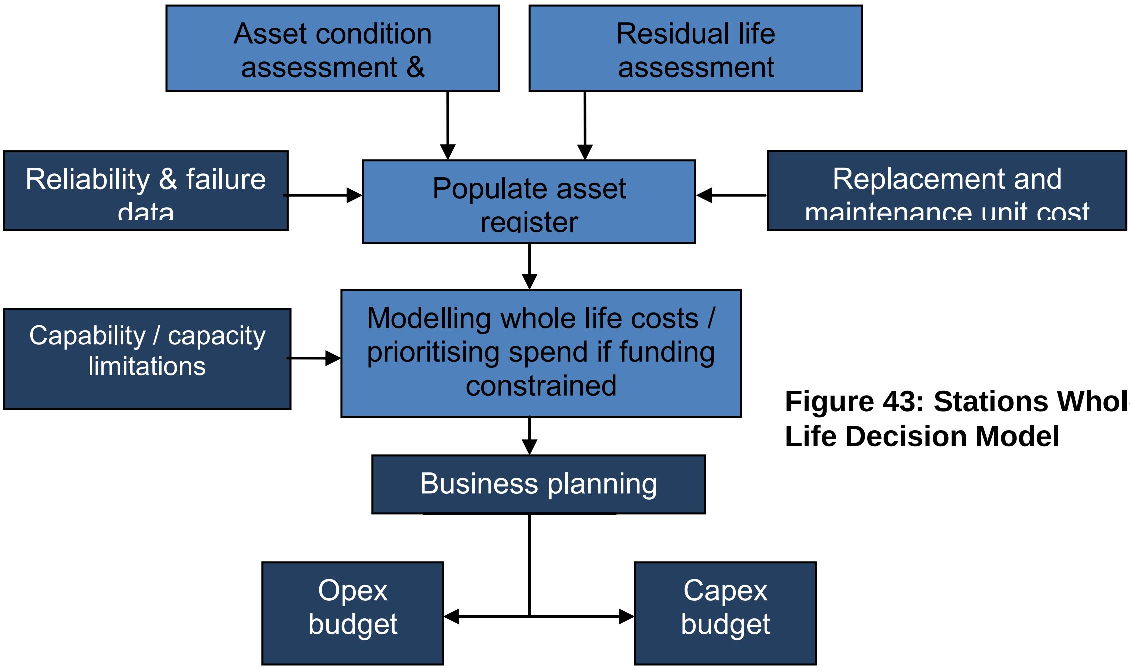


Figure 43: Stations Whole Life Decision Model

The collection and analysis of asset data is an essential element of asset management. Ongoing condition assessments enable forecasting of asset degradation and determine the optimum intervention point. Data collection and condition monitoring is through manual surveys or via monitoring technology, local and remote.

Further review of the key assets and associated costs to implement further technology is required. Remote monitoring will be introduced based on risk and criticality. In the interim data capture enablers such as installation of Wi-Fi to enable transfer of data is also looked at to enable implementation.

LU has two systems, Maximo and Ellipse, which are used to record asset information and plan maintenance activity. These two systems are under review to determine alignment of JNP and BCV/SSL processes and methodologies including data collection. The strategy is to ensure that these systems working in tandem with decision support tools such as ESTEEM and that we have the capability to provide:

- A common language of assets and condition across business.
- Aligned asset registers between asset planning and work scheduling systems.
- Alignment and transparency across business.

- Accurate long-term budgetary and condition forecasting.
- Whole life cost modelling and benchmarking.
- Degradation prediction capability and unit rates at asset level to allow whole life cost modelling
- Provide verifiable, automated annual condition reports
- Migrate responsibility of work planning from point of survey to planning team enabling definition and execution of preventative maintenance strategy
- Enable better resource and critical spares management

Predictive Maintenance Regime Strategy

LU is progressing towards a more predictive and preventative approach to maintenance and will require the use of various techniques to monitor the condition of the asset components in order to predict when failures are likely to occur and carry out the appropriate maintenance to ensure the assets remain in service and therefore reduce cost. This will provide greater awareness of the maintenance requirements of specific assets, together with advances in asset information systems and analysis techniques allows more effective maintenance regimes, such as condition based, to be evolved and introduced.

Predictive maintenance involves undertaking a maintenance task but only when warranted by the condition of the asset and at the optimum time to intervene. The advantage of predictive maintenance over planned preventative maintenance is that the occurrence of the invasive task is reduced by work only being undertaken when necessary. This not only reduces the cost to maintain the assets but also reduces the likelihood of introducing failure as a result of working on the asset.

Therefore LU is in the process of moving towards a predictive maintenance regime through:

- Wider implementation of condition monitoring whether manually or via monitoring technology, local and remote. The long term installation of remote condition monitoring equipment will only be pursued where a positive business case can be quantified and demonstrated, and may only be required at selected locations as opposed to a blanket approach. Existing systems such as the Stations SCADA system will be assessed to determine whether it can be used to support future installations. Any equipment installed will be fully integrated into the maintenance regime to ensure data is monitored regularly and necessary action is taken in a timely manner. Data will be accessible remotely and equipment installed will be ‘off the shelf’, rather than bespoke, where possible. A number of remote condition monitoring methods are already in place at selected locations, examples of which include remote control/isolation of fire panels and air-conditioning monitoring in CERs. Improvement of inspection regimes through introducing more targeted annual inspections for critical assets and improved specified data collection for principal inspections

- Develop temporal asset database including condition, degradation information and cost.
- Database will be continually updated through maintenance activities and also following completion of capital projects on stations to ensure data is as current as possible. Data will include condition information as well as associated costs where possible.
- As the maintenance regime develops effects on cost and reliability can be determined
- Review asset register and confirm list of critical 'golden' assets. This will inform risk assessment and prioritisation of works.
- New assets should meet the requirements to support a predictive maintenance approach

A detailed plan is required and will be developed to support and develop the proposed strategy.

11.11.2 Further Improvement of the Asset Strategy & Capability

The strategy is to have an asset management regime that is economic and efficient and ensures that deterioration of assets does not result in significant component or asset failures in the future. The following activities will also support the development of our asset management capability and improve our understanding of life cycle costs and asset degradation mechanisms as well as initiatives and opportunities to improve performance and efficiency:

- Alignment of JNP and BCV/SSL methodologies including data collection, is underway to determine best practice and align future works
- The introduction of processes and technologies that reduce the number of closures required to maintain and upgrade existing and the construction of new assets and maximises the amount of work done during engineering and traffic hours. One example is through the use of build off-site modular components, which will allow a move away from traditional construction to a process of assembly.
- Sharing of knowledge, good practices and lessons learned with other infrastructure organisations.
- Undertake review of delivery model. Considering cost, complexity and capability determine best delivery model for asset based works.
- Ensure asset information is accurate, reliable and supported by information management systems that allow that supports efficient whole life cost asset decision making. Processes shall maximise the use of systems and automated reporting without the need for manual manipulation of data. The development of LU's Graphical Information System (GIS) will combine data from various sources and display these through a graphical interface. This will eliminate data duplication and improve the accuracy and usability of critical data sets, leading to more efficient planning and data management.
- Utilisation of K&D to investigate opportunities including new technology for example fibre optic lighting. This will allow more detailed knowledge of

specifications, concerns and opportunities, whole life cost information and therefore efficient decision making.

11.11.3 Benchmarking

A benchmarking programme is currently underway which will deliver comparison of repeat deliverable work items. The station stabilisation programme for example is monitoring estimated costs against actual costs across the life cycle of the project. This will improve the accuracy of the programme forecast and feed into unit rates used for whole life costs. Further benchmarking exercises are being performed to develop information for unit rate on repeatable maintenance tasks.

Previous benchmarking has been hindered by limited cost breakdown information for assets. Going forward, due to the new contracts and better asset detail captured in Maximo and Ellipse, benchmarking will improve.

Opportunities are sought to benchmark costs, resource requirements and programmes against other rail infrastructure operators within the UK and around the world.

11.11.4 Technology: Innovation & Efficiency

The strategy for innovation of assets in stations is to monitor new products, liaise with suppliers and carry out trials where assurance is required of products suitability in a station environment. Particular attention has been given to products offering environmental benefits and reduced whole life costs.

Innovation is an important part of Stations' strategy. Changes currently being investigated by Stations are; using Wi-Fi facilities in stations to provide a means for remote monitoring of assets to enable proactive/predictive maintenance and optimising the scope for station modernisations (after 2017) to include new technologies aimed at reducing costs.

In addition to the strategy seeks to:

- Identify and promote best practice and actively share the processes and methods behind it. This may include strategic investment such as condition monitoring, development of alternative assets and a variety of innovative practices to improve reliability.
- Identify and implement improvement and efficiency opportunities that are consistent with Good Industry Practice
- Ensure Line Managers lead in innovation and that current best practices become our standard practice
- Employ six sigma/LEAN methodologies where appropriate
- Benchmark between LU and external parties to determine areas for improvement and gain knowledge from others
- Review of LU CAT1 Standards and utilise standard 'off the shelf' components and/or equipment where appropriate, safe and cost-effective to do so

11.12 Energy & Environmental Sustainability

The Climate Change Strategy primary objective is to improve the energy efficiency and carbon emissions associated with LU operations. All projects assess the impact on energy consumption and carbon emissions across the life of the assets. All station capacity and upgrade works, asset stabilisation and maintenance will promote the utilisation of low energy/carbon technology within a whole life cost approach where practical.

All works will conform to Part L2 of the Building Regulations. Designs should identify opportunities for alternative energy sources, e.g. Combined Heat and Power or micro generation, i.e. photovoltaic solar cells on building roofs where applicable. Energy efficient technologies such as LED lighting and centralised heating and cooling systems, will be rolled out across the network, as trialled under the Low Carbon Stations initiative at Leicester Square Station. Station projects will ensure that where electricity metering is replaced, the new metering will enable the automatic and remote collection of half hourly energy data, to facilitate improved energy management.
The strategy for climate change adaptation is to ensure that the risks of the long term impact of climate change are considered and that the assets will be resilient to this over the design life. These risks include flooding through inadequate drainage and third party impacts, structural risks and the impact of high temperatures on electrical/electronic systems.

Key activities for managing the impact of climate change associated with the stations assets include: Tunnel and Station cooling; Auto shut down /Start up of equipment when not in use; Upgrade of Cooling systems; Drainage effectiveness and improvement initiatives; and Flood protection.

11.13 Strategic Risks and Opportunities

11.13.1 Strategic Risks

The key Strategic risks are:

- Additional capital works are required as a result of unforeseen asset risk due to unknown condition.
- Reduction in future planned investment will reduce the ability to deliver planned works.
- Obsolescence and the inability to support unexpected failures and removal of asset from service
- There is a risk that LU may experience diminished water supplies, due to utility suppliers reducing flow and pressure to control leaks – this may impact the availability of certain fire suppression systems (e.g. sprinklers) and we are actively carrying out a programme of improvements to our fixed sprinkler and hydrant systems, to mitigate any reduction of supply pressure.

11.13.2 Opportunities

The key Strategic opportunities are:

- The renewal of maintenance contracts across the portfolio provides an opportunity to establish a joint approach gaining efficiencies and better visibility of asset and cost information
- Review opportunity to batch faults and deliver at appropriate time.
- Strategy is being developed to maximise daytime hours working on stations, such that more activities could be completed in traffic hours
- Remote monitoring provides the opportunity to reduce inspection visits on particularly difficult to access assets and consequentially drives down maintenance costs whilst simultaneously focusing on condition, making maintenance more predictive.
- A review of existing decision support tools and whole life cost models currently used across TfL to use for Stations assets

Renewal of maintenance contracts to establish a joint approach as soon as the contracts gaining efficiencies and better visibility of asset and cost information

12 Lifts & Escalators

12.1 Strategic Summary

12.1.1 Context

London Underground's Lift and escalator (L&E) assets comprise 184 lifts, 430 escalators and 4 passenger conveyors. The purpose of this asset base is to provide a means of accessing the station platform levels. The asset base is split into the following areas:

- Primary Means of Vertical Transport (PMVT) Lifts – at locations where the lifts are the primary means to get from street to platform level.
- Secondary Means of Vertical Transport (SMVT) Lifts – at locations where the escalators (or staircases) are the primary means of transport / route way from street to platform level. The SMVT lifts support the escalators and provide a means for mobility impaired passengers to access the platform levels.
- Passenger conveyors (or moving walks).
- Escalators.

The lift asset base consists of 57 PMVT and 127 SMVT lift assets, with 5 different design types. In addition, a further 45 new lifts are scheduled for delivery by 2018 following the Station Upgrade Programme and the Capacity Improvement schemes at Bond Street, Bank, Croxley, Greenford, Paddington, Tottenham Court Road, Tower Hill and Victoria stations. An additional 6 lift assets are also expected as part of the Northern Line Extension project.

The 434 escalators and passenger conveyors consist of 32 different design types. A further 31 new escalators are scheduled for delivery by 2018 following the Station Upgrade Programme, Congestion Relief and the Capacity Improvement schemes at Bank (Walbrook Square), Bond Street, Tottenham Court Road and Victoria stations. An additional 10 escalator assets are also expected as part of the Northern Line Extension project.

The lifts and escalator asset group accounts for 4% of London Underground's total asset expenditure profile, which includes operational and capital spend.

The L&E assets are critical to the management of congestion at our stations whilst also reducing end-to-end customer journey times. In addition, these important assets provide the means for ever increasing levels of accessibility onto our network.

This strategy covers the lifts and escalators (L&E) that are managed directly by LU on the BCV, JNP and SSL networks as well as the new lifts and escalators that will be delivered as a result LU's Station Upgrade Programme Capacity Improvement schemes. It does not currently cover the L&E managed by London Overground, DLR or the new L&E being delivered by the Crossrail project for LU's on-going asset stewardship, except to reflect where a coordinated approach is required to procurement or to the operations and customer impacts of proposed changes in current practices.

12.2 Our Goal

Our overall goal is to:

Provide safe, more efficient and reliable day-to-day means of vertical transportation within the 121 key stations currently served across the network and meet increasing demand

Our goals will be achieved through;

Planned renewal and upgrade programmes, prioritised based on station capacity and asset condition with special focus on addressing any emerging concerns in order to minimise the risk to safety and service loss.

Make 99.9% of the L&E assets available for operational service to prevent station closure and service disruption.

Address condition backlog, prioritised to reach a level of steady state, focusing on areas of high criticality whilst carefully balancing the associated access considerations to keep disruption to a minimum.

A comprehensive review of existing maintenance regimes will be undertaken with the aim to move to a **'predict and prevent'** approach based around asset criticality and risk. This will be enabled through the optimisation of existing and development of new technologies to increase levels of asset intelligence through the increased use of condition and status monitoring.

Implement standardised assets and components over time to reduce the current proliferation of component types. This will support maintenance regimes, reducing the potential of obsolescence. TfL as a whole will continue with the policy to procure new equipment to a commercially off-the-shelf standard. This is especially important during the period of construction for the Crossrail scheme as the combined escalator requirement together with LU's needs are in excess of 100 units and over 70 lifts.

This standard suite of products will be procured under a performance based, long term contract, covering the majority of the asset lifecycle. These arrangements will offer an end-to-end service to design, manufacture, install and maintain assets to high levels of performance.

Install new L&E assets as part of station congestion relief schemes aimed at creating **Capacity from growing the existing Network.**

Improve accessibility. When any station or L&E project works are planned, the opportunity to increase capacity and accessibility is considered. Options will include the replacement of fixed staircases with new inclined lifts, escalators or new lifts. Other capacity improvements opportunities are achieved through improved lift cycles times to increase passenger throughput. Access for major work will be optimised by taking advantage of blockades and combining planned interventions with other work programmes, such as station works, across the network.

Enhance accessibility with the introduction of new Secondary Means of Vertical Transportation (SMVT) lifts as part of the on-going Step Free Access (SFA) programme. A key enabler to delivering this strategy is affordability; therefore alternative lower cost lift products (such as platform and incline lifts) will be pursued which could be particularly advantageous at outer London stations.

Capacity from growing the network will be achieved through new line extensions such as Northern Line Extension and Croxley Rail Link. New lifts and escalators will be required to serve the new stations. All equipment for these locations will be specified to the new pan TfL arrangements as described above.

Improve signage to encourage passengers to use the L&E assets safely. The opportunity to provide passengers with service update information within the lift cars also will be pursued to enhance **customer service** whilst travelling throughout the station.

Reducing energy demand through use of more efficient equipment, use of regenerative braking as well as introducing off-peak escalator speed reduction and variable speed options as part of the escalator replacement programme to optimise asset operation according to required operation.

12.3 Contribution to Key Rail and Underground Priorities

L&E contributes to the continuous improvement in the **reliability and safety** of the network by aspiring to achieve a level of performance where, at any given time, 99.9% of the L&E assets are available for operational service. To achieve this, planned renewal and upgrade programmes are prioritised based on asset condition and criticality, to address any emerging concerns and to minimise the risk to safety and of service loss. In order to develop the area of prioritisation, a network-wide whole life cost model is currently under development for the L&E assets, to identify the optimal point for major periodic interventions and maintenance activities based on risk, condition, performance and cost. Our aim is to continuously improve and refine such models through progressively increasing levels of asset intelligence, e.g. degradation characteristics. This will enable us to manage our assets more cost effectively by avoiding unnecessary renewal works and optimising maintenance interventions.

This detailed knowledge of the assets will be obtained by regular inspection and the use of status and condition monitoring equipment, both hand-held and remote. This in turn will assist in detection of faults before they occur and help to develop a better understanding of degradation behaviour. From this, improved asset specific maintenance intervention cycles will be developed. These will be implemented dependent upon passenger flows and the criticality of each station (i.e. whether it is a key interchange station serving multiple lines).

Focussing on the root causes of any failures and a “right first time” maintenance approach is helping to eliminate repeat failures. However, as described above, London Underground is moving to a ‘predict and prevent’, rather than reactive, approach to maintenance, utilising a range of techniques, including condition monitoring.

A policy of standardisation of assets and components is being implemented over time to reduce the current proliferation of types. This will drive consistent and more effective maintenance regimes whilst also reducing the potential of obsolescence. TfL as a whole will continue with the policy to procure new equipment to a commercially off-the-shelf standard and hence provide the ability to maximise purchasing power through category management of L&E.

In the face of rising demand and to help manage crowding, LU needs to ensure maximum **capacity from the current network**. Maximising the availability of assets can be achieved by focussing on equipment reliability and reducing the number, frequency and duration of interventions, as well as reducing any disruptive access taken to manage these assets. This will be achieved by managing condition, standardisation of equipment and productivity improvements. Access for major work will be optimised by taking advantage of blockades and combining planned interventions with other work programmes, such as station works, across the network.

When major station or L&E project works are planned, there is an opportunity to further increase the capacity and accessibility at that station. Options include the replacement of fixed staircases with new inclined lifts or escalators. In addition, opportunities will be reviewed where cost effective and practical to do so, to install new SMVT lifts. Further capacity improvements opportunities will be considered as part of lift replacement and refurbishment works through reviewing improved lift cycles times, where practical and appropriate, to increase passenger throughput.

In the face of rising costs and environmental considerations, LU is committed to reducing energy demand. More efficient equipment will be specified such as the use of regenerative braking as well as introducing designs to include off-peak escalator speed reduction and variable speed options as part of the escalator replacement programme.

Capacity from growing the network - New and extensions to existing lines are planned as part of the future network upgrade. These include Crossrail, Northern Line Extension and Croxley Rail Link. This will bring a requirement to build new stations and to modify and improve existing ones. New lifts and escalators will be required to serve these stations. All equipment for these locations will be specified to the new TfL standard suite of products and make use of the category management approach. As part of this approach, all new assets will be procured under a performance based long term contract, covering the majority period of the asset lifecycle. These arrangements will be designed to offer an end-to-end service to design, manufacture, install and maintain assets to high levels of performance. The volumes offered collectively by TfL will ensure sufficient flexibility can be obtained to the mutual benefit of both supplier and TfL alike.

L&E assets contribute to the Underground's customer service offering by ensuring they are reliable, safe, clean, secure and accessible. In addition to opportunities brought about through major upgrade works, accessibility will continue to be enhanced with the introduction of new SMVT lifts as part of the on-going Step

Free Access (SFA) programme. A key contributor to delivering this is one of affordability; therefore alternative lower cost lift products (such as platform and incline lifts) will continue to be pursued which could be particularly advantageous at outer London stations.

Improvements to signage will be made where necessary to encourage passengers to use the L&E assets safely. The opportunity to provide passengers with service update information within the lift cars also will be pursued to enhance the passenger experience whilst travelling throughout the station.

The LU vision is to understand and become **'world class'** using benchmarked comparisons with national and international metros and industry peers to identify good practice, areas for **efficiency** and improved performance and knowledge. LU will continue to invest in its people to ensure that sufficiently skilled and capable staff are available in the right roles. They will be supported by the appropriate technology, to provide a modern, cost-efficient service in line with growing customer and stakeholder expectation and also business priorities

12.3.1 Approach

The strategy described above will be delivered through the continued improvement in performance and asset condition via the development of asset knowledge and asset management capability that will allow the progression towards a 'predict and prevent' approach to asset maintenance and for continuous improvement through the introduction of more cost effective and reliable assets in the future. This journey to achieve a world class L&E asset base is outlined in figure 44 below:

Figure 44: Lifts & Escalator Route Map

1. **Asset Condition Recovery** – the initial focus, in order to maintain assets on a whole life basis, is to ensure the condition of the assets is at kept at a steady state. Current levels of performance will be maintained through the implementation of a comprehensive planned maintenance regime. This is carried out alongside the planned intervention/refurbishment programmes which remove known condition concerns.
2. **Improve Performance –** Improvements to performance will be achieved through the implementation of asset specific maintenance to achieve optimum levels of availability and reliability.
3. **Introduce Standardisation** – the aim is to introduce new technology on time and to budget, minimising the disruption to customers, changing the

way we work to be more efficient and to get the most from the new equipment. This includes the introduction of standardised assets and components, which will reduce the complexity and number of bespoke variations of components and therefore reduce costs to maintain and replace.

4. **Predictive & Preventative Maintenance –** levels of asset performance and efficiencies will be optimised via the adoption of a ‘predict and prevent’ approach to maintenance. This entails moving from a reactive approach to maintenance once faults have occurred and moving to a preventative approach whereby faults can be predicted with the use of condition monitoring techniques. Faults will be prevented by tailoring the maintenance regime according to known trends, thus moving from time to condition or risk based maintenance. This will ensure money is being invested in the right place at the right time whilst providing high levels of performance and reliability. A number of trials have already taken place and when a positive business case is proven, the roll out of long term installations will commence.
5. **Continuous Improvement & Increase Capacity –** continuous research, development and benchmarking activities will be undertaken to exploit new technology and learn from others around the world. An assessment of the requirements for additional lift and escalator assets within stations to address the growing passenger demand and increase capacity for the travelling public will be undertaken. On existing assets and where feasible and cost effective, consideration will be given to increasing or varying the speed of operation.

12.4 Key Assumptions

The following are key assumptions that underpin the lift and escalator strategy, i.e. if they change, the strategy would have to change accordingly:

12.4.1 General

- The capital intervention programme and planned maintenance activities will ensure Lost Customer Hour (LCH) and Service Point (AS & FR) abatements are maintained at the lowest possible level.
- Once a lift or escalator has had a major refurbishment or been renewed, all components will be deemed to be in ACR physical condition ‘A’ and, where practicable, all functional concerns will have been removed.
- The existing movement of materials process will continue to be enforced and will be managed and controlled through licensing, training and supervision to prevent damage to the assets.
- The contractors in place will hold necessary lift and escalator spares as stock, required to achieve the performance obligations.
- Funding is maintained at the level defined and agreed as part of the 2013/14 spending review process.

- Removal of mitigations operating under a “case for safety” as far as practicable through the planned renewal programme.
- When replacing machines account will be taken of current and projected load growth (where reasonably practical) as part of the design and the evaluation of maintenance requirements, in line with projections of an escalator’s business criticality.
- The use of Pan TfL Contracts for the replacement or supply of new lifts and escalators.
- Where originally specified and required, the L&E assets will provide part of the emergency evacuation route for the station.

12.4.2 Lifts

- 40 and 20 year nominal design life for the PMVT and SMVT lifts respectively.
- Accord will continue to manage the JNP lift assets until contract expiry in 2018.
- Kone will continue to manage the BCV / SSL lifts assets either under the current maintenance arrangements until 2016 or following renewal, the Pan TfL contract until 2034.

12.4.3 Escalators

- Nominal design life of 40 years for all escalator assets (based on an whole life cost analysis over 40 years, lower life escalators may be considered where site conditions would allow replacement over a very short timescale, e.g. the escalators installed at Stratford).
- Kone will continue to manage the JNP JLE escalator fleet until contract expiry in 2018 and also the current BCV / SSL machines until their replacement under the Pan TfL contract.
- Following installation or renewal under the Pan TfL contract, the escalators will be maintained by Otis until 2042.
- The internal capability will be retained (DLO / TLES) to provide specialist technical delivery required for the maintenance of legacy ‘bespoke’ assets (BCV / SSL and JNP non-JLE fleets). In addition to provide a competitive benchmark to the external market supply.
- The Otis 520 HD Metro type ‘standard product’ designs will prove reliable and a cost effective whole life cost solution in LU operation as they already are in numerous other metro applications world-wide.

12.5 Asset Objectives

The assumptions outlined above are in support of delivering the L&E assets to the required function and level of performance at an optimal whole life cost and without compromising health, safety, environmental performance or the organisations' reputation. The asset group objectives are summarised in the following table.

Table 7: L&E Objectives & Targets

Asset Management Objective	Asset Management Targets
Deliver a safe and compliant railway	- Continually improve our approach to safety and meet statutory requirements - Implement an assurance regime and conduct regular audits to identify areas of non-conformance and implement changes where appropriate - Manage asset risk in accordance with standards and maintain risks ALARP by using the Asset Risk Model (ARM) process - Standardisation of European Norms to improve economies of scale and obsolescence - Support LU's design policies and aspirations to achieve "world class" (i.e. reputation) - Maintain our status as a competent body, through recognised training and competency based programmes
Manage the assets to deliver the required performance improvements	**Availability – LCH** - Lost Customer Hours (LCH) are incurred when a Lift or Escalator failure results in the asset being removed from service. The L&E assets are assigned a maximum LCH target each year. LCH abatements are the main financial driver for ensuring that faults are minimised and that fault response is conducted expediently - Aspirational availability targets to be set for each asset type - The adoption of more efficient and effective maintenance techniques to support the move to a predict and prevent maintenance regime - Strategic alignment of key suppliers to ensure the availability and timely provision of critical spares - Utilise cross-asset access synergies where possible to ensure minimal passenger disruption when an asset is removed from service for planned works **MTBF & Service Points – Thresholds** - Escalators can attract Fault Rectification (FR) service points. Lift faults can result in both Asset Systems (AS) and FR service points and failure of a lift asset is dealt with as rapidly as possible - Component replacement & reliability improvement growth plan programmes to improve MTBF, reducing failures and therefore Service Points - Regular monitoring of faults, carrying out trend and root cause analysis **Ambience** - Ensure that Ambience is sustained at appropriate levels, incorporating monitoring and auditing to identify areas for continuous improvement
Manage the assets to deliver the required condition improvements	**Reasonable Life** - Implementation of the refurbishment / replacement programme to ensure that all assets are managed to an overall state of good condition

Asset Management Objective	Asset Management Targets
	Residual Life - Undertake targeted work programmes to improve the residual life of components and to ensure that steady state is achieved
Improve Asset Management Capability	- Contribute towards integrated ISO 55000 certification by May 2014 and maintain thereafter - Participate in Asset Management benchmarking with Network Rail, international Metros and other Utility companies to deploy good industry practice and ensure unit rates are reduced to industry leading levels. - Continually improve the quality of asset information (including asset register, work management, root cause of failure and cost to fix) via the Ellipse/Maximo upgrades and information improvement programme - Embed asset risk management - Deploy innovative ideas to reduce whole life costs or improve performance or productivity
Adopt and demonstrate an efficient and economic whole-life cost asset management approach	- Good understanding and optimisation of current asset condition, performance, risk and cost via the use of whole life cost models - Use of benchmarking and decision support tools to establish optimal maintenance and life extension intervals - Optimisation of maintenance techniques in line with Good Industry Practice (e.g. risk based maintenance, condition based, reliability centred maintenance, etc.)
Deliver increased capacity to meet future demand and service requirements	- Ensure assessments are carried out regarding the need to install additional lift or escalator assets to increase station capacity. - Enhance accessibility with the introduction of new SMVT lifts as part of the on-going Step Free Access (SFA) programme. - Assess options to vary the asset speed and / or cycle times to support increasing passenger throughput.
Ensure assets support delivery of LU's environmental obligations	- Meet statutory requirements - Achieve an internal target of zero environmental harm incidents, measured through the Balanced Score Card (BSC) - Undertake carbon and energy impact assessments for all renewal projects and install modern, energy efficient products to reduce the energy consumption required to operate all L&E equipment. - Introduce energy efficient LED lighting where appropriate - Minimise environmental impacts and demands at all stages of the lifecycle (i.e. energy, noise, vibration, unpleasant odours).

12.6 Asset Strategy

From component life span studies and historical knowledge of component lives, a series of optimal timings and interventions for components prior to failure have been developed, to reduce cost and risk for each asset and taking into consideration the commercial implications and asset availability requirements. The focus on replacing components before they are life expired, combined with appropriate asset maintenance, will maintain assets with good reasonable life expectancy thereafter. Interventions are staggered to deliver a smooth programme and to avoid any resource constraints.

(Table 8)

Maintenance Area	Maintenance Strategy
General	The purpose of the current planned preventative maintenance (PPM) and corrective maintenance activities is to ensure that lifts and escalators: • are safe; • achieve the highest levels of availability, aspiring to achieve 99.9% availability; • operate reliably until the next capital intervention; and • component life is optimised. In order to achieve this, maintenance activities include: • **Inspection** – to assure compliance with statutory requirements and Category 1 standards. • **Condition assessment** – to record asset condition at component level so interventions can be tailored to suit actual asset condition and to demonstrate contract compliance. • **Planned maintenance** – routine planned preventive maintenance, such as lubrication. The scope and frequency of each visit is based upon original manufacturers' recommendations, and modified over time to take account of performance feedback and potential to move to a more risk based approach. • **Cleaning** – to ensure that fire safety compliance is achieved. • **Additional Inspection** – Components that are of non-compliant design or degraded condition will be subject to additional maintenance and mitigation inspections until the component can be replaced during a Capex intervention or as a separate maintenance activity. • **Corrective & Reactive maintenance** – carried out in response to either defects found during inspection, servicing, or due to in-service failure. All faults reported are reviewed to monitor any emerging trends, so that the scope, frequency of planned servicing, inspection can be adjusted if necessary. • **Rapid Response** – first line call-out teams to respond to in-service failures and where possible achieve a return to service at the first visit. The maintenance regime is designed to ensure that the assets remain in service until the next planned capital intervention, with a continued focus on reducing operating costs The frequency of the lift and escalator maintenance regimes have been developed and optimised over time via the continuous review of service performance, monitoring of component condition and implementation of good industry practice. Enhanced maintenance regimes will be implemented based on performance and condition concerns which will be eliminated through the planned intervention programme. Standards will be reviewed where improving the effectiveness of activities conflicts with a standard and there are no adverse safety implications. The main focus of this review is to reduce the use of bespoke equipment by looking at machines as a whole to determine where industry standard machines can be installed in line with European Standards EN115 (escalators) and EN81 (lifts). The long term strategy for the maintenance of the L&E assets is to move to a

Maintenance Area	Maintenance Strategy
	‘predict and prevent’ approach. This entails moving from a reactive approach to maintenance and moving to a predictive approach whereby faults can be predicted with the use of condition monitoring techniques. Faults will be prevented and performance improved by tailoring the maintenance according to known trends, supporting the move from time to condition / risk based maintenance.
Condition Monitoring Strategy	Moving to a predictive and preventative approach to L&E maintenance requires the use of various techniques to monitor the condition of the asset components. The implementation of asset condition monitoring will have significant benefits, including the ability to: • predict when failures are likely to occur • tailor the maintenance regime to ensure the assets remain in service • reduce the number of inspections / maintenance visits required • increase level of asset knowledge and information; and • ultimately reduce cost. Some examples of current condition monitoring initiatives include: **PLC controller event logging** – identifies the last 100 faults on the controller to quickly identify the root cause of failures; **SMART Step** – used when concerns regarding escalator alignment and step cracking are raised. Going forward the SMART Step will be fitted to all escalators after refurbishment where it will initially take a base reading and then linked to remote condition monitoring equipment to monitor the status of the steps and chain. **Remote Condition Monitoring** – following trials remote condition monitoring is being used more widely and will provide data for root cause analysis and ultimately reduce the number of technician visits. The technology used in remote condition monitoring systems has improved significantly over the past few years, which can provide accurate, reliable and timely information from the asset location to the user. Following successful trials, the long term installation of remote condition monitoring equipment will be pursued where a positive business case can be quantified and demonstrated, and may only be required at selected locations as opposed to a blanket approach. Existing systems such as the Stations SCADA system will be assessed to determine whether it can be used to support future installations. Any equipment installed will be fully integrated into the maintenance regime to ensure data is monitored regularly and necessary action is taken in a timely manner and the project will develop a set of IT tools for the business to manage and respond to information from condition monitoring systems. Data will be accessible remotely and equipment installed will be ‘off the shelf’, rather than bespoke, where possible. ***A number of remote condition monitoring methods are already in place at selected locations, examples of which include:*** • Lift pump room temperature monitoring • Lift door movement monitoring • Escalator gearbox monitoring ***LU will continue to monitor potential changes to technology and approaches that are taken across the lift and escalator supply chain as well as other Metros.***

Maintenance Area	Maintenance Strategy
Escalator Maintenance Strategy	LU standards contain mandatory maintenance activities and frequencies such as: • annual non-destructive testing of escalator steps; • heavy cleaning of escalator – minimum six-monthly; • dust tray cleaning – risk based; and • inspection – thorough independent six-monthly statutory inspections. When escalators are either replaced or refurbished, they are upgraded to meet current Category 1 Standards. This includes the installation of additional safety switches such as comb-plate switches and handrail entry switches. These safety features detect abnormal or unsafe operation (such as impact from a heavy suitcase) and protect both the user and the equipment by shutting down the escalator in such circumstances. Work is also being undertaken with LU COO Operations to ensure escalators are operated in both directions in order to maintain reversibility and meet the as installed passenger / materials handling capability. This will enhance operational flexibility and as an enabler to the implementation of escalators maintenance using L&E extended closure without undue disruption to customer services. **Maintenance following Pan TfL replacement** The routine maintenance regimes required for assets following replacement by the standard product specification under the Pan TfL contracts will follow suppliers' recommendations, based on their experience of world-wide metro practice, but also consistent with revised LU requirements and working practices following the efficiency initiatives and LEAN analysis.
Lift Maintenance Strategy	LU will continue to use a component based renewals approach supported by preventative and corrective maintenance activities and mandatory and supplementary quality inspection. The LU standards dictate mandatory maintenance activities where the frequency of the activity is also input specified, which includes: • annual condition assessments; and • heavy cleaning of lifts (minimum frequency 6 monthly). In addition, independent 6-monthly statutory inspections are dictated by HS&E statutory requirements. The scope and frequency of non-standards driven routine maintenance, such as lubrication and servicing attention have been developed based upon original manufacturer's recommendations and optimised over time through review of service performance. The key areas of scope are: • inspection; • planned preventative maintenance; and • reactive maintenance.
Spares & Obsolescence Management	LU takes a proactive approach in terms of managing obsolescence through spares management, with any issues generally identified prior to impacting asset availability. The major refurbishment and renewal programmes will be used to replace components with modern equivalent or enhanced components, where possible. If it is required to replace an obsolete part, where no modern equivalent can be sourced and where detailed drawings and specifications are not available, then

Maintenance Area	Maintenance Strategy
	the design for manufacture of the necessary components will be re-engineered or the whole component will be replaced. A strategy of procuring all such items up to 12 months prior to start on site has been established to minimise risks associated with delays to programme due to long lead items. In parallel, the procurement and storage of these items will provide LU with the ability to utilise them in an emergency where a long lead item is required to address an unplanned failure across our fleet there by reducing the escalator down time.
Chief Operating Officer (COO) Asset Performance Structure	The COO directorate is split into three delivery units, each with a Director who has responsibility for the assets within each line grouping: • BCV; • SSL; • JNP. Under each Director, the Asset Performance Manager will deliver L&E maintenance work.

12.7 Projects Delivery Strategy

The capital intervention programmes will be optimised and prioritised on an annual basis with the use of the L&E decision support tools, taking into consideration asset risk, performance, condition and resource constraints.

Once the year's annual work bank is agreed the intervention scope is initially determined by the nominal service life of the components and further supported by pre-intervention condition surveys and assessments. Major interventions are also tailored to ensure long term Asset Condition Reporting (ACR) concerns are removed to deliver reasonable life expectancy. The site surveys and assessments will dictate the scope required and ensures money is being spent on the right assets at the right time. Work with the external contractors and internal resource will continue to move from a time to a condition / location based strategy.

For the pan TfL contracts, an intervention programme is in place and will be reviewed and updated based on failure or RAM model analysis validated by the residual life models in place.

Detailed feasibility design and scoping of the more significant project interventions will be performed by the CPD , including direction and input as required by the specialist L&E professional engineers . Close liaison will be maintained with the relevant delivery suppliers and maintainers.

12.7.1 Future Optimisation

In the long term, it is intended to develop a network wide strategy for the delivery of lifts and escalator projects. New technology will be introduced during project work where appropriate as well as standardised assets and components. This will contribute to the reduction of energy consumption and obsolescence and also reduce the current proliferation of types to drive consistent and more effective maintenance regimes. Ultimately this will support the continuous quest to drive down costs of both project and maintenance work.

12.7.2 Accessibility and Capacity

When a location needing major project work is identified, an assessment of the requirements for additional lift or escalator assets within stations will be carried out. This may include the installation of new assets to support the requirements of Step Free Access (SFA) or the replacement of fixed stairways with new escalators or vehicular lifts. This will address the growing passenger demand and increase capacity for the travelling public.

Further capacity improvements opportunities will also be considered as part of lift replacement and refurbishment works. This will involve the review of lift cycle times and dependant on station layout may provide the option to increase speeds and therefore passenger throughput.

12.7.3 Escalator Project Delivery Strategy (Table 9)

<table>
<tr><th>Asset Area</th><th>Escalator Capital Works Strategy</th></tr>
<tr><td>JNP
JLE Escalators</td><td>The current component based intervention cycle for the JLE fleet is broadly based around a five yearly intervention cycle over the 40 year design life comprising of three intervention types, Modules 1, 2 & 3. The JLE cycle and scope summary is as follows and will be confirmed upon condition survey report:

JLE Intervention Cycle
<table>
<tr><th>Year</th><th>Intervention Type</th><th>Scope Summary</th></tr>
<tr><td>5</td><td>Module 1</td><td>Aimed at inspecting / replacing components such as handrails and carriage rollers, as well as major shaft lubrication.</td></tr>
<tr><td>10</td><td>Module 2</td><td>Module 1 scope, plus other key items subject to inspection, such as brakes, bearings and renewal of the step chain.</td></tr>
<tr><td>15</td><td>Module 1</td><td>See above.</td></tr>
<tr><td>20</td><td>Module 3</td><td>Module 1 & 2 scopes, plus other key items subject to inspection, such as tracking, steps, controller and gearbox.</td></tr>
</table></td></tr>
</table>

JNP

Non-JLE & BCV / SSL Legacy Escalators

The current strategy for these assets is broadly based on a seven yearly intervention cycle and the 40 year design life, comprising of three intervention types, Module A, B & C. The intervention cycle and scope summaries are outlined below and will be confirmed upon condition survey report:

Non-JLE & BCV / SSL Legacy Intervention Cycle

Year	Intervention Type	Scope Summary
7	Module A	Primarily a maintenance intervention which replaces consumables such as handrails, chain wheels and other consumable items. This is delivered by the AP directorate.
14	Module B	Module A scope, plus other key items subject to inspection, such as steps, drive chains, drive shaft bearings and brakes.
21	Module A	See above.
28	Module C	Module A and B scopes, steps and step chains as well as the replacement of electrical components, such as safety switches, controller, machine guarding and panels subject to inspection.

Conversion of those escalators still fed by DC power supplies to AC will be combined with either major refurbishment or step chain replacement work to ensure that all escalators are converted ahead of the Line Upgrade key milestones.

Pan TfL Otis Replacement Escalators

The new (HD Metro) specification will enable the replacement over time of the legacy fleets to prioritise and address performance and condition concerns and also provide standardisation to a very small number of different designs rather than the current proliferation of different designs.

The intervention strategy for escalators replaced under the new standard product-based specification is as follows on a seven yearly basis:

Pan TfL Escalator Intervention Cycle

Year	Intervention Type	Scope Summary
7	Module 1	Aimed at inspecting / replacing components such as lower curve and landing chain guides, handrails, handrail guide sweeps, step and chain wheels, catenary and carriage rollers, carriage alignment as well as major shaft lubrication, overhaul of the lubricator and check of the gearbox oil. Calibration of over / under speed governor and 5 year PPM.
14	Module 2	Module 1 scope, plus other key items subject to inspection such as brakes, bearings and auxiliary drive chains. Renewal of the step chain and inverter. Weight test.
21	Module 1	See above.
28	Module 3	Module 1 & 2 scopes plus other key items subject to inspection such as tracking, carriage and top and idler shafts. Renewal of top and idler shaft bearings, chain guides,

			steps, auxiliary chain sprockets, balustrade and skirt brushes, motor, controller, circuit breaker and field wiring.
	These planned interventions and their scope will be subject to regular review and updated as new asset intelligence is known and new knowledge available through the supply chain and other Metros.		

12.7.4 Lift Project Delivery Strategy (Table 10)

Asset Area	Lift Capital Works Strategy
General	Delivering the outlined strategy for PMVT and SMVT lift renewals will bring the lift assets into an overall good condition by reducing or removing all remaining ACR Code 3 and 4 functional concerns and bringing the physical condition to ACR Code A-C by 2025. The lift intervention programme is based on a five year cyclical intervention schedule combining planned major refurbishments, replacement, and module A and B interventions. The modular cycles and scope summaries are outlined below.
BCV/JNP/SSL **Existing PMVT & SMVT Lifts**	Although delivered by different contractors, the PMVT and SMVT lift intervention sequences and scopes for existing asset are broadly the same across BCV, JNP and SSL assets and will be confirmed upon condition survey report:

PMVT Lift Intervention Cycle

Year	Intervention Type	Scope Summary
5	Module A	Replacement of components such as V sheave and main ropes.
10	Module B	Module A, plus replacement / refurbishment of key components, i.e. Electrical components subject to test and report.
15	Module A	See above.
20	Major	All major components of the lift either replaced or overhauled, subject to testing and reporting.

SMVT Lift Intervention Cycle

Year	Intervention Type	Scope Summary
5	Module B (JNP) Module A (BCV/SSL)	Replacement / refurbishment of key components, i.e. Electrical components subject to test and report.
10	Major	All major components of the lift either replaced or overhauled, subject to testing and reporting.
15	Module B	See above.
20	Replacement	Complete replacement of asset.

<table>
<tr><td rowspan="1">BCV / SSL

SMVT Lifts under Pan TfL Contract</td><td>Existing hydraulic SMVT lifts will be replaced at their end of life or earlier where cost effective to do so with energy efficient “machine room less” (MRL) traction lifts. The following intervention cycle will be carried out on the BCV and SSL assets which come under the Pan TfL contract.

Pan TfL Lift Intervention Cycle

<table>
<tr><th>Year</th><th>Intervention Type</th><th>Scope Summary</th></tr>
<tr><td>3.75</td><td>Type 1 (Minor)</td><td>Replace batteries, UPS system / Com plus, etc.</td></tr>
<tr><td>7.5</td><td>Type 2 (Interim)</td><td>Type 1 scope plus replace car and counterweight shoes, re-rope hoisting and over-speed governor ropes, replace travelling flexes;
Car door operator – replace belts, air chord hanging rollers, skates, car gate contacts and door shoes;
Landing door – replace air chord, hanging rollers and door shoes (per landing entrance), replace lock contacts, pick up rollers, etc. (per landing entrance);
Replace VVVF inverters in the controllers.</td></tr>
<tr><td>11.25 (may vary depending on asset condition)</td><td>Type 1a (Minor)</td><td>Replace batteries, UPS system / Com plus, etc.</td></tr>
<tr><td>15</td><td>Type 3 (Major overhaul)</td><td>All major components of the lift either replaced or overhauled, subject to testing and reporting.</td></tr>
</table>
</td></tr>
</table>

12.7.5 Projects Delivery Structure

Work packages detailed in the Asset Plan will continue to be managed through CPD. The Head of Station Upgrades leads the delivery of the L&E replacement and refurbishment project work and, under his umbrella, the various managers ensure that these works are carried out according to the L&E intervention programme and within budgetary constraints.

Supply Chain (Table 11)

Area	Lift and Escalator Supply Chain Strategy
JNP Lifts	Since September 2011, JNP has had a whole life asset management contract in place with Accord for the maintenance of the lift assets until 2018. This includes the refurbishment and maintenance of all 111 lift assets (32 PMVT lifts and 79 SMVT lifts). The total contract duration is 6.5 years with the option to extend to 15, bringing the contract to an end at the end of 2018. Accord will have long term responsibility for a committed schedule of works, to encourage innovation and efficiencies throughout the lifespan of the contract.
BCV / SSL	The maintenance and capital works for the BCV and SSL lift assets are delivered

Area	Lift and Escalator Supply Chain Strategy
Lifts	utilising a combination of external and internal resources. All PMVT lift assets (with the exception of four lifts at Bank) are currently maintained under a three year agreement with Kone, until the point of replacement under the Pan TfL contract. In August 2012 the Pan TfL contract for the lift assets was awarded to Kone following a competitive tender process. The aim of the contract is to achieve supply chain stability, a reduction in unit maintenance and capital costs and a reliable energy efficient product for the Underground. The contract is based on a 22 year duration and includes: • Replacement of two SMVT lifts at Hammersmith; • Installation of 49 new machines for Crossrail, plus additional lifts installed as part of other TfL programmes such as two new lifts for the Walbrook Square development at Bank; and • Whole life asset maintenance thereafter. The machines will be largely based on the supplier's industry standard product. The contract duration was deemed the most economic and efficient and will provide sufficient time to carry out the first of the half-life major refurbishments from the point of installation. Following on from the initial contract award, it is intended to incorporate the replacement of a further 15 PMVT lifts as part of the existing Pan TfL contract with Kone. The remainder of the lift assets are currently maintained by the LU DLO.
JNP Escalators	JNP utilise a combination of internal and external resources through to the end of 2018 for the supply of escalator maintenance and refurbishments, in order to deliver the capital investment programme and performance obligations: • **Non-JLE Fleet (118 escalators) -** JNP's own direct labour organisation (Tube Lines Escalator Services - TLES) will undertake the escalator refurbishment and routine maintenance works. • **JLE Fleet (113 escalators) -** A whole life asset management contract is in place with external contractor Kone to maintain the JLE fleet, including all escalator replacement, refurbishment and maintenance works. The utilisation of Kone and TLES resources has supply chain advantages in that it provides direct access to the design skills of Kone as a major global escalator manufacturer and TLES who have a well-established supply chain in respect of the supply of bespoke replacement components. The mixture of internal and external contractor mix reduces risk exposure and dependency upon one contractor and develops internal knowledge and experts to ensure that optimum results from external contractors are pursued.
BCV / SSL Escalators	The maintenance and capital works for the BCV and SSL escalator assets are delivered utilising a combination of external and internal resources as follows: Following a process of joint dialogue between the contractors, Crossrail and LU, the Pan TfL contract for escalators was awarded in 2012 to Otis for 30 years. The contract includes: • Replacement of 46 BCV / SSL escalators • Installation of 57 Crossrail machines, plus additional escalators installed as part of other TfL programmes such as four new escalators for the Walbrook Square development at Bank; and

Area	Lift and Escalator Supply Chain Strategy
	• Whole life asset maintenance thereafter. The technical dialogue focused on understanding the differences between 'standard' HD Metro type offerings and the Cat 1 Standard. This work stream culminated in the production of a revised escalator replacement specification largely consistent with escalator industry standard products. Except for a small number of machines currently maintained under a short term contract with Kone, the remainder of the legacy BCV and SSL escalator assets are maintained and refurbished by the internal DLO. This has the advantage of retaining resource capability and knowledge in respect of the legacy HD fleet that is scarce in the external market and which supports an operationally critical asset. It also enables competition in delivery with the external market and some measure of fall back should an external supplier fail.
Major Component Supply	The internal labour organisations utilise a number of key suppliers to procure lift and escalator components. These are critical to the supply chain in order to maintain the lift and escalator assets, particular where supply is limited or where a component is single sourced. For example: • Barwit – manufacture of lift and escalator control systems • MDS – manufacture of legacy escalator steps If this supply chain is affected there may be a detrimental impact upon asset performance leaving assets out of service for prolonged periods.
Future Supply Chain	LU will continue to strive for the most economic and efficient strategy to deliver its' L&E maintenance and capital works objectives across the organisation. This will include continuous review of both the internal and external resources in place, particularly in 2018 when the external JNP contracts will be up for renegotiation. LU will assess the appropriateness of full or part integration of the internal resources which could result in shared on-call staff. Efficiencies will also be achieved when ordering in greater volumes. There is also an opportunity arising in 2018 to carry out another tender for the second tranche of assets to be incorporated into a Pan TfL contract for lifts and escalators. **A review of the current Pan TfL specifications will take place with the aim of achieving a common network-wide agreement that will contribute to the delivery of a common commercial / procurement strategy for L&E going forward.** The introduction of the 62 new L&E assets to be installed by Schindler as part of the station upgrade and Crossrail works at Canary Wharf, Tottenham Court Road and Victoria prompts another contract review. The contract for the on-going maintenance of these assets has not yet been awarded and will require a whole life cost analysis to be carried out in order to determine the preferred contractor. These could include Schindler, Otis, Kone and the direct labour organisations. In the longer term, the supply chain strategy is to have a limited number of contracts in place (including design, build, install, maintain and refurbish elements) with external contractors to deliver performance based whole life asset management over the life of the machines. These will be supported by an appropriate level of internal resource to ensure the specific knowledge and expertise around legacy assets is retained ensuring the older, more bespoke machines remain in operational service.

12.8 Access Strategy

- The requirements of the access code are adhered to when obtaining access to the LU network for work on L&E assets in order to facilitate a safe, orderly and equitable system.
- The current access strategy is based on actual available time at work sites, i.e. no frustrated access.
- L&E maintenance and inspections will be re-scheduled where possible to support the introduction of 24 hour running of the railway over the weekend However; this may not be required at locations with asset redundancy where not all machines would be required to operate during this time of extended running.
- L&E closure meetings are held fortnightly to seek agreement on the location and duration of each intervention that requires the asset to be removed from service or the route way or station to be closed. The 'Network L&E Planned Works' spread sheet is distributed to relevant parties as an output of this meeting.
- Reasonable LCH attribution to undertake the appropriate scope of works with the shortest duration (for example, if a planned escalator bank closure were undertaken, LCH would be calculated at a cost of a single escalator rather than the cost of a bank closure/major closure). Possible escalator bank or lift station closures would be subject to agreement with LU Operations and Events & Closures departments.
- Planned maintenance activities that are usually carried out during engineering hours will continue to be managed in this way. Where appropriate interventions will be carried out using a combination of engineering hours, fixed stairways and full asset closure with hoardings. This ensures the most economic use of the LCH closure allowance and minimises disruption to the travelling public and operational railway.
- Access will be modelled by machine, shaft and station to assess the optimum closure opportunities and to reconcile these with any opportunities and constraints of condition, performance, operation and cost.
- Reviewing the opportunity to carry out planned maintenance and component replacement during major renewal programmes (Stations, Line Upgrades, etc.);
- Utilising industry standard equipment that will reduce installation time and introduce significant maintainability benefits and thus reduce the duration of planned closures over the asset life;
- Agreement with COO Operations for L&E Extended Closures to achieve more effective maintenance and thus reduce closure periods. Annual plans for L&E Extended Closures, setting out the requirements for each escalator / site, are submitted by AP BCV, JNP and SSL for review and endorsement. The move towards extended engineering hours and where possible carrying out maintenance during traffic hours provides better

utilisation of resource and hence reduces unnecessary waste. The intention is to enhance operational flexibility where possible.

Asset Type	Intervention Type	Closure Strategy
Escalators	Planned Maintenance Activity	During timetabled engineering hours / L&E Extended Closures
	Minor intervention (i.e. Module A)	Fixed stair case with / without tank end hoardings at certain locations
	Intermediate intervention (i.e. Module B)	Single asset closure with hoardings (asset will be out of service)
	Major Refurbishment / Replacement	Single asset / escalator bank closure with hoardings (asset will be out of service) Major closure where major Civils works required (i.e. replacement of LHDM machines)
Lifts	Planned Maintenance Activity	During timetabled engineering hours / L&E Extended Closures
	Minor intervention (i.e. Module A)	Single asset closure with hoardings (asset will be out of service)
	Intermediate intervention (i.e. Module B) / Major Refurbishment / Replacement	**PMVT Lifts:** Single asset / lift shaft closure with hoardings (asset will be out of service) / Full station closure where appropriate **SMVT Lifts**: Single asset closure with hoardings (asset will be out of service). However, these closures will not incur LCH's as NACH's values only apply to PMVT lift assets.

Table 12: Intervention Closure Strategy

12.9 Energy & Environmental Sustainability

The L&E maintenance teams conduct internal audits against an agreed schedule. Maintenance also has process and controls in place to address hazardous materials such as asbestos containing materials, mercury, cadmium and other heavy metals. Licensed contractors are engaged to dispose of these materials in accordance with relevant legislation. Regular audits are conducted to ensure that compliance is maintained.

LU's energy and sustainability strategy comprises three themes:

- Developing a better understanding of the energy and sustainability impact of the existing assets;
- Improving the energy and environmental performance of the existing assets;
- Understanding the energy and environmental impacts of future changes to the railway.

For L&E assets these themes are supported by the following activities:

- All future lift installations will utilise new energy efficient drive and control systems, LED lighting, etc. These new technologies are 50% more energy efficient than existing system, hence reducing energy costs and improving the carbon foot print.

- Switching off some escalators during off peak times as an energy saving measure, wherever any redundancy of provision allows this to be done without undue customer disruption;

- New escalators will utilise inverter based drive systems allowing regenerated power to be fed back into the supply network. Timed off-peak speed reductions will also be enabled on future replacement projects;

- All future investment proposals will include a Climate Change and Carbon Reduction assessment (utilising the latest Pathway template);

- Energy assessment and certification of assets;

- Our compliance to relevant legislation and codes of best practice is regularly assessed using internal and external audits, as well as Planned General Inspections.

12.10 Asset Management Capability & Development

The following sections describe how the opportunities to improve the asset strategy and how LU's asset management capability can be developed further to optimise the whole life asset management of the lift and escalator assets.

12.10.1 Continuous Improvement

The L&E delivery teams are committed to identifying and implementing improvements that are consistent with Good Industry Practice (GIP) on the basis that such improvements ensure that the assets are managed as economically and efficiently as possible and will be introduced through training, research and interaction within LU and other Metros. Specifically:

- Implementation of visualisation and 'Balanced Scorecard' system for comprehensive performance measurement at all levels in the organisation;

- Reviewing the LU Category 1 Standard requirements that are above and beyond those specified in the European EN115 (escalators) and EN81 (lifts) standards. Optimising the use of the European standards will align working practices, inspection frequencies and design/material standards to bring commonality within the L&E industry in general and would increase the use of Industry Standard (IS) products across the network;
- Implementation of a predict and prevent approach to maintenance;
- Reviewing lessons learnt to enhance the process to completely encompass engineering.
- Competitive tendering to provide the most economic and efficient whole life cost strategy from the external market;
- Applying LEAN Six Sigma methodologies to streamline and improve processes;
- Acting on audits and corrective actions;
- Review and consolidation of processes and systems, including the use of the Asset Management systems, Maximo and Ellipse.

12.10.2 Technology, Research and Innovation

Governance arrangements are in place for Research and Development (R&D) work to ensure that:

- The work proposed is aligned to meet business and L&E strategy development priorities.
- Research / innovation proposals follow a format which ensures that a business case is in place, the relevant stakeholders support the study and that the owner would be prepared to integrate implementation of the research within future plans and resources if the outcome of the work delivers the anticipated opportunity.
- The efficiency savings tracking process will be used, where appropriate, for initiatives aimed at reducing maintenance interventions and/or costs.

Research, development and innovation initiatives are shared across the business for mutual benefit and that respective plans to undertake work are co-ordinated to avoid duplication. There is a dedicated Innovation team who support the process throughout the business and the following list represents some of the innovation initiatives which are currently being pursued:

- Escalator comb plate and balustrade LED lighting;
- Escalator traffic light system to indicate direction of travel;
- Escalator key clamp barriers, as opposed to more expensive scaffold equipment;
- Platform for escalator machine room chamber to allow staff to work on the incline;

- Use of more widely available and cheaper hydraulic lift oil;
- Installation of funicular lift on stairways to provide step free access;
- Lift rope tension monitoring device to keep the equal tension in all ropes;
  - LED lighting in lift shafts and other locations which are difficult to access for maintenance or bulb replacement; and
  - Metal spraying (additive layer) on shafts to extend asset life in L&E.

12.10.3 Whole Life Cost Model Development

Investment planning is prioritised in terms of safety, condition and compliance, performance (availability and reliability) and cost to maintain. Maintenance, work is prioritised (within the plan/budget) resulting from inspections to manage safety, compliance with applicable legislation and standards, condition based risk, performance and increased operational costs.

Priorities can change during the annual TfL planning round to reflect the Mayor's objectives. In addition, plans have to adapt to meet any change to the performance targets which are agreed with TfL annually and detailed in the Asset Plan and reflected during the quarterly financial forecasting process.

This investment prioritisation is currently supported by the use of decision support. Two whole life cost models (one lift and one escalator) are now being developed which will incorporate all BCV, JNP and SSL assets. This will enable various strategic scenarios to be applied in terms of delivering the optimum of level and scope of capital works and/or maintenance carried out on all or selected assets in order to achieve the required level of performance within given cost constraints.

12.10.4 Benchmarking & Efficiency

LU is committed to understanding practices that deliver cost efficiencies and high performance levels, and to identify the opportunities to learn from others, both internally and externally. Benchmarking activities are intended to assist LU to understand the performance of their businesses for the L&E asset area, highlighting areas for performance improvement. Benchmarking will also provide valuable information on cost drivers to provide a useful input to better whole life asset management decision making and continuous improvement.

As detailed in the *'Tube Asset Performance Benchmarking Report, Phase 8, June 2013'*, past studies have concluded:

- The reliability of L&E in LU are broadly comparable with the other Metros, however when incidents do occur they are resolved far more swiftly in London.
- Escalator reliability has improved by 24 per cent since 2008/09.

- International comparators have been identified through the 2009 CoMET Escalator Asset Management benchmarking study which looked at escalator costs of other Metros. Following completion of the study TfL revised its escalator strategy and introduced a more industry standard escalator specification, which is now represented by the Pan TfL escalator contract with Otis.
- The 2012 international lift study found that almost all Metros outsource maintenance of its lifts. Only two Metros retain an in-house direct labour organisation, one of which is BCV/SSL.

1. Going forward the Benchmarking team will be looking at the following studies which will incorporate the L&E asset area: Mechanised Maintenance;
2. Asset Information;
3. Predict and Prevent (Remote Monitoring);
4. Service Reliability.

The Joint Benchmarking of maintenance costs between BCV, JNP and SSL will continue to be undertaken, with a specific focus on the impact and productivity improvements achieved following the reviews of maintenance frequencies and changes in working practices being implemented. Benchmarking will continue to be conducted with other external Metros and UK national rail environment to identify good practice and gain knowledge from others.

12.11 Strategic Risks and Opportunities

The following section outlines the key high level risks and opportunities associated with the implementation of the lift and escalator asset strategy.

12.11.1 Strategic Risks

Currently there are two different processes being used for the management of strategic risks across the network:

- In accordance with the JNP Risk Management procedure P-345-A3, the L&E Active Risk Management (ARM) model captures, quantifies and ranks the risks and relevant consequences relating to Lift and Escalator assets. This model is reviewed and updated on a quarterly basis and fed back into the decision making process in relation to asset improvement to reduce risks.
- For BCV and SSL, a formal and centralised process of registering risk and risk mitigation options with feedback on effectiveness is currently being developed for each of the asset groups. This process will provide a clear link between maintenance, cost and methods to manage. Risk management will be undertaken in accordance with the Asset Risk Standard 5-044.
- The two approaches will be aligned to provide one centralised process for managing strategic risk across the network.

Strategic Risk Management

The risks below are the core risks that drive the strategy, rather than specific asset risks which are captured in the Active Risk Management (ARM) model. The commercial and strategic risks captured in ARM are regularly reviewed and updated with input of key stakeholders and assigned a commercial risk value. The top commercial risks faced by the L&E programme have been identified and mitigation plans developed and implemented. LU's strategy is to manage all risks to ALARP.

Table 14: Summary of Strategic Risks

Description	Impact	Mitigation
Obsolescence	Unable to support unexpected failures and could result in lift or escalator being removed from service. This risk is particularly high on the legacy fleets, i.e. LHD-M escalators and PMVT lifts.	Due to the quantity of components that are deemed obsolete, obsolescence issues are generally identified prior to causing an impact on L&E availability and managed locally through in-house design teams, but there is a risk that they will be identified too late to prevent such impact. In the long term, replacement and standardisation of machines will eliminate this risk.
Asset Condition	Asset performance and safety risk. Potential for non-compliance to standards. Increased faults and need for mitigation regimes/restrictions.	Formal inspections are carried out to identify any risks which are then assessed for likelihood and severity. These are recorded and tracked in the Asset Risk Model and as part of the Asset Condition Reporting (ACR) process to identify the necessary mitigation activities. The ARM is reviewed and updated quarterly; the ACR register is reviewed and updated annually. Asset condition is recorded in Ellipse, Maximo and the MIRE (JNP) register which then drive the intervention plans.
Catastrophic and single point failure leading to major incident	Serious injury / loss of reputation arising from incident. High costs associated with mobilisation of resources to mitigate and resolve issue.	Same as Mitigation above.

Description	Impact	Mitigation
Delay to capital works programme / Scope Change	Impact upon the timing of remaining interventions. This may result in an increase in asset failure and maintenance costs as well as additional LCH abatements or require additional capital expenditure to complete the task. Projects exceed authority; additional customer disruption.	The Capital Programmes Directorate (CPD) monitors the programme regularly and forecast completion dates. A recovery plan is put in place as and when necessary, for programme slippages. Comprehensive cross-functional design review, improvement and approval processes. Programme also monitored at the APRMs.
Supply Chain	Single supplier failing to meet expectations. Fragile supply chain limited to three UK sub-sets of main suppliers. Continued availability of LU bespoke products and support.	Dedicated functions in place to manage the contracts to ensure all milestones and obligations are met, whilst providing the contractor with adequate support and commitment to mitigate high risks and exploit opportunities. Standard product replacement specification will allow access to the international escalator supply market.
Insufficient Funding	Failure to deliver planned maintenance and/or capital projects leading to a decline in asset condition.	Project strategy is to substantially reduce costs allowing increased volume of work. Demonstrable whole life business case for strategy utilising decision support tools to derive strong business benefits.
Resource	Lack of availability of skilled/trained resource subject to market forces and is difficult to predict. May lead to inability to undertake work to programme or sub-standard work.	The current combination of long term external contracts and the utilisation of the DLO and TLES help to provide optimal resource availability. Recruitment and training strategies to be in place relative to forecast demand.

Also, in future, the introduction of 24 hour running of the railway is likely to affect the delivery of maintenance and project work schedules. It may also result in increased rates of component wear and therefore be detrimental to the performance of the assets.

Safety Risk Management

The management of the lift and escalator assets includes safety risk assessment as an integral part of the asset management process. Risk information is fed to the planning and management process to determine the optimal management arrangements for a particular asset, and for the asset base as a whole. These safety risks are captured in the Asset Based Risk Assessment (ABRA) model.

12.11.2 Strategic Opportunities

- Review of both the internal and external resources in place, particularly in 2018 when the long term JNP contracts will be up for renegotiation. Assess the appropriateness of full or part integration of the internal resources with potential for shared costs and efficiencies.
- Review the current Pan TfL contract specifications to deliver a common commercial / procurement strategy for L&E going forward.
- Investigate the opportunity to speed up lift cycle times and the applicability of installing new lifts or escalators where the infrastructure permits.
- Challenge LU CAT1 Standard and specification requirements.

13 Communications Systems

13.1 Strategy Summary

13.1.1 Context

Communications systems are a key strategic technological capability for the delivery of the four key priorities over the next 10 years; reliability and safety, capacity from the current network, capacity from growing the network and customer service. New technologies are challenging the existing principles of how we communicate to operate and maintain the railway.

The primary purpose of communications systems is to provide effective, secure and resilient audio, visual and data systems that support the operation and maintenance of the railway. Reliable communications systems are therefore critical to the safe operation of the railway. Systems must convey the right information to the right people, machines and places at the right time in order for the best decisions or actions to be taken.

New communication systems will also offer opportunities in other areas such as flexible railway operation, reduced asset base, automation of fault identification and lower operating cost. Consequently, a whole system approach will be the best way to deploy solutions to these issues and for related technological developments.

Since 2010, progress in communications systems includes:

- Progressive core asset refresh of CCTV and public address systems
- Implementation of new Track to Train CCTV systems in support of the Sub-Surface Upgrade
- Removal of legacy communications systems such as Signal Post Telephones and Breakdown Broadcast Messaging System
- Roll out of public Wi-Fi to 121 stations
- Networking of CCTV at 111 stations to LU and British Transport Police Control Centres for 2012 Olympics

13.1.2 Strategic Approach

Secure audio communication is required to provide command and control functionality across the network as well as to support the backbone shared with the emergency services. Effective use of networked CCTV systems shared with the emergency services instead of closed local systems reduces time to resolve incidents and improve punctuality of service.

The need for more flexible use of station staff requires communications systems to have the flexibility and expansion capability to cost effectively cater for new and changing business requirements. Consequentially, existing systems that no longer meet the performance requirements or are operationally obsolete will be removed.

High speed, high bandwidth communications networks are in use across the network to provide dependable connectivity for both operational and customer facing applications for the railway and customers. Data is made openly available via TfL On Line to support door to door journey information.

Passenger journeys on the Underground continue to rise and the demands for improved communications systems for staff and passenger increases proportionally. To meet future customer satisfaction targets our future vision includes further network enhancement, provision of mobile phone services in stations and trains and improved customer information.

Security of depots and sidings remains and imperative and CCTV and detection systems will continue to be improved to meet the threat of vandalism.

Convergence of traditional communication, control and information systems with IP based systems offers both a challenge and an opportunity to the railway. The challenge will be to enable a cost effective migration to new systems whilst maintaining the required performance, ensuring staff have the correct skills and competences to install and maintain the new technology. Opportunities will be realised from and integrated asset and resource base taking advantage of additional functionality such as condition monitoring and fault reporting.

The objective for the communications systems is to have a reliable and cost effective asset base that meets the requirements of a world class railway, delivered at the optimum whole life cost, within available funding constraints. Highly reliable and resilient communications systems offer network wide capabilities for intelligent, predictive and adaptive operational control of the railway.

The communications systems will be managed in accordance with whole life cost principles by optimising maintenance, renewals and life extension works, taking into account cost, risk, performance and asset condition / obsolescence. The management of communications systems also has to recognise the change in user requirements both internally and with external stakeholders such as the emergency services. All project work to upgrade existing assets, or to construct new ones, will adopt cost effective designs that consider future maintenance costs and sustainability.

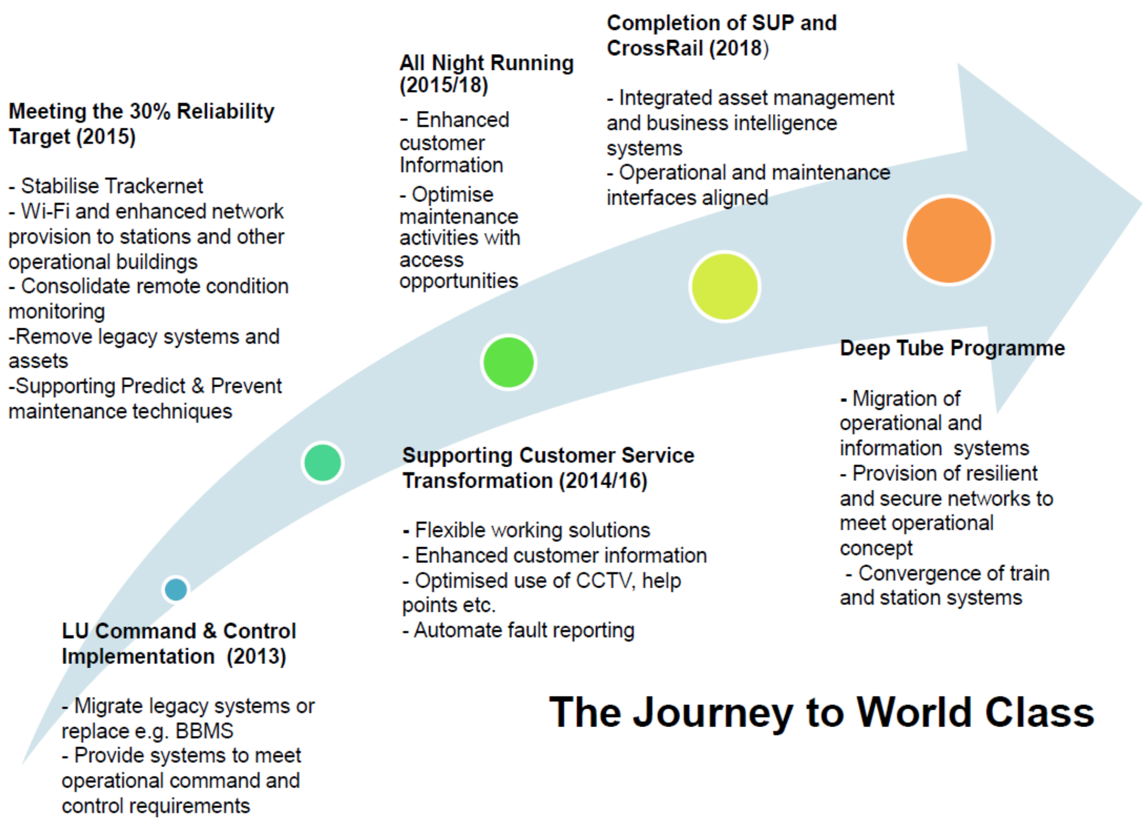


Figure 45: Communications Goal

13.2 Our Goal

Our overall goal for Communications Systems is to:

Provide highly reliable and resilient communication systems that offer network-wide capabilities for intelligent, predictive and adaptive operational control of the railway

Our goals will be achieved through;

Improved integration with network control and emergency services to improve incident response. This will be achieved by the networking of CCTV systems, better locational information from radios and other mobile devices together with improved integration with IM systems.

Provision of a secure voice and data network that links network, line and local control at all times. The present system provided via the Connect PFI contract has to be managed effectively to an end in 2019. The life extension and replacement of this system will be designed to provide higher levels of security and resilience and will align with the emergency services proposals for the replacement of the "Airwaves" communication system and exploit new 4g technology prior to 2020.

Implement digital networkable systems to enable more diverse and flexible modes of working, configured to provide services to multiple locations simultaneously, e.g. London Underground Operational Control and British Transport Police for CCTV images. The inevitable change of outmoded assets and their fixed services will be progressively brought up to date with commercially off the shelf networkable systems. Existing systems that no longer meet the performance requirements or are operationally obsolete will be changed based on criticality.

Progressive roll out of new CCTV systems across all lines to improve safety at the platform train interface. Migration to digital systems offers improved picture quality and opportunity to provide information to line and network control.

Improved CCTV and detection systems to enhance depot and siding security to reduce the threat of vandalism and trespass.

Roll out high speed, high bandwidth communications networks across the network to provide dependable connectivity for both operational and customer facing applications. Commercial and operational opportunities will be explored to exploit the functionality of Long Term Evolution (LTE) / 4g mobile communications to provide voice and expand data services in tunnels and on trains to enhance the customer experience.

Improved management and use of information technology will exploit TfL (and other relevant transport providers) data to provide passengers with personalised information services for journey and ticket information, entertainment and communication services. Access to information, tickets and best prices will be improved and simplified by the use of interactive help points and displays.

13.3 Contribution to Key Rail and Underground Priorities

Reliability and Safety

Reliability and safety is at the core of provision of communications systems across LU. These systems provide the backbone that enables operational and safety critical decisions to be made.

Fundamental to this is the provision of a secure voice and data network that links network, line and local control at all times. The present system provided via the Connect PFI contract has to be managed effectively to an end in 2019. Plans for life extension or replacement of the system are being developed to ensure that a high level of security and resilience is maintained. Plans are aligned with the emergency services proposals for the replacement of the "Airwaves" contract progressively between 2016 and 2020.

Improved integration with network control and emergency services will reduce decision making time during incidents to ensure a swift return to normal service. This will be achieved by the networking of CCTV systems, better locational information from radios and other mobile devices together with improved integration with IM systems.

Safety at the platform train interface will be maintained by the progressive roll out of new CCTV systems across all lines. Migration to digital systems offers improved picture quality and opportunity to provide information to line and network control.

Flexible digital networkable systems enable a much more diverse and flexible mode of working. This technology can also be configured to provide services to many locations simultaneously, e.g. LUCC and BTP for CCTV images. The inevitable change of outmoded assets and their fixed services must be brought up to date with flexible COTS digital networkable systems.

The accepted driving force behind the technological change within the communications market is due to obsolescence in response to the consumer market providing, faster, more powerful and greater functionality requirements of users. The market has abandoned many of the proven technologies in use within LU today, thus, making their continued availability more and more challenging and costly. The strategy to manage technological change must align the needs of the operator, the maintainer, engineer and sponsor to ensure an achievable plan can be delivered.

Reliability improvements will be achieved by the adoption of remote condition monitoring of systems enabling the migration to predictive maintenance techniques. Service disruption events will be minimised by removing further legacy systems such as Tunnel Telephone wires. The use of configuration control process and management techniques to reduce system down time or degraded operation will be developed across all communications systems.

Capacity from the current network

Communications systems are an enabler to gain further capacity from the current network. The main contributors and benefits are:

- Benefits from the networking of CCTV across the railway include:
- Reducing decision making time during incidents to ensure a swift return to normal service
- Removal of the need for local viewing suites freeing space within stations
- Integrating CCTV views at interchanges enabling better demand management

Benefits from Improving Customer Information include:

- Providing improved real time information that enables staff to make timely announcements to passengers ensuring minimal disruption during incidents and also allowing passengers to make informed decisions for alternative travel arrangements
- Removing legacy assets such as light boxes where it can be demonstrated they provide conflicting or inadequate information to customer resulting in increased journey times or inefficient routing.
- Flexible use of help points to ensure incidents are notified as quickly as possible to either a local or central location

The introduction of 24 hour running on selected lines and times from 2015 provides a significant challenge for communication systems. This is twofold; operational requirements may need to be modified due time of day and customer needs for service information and changes to maintenance / replacement plans due to reduced access time.

This challenge will be met by:

- Ensuring effective volume and zonal control is provided to public address systems at surface stations where 24 hour running will be operating.
- Introduction of predictive maintenance techniques to ensure the reduced access window for maintenance visits does not reduce performance
- Provide enhanced customer information systems to ensure customers make the correct multi-modal travel decisions
- The provision of Wi-Fi to stations, depots and other operational building offers benefits including:
- Low cost high capacity data download capability for train borne systems monitoring train and track condition
- Low cost connectivity to smart phones and tablets used by operational and maintenance staff enabling more flexible and effective resource utilisation.

- Optimisation of inspection and assessment of assets reducing access requirements and reducing time to rectify defects

Capacity from growing the Network

Increasing the capacity of the network through line extensions such as the Metropolitan line Croxley Link and Northern line to Battersea as well as station capacity projects such as Bank and Victoria cannot be fully realised without taking full advantage of the opportunities provided by modern digital communications systems.

These projects can be designed “digital first” taking account of the need for secure, resilient networks supporting Wi-Fi, CCTV, public address, customer information and help points. This also enables other assets that require digital transmission such as alarm and condition monitoring to be supported and designed in from the outset.

More importantly this will allow the communications systems to match the operational strategy for both trains and stations along with the link to line and network control.

This will enable:

- Optimised CCTV installations enabling passenger demand management and congestion control
- Improved access to real time information systems, Wi-Fi and ticketing systems.

Customer Service

Mobile communication providers, in association with LU, offer dependable high speed, high capacity seamless communications for passengers at a number of stations. These systems use standard commercial products to reduce capital costs and the risk of obsolescence. This will be expanded to include further commercial opportunities including:

- Deployment of LTE / 4g mobile communications
- Increasing the capacity on data systems to provide additional space for resale to mobile operators

As part of TfL’s overall Transport Strategy, one of the primary aims is to encourage smarter travel choices from private transport to public transport and a key to achieving this is the provision of good quality information about public transport alternatives. Within the communications strategy, real time information was identified as a key element to help passengers make a smarter choice when travelling. There are three parts to the strategy for improving customer service:

- Improving information to staff – Ensuring our staff have consistent accurate information derived from network and line control during both normal operation and during the management of incidents

- Improving public facing information on stations and on trains – Ensuring timely, accurate information is provided in a consistent manner via visual and audible systems
- Improving publically available information on the Internet – Ensuring consistent accurate information is available on the internet for use by third party developers and other transport operators
- The overriding strategy is to ensure that all three means of providing information are consistent, working to aligned processes during normal operation and during periods of disruption.
- Improved information technology, management and exploitation of pan TfL collaboration provides passengers with personalised information services for journey and ticket information, entertainment and communication services. Access to information, tickets and best prices should be improved and simplified by the use of interactive help points and displays.
- Passengers could be kept better informed through intelligent traffic management systems that identify real time location and distribute this information to passengers. This can be achieved through traditional fixed displays, social networking sites and the mobile applications for use on smart phones and tablets.

13.4 Technological change

The accepted driving force behind the technological change within the communications market is due to obsolescence in response to the consumer market providing, faster, more powerful and greater functionality requirements of users. The market has abandoned many of the proven technologies in use within LU today, thus, making their continued availability more and more challenging and costly.

The strategy to manage technological change must align the needs of the operator, the maintainer, engineer and sponsor to ensure an achievable plan can be delivered.

As LU is not a leading edge user of technology, LU looks to industry for good practice, identifying those systems in use by other parts of TfL, Network Rail, TOC and other metros (via CoMET). Through the knowledge and development programme we will assess methods and technology used by others to best meet with LU business requirements.

Many communications systems employ computerised devices to allow configuration and modifications to the software within them. LU must own such software Intellectual Property Rights (IPR) to ensure it has the continued ability to modify systems without restriction or be subject to unreasonable conditions by suppliers.

LU has in part started moving towards new technology in only a few places, e.g. Station Management Systems, smart phones, but many more opportunities exist to remove out-dated and obsolete systems, providing greater opportunities in flexibility with our staff freed to be visible, mobile and active, concentrating on providing increasing levels of customer care.

Our strategy to manage technological issues is to ensure change is managed through the ICT Transformation Board where all parts of the business are represented.

13.5 The Communications Asset Strategy

The communications system strategy can be summarised as a route map from the current position which is one where traditional systems require high levels of inspection and maintenance effort and where recovery from previous underinvestment is still underway through to a “World Class” position where optimum whole life cost asset management is carried out on modern assets which meets the demands and expectations of the modern railway.

The reliability of the train service, and hence the expectations on the reliability of communications are at the centre of LU’s strategy. For this reason asset reliability and reliability risk will now form a significant part of works prioritisation. Additionally there are a number of works being funded through RAMS to contribute towards the Mayoral target of a 30% improvement in reliability by 2015. Significant progress has been made towards this goal to date but there is still much more to be done.

This route map is articulated in the diagram below:

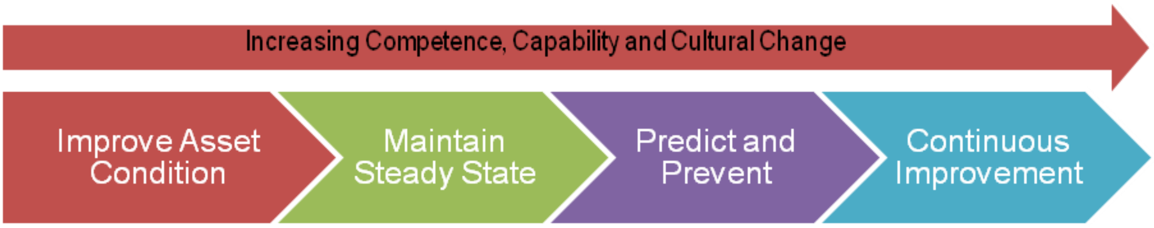


Figure 46: Commicication Systems Route Map

The four headings in the coloured chevrons are the four key objectives of this Strategy.

These are depicted in this way to show how the approach to management of communications assets will develop over time and the inter-dependency of these objectives. For instance, it would be impossible to effectively support business change programmes and maintenance automation if the condition of the assets had not been recovered to a suitable position as delivery resources would be too tied up managing asset failures to be able to analyse measurement data, clear work banks and push out planning horizons. Similarly it would not be cost effective to try to automate processes until the “predict and prevent” regime has identified the optimum work types and timings.

That said it is not necessary for the preceding objective to be completely met before works supporting later objectives are undertaken as long as the works delivered fit with the overall strategic direction. It is, however, true to say that the journey to ‘World Class’ for the communication systems will not be complete until all four objectives are fully met. The following sections outline these Asset Objectives in more detail along with the major work streams which contribute to their delivery.

13.5.1 Improve Asset Condition

Figure 47: Core Principles

Work will continue to be undertaken to reverse the impact of historic under investment in the communication systems and restore the asset condition to a ‘steady state’ position whereby a lower level of annual renewal is required to sustain a consistent asset condition. Whilst delivering this, the opportunity will be taken to replace the more traditional communications with modern designs which have a longer service life and fewer failure modes. This will deliver a more cost efficient ‘steady state’ position than would be achieved through a direct like for like replacement of assets. The key work streams which underpin this objective are outlined below, with the associated actions planned to be completed by 2017:

Make better use of existing assets whilst meeting the changing needs of the business– Utilise all the functionality of the current systems particularly networks and the Connect radio system. Ensure Operations and Delivery Directorates are fully aware of system capabilities. Remove systems where they are no longer operationally required or duplicates exist.

- Work with Operations to take the Network, Line and Local Operational Concepts to apply to the existing systems and asset base to determine gaps and duplication of systems.
- Ensure Configuration Change control is implemented for all communications systems across LU**.** Complete removal from service of Signal Post Telephones on Central and Metropolitan Line en**ab**ling all train to service control communication is by secure radio systems Complete removal of tunnel telephone wires and its future integra**tion in a re**placement power SCADA system Review provision of back of house systems i**n stations to m**eet emerging operatio**nal concepts su**ch as provision of PC's**, telephone**s and clocks **(December 2014)**

Manage obsolescence whilst encouraging and exploiting innovation to:

- Ensure all a**ssets have** a plan for re**placement aligne**d with operational needs.
- Ensure obsolescence is managed throughout the system life cycle particularly spares management and software support.
- Encourage innovation through both engineering and operations to ensure we make best use of new and emerging technologies.
- Ensure operational obsolescence identified as a result of business process changes is incorporated into maintenance and delivery plans
- Ensure obsolescence and innovation is reviewed periodically at the ICT Transformation Programme Board
- Ensure the ongoing innovation programmes in TfL IM are fully co-ordinated with the needs of LU and aligned with Knowledge and Development programmes developed by the Asset Management and Investment team.
- Ensure the Knowledge & Development programme for communications reflects the business delivery and operational needs
- Engage within TfL, other Metros and transport organisations to share innovation opportunities

Manage networks and the convergence of technologies – Manage communication networks proactively removing duplication of networks whilst retaining appropriate security and resilience. Use communications systems to exploit the convergence with other IP based technologies to drive efficiencies in installation and maintenance costs as well as supporting the changing needs of delivery and operational staff.

- Maximise the use of communication networks to facilitate the use of IP based systems and technologies.

- Ensure data networks are suitable for the increased use of networked CCTV, data and voice systems as a consequence of centralised command and control and deployment of mobile devices.
- Review the traditional interface between communications, signalling, control & information and IM systems to ensure best fit for maintenance and capital investment
- Ensure the deployment of mobile devices into the delivery and operational environment to facilitate flexible working.

Ensure safety, environmental, legal statutory compliance – Ensure compliance issues are fully considered as part of condition and risk reviews. Ensure risk modelling is appropriate to the systems, assets and their operation. To update Cat 1 and guidance standards to reflect the changing needs of the railway and the technology used.

- Ensure the Communications condition review continues to reflect asset health and performance
- Update Communications Cat 1 standards and guidance documents to reflect changes in operational, maintenance and engineering requirements due to changing technologies
- Review the Rulebook and amend as necessary to ensure it reflects changing technological requirements

Ensure appropriate resilience and security is provided to communications systems both internally and externally – Ensuring the operational requirements of the business for flexible information transfer and usage is reconciled with the need for a secure system resilient to virus and / or cyber-attacks. Additionally ensure that all related assets and systems offer similar levels as the associated communications assets such a reliability of power supply, cooling of equipment rooms and security to equipment. This includes:

- Ensure LU and TfL IM operational security policies are applied to all communications projects
- Ensure the needs of security match the requirement for operational flexibility and efficiency of operation
- Ensure consistent application across Enterprise and Operational networks including SCADA and other control / monitoring systems
- Ensure appropriate resilience is applied to associated assets such as power supply, cooling and accommodation to ensure required levels of operation are met.

Figure 48: Steady State

Ensure communications systems meet the requirements for Delivery Organisations	Ensure integration of communication systems from Line Extensions, major enhancements and CrossRail
Ensure consistency of train service information	Ensure communications systems meet the needs for future Night Tube train service

13.5.2 Maintain Steady State

Having recovered the asset condition and put in place a robust process for the management of obsolescence and convergence of technologies the strategy needs to address the ongoing need for Operational change through business and process change programmes. At the same time the strategy needs to address the impact of station and line enhancements and extensions.

The key work streams which underpin this objective are outlined below, with the associated actions planned to be completed by 2017:

Ensure communications systems meet the requirements for Operational and Delivery Organisations – engage with Operations, Strategy and Delivery to determine the functional requirements to be translated into engineering scope to deliver a more flexible railway. Use operational concepts for both business as usual and incident management to determine the requirements for future communication systems. Ensure standardisation of interfaces for both staff and public particularly the operation of station management systems and public address systems. This will include:

- Work with Operations and S&SD Strategy to determine future communications requirements to support the future operational concepts to be adopted at network, line and local levels.
- Develop with Operations the transition to flexible working arrangements ensuring alignment of plans to business process change.
- Develop with Operations and Maintenance requirements to ensure suitable operation of visual and audio system during periods of 24 hour running.
- Develop with Operations migration to communication systems that facilitate train service and passenger flow regulation and provide situational information for critical assets.

- Develop with Operations and Delivery organisations integration of line extensions, capacity improvements and CrossRail into the existing communications infrastructure.

Ensure communications systems meet the needs for future Night Tube train service – There is increasing pressure for London to become a 24 hour city with tube services to match. For this reason the communication systems need to be designed and managed in the expectation that this change will occur in the future. More robust assets in conjunction with automated fault reporting will result in a reduced inspection requirement and automation will reduce the access required to fix faults. This will include:

- Ensure communication systems meet both the operational and maintenance challenges of extended hours of operation.

Ensure consistency of train service information – ensure our staff and passengers have the same train service and disruption information as those with internet or smart phone access.

- Ensure continued synergy with the TfL "Digital Strategy" across Rail and Underground**.**
- Ensure staff and customers have the same access to train service and disruption information via station, internet or mobile based applications**.** Integrate customer information programmes into future business change programme requirements to ensure consistency of application and efficiency of delivery **.**
- Ensure integration of network, line and local systems.

Ensure integration of communication systems from Line Extensions, major enhancements and CrossRail – Ensure new systems integrate where required with the existing railway and satisfy the same requirements for performance, reliability and durability. Ensure that these programmes meet the same challenges of obsolescence and technology change at the rest of the network. This includes:

- Ensure new systems integrate where required with the existing railway and satisfy the same requirements for performance, reliability and durability.
- Ensure that these programmes meet the same challenges of obsolescence and technology change at the rest of the network.

13.5.3 Predict and Prevent

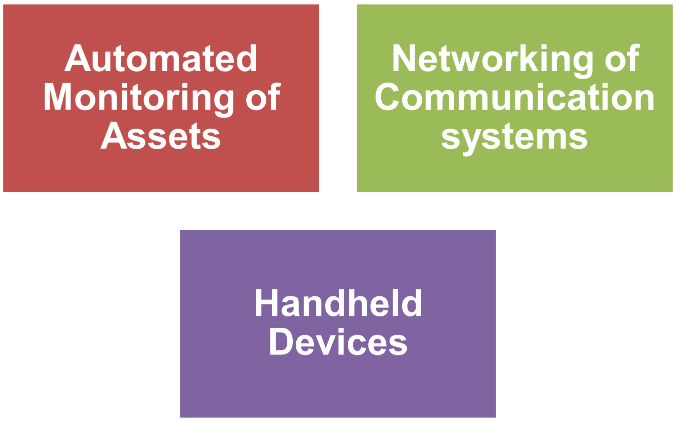


Figure 49: Predict & Pevent

Having recovered the condition of the communications systems and made the transition to a 'predict and prevent' approach to maintenance to achieve a reduction in the cost of maintaining and renewing the systems through its life, further efficiencies will be targeted through automating work activities or introducing new technologies which reduce the levels of resources required to deliver the workload. If the 'predict and prevent' approach can be summarised as doing the right work at the right time, this objective can be summarised as delivering that work to high quality at least cost. The main work streams which support this objective are outlined below:

Automated Monitoring of assets – Remote condition and status monitoring is readily applied to communications systems thereby reducing the need for physical inspection and fault analysis. The potential for use will be reviewed across all assets particularly with regard to CCTV and public address systems.

Networking of Communication Systems – The networking of communication systems offers a number of opportunities to reduce the cost of operation, reduce fault correction times and enable centralisation of operating functions. This will include:

- **CCTV Systems –** Networking of CCTV facilitates both remote reviewing / replay of images as well as remote fault identification / rectification. This also allows the remote copying of data for incident investigation etc.
- **Help point Systems** – The networking of help point systems enables to provision of a more flexible operating concept with both local and central operation for both help and information requests.
- **Public Address** – The networking of public address systems offers similar flexible operation to meet the emerging future operating concept of the railway.

Handheld Devices - The use of hand held equipment in managing communications assets will be further reviewed in light of emerging tablet and smart phone technologies. Works to develop better interfaces with Ellipse and Maximo are already underway as part of the upgrades of the two systems and new functionality is being brought in but quality of information available to staff on the ground will also be reviewed, particularly around data-sets such as the condition and data management toolset (CDMT) where it would be useful to have detailed information on location, measurement and camera footage.

13.5.4 Continuous Improvement to support the Requirements of the Future Railway

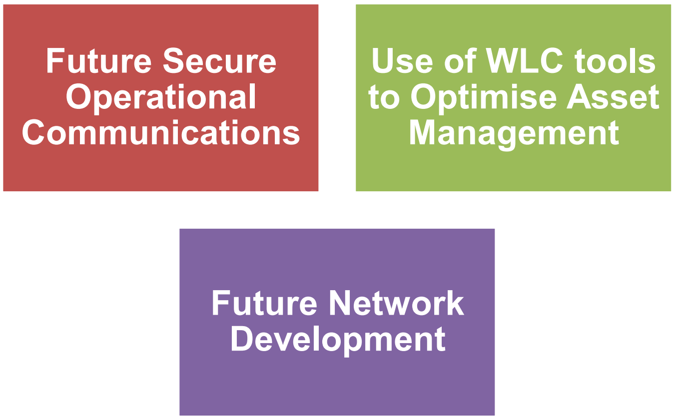


Figure 50: Future Priorities

The final cornerstone objective in the Communication System Strategy is about building upon the benefits of having robust assets maintained under an efficient maintenance regime with cost effective delivery and making further improvements in processes and approach to ensure that the management of communication systems on the LU network is World Class. Alongside this is ensuring that the assets continue to meet the requirements placed on them as LU as a whole becomes world class, particularly around asset reliability and ability to support increased train services and faster train operations following line upgrades. Continuous improvement in reliability, cost, risk and quality will continue to be undertaken on the asset. This objective is delivered by the following work streams:

Future Secure Operational Communications – Initiate a condition, performance and functionality review to determine options for the future investment and maintenance of radio, data and video networks. Proactively manage the refresh programme required under the PFI contract ensuring compatibility with operational requirements.

- Proactively manage the contract via a cross business steering group that will review all options for secure voice and data systems**.**

- Ensure the operational needs of LU are reflected in "reversionary contractual discussions " with Citylink**.**
- Ensure the requirements for radio and data systems are consistent with the needs of business and process change programmes**.**
- Ensure emerging plans for secure voice and data systems are aligned with wider TfL commercial plans for data and voice networks**.**
- Ensure emerging plans for secure voice and data system are shared with external stakeholders (Home Office & Emergency Services)**.**

Use of WLC tools to Optimise asset management - Over the last few years' substantial effort has been invested in developing a robust whole life cost modelling tools. These models combine a theoretical assessment of expected asset lifespan with actual data from sources such as Ellipse/Maximo and asset condition to form a view of where assets currently sit in the asset lifecycle. This assessment is then related back to predictions on required maintenance effort, performance and risk. These skills will be used to develop a similar model for communication systems and other related ICT based systems. Going forward, this model will eventually be able to assess the best WLC intervention based on data on asset condition, performance and site specific risk. **(Development of communications WLC model underway)**

- **Future Network Development** – Ensure data networks are suitable for the increased use of networked CCTV, data and voice systems as a consequence of centralised command and control and deployment of mobile devices.
- Review the traditional interface between communications, signalling, control & information and IM systems to ensure best fit for maintenance and capital investment**.**

13.6 Key Assumptions

The key assumptions are:

- Communications are enabling systems and as such will be required to provide a means of communication of data, audio or video for other asset disciplines and for the operation of the railway. A key assumption of this strategy is that where other asset or business areas require the use of the communications infrastructure it will be defined in the relevant strategy.
- Enhancement of communications assets will be justified by a positive business case supporting savings to operational costs, customer benefit or third party opportunities. These improvements will generally be provided by:
    - Station capacity projects
    - Line upgrades
    - Operational or customer care initiatives

- The emergence of the business process change programmes challenges overall methods of railway operation providing a further opportunity for enhancement.

- Maintenance of communications assets is split across a number of business areas detailed in section 3.3. The assumption is that the delivery of all communications maintenance will be challenged as part of the wider reorganisation of Rail and Underground particularly the integration of BCV / SSL / JNP maintenance and station / train operations.

- Current asset base will be extended by the delivery of capacity improvement projects, third party developments, line upgrades and the London Overground (former Silverlink) stations.

- Future maintenance costs associated with CrossRail (from 2017) require development as final designs are verified and their integration with existing station systems at Paddington, Bond Street, Tottenham Court Road, Farringdon, Barbican, Moorgate, Liverpool Street and Whitechapel.

- The existing performance code with cross asset targets for asset availability, service disruption and ambience will continue but will be reviewed as part of the amalgamation of maintenance and operations.

- The Connect PFI contract terminates in 2019. The assumption is that it will run its course until then with residual life condition applied in 2017. A working group has been established to review and investigate other options. The requirements of The Home Office and the emergency services will be incorporated into our strategy when confirmed and agreed.

13.7 Core assumptions for system replacement

The core assumption for communications system replacement is that funding will continue as detailed in the existing business plan to 2021/22. This level of funding although relatively constrained is sufficient to:

- Replace obsolete systems assets
- Replace systems or assets forming part of a system at end of life

This funding is currently split between:

- Station and non-station building communications
- Linear line based assets
- Depot and sidings assets
- Telephone services
- Connect PFI
- Commercial exploitation

There is an assumption that requirements for new functionality of some communications assets, will emerge due to a changing vision of stations operations. In particular this anticipated for:

- CCTV – who, where and how both live and recorded images are viewed during normal operation and for incident management. This includes where recorded information is stored, data quality and the period of retention.
- Public address – provision of disruption information (network, line and local), consistency of message with trains and with visual information and use of live / recorded information.
- Help points – operation of help points and interface with staff local or remote, use of information button and integration with other customer facing initiatives.
- Regular meetings are in place to engage with the business change programmes and stakeholders to create a strategy and vision of communication systems to meet aspirations for future operational and customer information needs. It is expected that there will be greater use of technology to provide live intelligence of system functionality, improved customer information and to support greater efficiency in utilisation of staff.

13.8 System Strategy

13.8.1 Overview

ICT systems are a diverse asset grouping covering all forms of electronic communication within and external to the railway. Figure 3-1 identifies the spectrum of systems within the communications asset group.

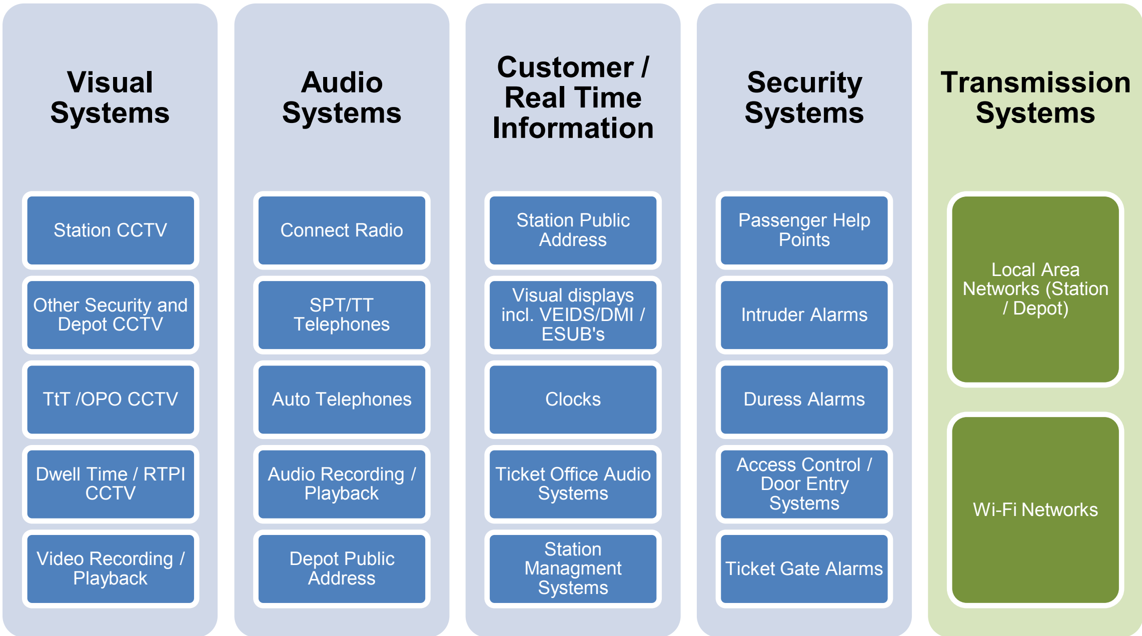


Figure 51: Information and communications systems

Obsolescence is a major influence over life cycle of these assets and their replacement. There are a number of forms of obsolescence but those particularly impacting this sector are:

Physical – Physical damage to an asset where replacement parts are no longer available i.e. the risk of non-repairable failure has become unacceptable

Economic – Continued maintenance (including support costs) would cost more than replacement

Functional – The functions offered by the asset no longer meet the operational requirements of the business

Technological – More modern technology makes the asset obsolete either due to manufacturers not wishing to continue with older models or demand from other market sectors declining making the cost prohibitively expensive

Legal or Social (environmental) – Change in legislation forces a change in asset or means of operation

Obsolescence equally applies to software as well as hardware and management plans need to take account of support to both. The strategy for managing obsolescence is to:

- Monitor through regular contact with suppliers and maintainers assets that are reaching the end of the manufacturing cycle, hardware and software support. This is facilitated through the maintenance contract.
- Manage obsolescence through the appropriate asset working group or steering group for each system.
- Record obsolescence through asset condition reporting.

The communications systems will be managed in accordance with whole life cost principles by optimising maintenance, renewals and life extension works, taking into account cost, risk, performance and asset condition / obsolescence. The management of communications systems also has to recognise the change in user requirements both internally and with external stakeholders such as the emergency services. All project work to upgrade existing assets, or to construct new ones, will adopt cost effective designs that consider future maintenance costs and sustainability.

13.8.2 Visual systems

Overview

Visual systems comprise the means of acquiring CCTV images, their transmission, interpretation, use and storage.

Over the last decade CCTV surveillance and the evidence obtained have become increasingly vital tools in the prevention, investigation and detection of crime and terrorism. We have seen significant reductions in crime on the railway and CCTV has played a key role in helping to achieve this outcome and in making the railway safer.

Station, train and station car park based CCTV has been widely deployed by as a means of protecting the safety and security of the public and staff; as an aid to police investigations; and as a tool to assist in the general management of the railway environment. CCTV is at the core of the Department of Transport (DfT) / BTP Secure Stations Scheme in that it demonstrates that LU has taken steps to prevent crime and enhance passenger safety.

The rapid progress of technical developments such as a move from analogue to digital, IP Transmission networks, etc. along with changes to work programmes, have often meant that inconsistencies are apparent not just between different stations but also across the network and pan-TfL on similar Overground and DLR installations.

The overriding strategy is to provide systems that meet the needs of the Operator and that of British Transport Police in support of criminal evidence as detailed in National Rail and Underground CCTV Guidance Document (ATOC)

The operational strategy for visual systems is to use the current assets to:

- To monitor and manage passenger flows and crowd control
- To reassure and give confidence to the public and staff
- To investigate staff, public and rail related accidents and incidents
- Facilitate more flexible working
- To assist the emergency services
- To meet all statutory requirements and obligations
- To deter, prevent and detect crime/terrorist activity
- To investigate crime/terrorist activity and provide evidence in criminal and civil proceedings

This will cover as a minimum all customer facing locations, high risk entrances to stations, depots and offices. The need for specific CCTV provision shall be determined by operational and security review ensuring:

- Coverage will be sufficient to meet the normal operational needs of each station / building / facility enabling images to viewed and recorded locally
- Images shall also be able to be transmitted to remote control rooms such as line and network control where they can be viewed and recorded
- Images shall be available to all parties at all times and should not be impeded by other users' selection requirements

- Operational CCTV for management of the platform train interface and for train identification shall be determined by operational review appropriate to the type of rolling stock, location and interface with other operators.

Maintenance

The strategy for visual systems is to incorporate the planned and reactive maintenance of assets into an externally sourced performance based contract using specialist sub-contractors experienced in the CCTV systems in the operational railway environment. Scope and frequency of planned maintenance to suit the environmental and access constraints of the specific installation.

The use of automatic condition monitoring will be introduced as part of the networking of surveillance CCTV systems. This will enable the automatic detection of configuration and image quality change.

Replacement and Migration Strategy

The business plan cannot fund wholesale replacement of visual systems across the railway. The migration strategy will be to convert individual parts of the CCTV systems to IP technology. However, existing analogue cabling and cameras may be exploited in the short term to prolong the life of the current systems.

Surveillance system replacement will generally be aligned to other station or building improvements and capacity enhancement projects. Operational system replacement will generally be linked to fleet replacement or significant timetable / route changes.

Technological Change - As detailed earlier visual systems are going through significant change and manufacturers are seeking to address the challenges of new technology through the introduction of:

- IP addressable devices for cameras, controllers and recording
- High definition (HD) cameras, LCD panels and recording
- 180 and 360 degree cameras using image flattening software
- Use of widescreen (16:9) LCD panels in lieu of traditional (4:3) panels and monitors
- Streaming of recorded images to mobiles devices for incident investigation
- Network video recorders

The strategy for the installation of new and replacement systems will be to adopt IP addressable COTS solutions.

Flexible Operation and Remote Access - Having remote access to CCTV data is of benefit to Operations and the Police and supports the development of new and more efficient CCTV management processes. These include, but are not limited to:

- Remote management of stations
- Live operational management
- Events management
- Incident / Response management
- Post incident investigations (access to and exporting of recorded data)
- Intelligence gathering
- Minimisation of disruption during incidents
- Improved capability for crowd management
- More efficient CCTV retrieval

Extraction of CCTV footage across a network enables further efficiencies to be made including the removal of playback suites in stations. All new CCTV installations must include for the retention or expansion to facilitate remote access.

13.8.3 Audio systems

Overview

Audio systems provide both live and recorded messages to staff across the network. This is provided by a diverse range of assets differing in age, technology and application. These are:

- A Radio system provided by the Connect PFI contractor serving all areas of the network using a combination of fixed and hand portable devices. This also serves the emergency services and includes a link to legacy LFEPA radio base stations
- Fixed telephone systems serving handsets, fax machines, signal post telephone and the tunnel telephone system
- Mobile phones
- The depot public address system

The Connect Radio system has now been in operational use for a number of years and covers all running lines, all operational and disused stations, intervention points, depots, sidings, tunnels and tracks. This has allowed the removal of legacy systems such as signal post telephones and station to station telephones. The operational strategy for Connect Radio is to use the current assets to:

- Improve real time information
- Improve event management communication including incidents
- Improve co-ordination with emergency services
- Facilitate more flexible working by improving links to the auto phone system and to station help points

The legacy LFEPA radio system provide "Fire Ground" cover will be replaced with a like for like equivalent system ensuring we continue to meet our statutory obligations.

Fixed telephone systems are the traditional method of audio communication between staff. With the advent of new radio systems and the use of mobile phones their use has declined. The strategy for telephones is:

- Migration of the telephone systems to a voice over IP (VOIP) solution by evolution of the existing facilities.

- Extend the telephone systems to include other VOIP solutions as provided such as help points.
- Retain handsets where operationally critical, removing those where radio or mobile handsets offer a more appropriate method of communication.
- Remove the remaining legacy systems such as signal post telephones.

Current railway voice networks are based on traditional telephone exchange technology, which has limited scope for expansion and improvement in functionality across the network. The strategy is to be

- Incremental by design and make best use when possible of existing infrastructure and processes
- To achieve a balance between immediate infrastructure improvement and investment in future improvements

Mobile phone use is now extensive across the network by staff and passengers. Data usage of mobile phones is being extended by the introduction of Wi-Fi systems at stations and depots. This will allow the use of VOIP for audio communication by staff.

The depot public address systems whilst not used as voice alarm systems for evacuation will be retained as they are operationally critical. Refer to the Depot Asset Strategy for further detail.

Maintenance

The strategy for audio systems is to:

- Continue the maintenance of the Connect Radio system through the PFI contract until the end of the contract in 2019. Options will be developed by the Connect steering Group for future maintenance requirements beyond the end of the contract. This will include both internal and external solutions and well as options to modify the current contract.
- Maintenance of the replacement LFEPA radio base stations will transfer to COO Maintenance.
- Continue with the maintenance of the telephone services contract through TfL IM on a term contract basis. The strategy will be to ensure telephone systems including VOIP solutions are maintained through IM as they are modernised.
- Mobile phones are currently provided on a pan TfL basis which will continue.

Replacement

There are a number of challenges relating to future voice communication systems. These are financial, technological and operational. The PFI contract for radio systems gives poor protection to LU in the event of the contractor not meeting their commitment to refresh the system.

A larger challenge relates to technology change. The use of TETRA radio systems is linked to their use by the Police and Ambulance Services. The contract for their systems with Airwaves expires across the UK progressively between 2016 and 2019. The Home Office is currently considering options for a replacement system or systems. Options currently being considered include:

- Retaining a TETRA based system for nationwide emergency audio communications. 3/4G cellular technology being utilised for data.
- Retaining a TETRA based solution in high risk area such as Central London with a 4G solution used elsewhere. 3/4G again being used for data
- A solely 4G solution for both audio and data secure communication.
- The key factor being where the emergency services move to we will have to follow. A decision on technology and funding for the emergency services will not be decided until the next Parliament expected in 2017. The other technological factor is that manufacturers are slowing development of both 4G and TETRA based system due to market uncertainty. The current expectation is that 4G based solutions will not be available until 2025.

The Connect Steering Group will develop proposals for a future voice system and act as the point of contact with the Home Office and Police Authorities.

Fixed telephone systems have adopted a programme of evolution rather than replacement enabling full use to be retained of legacy systems whilst migrating to a VOIP solution. Discreet systems such as control room touch screen systems will be replaced as a whole system to ensure commonality of operation. Convergence of technologies as described earlier will extend the application of VOIP systems to help points and long line public address. Exchange systems will require replacement from 2016/7 and Are currently included in the future TfL IM plans. Our strategy will be to assist IM in scoping the replacement programme aligned to future use and reduction in head office buildings.

Migration Strategy

Migration to any future radio / cellular telephone solution has to be planned in consultation with the emergency services. This will be managed through the steering group as part of the wider change programme.

Migration to VOIP telephony solutions is dependent on:

- Availability of local area network (LAN) connected to the metropolitan area network (MAN)

- Operational agreement on the future use of help points and networked public address

13.8.4 Customer & Real Time Information

Overview

As part of TfL's overall Transport Strategy, one of the primary aims is to encourage smarter travel choices from private transport to public transport and a key to achieving this is the provision of good quality information about public transport alternatives. Within the communications strategy, real time was identified as a key element to help passengers make a smarter choice when travelling.

Real Time information:

- Removes the uncertainty a passenger feels when waiting at the station, by providing accurate information about the arrival of services.
- Provides confidence for passengers to make an informed and smart choice to travel by public transport.

This requires LU to provide clear, correct, concise, timely visual and audio information. Real time information will be provided:

- **At Stations**
  - Visual displays such as dot matrix indicators (DMIs), Visual Electronic Information Displays (VEIDs) and electronic service update boards (ESUBs).
  - Audio information via public address systems and direct contact with operational staff
- **By the internet** – Real time information is available via the TfL website or third party sites using real time information derived from TrackerNet
- **By Third Parties**– Real time information sourced from TrackerNet is available via third parties such as Network Rail, other Train Operators and local authorities.

The overarching strategy is that staff and customers should have the same level of train service and disruption information available to them irrespective of the medium used or their location. Within Stations the strategy is:

Visual systems:

- All stations shall be provided with visual information systems detailing train service and disruption information. The level of information provided needs to be tailored to the location, layout, frequency of train service and passenger usage

- Legacy systems such as light boxes and dot matrix indicators shall be replaced with VEIDs when they are life expired or cannot be modified to meet the service pattern following a line upgrade. Where heritage light boxes installations are retained, the modern equivalent VEID shall also be provided wherever practical
- Electronic service update boards (ESUBs) shall be provided where customers make multi-mode travel decisions. ESUBs shall either be standalone displays or integrated into CIS Help Points or other multi-functional displays

Audio systems:

- All stations shall be provided with audio systems that can provide both real time and automated announcements covering:
- Train service and disruption information
- Safety and other operational announcements
- Flexible train service operation needs to be reflected in the provision of audio information. Therefore future public address systems will require messages generated from Network Operations Centre, Line Service Centre (from Line Information Specialist) and local station control to be provided as appropriate to the mode of operation of the station
- Service updates provided to DVA through ESUI (ESUB)
- Radio microphone interface with public address systems extended to include all operational areas where live operational announcements are required.

Maintenance

The strategy for audio systems is to incorporate the planned and reactive maintenance of assets into a service level agreement with COO Maintenance. Scope and frequency of planned maintenance to suit the environmental and access constraints of the specific installation.

For digital voice announcers and station management systems, the strategy is to incorporate the planned and reactive maintenance of assets into an externally sourced performance based contract using specialist sub-contractors experienced in these systems in the operational railway environment. Scope and frequency of planned maintenance to suit the environmental and access constraints of the specific installation.

Replacement and Migration Strategy

The replacement and migration strategy for customer and real time information systems is:

Visual Displays – Visual displays will be replaced either as part of station improvements or line upgrade whichever occurs first in order to meet the strategy outlined above.

Light boxes – where light boxes are considered heritage feature such as at Earls Court and Gloucester Road they will be retained. Elsewhere they will be replaced when considered at end of serviceable life.

Electronic Service Update Boards – The use of ESUBs is evolving from the need to provide more information to the public. This will require further software and hardware development of the ESUBs including a more flexible approach to their real time inputs (NOC / LIS and other transport operators) and addressing obsolescence issues such as LCD panel size. The use of commercial off the shelf alternatives will also be considered as other operators adopt the ESUB concept.

Audio systems – Audio systems will be replaced at end of serviceable life or where they are not extendable to meet the needs of station capacity improvements.

13.8.5 Security systems

Overview

Security systems are required to:

- Deter crime and disorder on our network
- Reassure passengers and employees
- Help to reduce crime and the fear of crime
- Help to deal with incidents of antisocial behaviour

These systems are:

1. Customer facing - Help points
2. Staff protection – Duress alarms and door entry systems
3. Property protection – Access control and intruder alarms

Help points are in extensive use throughout the network. They are used for two purposes 1) to obtain assistance if no member of staff is available and 2) obtain travel information, direction and general help. Experience ii operation of help points and advances in technology enables a change to our forward strategy. This is:

Help points will be installed only in stations where there is no regular staff presence on platforms. Provision of help points will be evaluated on station specific requirements including layout, usage and operation.

The basic help point will continue to be a circular 570mm pod wall mounted or free standing containing both emergency and information push buttons. In sub-surface locations with fire detection systems the pod will be provided with a fire alarm call point. At surface stations, the following options will also be provided subject to station specific requirements:

- Integral audio frequency induction loop (AFILs) for hearing impaired persons

- **An integral Touch-Screen** with an integrated computer equipped with either an Ethernet interface for the data transmission from a centralised data server, so that additional information such as train service updates, service disruption, tourist information, marketing etc. can be displayed.
- Solar powered where possible

All future and replacement Help Points shall be equipped with an Ethernet interface for voice over internet (VOIP) communication to the operator. The adoption of VOIP will allow the system to be connected via the auto phone system to the local station or remote control point(s). The use of the VOIP as the method of communication will open the supplier market for the provision of help points avoiding the use of bespoke station based systems. This will also facilitate the development of a common interface to be adopted across the network facilitating the development of flexible working.

Our security regimes have to find the right balance between that core value of time and having proportionate measures that minimise unnecessary disruption and keep staff and customers safe by responding appropriately. To support this, the overarching strategy is:

- Personal alarms will be available to all staff vulnerable to abuse or attack. This will normally be via duress alarm in ticket offices or via the personal alarm on radios
- Staff accommodation shall be protected from un-authorised public access by the use of access control or entry phone systems
- Rooms containing operational and safety critical equipment shall be protected by access control systems to both monitor and regulate access

Revenue protection systems such as video help points at gate lines or ticket gate alarms are not considered as part of this strategy.

Maintenance

The strategy for security systems is to incorporate the planned and reactive maintenance of assets into an externally sourced performance based contract using specialist sub-contractors experienced in similar systems in the operational railway environment. Scope and frequency of planned maintenance to suit the environmental and access constraints of the specific installation.

With the replacement of help points to VOIP solutions future consideration will be given to the transfer of maintenance to Telephone Services.

System Replacement

Security systems installed on the LU network have a history of poor management of obsolescence. This has primarily been due to the use of bespoke systems, particularly for help point and access control systems preventing interchangeably of hardware and software. The introduction of IP based solutions gives the opportunity of more flexible procurement of hardware enabling better control of obsolescence.

Migration Strategy

Migration to VOIP solutions is dependent on:

- Availability of local area network (LAN) connected to the metropolitan area network (MAN)
- Operational agreement on the future use of help points and long line public address systems

13.8.6 Local Data Transmission Networks

Overview

Information resources are a vital element of efficient and effective service delivery in the modern railway. A fit-for-purpose communications infrastructure must be able to deliver on a number of key demands:

- Location of staff wherever service delivery is required
- Remote and flexible working
- Flexibility to redesign service to meet customer needs
- Timely access to information
- Consistent quality of information across the Network
- Shared information across organisational boundaries
- Security of the information stored within LU / TfL
- Increased complexity of information

Additionally, over recent years, the use of the network has increased beyond simply providing networking services to computers. A number of other systems now use the network and this continues to increase. This has resulted in the network becoming an underpinning infrastructure component on which a number of other systems/services now rely. The network must be capable of supporting such systems, including: IP Telephony, Radio systems, enterprise wide building access control, building management systems, CCTV, operational and asset management applications.

Technologies have matured and cost structures have developed so that there is now a real opportunity to implement a communications model that provides a higher level of services both in terms of all-round quality and geographic coverage.

Keeping abreast of emerging communications technologies is important, too. TfL / LU recognise a need for radical change to deliver efficiencies and services which meet 21st Century requirements. It cannot achieve this without a continually evolving and improving communications infrastructure.

The goal of improving the railway's networks when set against the constraints of tightening budgets and limited resources, demands that innovation, smart methods of working, and high quality management is applied. Effective partnering is important in achieving these objectives.

What the Railway Requires	How We Deliver
Secure access to timely and increasingly complex information, provided regardless of service or staff location	High bandwidth, dependable, properly protected networks
Flexibility in location for staff and more effective use of accommodation	Combined voice and data network and the introduction of up to-date developments in telephone systems
Capability to respond to future requirements for business communications	Infrastructure model based on international standards
Reduction in running costs	Removal of redundancy in lines and equipment
Creation of opportunities for improvements in working practices	Functionality provided by modern telephone systems
Support for cross-organisational data-sharing	Use of up-to-date security and integration technologies
A robust foundation to network services	Effective capacity planning and management of network availability
Contribution to continuous improvement in service delivery	An innovative approach and effective use of technical expertise

Table 14: Network Requirements

Wired and Wireless Local Area Networks

The railway supports both wired and wireless networks within the corporate network to maximise the advantages of each technology. In general, wired local area networks will be first choice for factors of cost, resilience, functionality and speed. Wired networks provide greater security as unobserved snooping of the LAN is more difficult. They also give easier access for IP telephony.

The standards for premises cabling have been developing for several years to meet the demand for higher data transfer speeds. Category 6 (CAT 6) cable can cater for data transfer rates of up to 1Gbps over twisted pair cable. The previous version Category 5E (CAT 5E) cable was specified to handle speeds of 100Mbps. New wired networks will be installed to CAT 6 standard. Existing wired networks will be expanded at CAT 5E standard as the expense of replacement is prohibitive unless additional speed is essential.

Wireless networks provide greater freedom in use of mobile technology and data communications within the area covered by the access point. Wireless networks are also applicable for temporary installations and where speed of installation is important. Wireless networks will be installed where flexibility and / or mobility are of paramount importance.

Maintenance

The strategy for networks is to incorporate the planned and reactive maintenance of assets into an externally sourced performance based contract using specialist sub-contractors experienced in information systems in the operational railway environment.

13.9 Heritage Issues

We aim to improve customer service by delivering a world-class Underground with world-class surroundings and facilities. Our conservation challenge is to deliver this in a way that respects the rich heritage of our underground railway system while following our Design and Heritage Policy embedded in our Design Principles and Strategies

Station heritage and design are a vital part of our vision of becoming world-class. A number of communications assets are considered part of our heritage. These include:

- Clocks
- Train Destination Indicators (light boxes)
- Ticket windows incorporating audio voice transfer units

Many modern communication assets such as visual displays require being sympathetically located in listed or heritage locations. The strategy for heritage locations is to work with Heritage experts both within LU and Local Authorities and English Heritage to ensure the correct balance is made between improvement and preservation.

13.10 Asset Disposal

LU recycles as much electronic and electrical equipment as possible and has a duty to arrange for the treatment and environmentally sounds disposal of its electronic and electrical waste.

- Equipment that can be re-used is sold via a broker;
- Equipment that is deemed unsellable is recycled, in accordance with the European Community directive for the disposal of waste electrical and electronic equipment (WEEE).

13.11 Third Party Interfaces

There are numerous interfaces with third parties impacting on communications systems. This can be split into:

- Service providers e.g. Virgin Media
- Suppliers and Contractors e.g. Citylink (Connect PFI), CBSO, Fujitsu
- Other TfL transport providers sharing our telecom infrastructure e.g. DLR, London Overground
- Other transport operators sharing telecom infrastructure e.g. Chiltern Trains, South West Trains
- Commercial contracts such as station public Wi-Fi with Virgin Media and advertising with CBSO

Service providers and suppliers / contractors are managed via the agreed commercial agreements via the TfL Commercial team.

Other transport operators are interfaced internally through TfL or via the National Rail Agreements team covering:

- LU's trains that operate over Network Rail's networks between Queen's Park and Harrow & Wealdstone; and Turnham Green and Richmond
- TOC trains which operate over the Underground between Harrow-on-the-Hill and Amersham; and East Putney to Wimbledon
- LU stations served by TOCs and TOC stations served by LU and the major London terminus interchanges

Commercial Opportunities

A number of commercial opportunities have been identified that provide both risk and opportunity to communication systems. Working with the TfL Commercial team those currently being explored are:

- Commercial exploitation of 4g cellular telephone networks
- Use of spare data network capacity for commercial use
- Use of data networks to provide enhanced advertising systems in stations

The commercial opportunities have to be reconciled with the operational requirements. The strategy is to ensure that the safe, effective operation of the railway is paramount and security and resilience maintained at all times.

13.12 Delivery Strategy

13.12.1 Supply chain strategy

The maintenance and investment programmes for communications across Rail and Underground are unduly complicated, mainly as a legacy of PPP and PFI contracts. There are currently nine maintenance and six capital investment programmes delivering communications assets and systems.

As part of the strategy to deliver increased efficiency and effectiveness communications delivery needs to be rationalised into a coherent delivery organisation that also meets the challenge of technology and operational change.

Recognising the need for change the ICT Transformation Board has asked the Capital Programmes Directorate to review options for delivery in the future. This is due to report its proposals for the future in December 2013.

Achieving the Vision

There are common factors that apply to communications systems that differentiate them from other engineering disciplines within LU and TfL. The nature of development in the communications industry has historically resulted in shorter life-cycles and higher rates of equipment refresh than in other asset areas.

Considerable consolidation and realignment amongst both communications equipment suppliers and operators has taken place with the emergence of the dominant global trend for migration of traditionally separate data and voice communications networks to a single converged platform. Converged networks potentially offer increased flexibility, reduced costs and improved performance for the customer, but have the trade-off of usable equipment lifecycles being more comparable with those of Information Management (IM) than traditional communications.

Our network needs to interface with third parties and therefore we have adopted a strategy that converges, where appropriate, whilst continuing to operate legacy systems that support other engineering disciplines, until it becomes technically possible to convert or migrate them.

13.12.2 Maintenance Delivery

Communications Assets

The strategy for stations maintenance is to retain the existing direct labour (communications, lighting and LV electrical) and establish contacts with specialist external suppliers for all other requirements. Direct labour expertise currently covers the following communications systems:

Public Address systems in stations and depots

Legacy Clock systems (not forming part of a Stations Management System) including heritage installations

Tunnel telephone and remaining signal post telephone systems

The direct labour organisation now also maintains a number of systems that were considered "orphans" under PPP. These include the Christmas intruder detection systems, **LFEPA** radio base stations; collapsible gate alarms and electronic service update board (excluding the controlling PC which is maintained by TfL IM).

The maintenance of other communications systems is sourced from external suppliers. This has been demonstrated to achieve savings through economies of scale, multi-skilling and continuous improvement plans. The contracts cover inspection, planned, remedial and reactive maintenance.

A separate facilities maintenance contract has been established to cover non-core BCV / SSL assets such as train crew accommodation and former TfL GP&F buildings. The strategy is to retain this contract until a comparable cost can be made with external supply chain delivery and a decision to keep separate or integrate made.

For communications assets within JNP lines all maintenance is included in the outsourced contract with Telent.

Telephone Services

Telephone services contracts for fixed line and mobile are currently managed by TfL IM. Telephone Services maintenance is outsourced via fixed term contracts via Fujitsu and Damovo, mobile service are currently with O2. The current strategy is to group all fixed line telephony into a single service. This will result in some voice recording systems transferring to Telephone Services maintenance as contracts expire or assets are replaced.

The growth of mobile based technology in use across the railway is increasing rapidly with the roll out of tablets and smart phones. The maintenance of these devices gives a number of challenges around short life span of device, durability and use of applications. Long term plans are being prepared for submission to the ICTT Board

Radio and associated data systems

The Connect PFI contract for radio and associated data systems will conclude in 2019. This strategy assumes the following:

- The PFI contractor City Link completes an annual asset register and condition assessment from which is derived improvement plans up to the end of the contract in 2019.
- An ongoing refresh programme will be completed by the contractors cost to ensure the ongoing availability of the system and compliance with the performance measures in the contract
- By 2017 the PFI contractor will agree via independent experts the required condition and performance improvements to ensure satisfactory operation of the radio and networks until 2021.
- Maintenance and improvement of the system post 2019 is yet to be developed and all options are to be investigated by LU between 2011 and 2017.

13.12.3 Capital Project delivery

The delivery of projects partly due to organisational structure and also due to the diverse nature of communications is split between:

- CPD – Power, Cooling and Communications (PCC) Programme,
- CPD – Station Works Improvement Programme (SWIP),
- CPD – Major Enhancements and Line Upgrades
- Connect PFI contract with variations and enhancement work delivered by the CPD PCC programme
- IM – Wi-Fi, Fixed telephone and mobile telephony projects

In future the strategy will be that work to communications systems impacting the operational railway will be:

- Managed by CPD within R&U governed by Pathway

- Delivery organisations within CPD will match the needs of each programme and project reflecting the change in technology, working practices and access to the railway
- Communication system projects must include within their project scope and costs all associated building, electrical, cooling, security and fire requirements

Conversely all other projects having components within their scope that requires communications support shall make allowance in their scope, programme and budget for the necessary support for project delivery and on-going support.

13.12.4 Other supply chain and procurement strategies

The TfL Category Management project has initiated a review of assets that may benefit from cross TfL procurement. Within communications assets this has been identified as:

- CCTV cameras and monitors
- Help points
- Customer information systems

The strategy is to maximise equipment procurement opportunities without compromising maintenance agreement or performance requirements.

Access

Both capital programmes and maintenance are developing delivery plans to maximise daytime hours working on stations, such that activities could be completed in traffic hours, where safety and operational controls are not compromised.

The default position for all engineering work relating to communications systems is to fully utilise Engineering Hours wherever possible. Any interventions requiring access in excess of those available in timetabled Engineering Hours will be planned and agreed in co-operation with Events and Closures in order to ensure that the needs of both the programme and operations/customers are considered. Our strategy assumes the following access principles:

Reactive fault correction is required to meet the performance code. Therefore procedures are in place for the resolution of service affecting failures such as voice alarm or OPO system failure.

Procedures are in place and generic access codes agreed for traffic hour’s access for work that does not impact on the operation of the railway and does not increase safety risk to staff or passengers. This work includes cleaning, back of house maintenance, servicing of non-essential communications equipment. The default position for routine maintenance is that activities will be completed in engineering hours.

Where possible for outer London stations agreement will be sought for work to be delivered in extended engineering hours, or in traffic hours through local agreements with operational staff, where safety and operational controls are not compromised.

Where communications systems are increasingly software based utilising digital IP based networks remote monitoring, software updates and corrective actions will progressively become the default means of maintenance. This requires a new approach to access which will be developed in conjunction with other common access improvements.

13.13 Asset Management Capability & Development

13.13.1 Opportunities to improve the Asset Strategy

Core Development Areas

ICT systems and communications assets in particular are new asset grouping. The asset management capability for this area is therefore at the beginning of its development journey. The current areas of capability development are as follows;

On-going development of a whole life cost model for communications systems. The model will be closely aligned to similar models being developed for other ICT systems.

Training of asset management staff in whole life asset management, preparation and operation of models and other decision support tools.

Development of a series of overlays to the model to demonstrate the impact, synergies and opportunities as a result of operational changes being proposed by COO particularly as part of the customer service transformation programme.

On-going improvement of the strategic risk assessment, by including business risks and operational risk assessments. .

Review of impact from technology change particularly with regard to change in working practices, competence requirements, use of COTS systems and integration with IM systems. Improvements will be made to the model to assess these impacts on the delivery programmes.

13.13.2 Application of Whole Life Cost Management

The communications systems will be managed in accordance with whole life cost principles by optimising maintenance, renewals and life extension works, taking into account cost, risk, performance and asset condition / obsolescence. The management of communications systems also has to recognise the change in user requirements both internally and with external stakeholders such as the emergency services. All project work to upgrade existing assets, or to construct new ones, will adopt cost effective designs that consider future maintenance costs and sustainability.

Where funding constraints do not allow the adoption of the least WLC approach, the optimum solution for the funding available will be selected and long term financial impact of that decision understood. Decisions will be informed by:

- Asset knowledge derived from delivery teams
- Performance of the systems and assets
- Supplier obsolescence and technology refresh plans

13.13.3 Good Industry Practice / Innovation

LU is committed to identifying and implementing improvements to the management of its communications assets, in order to ensure that it is carrying out the right activities, in the optimal way and that the price it pays is value for money. LUL is also committed to continuous improvement, to ensure that it is always looking for opportunities to improve its asset management.

LU is committed to identifying and implementing improvements that are consistent with Good Industry Practice (GIP) on the basis that such improvements will further improve the economy and efficiency of its maintenance operations.

The ICT team identifies and applies good practice methods and processes to ensure that the all assets are managed as economically and efficiently as possible, through training, research, and interaction with other infrastructure owners. Good practice continues to be developed through the Knowledge and Development Projects.

13.13.4 Ongoing Initiatives

There are a number of ongoing initiatives that promote general GIP and innovation, including;

- Use of objective industry standards, such as PAS-55 accreditation.
- Sharing of knowledge, good practices and lessons learned with other infrastructure organisations, through conferences and working groups, such as the asset owners' forum.
- Implementation of Knowledge and Development Programme to research new techniques and innovative ideas applicable to communications systems. This includes demonstration of "proof of concept" to COO to initiate potential process change or
- Information sharing with other transport operators such as Network Rail, RATP Paris and MTR where common challenges and opportunities exist e.g. CCTV system migration to digital, 4g telephony and Wi-Fi installations
- Use of the CoMET benchmarking group to identify good practices from other metros, and understand how these have been introduced.

13.13.5 Knowledge and Information

The Information Strategy for communications assets recognises LU's overarching vision and strategy for information, i.e. enabling the right information, to the right people, at the right time and at the right cost.

The strategy is to obtain up-to-date and accurate asset information to support the following asset management activities;

- Optimisation and prioritisation of the delivery plan(s) using whole life cost modelling techniques
- Assessing the financial benefits of planned improvement activities
- Determining the operational and financial impact of asset unavailability or failure
- Making life cycle cost comparisons of alternative capital investments
- Determining the end of economic life of assets/asset systems i.e. the point in time when the asset related expenditure exceeds the associated income.
- Determining the cost of specific activities (activity based costing).
- Obtaining asset replacement values
- Assessing the financial and performance impacts of deviating from plans
- Assessing overall financial performance
- Undertaking the ongoing identification, assessment and control of asset related risks
- Ensuring compliance with statutory and regulatory obligations.
- Following a review of information needs, the strategy is to develop an 'asset management dashboard', which will bring together from various sources all the asset information required to support the above activities.
- All information required to support the life-cycle management of the assets is held in the Core Asset Information (CAI) repository, which contains approved documentation relating to projects, maintenance, inspections and assessments. Controlled processes are in place to ensure the information held is complete, accurate and up to date.
- Asset information requirements will be regularly reviewed and, in order to ensure cost effectiveness, information will not be maintained if it is no longer required, or if the costs of maintaining the information outweigh the benefits.

13.13.6 Investment Prioritisation

Investment planning is prioritised in terms of safety, condition and compliance, performance (availability and reliability) and cost to maintain. Maintenance, work is prioritised (within the plan/budget) resulting from inspections to manage safety, compliance with applicable legislation and standards, condition based risk, performance and increased operational costs.

Priorities can change during the annual TfL planning round to reflect the Mayor's objectives. In addition, plans have to adapt to meet any change to the performance targets which are agreed with TfL annually and detailed in the Asset Plan and reflected during the quarterly financial forecasting process.

This investment prioritisation is currently supported by the use of decision support tools. However, two whole life cost models (one Communications and one Information Management) are now being developed which will incorporate all ICT systems. This will enable various strategic scenarios to be applied in terms of the level and scope of capital works and/or maintenance carried out on all or selected systems in order to achieve the required level of performance within given cost constraints.

13.13.7 Development of Asset Management Capability

Asset knowledge has been significantly improved by proactively managing the asset condition reporting process. By involvement of both the engineering authority and end user a more comprehensive list of condition and performance concerns have been compiled. This has been used to inform both the work bank and strategic risk register. Quarterly reviews are held with Engineering and Maintenance to review changes to concerns and risk.

13.13.8 Benchmarking

The benchmarking of communications systems is at an early stage of development having previously been considered part of stations. The strategy is to develop benchmarking to support investment and business planning decisions. This will be achieved by:

- Comparing the delivery of outsourced maintenance contracts
- Comparison with other TfL businesses with similar assets such as DLR and Overground
- Data from the asset category framework contracts
- Comparison with Network Rail and TOC's
- Comparison with other transport operators

13.14 Risk and Opportunities

The evolution of communications systems is going through a period of intense change both internally and externally. This offers a number of risks and opportunities to LU over both the short and long term.

13.14.1 Business Change

The business change programmes have highlighted new technology and communications systems in particular as a fundamental enabler for change. This gives the opportunity to automate functions or use new technology to complete tasks faster or better. However, the rush to adopt new systems and technology brings the risk of poor requirements definition and selection of systems.

13.14.2 Obsolescence

Traditional communication systems through technological development are moving towards a digital IP based solution. This process of migration to digital needs to be managed to mitigate the risk of the change being led by manufacturers and suppliers. LU need to manage the migration to ensure performance and cost is managed and that convergence does not happen faster than the business is able to respond.

The change to digital systems introduces other uncertainties that are not an issue with analogue systems. This includes compatibility of systems and software and failure of suppliers to continue to develop software. Multiple standards both driven by national bodies such as ISO and BS and manufacturer trade associations are seeking to mitigate these problems but there will be a period over the next 3 to 4 years where these issues remain uncertain.

Correct management of obsolescence can also deliver benefits such as a reduced asset base, easier provision of remote condition monitoring and synergies with other asset such as sharing data transmission on a local or wide area network

13.14.3 Commercial Opportunities

Commercial exploitation of communication systems for mobile telephony and data transmission offer a major opportunity to LU as the demand for mobile systems continues. Commercial revenue is able to support the business case for initial investment as proven by the introduction of Wi-Fi. Ongoing revenue also support future maintenance and refresh costs. However, the opportunities for commercial exploitation must be measured against the operational needs of the railway and ensure its safe reliable operation at all times. A fine balance has to be struck to maximise revenue whilst ensuring the operation of railway services.

13.14.4 Delivery

Delivery of capital projects and maintenance for communications is over complex. If delivery of communications is not changed we risk:

- Failing to reduce unit costs
- Continuing with multiple supply chains delivering differing solutions to common issues

- Continuing to provide dissimilar systems across the network leading to training and maintenance issues in the future

13.14.5 Resources, Skills and Competence

The change from traditional communications systems means we have a challenge to adapt both our internal and our external suppliers' resources to meet the installation and maintenance needs of the new technologies. This will need to be managed over a period of time to ensure traditional skills are not lost when they are still required.

The change in technology however brings the opportunity to introduce new suppliers and experience into both the capital and maintenance programmes.

14 Strategy Integration

The London Underground railway is a complex system of many interacting parts which must all work together to achieve the desired functionality, performance and reliability which is demanded to operate and improve the service.

Key asset interfaces include;

Platform to train - Reducing dwell times and risks at the platform train interface.

Train and track - Developing the Wheel Rail Interface plans to minimise wear and potential for defects in context of increasing service volumes.

Train and Infrastructure - Managing and removing constraints to operate reliably and improving capacity by removing speed restricted infrastructure areas.

Upgrades – Ensuring all system interfaces are understood and managed through to successful project completion.

A critical aspect of developing our overall strategy is to ensure that our asset strategies, operational delivery, commercial development and engineering strategies are aligned. In terms of the asset strategies this means that we define interfaces and are clear on the criticality of the interfaces, define how we organise to manage these interfaces and in which element of the plan they are covered.

An asset and system level matrix has been prepared to ensure that we cross check that the asset strategies properly cover integration on a risk basis. In parallel, work is underway to develop the Intranet so that, for example asset, commercial and engineering strategies are more visible and easily accessible to improve collaboration across the business and the practitioners who need access to the information.

15 The Asset Management Improvement Programme

The Asset Management Improvement programme (AMIP) is focussed on improving LU's asset management maturity and is focussed on the key areas identified in figure 1. Whilst this improvement programme refers to LU, where suitable, activities will be integrated across TfL to facilitate a move to a single TfL wide approach.

LU achieved PAS55 certification in 2011 and will be undertaking certification against ISO55001 in 2014. As part of the ISO55001 certification, LU will also generate AM maturity scores against the IAM's 39 asset management subject areas. This will then be used to further refine the AMIP. LU will prioritise the AMIP on areas that have the greatest impact on improving business performance. In this respect LU may chose to remain at maturity level 3 where no immediate business benefit can be realised.

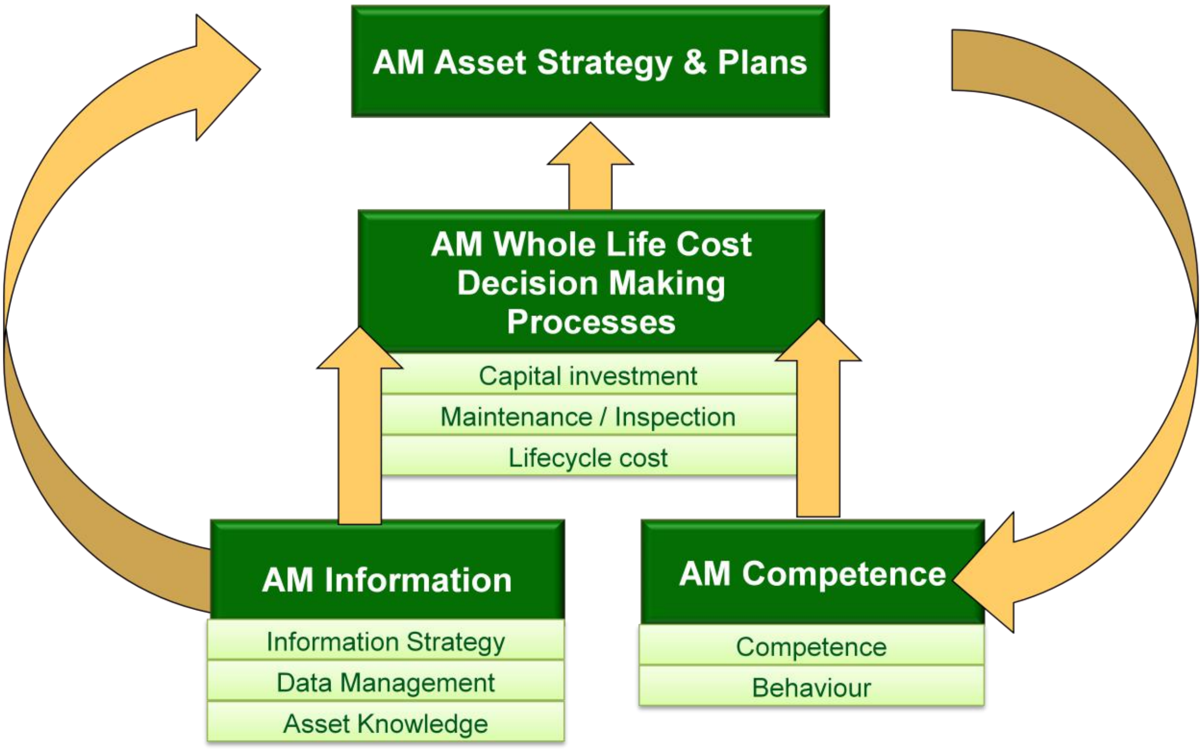


Figure 52: Asset Management Improvement Priorities

15.1 Asset strategy and plans:

The asset strategy specifies the major inspection, maintenance and renewal interventions that take place over the life of the asset. These interventions need to be optimised to ensure that they provide the best whole life cost for the asset. The asset strategy needs to be based on a thorough understanding of the asset base, asset degradation and the impact of asset condition on safety and performance.

- Good practice process for strategy development covers the following stages:
- Asset description
- Historical analysis
- Asset criticality
- Asset degradation, asset condition, failures and consequences
- Intervention options
- Cost and performance scenarios
- Life cycle cost and cost/volume/output forecasts
- Investment optimisation
- Strategy selection

The asset management plans are being continually improved and this will continue as the decision support processes and asset information continues to improve. A 'lessons learnt' exercise was undertaken following the completion of the LAN 13/14. This, alongside the need to adapt to recent organisational changes (e.g. the integration of Tube Lines), has resulted in an improvement plan which includes initiatives to ensure greater consistency and quality of data, standardisation of information; improved presentation of materials, improved maturity of performance models etc. These improvements are scheduled to be completed in time to support the development of the next LAN publication.

15.2 Benchmarking

Benchmarking will continue to be used to understand good practice asset management and enable LU to understand and develop towards world class performance where it is appropriate. This will be achieved through the following activities which will be used to identify current good practice and areas of improvement:

- Ongoing development of capex and opex comparator data
- Collaboration with CoMET, UTIP and other rail industry bodies to identify current rail practice and performance comparators.
- Direct contact with other major infrastructure owners to understand asset management practice.

15.3 Asset Management Whole Life Cost decision making

Whole life cost decision making is required throughout the lifecycle of the asset in order to minimise the cost. The greatest opportunity to optimise whole life cost occurs at the planning and acquisition stages, but important decisions are made at all phases of the asset life.

The following decision types are examples of those made throughout the asset life:

- Establishing asset requirements
- Specification, selection or design of a new asset
- Optimising asset utilisation
- Selection of the most appropriate maintenance strategy
- Selecting the most appropriate inspection strategy
- Determining the timing of asset refurbishment or replacement

Whole life cost decision making can be considered on three levels. Levels 2&3 cover the optimisation of decisions within an asset group and level 1 covers optimisation across all asset groups.

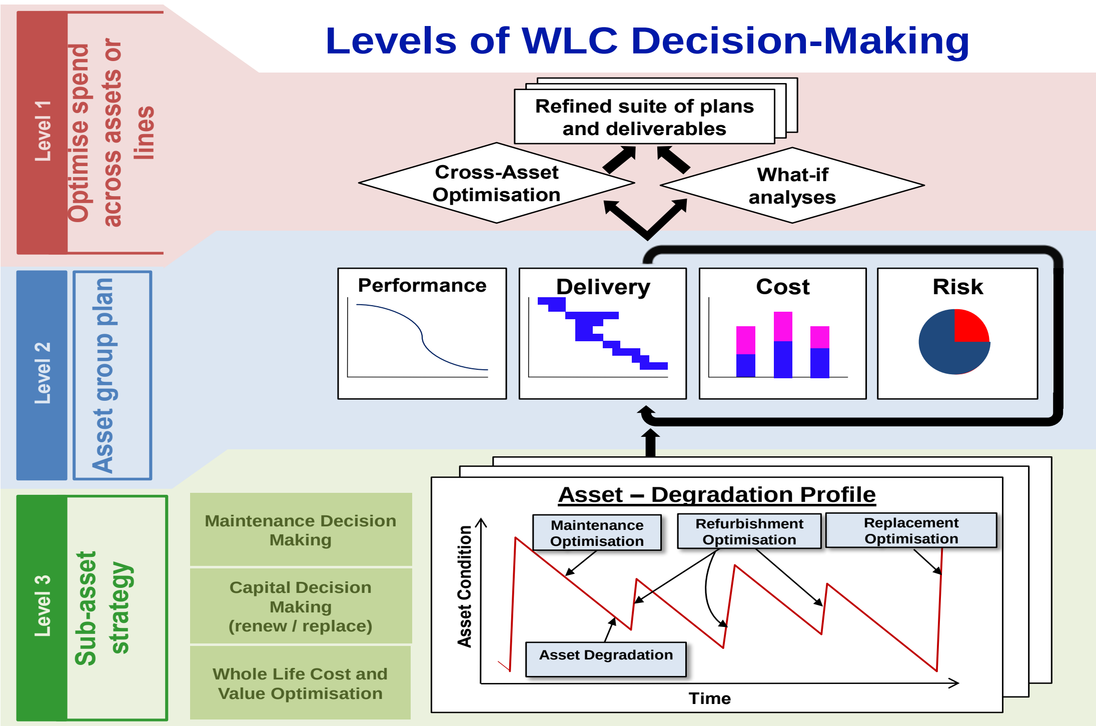


Figure 53: Approach to Whole Life Cost Modelling

Whole life cost decisions are often complex, requiring a good understanding of the condition/risk/performance interrelationship, good understanding of the capital cost of new assets and the operating and maintenance costs of existing assets as they degrade through their life. The use of models and tools to help understand these complex trade-offs is essential to improve the quality and consistency of decision making at the different points in the asset lifecycle, and to enable the comparison of multiple options/scenarios, to select the best whole life solution within funding and access constraints. LU will continue to develop WLC decision support tools, as appropriate, through the AMIP.

15.4 AM Information

Quality asset information is the foundation of good asset management and LU aims to optimise decision making by providing quality asset information through out the asset lifecycle. Analysis has been undertaken of the maturity of asset information processes and a series of improvement activities have been identified that cover all aspects of asset information.

The following improvement areas have been identified as key to the improvement of LU's approach to asset information improvement:

- Revision of the AI Strategy and development of an integrated AI development plan
- Review of AI governance, ownership and accountability
- AI standards review
- Development of AI quality measures and targets
- Improved AI visualisation through GIS
- Future strategy and integration of AM information systems
- Identification of mandatory and secondary information
- Improved AI handover between projects and maintenance lifecycle stages
- Improved data collection through the use of handheld technology.

These will be included in the asset information strategy and asset information improvement plans.

As the project execution plans for these improvement areas are developed, the resultant projects will be incorporated in an overall 5 year improvement plan. Core to AI improvement is ensuring that there is a single integrated plan that covers all information projects. This will require all AI improvement activity to be part of this one integrated plan regardless of where in the organisation the activity is initiated.

This approach requires the identification of mandatory information for decision making and the measurement of information quality and completeness. Whilst many of the activities identified can be seen as enabling clarifying mandatory information and ensuring it is of the right quality and completeness will result in the greatest improvement in decision making.

15.5 Asset Management Competence

Competences represent the skills and behaviours required of individuals and teams. The competence requirements provided guidance for the development of individuals and teams as well as understanding where gaps might exist and present a risk to delivery of activity.

Competence frameworks covering technical, front line and behaviour are in place for each directorate and are being continually developed so that they also cover the specific skills required to deliver activity within the asset lifecycle.

The following AM competences areas have been developed that are relevant to all staff who are engaged in asset management activity across LU. The level and or applicability of competence required will vary significantly dependent on the role and they will be incorporated, where appropriate, in to competence frameworks for Engineering, Commercial, Project Management, and Sponsors. These are the core competences for Asset Strategy and Investment roles.

The key AM competences are:

- Asset management strategy development
- Whole life cost analysis
- Asset management planning
- Developing asset management capability
- Risk management and performance improvement
- Information management.

TfL are adopting an integrated 'Job Family' approach to competence and AM competences will be incorporated in competence frameworks as they go though this process over the next 3 years.

To support AM competence development,, training will be developed and delivered aligned at three levels: introductory, intermediate and advanced levels. The introductory aims to provide a general awareness and will be relevant to all staff involved in AM activity whilst the advanced level will be provide detailed development for staff who are engaged in AM activity as the core part of their role. A key part of AM will be self learning and mentoring which will be undertaken on an on going basis.

15.6 Asset Management Knowledge, research and development

Asset management knowledge, research and development will address gaps identified in the overall knowledge of the asset, significant improvement opportunities are identified or improvement in overall AM practice is identified, activities will be developed through the knowledge and development plan. This will cover a number of areas including:

- Development of Improvement in WLC decision making process
- Development of asset technical strategy and knowledge
- Improving asset knowledge
- External benchmarking

16.0 List of Abbreviations

ACCAT	Adhesion condition controllers assessment tool
ACR	Asset condition report
AI	Asset information
ALARP	As low as reasonably practicable
AM	Asset management
AMS	Adhesion Management System
AMS	Asset management strategy
ARM	Active risk manager
ATC	Automatic train control
ATO	Automatic train operation
ATP	Automatic train protection
BSP	Bulk supply points
BTP	British Transport Police
CAS	Condition assessment system
CCTV	Closed circuit television
CDMT	Condition and data monitoring toolset
CER	Communication equipment rooms
CoMET	Community of Metros
COO	Chief Operating Office
COTS	Commercial of the shelf
CPD	Capital Project Directorate
DALI	Daylight saving controls
DfT	Department for Transport
DLO	Direct labour organisation
DLR	Dockland Light Railway
DMR	Depot maintenance regime
DNO	Distribution network operators
DP&E	Depot plant & equipment
DTP	Deep tube project
ELLCCR	Extra low loss composite conductor rail
EMS	Environmental management system
ESTEEM	Stations WLC decision support toll
ETE	Electrical track equipment
FSCP	Future station capacity plan
GP&F	Group Property & Facilities
HV	High Voltage
IM	Information management
IPR	Intellectual property rights
JLE	Jubilee line extension
JNP	Jubilee, Northern, Piccadilly
L&E	Lifts and Escalators
LCH	Lost customer hours

LFEPA	London Fire and Emergency Planning Authority
LUCC	LU Command and Control
LV	Low voltage
LVAC	Low voltage alternating current
MAID	mandatory asset information and data
MTS	Multi train simulation
NLE	Northern line extension
NLTSC	Northern line train service contract
NLU	Northern line upgrade
NTfL	New tube for London
P&C	Points & crossings
PCCT	Power, Cooling & Communication delivery Team
PED	Platform edge doors
PMVT	Primary means of vertical transportation
PPP	Public private partnership
PSC	Power Service Contract
PTI	Platform train interface
QICC	Quality inspection completion certificate
RAM	Reliability, availability and Maintainability
REW	Rail Engineering Works
RVAR	Rail vehicle access regulations
SCADA	Supervisory control and data acquisition system
SER	Signal equipment room
SFA	Step free access
SMVT	Secondary means of vertical transportation
SSL	Sub Surface Lines
SSR	Sub surface railway
SUP	SSL upgrade programme
TBTC	Transmission based train control
TLES	Tube Lines escalator services
TMR	Train maintenance regime
TOC	Train operating company
tph	trains per hour
TSSSA	Train support & spares supply arrangement
VLU	Victoria line upgrade
VOIP	Voice over internet protocol
WEEE	Waste electrical and electronic equipment
WLC	Whole life cost

Estimate (Stages 1-6)

Purpose

To provide an estimate of the cost of a project. The estimate provides:

- The initial baseline cost and must be reviewed and updated during the lifecycle
- The cost plan for cost checking and control during the design development stages
- The structure for cost feedback of completed project costs.

Applicability

This product must be produced for all projects.

Templates

For TfL generally, the following template applies:

- Project Estimate Summary (PES)

Estimating within Surface

- Contact Amri Denton or Martyn Quarterman

Estimating within TfL IM

- Cost Tracker for stage 1, 2, 4, 5 and 6
- Project Estimating Tool (PET) for stage 3

For London Underground (LU) the following templates apply:

- Cost Feedback Structure
- Estimate Review & Validation Checklist
- Estimating Strategy Template

Estimating within Other Rail Businesses

- TLF-029 :Estimate Review Checklist

- TLF-030 :Overall Estimate Statement
- TLF-031 :Request for Group Estimate
- TLF-032 :Detail Estimate Checklist - Levels 1 and 2
- TLF-148 :Overall Estimate Statement Form

All methodologies should include contents shown below.

Contents

Contents of the Estimate are defined by the respective templates and will include:

- Description and context of the project
- Listing of Assumptions, exclusions and qualifications
- Details of Unit Costs (i.e.cost per m2 or other applicable unit of measure)
- Statement of estimate accuracy
- Details of estimate verification and sign-off

Quality criteria

- All estimates must be prepared in accordance with applicable local business area methodologies and include recommended contents above
- Estimating strategy shall be set out in Project Execution Plan (PEP).
- For London Underground: Estimates must be prepared in accordance with Cost Feedback Structure and supporting LU Cost & Estimating System Coverage & Inclusion Rules. Estimates/Cost analyses must be prepared and uploaded to the LU Cost & Estimating System at the end of Stage 4 and Stage 6. Where the LU Cost & Estimating System is not used for estimate preparation, for example estimates prepared externally, such estimates must be structured and coded to allow upload to the sytem.
- An assessment of the accuracy (level of confidence) of the estimate should be included at each stage.
- All estimates shall be prepared on a 'base cost' basis i.e. excluding allowance for risk, contingency and inflation. Risk & Inflation through to completion should be allowed/shown separately in accordance with TfL guidance described in the Business Case Development Manual Appendix N and Tender Price Inflation Guidance

Business area specific

The following are specific requirements of this product by business area.

Area	Detail
London Underground	A bespoke cost and estimating system (RIB system) is used by LU to manage cost analyses and unit rates.
TfL IM	A bespoke cost and estimating tool used by TfL IM (PET)
Other TfL Business areas	Alignment of estimating methodologies is under development. Local practice should be used until further guidance on the extent of integration is available.

Document management

Estimates must be filed in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

The comprehensive RACI table used within IM can be found here.

Responsible (Responsible for producing all or part of quality product)	**Accountable** (Accountable for ensuring timely delivery of quality product)	**Consult** (Must be consulted when product is being produced)	**Inform** (A copy of the signed-off product must be sent to)
Sponsor (Stages 1-2) Commercial Lead (Stages 1-6)	Sponsor (Stage 1-2) Project Manager (Stages 3-6)	Planning Manager Subject Matter Expert User representatives	Finance (Business Accountant)

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for consultation	IPPM
A2	08/04/2013	Issued for use	IPPM
A3	10/07/2013	Updated for IM with links to PET	IPPM
A4	12/08/2014	TfL Project Estimate Summary (PES) added	Estimating Working Group

Guidance Document

G1448 TfL Lessons Learned

Contents

General Principles

The Pathway Lessons Learned product description stipulates that lessons should be captured throughout each stage of the project, programme or delivery portfolio lifecycles.

A project, programme or delivery portfolio should not be able to progress through a Stage Gate without producing satisfactory evidence that lessons learned activity has been carried out. There should be evidence that:

1) Lessons learned activity has been carried out and any lessons learned have been uploaded into the TfL Lessons Learned Portal,
2) the TfL Lessons Learned Portal has been searched for Lessons Learned for the next stage of the project, programme or delivery portfolio,
3) relevant lessons have been added to the project workspace, and,
4) if necessary, owners have been assigned to actions and progress of these actions are tracked

The lessons learned process should start with the Sponsor.

Informally, lessons learned can be uploaded and searched on the TfL Lessons Learned Portal at any point during the project, and can be attached to the relevant Pathway Product Management Plan (PPMP).

Lessons learned is a vehicle by which the business can identify processes and procedures for review or improvement as a part of continuous improvement. More information on this can be found here.

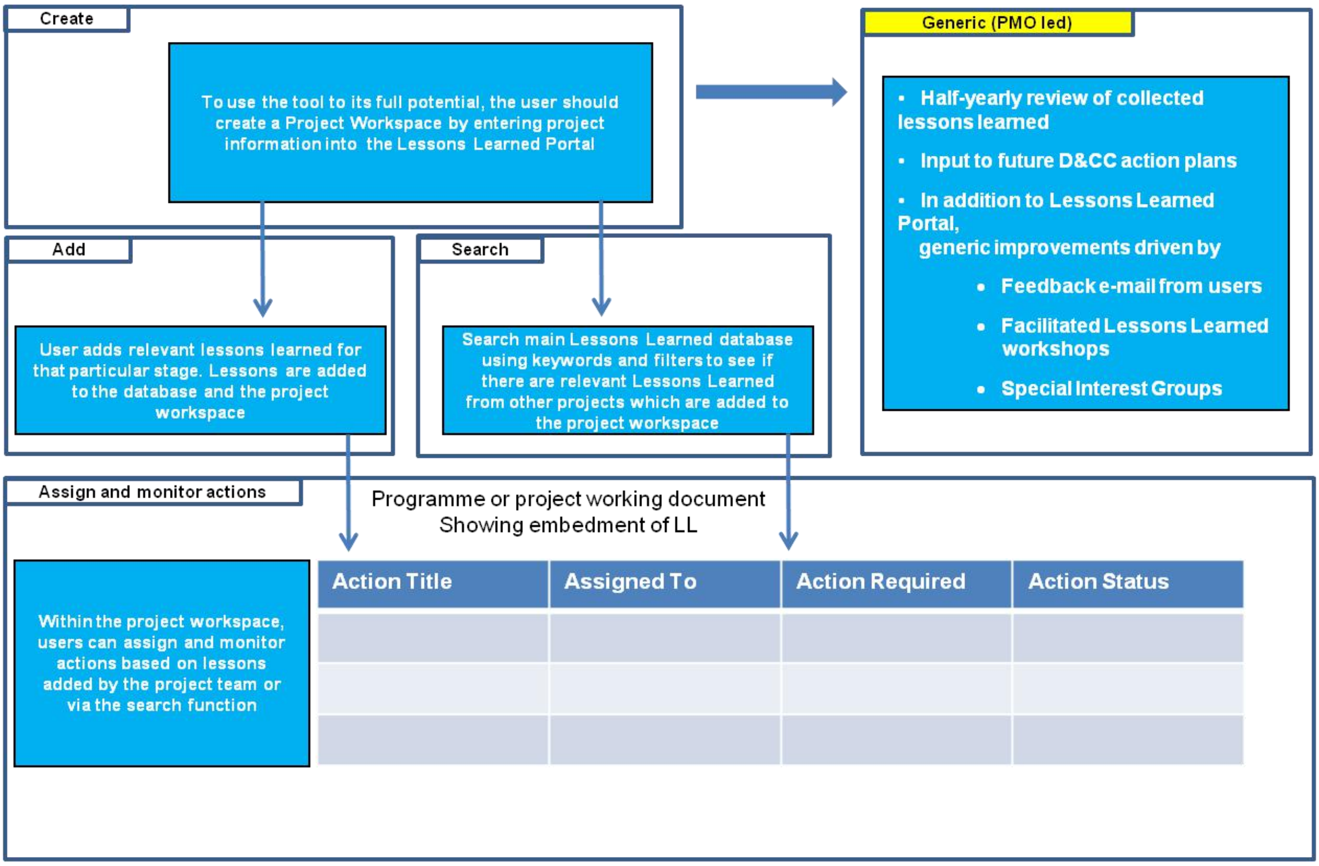
What is a Lesson Learned?

TfL Pathway states that the purpose of lessons learned is to capture and record project and programme activities that both went well and could have gone better, so that they can be usefully applied to other projects and enable the continuous improvement of processes and procedures.

Lessons can be drawn from a variety of sources and using different techniques.

A example of good practice can be found here [insert link].

TfL Lessons Learned Process



TfL Lessons Learned Portal

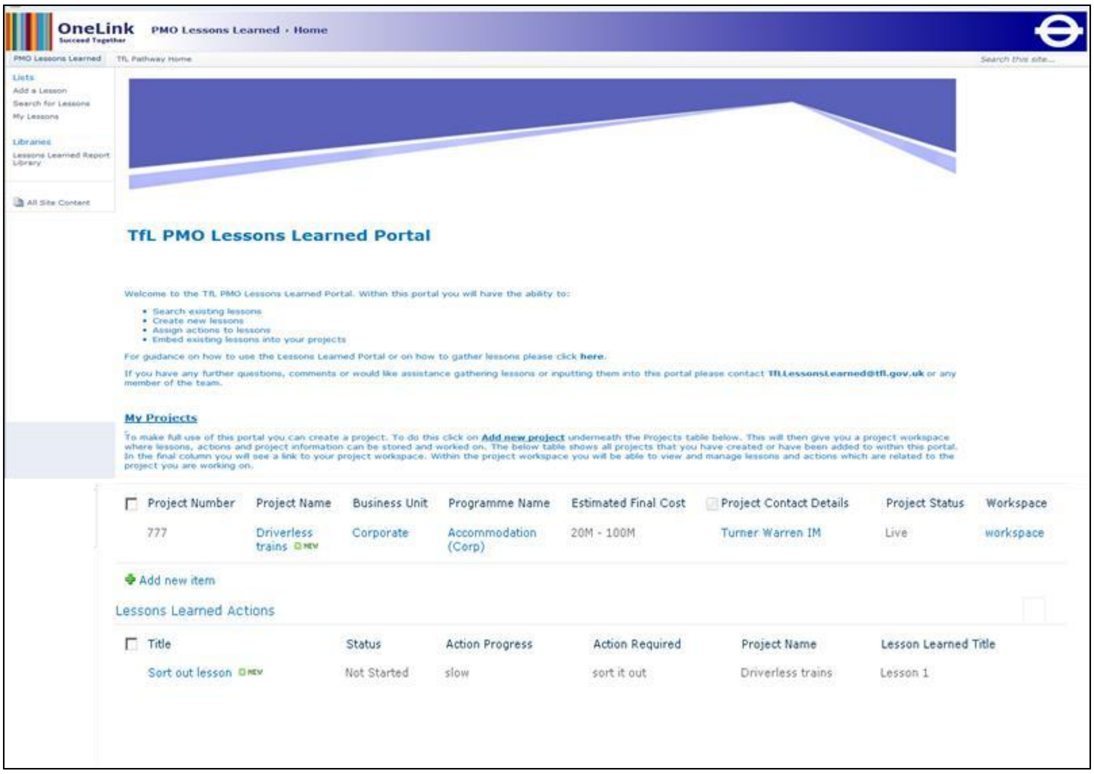
The TfL Lessons Learned Portal is a pan-TfL interactive repository.

It contains the following options:

- creating a project
- uploading and searching for lessons learned
- creating a project workspace where lessons can be attributed
- actions from those lessons can be assigned and monitored to demonstrate project based learning

Landing Page

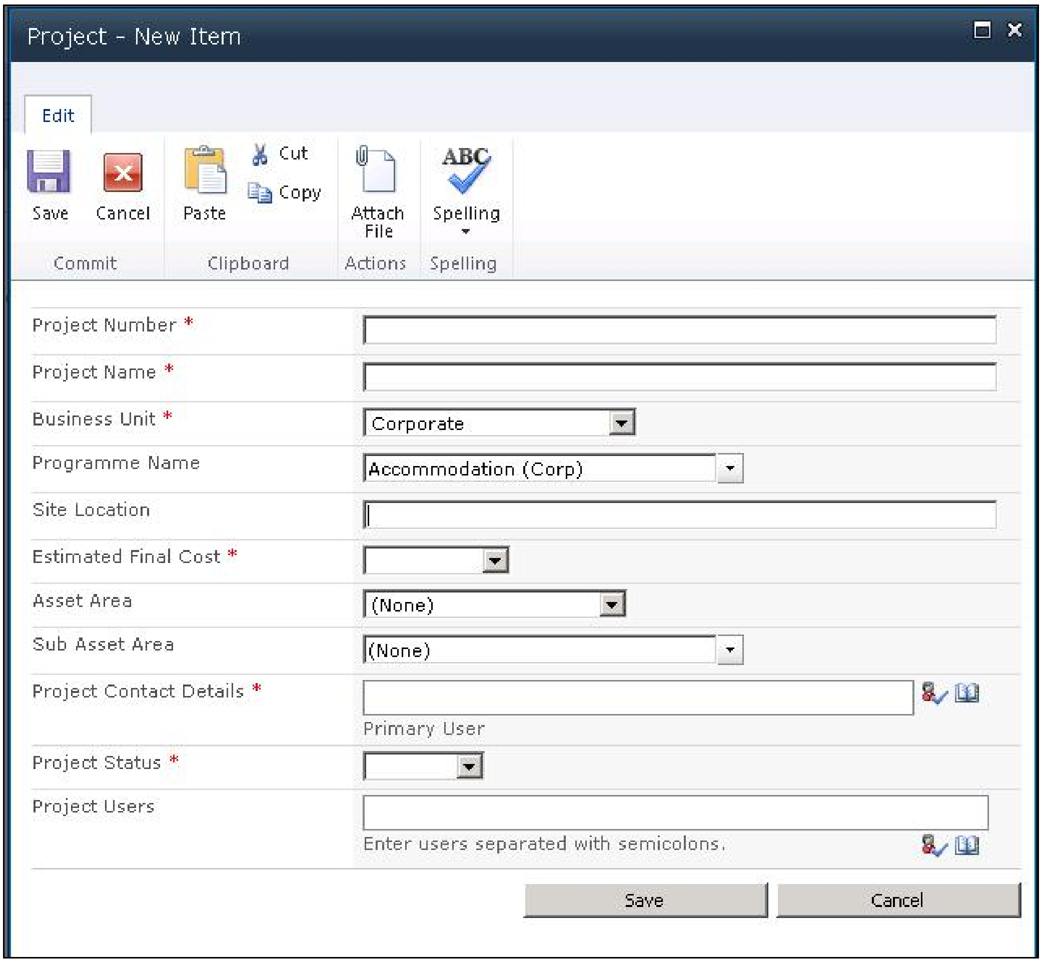
The personalised landing page below illustrates [i] what projects the user has involvement with, [ii] any actions assigned to the user, which have fallen out of the search and [iii] any lessons that the user has added.



Creating a Project

To be able to utilise the database to its full potential and evidence project learning, it is recommended that users create a project workspace prior to adding their lessons to the database.

If the characteristics of the project change, then the 'Project Contact' has the permissions to amend these details.



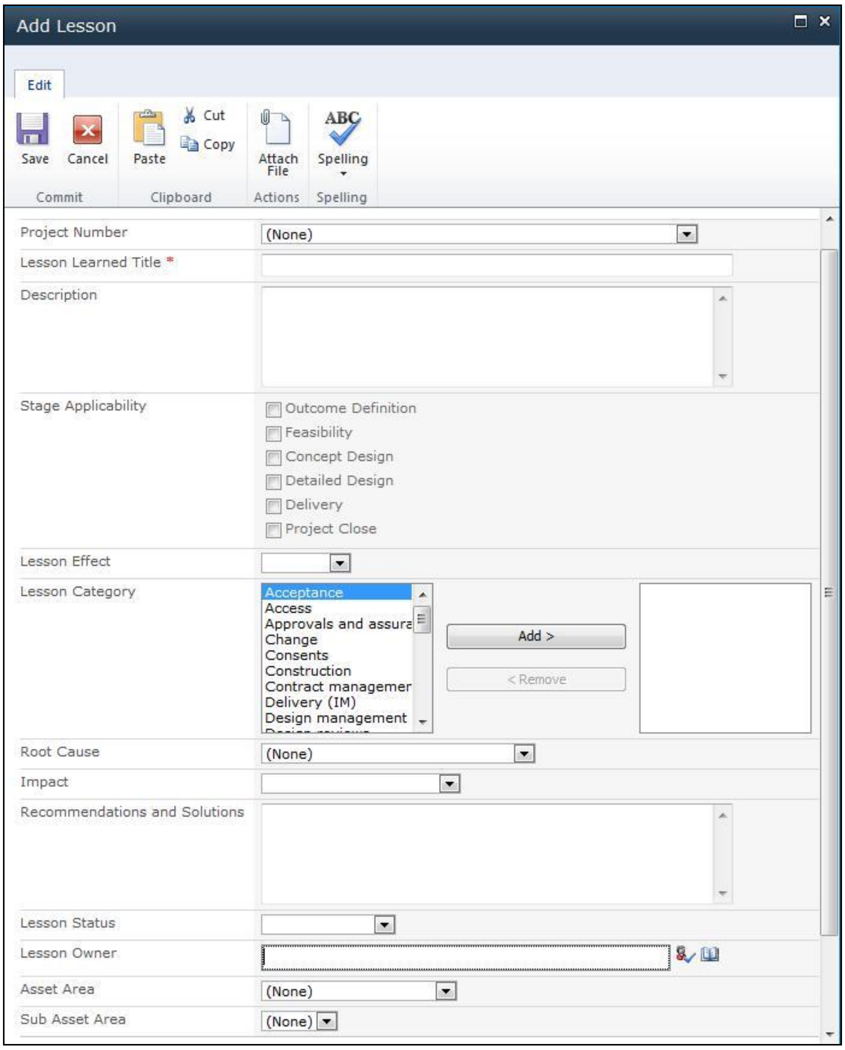
Field	Guidance
Project Number	Enter the UIP, unique index to prevent duplications. This is a mandatory field. If you are working on a project without a UIP, then please

Field	Guidance
	consider using a letter and number combination that is unique. For example, BUSCHANGE1234AB (Programme-Number-PM Initials).
Project Name	Enter the name of the Project. This is a mandatory field.
Business Unit	Enter the name of the Business Unit from the drop-down menu. If you have a lesson which is 'External to TfL', a list of external bodies is provided within the Programme drop-down list.
Programme Name	Enter the name of the Programme from the drop-down menu. This is a mandatory field. If you are working on a Programme that is not listed, then you should select 'Other' from the dropdown and contact the TfL Lessons Learned mailbox for inclusion.
Site Location	If applicable, enter the site location.
Estimated Final Cost	Enter the Estimate Final cost from the options provided in the drop-down menu. This is a mandatory field.
Asset Area	If applicable, enter the Asset Area
Sub Asset Area	If applicable, enter the Sub Asset Area
Primary Contact Details	Enter the name of the primary contact. This should be a member of the project team that will be able to provide more information on a lesson if contacted by a user. For example, this could be the Project Manager. This is a mandatory field.
Project Status	Indicate if this project is live or not live. If the status is live, the project will be listed in 'My Projects'. This is a mandatory field.
Project Users	List project team members who should have access to this project and its lessons learned. The members of this field will have access to updated project details if required. Roles that be could considered are Assistant Project Manager, Project Engineer, HSE Advisor, Commercial Manager and Maintenance.

Adding a Lessons Learned

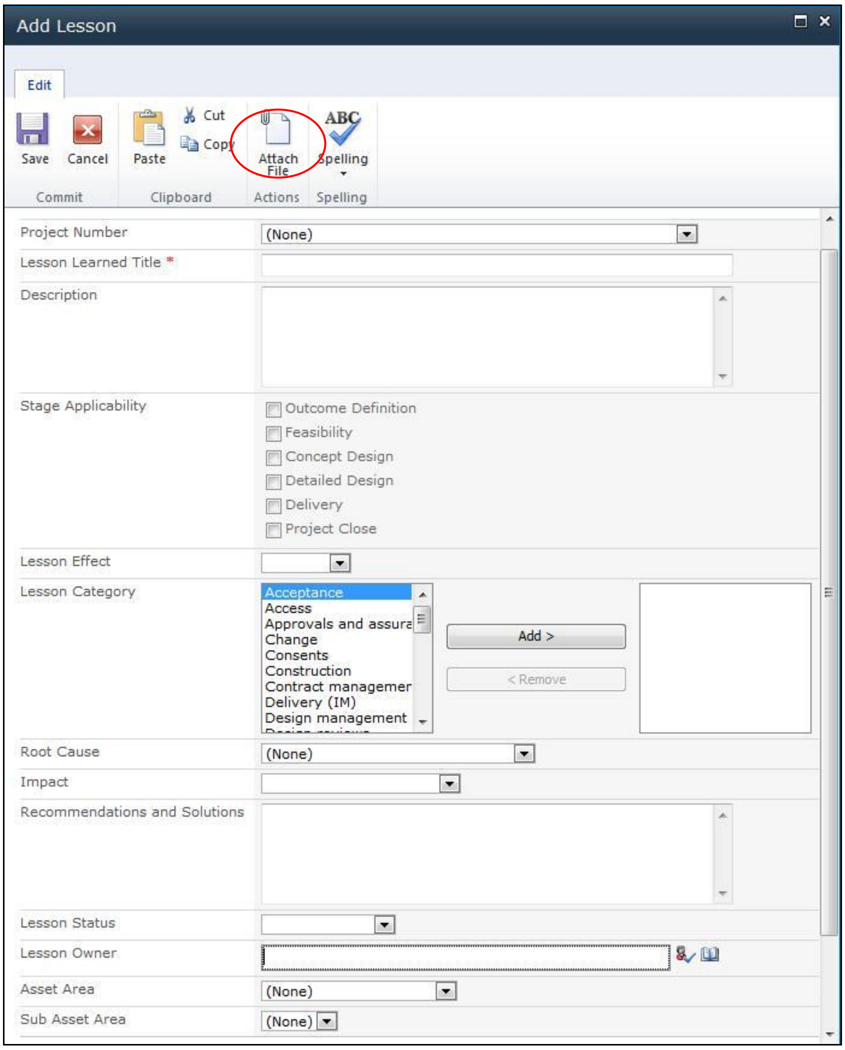
Users will be able to add lessons to the database as a standalone activity or assign them to a project. To have the opportunity to assign the lesson to a project, the project must be registered on the database.

There is also an option for the 'Lesson Owner' to amend the lesson.



Field	Guidance
Project Number	If this lesson applies to a particular project, insert the project ID in this field. This will assign the lesson to this particular project and will be visible in the projects workspace. If the lesson doesn't relate to a particular project, then this field can be left blank
Lesson Learned Title	What is the title of the lesson? Ideally this should be concise.
Description	Setting out the story behind the lesson. What happened and what was the impact.
Stage Applicability	What stages of the Pathway project lifecycle does this lesson apply to? There is an option to indicate more than one stage is necessary.
Lesson Effect	Did the lesson have a positive or negative effect on the project? Options are presented in a drop down menu.
Lesson Category	What category does this lesson fall under? Options presented in a drop down menu. There is an option to indicate more than one category where required.
Root Cause	What was the root cause of the issue? Consider using the 5 Why's to explain this. Options are presented in a drop down menu.
Impact	What level of impact did this have on the project? Low, medium or high. Options are presented in a drop down menu.
Recommendations and Solutions	What can be learned from this? What could be done in the future to minimise or maximise this?
Lesson Status	Options provided are: 'Searchable' and 'Non-searchable'. If the lesson is politically or commercially sensitive, the lesson will added to the database but will not be published. Additionally, this could be utilised if the lesson learned fields are not complete.
Lesson Owner	Who the project member responsible for this lesson? This is usually the project manager but could be another member of the project team.
Asset Area	If applicable, enter the Asset Area

Field	Guidance
Sub Asset Area	If applicable, enter the Sub Asset Area

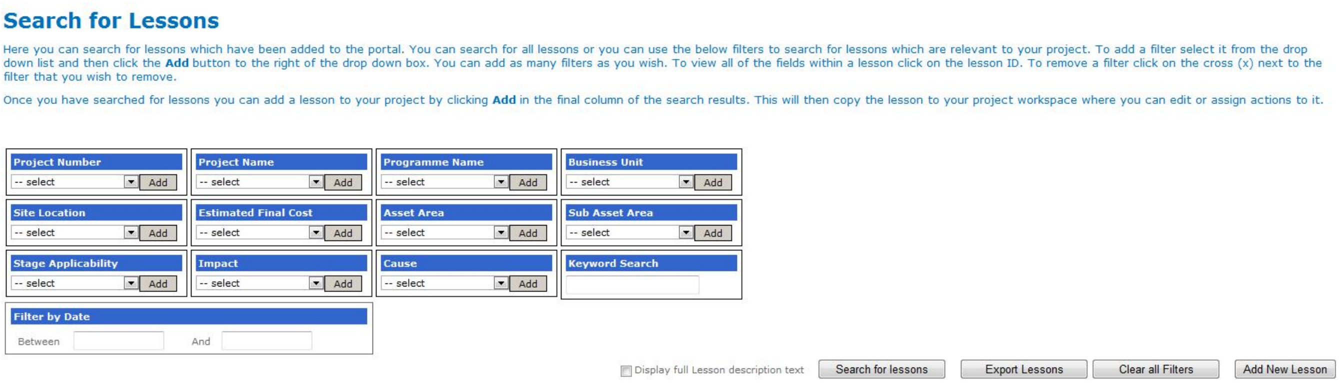


Users also have the option to attach files when completing or updating the lessons learned form.

Searching for Lessons Learned

When searching for Lessons Learned, the user is not restricted to just using the TfL Lessons Learned Portal. Users are encouraged to use other sources, for example, utilising COMET.

Please note that some of the data has been migrated from older systems and might not have the full level of detail that the business now expects.



Function	Guidance
Search Fields	Provides the user with search criteria. The search fields align with the fields used for creating a lessons learned. To utilise this function, use the drop down menu to select an option and then add it to the search criteria. The more options added will result in a narrower search.
Keyword Search	Provides the user with option to search for lessons using keywords or phrases.
Search for Lessons	Once the search criteria has been entered, 'Search for lessons'.
Export Lessons	Allows the user to export lessons matching search criteria to Excel.
Clear all filters	Use this option to reset the search criteria.
Add to Project	Select a project from the drop-down menu and click Add to copy the Lesson and attach it to the selected project. A project is only available to the user if they are included in that individual project.
Add New Lesson	Provides the user with the opportunity to add a new lesson to the database.

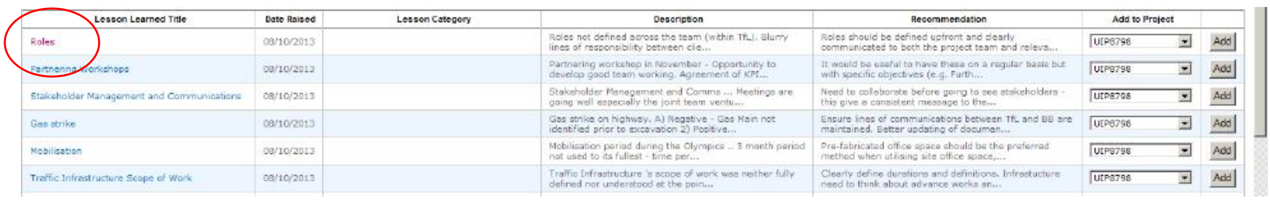
To select search options, the user should use the drop down option on the various available fields. When the appropriate selection has been found, the user should click on ‘Search for lessons’.

The user should note that the more drop downs that are selected, the more focussed the search will be, as shown below.

The user can also select more than one option per field, as shown below.

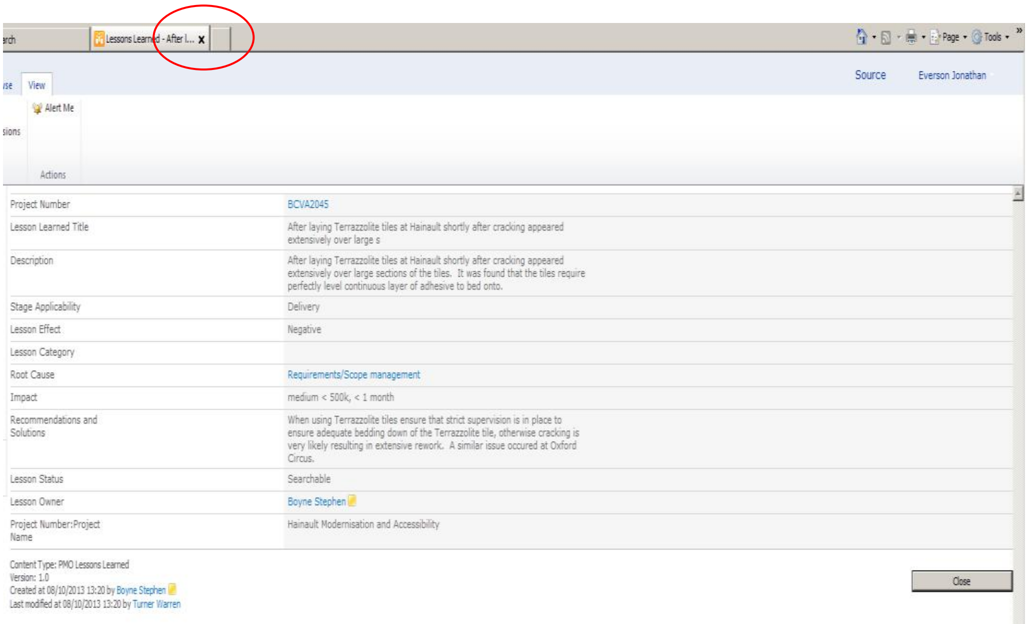
Viewing a Lesson within the Search Function

The user can view a lesson in its entirety by clicking on the Lesson Learned title, as indicated below.



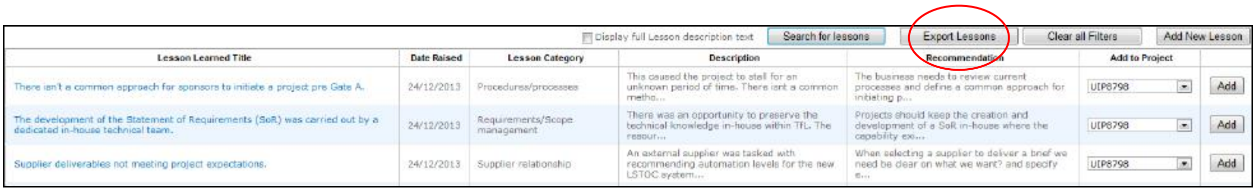
The lesson will then open in a new tab.

When the user has finished reading the lesson, it is advisable to close the tab itself rather than using the close function. Using the close button will lead the user to a list of lessons learned, which could be confusing.

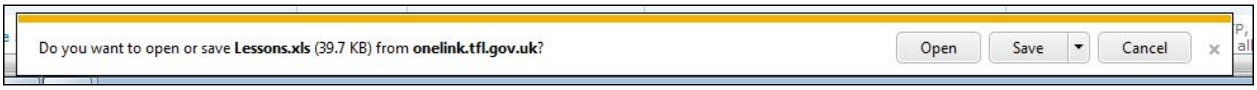


Exporting Lessons Learned to Excel

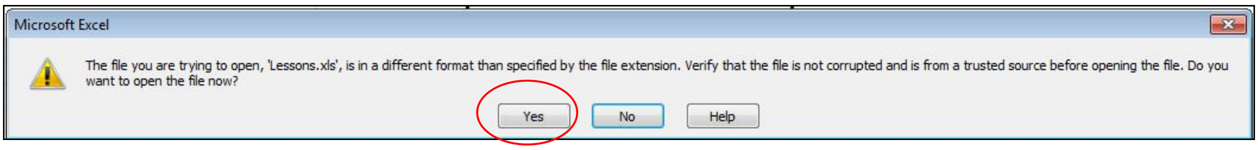
Once a search has been completed, the user can view these lessons in excel using the export option.



The user should click on the ‘Export Lessons’ button.



The user will then be given the option to ‘Open’ or ‘Save’ the document.

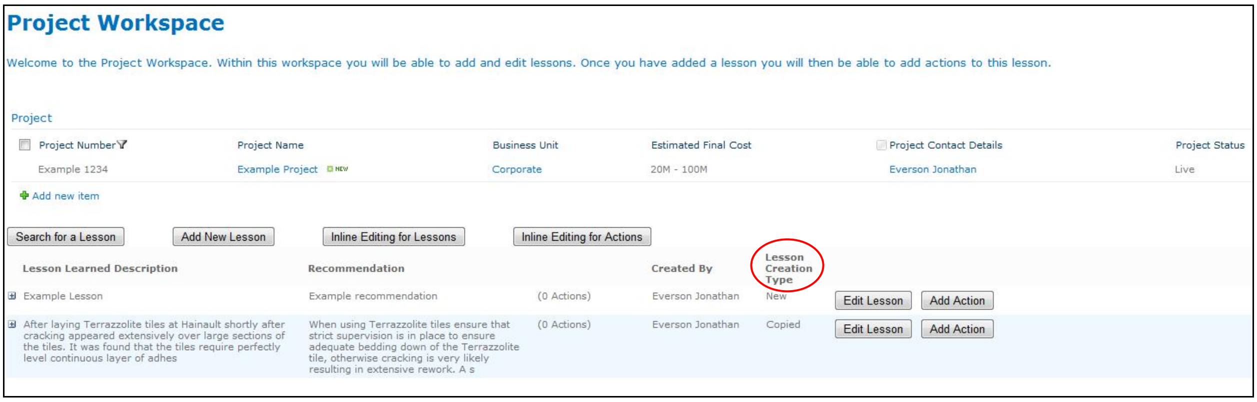


The user will then need to click ‘Yes’ to open the document.

Project Workspace

Following the search for Lessons, the user will be able to add relevant lessons to their project workspace, which is shown below.

This workspace can be presented to satisfy part of the Integrated Assurance Review (IAR) for the Stage Gate Certificate. This link should also be inserted into the Pathway Product Management Plan (PPMP).



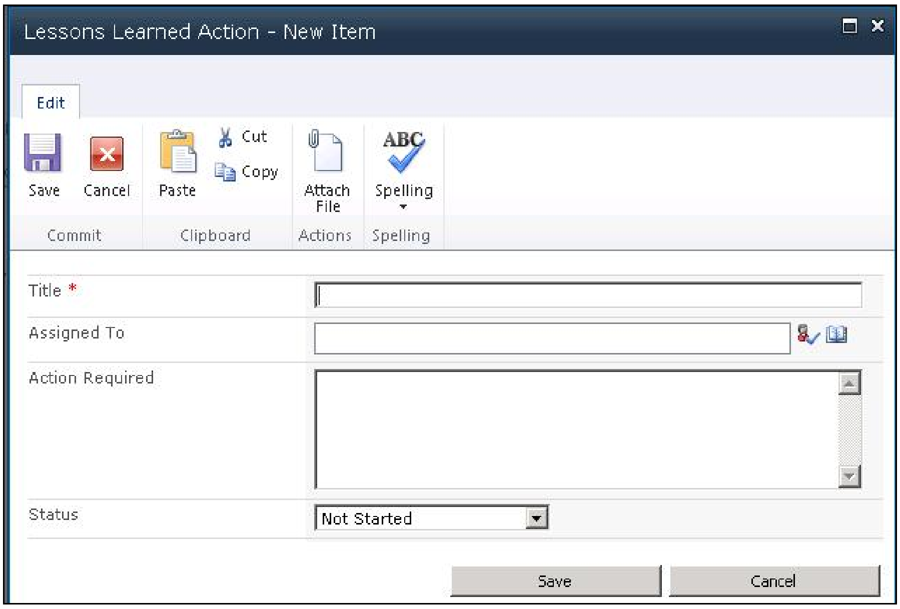
For clarity, the user will be able to note if a lesson has been added by a project team member or copied from the search functionality. This is listed under Lesson Creation Type (circled above):

Lessons Creation Type	Guidance
New	Lessons added to the project via the lessons learned form
Copied	Lessons added to the project via the search functionality

From the lessons selected through the search function, actions could be required to mitigate perceived risks within in a project environment. Within this function, actions can be assigned and progress monitored. In-line editing will be available for this function.

Adding an Action

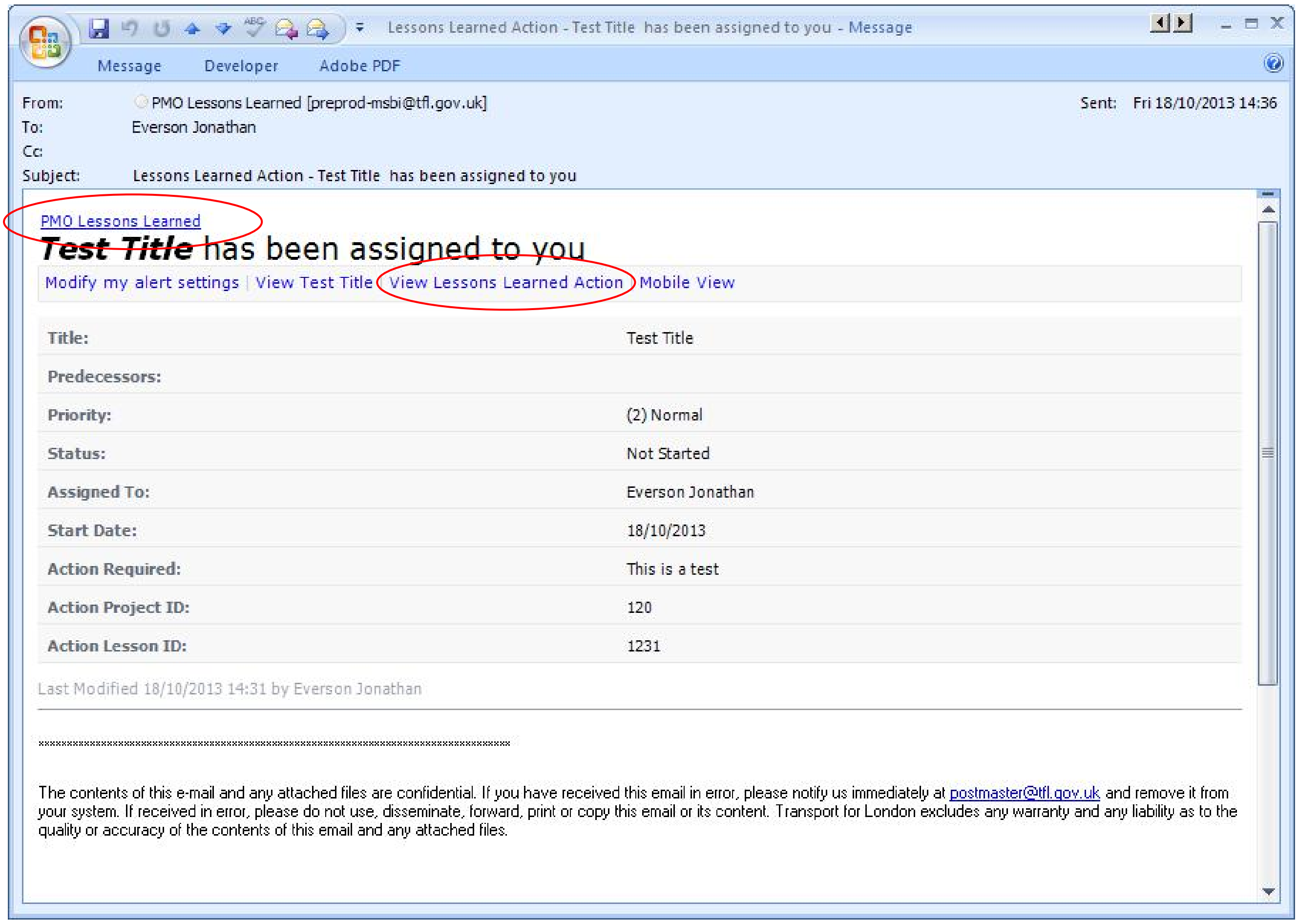
Within the project workspace, the user will be presented with a list of lessons that he has added either by the search function or if added individual to that project by the user. Actions can be assigned to project team members by selecting the 'Add Action' button next to the relevant lesson. The following screen displays ready for completion.



Field	Guidance
Title	What is the title of the lesson.
Assigned To	Which member of the project team has been assigned this task
Action Required	What action is required from the assignee
Task Status	What is the status of the task

The user will be able to amend, update and delete the action as the project progresses.

Once this action has been allocated, the assignee to that action will be informed of this via email.



If the assignee chooses to use this email to access the allocated task,

To access the allocated task via email, the assignee should opt for one of the options circled in red.

Link	Guidance
PMO Lessons Learned	This link will take the user/assignee to the PMO Lessons Learned landing page, where any allocated lessons are located.
View Lessons Learned Action	This will navigate to a page which lists of the users assigned actions.

Lessons Learned Report Library

The Lessons Learned Report library is a document repository for specifically written lesson learned reports. A Lessons Learned Report could be appropriate for projects closing out using older project delivery processes. Please be aware that if a project is following Pathway and using the Lessons Learned Portal, a section is provided in the Project Close Report for key lessons learned. If you have written a Lessons Learned report and wish to submit it, please send it to TfL Lessons Learned.

Harvesting Lessons

Lessons can be gathered using a variety of methods. An ideal opportunity to gather lessons learned is during review meetings. This gives the project team an opportunity to gather their lessons learned gradually. Lessons can also be discovered via less informal meetings. Lessons can also be added on an individual basis. Alternatively, Lessons Learned can be extracted using a workshop.

Lessons Learned Workshops

A Lessons Learned workshop is an opportunity for project, programme or delivery portfolio (from here on referred to as 'project') stakeholders to discuss what went well and what not so well at the end of a Stage. Attendance of a Lessons Learned workshop should not be restricted to project team members only. Key stakeholders, either internal or external, should be identified and invited to attend. If any lessons learned are identified, then they should be uploaded into the TfL Lessons Learned Portal for others to search and, possibly benefit from.

Ground Rules

Suggested ground rules for a Lessons Learned workshop are:

- No mobile phones or on silent so you can participate in the meeting
- Criticism of the project and its processes is encouraged
- Criticism of people is not permitted - this is not a blame game
- Participation is encouraged from everyone; differing views are healthy

- Be open, honest and constructive and make the meeting a positive experience for learning and growing

The following items could be required for the workshop:

- A timeline of the project, preferably on plotter sized paper, if not, A3 should suffice. See T Lessons Learned Timeline for a workable example.
- T Lessons Learned Forms – contains project and lesson learned data templates and drop down options.
- Blue and red stickers for pinpointing positive and negative periods during the timeline of the project
- Flipchart paper to theme the lesions via categorisation
- Post-it notes, pens et al

Workshop roles

- Facilitator – either a Knowledge Management team member or locally agreed facilitator.
- Scribe – to note the lessons on the template as they are built and agreed. This can either be carried out via paper based activity or straight into the Lessons Learned database.

Pre Workshop thinking

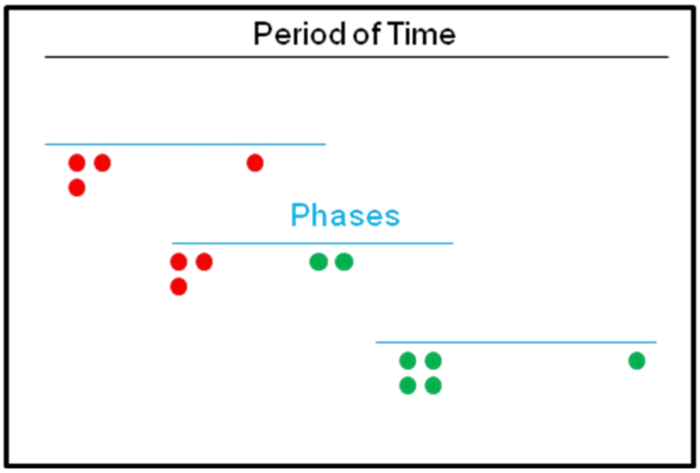
The project manager, possibly collaborating with key project team members and TfL Knowledge Management, should look at the characteristics of the project and agree on the key project themes such as: governance, communications, supplier management, operations and scope. Having five themes is a suggested number, but depending on the size and complexity of the project, this could be more or less than five.

Prior to attending the Lessons Learned workshop, all attendees should be encouraged to think about three things that (i) went well, (ii) went not so well and (iii) could’ve been done differently. This is only a guideline, attendees can suggest more or less if required.

Timeline Exercise

- Using the timeline of the project (on the A0 or plotter sized paper), attendees should be invited to place one green and one red sticker on the timeline to indicate where the project has gone well (green sticker) and where things have gone not so well (red sticker).

The image below gives an indication of how this could be constructed.



- This can be used as an icebreaker and will help the attendees begin to focus on the next activity.

Discussing, creating and agreeing Lessons Learned

- The attendees write out on separate post-it notes the three things that (i) went right, (ii) went not so well and (iii) could've been done differently. The attendee or the facilitator (whichever works for the forum) then place these on the flipchart with the categories on them.
- Once all the post-it notes have been placed on the flipchart, the facilitator should begin to group together any post-it notes with similar statements. The facilitator should seek clarification from attendees if any post-it notes are unclear and should also ensure that the attendees agree with any groupings.
- If there is a time limit on the workshop, then the team members should prioritise the categories and start with the most important.
- The group should then build the lesson using the following T Lessons Learned Form.
- At the end of the meeting, attendees have the option to write up additional lessons learned and share with the group for comment and agreement.

Post workshop

- Once all lessons learned are agreed, the scribe should share these with the attendees and upload to the TfL Lessons Learned Portal.

Further Assistance

If further assistance or guidance is required, please contact a member of the PMO Knowledge Management Team

Document history

Revision	Date	Reason for change	Author
A1	01/03/2014	Issued for use	TfL PMO Knowledge Management
A2	14/05/2014	Amendments to search criteria following feedback from users	TfL PMO Knowledge Management
A3	01/10/2014	General updates to document	TfL PMO Knowledge Management

Addendum

Include explanations of drop down selections, especially categories/root cause.

Category / Root Cause	Guidance
IM&M – Information Modelling	**IM&M** - A term used by TfL to describe what the industry has coined Building Information Modelling (BIM) and used to highlight not only the production and utilisation but more importantly the management of data and information. Information Modelling & Management is used to prevent misconception that BIM is only about Buildings. **Information Modelling** – Information Modelling is the process of creating data and information through the use of appropriate systems, following agreed standards. The output of this process would be an Information Model which could comprise of three constituent parts; graphical data, non-graphical data and documentation.
IM&M – Information Management	**IM&M** - A term used by TfL to describe what the industry has coined Building Information Modelling (BIM) and used to highlight not only the production and utilisation but more importantly the management of data and information. Information Modelling & Management is used to prevent misconception that BIM is only about Buildings. **Information Management** – Information Management is the collection, processing and management activities (including roles and responsibilities) of information, following defined procedures that ensure accuracy, accessibility and integrity of data and information.

Pathway Handbook

Project Controls

(Incorporating Integrated Project Controls)

Contents

General

What this handbook is for?

This handbook gives practical instruction and guidance on the management of projects.

A significant element of this hand book is dedicated to Project Controls which provides guidance on how to develop, integrate, publish, monitor, maintain and control a project in terms of scope, cost, time and risk.

Who needs this handbook?

You will need to refer to this handbook if you are involved in the delivery of a project for Transport for London (TfL). It is of particular relevance to roles associated with project, cost and risk management, project planning and financial accounting.

Project, Programmes and Delivery Portfolios

Programme management differs from project management insofar as it is more concerned with managing the interdependencies between projects, and the programme environment, rather than the projects themselves. With programmes, the projects are linked to deliver a wider business benefit whereas delivery portfolios may be a collation of projects not necessarily delivering a common benefit but linked by use of common resource or geography. For guidance on managing programmes, there is a dedicated Managing a Programme handbook.

A number of products are available within Pathway to support the management of projects, programmes and delivery portfolios. Project Controls, however, focuses specifically at the project level. Project performance is measured periodically and aggregated to a programme or delivery portfolio level.

The Execution Plans and other Core Documents

The TfL Pathway Product Matrix, contains Project, Programme and Delivery Portfolio Execution Plan templates, for use when planning and delivering programme and projects. The Execution Plan is a core document which is mandatory for every Project, Programme and Delivery Portfolio as appropriate.

The Execution Plans each contain a number of sections that may be written as separate documents or encompassed within the Project Execution Plan product description. The approach to drafting and structuring the document is dependent on professional judgement.

Other key documents in this section of the Product Matrix are the Schedule, Risk Register and Progress Report.

Benefits and Value

Benefits Management provides a structured framework to identify, capture, monitor, measure and report anticipated project benefits. Benefits and Value activities are summarised in the Benefits and Value Handbook.

Integrated Project Controls (IPC)

Introduction

Project Controls encompasses the people, processes and tools used to structure project scope, cost, time and risk. It allows project teams to plan, manage and control the project and mitigate cost and schedule issues and any risk that may impact a project. This requires collaborative effort from various project team members to develop and manage a project baseline that integrates scope, cost, time and risk - the result of which will effectively support project delivery.

The key to applying Project Controls successfully to any project is to develop and maintain a disciplined application of consistent data structures for scope (Work Breakdown Structure), cost (Cost Breakdown Structure), time and risk at the point of publishing the project baseline. This baseline is then adopted by the project team to control change and monitor performance. Changes to the baseline are managed via the change control process, thereby ensuring an Integrated Project Controls (IPC) solution.

The Figure 1 below illustrates the TfL approach, showing the key constituents of the IPC solution. Business planning, cost and time estimating, procurement and project approval initiate the project delivery phase, during which changes to project scope, cost, time and risk are controlled.

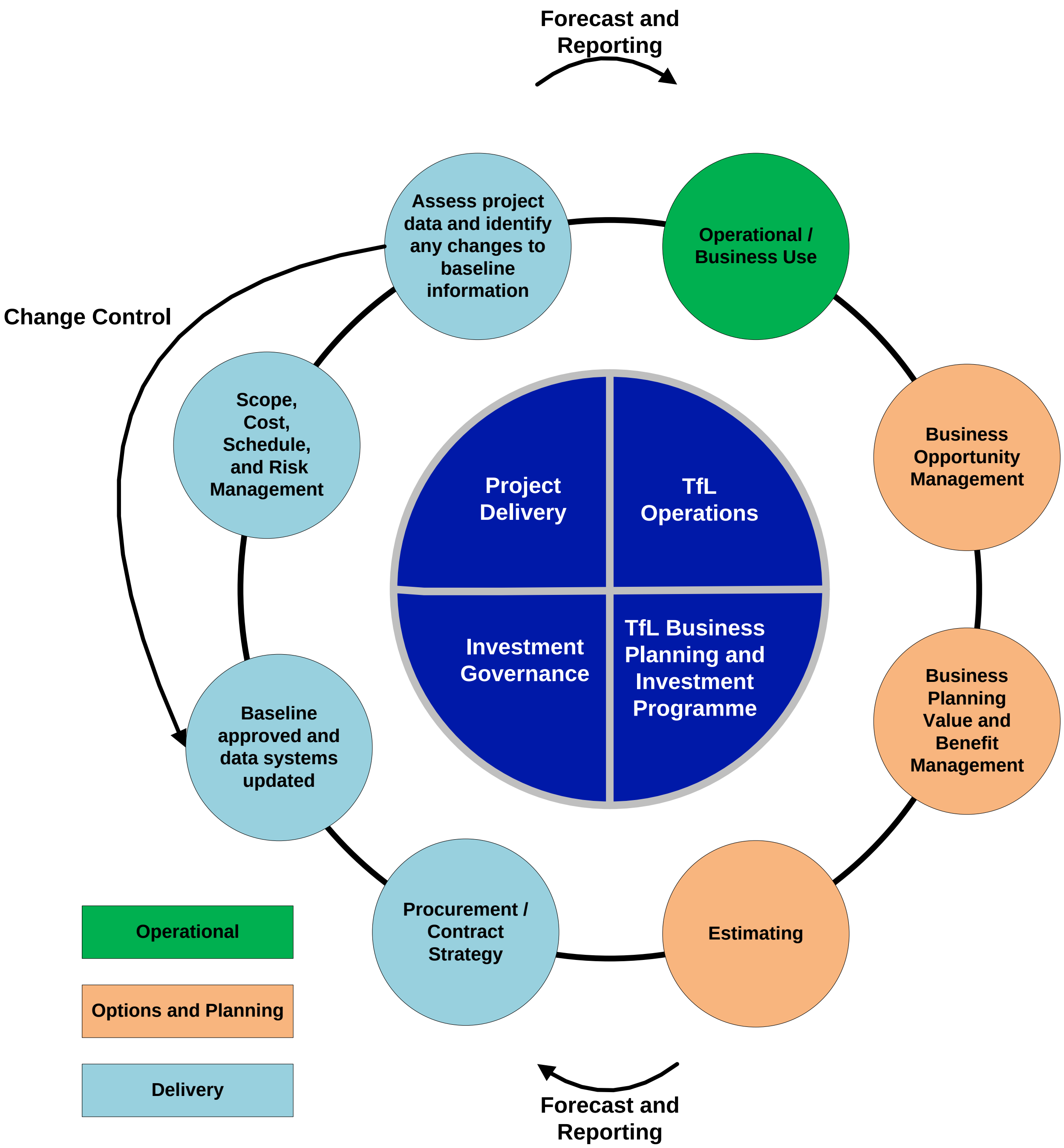


Figure 1: Integrated Project Controls and the Asset Creation Cycle

The diagram illustrates that the business planning and project delivery processes that create the asset and project controls are closely linked, and are cyclical. The impact of any changes to the baseline needs to be assessed and approved (via formal governance) and data systems updated. Periodically, a number of reports and forecasts will be generated, to inform management decision making. Baselines will be updated at key lifecycle stages, and following any budget or project authority adjustments.

The core systems are the planning tool (such as Primavera 6 or Microsoft Project), the financial tool (such as SAP or Oracle), the project reporting tools (such as MPD for LU and OPPM), the risk management tool (ARM) and the cost spreadsheet or cost system used to manage detailed costs, estimates and accruals.

IPC Methodology

The key principle for an IPC Solution is to ensure a project is under control. This is achieved by aligning and periodically publishing information which accurately reflects the status of the project. Project teams, and in particular the Project Manager, can then trust the data and make informed decisions.

In addition, an IPC solution will ensure:

- an enterprise level plan is developed centrally which will hold summary level project data (Budget, Planned, Actual) as the single source of true project performance
- the enterprise level plan is fed by key data from programme and project level plans held in the planning system (Primavera P6 or Microsoft Project)
- a standard project structure, in line with the contract packaging strategy, is developed by the project team in consultation with the PMO Programme Controls Team
- the agreed project structure integrates scope (including Repeatable Work Items (RWIs) and other resources as appropriate), cost, time, and risk, which is endorsed by the Programme Controls Team as suitable for adoption by the project team at the appropriate stage gate
- the project structure is consistent with the Pathway Lifecycles
- the project structure is reflected within the planning system and aligned across the financial, cost management and risk systems used by the project team to manage the project and monitor progress
- information can be summarised at contract package, project, programme, delivery portfolio, business unit and TfL levels

The Figure 2 below demonstrates how a project team will develop, finalise and publish the project baseline. This should be adapted as appropriate, for example simple projects may choose to combine some of the activities and workshops.

An example of a published project baseline, in terms of the project structure and how it is reflected within the contract strategy, SAP and the planning system is provided for reference.

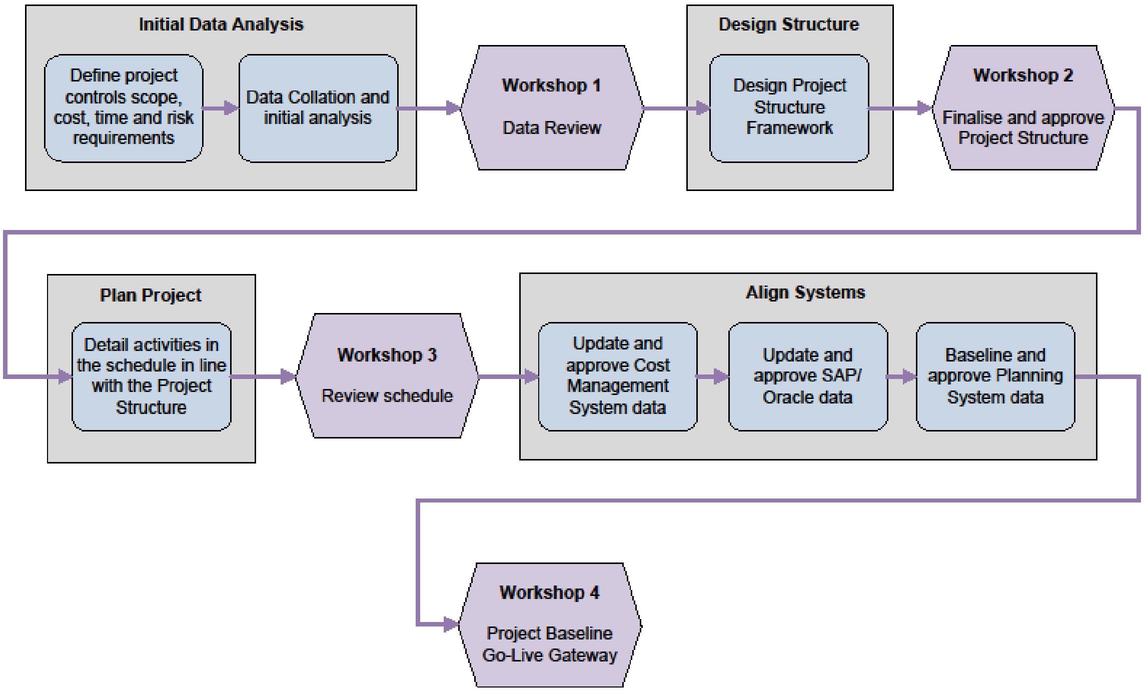


Figure 2: The Development and Publication of a Project Baseline

The project structure enables project scope to be wholly incorporated into work packages which can then be contracted and delivered by the supply chain or managed by the project team.

Figure 3 illustrates how the project structure fits within the overall TfL reporting framework and Pathway Project Life Cycle. The project structure maps 1:1 across the planning, cost management and finance systems at the Primary Work Package Level (level 3). As this level represents the work packages to be delivered by the contracted project suppliers, it is a significant input to the project procurement strategy. Performance is monitored and reported at work package level (level 3) and aggregated to project (level 2), programme or portfolio (level 1) and ultimately the entire TfL plan, or enterprise level (level 0).

Below level 3, project teams have the flexibility to provide further detail in terms of schedules and cost plans as appropriate. However, this must be aggregated to level 3.

The structure shall be cognisant of the TfL Pathway Lifecycle (level 4) and be able to reference RWIs and other resources (level 5).

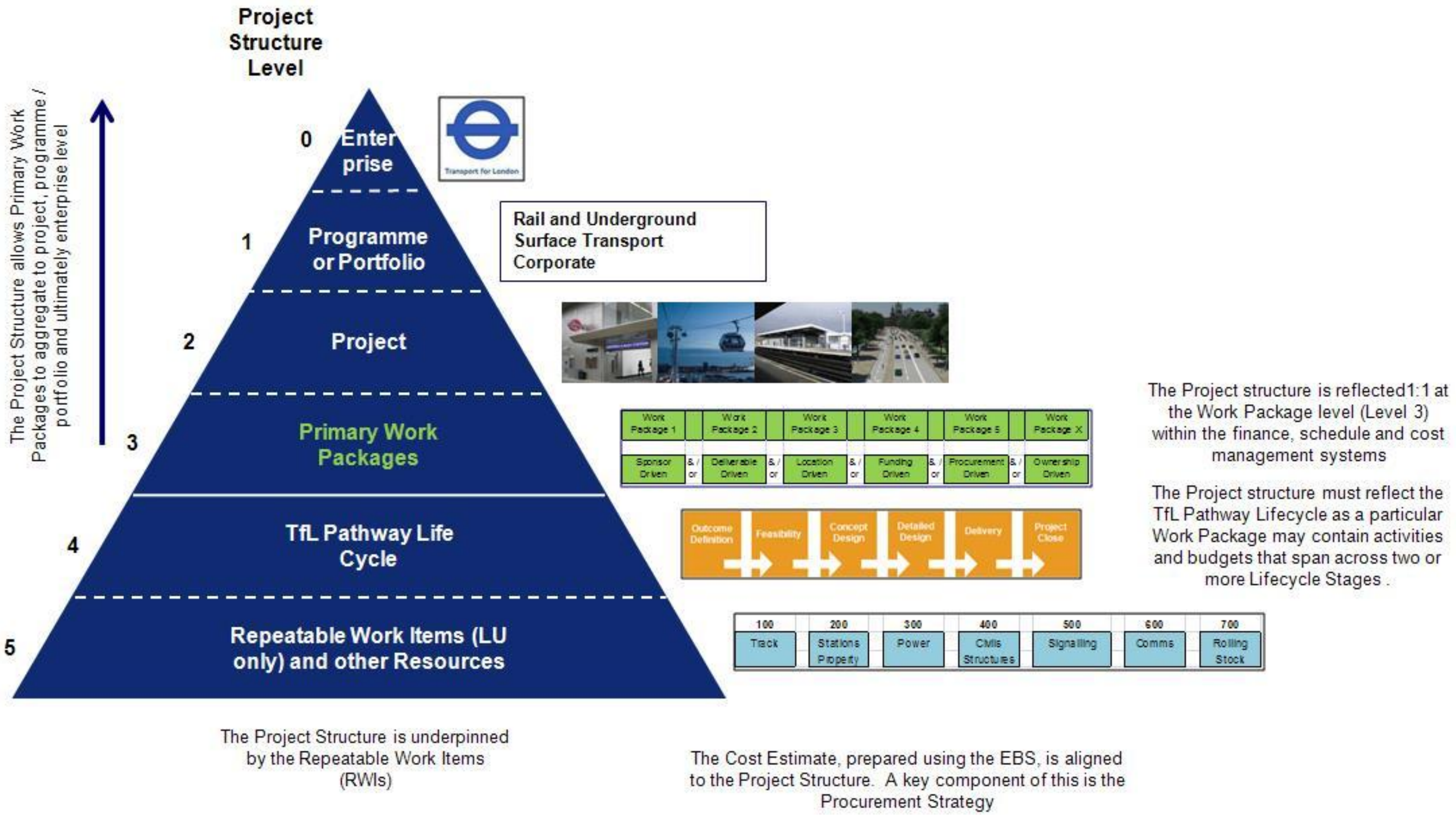


Figure 3: The Project Structure and the TfL Reporting Framework and Pathway Project Life Cycle

Organisation

Programme Controls

The PMO Programme Controls Team provides support for project teams to ensure projects are planned and managed effectively. It enhances and embeds existing core project systems and for introducing new project control strategies and tools, such as the IPC solution. The PMO Programme Controls Team will also support project teams establish appropriate project controls.

Project Controls within Project Teams

The project controls function within a particular project team will vary depending on the size, complexity and resource constraints of the project, programme or delivery portfolio. Complex programmes may have a specific Project Controls Manager whilst simple projects may incorporate the project control responsibilities within the planning and commercial functions or request resources from other programmes or corporate teams when required.

Figure 4 shows how the PMO Programme Controls Team and project team roles associated with project controls inter-relate.

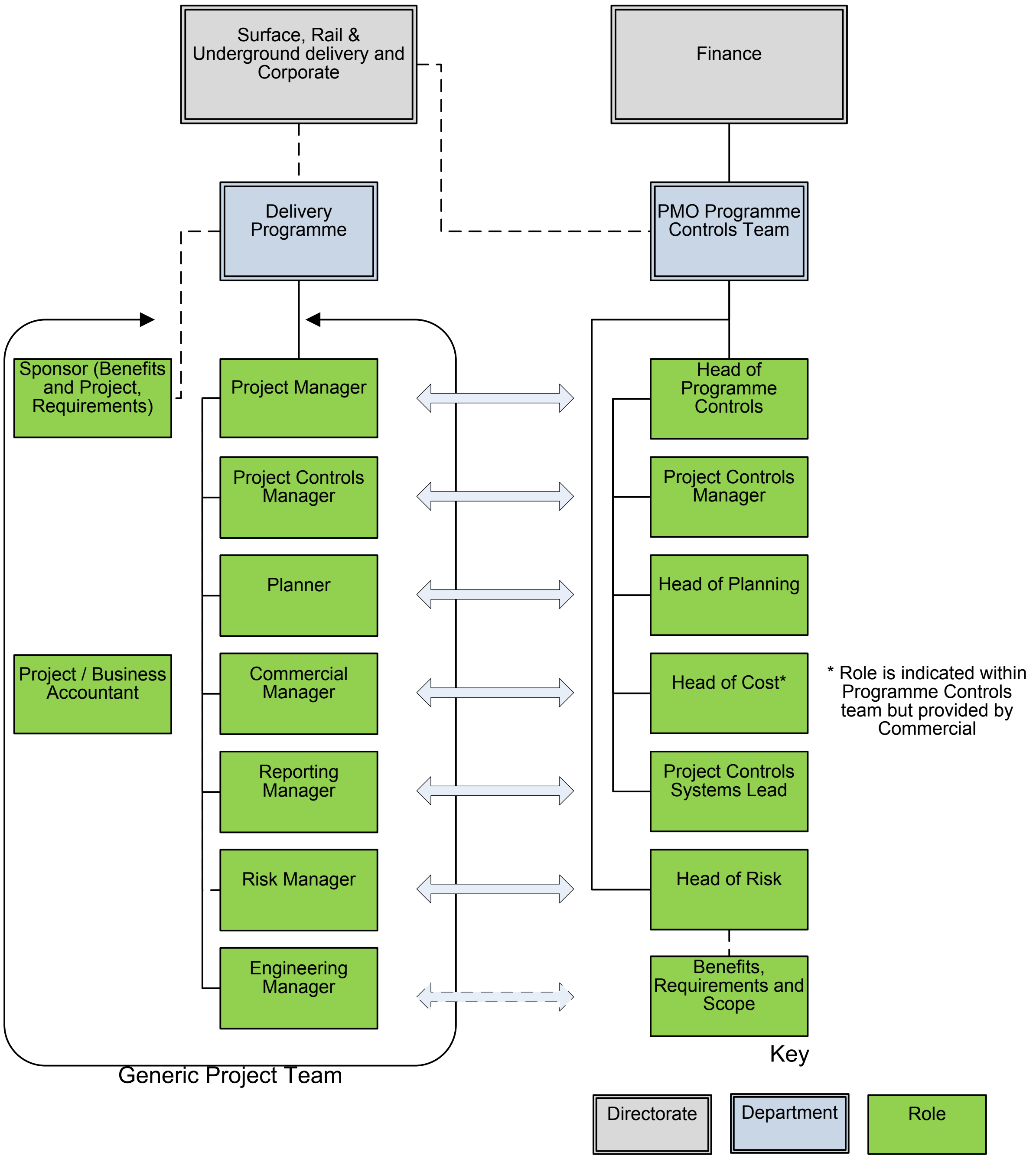


Figure 4: Inter-relation between the Project Team and PMO Programme Controls

In order to ensure that the elements of Project Controls are fully integrated, it is essential that key project roles work collaboratively to develop a robust solution that aligns scope, cost, time and risk from which progress can be reported consistently across TfL's governance structure. A generic overview of the key project delivery roles in relation to project controls is provided within Table 1 below.

Project Role	Project Controls Responsibilities
Project Manager	Responsible for applying the IPC solution on the project thereby ensuring the project team complies with project controls processes in order to maintain control of the project. Responsible for the development of the original project baseline and any subsequent changes.
Project Controls Manager	Responsible for ensuring the project structure is compliant with the IPC methodology and the integrity of project data submitted periodically. Also responsible for project reporting in lieu of a Reporting Manager.
Planner	Collaboratively build, optimise and maintain the project delivery schedule, in accordance with the planning processes, with other members of the project team and supply chain. Accurately measure performance and inform project management decision making process.
Commercial Manager	Develop the cost estimate in accordance with the estimating procedure. Manage the project costs in accordance with the baseline. Measure and assess supplier progress in order to update actual and forecast costs. Develop and implement the procurement strategy and support contract administration in accordance with the IPC methodology and commercial processes
Risk Manager	Facilitate and provide technical guidance for the identification and mitigation of risks and opportunities.
Reporting Manager	Responsible for all aspects of project reporting including timely submissions in accordance with the period reporting cycle and accuracy of data submitted.
Project Engineer (if applicable)	Responsible for ensuring the project requirements, as defined by the Project Sponsor, are accurately reflected within the project delivery scope via the Engineering Brief and Supplier Works Information.
Project Sponsor	Ensure that project baseline accurately reflects the project requirements.
Project / Business Accountant	Assure project finances are in accordance with TfL accounting rules and regulations.

Table 1: Project Team Responsibilities for Project Controls

Baseline Management

A baseline is an important concept in the delivery of a project. Proper generation of a project baseline will:

- provide a formally approved alignment of project scope, cost, time and risk at a point in time
- reflect the project's maturity at a point in time within the project lifecycle
- include sponsor requirements as the project scope
- allow for controlled project development and delivery
- provide a reference point for monitoring delivery performance and controlling change, e.g. through the use of Earned Value techniques.

During the early stage of project development, a preferred option will be established (usually at the end of the Feasibility stage) which represents the solution which fits the Sponsor Requirements for optimum value. At this point, a baseline should be generated for scope cost and time, however, it will be immature and subject to change as the scope and plans are further developed and refined.

During Concept Design, the design principles will be established which will allow the project scope to be "frozen" thereby providing an opportunity to generate a firm baseline from which the project can be controlled. At this stage gate, the first full project authority should be sought for cost and time, including project risk provision.

It's important to recognise that there is an inevitable time lag associated with translating requirements into scope, then design, and then subsequently updating the schedule, cost plan and risk register. Hence, establishing a baseline at a defined date will require freezing of some elements (i.e. requirements and scope) at an earlier point to allow sufficient time to develop the project plan.

The baseline reflects the choices that have been made during Feasibility and Concept Design. The resulting baseline should be approved by the Sponsor, the User Representative and principal parties accountable for delivery (i.e. Programme Director, Project Manager and Programme / Project Board).

Baseline Change Control

Once established, any changes to the baseline must be subjected to proper governance via the Change Control Register product description. This ensures that impacts of making changes are thoroughly assessed and that appropriate approval is secured for each change. Once approved, the changes can be reflected back into the baseline documentation (requirements, specification, design, cost plan, schedule, risk register etc.) and instructed to parties engaged in design and delivery.

Pathway Project Lifecycle and re-baselining / re-profiling

Within TfL, there are two terms associated with updating a baseline, namely re-baselining and project re-profiling.

Re-baselining is necessary if additional time or money is required outside of the current Project Authority (i.e. Estimated Final Cost (EFC) is greater than authorised baseline cost + risk provision) to achieve the project objective. At this point, a Change Request Form (an example of which is provided in the Change Control Register product description) must be approved by the appropriate authority.

The approved Change Request Form must be sent to the PMO, who will update the baseline to reflect any required associated changes.

Project re-profiling applies for changes within the current approved project authority. It requires the project baseline to be updated with new scope, new targets (that do not affect the project authority) and Programme Accountable Milestones (PAMs). This is generally a low level change to better reflect the project going forward and ensure robust forecasting. This process is governed by project / programme team.

Baseline generation in line with Pathway Lifecycle and re-baselining / re-profiling is shown in Figure 5 below.

Figure 5: Baseline Generation and Pathway Lifecycle

Scope Management

The primary purpose of scope management is to ensure that all the required work, and only the required work, is performed to complete the project successfully and deliver the planned benefits. This is accomplished by defining and controlling what is included in the programme or project and what is not.

The role of the Sponsor in defining the programme / project

Guidance on Sponsor Requirements can be found in the Sponsorship Handbook.

Changes to Sponsor Requirements are managed via Change Control Register product description so that impacts to project scope, cost, time and risk are properly assessed and understood prior to considering the change for approval. Any direction or clarification required by the project team should be formally provided by the Sponsor, which may be provided formally via a Sponsor's Instruction.

The role of the Project Team in defining and managing the project scope

It is important that the baseline represents the full scope of a project required to deliver the Project Requirements. Scope gaps may occur from project scope not previously identified as a result of a maturing design. Any variations to the baseline scope, cost, time and risk are managed via Change Control Register product description.

The Sponsor requirements are responded to by the Project Team throughout the project lifecycle as follows:

- develop the Project requirements which describe the project scope and Technical Requirements Specifications (where appropriate) which detail the functionality to ensure the proper interpretation and understanding of the Sponsor requirements
- freeze the project scope at the end of Concept Design to form the basis of a project baseline together with the project budget and target completion dates
- Project Sponsor reviews the project baseline to ensure that it is in accordance with the Sponsor requirements and ultimately will enable the Business Case benefits to be realised. Project Authority is granted on the basis of this baseline information
- Any changes to the Sponsor requirements initiated either by the Project Sponsor or as a result of reviewing the baseline, must subsequently be reflected in an updated Business Case.

Once the baseline is fixed, the scope is further developed via detailed engineering design and business benefits realised via delivery, handover and ultimately integration into the existing operation. As the project progresses through these stages, outputs such as the detailed design, testing and commissioning and handover plans are verified and validated against the Specifications and Requirements. The performance of the operational facility is finally compared with the published benefits.

An illustration of how the business benefits flow through to form the baseline scope which is ultimately delivered by the project team is given below in Figure 6.

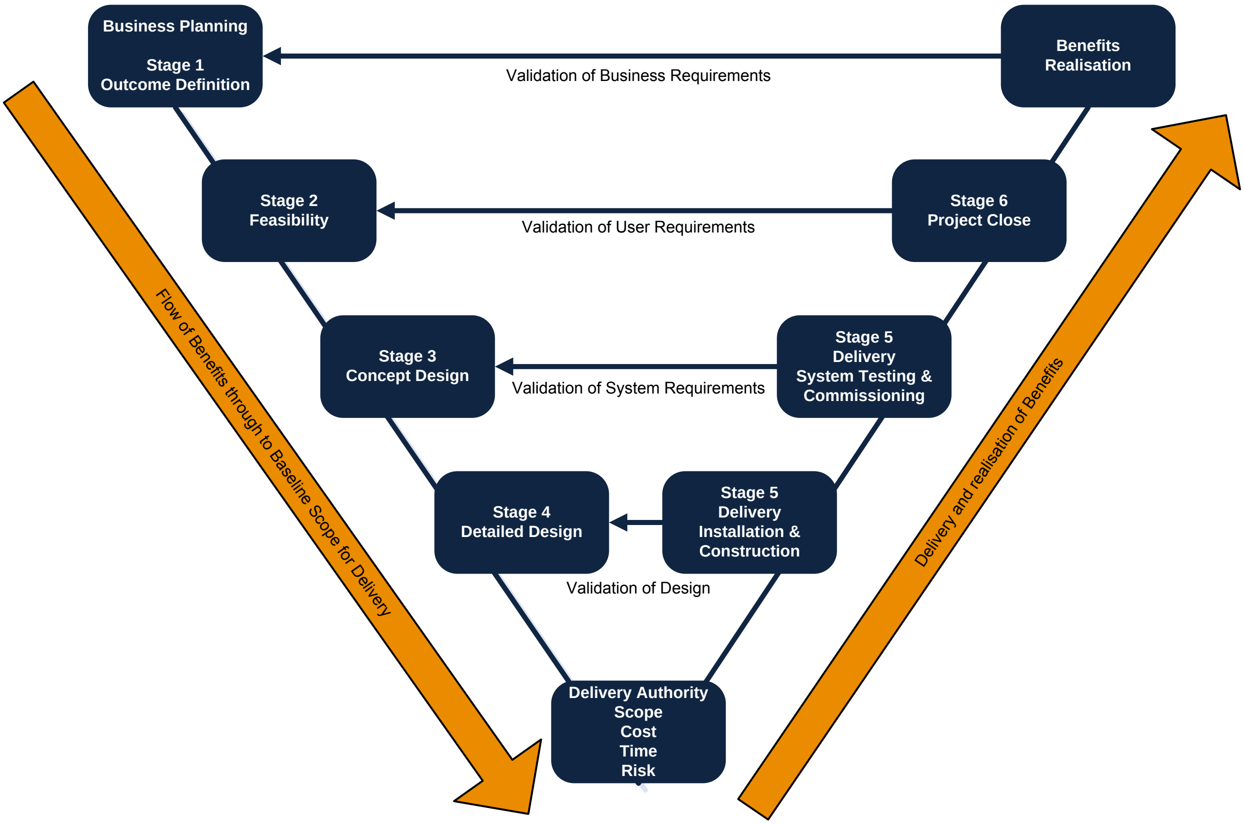


Figure 6: Business Benefits and Baseline Scope

Change Control

General principles

Change control is a fundamental aspect of the IPC solution, ensuring that changes are systematically and proportionally managed in a consistent, effective and efficient way. Change to any element of the baseline shall be subject to change control. However, the governance of change is subject to whether it falls within (minor) or outside (significant) agreed tolerances as set by the approval of the Project Authority Submission. Further guidance on the type of change and associated templates can be found in the Change Control Register product description

The change control process consists of four activities:

- change identification
- change evaluation
- change approval
- change implementation

This process will be applied to all stages of the project lifecycle when proposing baseline changes. It includes the following guiding principles and instructions:

- the Change Requester must provide relevant information on the nature of change
- change must be reviewed to consider if it is worthwhile evaluating in detail
- detailed evaluation of each change must consider the impact on programme or project baseline scope, time, cost, resources, quality, risk of achieving the project objectives balanced against the agreed benefits of implementing the change
- recommendation must be made and communicated as to whether the change should be approved, conditionally approved, endorsed, or rejected
- the Change Requester must be informed of the outcome and the change request form closed out in the change control register
- approved changes must be reflected within the relevant systems – refer to Project Controls Data Governance Guidance Note
- any unauthorised change must be retrospectively put through the change control process

Change identification

When a potential change is identified, the Project Manager must:

- adhere to the quality criteria set out in the Change Control Guidance Note
- review the change to consider if it is worth evaluating in detail (evaluation of change consumes resources which itself is a deviation from the plan). Either rejects the

change if deemed inappropriate, or progress to evaluation, and communicate the outcome to the originator.

Change evaluation

The Project Manager, Programme Director and/or Project Engineer, as appropriate, must assess the change and proposed solution to understand the full impact on the project or programme. The evaluation must include:

- understanding the time and effort required to carry out the evaluation itself
- confirming the impact type and nature of the change, for example scope, cost, schedule, risk and so on. The impact type will often determine the priority and how it is managed.
- The assessment of resource implications and confirmation that suitable and sufficient resources are available to undertake works safely
- analysing the change to determine the most efficient means for implementation
- cost and schedule impacts must be supported by a revised EFC and revised schedule incorporating the change
- confirming that Project, Programme or Delivery Portfolio objectives are not compromised
- identifying who needs to be consulted as part of the evaluation, those who have a specific interest in the change (key stakeholders) and those who must sign the Change Request Form (CRF)
- identifying funding for the change, for example, risk or contingency provision. The evaluation may identify a need to apply for additional authority
- updating the CRF with the quantified impacts and evaluation information
- referencing all supporting information in the CRF and filing them within the document management system
- distributing a copy, along with supporting information, to all those who were consulted

Stakeholders consulted must review the CRF and:

- confirm satisfaction with engineering, maintenance, operational, safety and environmental implications as recorded
- confirm satisfaction with impacts on planning and consents
- confirm satisfaction with the impact of project-level changes on the programme, if appropriate
- sign (or confirm electronically via work flow) a hard copy and return it, along with any supporting information.

Change approval

The Project Manager or Programme Director may approve the change request if the change is within their authority, otherwise the change request must be escalated to the appropriate body in accordance with the established governance arrangements. These must allow for the review of each CRF and supporting information specifically to address:

- mitigation options
- budget or schedule impacts
- alternative proposals
- project authority submission or business case (and associated benefits)
- cash flow analysis
- impacts on other projects
- evaluation of risk to the project of implementing the change

The approval body must:

- **approve the change** if the impact is within the project manager's current delegated authority for risk and contingency drawdown
- **conditionally approve the change** as above, but subject to conditions or subsequent actions
- **endorse the change** for "approved" change outside the authority of the Change Management Meeting (CMM) (endorsed changes are passed to those of higher authority for review and approval in accordance with delegated authority limits), or
- **reject the change**, the CRF will be updated with reasons for rejection. Further evaluation and solution development must occur before resubmission.

Minutes summarising the outcome and supporting reasons must be circulated to the appropriate parties.

- update the CRF to reflect the outcome of the approval process
- retain the approved CRF and distribute a copy to inform the change originator, PMO and any other concerned parties as appropriate, of the outcome, and close the change request in the register
- implement the approved change by formal instructions to the relevant parties and updating project information such as engineering drawings
- update the relevant systems, for example, Primavera, Master Projects Database (MPD), SAP, Active Risk Manager (ARM) and so on to reflect the change

Estimating

General principles

Estimating is the process by which an approximation of the project cost is calculated and includes the following principles:

- core estimates must be prepared on a 'base cost' basis (i.e. excluding allowance for risk, contingency and inflation/indexation)
- risk and inflation through to completion should be allowed / shown separately in accordance with TfL risk and project finance guidance
- cost estimates must adhere to the Estimate product description
- cost estimates prepared must be able to align with the agreed Project Structure and the Procurement Strategy
- the base cost estimate is used as the input to the Authority Submission. Once approved, this forms the baseline cost estimate
- the base cost estimate must reflect the approved project scope and schedule milestones
- an assessment of the accuracy (level of confidence) of the estimate should be included at each stage
- cost analyses / reconciliations should be carried out at project completion to provide feedback data for future estimates

! When preparing the cost estimate, the sponsor, programme or project manager must seek support from the appropriate Commercial team to assist in preparing the estimate

Business area specific

Area	Detail
London Underground programmes or projects	The LU Cost & Estimating System must be used. The system provides three primary functions: • data input – this enables upload of analyses and feedback reconciliations for programmes or projects in accordance with the LU estimating breakdown structure (known as the Cost Feedback Structure) • data output – this enables extraction of unit costs for preparation and validation of estimates or benchmarking analysis • preparation of estimates – this provides

	standardised templates for the preparation of estimates and includes a storage capacity to retain estimates

For any queries in respect of access, log-in and operation of the LU cost and estimating system contact TfL Commercial Centre of Excellence

Estimate detail by stage

Table 2 below illustrates estimate type, purpose and level of detail required at each stage of the lifecycle:

		Project Lifecycle					
		1	2	3	4	5	6
Development Stage	Business Planning	Outcome Definition (RIBA A)	Feasibility (RIBA B)	Concept Design (RIBA C / D)	Detailed Design (RIBA E / F)	Delivery (RIBA G, H, J, K)	Project Close (RIBA L)
Estimate Type	Order of magnitude estimate	Outline budget estimate	Quantified estimate	Definitive estimate	Detailed estimate	Contractor's estimate	Close out analysis
Purpose	Business Planning	Authority to develop / business case	Selection of most efficient option	Authority to proceed and contractual comparison	Authority to proceed and contractual comparison	Management to the Baseline	(for LU only) input to estimating database)
Level of Detail	Provides an initial figure based on outline scope	Provides first budget split by defined Estimating Breakdown Structure (EBS)	Scope of works with approx. units of measure and rates, structured to EBS and mapped to the Project Structure	Scope of works with approx. units of measure and rates, structured to EBS and mapped to the Project Structure	Scope of works with firm units of measure and rates, structured to EBS and mapped to the Project Structure	As defined by the work packages within the Project Structure aligned to the EBS	As defined by the work packages within the Project Structure aligned to the EBS

Table 2: Estimating Maturity throughout the Project Lifecycle

Cost Management

Cost Management Overview

The management of project costs pre and post contract award is a key part of an IPC solution. This is initiated by the project estimate which is used to set the project budget from which actual and predicted costs must be carefully managed in order to reflect the developing project scope and timescales.

The purpose of Cost Management within TfL is to:

- accurately capture and report all costs associated with implementing the project throughout the project life cycle
- control the overall cost of the project by reviewing cost performance data and accurately reflecting the status of the project, including an appropriate level of risk provision, within the EFC.

Cost Management includes the following activities:

- set budgets for work packages during each project life cycle and determine funding requirements to be included within funding submissions. Budget information is used to determine value of purchase orders to be raised.
- define the overall project estimate in line with the agreed scope and schedule to determine the project baseline budget and spend profile
- align cost plans with the agreed Project Structure and the Procurement Strategy
- determine split between RWIs (or other equivalent items) and other resources to drive unit cost reduction
- for site based activities, determine and agree supplier work completed to date prior to the preparation and submission of supplier invoices for payment against purchase orders raised
- forecast the cost to complete for the project including approved and pending changes, approved Project Manager's Instructions (PMIs) and risk provision
- determine phasing of forecast project costs in accordance with updated project schedule (phasing of cost forecast must reside within the planning system)
- monitor expenditure against budget and report project cost performance
- verify project and supplier accounts, as required by the contract terms
- agree final accounts with suppliers
- analyse cost performance of the project, including supplier cost management reviews. Feedback lessons into future cost estimation and cost management.

To do this effectively, the method and structure of capturing cost incurred to date and forecasting cost to complete must be coherent with those adopted within financial (SAP) and planning (Primavera P6 or MSP) systems. In addition, the overall project estimate and EFC must accurately reflect the agreed project scope.

The method and structure of capturing project costs is independent of the cost management system used (e.g. Excel or a bespoke cost management system). An example of capturing project costs via a spreadsheet is provided for information.

Project Manager or Programme Director must provide cost feedback for Repeatable Work Items, where used, because it:

- helps measure supplier performance
- will provide data to improve the robustness of future estimates
- will ensure consistent structure that enables comparisons on a like for like basis
- allows benchmarking and provision of unit cost comparators

Business area specific

Area	Detail
London Underground programmes or projects	In LU, data is used to populate the Cost and Estimating System. The Project Manager or Programme Director must: • upload cost analyses at the end of stage 4 for both whole project and next stage costs, into LU Cost & Estimating System • structure estimates in a standard breakdown structure aligned to the Project Structure together with the relevant technical and contextual attributes of the work. Within LU this structure is known as the Cost Feedback Structure (CFS) • carry out cost feedback reconciliations at stage 6 and upload into the LU Cost and Estimating System. This must be carried out by analysis of the final account in line with the Cost Feedback Structure or direct upload from SAP where available • adhere to the rules of analysis set out in Coverage and Inclusion Rules

Planning and Scheduling

Principles

Scheduling determines the overall project duration and when activities, and their logical dependencies, are planned to happen.

The creation and development of a robust project schedule forecast that reflects the project scope and key milestones will enable a project to monitor and control supplier progress. Time phasing the complete contract budget and identified risks using the planning system will help integrate project scope, cost and risk with time.

The schedule is used by the project team to forecast activity durations and outputs (milestones), measure performance and support the overall management of the project. Project schedules can then be aggregated to forecast and measure performance at a portfolio or programme level.

Defining the Project Structure

Using professional judgement, the project team, under the guidance of the Project Manager must define the project structure that best fits the scope, schedule, commercial, financial and risk requirements of the project. The Project Structure should be developed collaboratively between all project team members responsible for scope, cost, time and risk and in accordance with the principles of an IPC Solution stated within the IPC Methodology Section of this Handbook. The work must be broken down into logical work packages that make sense to be managed as discrete deliverables.

Prepare the schedule

The Project Manager must use the project structure to prepare a schedule which is fit for purpose including:

- identify activities and their logical dependencies
- have a clear critical path
- adhere to the quality criteria set out in the Schedule product description
- clearly provide line items that define the primary work packages of any supplier participating in the project
- align to the project contracting strategy
- reflect the project scope as stated within the Baseline and linked to Sponsor Requirements and the benefits stated within the approved project Business Case

Scheduling requirements

When preparing a schedule for a programme or project, the instructions provided here must be followed:

- the programme or project schedule must capture the current scope of the project in its entirety, including all authorised (baseline) elements plus their logical dependencies and interfaces with other project activities
- the work package breakdown of the project must follow the agreed Project Structure prior to baselining. In addition, it should consider as a minimum:
    - sponsor-driven needs
    - project deliverables
    - location breakdown
    - funding sources
    - procurement strategy
    - contracting strategy
- the programme or project schedule must have one start milestone and one finish milestone bracketing the entire programme or project
- the programme or project schedule and activities contained within it must span and align with project lifecycle stages as determined by the Pathway Product Management Plan (PPMP) product description
- as a guideline, activities should have an appropriate level of granularity to allow effective progress monitoring against defined durations
- all projects shall include sufficient Project Manager Milestones (PMMs) - refer to Milestone Selection and Change Request Guidance note for further definition
- there should be no mandatory constraints within the schedule
- A project with an EFC greater than £1m must have a minimum of one PAM for each financial year of execution where the planned annual spend is anticipated to be in excess of £1m and at least two PAMs should be identified per financial year where the anticipated annual spend is in excess of £10m. This guidance also applies where annualised programmes have an in year spend of £2m and above - refer to Milestone Selection and Change Request Guidance note for further definition
- projects must have a baseline schedule aligned to scope and cost, corresponding to an authority approval paper, and be under formal change control
- authorised risk funds to be profiled into baseline when released
- the EFC must be built up from the schedule to include the full lifecycle of the programme or project, regardless of released authority
- schedule should have an Acumen Fuse score of at least 75%

Programme or project schedules and their reporting must comply with the schedule requirements mentioned above.

Business area specific

Area	Detail
London Underground Projects >£1m	For projects that are to be submitted to the Rail and Underground Board as part of the authority process, the schedule must be submitted for review by the Programme Controls Team, on or before gate 2

The Project Manager must ensure current schedules are maintained. The primary requirements for a well controlled programme or project schedule are:

- preparing a logical schedule in accordance with the project structure that will deliver 100% of scope
- optimising the schedule to deliver for the least cost and most beneficial time frame, bearing in mind interfaces to other works and availability of funds
- once the schedule is approved, generating a project baseline and implementing formal change control against it for the remainder of the project life
- progressing the project schedule on a minimum of a 4-weekly cycle, in order to forecast potential impact on outcome time and costs.

In order to progress an active schedule, the following data must be updated:

- revised Project Authority (if applicable)
- physical percentage complete (using RWIs where possible)
- remaining duration
- finish date
- actual cost
- forecast cost to complete

Business area specific

Area	Detail
London Underground Projects >£1m	within London Underground, the use of Primavera P6 and MPD is mandated for projects with an estimated final cost of greater than £1m. The following additional principles apply to scheduling: • a Primavera schedule must be maintained, updated and submitted to MPD every period • the project schedule title must match the programme or project title in MPD and SAP • all project schedules must have an integrated Project Structure. This shall be held within Primavera P6 as the Work Breakdown Structure (WBS) and is aligned with the Cost Breakdown Structure (CBS) held in SAP and the cost management system • activities must be coded against the appropriate structure code • every period, the programme or project schedule must be progressed using the standard data date as specified in the MPD Desk Reference • all project schedules must be prepared in accordance with the MPD validation routine • the baseline in P6 must match the SAP base costs forecast at the point of authority submission • Forecast P6 costs should be within +/- 5% of SAP

Optimise the schedule

The Project Manager must optimise the schedule to a sufficient quality and maturity to support the application for financial or project authority. Information from the schedule should be used to mitigate potential delays such as:

- risks and mitigation impacts identified through the risk management process
- financial constraints; profile must align with authorised budget
- access to the transport network must be considered and planned appropriately
- resource constraints, including people, equipment and material
- times and dependencies on other programmes or projects, internal or external

Risk Management

TfL's approach to risk management is described in the Risk Management Handbook. The handbook provides a consistent, efficient and best practice approach to risk management within TfL.

The Risk Management Handbook also describes TfL's approach to risk provision (which must be calculated and included within each request, see Authority Submission project description) and contingency.

The project EFC is the sum of actual costs (including risk realised and drawn down from the original risk provision), forecast base cost plus the remaining risk provision. The time phased EFC, including remaining risk provision, should be held within the planning system.

Quantified Schedule Risk Assessment

Schedule risk provision defines the level of schedule uncertainty. This is determined by linking the project risks impacting on time and cost that reside within the project risk register with the appropriate time phased activities within the schedule.

Monte Carlo simulations can be run via the Primavera Risk Analyser (PRA) to calculate the net cumulative effect of uncertainty throughout the project lifecycle based on the known risks. The simulation will determine the P50 and P80 milestone completion dates which can be used to justify the schedule risk provision when submitting Project Authority for Approval.

Activities associated with mitigation of risk must be added to the plan, and following risk drawdown the baseline should be reprofiled.

Data Governance

For effective Project Controls, it is essential to understand the project data elements which form the basis of project information presented and reported to inform the decision making process. Project information requires careful management and regular updating throughout the project lifecycle. Key to this is an understanding of the logical flow of information from one data system to another thereby ensuring all systems are aligned and accurately reflect the project status.

There are two occasions when data requires updating:

- a general update reflecting project progress and performance against the approved baseline (such as Cost of Work Done or schedule progress). This is done periodically in accordance with the reporting cycle.
- when changes to the baseline scope, cost, time and risk require approval by the relevant governance authority (e.g. Project Manager, Project Board, TfL Board) via the Change Control Register product description. Occasions for changing the baseline are known as re-baselining or project re-profiling. This could be as a result of the annual budget review process.

Table 3 below provides an example of the various data elements that require updating, either periodically or post approval of a change, which systems the data resides within and the role responsible for updating the relevant system. Note that systems may vary depending on the business unit.

In each case, the source of master data is shown in green. A log of all changes must be maintained by the central PMO Programme Controls Team, providing an audit trail to show that all changes have been fulfilled as required.

System		SAP	P3M	MPD	P6	CMS	ARM	WBS	Scope	Business Case
Responsible Person		Finance Manager	PMO	PMO	Planner & PMO	Cost Manager	Risk Manager	PMO	Eng. Manager	Sponsor
Change Element (What requires adjustment)	Baseline	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Original Project Budget	✓	✓	✓	✓	✓				✓
	Budget Transfer	✓	✓	✓	✓	✓			✓	
	Project Authority	✓	✓	✓	✓	✓			✓	✓
	Project Scope				✓	✓		✓	✓	✓
	Project WBS	✓			✓	✓		✓		
	Planned Cost of Work Done	✓	✓	✓	✓	✓				
	Actual Cost of Work Done	✓	✓		✓	✓				
	Draw down from Project Risk	✓			✓	✓	✓			
	Draw down from Project Contingency	✓			✓	✓	✓			
	Identified Risks				✓	✓	✓			✓
	PAM		✓	✓	✓					✓
	PMM		✓	✓	✓					
	Milestone Target Date			✓	✓					
	Milestone Actual/Forecast Date			✓	✓					

Table 3: Data Element in relation to Systems

The Project Controls Data Governance Guidance Note provides an overview of how data shall be maintained and updated, the governance of the data (i.e. who is the approving party, the process for how changes to the data are tracked and how often the data is updated).

Report Progress and Performance

Principles

Reporting is the process by which qualitative and quantitative data is collated, consolidated and presented in a format which provides timely, accurate and decision-enabling information. Reporting is a fundamental activity within the project lifecycle and includes the following guiding principles:

- reporting for programmes and projects should begin as soon as they are approved by the appropriate authorising body and created in SAP in line with period reporting timescales
- reports must be underpinned with robust validated data
- reporting must monitor progress at project, portfolio, and programme levels
- reporting supports decision-making within TfL, making available appropriate, timely and accurate information
- reporting can include information on progress against schedule, the achievement or re-forecasting of milestones, risk, opportunities, financial information, scope change, impacts on third parties, plus other information as directed by a report's key recipients
- reporting information must be provided in time to keep the central repository up to date and accurate
- reporting requirements must be set out in the Project Execution Plan product description in accordance with the established governance arrangements

Timescales

Reporting activities are typically aligned with the TfL periodic calendar which comprises 13 four-week periods within the financial year (April – March).

Systems and tools

- **SAP** is an accounting software package used for programme and project accounting (amongst many other uses). For more information refer to the SAP intranet site.
- The TfL P3M System is a software package which receives data from SAP and MPD, enabling the production of reporting and analysis. This is the basis of periodic and quarterly (dashboard) reporting within TfL and can also be used to generate bespoke reports on project and programme status.

Business area specific

Area	Detail
London Underground Projects >£1m	• Master Projects Database (MPD) records key information against programmes and projects, particularly within LU. For more information, refer to the MPD Desk Reference Guide. • Primavera (P6) is the system used to plan, baseline and monitor progress against programme or project schedule. The system is the primary source of information that is fed into the Master Projects Database. Schedule format and level of detail must conform to the requirements set out in the Manage the Schedule section of this handbook.

Reporting types

Periodic reporting provides updates on progress and issues within the latest period for major projects and programmes. Programmes and Projects will often produce internal reporting for communication of information between the Project Manager and the Sponsor or other stakeholders. A number of templates are in use throughout TfL and the template will be determined by the report's key data recipients.

Projects and Programmes may also be asked to contribute to higher-level periodic reporting to local approval boards (e.g. RUB or Surface Transport Board). Where appropriate, information will be extracted from MPD, SAP, Primavera and TfL P3M, with teams being requested to provide commentary on trends or issues identified by this management information. Typically this information will relate to the following themes:

- safety
- progress, planned versus achieved
- milestones achieved or forecast
- risks and issues
- reliability
- Lost Customer Hours and Engineering Overruns
- financials
- upcoming Integrated Assurance Reviews
- red / amber / green (RAG) status reporting

Quarterly reporting follows quarter ends and takes the form of a dashboard report generated from TfL P3M. This report is submitted to the Projects and Planning Panel and is accompanied by a public-facing textual progress report. Quarterly reporting is undertaken for projects with an EFC of over £50m, annualised portfolios with an annual spend of over £10m and any others which have been deemed as important or high risk.

The following summarises the information provided within the report:

- page 1 provides an overview and summary performance dials
- page 2 provides financial performance information
- page 3 Provides performance information on milestones, risks and safety
- page 4 provides information on performance on use of unit rates of measure

Visualisation ("Viz") boards are a mechanism used in some areas within TfL, often informing the agenda of a meeting. Viz boards offer direct, immediate and evidence-based reporting and decision-making including:

- issues, concerns and actions both up and down the performance management chain
- review of causes for performance gaps on the Viz Boards and determine actions
- list open actions, including who is responsible, when the action will be complete
- state achievements and the benefits associated
- update on project RAG status
- ensure accuracy and ownership of actions through to successful closure

Earned Value Management (EVM)

Project level earned value is calculated every period by comparing actual with planned cost and schedule information, provided by the project team, with the project baseline stored centrally by the PMO Programme Controls Team. Project level earned value therefore provides a good indication of project status which in turn focuses and directs management attention to arising issues. The quality of the schedule and rigorous change control of the baseline information is fundamental to the successful application of earned value.

Contract level earned value is used by the project team to measure supplier performance. The following points should be considered when determining earned value at a contract level:

- the process of earned value measurement is against the latest Earned Value (EV) baseline (approved contractor's schedule) which is agreed as part of the regular progress meetings held between the Project Manager and Supplier
- future costs should be spread across the remaining activities
- costs associated with non productive tasks (such as project management and material costs) should not be included within the earned value calculations
- budgets and progress should be quantified using RWIs where appropriate
- the schedule must be fully cost loaded and aligned with the Project Structure and contractors plan, where available
- agreed compensation events are shown as separate line activities within the schedule so that progress can be determined against the original scope incorporated within the contract data
- supplier application for payments should be based on the EV of work achieved (if activities are site related) or milestones achieved.

Document Management

Document management is a fundamental aspect of project delivery particularly in supporting assurance processes and the handover to maintainers at completion.

Document management is the collection, storage, dissemination and archiving of project / programme / delivery portfolio documentation in a structured manner.

Document Management also encompasses the process of 'document control' which involves maintaining records of document versions and an audit trail of documents exchanged with suppliers or other stakeholders.

Checklist

During Stage 1, all project / programme / delivery portfolio must complete the Document Management Checklist. This checklist will assist in setting up a document control function correctly.

General requirements

> i The term 'document' applies to any formatted information that passes the test 'is it in the interest of the programme or project that this information be safeguarded?'

- Project, Programme and Delivery Portfolio teams are advised to use Livelink as their document management system. For areas where other document management systems are prevalent it is acceptable to continue with their use.
- Project, Programme and Delivery Portfolio teams should base their selection of document management system on the TfL Document Management System Strategy
- Shared drives are not recommended for programme or project documentation. Where there is no practicable alternative, projects using shared drives shall use a spreadsheet or other means for version control.
- Project Manager is accountable for the diligent management of documents in accordance with this handbook. Responsibility can be delegated to nominated persons to undertake the role of document controller; the level of document control resource depends on the size, scale, complexity and risk of the Project, Programme or Delivery Portfolio.
- Electronic format is the preferred option and suppliers must submit documents in this format. Except where copies of wet signatures are needed, electronic conversion of native formats (Excel, Word etc) to PDF is preferred to scanned images of pages.
- Project documentation must be filed in accordance with the standard Projects Document Filing Structure
- Where Project, Programme and Delivery Portfolio teams use other systems to manage documents, such as an New Engineering Contract (NEC) forms system, the DMS remains the principal document repository and "single source of truth"

- Emails must not be used to give instructions to contractors or to provide contract management.
- Completion of the Document Management Checklist may identify the following additional requirement for programmes or projects:
  - A process for the systematic tracking of all assurance documentation into and out of the programme or project team.
  - A schedule, with indicative dates, for the receipt and creation of all documentation required to complete a programme or project.
  - A process for the use of a published / release area.

> ! R0594 Document Management for Pathway Methodology provides additional detail on how project teams can meet TfL document control requirements.

Safeguarding important documents

For documents that need to be safeguarded the programme or project manager must:

- retain hard copies of documents to comply with legal requirements
- adhere to the document filing instructions set out in each product description
- store e-mails in the DMS filing structure (these are not exempt from the Freedom of Information Act (FOI) requests - emails are also admissible for claims and disputes)
- store Computer aided design (CAD) files in the DMS in PDF format
- manage CAD files in accordance with category 1 standard S1037, Computer Aided Design Data (LU only).

> ! **Hard Copy:**
>
> - must be scanned and uploaded into the DMS within 72 hours.
> - Must be retained hard copy as necessary to comply with legal or commercial requirements (e.g. documents containing the wet signatures of third parties such as signed contracts, deeds, agreements, licences, and permits)
> - must be filed in ring-binders or similar, which are labelled and divided to mirror the Projects Document Filing Structure
>
> Templates and labels for ring-binders are available from the PMO Document Control Team.

Version control

The Project manager must:

- ensure that all document changes are recorded and documents marked appropriately so it is clear that a revision has taken place
- ensure all programme or project staff use the correct version of each document

- maintain a tracking spreadsheet, or use an appropriate database tool, that shows the status and revision numbers of each drawing and assurance document, if required by the programme or project team

Document security and access

The Project Manager must adhere to the TfL's Information Security Classification Standard marking documents with the correct security classification where required.

TfL security classification categories

- TfL Unclassified
- TfL Restricted - commercial in confidence
- TfL Restricted - personal data - *must not be kept in project folders*
- TfL Confidential - *must not be kept in project folders*

The Projects Document Filing Structure provides guidance on the security classification appropriate for various types of document.

Project documents categorised as TfL "Restricted" or "Confidential" (e.g. Confidential correspondence, financial and commercial information) must be stored in areas where appropriate access restrictions are applied.

'Personal data' is a category used by TfL to identify information subject to the Data Protection Act and must not be stored in project folders or similar areas.

Handover of documentation at Project Completion

At an early stage, the Project Manager shall obtain detailed agreement, usually from the Sponsor or Asset's Maintainer, what documents need to be provided at project completion.

The Project Manager and Commercial Manager shall ensure that suppliers are contractually bound to supply handover documentation as required such as, for example, 'as built' drawings, engineering assurance documents (e.g. installation and testing certificates) and operation and maintenance manuals. The agreement with suppliers should specify the quality and format requirements for these documents.

All projects except LUL:

Ensure that all legislative, contractual and local requirements are met for the provision of 'handover' documentation to the owner or maintainer of the completed asset. Construction projects must comply with 'The Construction (Design and Management) Regulations in regard to providing a 'Health and Safety File' containing information required to safely maintain an asset.

LUL Projects:

- Ensure all “core asset information” (CAI). i.e. the information that has been captured in the MAID, is transferred to the CAI repository
- Use the Project Completion and Handover Certificate to approve the MAID
  - part 4 must be signed by Asset Performance Directorate (APD) to verify that the maintenance documentation is complete and approved by APD
- Once approved, contact the CAI Team (using the CAI Team Mailbox) who will transfer the MAID documents into the CAI repository.

! The MAID is required to be uploaded into the CAI Repository no later than 1 week prior to the Gate 5 stage gate review meeting. If the information is not in the CAI Repository, Gate 5 will not be approved.

Archiving of documents post project completion

Electronic Documents

! **Retention metadata**

All programme and project documentation is subject to TfL Corporate records retention and disposal standards. If available, the 'Records Management' functionality of the DMS shall be used to set date of 7 years after the completion of a programme or project for a *review* of the documentation by TfL Information Management. If there is no reason to retain the documentation, it will be marked for disposal after a further 3 years has elapsed.

Prior to Gate 6 the Project Manager should initiate the archiving of all project documents.

TfL projects should contact the TfL PMO Document Control Team.

For LUL projects the PM shall contact the CAI team via CAI Team Mailbox.

Hard-copy Documents

Hard copy documents that require retention shall be sent to the TfL Records Store in accordance with TfL’s policy on information retention and disposal. Boxes of mixed project documents should be marked for review 7 years after the project (or contract) end.

Project Finances

Guidance for project teams

Guidance on financial aspects of project management can be found in the following:

Project Accounting Standard

- http://source.tfl/DoingMyJob/Manuals/5713.aspx
- The Project Accounting Standard concentrates purely on how to reflect and treat the expenditure which is incurred on a project for the purposes of the statutory financial statements of TfL (i.e. its balance sheet and profit and loss). The allocation is determined by the type of asset or nature of the work.
- This guidance is for the project accountants who should liaise with Project Managers to interpret the guidance and correctly apply the standard accounting rules. Project Managers seeking to understand this level of detail and its interpretation should seek the support of the project accountant.

Document history

Revision	Date	Reason for change	Author
A1	09/04/2013	Issued	IPPM
A2	11/10/2013	Updated with Integrated Project Controls	TfL PMO
A3	16/01/2014	Updated to include the need to evaluate resource implications of change	TfL PMO
A4	05/03/2014	Title of Handbook changed	TfL PMO
A5	11/03/2015	Removed year after Construction (Design and Management) Regulations	HSE

London Underground Project Management Training

People and development

Introduction

The Resource Management and Capability Development function sits within the Project Management Office (PMO) Centre of Excellence and is responsible for developing initiatives that will assist in raising the project management capability of the TfL community.

PYRAMID

PYRAMID was a cross-modal initiative aimed at enhancing the capability of the Transport for London internal Programme and Project Management (PPM) community to deliver its investment programme. The PPM community has over 1,400 members. It provided the business with visibility of its PPM capability needs, designed and delivered a portfolio of PPM development opportunities, and delivered a series of knowledge-sharing events and best practice seminars.

The TfL PYRAMID competency development tool tracked project management competencies from a technical viewpoint. All permanent project managers, risk managers, planners and document control staff directly employed by LU had to have a PYRAMID account and complete their assessments before the end of February each year to allow review with their manager during their performance and development (P&D) sessions in March and September. This assessment was against a recognised competence framework aligned to a professional body, the Association of Project Management (APM).

Line managers to those using PYRAMID were expected to manage their assessments and development requests.

There were a number of benefits for PYRAMID community members:
- Identification and access to suitable and relevant development opportunities (including professional qualifications) to develop skills and future careers
- Facilitation of more informed, meaningful discussions with line managers about an individual's development
- Opportunity to attend cutting-edge external events for development and to benchmark our work against other industry leaders
- Use of the in-house, fully-managed training suite in central London

Project management job role profiles were loaded on the PYRAMID tool. These showed the level of project and programme management competencies expected against the TfL PPM competency framework by role and allowed line managers to see how their team members were performing and helped inform P&D discussions. Role profiles were added to following job roles:

- Project Managers
- Risk Managers
- Planners
- Document Controllers

The role profiles differ according to role and seniority, i.e. competencies for an Assistant Project Manager will be different to those for a Project Manager.

PYRAMID update (May 2015)

In order to bring greater clarity to development conversations TfL is introducing role families for a number of pilot areas, including Project and Programme Management (PPM). Role families bring together similar roles to reflect the professional communities across the organisation.

To support the introduction of role family frameworks for pilot areas including PPM, a new tool called SuccessFactors has been developed for capability assessment. The contract for the PYRAMID Online Tool expired at the end of April 2015, and the Tool is no longer available.

Those mapped to the new role families will be given access to SuccessFactors automatically (unlike applying for PYRAMID membership).

PYRAMID Development Portfolio

IMPORTANT: The information below is historic and is retained during the transition from the PYRAMID processes.

The following training courses were available through PYRAMID:

- Association of Project Managers (APM) Introductory Certificate
- Introduction to Business Cases
- APM Professional
- APM Practitioner Qualification
- Practical Planning for Project Managers
- Portfolio, Programme and Project Offices (P3O) Foundation
- Portfolio, Programme and Management (P3O) Practitioner
- Advanced Project Management
- Managing Successful Programmes (MSP)
- APM Registered Project Professional
- Benefits Realisation Awareness
- Management of Value Foundation
- Management of Value Practitioner
- Management of Risk Foundation
- Management of Risk Practitioner
- Project Management in Practice (PMIP)

Courses could be attended based on the level of knowledge and experience. There was no need to start on the lowest level before attending courses on a higher level. Courses which will target staff development most effectively should be attended regardless of the level of entry.

1.1 Useful Course Documents (not attached)

- APM Introductory Certificate Syllabus (PDF 92KB)
- APM Introductory Certificate Question Samples (PDF 94KB)
- APMP Examination Syllabus (PDF 257KB)
- APMP Sample paper and Marking Scheme (PDF 81KB)
- PYRAMID – Ground rules for learning and development (PDF 28KB)

1.2 APMP vs Prince

The APMP provides knowledge and skills to project managers to apply any method to best effect. PRINCE is a methodology, but PATHWAY is the methodology which is used to deliver projects in TfL. Project managers should be advised to attend PATHWAY training plus the APMP and other PYRAMID courses.

Please see here for the differences between Prince2 and PYRAMID's APMP (PDF 28 KB) (not attached)

London Underground Personnel Development

- Succession planning
- Training activities periodically reviewed.
- Data is collected to determine training effectiveness.
- A documented process is in place for recognizing outstanding performance on projects
- Linkage has been established between performance and reward.
- Project Management is an established career path
- A competency model is used that includes proficiency assessments.
- Established goals for improving project management capabilities.
- Employees have personal development plans.
- Training on team development exists
- Employee's contribution to organizational strategic goals and objectives are

Construction Management Plan (CMP) (Stages 4-5)

Purpose

To act as the central reference document for managing the construction process which aligns the various plans and describes the approach to be adopted to satisfy the requirements.

Applicability

This product must be produced for all (large) projects that involve construction. Recommended for works over £10M.

This product is normally created at project level, but with Programme/Porfolio Manager agreement a generic version of the product can be produced for a group of projects.

Templates

- Construction Management Plan
    - Construction Services Menu

Contents

- Contents is defined by the template

Quality criteria

- All sections must be completed or make reference to another document providing greater detail
- Project objectives, deliverables and scope must not be defined in this document
- The level of detail required is proportionate to the scope of the project and the complexity of the work to be undertaken
- Includes information captured from the cross-departmental kick off meeting

Document management

Construction Management Plans must be filed in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

Responsible **(Responsible for producing all or part of quality product)**	**Accountable** **(Accountable for ensuring timely delivery of quality product)**	**Consult** **(Must be consulted when product is being produced)**	**Inform** **(A copy of the signed-off product must be sent to)**
Construction Manager Project Manager	Project Manager	HSE Adviser Project Engineer Sponsor Stakeholders	

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for consultation	IPPM
A2	08/04/2013	Issued for use	IPPM

Contract Management Plan (Stages 2-5)

Commercial should be contacted at the earliest available opportunity.

Purpose

To enable both TfL and its supplier to meet obligations set out in the contract. A Contract Management Plan (also know as Contract Management Matrix or Contract Summary Document) may be required for Contract's over a certain value. This is set out in local procedures.

The end-to-end procurement process is described in the Commercial Handbook.

Applicability

This product may be produced for projects that involve procurement from external suppliers.

Appropriate to the size, scale, complexity and risk of the Project can be produced:

- At project level – typically for large/complex projects.
- As a sub-section within Project Execution Plan – typically for small/less complex projects.
- One separate Contract Management Plan or (Contract Management Matrix for Surface) is generally required for each contract or set of contracts that have been awarded.
- An Electronic Contract Management System may be required for use.

Business Area Specific

Area	Detail
LU	All communications with suppliers in relation to this transaction are to be conducted by the Commercial lead only. Asset Performance Directorate must be consulted throughout the contract management phase to ensure appropriate asset into use handover. A separate Contract Management Plan is required as per local procedures and is normally included within the Project Execution Plan. Please also note the LU CPD – Commercial Guidance Note on Responsibilities

ICT	A Contract Summary Document may be required dependent on the nature of the contract, this will be identified by the Commercial lead.
Surface	A Contract Management Matrix should be prepared for all contracts that are above the EU threshold and are longer than one year in duration.
Services	A Contract Management Plan is not normally necessary but any requirement will be identified by the Commercial lead and the Contract Manager.

Templates

- Business Unit specific Templates can be accessed here.
- Project Execution Plan
- All staff must complete a declaration of interest form

Contents

- The contents is defined by the template(s)
- The Project Manager will be responsible for ensuring the Commercial Lead is fully informed of all Project and Contractual matters.
- Is defined by the Contract Management System.
- The Commercial Lead will complete the Contract Management Plan before handover to the Contract Manager.

Quality criteria

- Is defined by the guide and template

Document management

Contract Management Plans must be filed in accordance with the document filing structure.

Roles and responsibilities

For information on the roles and responsibilities in the table below, refer to the Pathway Glossary.

The consultees must be identified at the start of the project in conjunction with the Commercial Lead, these will vary depending on the size and complexity of the project and business units involved.

For London Underground, Surface Transport, ICT and all other areas of TfL, excluding London Rail, the Commercial Lead will sit in the Commercial Directorate or Commercial Rail and Underground Directorate.

Responsible (Responsible for producing all or part of quality product)	**Accountable** (Accountable for ensuring timely delivery of quality product)	**Consult** (Must be consulted when product is being produced)	**Inform** (A copy of the signed-off product must be sent to)
Commercial Lead Project Manager	Project Manager	Other Stakeholders as required.	

Further information on the Roles and Responsibilities of Commercial and the Project Manager under NEC3 Contracts can be found below:

- London Underound
- Surface Transport

Feedback

If you have any queries, feedback or improvement suggestions about this Product Description then please contact tflpathway@tfl.gov.uk.

Document history

Revision	Date	Reason for change	Author
A1	30/11/2012	Issued for consultation	IPPM
A2	08/04/2013	Issued for use	IPPM
A3	21/08/2014	LU CPD Guidance note on responsibilities (DRACCT 03000)	AB

Pathway Information (delete when you use this template)

Template reference	**Template file name**	**Version**	**Date**
F0820	T Document Management Checklist	A3	24/02/2015

Programme

Project

Document reference

Document Control Checklist

		Signature	Date
Prepared by	<Name> <Role>	------------------------------	------------------------------
Reviewed by	<Name> <Role>	------------------------------	------------------------------
Approved by	**I confirm that I have undertaken this checklist and have developed a plan to ensure that the project documentation for the project is managed in line with the** Project Controls Handbook **and R0594** Document Management for Pathway Methodology**.** <Name> Project Manager	------------------------------	------------------------------

Distributed to

<Name>	Sponsor
<Name>	Programme Manager

Document History

Revision	Date	Summary of changes
A2	14/12/13	First draft
A3	24/02/2015	Amendment regarding Shared drives

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DELETE THE BLUE TEXT AS THIS IS FOR GUIDANCE ONLY

General Guidance

A project team needs to address document management as soon as practicable at an early stage in the project. This will ensure important documentation produced during initial stages is captured and also that a plan is in place to manage documentation to the required standard and before any bad practices become irreversible.

Unless there is a justifiable reason not to do so, a project team shall adopt the mandatory requirements of the TfL Pathway and follow all relevant TfL policies.

The questions below should be answered prior to a project or programme passing Stage Gate 1; **notes are included below to give guidance on answering the questions**.

Further information can be obtained from the TfL PMO Project Controls team.

1 Document Management Checklist

1. Have read the **Manage the Project, programme or Delivery Portfolio** and **R0594 Document Management for Pathway Methodology** and have understood the mandatory and non-mandatory (but advised) requirements for document control?

2. Have made the selection of content management system based on advice from the TfL PMO Document Control Team.

   What content management system is the project team going to use?

   Livelink

   SharePoint

   Other

   Provide justification for other content management system

3. Have considered the number of document controllers required for the project.

   How many document controllers is the project going to employ?

2 Configuration of Template

Following selection of your content management system, a project team is then required to make some decisions regarding configuration of the system. Users of Livelink shall use a form of the Project Template, where SharePoint or other solution is used a suitable template that meets the requirements of the Pathway Project Controls Handbook shall be selected.

- Have made the selection of file plan.

  What file plan is the project going to use?

  Simple (Top level folders only)

  Complex (Including sub-folders)

- Have made the decision to use a release/published area or not?

  Yes

  No

- Have considered what process the project is going to use for managing document transmittals.

  What type of document transmittal / tracker system is the project team going ` to use?

- Have considered what process the project is going to use for managing the document schedule.

  What type of document schedule is the project team going to produce and use?

- Have considered what training is required for general users, document controllers and super-users on selected document management system?

  Action taken

3 Notes to help complete the Document Management Checklist

3.1 General Document Management Principles

Read the Document Management Section in the TfL Pathway Handbook - **Manage the Project, Programme or Delivery Portfolio**. This Handbook contains the mandatory requirements.

More detailed guidance information is provided in **R0594 Document Management for Pathway Methodology**. This contains the non-mandatory requirements which should be complied with unless there is a good reason not to do so.

3.2 Document Management/Document Control Systems

Shared network drives are not recommended for project document control. This is because shared drives have no automatic version control, weak access security and files can too easily be lost or deleted. If a document control system is not available, projects may use shared drives. When changes are made to a document stored on a shared drive the 'Save As' function should be used to create a new version.

TfL Document Manager (Livelink) is the recommended system for projects which plan to deliver new or modified assets into the TfL infrastructure. Other options include SharePoint or the purchase of externally hosted systems.

All systems have limitations either functionally or commercially and the advice of the TfL PMO Document Control Team should always be sought in considering selection of any system.

Similarly, advice should be sought regarding configuration of system attributes such as classification/taxonomy, access controls (permissions), and other metadata.

For Livelink or SharePoint pre-configured templates are available which will facilitate quick deployment with minimal set-up time.

Choosing an unsuitable system, or one with poor configuration or commercial constraints, risks delay to a project's delivery schedule.

3.3 Document Controller Resourcing

The resource levels suggested below should be regarded as general guidance. The type of project, scope and procurement method should be taken into account when sponsors and PMs agree resource levels. Projects producing a large number of technical documents (e.g. specifications and drawings) may require more document controllers than the guidance suggests. Projects which envisage using supplier's resource to deal with document management may require fewer document controllers. However, experience has shown that, even when suppliers undertake much of the document control work, it is highly desirable for the TfL client to employ a document controller to supervise the supplier and ensure documents are captured and stored correctly.

Document Controllers should be appointed using one of the three available Job Descriptions available from TfL HR.

- Document Controller (Band 1)
- Senior Document Controller (Band 2)
- Document Manager (Band 3)

If more than one document controller is employed, one should be designated as the 'Lead Document Controller' who should supervise the work of more junior staff. This person would normally be appointed using the Band 2 JD above. For very large programmes or projects (approx EFC >£500m) it would be appropriate to appoint a Band 3 Document Manager.

- If a project spends less than £1M per year it probably does not need a document controller (it is assumed at this level of spend the project manager has only a few (if any) staff.

- If a project spends less than £20M per year it possibly does not need a document controller, though it will need to nominate staff to perform some of the functions of a document controller or justify a document controller based on one or more of the cases below.

- A project must have a document controller for approximately every £20M of spend per year it undertakes, in other words if a project spends £100M in a year they must have 4-5 document controllers.

- A document controller shall be employed if the documentation through-put (receipt or issue) is more than approximately 4,000 documents in a year.

- A document controller shall be employed by a programme, if the combined value of work is similar to a single project above.

- A document controller shall be employed in a project or a project outstation, if there is a significant risk of documentation being lost.

3.4 File Plan

There are two file plans: the **simple file plan** has eleven first level folders and no second level folders, the **complex file plan** has the same eleven first level folders, but has a number of second level folders (and some third level) to make 95 folders in total.

It is recommended that projects which plan to produce or to receive more than a 2000 documents should use the complex folder structure; projects that expect to receive less than 2000 documents should use the simple file plan.

However a degree of flexibility is permissible: all projects must use the eleven top-level folders but can design alternative second and subsequent levels to suit their circumstances.

Folder structures should be no more than 5 levels deep, including the top level.

Projects that take the option of designing their own folder structure at lower levels are advised to discuss their scheme with the TfL PMO Document Control Team.

3.5 Release / Published Area

It is good practice to have a separate 'release' or 'published' area where documents can be shared with stakeholders outside the project team. A project can choose not to utilise a release area if they do not have sufficient resource or the project is not focussed on delivering documentation for either assets or not required to deliver a significant number of documents. A release area shall be used for capital projects where the project team expect to create a MAID.

3.6 Document Tracking / Transmittal

If a project spends less than £1M a year, no specific document transmittal process is required, though it is good practice to know when important documents are received and sent (see document schedule requirement).

If a project spends more than £1M a year, but the numbers of documents is not large <1000, a tracking spreadsheet or simple workflow is acceptable for the management of documentation.

If a project spends more than £1M a year and handles a large number of documents, a project should use a bespoke document transmittal application or module i.e. ASSAI or a document control tool.

A low value project, or a programme with lots of low value projects, should also use a bespoke transmittal application or module if they handle large numbers of documents >1000 or there is a strong contractual requirement to exchange documents formally.

3.7 Document Schedule

All projects must produce a Document Schedule showing the documents they expect to create and to receive and when this will occur.

Users of SharePoint or shared drives can use a spreadsheet or another bespoke application to manage their schedule.

Users of Livelink can use its milestone and tasks functionality (as described in the Project template documentation) to plan and track the document progress. Alternatively they can use a spreadsheet or another bespoke application to manage their schedule.

3.8 Training Issues

To undertake document control effectively it is important that suitably competent staff are employed. Projects should discuss their training needs with the PMO Document Control team. Large projects or programmes will need to ensure that the lead document controller is trained to the level of ‘Administrator’ or 'Super-User' in relation to the document management/control system in use.

SharePoint and TfL Document Manager Administrator training is available from IM Training.

Reference Document

R0594 Document Management for Pathway Methodology

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MAYOR OF LONDON

Contents

1 Purpose

1.1 The purpose of this reference document is to provide factual information to those who are making decisions regarding how they are going to manage documents while undertaking a project, programme or portfolio. It is required and essential reading for effective document management when using the Pathway – project management methodology.

1.2 This document attempts to bring together all the mandatory requirements of document management, also included is background information and examples of best practice. Projects should endeavour to comply as much as practicable with best practice.

1.3 This document has also been revised to align with the requirements of Building Information Modelling (BIM), see Clause 3.6 for a description of BIM. A significant amount of work has been undertaken to introduce BIM into various parts of the business. The Rail and London Underground initiative is known as the **Information and Modelling & Management (IMM) Change Programme** and its activity can be seen on their intranet site **Building Information Modelling (BIM)**. Surface Transport has their own closely related initiative which can be viewed on their intranet site **Information Modelling & Management Capability Project**. These initiatives represent a massive change in working practices in information management.

1.4 Unless stated specifically, all references to projects equally refer to programmes and portfolios.

2 Scope

2.1 This document applies to all projects, programmes and portfolios that are delivering projects for Transport for London which are using the Pathway methodology.

2.2 All asset based projects are mandated to use the Building Information Modelling (BIM) methodology, at first reaching BIM Level 1 capability (2015) and then obtaining level 2 capability later (2016). There is no mandate to force non asset projects i.e. IM or Business Change or currently in-flight projects to use BIM processes, but they are still expected to follow the mandatory requirements of Pathway.

At the time of writing there is no formal statement on when projects are expected to adopt BIM.

2.3 For the avoidance of doubt, the adoption of the BIM does not mean that a project is excused from complying with Pathway, CDM, health or safety or any other compliance requirements.

3 Information

3.1 Overview

3.1.1 Purpose of Document Management

The function of Document Management includes, but is not limited to:

3.1.1.1 To provide traceability and a standardised process for each document being handled by a project team (Document Control).

3.1.1.2 To keep the 'life story' of a project in one place, so that subsequent users can understand how the project is to be or was completed (Records Management).

3.1.1.3 To be compliant with any statutory and business requirements, including being able to respond adequately to claims (eDiscovery) and Freedom of Information (FOI) requests (Information Compliance).

3.1.1.4 To show that a project was diligently controlled and professionally managed.

3.1.1.5 Protect sensitive/personal information from exposure (Data Protection Act).

3.1.1.6 Ensure the correct documents are used (Single source of truth).

3.1.1.7 Ensure users can locate and use information efficiently.

3.1.1.8 To ensure, if required, handover documentation is delivered to the appropriate maintainers/organisations.

3.1.2 Purpose of Document Controllers

The function of a Document Controller includes, but is not limited to:

3.1.2.1 As far as practical, ensure the principle of "single source of truth" is maintained.

3.1.2.2 To ensure that all project documentation is captured and processed appropriately and a person or persons made responsible for it.

3.1.2.3 Correctly manage documentation into and out of the project/department following a prescribed process.

3.1.2.4 To facilitate the correct use of the systems being used.

3.1.2.5 To facilitate the project team in passing gate reviews and to handover to Maintenance/Engineering.

3.1.2.6 Protect data from loss and archive at project end.

3.1.2.7 To be the expert on the documentation within a project, to be able to locate documentation when others cannot.

3.2 Requirements of Document Management

3.2.1 This section describes mandatory requirements as detailed by the Pathway project methodology and requirements from other sources i.e. Information Governance. Other requirements included here, while not mandatory represent best practice and should be followed whenever possible. Where possible a statement references the source of the requirement.

3.2.2 As a basic requirement a document controller should ensure as many project or business specific documents as possible end up on the document repository (archive).

3.2.3 All projects shall complete a document control checklist; the use of this checklist is to help projects to decide on system/s selection, file plan, document processes and document control resourcing [1].

3.2.4 All hard copy documents must be scanned & uploaded onto the system/s within 72 hours of completion. Hard copies that need to be retained must be stored in a “Site Filing System” [1].

3.2.5 Give each document an appropriate title so that you know what each document is by just looking on a list (not simply numbers or initials) [2].

3.2.6 Ensure that duplicate documents are prevented (single source of truth) and versions of a document are controlled appropriately. [1].

Note:	Exceptions to this rule, include “red line” (as built) drawings and original design drawings where one is a work in progress and the other is from the design phase. Having Work in Progress/Shared/Published areas also creates recognised duplicates which require to be managed appropriately.

References

[1] - Pathway Manage the Project handbook.
[2] - Records Management Quick Guide 3 – Naming documents and folders
[3] - Records Management Quick Guide 12 – Storing information

3.3 Document Management Basics

3.3.1 What is a document?

3.3.1.1 A document is any self-contained unit of information. Documents may exist in a variety of forms, often text, but may also be or include graphics, figures, or data in other formats including paper, CDs, DVDs or electronic records of verbal communications.

3.3.1.2 Project documents are created both internally and externally of the project.

3.3.1.3 The term ‘project document’ applies to any formatted information that passes the test ‘Is it in the interest of the Project that this information be safeguarded?’

3.3.1.4 The terms ‘assurance document’ or ‘managed document’ loosely applies to any project document that requires recording and management into and out of the project team.

3.3.2 Document Security and Access

3.3.2.1 Access rights should be maintained and rigorously managed using groups and roles. Where contractors or other third parties have access to Project areas, particular care must be exercised to ensure that restricted and confidential documents are protected through the correct setting and maintenance of system access privileges.

3.3.2.2 Security Classifications

Each document created and included on the document management system shall be classified for confidentiality as per the TfL's standard for Information Security Classification.

The three classifications are

1. **TfL Unclassified,**

2. **TfL Restricted Part 1 (Commercial in Confidence) and**
   TfL Restricted Part 2 (Personal)

3. **TfL Confidential.**

The classification shall be included on each document, and where the system allows, included as part of the document's metadata within the system/s. Guidelines for security levels can be found on the Product Document Filing Structure document. The vast majority of project documents fall under "TfL Unclassified".

However, it is the document creator's responsibility to appropriately classify the documents they create; this can mean upgrading or downgrading the classification depending on its contents.

Note:	Documents deemed to be TfL Unclassified do not require to be marked.

3.3.2.3 Personal Information

Nothing that can be considered personal information shall go into the Project Folders, if necessary documents should be edited (redacted) to remove all personal information.

This requirement is from the Information Security Classification Standard.

Personal Data that can be included (e.g.)

1. Work address details and work email addresses
2. Attendance to (work) meetings (minutes)
3. Compliance and competency statements
4. Aggregated timesheets

Personal Data that cannot be included (e.g.)

1. CVs
2. Personal addresses and personal email addresses
3. Any information that rates or assesses a person or passes personal comment
4. Time Sheets that contain personal information

All personal information must be stored at a programme or portfolio level and access must be restricted to the appropriate staff. If possible Personal Information (PI) areas should be set up within a Human Resources area of the document system where all personal information can be directed.

3.3.2.4 Confidential Information

TfL Confidential information may only be stored on a document system if access can restricted to a specific group of individuals.

3.3.2.5 Enhanced Security

Enhanced protection should be given to the following sections (Generic Projects Folder Structure);

1.3 Confidential Correspondence
2.2 Project Governance & Cost
4.0 Contracts and Commercial Management (and Sub-sections).

3.3.3 Schedule of Documents

3.3.3.1 As a mandatory requirement of Pathway, all projects should at an early stage, create a document schedule showing what documentation is to be produced, received or sent. Pathway deliverables (including the PPMP/MAID/Health and Safety File or other handover requirements) shall be the basis for this schedule which can then be updated to include more detail as the project proceeds.

Additionally, as part of the Building Information process, each project should collate a list of document deliverables to be received from each contractor, known as a Task Information Deliverable Plan (TIDP), into a Master Information Deliverable Plan (MIDP), this is mandated by our standards.

Note:	Note that the Rail and Underground standards have dropped the term Task Information Deliverable Plan.

3.3.3.2 A Schedule of Documents shall be agreed between the Project Manager, project team and the supplier chain and then passed to the Document Controller for tracking. Agreed dates should be tracked for document delivery and action taken if documents are not received by these dates.

3.3.3.3 Notwithstanding the BIM requirement and depending on the size and requirements of the project, the schedule can be managed by using planning tools i.e. Primavera, using tools available on the document system or using a spreadsheet or word document. The key objective is that the project can demonstrate that it is managing its documentation.

3.3.4 Document Transmittals and Review

3.3.4.1 All projects and departments should follow a consistent process for managing documentation into and out of their respective teams. This is a mandatory requirement of Pathway and is described fully in Clause 3.4. Documents can be transmitted by using transmittal notices or collaboration systems using agreed workflows.

3.3.5 Published / Release Area

3.3.5.1 Projects creating large numbers of managed documents should create areas for their published, completed or released documentation. While this appears to break the commitment to single source of truth, it offers greater assurance that any documents in these areas are “correct”. If a system that can effectively differentiate between draft and published versions is used this is also acceptable.

3.3.5.2 A published folder area also allows greater access to documentation, while restricting access to work in progress or un-authorised documentation. Pragmatically, having a “work in progress” area and a “published” area provides better control and security for projects.

3.3.5.3 However a shared and published folder area with require to be used as part of a written process and a resource or resources (i.e. document controllers) used to manage these areas.

3.3.5.4 A shared and published area is also a concept used by Building Information Management (BIM); see Section 3.6.6 for a fuller description of the Common Data Environment.

3.3.6 Hard Copy Documents

3.3.6.1 The overarching principle is that electronic records are always considered as the prime source for documents. For this reason all completed hard-copy documents should be scanned and uploaded to the project filing structure within 72hrs. However, site or project offices will need to retain hard copies of documents to comply with legal or commercial requirements. Any hard copies which are retained must be filed in ring-binders or similar which are labelled and divided to mirror the Project Document Filing Structure. Templates are available from the PMO Document Control Team for labelling these folders (See above right).

3.3.6.2 A hard copy may be created to enable it to be authorised (signed off) or it may be received directly as a hard copy, either way the hard copy must be scanned and added to the document system as soon as possible.

3.3.6.3 Document retention and archive is detailed in Sections 3.3.12 and 3.3.13.

3.3.6.4 Scanning hard copy document should be undertaken following the processes described in Section 3.7.

3.3.7 Emails

3.3.7.1 Project-related emails must be treated in the same way as all other documents: they must be classified and stored in the correct folders within the document system. Emails are not exempt from Freedom of Information Act (FOI) requests and are also admissible as part of the legal discovery process that may arise from a commercial claim or dispute.

Note:	Emails captured by the Enterprise Vault will eventually be deleted after two years, therefore if you wish to retain an email; it will need to be moved / copied to the document system.

3.3.7.2 Archived emails must not be stored in the document system E.g. Emails with this icon

3.3.7.3 To obtain an un-archived version of an email, the easiest method is to forward the email to yourself.

3.3.7.4 Storing e-mails with attachments should be avoided, and users should use links to documents rather than copies whenever possible. If a document has been included with an email and this document needs to be added to another part of the document system, it should be copied and placed in the correct location.

3.3.7.5 Best practice would then to be to delete the attachment; however a project/department may need to assure themselves that the correct document and version is identified with the email, therefore the attachment must be clearly identified.

3.3.8 Contract Management

3.3.8.1 Emails should not be used to give instructions to contractors or provide contract management. All such correspondence shall be undertaken in accordance with the Commercial (Procurement and Contract Management) handbook.

3.3.8.2 Where projects use other systems to manage documents, such as an NEC contract forms system, the document system remains the principal document repository and “single source of truth”. In other words, the information created from such systems requires to be captured at project end / end of life or use of the system.

3.3.9 Configuration Management

3.3.9.1 Some types of document may require special management, either using an additional management tool or spreadsheet. In this situation the Document Controller should ensure that the list of documents is fit for purpose. Typically Drawing or Contract Variation (or similar) lists require to be maintained to ensure that the correct drawings are used or the status of a project element is known. See also Section 3.4.2 "Document Tracker".

3.3.9.2 Configuration management is defined in British Standard BS 10007 2003 - Guidelines for Configuration Management. Pathway (LU Only) also has a product Configuration Management Plan and there is a supporting LU Cat 2 standard S2120 Configuration Management.

3.3.9.3 Configuration management is an often an overlooked component of project controls, however it can be vital in complex projects where assets can have dependencies with each other. Compliance to BS 10007 is also mandatory for Level 2 BIM.

3.3.10 CAD Systems

3.3.10.1 The implementation of Building Information Modelling (BIM) means that both CAD systems and CAD repositories i.e. Project Wise will require better integration with a projects document control processes.

3.3.10.2 Specifically, CAD models and other model related information will be required to be exchanged in a Common Data Environment (CDE), using agreed processes.

3.3.11 Handover

3.3.11.1 LU Only

All asset based projects must; as a part of the Mandatory Asset Information Delivery (MAID) process first get their asset information approved by COO Asset Managers and get a Project Completion and Handover Certificate signed off.

See PD-10866 for process.

Then all asset information is passed to the Core Asset Information team; they will use their own retention criteria to manage the documentation. This should mitigate almost all issues regarding protecting information that needs to be retained for an extended period.

Once a project has been handed over to maintenance (as part of the MAID/H&S file process) all the handover documentation is also to be uploaded into the CAI repository.

The location of the CAI Repository is as follows (available to TfL DM (Livelink) users only) Core Asset Information Portal

3.3.11.2 TfL/Non LU

All organisations other than LU shall manage their handover documentation as described by their local and Health and Safety file processes and/or process specific to Pathway i.e. CDM Datastore.

See the Health & Safety product description for process.

3.3.12 Document Retention and Disposal

After a project is complete and “Handed over”, the business still needs to retain all documents in case of disputes or claims. Therefore a document controller should ensure that all hard copy and electronic documentation is retained correctly (see below).

3.3.12.1 Electronic Document Retention

To support any future search for information it is essential that all projects documents and e-mails are stored correctly in the Projects Document Folder Structure as previously described. Projects should not use shared drives to store documentation, however if shared drives have been used this data should be archived along with any managed documentation (see below).

A general disposal rule (Classification - CPD0001) has been created for projects using the TfL Document Manager system (Livelink); this rule should be applied to all future projects using this system as required by the governance rules for the TfL Document Manager system. However, at the time of writing there is no mechanism or process in place to enable records disposal take place.

The rule is;

A project close date is set and the first part of the rule will be triggered 7 years after this date. The project documentation will appear on a disposition report and will be reviewed, if there is no issues with the documentation i.e. no legal holds or claims pending, the second part of the rule will be started. After a further 3 years if no hold or claim has been made on the documentation it is deleted.

3.3.12.2 Hard-Copy Retention

At project completion these files must be boxed and sent to the TfL "Records Custody Service". Details of the procedure for archiving can be found here: Records Custody Service

When documentation is stored in the repository the account holder has to select the most appropriate records retention date for the documentation being stored.

3.3.13 Electronic Document Archiving

3.3.13.1 It is the intention of the business to store all remaining (after handover has taken place) documentation in a specific archive area. TfL Document Manager (Livelink) is generally being used for this function to make use of its records management facilities. The basic process will be that the write access for each document (and folder) is disabled and the documents are moved (or hidden) into an area with reduced access. Documents that originated on TfL Document Manager will have a link added to the document's old location. Generally, archiving will occur after handover and during project close, but could be done non-cooperatively anytime after the project's end.

3.3.14 Document Numbering

3.3.14.1 The Building Information Modelling processes mandates that projects apply a standard unique identifier to all documents that are controlled through the Common Data Environment.

For LU projects the standard is S1-761 – Project Documents

For ST projects the standard is TfLIMM-HYD-X-GBR-SP-IS-0020 – IMM File Naming Convention

3.3.14.2 A unique identifier that is applied to a document can be known by a number of different names.

For instance

- Document Number
- Document Reference
- File Number
- File Reference
- File Name (see below)

All the above are synonyms for a unique identifier, though file name might be considered a special case.

3.3.14.3 The Building Information Modelling standards use “File Name” as a unique identifier for project information; however it doesn’t specify a field for a human readable name of the file. It would be expected that any system that is adopted by a project team would have both a ‘File Name’ to comply with BIM and a ‘Title’ (or similar) that is human readable.

For LU the standard is S1-760 – Common Data Environment (CDE) Process Requirements

3.3.14.4 Contractor’s References

Contractors are expected to use agreed standards for document numbering, where transitioning from one system or format is required, this must be agreed with the client.

3.3.14.5 Document Number Blocks

If required, document references can be given out in blocks of numbers, providing the users are instructed not to use the same document number twice and they don’t exceed their range of numbers.

3.3.15 Document Title and Name

3.3.15.1 Care is needed when referring to a file's "title" or "name" as document systems can consider these to be 2 different pieces of metadata. Giving a document a sensible title that describes its content is essential if you wish to use a document system effectively: you cannot expect other people; or even yourself after six months, to know the true contents of a document from a cryptic or short name. Some document systems index the contents of a document; this will help with searching, but won’t help with images and scanned documents.

Good practice is to start titles of all letters and other documents that do not change with the date i.e. 2011-12-31 - Letter RE The letter description.

For assurance documents, and depending on the system you are using, it is good practice to start the title with the documents reference number, the document description and possibly the issue/version/date if appropriate.

Note:	The version number of a document and the document system version number are not necessarily the same thing. When a document is amended outside of the document system, it will need to have the version manually updated - it is generally better to do this as a separate field of metadata rather than in the title to avoid having to change the document's title after each amendment. A Tracker (see 3.4.2) should normally be used to record formal version changes to a document.

See Clause 3.3.14.3 regarding the implications of BIM on document title and name.

See also the Information Governance standard for naming documents, Quick Guide 3– Naming documents and folders.

3.3.16 Document Revision Numbering

3.3.16.1 Ideally documents should be created using the project team's document management systems versioning standard, however as noted above, it is likely that documents will also exist outside the system; therefore you may have to adopt a process that is flexible to suit internal and external creation of documents.

3.3.16.2 Projects should implement the Common Data Environment methodology for numbering revisions on documents.

For LU projects the standard is S1-761 - LU Category 1 Standard Project Documents

For ST projects the standard is TfLIMM-HYD-X-GBR-SP-IS-0020 – IMM File Naming Convention

The BIM standard is unusual in that the first draft is labelled P01.1, then P01.2 etc. When the document is shared or published it becomes revision P01 (or C01), the next draft then becoming P02.1 etc. The revision is also a little odd when a document goes from Provisional "P" to Contractual "C".

Note:	The standard BS 1192 uses 'Revision' to identify different versions of the same document, other terms like 'Issue' and 'Version' etc. should not be used.

3.3.17 Electronic and Digital Signatures

3.3.17.1 An electronic signature is any electronic method that can establish the identity of a user and the integrity of any data. Therefore the use of usernames and passwords is a form of electronic signature and therefore can be an acceptable replacement for "wet signatures". See the following article http://www.out-law.com/page-443 on electronic signatures.

3.3.17.2 A digital signature is a particular type of electronic signature that can provide enhanced authentication, Digital signatures are NOT scanned images of a person's handwritten signature, they are a method for adding a person's digital ID to a document and establishing that a document has not been changed since being created.

3.3.17.3 Digital ID's use private and public keys (encryption) to establish that the person who adds the signature is the person they say they are. A person can use a self signed digital ID, however in a business context a user should obtain a digital ID from a recognised Certificate Authority (CA) e.g. Verisign.

3.3.17.4 To add digital signatures to Microsoft Office documents, the purchase of applications like Docusign or Echosign would be required, it is possible to add digital signatures to PDF's using Adobe Acrobat or Reader, but currently TfL does not have any means to provide a valid authentication.

3.3.17.5 The following is an example of a self signed digital signature from a PDF document.

3.3.17.6 The company's published policy on Digital Signatures can be found via this link, Records Management Quick Guide 21 – Digital authorisation.

3.3.17.7 Good practice, in lieu of a digital signature system, is that any legal, assurance, contractual document or key correspondence continues to be physically signed with a "wet" signature.

3.3.18 Safe System of Work Plan (Method Statement)

3.3.18.1 A safe system of work plan is not just a method statement, but a collection of relevant documents that make up the "package" that constitutes the work to be undertaken.

Documents like method statements can be made up of many supporting documents; for storage, best practice is to compile the package into one single document (There is an option to do this using Adobe Acrobat).

3.3.19 Document Withdrawal (Non-archived documentation)

3.3.19.1 Best practice, when withdrawing a document, is to ensure that it is not inadvertently used again (this is especially true if superseded by another document). Therefore, if available, the status of the document should be amended, the title or document description appended too and, if deemed necessary, a cover note placed in front of the document.

3.3.20 Meta-Data

3.3.20.1 The collection of meta-data can aid the searching of documents and can help sort and collect similar documents together and specific meta-data has been developed for security classification and for records retention.

3.3.20.2 Building Information Modelling introduces a set of mandatory data that is required to be collected for each piece of asset information in the Common Data Environment.

3.3.20.3 If a project wants to add additional meta-data, other than what is described by the BIM meta-data standards, it is up to the project team to collect and manage this data set.

3.3.20.4 Additional meta-data will need to be collected to create workflows and to aid reporting, this meta-data has not been described.

3.3.21 Suitability (Codes)

3.3.21.1 Building Information Modelling (BIM) formalises the concept of 'Suitability' and 'Suitability Codes', these terms are used to describe the appropriateness of the information and what purpose it has been released for. It is similar to terms like "Issued for Information" or "Issued for Approval", however it is much more detailed.

3.3.22 Folder Structures

3.3.22.1 Pathway defines a mandatory standard project folder structure that projects should adopt. The original Project Management Framework (PMF) folder structure which was specifically created for LU projects has been simplified in Pathway to enable smaller and Non-LU projects to adopt it. The folder structure was simplified by removing the second level folders from the structure leaving just the eleven top level folders, for LU projects it is recommended to continue to use the ex PMF structure. To identify the differences the ex PMF structure has 86 folders and is known as the **Complex Pathway Generic Folder Structure** and the new Pathway folder structure with 11 folders is known as the **Simple Pathway Generic Folder Structure**.

3.3.22.2 If more appropriate to your document management system/s, documents can be classified using meta-data and displayed using different views. Innovative methods to store and display documents are encouraged, providing the classification and views align with the folder structure.

3.3.22.3 It is recommended that projects do not have folder structures that are greater than 3-5 layers deep. Generally having a shallower but wider set of folders is considered preferable, making it easier to recognise a location of a document rather than trying to recall it.

3.3.22.4 Generally document management systems have very powerful search engines that use both meta-data and the document content to index documentation. To reduce the dependency on folders, best practice is to ensure that users of these systems have appropriate training in using the search and filtering functionality.

3.3.22.5 Generally projects shouldn't name folders the following

1. By People's names - People leave or move
2. By Project Stages - You will end up with many copies of the same document
3. By Date - Unless the set of documents are records
4. Admin / General - Doesn't mean anything

3.3.23 Excel versus Access versus SharePoint

3.3.23.1 Excel has been developed by Microsoft to a point where it can be a mini application; similarly Access can be configured and programmed to a point where it can do amazing things. However, developing Excel and Access has inherent dangers, that creators and user's must make note of.

3.3.23.2 Excel is excellent for lightweight financial calculations, ad hoc reporting and visualisation, but there is great risk in using Excel for large scale financial planning and other purposes where accuracy is paramount. Purposely created applications, offer security, accuracy and resilience, with Excel you effectively have **NO** IM support (best endeavours only) for the data included in the document.

3.3.23.3 Access is a lightweight Relational Database that is also tends to get misused. IM tends not to support Access databases that well either and therefore using an Access database for critical data is potentially risky. Access also has limitations regarding concurrent use and has an upper capacity (2 GB).

3.3.23.4 SharePoint has Microsoft SQL sat behind it, Microsoft SQL is a full featured and enterprise grade relational database. It also can have installed "Excel Services", this allows Excel spreadsheets to be shared etc. and viewed in a browser. For those who use linked spreadsheets SharePoint may offer a better environment, than trying to use a pure Content Management System (CMS), in fact, many CMS system can not handle linked spreadsheets. SharePoint offers many advantages over Excel alone or Access, not least it will be better supported by IM, but it can be more complicated to manage and may require some development.

3.3.23.5 Locally developing Excel, Access or SharePoint can offer a quick and easy solution to an immediate problem, but be aware that documentation will be non-existent and support for the solution will only last while the person who created it is still with the company. If information is vital to the continuation of the company or is required to be accurate, a purposely created and fully supported application should be obtained.

3.4 Document management processes

3.4.1 Document Transmittal Process

3.4.1.1 All projects adopting Building Information Modelling processes, shall also adopt the use of a Common Data Environment (CDE) to exchange information.

3.4.1.2 A project should track all assurance documentation into and out of the project team as it may be vital to protect the team (and specifically the Project Manager) if there is a dispute. This job is a key responsibility of a document controller.

3.4.1.3 All incoming and outgoing project documentation should be registered at a central point that allows the status of all documentation to be identified.

3.4.1.4 If a team does not have specialist software, the process of tracking documents should be undertaken using a spreadsheet.

3.4.1.5 All hard copy documentation should be issued under a transmission notice or covering letter.

3.4.1.6 All project critical emails should be copied from the users email accounts and stored in the document system. As a rule, all instructions and formal correspondence should be undertaken using signed letters or specific contract management systems.

3.4.1.7 A project team should create a local working procedure for the review of documentation and ensure that all parties in the project agree to work to the process. Building Information Modelling requires all parties agree to adopt prescribed “Standards – Methods – Procedures” (SMP), these are agreed to before the project commencing.

3.4.1.8 The document controller should, if able to, provide for the Project Manager regular reports listing the status of documents e.g. documents awaiting review or approval, documents due from suppliers and overdue reviews, approvals or receipts.

3.4.2 Document Tracker

3.4.2.1 If specific software is not available, it is good practice to use an Excel spreadsheet to maintain control of documentation. No specific tracker is mandated, as they can be very specific to the type of documentation being managed. Several different examples of trackers are available throughout the business, though to different degrees they all record the following information.

1. Document reference, title and version
2. Date Sent/received
3. Who reviewed/received by
4. Target return date
5. When returned
6. Action taken
7. When closed

3.4.2.2 Depending on requirements, documents shall be registered into the business from a third party and then tracked inside the business. Alternatively the documents shall be registered and tracked out of the business.

3.4.2.3 At appropriate times, reminders shall be sent to the people or organisations who have not replied to review / authorisation requests.

3.4.2.4 A Common Data Environment and related functionality provides the necessary aspects of a Document Tracker.

3.4.3 Review Process (Generic)

3.4.3.1 The process below is generic and system agnostic, if your project has specific requirements and/or has workflow enabled in your document systems you should amend your local processes accordingly. BIM procedures are detailed in “Standards – Methods – Procedures” (SMP) documentation, these are agreed upon prior to the start of the project.

3.4.3.2 All documents must have an owner, if responsibility is not given there is no guarantee that the project documentation will be managed correctly and this could adversely affect the project delivery.

3.4.3.3 For documents created within the project. The author creates the document and decides whether it needs to be managed.

3.4.3.4 If yes, they ensure that a unique document number is assigned and that the document is stored in the document system. Then go to step 3.4.3.9.

3.4.3.5 If No (e.g. routine email), then no further action

3.4.3.6 For documents received from outside the project. The receiver decides whether formal control of the document is required.

3.4.3.7 If Yes, the receiver passes the document to the document controller who ensures that a unique document number has been assigned, that the document is stored in the document system, finally that the document has an individual ‘Owner’ within the project. Then go to step 3.4.3.9.

3.4.3.8 If No, the receiver becomes the ‘Owner’ within the project.

Note:	It is best practice for all documentation to be routed through the document controller so that they can manage the process efficiently.

3.4.3.9 Author/Owner decides if review by others

3.4.3.10 If yes, go to step 3.4.3.12.

3.4.3.11 If No review required, author confirms who is the ‘Owner’ of the document and informs the document controller of the document’s status.

3.4.3.12 The Author decides who needs to review the document, and communicates specific review requests (what to review and by when) to reviewers with link to the document (provide a copy of document only if reviewer unable to use host document system) and, if appropriate, a link to the comments log.

3.4.3.13 Reviewers send responses to author or updates comments log.

3.4.3.14 The Author incorporates responses as necessary, assigns an individual ‘Owner’ within the project (this will usually be the author), updates the document in the document system and informs the document controller of the document status. If further review necessary, repeat steps 3.4.3.12 and 3.4.3.13

3.4.3.15 The ‘Owner’ decides who needs to act and/or be informed as a result of the document and distributes document by emailing link to document (provide a copy of document only if reviewer unable to use host document system system) with appropriate guidance e.g. ‘Formal sign- off required’

3.4.3.16 The ‘Owner’ ensures that any further change to their document is controlled so that the latest version (and not an earlier version) is available to the project team.

3.4.3.17 The ‘Owner’ or ‘Review Manager’ update the Project team’s document tracker as required at each stage of review.

3.4.3.18 To finalise the review, if required, the ‘Owner’ communicates the result of the review and the actions taken or actions to be taken.

3.4.4

3.5 Document Lifecycle

3.5.1 The following are some statistics Microsoft has assembled regarding the document life-cycle.

1. 85% of documents are never retrieved.
2. 50% of documents are duplicates.
3. 60% of documents are obsolete.
4. For every dollar that a company spends to create a final document, 10 dollars are spent to manage the document creation process.

This basically means that there is a significant cost in managing documents, most documents are never looked at again and over half are wrong anyway. Therefore, it makes sense to dispose of as many documents as possible when they are no longer required.

3.5.2 Where possible documents should be created within a document system and not be printed or copied unless there is a good reason to do so. If forwarded for people to view or comment on, it is preferable to send links rather than copies.

3.5.3 If a hard copy is obtained, effort must be made to ensure that the document is already on the document system, if it is not, it must be scanned and added to the system.

3.5.4 To avoid doubt, it is good practice to mark up a scanned copy with a date stamp, see scanning process Clause 3.7.

3.5.5 Documents should not be retained as hard copy if they have no purpose, destroy all documentation, that is confirmed captured on your document system and is no longer of use. All hard copy documents that are to be retained for longer than a year must be sent to the Records Custody Service (See Information retention and disposal – Retention Schedules).

3.5.6 Documents with wet-signatures or other documents can be retained for authenticity (legal or health and safety) reasons, however note that for legal admissibility (though not evidential weight), scanned versions have the same weight as original paper copies.

3.5.7 At a projects end, effort must be made to ensure that all paper versions have been scanned and are on the document system. However, if for the benefit of doubt, it is decided to archive certain documentation, they must be archived as per the requirements of the Records Custody Service.

Note:	Each box of documents that are stored by the Records Custody Service, is cross charged back to your cost centre, therefore unless you want to waste a lot of money, ensure that what is stored is actually required.

3.6 Building Information Modelling (BIM)

3.6.1 Building Information Modelling can be defined as

"Building Information Modelling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of places"

It is important to note that BIM is not just the adoption of new technology, though this is an important element to getting the full benefit of BIM.

The British Government as part of a policy to promote the adoption of BIM, have mandated all directly funded government departments comply with BIM maturity level 2 by June 2016, see the Building Information Modelling Task Group web-site for more details. As TfL receives a significant proportion of it's funding from central and local government, we have made a commitment to be BIM Level 2 capable by June 2016.

3.6.2 Building Information Modelling has the potential to revolutionise how projects create, develop and manage asset information in a project. Once information is handed over the information is reused and updated for the rest of the life of the asset.

3.6.3 The fundamental aspect of BIM is the use of a Common Data Environment (CDE) for collaboration; this concept is described in BS 1192:2007. This standard describes the areas information needs to pass through, the naming/numbering conventions, the revision standard, the workflows required and other details about the management of information. This and the other standards related to BIM provide a high level of prescription that some projects have not experienced previously.

3.6.4 A Common Data Environment does not have to be one application and can be composed of a federation of applications and services. As long as the process to use the components is agreed along the whole of the supply chain, just about any variation is acceptable.

3.6.5 The processes etc. for non asset information should be aligned as much as possible to the processes for asset information. For the avoidance of doubt, this is a requirement of the BIM standards/specifications.

BS 1192:2007 (Page 1)

"This standard applies to all construction project documentation …"

PAS 1192-2:2014 (Page v)

"PAS 1192-2 provides specific guidance for the information management requirements associated with projects delivered using BIM. Not all information on a project will be originated, exchanged or managed in a BIM format. This information will also need to be managed in a consistent and structured way to enable efficient and accurate information exchange. BS 1192:2007 provides details of the standards and processes that should be adopted to deliver these outcomes. Only information exchanges specific to BIM are described in this PAS. It is assumed for the purposes of this standard that non-BIM information exchanges between a principal supplier and employer and within the supply chain will be managed using equivalent information management standards. **Furthermore, and for the avoidance of doubt, all project information, whether in BIM environments or in conventional data formats should be shared using a single collaborative data environment (CDE)."** [Emphasis added].

Specifically, for LU projects, the project team should use the Task Team Work in Progress Area to develop all documentation and use the BIM processes as much as practicable i.e. S3 – Internal Review and publish to the Task Team Shared Area. Documents requiring sharing with the supply chain etc. then being moved to the Project shared area as per the requirements of H072 - Manage Production Information and Handover Information Handbook.

3.6.6 Common Data Environment (CDE)

A Common Data Environment is composed of the following areas.

BS 1192:2007

3.6.6.1 Shared & Published Areas

A project will require a collaborative area for information deemed fit for sharing and another area for information that has been authorised as Published Documentation.

It is vital that these areas are exposed to the Supply Chain, while at the same time maintaining full control of access and security. This part of the CDE could be owned by the owner / operator (TfL), by the main contractor or by another agent i.e. the architect. It is likely that we will use a number of solutions, both internal and external.

To differentiate from a **Shared Area** on the Common Data Environment and a **Shared Area** exclusively used by a Task Team (i.e. a sub-contractor) LU use the terms, **Project Shared Area** and **Task Team Shared Area** respectively.
LU has labelled the **Published Area** in the collaboration environment as the **Project Published Section**.

3.6.6.2 **Work in Progress (WIP) Area**

A Work in Progress area is required for developing information and for performing internal reviews prior to moving documentation to the Shared or Published areas. As each member of the supply chain have their own Work in Progress area, it is highly probable that each area will be on the supplier's own systems. It is important to note this, as it has a great bearing on how BIM can be pragmatically implemented.

To recognise that each "Task Team" can have their own WIP area, LU has named this area the **Task Team Work in Progress Area**.

3.6.6.3. **Archive Area**

A CDE also has the concept of an Archive area, it is assumed that projects will use there document system's version control functionality to store previous versions of information, but may also use a separate Archive area depending on the systems used.

A project will also require a store of all the documentation it creates and receives in a repository at projects end. Preferably this information should have Retention Periods set against them and be disposed of after a suitable time period.

3.6.6.4 Asset Information Model (AIM)

During the life of a project the information being gathered is known as the **Project Information Model (PIM)**, at project end the information is validated and handed over to the Asset Information managers where it becomes known as the **Asset Information Model (AIM)**.

All the AIM's are collected together into a system or systems to create the Corporate Common Data Environment. This is managed by the Asset Information managers as required by PAS 1192-3:2014.

3.6.7 A number of new manuals/standard/products have been produced to support the implementation of BIM, these include

Rail and London Underground

H-067 - Manage Production Information and Handover Information Handbook
S1-037 - LU Category 1 Standard S1037 Computer Aided Design (CAD) Data
S1-026 - Topographical Survey & Mapping
S1-538 - Assurance
S1-041 - Engineering Asset Information
S1-035 - Location Coding System
G1353 - Production of Drawings, Red Line Information & As Built Drawings
S1-760 - LU Category 1 Standard Common Data Environment (CDE) Process Requirements
S1-761 - LU Category 1 Standard Project Documents

Surface Transport

TfL-IMM-HYD-X-GBR-SP-IS-0020 – IMM File Naming Convention
TfL-IMM-HYD-X-GBR-SP-IS-0021 – IMM Modelling Standard
TfL-IMM-ECS-X-GBR-SP-IS-0022 – IMM Asset Classification
TfL-IMM-ECS-X-GBR-SP-IS-0020 – IMM File Naming Convention Codes

The above standards are still emerging and are likely to change, other departments not affiliated with Rail and Underground or Surface Transport i.e. Accommodation will also need to develop their own standards.

3.7 Scanning Policy and Process

3.7.1 Background

3.7.1.1 Scanning for legal admissibility as per BS 10008 and 'TfL Standard - Scanning for legal admissibility – 2009-09-25' is too onerous for the project environment and therefore this best practice has been developed to detail the minimum requirements a team should follow to established confidence in document authenticity.

Specifically, based on the TfL standard, scanning for legal admissibility has been considered too onerous because (this list is not exhaustive).

Clause 1.1 - The requirement to have a secured scanning area is impractical in many site offices where space is limited and working conditions are poor.

Clause 1.2 - A project, programme or portfolio would have to instigate an additional layer of administration to give certain personnel a security rating.

Clause 1.6 - New scanning equipment, with the required functionality would need to be purchased.

Clause 2.0 - A project, programme or portfolio would have to set up a team of mail room administrators to enable the interception of mail, its scanning and distribution through the organisation.

Clause 4.8 - Creation and retention of batch control certificates will require additional administration.

Clause 9.0 - All auditing will incur additional costs and extra administration.

3.7.1.2 In addition to the points raised above, a significant portion of scanned images will be received from 3rd parties and contractors, there is no guarantee this information would have been scanned for legal admissibility and this would make a scanning policy very inconsistent.

3.7.1.3 Documents that are scanned from hard copy versions or have scanned authorisation sheets (for signatures) need to be captured in such a way that confidence in the authenticity of these documents is enhanced.

3.7.1.4 Scanning documents as soon as they been received or as soon as they have been completed goes a long way to ensuring confidence in the authenticity of a document.

3.7.1.5 In terms of file size and image quality it is almost always preferable keep a document electronic, however many of our documents require authorisation signatures added to an authorisation block on the front page (or elsewhere).

3.7.1.6 Falsifying the authentication of documentation is a serious matter and could lead to disciplinary proceedings or termination of contract.

3.7.2 Purpose

3.7.2.1 This reference document details a set of minimum procedures designed to ensure adequate capture of scanned documentation.

The objectives are to:

1. Improve the reliability of, and confidence in, electronically stored information.

2. If required to be used in a dispute, minimise the threat of a challenge to the veracity of our documentation,

The guidelines are designed to:

1. Provide clear guidelines on minimum standards for projects wishing to conform to Pathway and the storage of scanned documentation.

2. Provide scope for the reduction of paper documents within site offices and the potential of not using the correct document.

3. Provide a procedure for the acceptable addition of a signage block to an electronic document that would otherwise have to be scanned in its entirety.

3.7.3 Security

3.7.3.1 The scanner operative should ensure that the document due for scanning is a true record of the document the owner requires to be scanned. If found to be falsified in any way the operative should raise this issue with creator/owner, and if necessary, should refuse to scan the document.

3.7.3.2 All staff employed in scanning should be made aware of their duty to ensure the appropriate amount of security in regard to the documentation they handle. Instances of mishandling sensitive information could lead to disciplinary action. Special care needs to be taken with personal and 'TfL Confidential' information and the operator themselves should have the appropriate security clearances to handle any documents in accordance with TfL's Information Security Policy.

3.7.4 Receipt and Upload to Document Management System

3.7.4.1 The minimum standard is the person scanning a document should mark up a document to show when a document was uploaded to the document management system by writing on the document using a pencil, other methods include using a red dot. Best practice is to use a date stamp to identify documentation has been officially received and added to the document system, any markings on documents must not obscure any text (including reference numbers).

3.7.4.2 All scanned documents should be uploaded onto a document system directly or as soon as possible after creation.

3.7.5 Preparation of documents

3.7.5.1 Staples and paper clips will be removed and folded papers straightened.

3.7.5.2 Torn documents will be repaired using clear adhesive tape (if possible on the blank side of the page). A note that a repair has been undertaken should be made either on the document or in the associated metadata.

3.7.5.3 Documents beyond repair or illegible in their original format will be photocopied and/or enhanced prior to scanning. A record of any such amendments or enhancements (or of document illegibility) will be maintained either on the document or in the associated metadata.

3.7.5.4 Documents which are photocopies of originals should be clearly marked “Photocopy”.

3.7.5.5 Documents which are faxes will be clearly marked “Fax”.

3.7.5.6 Documents which have been amended or annotated should be marked “Amended” or “Annotated”.

3.7.5.7 Each document will be allocated a unique document identification number through the document system.

3.7.5.8 All pages of a multi-page document should be kept together and in the appropriate order before, during and after scanning. Blank pages within a multi-page document which are numbered should be scanned.

3.7.5.9 Document separator sheets should be inserted between different document types within a batch.

3.7.5.10 Using post-its to amend a document is not good practice and should not be accepted. However, if post-its are appended to any documents, a decision must be whether to keep or remove, if not additional information to the content of the document i.e. says “Fred, please scan and return to folder”, it can be removed. Otherwise it should be retained, though it must not obscure any other information and should retain its context.

3.7.6 Scanning

3.7.6.1 The preferred scanner setting is 300 DPI, higher settings can be used, if required to obtain an acceptable image from the original.

3.7.6.2 The preferred scanned format is PDF, where available on your version of Adobe Acrobat (Version 8 and above), select “Make PDF/A compliant” when scanning documents.

3.7.6.3 The colour scanning option should be used if the document is predominately colour images or colour is used as a key to understanding the content.

Note:	Red Line drawings MUST be in colour.

3.7.6.4 Avoid scanning blank pages other than those which include page numbers or counted in the numbering.

3.7.6.5 The operator should quality check all scans to ensure completeness and readability, if necessary; the operator should rescan all pages that fail the quality check.

3.7.7 Document Capture and Document Indexing

3.7.7.1 Scanned documents shall be added to the projects teams document system, in the locations specified by the Project Generic Folder Structure. The available meta-data shall be completed correctly as possible.

3.7.8 Capturing Authorisation Sheets

3.7.8.1 All pages requiring signatures should be printed off and signed, pre-scanned signature images should not be added to electronic pages.

3.7.8.2 All authorisation sheets should detail the document they are attached to, including date, revision and document number. It must be possible to show that an authorisation sheet and content are for the same version; this is usually achieved by using a header/footer to display the version/date.

3.7.8.3 If necessary the authorisation sheet can be scanned and sent to other people for their signatures.

3.7.8.4 Once an authorisation sheet has been completed, the authorisation page should be added in its entirety to the original electronic document and replace (or cover over) the original authorisation sheet.

3.7.8.5 Alternatively, a pdf version of the entire document can replace the original document in the document system, providing there is no issue regarding changing formats.

3.8 Information Management Overview

The following text attempts to give guidance on information management and is not to be considered mandatory or authoritative.

3.8.1 Definition #1 (File Formats)

3.8.1.1 Information management can mean many things, for the purposes of this section it is how and where different types of information shall be stored.

3.8.1.2 As projects and departments are using different document systems and have different resources and requirements, therefore conformance to this strategy is best endeavors only.

File Formats

File Types	Location	Notes
Office Documents (Word / Excel / PowerPoint / Visio)	Document system	Older file types i.e. old Word formats may not be viewable in new document management systems. In this instance it may be preferable to convert them into a stable format like PDF or ensure that a viewer is available that can show these documents.
Linked Spreadsheets or MS Project files	Shared Drives	If linked spreadsheets or MS Project files require to be used and they don't function correctly in the document system, shared drives or SharePoint should be used in the document systems place.
PDFs	Document system	Hard copy documents scanned to PDF should follow the scanning policy above
Image Formats (JPEG / TIFF / PNG etc)	Document system	All images should have context, this would normally mean having an appropriate title - giving a description, location and a date.
Emails	Document system	All project critical emails should be copied and stored in the document system. Emails left in Outlook will be subject to the Corporate email retention policy (in other words destroyed after two years).
CAD Files	LU Only CAD system (Project Wise) TfL/Non LU Other system	**LU Only** All CAD files should be stored in the corporate CAD repository. Drawings shall be in PDF format when created from a CAD file. **TfL/Non LU** If a part of organisation does not have a suitable repository for CAD files the document system shall be used to store. Preferable CAD files should be converted to PDF to enable to be viewed natively in
Video and Audio Files	Shared Drives or	Unless relatively small or infrequent, these files are not to be stored in a document system it is preferred that

File Types	Location	Notes
	hosting site (i.e. FTP site)	a link to the files are created in the document system to enable searching. A hosting service or FTP site is also an appropriate place to store this type of information.
Data files	Shared Drives	As above
Database data-files	Shared Drives	As above.
Access Databases	See note	Corporately Access Databases are not supported, if you wish maintain an Access Database you do so at your own risk, otherwise an Access Database could be converted to a SharePoint site.
Exe and source code files	Document system	If Executable or source code files require to be stored as a record then your document system is the chosen location, however your system may not be able to store them natively, therefore they may require to be zipped up or added to a shared drive and links to the document system made.
Zip Files	Document system (see note)	Normally all zipped documents should be unzipped and added normally to a document system. The document system must also be able to hold this type of file and not the file that has been zipped).
PST Files	No where!	PST Files are stored by exception; generally they not allowed in document systems and Corporately are not wanted on any system.
Hard Copies (Record keeping of)	Document system	If your document system has the functionality to control hard copies it should be used otherwise a Database (SharePoint) should be used.
Hard Copies	Archive Store	If is preferable that all hard copy documents are scanned and stored on your document system. All retained documents shall be stored in Archive by one year of completion of use.
Hyperlinks	Document system	Hyperlinks have been used extensively within the Pathway Product Management Plan and MAID products, however be aware even using a permanent link (node address) there can be no guarantees that the link with remain more than a couple of years after a project has been completed.

Different document systems will typically have different thresholds for the maximum size of documentation that can be uploaded, but a document greater than 500MB will probably need to be stored in a shared drive.

If you have a document that has special functionality that does not function inside a document system, should also be stored outside of the system i.e. linked spreadsheets.

In these situations, it would be best practice to refer to the document inside the document system by creating a link to it.

3.8.2 Definition #2 (Lifecycle of information)

3.8.2.1 Electronic Documentation

All project document information will be subject to the following information management strategy.

LU Only

All appropriate documentation will be uploaded into the Core Asset Information (CAI) Repository on TfL Document Manager (Livelink) as per the MAID / PPMP processes at projects end. All other documentation will be moved or uploaded into the Archive area of TfL Document Manager (Livelink).

The intention in due time is to apply the appropriate retention policy to all document, which will be disposed of when appropriate.

TfL/Non LU

Provision for all vital information shall be made to ensure it is protected from premature disposal, exposure or loss. Typically asset and contractual information will require to be safeguarded.

3.8.2.2 Hard Copy Documentation

All hard copy documentation will be managed (including disposal) as per the requirements of the Records Custody Service.

3.8.2.3 Other Information

A policy for database and non document system stored information needs to be developed.

3.8.3 Definition #3 (Information Management Systems)

3.8.3.1 A content management system (CMS) is HIGHLY recommended as the minimum acceptable system for the storage of documentation, a document management system is a system that all members of project team contribute to and a document system typically replaces the use of a shared drive.

3.8.3.2 Project documentation should reside on a recognised TfL Enterprise Content Management system; the strategy is to use either the TfL Document Manager system (Livelink) or SharePoint. Projects delivering asset based projects are recommended to use the TfL Document Manager system.

3.8.3.3 Projects and programmes that can not comply with this requirement shall endeavour to comply with the mandatory requirements and principles of Pathway and all other information governance requirements, as described in the Information and Records Management Toolkit.

3.8.3.4 If required, a project can also use specific document management tools e.g. Assai or Asite, for transmittal management and / or collaboration. Specifically BIM requires a collaboration environment to share and publish documentation.

3.9 Project Management Framework Extra Information

3.9.1 A number of PMF product descriptions have been removed from the Product Matrix without suitable replacement.

LU-PD-10720 – Red Line Drawings & Plans (See G1353 - Production of Drawings, Red Line Information & As Built Drawings)
LU-PD-10724 – Test Report
LU-PD-10727 – As Built Drawings & Plans
LU-PD-10733 – Maintenance Manual
LU-PD-10736 – Plant, Tools & Equipment Approval
LU-PD-10787 – Operations Manual
LU-PD-10818 – Authority to Work Certificate (AWC)

If a project team wants advice on how to produce these products please contact the TfL PMO – Document Control.

3.10 Responsibilities

3.10.1 Project Manager

3.10.1.1 The Project Manager is ultimately responsible for ensuring that all project documents are managed diligently.

This entails:

1. All project staff being made aware of, and complying with, the requirement to manage project documents.
2. The Project Manager is also responsible for making available all documentation required at Project Completion (including handover).

3.10.2 Document Controller

3.10.2.1 The Project Manager will nominate a person, or persons, to the role of Document Controller. This role can be a dedicated resource or a part-time role as required by the needs of the project. A Document Controller controls documents within the project ensuring that.

1. They have a document number (where appropriate).
2. They have been given a title which clearly describes the file contents (not simply numbers or initials) and as per the requirements of Quick Guide 3 – Naming documents and folders.
3. They are stored in the correct location (or given appropriate meta-data) in the document system as per the Projects Document Folder Structure.
4. Ensures that deliverable documents are of acceptable quality, fit for purpose and available for review.
5. Where available, ensures that the appropriate meta-data is added to each document.
6. Will ensure that all managed documents are tracked in line with project assurance procedures (including nominating owners, raising transmittals etc.).
7. Ensure document protection and hard-copy-archiving is in accordance with corporate policy.
8. Ensure that, where available, the correct document template/s are being used.
9. The Document Controller must know how to use the system better than the users. The Document Controller may also be the administrator for it.

3.10.3 Knowledge Administrator (TfL Document Manager)

3.10.3.1 A Knowledge Administrator for the document systems will be nominated to the project, either centrally or by the Project Manager. The Document Controller can act as a Knowledge Administrator provided they have had sufficient training.

They will.

1. Manage access rights for the Project Group.
2. Add or remove staff from the project group depending on movement of staff.
3. Maintain their "Domain" in accordance with the governance rules.

3.10.4 Document Owner/Creator

3.10.4.1 The creator or owner of any project document shall.

1. Ensure that their documents are in the correct location.
2. Ensure that their documents have a reasonable title.
3. Ensure that their documents have the correct meta-data.
4. Follow the projects procedure for managing formal documents.

4 Supporting information

4.1 Background

4.1.1 This document is for reference on how to best follow the Pathway project management framework and specifically the document management requirements of the Pathway Manage the Project handbook.

4.1.2 This document also highlights the information and records management requirements for all parts of TfL, specifically the hard copy, security classification and records retention. More information regarding these subjects can be found on these links Records Management and Records Custody Service.

4.2 Safety considerations

4.2.1 There is no safety considerations related to the guidance document.

4.3 Environmental considerations

4.3.1 There is no environmental considerations related to the guidance document.

4.4 Customer considerations

4.4.1 This document has been written to be systems neutral, accepting that projects predominately use either TfL Document Manager (Livelink) or SharePoint and the system of choice for the Core Asset Information (CAI) repository and archiving is also TfL Document Manager.

4.4.2 This document mostly assumes that a project team will have a dedicated resource for document control, this is not a mandatory requirement and it is recognised that small teams will not have access to one. In this instance, the team need to manage documentation in an appropriate manner themselves; this usually means nominating someone to fulfil the role. However, it has been identified by the TfL Internal Audit Team that teams with a dedicated document controller have better managed documents.

4.5 Other information

More information and guidance can be found on the TfL PMO Document Control Collaboration Intranet Site.

5 References

5.1 Abbreviations

The following abbreviation are created

a) within London Underground's Glossary of Terms (1-622) (a Category 1 Standard)
b) from published sources that are clearly identified

Abbreviation	Definition	Source
AIM	Asset Information Model	b) PAS 1192-2/3
BIM	Building Information Modelling	b) BS 1192
CAD	Computer Aided Design	a)
CAI	Core Asset Information (Repository)	b) Pathway
CDE	Common Data Environment	b) BS 1192
CMS	Content Management System	b) AIIM
CPD	Capital Programmes Directorate	a)
CMS	Content Management System	b) AIIM
ECMS	Enterprise Content Management System	b) AIIM
FOI	Freedom of Information (Request)	b) FOI
IMM	Information Modelling and Management	a)
IMMCP (1)	Information Modelling and Management Change Programme	b) RUG
IMMCP (2)	Information Modelling and Management Capacity Project	b) ST
LU	London Underground	a)
MAID	Mandatory Asset Information Deliverable	b) Pathway
MIDP	Master Information Delivery Plan	b) PAS 1192-2/3
PIM	Project Information Model	b) PAS 1192-2/3
PMF	Project Management Framework	b) Pathway
PMO	Programme Management Office	a)
ST	Surface Transport	a)
TfL	Transport for London	a)
TIDP	Task Information Delivery Plan	b) PAS 1192-2/3

5.2 Definitions

The following topic specific definitions are created:

a) within London Underground's Glossary of Terms (1-622) (a Category 1 Standard)
b) from published sources that are clearly identified

Term	Definition	Source
Archiving	File archiving is an automatic process that replaces selected files in your shared and personal 'U' drives with shortcuts	b) Archiving
Configuration Management	Technical and Administrative activities concerned with the creation, maintenance and controlled change of configuration throughout the life of the product.	b) APM
Contract Management	An arrangement under which operational control of an enterprise is vested by contract in a separate enterprise which performs the necessary managerial functions in return for a fee.	b) Enterprise
Digital Signatures	A digital signature or digital signature scheme is a mathematical scheme for demonstrating the authenticity of a digital message or document.	b) AIIM
Document Management (Lifecycle)	The process of applying policies and rules to how documents are created, persisted, and expired within an organization.	b)
Information Management	The collection and management of information from one or more sources and the distribution of that information to one or more audiences.	b) AIIM
Project Document	A document that is it in the interest of a project to safeguard.	b) This
Retention Period	Represents the period of time a document should be kept or "retained" both electronically and in paper format.	a)
Scanner	A device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image.	b)
Schedule of Documents	A document created to ensure all the required documentation is received or created by the required date.	b) This

5.3 Person accountable for the document

Person accountable for the document
Tim Henderson – Document Control Manager

5.4 Document History

Issue No	Date	Changes	Author
A1	April 2013	Originally DRACCT 1468 which was created as a Guidance document (G1325), request made DRACCT 1748 to rebrand document which has now been revised as a Reference Document	Ian Chatting
A2	July 2015	Revised to include references to Building Information Modelling and related LU standards	Ian Chatting

Guidelines:

1. **This is a fillable MS Word Questionnaire.**

2. **If a question is not applicable, please type in NA.**

3. **Where tables are provided for your input, please feel free to re-format information or share existing attachments if that better reflects your response to the question(s).**

4. **As stated in the letter, LACMTA's goal to position itself to deliver quality capital projects on time and within budget as it builds a significant, long range portfolio. Please share attachments, where possible, which –**
    a. **Elaborate your responses in this questionnaire AND/OR**

    b. **Provide LACMTA additional insights, tips and guidance in building on its strengths but also in identifying our areas of improvements and proactively implement a robust project delivery and capital forecasting framework.**

5. **Attachments can be shared by embedding files in this section or by attaching them to your transmitting email.**

LACMTA is most appreciative of your time and efforts.

A. Agency Information

a. Agency Contact

Contact Information	Description
Agency	MTA New York City Transit
Contact person	Robert Cumella
Title	Chief, Capital Planning ad Budget
Phone Number	646-252-4305
Email	Rober.Cumella@NYCT.com

b. Agency Capital Plan Overview

Please provide the information requested below. Since we are reaching out to a diverse group of agencies, this information will help LACMTA group the responses appropriately.

a. What is your primary business line? The mission of MTA New York City Transit is to provide customers with safe, reliable and convenient public transportation in a cost effective manner.
b. What is the Total Dollar Value of Current Capital Plan $11.6B 2010-2014
c. How many years does the capital plan expenditure above span? Five (5) years
d. How many projects are in the capital plan? Approximately 740
e. How many active professional services contracts do you use to deliver capital projects? Approximately 100 professional service contracts
f. What is the total dollar value of these professional contracts? Since January 2010 to date: approximately $560 Million
g. What is the percentage of in-house staff to professional service consultants involved in capital project delivery 18.2%
h. Please provide the approximate number of full time equivalent (FTE) staff performing each of these functions in support of the delivery of the capital program. Table 1: Internal Staff versus Consultant Staff for Capital Programs

Staff Type	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff	1,345	85%
Consultants	246	15%
Independent Contractors		
Total		100%

i. What percentage of completed capital projects finished on time? 78%
j. What percentage of completed capital projects finished within the original contingency budget? 78%.

Below is a summary table of NYC Transit's Schedule and Budget Performance.

2010-2014 Program performance of completed projects

	On-Time < 3 months delay*	Delay* 3-6 months	Delay* > 6 months	Total
Schedule Adherence # of projects	247 78%	29 9%	40 13%	316 100%
	On-Budget within 5%	Over budget 5-10%	Over budget >10%	Total
Budget Adherence ** # of projects	247 78%	22 7%	47 15%	316 100%

B. Questionnaire

B.1 Planning

Project Manager's Role

1. Please share information regarding the Project Manager's role in the table below:

Table 1. Role of the Project Manager

Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes/No			
Yes	At NYC Transit, our Project Managers (PM) are responsible for the Planning, Design, Construction, and Testing/Acceptance of Capital Projects. They are not responsible for the Maintenance, Operation, of said projects. Upon substantial completion, the responsibility of the project is returned to our Operating Departments.	PM is involved from the inception of the project; the development of the Master Plan and detailed Scope Development. Using the MP as a background, a detailed multi-discipline design is developed. Contract specifications and drawings are developed. Engineering support is provided during the procurement/bid phase and both design and construction management work hand in glove with each other and our Operating Departments in the delivery of a completed capital project. This interwoven approach allows for checks and balances as well as provide our customer (both the riders and our Operating Departments) with a quality product on time and within budget.	Project durations often exceed the tenured assignment of responsible personnel from NYCT and contractors.

2. Describe any best practices used to develop a complete project scope and verify it with the end user NYC Transit's PMP 320 incorporated a requirement for a Concept of Operations which describes the project from the perspective of the key stakeholders, and is signed off by them. From which a Project Profile is developed. This Profile is then evaluated by our Capital Planning and Budget Office before being referred to our Program Management Office for development of a Project Master Plan. The MP consists of an Executive Summary, Detailed Scope of Work, a Preliminary Cost Breakdown (Design, Bid and Support costs) and Operating Budget Impact (OBI) analysis and a Project Justification.

3. Describe any best practices used to capture early studies and planning costs to a project charge number NYC Transit incorporates to support the proposed system into the Master Plan.

Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below. Change the phase name to correspond to your terminology

Table 2. Funding Gates

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used
Annual Capital Planning	The MTA does not manage capital funding on an annual basis. Rather, as specified under the NY State Public Authorities Law, MTA's capital work is funded via 5-year plans that support all phases of capital projects that are included in those plans. Establishment of 5-year plans requires approval from the MTA Board of Directors and the MTA Capital Program Review Board (CPRB), a committee appointed by the Governor and representing the NYS Senate, NYS Assembly, Governor, and the City	There is no threshold.	All phases	Projects may be included in a capital plan if they conform to MTA capital eligibility policies. The basic policy is that the work must result in a capital asset having useful life of 7 years or greater and having a unit cost of $25,000 or greater.

	of New York. Changes to a capital plan (known as amendments) usually require MTA Board and possibly CPRB approvals.			
Conceptualization/ Study	Specific operating agencies authorize such work within an approved capital plan. See “Annual Capital Planning” section above. Note that 3rd party engineering / architectural / planning usually require MTA Board approval because such contracts are usually procured via RFPs (i.e. that are selected based on negotiations rather than solely based on low bids).	There is no threshold.	Scope development	All projects are subject to the “Projects Gates,” an analytic review that occurs at 4 key stages in its lifecycle (PE, final design, construction, and completion). Work includes developing detailed project scope (project master plan), operating budget impacts, alternatives analysis, etc.
Project Planning	Operating agencies authorize work within an approved capital plan. See “Annual Capital Planning.	There is no threshold.	Scope development	See discussion of “Project Gates”.
Preliminary Design	Operating agencies authorize work within an approved capital plan. See “Annual Capital Planning”.	There is no threshold.	Preliminary Design	See discussion of “Project Gates”.
Final Design (CDs)	Operating agencies authorize work within an approved capital plan. See “Annual Capital Planning”.	There is no threshold.	Final Design	See discussion of “Project Gates”.
Bid & Award	Operating agencies authorize work within an approved capital plan. See “Annual Capital Planning”.	There is no threshold.	Advertisement of 3rd party contracts requires authorization	See discussion of “Project Gates”.

			through MTA HQ to address any Project Gates issues and to ensure that funding and budget are in place.	
Construction	Operating agencies authorize work within an approved capital plan. See "Annual Capital Planning".	There is no threshold.	Through closeout	See discussion of "Project Gates.
Closeout	Operating agencies authorize work within an approved capital plan. See "Annual Capital Planning".	There is no threshold.	Through closeout	See discussion of "Project Gates.

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project? Capital Planning and Budget and Sponsor and Managing Departments are responsible for the adoption and completeness of the Master Plan process to a high level of confidence. However in terms of delivering a 5 year capital program it is impractical to have all projects in PE prior to the Board's approval.

6. What % contingency does the Board authorize for construction change orders? NYCT budgets the majority of the capital projects with a 5% contingency and authorizes its Program Areas to spend within these limits without requiring Board approval.
7. Who controls the contingency? Procurement rules govern the use of project contingency as part of capital contracts
8. What does the Board require the Agency to do in order to get additional contingency? Changes to project budgets are required to follow a Budget Modification process with different levels of approval based on the amount of capital money being requested.

9. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings? The Board routinely approves the Capital Program Status reports, their Construction Oversight Consultant issues monthly reports based on complex projects, budget procedures as well as information on major scope budget and schedule changes.

Contracting Strategies

10. What contracting strategies does the AGENCY use for its capital projects? Please use the table below.

Table 3: Contracting Strategies in use at the AGENCY

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build				
Design/ Build (D-B)	Technology, Complex Construction, New Buildings	Up to $1B	Ability to negotiate Terms & Conditions, review many alternate ideas to reduce cost, risk, schedule etc., open communications with Contractors throughout the negotiations in order to receive a better product.	Very time consuming – can often take a year longer than a D/B/B. It can be a drain on internal labor resources and is also costly to the contracting society.
Public Private Partnership (PPP)	N/A			
Negotiated Procurements	Qualifying alternate sources (i.e. CBTC 3rd Supplier)	Various	Contractor foots most of the cost to Qualify as an approved supplier.	Very time consuming – It can be a drain on internal labor resources and is also costly to the contracting society.

11. If the AGENCY has used D-B, what conditions guided the AGENCY to consider it?

Complexity and Size of the Project. A D/B/B requires a full biddable design and scope and many complex projects require contractor input into the design and scope. Contractor input can offer other means and methods to achieve our goals with lower costs and risks to all parties.

B.2 Design

1. Please describe any best practice tools and processes that your AGENCY uses to control scope creep as scope is progressively elaborated from planning to early design to detailed design and into construction award. Through the use of software requirement tracking tools, such as IBM DOORs, NYC Transit is able to document and trace design requirements throughout a project's life cycle. The use of requirement management tools, as well as diligent scope review by our Program Management staff scope creep is kept to a minimum while allowing design changes to be thoroughly evaluated with regards to schedule and budget.

1. Please describe any best practice tools and processes that your AGENCY uses to improve the quality of design? What department/group is responsible for ensuring quality of design?

NYC Transit's Engineering Services Division within our Department of Capital Program Management is responsible for the quality of our capital project designs. Through the use of BIM on typical construction projects, NYCT designers are able to identify interferences and coordinate with our different engineering disciplines; thereby mitigating design issues and delays. Also, each design discipline has a set of Design Guidelines to ensure standardization and quality. NYC Transit Engineering established their own set of PMP/PMGs to assist in the design and management of projects.

B.3 Construction

Construction Change Order Process

2. Please share your Agencies' change order approval authority in the table below or via an attachment showing the workflow, responsibilities and approval thresholds?

*Table 4: Construction Change Order **(CO)** Approval Thresholds (NYCT CCO PMP Attached)*

Change Order Value	Construction Manager /Resident Engineer	Project Manager	Contracts Specialist	Procurement Support	Board	Agency EVP and President
Above $750K	A/C/I	R/A	R/A/C	R/A/C	I	I
Between $250K and $750K	R/A	R/A/C	R/A/C	R/A/C	N/A	I
Between $100K and $250K	R/A	R/A/C	R/A/C	R/A/C	N/A	N/A
Up to $100K	R/A	R/A/C	R/A/C	R/A/C	N/A	N/A
Below $25K	R/A	R/A/C	C/I	C/I	N/A	N/A

R = Responsible; A = Accountable; C = Consulted; I = Informed

Construction Claims Management

3. Please describe any successful techniques you use to avoid claims

   NYCT CCO guidelines require the contractor to address their claim to the Program Officer (PMO) as an intermediate step before formally submitting a claim to the chief engineer. The only claims that make it to the chief are those claims that were unable to be resolved in the PMO and which require the Chief Engineer to adjudicate.

4. Please describe any best practices that encourage/require contractors to submit time extension requests or claims as they happen during construction rather than at close-out?

NYC Transit Contract Specification Section 2.04 requires the contactor to submit their request for Extension of Time (EOT) within ten days of its occurrence otherwise EOT will not be entertained

5. Please describe any best practices the AGENCY uses for dispute resolution (DRB/arbitration/litigation)? For the majority of our construction contracts, we include an Alternative Dispute Resolution process that requires claimants to file disputes with either the Transit Authority's designated Chief Engineer or with the Contractual Disputes Resolution Board that is comprised of attorneys from other agencies. The disputes process is designed to provide real time dispute resolution in a manner that keeps the parties focused on project completion without the acrimony that oftentimes accompanies judicial intervention. If the contractor wishes to challenges the decision of the Chief Engineer or arbiter assigned by the Contractual Disputes Resolution Board, it can file an Article 78 proceeding in Court.

Utility Relocation

6. Please describe any best practices you use to identify utilities in the way of construction

   NYC Transit conducts non-destructive field surveys using electronic metal detector/utility locator and Ground Penetrating Radar (GPR) equipment; we also perform air/vacuum excavation followed by exploratory test pit excavation.

7. Please describe any best practices you use to relocate utilities

   NYC Transit starts coordination and communication with the specific utility owners/operators as early as possible during the design phase of the utility relocation. We conduct all required property acquisition and/or property management including clearing and improvement for ROW as a priority item. We arrange frequent joint meetings with utility owners as the project's design progresses to get their input on relocation issues and to make certain that they coordinate the proposed relocation designs with their maintenance team for any prioritization requirements.

8. Please share your experience with Utility Relocation challenges below. If you issue advance utility contracts please discuss your experience with this mitigation approach. Also discuss your experience partnering with utility companies to get timely relocations by their forces.

Table 5: Top 3 to 5 Challenges with Utility Relocations

Challenge Description	Impact on Capital Projects (High/Medium/Low)		AGENCY Response to Mitigate Impacts	Additional Comments
	Cost	Schedule		
Service Interruption	High	Low	Provide alternate sources	
Communication with affected residents	Low	High	Notify the residents early through community meetings	
Solutions for unexpected utility conflicts during construction	High	High	Develop design solution as quickly as possible	

9. How does the AGENCY resolve resource constraints that exist for a utility company?

NYC Transit conducts multiple meetings with utility companies well in advance to discuss the projects and their support/assistance required for their resource planning. We invite utility company personnel to pre-construction meetings and request utility company personnel involvement as deemed appropriate, during the construction phase of the project.

Contractor Management

10. Please share the AGENCY's top 3 to 5 challenges with effective contractor management and communications.

Table 12: Top 3 to 5 Challenges with Contractor Management & Communications

Challenge Description	Impact on Construction Delivery (High/Medium/Low)		AGENCY Response to Mitigate Impacts	Additional Comments
Maintaining an accurate contract	Cost High	Schedule High	N/A	

schedule that reflects all the on-going changes and identifying any impacts to the project.				
Ensuring quality in the on-going work and work is following contract specs and follow approved drawings	Medium	High	N/A	
Maintaining a safe work site and enforcing safe work plans	Medium	Low	N/A	
Ensuring Proper coordination with all the Sub-contractors.	Low	Medium	N/A	
Coordinating and getting access to the job site	Low	Low	N/A	

B.4 Operations/Maintenance

11. Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations

NYCT develop, organize and implement a test process that verifies the adequacy of the system to meet all functional, safety, and performance requirements. Both factory and field tests are performed. Factory testing ensures that subsystem software and hardware are fully tested to all extent practicable before being released to the field. Field testing shall ensure that the Signals and Train control systems have been properly installed, and that the system satisfies all performance; safety, reliability, and functional requirements before the systems can be placed in service.

12. Please describe any best practice tools, processes and procedures the AGENCY uses for Asset Management. Please discuss how you do condition assessment, identify maintenance and capital improvement needs, get the projects in the capital plan or issue work orders, etc

NYCT adapted several processes to ensure the proper management of key assets identify maintenance and capital improvement needs, Configuration Management (CM).
CM is a systematic Post In-Service process that details the approval control of changes to specifically identified system assets (software and firmware). It ensures that these changes have been properly

evaluated and agreed upon by the necessary disciplines prior to change implementation. The process has been modeled on Military Standard 973. The major functions of this process are:

- Configuration Identification
- Configuration Change Control and Configuration Control Authority meetings
- Configuration Status Accounting
- Configuration Verification and Audits

The Engineering Support process is in place to ensure that NYCT can reach the installer(s) systems in the event of a system issue which is beyond the expertized of NYCT. A service contract is issued the installer. This contract can also be used to modify or improve the performance of the provided system

B.5 Supporting Processes

Scheduling

13. Please check the box next to each best practice tools the AGENCY uses for Cost/Schedule management?

☐ Enterprise schedule software (Provide software name) N/A

☒ Integrated Master Schedule (all projects in capital plan by Program Area)

☐ Contractors' Schedule Updates in one central schedule database (N/A))

☐ Cost-Loaded Schedules (N/A)

☐ Cost Forecasting (Please describe method & tools) N/A

☒ Earned Value Management System (Please describe) Primavera 6 (P6) Software

☒ **Off-the-shelf Cost Estimating software (MS Excel and Oracle P6 Software)**

☐ Project Risk Management program (Please describe method & tools in the table below)

Table 6: Overview of Risk Management Program

Project Size	Risk Registers	Type of Risk Analysis	Monte-Carlo Based Contingencies	Approved Project Budget or Capital Plan Includes Risk-based Contingencies
Above $100M	Yes	For both Cost and Schedule	Yes	Risk Based Contingencies are included in Project Budget. Commitment to perform RA on projects $100M plus complexity and/or new technology

14. Please describe any Lessons Learned program the AGENCY has, noting how lessons are (1) collected (2) published and (3) retrieved as needed:

The purpose of Lessons Learned is to share and use knowledge derived from capital project design and implementation experiences to promote the recurrence of desirable outcomes and preclude repeating mistakes. There have been several attempts over the last fifteen years to institutionalize a Lessons Learned process, but a current initiative within NYC Transit's Capital Program Management (CPM) is being rolled-out and is being met with enthusiasm because of its tech-forward, user-friendly approach.

CPM is in the process of addressing two concerns: timeliness of reporting Lessons Learned and the dissemination of this information. In the past, Lessons Learned were compiled at the end of the job. When projects ran three to five years, it was often difficult to recall specific learnings. In addition, employees whose institutional knowledge were critical to the Lesson had oftentimes moved on. At the end of project, a multi-page report was produced and unfortunately was never adequately disseminated for use.

The new model will collect Lessons after each life-cycle phase not at the end of the capital project. This ensures information will be captured much closer to the actual events by the actual employees involved. It will now use a shared data base that will allow input from reviewers. To make information more accessible, users can search by project name or project phase. A google-type query can also be used to retrieve information. If a user types in a word or phrase, the program will return any record of Lessons with that word or phrase

15. Please describe (and if possible provide a copy of) any written project management and controls procedures. Describe how the agency ensures all participants are following the procedures. Please also discuss any training programs, noting if they are for employees only or include outside consultants. Please share some details about the training program in terms of frequency of sessions, types of sessions, types of participants and who hosts the program?

To date, CPM is updating its own master specification with the Lessons Learned it has thus far collected. This data base currently presides within one program area, but plans are being made to have it accessible to all of CPM and possibly in the future—agency-wide. At present the team is defining a "Lesson". The new model should not solely collect "complaints", but instead offer a corrective action. Lessons should also capture positive experiences—good ideas that prevent accidents or save money. The goal: "Repeat Successes, Not Mistakes"

Going forward, CPM will determine: how this new initiative will be documented into an engineering Project Management Procedure addressing issues like controls and use; different reporting models, the host or "owner" the program; training for users; and how if and how consultants will have access.

Project Delivery Staffing

16. Does the AGENCY have a Project or Program Management Office (PMO)?

☒ **Yes**

☐ **No**

17. If Yes, please share the information in the table below –

Table 14: Overview of the AGENCY PMO

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	Yes	-	Direct management of projects	-
Project Controls	No	Program Support	Less staff needed to support multiple projects	Lack of direct control by project management
Project Quality	No	Program Support	Less staff needed to support multiple projects	Lack of direct control by project management
Project Safety	No	Program Support	Less staff needed to support multiple projects	Lack of direct control by project management

18. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (ie- contract language, procedure, workflow, etc.) The following will improve your chances for a successful project outcome: Clear unambiguous requirements A cooperative environment between the Contractors, the Project Team and all Stakeholders Following formal methods that will establish common expectations from all parties Timely response by all parties, to any request for information or documentation review Executive Management support by providing the necessary resources to ensure success Realistic planning of both the schedule and budget from the outset of the project and holding the Prime Contractor responsible for the performance of their Sub-Contractors .

End of Questionnaire

NYMTA Asset Management BP

NYCT adapted several processes to ensure the proper management of key assets identify maintenance and capital improvement needs, Configuration Management (CM).

CM is a systematic Post In-Service process that details the approval control of changes to specifically identified system assets (software and firmware). It ensures that these changes have been properly evaluated and agreed upon by the necessary disciplines prior to change implementation. The process has been modeled on Military Standard 973. The major functions of this process are:

•Configuration Identification

•Configuration Change Control and Configuration Control Authority meetings

•Configuration Status Accounting

•Configuration Verification and Audits

The Engineering Support process is in place to ensure that NYCT can reach the installer(s) systems in the event of a system issue which is beyond the expertized of NYCT. A service contract is issued the installer. This contract can also be used to modify or improve the performance of the provided system

NYMTA Lessons Learned

The purpose of Lessons Learned is to share and use knowledge derived from capital project design and implementation experiences to promote the recurrence of desirable outcomes and preclude repeating mistakes. There have been several attempts over the last fifteen years to institutionalize a Lessons Learned process, but a current initiative within NYC Transit's Capital Program Management (CPM) is being rolled-out and is being met with enthusiasm because of its tech-forward, user-friendly approach.

CPM is in the process of addressing two concerns: timeliness of reporting Lessons Learned and the dissemination of this information. In the past, Lessons Learned were compiled at the end of the job. When projects ran three to five years, it was often difficult to recall specific learnings. In addition, employees whose institutional knowledge were critical to the Lesson had oftentimes moved on. At the end of project, a multi-page report was produced and unfortunately was never adequately disseminated for use.

The new model will collect Lessons after each life-cycle phase not at the end of the capital project. This ensures information will be captured much closer to the actual events by the actual employees involved. It will now use a shared data base that will allow input from reviewers. To make information more accessible, users can search by project name or project phase. A google-type query can also be used to retrieve information. If a user types in a word or phrase, the program will return any record of Lessons with that word or phrase

LA County MTA (LACMTA)'s objective for this study is to position itself to deliver quality capital projects on time and within budget as we build a significant, long range portfolio. This questionnaire is designed to gather any best practices PANYNJ has developed to address the challenges of delivering a complex portfolio of projects.

Guidelines:

- If a question is not applicable, please type in NA.
- Where tables are provided for your input, please feel free to re-format information or share existing attachments if that better reflects your response to the question(s).
- Please share attachments, where possible, which –
    - Elaborate your responses in this questionnaire AND/OR
    - Provide LACMTA additional insights, tips and guidance in building on its strengths but also in identifying our areas of improvements and proactively implement a robust project delivery and capital forecasting framework.
- Attachments can be shared by embedding files in this section or by attaching them to your transmitting email.

LACMTA is most appreciative of your time and efforts.

A. PANYNJ Information *(This section gathers info about your agency)*

1. PANYNJ Contact *(please fill in your contact information below)*

Contact Information	Description
Agency	Port Authority of NY & NJ (PANYNJ)
Contact person	Ms. Stephanie Dawson
Title	Acting Chief Operating Officer
Phone Number	212-435-7887
Email	sdawson@panynj.gov

2. PANYNJ Capital Plan Overview (*Please provide PANYNJ information below)*

a. What is your primary business line? New York/New Jersey Region's Trade and Transportation Network – Airborne facilities include 6 Airports; Ocean-borne facilities include 5 Ports, Public Transportation (Rail, Bridges, Tunnels, Terminals)

b. What is the total dollar value of agency Capital Plan $27Billion

c. How many years does the capital plan above span? 10-years

d. How many projects are in the capital plan? Over 500 projects

e. # of professional services contracts for the capital plan? Click here to enter text.

f. What is the total dollar value of professional contracts? Click here to enter text.

g. Please fill in the table below:

Staff Type involved in capital program only	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff	---	
Consultants	As needed	
Independent Contractors		
Total		100%

h. Please share any succession planning best practices you may be using to deal with an aging workforce The agency has developed a formal Talent Review process to assist in evaluating and understanding the potential of people in all of our departments. Through understanding potential, an individual's ability to take on more responsibility, we can be better informed when developing our succession plan. An individual's potential is determined through managers evaluating their direct reports leadership ability, leadership aspiration and learning agility. The results of these evaluations will inform the succession slates for Mission-Critical positions in 2015 and both Mission-Critical and Department-Essential positions in 2016.

i. Please share any stakeholder management best practices you may be using Click here to enter text.

j. What percentage of completed capital projects finished on time? Click here to enter text.

k. What percentage of completed capital projects finished within the original contingency budget? Within 11% of original contingency

B. Questionnaire *(This section gathers best practices in each project phase)*

B.1 Planning

B.1.1 Project Manager's Role

1. Please share information regarding your Project Manager's role in the table below:

Does PM have Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes/No			
yes		Continuity; oversight throughout the project life cycle	Difficult for one person to control spending and schedule for task managed by others on day-to-day basis.

2. Describe any best practices used to develop a complete project scope and verify it with the end user Project Initiation Request Form has been established, PIRF was developed to ensure agreement on project scope prior to start. Gate Review process also support scoping and verification.

3. Describe any best practices used to capture early studies and planning costs to a project charge number Separate charge code for each stage of project development

B.1.2 Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below. Change the phase name to correspond to your terminology

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used
Planning Authorization	Board			Planning cost > $500k
Project Authorization	Board			State of Good Repairs, Mandatory & Security projects with a Total Project Cost (TPC) equal or greater than

				$20M
Contract Authorization	Board			All contract awards with Total Construction Cost (TCC) of $2.5M or more

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project? Board Approval Process – Planning Authorization, Project Authorization, Contract Authorization
6. What % contingency does the Board authorize for construction change orders? 6-8% for Extra Work
7. Who controls the contingency? For Construction Contracts, Construction Management Division (CMD)/ Engineering Department oversees Extra work allowance within each contract and contract change approval process for use, as long as the project is within the authorized Total Project Cost (TPC)
8. What does the Board require the PANYNJ to do in order to get additional contingency? For Construction contracts, If additional cost to complete the project is more than previously authorized TPC, the project is presented to the board for re-authorization
9. Please provide a representative attachment, if possible, of the workflow and content required to obtain original and additional funding from the Board will be very helpful. Click here to enter text.
10. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings? They are not involved in the management of projects. ----

B.2 Design

11. Please describe any best practice tools and processes that PANYNJ uses to control scope creep throughout the project lifecycle. Project Delivery Performance system (PDPS) is used to prepare engineering proposals defines scope, delivery schedule and cost. If the project scope, budget, or schedule changes the Lead Engineer, with the assistance of the discipline Task Leads, will revised schedule, and budget in the PDPS system for approval by the PM. For changes later in the design process a supplemental request proposal can be prepared in lieu of reissuing the entire proposal.
12. Please describe any best practices you use for design reviews Every project undergoes a rigorous QA/QC project prior to the completion of Stage III design. QA/QC is the responsibility of every member of the design team. The Lead Engineer ensures that technical coordination of the design has been performed by the project design team and any comments from other disciplines, divisions, departments, agencies, and the facility are met, input, and followed. Each discipline is responsible for ensuring the quality of the information they coordinate with the

other Designers. A designated 'Checker' checks and verifies the work performed by the Designer according to a predetermined checking percentage for each item. The goal of the Checker is to examine the design methodology and verify that it is a valid approach. Once the methodology is accepted, the Checker verifies that the Designer correctly follows it. Peer Reviews are conducted on a project- by- project basis.

13. Please describe any best practice tools and processes that PANYNJ uses to improve the quality of design. What department/group is responsible for ensuring quality of design? BIM for large complex construction programs. Peer Review large unique/complex; Chief Engineer signs-off plans for in house design; Value Engineering Effort performed for certain projects; Review process – Design submittals review by stakeholders and external Departments.
The Port Authority performs Value Engineering on all Projects over $25 million, projects over $10 million that are unique or complex or repeated (at the discretion of the PM/Lead Engineer for determination of unique or complex or going below the $ threshold). Value Engineering (VE) is a methodology that applies teamwork and a systematic analysis of function to remove unnecessary costs from a project or process, while maintaining the required characteristics regarding performance, schedule, safety, reliability, maintainability, and customer/user acceptance. It is based on generally accepted VE methodology promoted by the Society of American Value Engineers (SAVE). VE is the same as, and sometimes referred to as, value management, value improvement, or value planning. For the best effect, VE studies take place prior to the Stage III point of a project. This will allow for any necessary changes in design with as little disruption to the project as possible.

B.3 Construction

B.3.1 Construction Claims Management

14. Please describe any successful techniques you use to avoid claims Try to resolve disputes as soon as they occur rather than have them linger and build into a larger dispute.

15. Do you require contractors to submit time extension requests as they happen during construction or do you wait until close-out? Yes, the contract language requires them to submit as they happen. Although we do recognize if a contractor waits until the end to submit it. We typically will not deny based on untimely submission of claim, as long as the request is legitimate.

16. Please describe any best practices you use to timely resolve claims See 14 above. Also, for disputed items of work, keep Time and Material records.

17. Please describe any best practices you use for dispute resolution of unresolved claims (DRB/arbitration/ litigation)? Our contracts state that claims that cannot be settled within the supervisory ladder can go to the Chief Engineer for final, binding, resolution. This has been challenged in court and upheld. We have had less than 5 Chief Engineer's decisions in the last 30 years.

B.3.2 Utility Relocation

18. Please describe any best practices PANYNJ use to identify utilities in the way of construction

Surveys performed during Preliminary &Final Design Phase. Surveys performed during Preliminary &Final Design Phase. One-Call system in place before digging. Our in-house surveyors also verify prior to construction. Contracts require hand digging over utilities.

19. Please describe any best practices you use to relocate utilities Pre-Bid: Work with the utility companies to finalize utility agreements & review utility relocation plans. Coordinate w/ upcoming projects in the same area.
20. If you issue advance utility contracts please discuss your experience with this mitigation approach. More beneficial, improves the need for coordination between the utility contract and Port Authority contract performing Roadways project as an example. Port Authority contractor able construct without utility relocation delays.
21. Please discuss your experience partnering with utility companies to get timely relocations by their forces. Experience has been positive in having utility companies perform relocation work advance of our project needs.
22. Please share your experience with Utility Relocation challenges in the table below. Click here to enter text.

Challenge Description	Impact on Capital Projects (High/Medium/Low)		PANYNJ Response to Mitigate Impacts	Additional Comments
	Cost	Schedule		
Known utility relocations	Medium	Medium	Coordinate w/ utility companies for timely approval/switchover.	
Unknown utility relocations	High	High	Need timely turnaround of design details along with approval/ coordination w/utility company	
Utility cost for relocation	Medium	Medium	Provide greater scope of definition during project design phase	Utility cost estimates are exceeded on many occasions impact project cost and schedule (re-authorize agreements with Board)

23. How does the PANYNJ resolve resource constraints that exist for a utility company? Pre-construction Utility relocation agreements. Try to perform as much of work with our own forces or our contractors, Try to leave minimal work/approvals for them.

B.4 Operations/Maintenance

24. Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations Commissioning of newly installed equipment is performed by the contractor and the Construction Management Division (CMD) staff. Commissioning agents are assigned to assist in this process. The primary purpose of the use of a commissioning agent is to have an entity focused solely on commissioning; including maximizing quality and efficiency, minimizing energy consumption, reducing cost and emissions and ensuring that Port Authority sustainability guidelines are adhered to. During Design (Stage I-III) phases, the commissioning agent is tasked with communicating with Line and Engineering staff to assure the overall quality of the design documents regarding commissioning issues. During Design (Stage I-III) phases, the commissioning agent is tasked with communicating with Line and Engineering staff to assure the

overall quality of the design documents regarding commissioning issues. During Construction (Stage IV) phase, the commissioning agent is responsible for working with the Resident Engineer's Office, facility staff and the contractors to implement the commissioning plan. Tasks include the verification of systems installation and performance; including functional tests, training for operation and maintenance, and preparation of O&M manuals.

25. Please discuss how you identify maintenance and capital improvement needs Condition assessments by Line Department or Quality Assurance Division/Engineering Department

26. Please discuss how you do condition assessment Cyclical inspections by Quality Assurance Division/Engineering Department; Pavement Management Program; Status Reports

1. Please discuss how you get the projects in the capital plan Line Departments prepare a "wish list" of projects, QAD conditions assessments, Surveys, and Study programs identify required maintenance, new regulations dictate new project needs. Proposed projects are entered in Capital Management System/Platform as unmet needs at project level without a stage template. The Project Initiation Request is used to determine the project's alignment with organizational objectives and to assess if the proposed project can be successfully completed based on current resource availability. If approved, the Project Initiation Request establishes a defined budget and schedule and projects are then prioritized using weighted criteria. Studies are done on selected projects using general funds, and help to refine budget and prepare a stage level cost loaded schedule.

2. Please discuss how you issue work orders. Port Authority uses established Work Order type of contracts to perform some of the maintenance type of work at the facility. Developed work order documents are issued to the contractor to commence work through CMD/Engineering Department.

3. Please describe any other best practice tools, processes and procedures the PANYNJ uses for Asset Management. Various tools, processes and procedures are used eg. IBM Maximo is used for Road Devices Management System to catalogue, manage and maintain Traffic assets, and pilot program for Aviation- EWR Airfield Lighting; PATH is using AssetWorks

B.5 Supporting Processes

B.5.1 Scheduling

4. Please check the box next to each best practice tools the PANYNJ uses for Cost/Schedule management?

☒ Enterprise schedule software (Provide software name) Oracle Primavera P6

☒ Integrated Master Schedule (all projects in capital plan in one schedule file) (ICMS project schedules are not integrated)

☐ Contractors' Schedule Updates in one central schedule database

☐ Cost-Loaded Schedules

☒ Cost Forecasting (Please describe method & tools) Professional schedulers in PMO work with Project Managers to get forecast updates.

☐ Earned Value Management System (Please describe) Not Done

☒ Off-the-shelf software (Primavera P6)

☒ Project Risk Management program (Please describe method & tools in the table below) –Current practice - every project going to board require to have risk assessment

Project Size	Risk	Type of Risk	Monte-Carlo Based	Approved Project Budget or Capital Plan Includes Risk-based

	Registers	Analysis	Contingencies	Contingencies
Above $2.5M or complex/high-profile project	Yes	Qualitative in early design phase; Quantitative at later design & Construction phase	Yes- use NetRisk	Projects do risk register as early @ 50% Stage 1, update to risk register at stage end and later stage of project development, use to set contingency on larger programs
Between $XX and $YY	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Below $ZZ	No	None	No	None.
Please edit/add thresholds as appropriate				

5. Please describe the process you follow to review contractor's schedules. Construction Management Division/Engineering Department Schedulers review and analyze contractor's schedules

6. Please describe any best practices you may follow to integrate progress payments with cost-loaded schedules ---

7. Please describe any Lessons Learned program the PANYNJ has, noting how lessons are (1) collected (2) published and (3) retrieved as needed: Lessons learned exercises are conducted on a project- by- project basis. Issues are catalogued with possible solutions to be referenced for future projects. Aviation has a Capital Program Quality Council tasked to gather and collect lessons learned from the project managers for discussion. During the Council Meetings project managers from each airport discuss challenges of advancing projects at different stages of the life cycle. In their current effort, they have developed an approach to collect and assemble lessons learned at the completion of each stage. By developing this lessons learned register a project manager can access information on situations or problems that are new to them and can see how someone else managed it.

8. Please describe (and if possible provide a copy of) any written project management and controls procedures. Documentation of current process and procedures is on going

9. Describe how PANYNJ ensures all participants are following the procedures. PMO holds responsibility to verify integrity of cost/schedule data and oversee controls security; PMO Project Controls Specialists maintaining schedules in concert with project managers; update and monitor Agency's Capita Plan & Operating Program; and perform schedule and cost analysis

B.5.2 Human Resource Management

10. Is a Staffing Plan created and followed for every project?

☒ **Yes** (PDPS provides engineering budget and staffing plan for each project; Annual PM Workload & FTE analysis)

☐ **No**

11. Check the box next to any organization-wide HR Management procedures that PANYNJ has implemented for individual/personnel development:

☒ Succession planning

☒ Training responsibilities are assigned to named individual(s). (PMO Training Coordinator for Project Management Training only; HR Rep)
☒ Training activities periodically reviewed.
☒ Budgets/funds direct and indirect costs of training.
☐ Data is collected to determine training effectiveness. KPIs are tracked and refresher training assigned by manager
☐ A documented process is in place for recognizing outstanding performance on projects.
☐ Linkage has been established between performance and reward.
☒ Project Management is an established career path
☒ A competency model is used that includes proficiency assessments.
☐ Established goals for improving project management capabilities.
☒ Employees have personal development plans.
☒ Training on team development exists
☐ Project Team development is planned and budgeted
☒ The effectiveness of the various HR programs are periodically reviewed.
☐ Key individuals on the project team are identified as critical to project performance
☒ Employee's contribution to organizational strategic goals and objectives are assessed
☐ A mentoring program is in use that provides timely feedback
☐ The effectiveness of mentoring is periodically reviewed.

12. Does PANYNJ have any formal training programs?

☒ **Yes**
☐ **No**

If Yes:

13. What is the frequency of training? Annually and more frequently when needed
14. What curriculum is taught? Project Management, leadership skills and technical skill and operations and maintenance training
15. What position titles are given training? All levels, represented and non-represented
16. Are consultants also trained? It depends- only PA specific process & procedures training
17. Who administers the program? The programs are administered by internal Talent Management staff as well as consultants and vendors depending on the type of training.

B.5.3 Project Delivery Organization

18. Does PANYNJ have a Project or Program Management Office (PMO)?

☒ **Yes**
☐ **No**

19. If Yes, please share the information in the table below –

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	NO	Project Management reside with the Departments	Focus on department and Facility needs	Inconsistent management practice

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Controls	Yes		Transparency, allows Independent oversight, consistency	
Project Quality	No	Department/Engineering		
Project Safety	No	Department/Engineering		
Please edit/add functions as appropriate • Risk Management in Project Controls • PM Systems and Applications • Project Management Process & Procedures				

B.5.4 Contract Management

20. What contracting strategies does the PANYNJ use for its capital projects? Please use the table below.

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build	Most projects	all	PA retains control of design and oversee project execution	Projects take longer. PA responsible for design errors/omissions
Design/ Build (D-B)	Some projects- Bayonne	large	Projects get done faster; less change orders	Minimize control of design; quality and longevity may suffer
Public Private Partnership (PPP)	Some- GW Bus Station, LGA Redev, others	Larger Facilities with revenue	PA leverages private money to improve facilities. Operation risk contracted away	Minimize control of design & operations; reduce revenue
Others (Please Add)	CM/GC	Need -Basis	More collaborative relationship	

21. If the PANYNJ has used D-B, what conditions guided the PANYNJ to consider it? Complete project faster and reduce risk
22. If the PANYNJ has used PPP, what conditions caused the PANYNJ to pursue such a model? Limited available funding; leverage private partner expertise
23. Did the use of alternative contracting methodologies improve project success? If yes, please describe what aspect of that methodology made a difference. Yes. Projects moved faster; less change orders
24. Please share the PANYNJ's change order approval authority via an attachment showing the signature authority and approval thresholds? Resident Engineer – up to $50K, Engineer of Construction – up to $100K,Chief of Construction – up to $250K, Chief Engineer – over $250K
25. Please describe any best practices you follow related to contract management or communications. Resident Engineer in Construction Management Division/Engineering Department manage all construction contracts on behalf of the Chief Engineer and communication protocol of one point of contact w/contractor is clearly established.

B.5.5 Document Management

26. What document management system do you use? LiveLink, SharePoint
27. Is it used for all projects? Yes, for most projects
28. Is a different tool used during construction? Yes, Mainly Primavera Contract Management, E-Builder for some specific Projects
29. If yes how do you integrate the two systems? Manually
30. Are construction progress meeting minutes maintained in a database that tracks action items to completion? For some projects, at the discretion of the Resident Engineer.

C. Catchall Question

31. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (ie- contract language, procedure, workflow, etc.) General Agency oversight of projects (Monitor & Control)

<u>End of Questionnaire</u>

PANYNJ Utility Relocation Challenges

Challenge Description	Impact on Capital Projects (High/Medium/Low)		PANYNJ Response to Mitigate Impacts	Additional Comments
	Cost	**Schedule**		
Known utility relocations	Medium	Medium	Coordinate w/ utility companies for timely approval/switchover.	
Unknown utility relocations	High	High	Need timely turnaround of design details along with approval/ coordination w/utility company	
Utility cost for relocation	Medium	Medium	Provide greater scope of definition during project design phase	Utility cost estimates are exceeded on many occasions impact project cost and schedule (re-authorize agreements with Board)

PANYNJ PMO Functions

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	NO	Project Management reside with the Departments	Focus on department and Facility needs	Inconsistent management practice
Project Controls	Yes		Transparency, allows Independent oversight, consistency	
Project Quality	No	Department/Engineering		
Project Safety	No	Department/Engineering		
Please edit/add functions as appropriate • Risk Management in Project Controls • PM Systems and Applications • Project Management Process & Procedures				

PANYNJ Contracting Strategy

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build	Most projects	all	PA retains control of design and oversee project execution	Projects take longer. PA responsible for design errors/omissions
Design/ Build (D-B)	Some projects- Bayonne	large	Projects get done faster; less change orders	Minimize control of design; quality and longevity may suffer
Public Private Partnership (PPP)	Some- GW Bus Station, LGA Redev, others	Larger Facilities with revenue	PA leverages private money to improve facilities. Operation risk contracted away	Minimize control of design & operations; reduce revenue
Others (Please Add)	CM/GC	Need -Basis	More collaborative relationship	

LA County MTA (LACMTA)'s objective for this study is to position itself to deliver quality capital projects on time and within budget as we build a significant, long range portfolio. This questionnaire is designed to gather any best practices POLB has developed to address the challenges of delivering a complex portfolio of projects.

Guidelines:

- If a question is not applicable, please type in NA.
- Where tables are provided for your input, please feel free to re-format information or share existing attachments if that better reflects your response to the question(s).
- Please share attachments, where possible, which –
    - Elaborate your responses in this questionnaire AND/OR
    - Provide LACMTA additional insights, tips and guidance in building on its strengths but also in identifying our areas of improvements and proactively implement a robust project delivery and capital forecasting framework.
- Attachments can be shared by embedding files in this section or by attaching them to your transmitting email.

LACMTA is most appreciative of your time and efforts.

A. POLB Information *(This section gathers info about your agency)*

1. POLB Contact *(please fill in your contact information below)*

Contact Information	Description
Agency	Port of Long Beach (POLB)
Contact person	Mr. Doug Thiessen
Title	Managing Director - Engineering
Phone Number	(562) 283-7065
Email	doug.thiessen@polb.com

2. POLB Capital Plan Overview (*Please provide POLB information below)*

a. What is your primary business line? The Port of Long Beach is an innovative provider of state-of-the-art seaport facilities and services that enhance economic vitality and improve quality of life and the environment.

b. What is the total dollar value of agency Capital Plan $5 Billion total current budget of active projects, of which $2.5 Billion is forecasted over the next 10 years

c. How many years does the capital plan above span? Approximately 20 years, including a 10 year forecast

d. How many projects are in the capital plan? Approximately 80 projects

e. # of professional services contracts for the capital plan? 100 current active contracts

f. What is the total dollar value of professional contracts? $421,428,530

g. Please fill in the table below:

Staff Type involved in capital program only	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff		
Consultants		
Independent Contractors		
Total		100%

h. Please share any succession planning best practices you may be using to deal with an aging workforce. Maintain a consistent ratio of entry-level, mid-level, and management positions. Training and mentoring staff so staff is prepared for next level and we are able to promote from within if possible.

i. Please share any stakeholder management best practices you may be using Proactively engage communication with stakeholders, develop a communication plan, obtain agreement on and commitment to the project scope with stakeholders, obtain required permits and appropriate environmental approvals, perform outreach to the community and other stakeholders as needed, conduct regular meetings with stakeholders.

j. What percentage of completed capital projects finished on time? Not benchmarking this measure at this time. N/A

k. What percentage of completed capital projects finished within the original contingency budget? Not benchmarking this measure at this time. N/A

B. Questionnaire *(This section gathers best practices in each project phase)*

B.1 Planning

B.1.1 Project Manager's Role

1. Please share information regarding your Project Manager's role in the table below:

Does PM have Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes/No			
Cradle to grave responsibility is transitioning. The PMs within Program Management Division will have defined cradle to grave responsibility in the new project delivery model established in the Bureau Reorganization that we are undergoing.	Currently, in the model that we are transitioning from, the PM generally has cradle to grave responsibility. However, they more directly manage all phases of delivery, except Construction. This applies to PMs in both PM Division and Design Division.	The new model supports Integrated Project Delivery and building centers of excellence aligned with the Engineering Bureau's Divisions.	Maintaining momentum on active projects while transitioning to the new model.

2. Describe any best practices used to develop a complete project scope and verify it with the end user. Best practices used are defined in the Project Delivery Manual

3. Describe any best practices used to capture early studies and planning costs to a project charge number. At the onset of a stand-alone project, a work order (WO) and specification number is obtained and early project development costs are captured against the WO. For projects that originate from a larger program, a program-wide WO is obtained immediately to capture early development costs. These early costs eventually get allocated appropriately to the projects that develop from the program. Specification numbers are assigned to each project as early as they are defined within a program, and the combination of program-wide WO and project specification number enables project specific costs to begin being captured.

B.1.2 Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below. Change the phase name to correspond to your terminology. These are the gates that have been practiced for years; however they are being redefined now as part of the Engineering Bureau Reorganization and we expect to launch the new gate methodology over the next few months.

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used
Annual Capital Planning	Board of Harbor Commissioners and City Council	Not specified.	N/A	Based on Port business and operation decisions.
Conceptualization/ Study	Board	Over $200k in requested authorization for spending	Through completion of study.	
	Chief Exec Officer	Under $200k in requested authorization for spending	Potentially through final design, if an EIR is not required.	
Project Planning	Board	Over $200k in cumulative request for spending	Through completion of environmental documentation and preliminary design.	
	Chief Exec Officer	Under $200k cumulative request for spending	Potentially through final design, if an EIR is not required.	
Preliminary Design	Board	Over $200k in cumulative request for spending		If additional authorization for spending is needed
	Chief Exec Officer	Under $200k cumulative request for spending		If additional authorization for spending is needed
Final Design (CDs)	Board	Over $200k in cumulative request for spending	Through Final Design	

	Chief Exec Officer	Under $200k cumulative request for spending	Through Final Design	
Bid & Award	Board	N/A	Advertisement up to conditional award of construction contract.	
	Board	Not specified. Based on business decisions.	Authorizes conditional award through construction and closeout.	
Construction	Board	Over $200k in change (either additional or deductive)	The duration of the construction contract	All cost changes to construction contract
	Chief Exec Officer	Under $200k in cumulative change, either additional or deductive (which is refreshed by Board)	The duration of the construction contract	All cost changes to construction contract
Closeout	PMD or Board	Limit of Board Approved Budget	N/A	If final project costs are within the approved budget, then final closeout can be an administrative action by PMD. If final project costs exceed the approved budget or unused budget needs to be reallocated to program contingency, then Board approval is required.

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project? While there may be situations that could necessitate such a request for full funding at such an early stage (i.e. emergency projects and small projects – those short in duration and/or with lower budgets).Typically this is not practiced, and no special criteria have been established.
6. What % contingency does the Board authorize for construction change orders? At the time of Conditional Award of a construction contract, the Board approves project budgets which include contingency (generally approximately 10% of the construction value) based on project specific Risk Assessments performed. Board authorizes signing authority for Change Orders up to an accumulated $200,000. Once this limit is reached, staff may request refreshing the $200,000 signing authority.
7. Who controls the contingency? Program Managers control the project/program contingency and Construction Managers control the construction contingency. Program Managers approve changes (increase/decrease) to construction contingency, which is subject to the Board's approval.
8. What does the Board require the POLB to do in order to get additional contingency? If additional contingency is required which results in an increase to the approved program or project budget, Board approval is required.
9. Please provide a representative attachment, if possible, of the workflow and content required to obtain original and additional funding from the Board will be very helpful. The process for obtaining origin or additional funding is being revised. However, attached is a Directive which defines the process that has been practiced over the last two years.
10. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings? The Board of Harbor Commissioners is constituted as an oversight body and meet twice a month. They do not manage projects, but they are required to approve a number of items related to the projects, such as: scope; budgets; authorizations for spending; professional service contracts and amendments; construction contract bid and award; construction change orders over $200k; substantial completion; and final acceptance. The Board does not typically communicate directly with the project team outside of Board meetings, except as necessary in relation to Board action items.

B.2 Design

11. Please describe any best practice tools and processes that POLB uses to control scope creep throughout the project lifecycle. Scope of the work developed by the project team is usually prepared with a design proposal which is broken down with WBS which is also tied to the project schedule. When there are any changes to the project scope, those are addressed with revised proposal and schedule so they can be tracked.
12. Please describe any best practices you use for design reviews. Port of Long Beach (POLB) has Quality Management System Manual (QMS) to follow. QMS requires the design teams to prepare Design Quality Management Plan (DQMP) which identify checkers and Quality Control Manager for the projects. Typically design packages are submitted at 15%, 50%, 100%, and final for interdivision reviews. Prior to submitting for interdivision review, it is required to have internal quality reviews.

13. Please describe any best practice tools and processes that POLB uses to improve the quality of design. What department/group is responsible for ensuring quality of design? Typically Engineering Design Division is responsible for quality control and quality of the design packages. Project Management Office under Program Management Division is responsible for Quality Assurance (QA). POLB also implemented Risk Assessment Process which requires the project team to go through risk assessment workshops throughout the project. The Port also has instituted, as needed, third party independent review of project design documents.

B.3 Construction

B.3.1 Construction Claims Management

14. Please describe any successful techniques you use to avoid claims. Implementation of strategies to develop good contract documents, including: subsurface investigations, Quality Management System, project risk assessments, peer reviews, constructability reviews, etc. Implementation of strategies during the Construction Phase, including: partnering, pre-activity meetings, full-time inspection, QA material testing, thorough and accurate daily reports, job photos, thorough documentation, and proactive issue resolution.

15. Do you require contractors to submit time extension requests as they happen during construction or do you wait until close-out? They are required to submit as they happen, but it is extremely difficult to implement. It is often mutually agreed upon to defer time analysis, with alternate language added to the Change Order to indicate the CO represents full accord and satisfaction as to the Direct Costs, and time and time-related overhead is deferred.

16. Please describe any best practices you use to timely resolve claims. Partnering – resolve at lowest level with the individuals most familiar with the issue. Include escalation ladders as part of partnering so contractor and owner know who to contact if it is not resolved.

17. Please describe any best practices you use for dispute resolution of unresolved claims (DRB/arbitration/ litigation)? Partnering escalation and mediation.

B.3.2 Utility Relocation

18. Please describe any best practices POLB use to identify utilities in the way of construction. Maintain record of utilities in GIS system, research as-built drawings, perform utility site investigations.

19. Please describe any best practices you use to relocate utilities. Meet with utility agencies well in advance of anticipated development to discuss options to accommodate the project. Options may include: defining requirements for the contractor to protect utilities in place and not disturb operation; coordinating a schedule for the utility agency to move their utilities out of the way; or requiring the contractor to relocate or abandon the utilities in question.

20. If you issue advance utility contracts please discuss your experience with this mitigation approach. POLB has long term utility agreements in place with utility companies that establish assignment of responsibilities and define who pays for specific costs. With these in place, POLB can issue advanced Directives to relocate utilities prior to construction as needed. This approach works well.

21. Please discuss your experience partnering with utility companies to get timely relocations by their forces. In an effort to get timely relocations of utilities, POLB also conducts joint quarterly meetings with utility agencies to discuss future planned work. As a result of this practice, Long Beach Gas & Oil looked at the Port's long term development and decided to proactively move a large volume of their lines and equipment out of the way.

22. Please share your experience with Utility Relocation challenges in the table below. Click here to enter text.

Challenge Description	Impact on Capital Projects (High/Medium/Low)		POLB Response to Mitigate Impacts	Additional Comments
	Cost	Schedule		
Known or identified utilities	Generally Low	Generally Low	Advanced planning, early relocations or coordinated relocations during construction	While there can be substantial costs associated with these relocations, they are generally reduced with advanced planning.
Unknown or unforeseen utilities	Low, Med or High	Low, Med or High	Address safety and environmental issues immediately. Work with utility agencies and contractors to define solutions while minimizing the cost and schedule impacts to all stakeholders involved.	

23. How does the POLB resolve resource constraints that exist for a utility company? POLB practices providing as much advanced notice as possible and working with the utility agencies to identify challenges then incorporating their requirements and constraints into the plan and schedule. When unexpected utility resource constraints impact work during construction, POLB works with the agencies to define alternate approaches or solutions to minimize impacts (both cost and schedule) to the contract and to the other stakeholders involved.

B.4 Operations/Maintenance

24. Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations. Asset commissioning and testing requirements are written into the construction contracts. Typically, the contractor is required to develop and submit a testing plan and O&M Manuals for review and acceptance by POLB. Contractor is also required to demonstrate operability of the equipment during testing and/or final job-walk and provide owner/operator training of the systems and equipment. A commissioning agent is hired to conduct commissioning activities for LEED buildings.

25. Please discuss how you identify maintenance and capital improvement needs In 2016 we are initiating the first phase of an asset management program to include a facilities condition baseline and incorporating into the computerized maintenance management program and/or 10-year CIP plan.

26. Please discuss how you do condition assessment See question #25

27. Please discuss how you get the projects in the capital plan. As part of the annual budget process, the Engineering Bureau provides a 10-year projection of the forecasted capital outlay expected for all active and anticipated projects that constitute the Capital Improvement Program. This forecast gets incorporated into an over-all cash-flow projection for approval by Executive

Management and the Board of Harbor Commissioners. As new projects get identified each year, they are also approved by Management and the Board.

28. Please discuss how you issue work orders. Both internal and external customers contact the Maintenance Division (via electronic or telephony) and a work request is established. These requests are reviewed and appropriately assigned to the correct maintenance section manager. The manager establishes a priority to the request and creates a work order which is included on a 12-day planning schedule for the crew(s) to act upon. Emergencies and high-priority requests are handled on a case-by-case basis.

29. Please describe any other best practice tools, processes and procedures the POLB uses for Asset Management. See question #25

B.5 Supporting Processes

B.5.1 Scheduling

30. Please check the box next to each best practice tools the POLB uses for Cost/Schedule management?

☒ Enterprise schedule software (Provide software name) - Primavera P6

☒ Integrated Master Schedule (all projects in capital plan in one schedule file)

☐ Contractors' Schedule Updates in one central schedule database - Goal for development

☒ Cost-Loaded Schedules - For internal CIP Schedules only (for capital outlay projection as part of cash-flow forecasting), not Contractor Schedules

☒ Cost Forecasting (Please describe method & tools.) - The tools currently being used for Cost Forecasting are Unifier, P6 and Excel. Over the course of a project, cost estimates are produced based on established cost estimating standards for Class C, B and A. The project schedule is established and standard cash flow curves (generated from historical data) are selected for the project. The schedule is then cost loaded with the project budget accordingly. Project team also tracks project issues with potential costs and all construction changes (pending, potential, and actual) in Unifier. PM validates Unifier and P6 output, considering progress made, expenditures to date, and burn rate.

☐ Earned Value Management System (Please describe) - Under consideration as a goal

☒ Off-the-shelf software (Please provide software name) - Primavera P6, Microsoft Project

☒ Project Risk Management program (Please describe method & tools in the table below)

Project Size	Risk Registers	Type of Risk Analysis	Monte-Carlo Based Contingencies	Approved Project Budget or Capital Plan Includes Risk-based Contingencies
Above $30M	Yes	Both Cost & Schedule	Yes	Project & Capital Plan
Between $5M and $30M	Yes	Both Cost & Schedule	Not required unless there is a specific need identified due to complexity or other risk factors	Project & Capital Plan
Below $5M	Yes	Both Cost & Schedule	No	Project & Capital Plan

Please edit/add thresholds as appropriate	

31. Please describe the process you follow to review contractor's schedules. For most projects we require Primavera P6, and use a consultant scheduler to review the baseline, monthly updates, and Time Impact Analysis. Each consultant can chose the type of software they use to analyze/review schedule, such as using Claim Digger. The Construction Manager is responsible for reviewing the schedule for logical sequence and scope that matches the contract requirements. The Port is in the process of hiring in-house schedulers and centralizing construction schedule reviews.

32. Please describe any best practices you may follow to integrate progress payments with cost-loaded schedules. Not currently integrated.

33. Please describe any Lessons Learned program the POLB has, noting how lessons are (1) collected (2) published and (3) retrieved as needed: In the past, we would perform a Construction Contact Close-out survey on large projects, but did not have a formal process to publish and retrieve Lessons Learned (LL). This process is being redefined as a Project Close-out effort and expanded to include collection of LL throughout the course of project delivery, performing root cause analysis, and implementing process improvements as deemed necessary by Bureau Management. Currently, we manage all projects with enterprise project management software, so issues on previous projects can be retrieved and reviewed by other staff. Additionally, the Port has initiated development of a LL database as an interim solution to collect publish and retrieve LL until the full functionality is built in the program management software. Port also has a Specification Committee with staff members from the various phases of project development that meet quarterly and discuss/recommend revisions to the standard Contract Documents (General Conditions, Standard Conditions, typical Technical Provisions, bid documents, etc) based on LL.

34. Please describe (and if possible provide a copy of) any written project management and controls procedures. Project Delivery Manual, Draft Project Controls Practice Guide, Quality Management System Manual, Risk Assessment Manual, Design Standards, Construction Management Division Procedures Manual, Engineering Design Division Procedures Manual, Guidelines for Professional Consulting Services, and Directives. Not all of these documents have been updated to reflect the on-going Bureau Reorganization adjusted roles, responsibilities and procedures.

35. Describe how POLB ensures all participants are following the procedures. Primarily, in-house staff supervisors provide oversight to assure procedures are being followed consistently. Currently, we manage all projects with enterprise project management software (Unifier), which provides consistency in the process flow, approvals, and forms. Additionally, we are continuing to build project management business processes in Unifier.

B.5.2 Human Resource Management

36. Is a Staffing Plan created and followed for every project?
    - ☒ **Yes**
    - ☐ **No**

37. Check the box next to any organization-wide HR Management procedures that POLB has implemented for individual/personnel development:
    - ☒ Succession planning.
    - ☒ Training responsibilities are assigned to named individual(s).
    - ☒ Training activities periodically reviewed.

- ☒ Budgets/funds direct and indirect costs of training.
- ☐ Data is collected to determine training effectiveness.
- ☐ A documented process is in place for recognizing outstanding performance on projects.
- ☐ Linkage has been established between performance and reward.
- ☒ Project Management is an established career path.
- ☐ A competency model is used that includes proficiency assessments.
- ☒ Established goals for improving project management capabilities.
- ☒ Employees have personal development plans.
- ☒ Training on team development exists.
- ☐ Project Team development is planned and budgeted.
- ☐ The effectiveness of the various HR programs are periodically reviewed.
- ☒ Key individuals on the project team are identified as critical to project performance.
- ☒ Employee's contribution to organizational strategic goals and objectives are assessed.
- ☐ A mentoring program is in use that provides timely feedback.
- ☐ The effectiveness of mentoring is periodically reviewed.

38. Does POLB have any formal training programs?
    - ☒ **Yes**
    - ☐ **No**

    If Yes:
39. What is the frequency of training? Various formal training sessions are provided and vary depending on the subject and audience. Department goal is 40 hours per year.
40. What curriculum is taught? Varies depending on the need (ranges from technical to interpersonal)
41. What position titles are given training? Various training is provided for all position titles.
42. Are consultants also trained? No
43. Who administers the program? Human Resources or other Specialty teams (i.e. Cal State Long Beach, PMI, CMAA, ASCE, Academy Leadership, etc.)

B.5.3 Project Delivery Organization

44. Does POLB have a Project or Program Management Office (PMO)?
    - ☒ **Yes**
    - ☐ **No**
45. If Yes, please share the information in the table below –

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	No	PMO function resides in Program Management Division within the Program Delivery Group	Directly supports needs of PM project delivery (cradle to grave) guidance, methodologies, processes, support	This may be too deep in the organizational structure.

Project Controls	No	Project Controls Division of the Program Delivery Group.		
Project Quality Assurance	Yes	N/A	See comments for Project Management	
Project Safety	No	Risk Management Division, Construction Management Division		
Program/ Project Risk Assessment	Yes	N/A	See comments for Project Management	
Lessons Learned/ Process Improvement	Yes	N/A	See comments for Project Management	
Please edit/add functions as appropriate				

B.5.4 Contract Management

46. What contracting strategies does the POLB use for its capital projects? Please use the table below.

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/Bid/Build	Typically all projects, such as: Infrastructure (roadway, sewer, water, storm drain, etc.), Marine (dredging, landfill, rock dike, wharf, etc.), Buildings, Rail, Demolition, etc.	\$10k to \$200M	Transparent, legally defensible, standardized	Schedules, change management, liabilities
Design/Build (D-B)	Large cable-stay bridge	\$650M (original contract)	Transfer of risk, schedule and associated cost savings	Identifying/assessing changes, costs of delays
Public Private Partnership (PPP)	New Civic Center Facility	\$225M	Burden of cost spread over time, third party	Loss of control

			investment can offset initial capital cost	
Others (Please Add)	N/A			

47. If the POLB has used D-B, what conditions guided the POLB to consider it? Funding needs (the State's Design-Build Demonstration Program provided additional funding for the bridge) and schedule conservation (this methodology accelerated project delivery).
48. If the POLB has used PPP, what conditions caused the POLB to pursue such a model? In partnership with the City for the new Civic Center, this methodology enabled navigating through financial challenges and building public acceptance.
49. Did the use of alternative contracting methodologies improve project success? If yes, please describe what aspect of that methodology made a difference. Yes, both financially and in delivery schedule. Building cooperative relationships with the Stakeholders and consultant/ contracting teams for the alternative delivery projects.
50. Please share the POLB's change order approval authority via an attachment showing the signature authority and approval thresholds? The Chief Executive authority to issue change orders for up to $200k in cumulative change (either additive or deductive). Once the cumulative amount is reached, staff seeks approval from the Board for the next change order, ratification of the previous change orders, and refreshes the Chief Executive's change order authority.
51. Please describe any best practices you follow related to contract management or communications. Best practices used for construction contract management are generally addressed in the Construction Management Division Procedures Manual. Best practices used for professional services contract management are in the Guidelines for Professional Consulting Services, Contracting Procedures Manual, and other guidance documents depending on the type of services being provided.

B.5.5 Document Management

52. What document management system do you use? Primavera Unifier for some project management and all construction management documents during the project lifecycle, Bentley ProjectWise for CAD drawings, and EMC EDRMS for record archiving.
53. Is it used for all projects? Yes
54. Is a different tool used during construction? No
55. If yes how do you integrate the two systems? N/A
56. Are construction progress meeting minutes maintained in a database that tracks action items to completion? Yes (Primavera Unifier)

C. Catchall Question

57. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (i.e. - contract language, procedure, workflow, etc.). Experienced and competent in-house staff that know the project goals, stakeholders, the unique business challenges, the Port complex, ability to work with other Port groups to get things done

quickly, and know history of Port and challenges of the site. In addition, competent consultant support, good team communications, a team that anticipates potential issues early on during project planning/design and accounts for them in the contract documents.

End of Questionnaire

LA County MTA (LACMTA)'s objective for this study is to position itself to deliver quality capital projects on time and within budget as we build a significant, long range portfolio. This questionnaire is designed to gather any best practices SFIA has developed to address the challenges of delivering a complex portfolio of projects.

Guidelines:

- If a question is not applicable, please type in NA.
- Where tables are provided for your input, please feel free to re-format information or share existing attachments if that better reflects your response to the question(s).
- Please share attachments, where possible, which –
    - Elaborate your responses in this questionnaire AND/OR
    - Provide LACMTA additional insights, tips and guidance in building on its strengths but also in identifying our areas of improvements and proactively implement a robust project delivery and capital forecasting framework.
- Attachments can be shared by embedding files in this section or by attaching them to your transmitting email.

LACMTA is most appreciative of your time and efforts.

A. SFIA Information *(This section gathers info about your agency)*

1. SFIA Contact *(please fill in your contact information below)*

Contact Information	Description
Agency	San Francisco International Airport (SFIA)
Contact person	Mr. Geoffrey Neumayr
Title	Deputy Airport Director, Design & Construction
Phone Number	(650) 821-7713
Email	Geoff.Neumayr@flysfo.com

2. SFIA Capital Plan Overview (*Please provide SFIA information below)*

a. What is your primary business line?
Delivery of capital and facilities maintenance design and construction projects.

b. What is the total dollar value of agency Capital Plan Approximately
$4.8b over the next 10 years.

c. How many years does the capital plan above span?
10 year planning cycle which is updated each year.

d. How many projects are in the capital plan?
Approximately 220, with a range of budgets. See attached project report.

e. # of professional services contracts for the capital plan?
5 CM/GC with an A&E component and PM Support Services component, approximately 20 Design-Build contracts which includes design services and PM Support Services, and approximately 6 other professional services contracts. See attached project list.

f. What is the total dollar value of professional contracts?
Approximately $340m budgeted, $40m awarded

g. Please fill in the table below (see attached report):

Staff Type involved in capital program only	Estimated number of FTE staff -capital program only, not maintenance	Estimated Percentage of Capital Program Delivered (Excluding Construction Contracts)
Internal staff	Approximately 150 architects and engineers, construction services staff, inspectors, code compliance reviews, maintenance staff, etc.	4.2%
Consultants	Estimate = $340m/$200hr/40 hrs/week/52 weeks = 165 yearly FTE for	7%

	each year of the capital program	
Independent Contractors	N/A	N/A
Total	315	100%

h. Please share any succession planning best practices you may be using to deal with an aging workforce

Design & Construction tries to promote from within and we try to give junior staff opportunities to manage contracts with increasing complexity. Much of our project management staff were promoted from our Architecture and Engineering sections. Additionally we have created a Design & Construction Leadership Committee which has been looking at succession planning issues.

i. Please share any stakeholder management best practices you may be using

We have a very structured and thorough stakeholder engagement process that gathers input from stakeholders throughout each phase of our project delivery. The Stakeholder Engagement Process (SEP) is defined in our Delivery Exceptional Projects document (see attached).

j. What percentage of completed capital projects finished on time?

We develop the project schedules working collaboratively with the contractors, designers, and stakeholders. It is rare that a project exceeds the mutually agreed schedule without a specific reason for a change (scope addition, etc.).

k. What percentage of completed capital projects finished within the original contingency budget?

We develop the project budgets and contingencies working collaboratively with the contractors, designers, and stakeholders. It is rare that a project exceeds the mutually agreed budget and contingency without a specific reason for a budget or contingency change (scope addition, etc.).

B. Questionnaire *(This section gathers best practices in each project phase)*

B.1 Planning

B.1.1 Project Manager's Role

1. Please share information regarding your Project Manager's role in the table below:

Does PM have Cradle to Grave Responsibility	If No, what phase(s) is the PM involved in? Who do they hand off to?	Benefits of Approach	Drawbacks of Approach
Yes	Yes	PM takes ownership of delivering the Airport's vision, taking into account all stakeholder input through all phases	Becomes a challenge in staffing change situations

2. Describe any best practices used to develop a complete project scope and verify it with the end user

We have established a Programming Phase, which occurs before design starts, and allows the entire project team (Airport staff, Designers, Contractors, and all stakeholders) to jointly develop the project program. This program becomes the Basis of Design. See Delivery Exceptional Projects document (attached).

3. Describe any best practices used to capture early studies and planning costs to a project charge number

   All staff members charge to a project number, and we split out these costs based on the schedule of the project.

B.1.2 Board Governance Process

4. Please share your project authorization/funding gate process by phase in the table below. Change the phase name to correspond to your terminology

Gates↓ Features→	Who Authorizes? (Board, PMO, Others – please specify)	Funding Threshold ($ Limits)	Enables Project Through which phase(s)?	Criteria Used
Annual Capital Planning	Airport Commission, Majority in Interest Review (MII)	Approved Capital Budget and MII Reviewed Amount	Bid	The Capital Planning Committee assess project need and agrees on the priorities of Capital Projects.
Conceptualization/ Study	Airport Management	Approved Funded Amount		
Project Planning	Airport Management	Approved Funded Amount		
Preliminary Design	Airport Management	Approved Funded Amount		
Final Design (CDs)	Airport Management	Approved Funded Amount		
Bid & Award	Airport Commission	Contract Award plus any change orders	Design NTP	
Construction	Airport Management	Contract Award plus any change orders and GMP	Final GMP	

Closeout	Airport Management	Approved Funded Amount		

5. If a project is fully funded before preliminary design is complete, are there additional / special criteria used to enable the Board to feel comfortable committing full funding at such an early stage of the project?

   Projects are not fully funded before preliminary design. Projects are funded progressively throughout the life cycle of the project. It is the job of the Airport Project Manager or Contract Manager to request incremental funding.

6. What % contingency does the Board authorize for construction change orders?

   The Airport Commission authorizes up to 10% contingency for construction change orders with the initial authorization to proceed with construction. Typically, the teams request 7.5% of the direct cost of construction in contingency. In the event that change orders beyond the contingency are required, additional approvals are required by the Airport Commission.

7. Who controls the contingency?

   The project manager controls the contingency, although there are executive level sign offs required for single or cumulative changes, depending on the amount.

8. What does the Board require the SFIA to do in order to get additional contingency?

   Airport Commission approval, which includes justification for change as well as cost, schedule and project impacts.

9. Please provide a representative attachment, if possible, of the workflow and content required to obtain original and additional funding from the Board will be very helpful.

   We ask approval from the Airport Commission to award and modify contracts (see attached templates for documents submitted to the Airport Commission). We ask our Business & Finance department to incrementally fund projects using their Capital Planning System.

10. Please describe how involved your Board or its representatives are in the management of projects. Do they meet frequently or communicate directly with the project team outside Board meetings?

    The Airport Commission puts a great deal of responsibility on the project team to appropriately manage the project. Design & Construction management typically only go to the Commission for the required approvals at regular Commission Meetings. However, the Commission is updated on the progress of the large capital projects and other important issues via special presentations during Commission Meetings, of calendar memos, and story board presentations at Commission Meetings.

B.2 Design

11. Please describe any best practice tools and processes that SFIA uses to control scope creep throughout the project lifecycle.

    As part of the Delivery Exceptional Projects, stakeholders are engaged early in the project development process. They participate in the program development process and sign-off on their components of the projects in the programming phase, so the projects are more fully developed before they move into the design stage. Stakeholders are also kept involved during the design phase and are part of the decision making process when difficult program or design choices need to made by the project team. This helps limit scope creep.

12. Please describe any best practices you use for design reviews.

    Design drawings will soon be routed to reviewers through our Project Management System, Primavera Unifier. For actual design review we will be using Blubeam to graphically capture design review comments and responses. This will allow all reviewers to see other reviser comments and allow for coordination and reconciliation of comments.

13. Please describe any best practice tools and processes that SFIA uses to improve the quality of design. What department/group is responsible for ensuring quality of design?

    We have an in-house QA/QC staff member whose job it is to provide a quality review of designs performed by our in-house design teams. For projects designed by external teams, we rely on the project management support services teams to provide quality reviews. We also review design documents closely with the stakeholders.

B.3 Construction

B.3.1 Construction Claims Management

14. Please describe any successful techniques you use to avoid claims

    Part of Delivering Exceptional Projects and the Structured Collaborative Process is project partnering. Project partnering starts in the programming phase for executive staff and project stakeholders, and starts with the design-build teams as soon as we bring them onboard. We have found through partnering, the early identification of problems/issues, and open and honest communication amongst all project team members and stakeholders, that we have been able to avoid claims and litigation. See attached Delivering Exceptional Projects document.

15. Do you require contractors to submit time extension requests as they happen during construction or do you wait until close-out?

    Contract issues that require time extensions are identified as early as possible resolved and added to the contract as appropriate if easily accommodated. Contract time extensions that cannot be easily accommodated or have other project/stakeholder impacts may have to be resolved through the partnering process.

16. Please describe any best practices you use to timely resolve claims See previous answers.

17. Please describe any best practices you use for dispute resolution of unresolved claims (DRB/arbitration/ litigation)? See answer to Question #15.

B.3.2 Utility Relocation

18. Please describe any best practices SFIA use to identify utilities in the way of construction

    Except for a portion of a natural gas distribution line (owned by Pacific Gas and Electric), the aircraft fueling system (third party operator), and legacy portions of AT&T's telecommunications cabling, all other utility infrastructure on the airport campus is owned, maintained, and operated by the airport. This allows us much greater flexibility incorporating utility relocations into our projects. When have had to relocate the natural gas distribution line, it has taken considerable planning and process with PG&E

19. Please describe any best practices you use to relocate utilities

    The Airport has invested considerably into the underground infrastructure to reduce many of the unknowns. Understanding the utilities in the design phase of projects lends itself to better utility designs and bid pricing. Moreover, Airport planning documents are typically referenced in utility relocation projects to develop utility corridors for future construction.

20. If you issue advance utility contracts please discuss your experience with this mitigation approach.

    Generally utility relocation is an early activity in a larger project, although sometimes it is carved out as a predecessor contract. The direction taken is usually dependent on project scope and schedule considerations

21. Please discuss your experience partnering with utility companies to get timely relocations by their forces.

    When working with the PG&E to relocate their infrastructure, it takes a lot of discussion and planning early in the programming phase to ensure the scope of their work is clearly defined, the design schedule and deliverables are established. In some instances the Airport has taken on the design responsibility for PG&E utility relocations under their oversight. Also the means of construction agreed to, i.e. will PG&E self construct or can the Airport's contractor construct under PG&E oversight.

22. Please share your experience with Utility Relocation challenges in the table below.

Challenge Description	Impact on Capital Projects (High/Medium/Low)		SFIA Response to Mitigate Impacts	Additional Comments
	Cost	Schedule		
Encountering unknowns during excavation	High	Medium	Conduct pre-engineering underground investigations before design begins.	Usually results in a change order

23. How does the SFIA resolve resource constraints that exist for a utility company?

    Historically, the Airport has competitively bid components of the installation work that otherwise would be performed by the utility company. This approach allows the Airport to reduce the schedule risk of integrating utility companies into a project schedule and proves to be more cost effective.

B.4 Operations/Maintenance

24. Please share any best practices you use for asset commissioning & testing prior to hand-off to the facility operations

    All systems require some level of acceptance testing and commissioning, that is usually specified in the design specifications. The testing and commissioning is generally to the requirements of applicable codes and jurisdictions, or nationally accepted standard setting bodies. For selected building systems, the airport does hire third party commissioning agents to test, commission and monitor system performance over an initial operating period.

25. Please discuss how you identify maintenance and capital improvement needs

    The airport has a preventative maintenance program that produces and tracks maintenance work orders. The system can also be used to identify equipment that needs replacement. Campus wide infrastructure systems are tracked in a GIS database that can be used to determine project need. In-house engineering and maintenance staff monitor system performance and recommend projects for inclusion on the capital plan. The very largest capital plan projects are developed and included on the Airport Development Plan which is a planning and programming document used to identify future growth, funding, and permitting requirements.

26. Please discuss how you do condition assessment

    The airport's preventative maintenance program that produces and tracks maintenance work orders is one tool to perform equipment condition assessment. The GIS database that tracks campus wide infrastructure systems can also be used to do system based condition assessment. In-house engineering and maintenance staff working closely to monitor system performance is a third.

27. Please discuss how you get the projects in the capital plan

    The airport has established a Capital Plan Review Committee (CPRC) to review and rank capital plan projects proposed for inclusion on the capital plan. The CPRC reviews the project against a set of established criteria. Contracts ranking above a minimum threshold are recommended in total to senior staff for approval.

28. Please discuss how you issue work orders.

    The Maintenance Division has a preventative maintenance program that produces and tracks work orders

29. Please describe any other best practice tools, processes and procedures the SFIA uses for Asset Management.

    The airport does not have a formalized Asset management program, various departments track the assets under their care with a variety of tools.

B.5 Supporting Processes

B.5.1 Scheduling

30. Please check the box next to each best practice tools the SFIA uses for Cost/Schedule management?

☒ Enterprise schedule software (Primavera P6 EPPM)

The Airport is in the process of procuring an enterprise deployment of Primavera P6 EPPM. This tool will be used by our Program Management Consultant to help us develop an integrated master schedule for all Design & Construction project. We expect to finalize the integrated master schedule in Q1 of 2016.

☒ Integrated Master Schedule (all projects in capital plan in one schedule file)

☒ Contractors' Schedule Updates in one central schedule database

☒ Cost-Loaded Schedules

☒ Cost Forecasting (Please describe method & tools)

Use real-time forecasts which include estimated contract growth, trends, changes, etc. using our enterprise-wide Project Management System, Primavera Unifier.

☐ Earned Value Management System (Please describe) Click here to enter text.

☒ Off-the-shelf software (Primavera Unifier as our Project Management System)

Primavera Unifier was purchased as an off-the-shelf cloud-based tool, but a great amount of time and energy has been spent configuring the processes to match the way we do business.

☒ Project Risk Management program (Please describe method & tools in the table below)

The Airport does not have a formal risk management system. Each project uses a risk management approach appropriate for the needs of the project.

Project Size	Risk Registers	Type of Risk Analysis	Monte-Carlo Based Contingencies	Approved Project Budget or Capital Plan Includes Risk-based Contingencies
Above $XX	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None

Between $XX and $YY	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Below $ZZ	Yes/No	Cost/Schedule /Both	Yes/No	Project/Capital/Both/None
Please edit/add thresholds as appropriate				

31. Please describe the process you follow to review contractor's schedules.

    Most projects hold weekly meetings to review schedules (amount other things). Our project managers and management consultants are constantly aware of the project's schedule. When we put in place the integrated master schedule, we'll be able to review dependencies and overlaps between multiple projects.

32. Please describe any best practices you may follow to integrate progress payments with cost-loaded schedules

    We are developing our procedures.

33. Please describe any Lessons Learned program the SFIA has, noting how lessons are (1) collected (2) published and (3) retrieved as needed:

    We are developing our procedures.

34. Please describe (and if possible provide a copy of) any written project management and controls procedures.

    SFO has developed a contract process and procedures manual for contract management. In addition, we developed a construction management manual for use under our FAA mandated runway safety area program that completed last summer. That manual is being modified to become a generic construction management manual.

    Both of these manuals are living documents that will be or are updated to reflect legislative changes, process and procedure changes, or new best management practices.

35. Describe how SFIA ensures all participants are following the procedures.

    Each project team is expected to develop a Project Management Plan using the Policies and Procedures as a starting point. We hold regular training on the various processes and procedures that are regularly used by project teams. Finally, our Accounting department holds regular Internal desk reviews which identify any discrepancies, and we work with project teams to revise processes as necessary and ensure other projects are aware of any changes.

B.5.2 Human Resource Management

36. Is a Staffing Plan created and followed for every project?

    On the large D-B capital projects there is a staffing plan for the program management support service (PMSS) consultant that is brought on in the programming phase and that remains on the project until construction close out. There is not a formal staffing plan developed for the design build team that is reviewed or followed by the airport

    ☒ **Yes**

    ☒ **No**

37. Check the box next to any organization-wide HR Management procedures that SFIA has implemented for individual/personnel development:

    ☐ Succession planning

    ☒ Training responsibilities are assigned to named individual(s). Training is decided upon by managers and staff and is tailored the individual or project needs.

- ☒ Training activities periodically reviewed. Training is reviewed during the annual evaluation process.
- ☒ Budgets/funds direct and indirect costs of training.
- ☐ Data is collected to determine training effectiveness.
- ☐ A documented process is in place for recognizing outstanding performance on projects
- ☐ Linkage has been established between performance and reward.
- ☒ Project Management is an established career path
- ☐ A competency model is used that includes proficiency assessments.
- ☐ Established goals for improving project management capabilities.
- ☒ Employees have personal development plans.
- ☐ Training on team development exists
- ☐ Project Team development is planned and budgeted
- ☐ The effectiveness of the various HR programs are periodically reviewed.
- ☐ Key individuals on the project team are identified as critical to project performance
- ☐ Employee's contribution to organizational strategic goals and objectives are assessed
- ☐ A mentoring program is in use that provides timely feedback
- ☐ The effectiveness of mentoring is periodically reviewed.

38. Does SFIA have any formal training programs?

☒ **Yes**

☐ **No**

If Yes:

39. What is the frequency of training?

Training on process, procedures, and new systems/system changes, and controls are held as required. Training for specialized areas are coordinated by staff and managers. Specialized training is dependent on the individual, their project assignments, and their career goals. Additionally, the Airport's Equal Employment Office regularly offers training for staff on safety, customer service, etc.

40. What curriculum is taught? See above.

41. What position titles are given training?

Any staff member that wishes to attend the training, or when specifically identified by a manager.

42. Are consultants also trained?

Yes - They can be if the training is on airport specific process, procedures, and new systems/system changes, and controls.

43. Who administers the program?

There is no assigned program administrator, however, trainings are often held by our contracts group, process & controls group, and our legal team.

B.5.3 Project Delivery Organization

44. Does SFIA have a Project or Program Management Office (PMO)?

☒ **Yes**

☐ **No**

45. If Yes, please share the information in the table below –

Function	Resides in PMO	If No, Where Does the Function Report To?	Benefits	Drawbacks
Project Management	Yes		Consistent approach to management of projects.	
Project Controls	Yes		Consistent approach to project controls	
Project Quality	Yes & No	Project quality is reviewed by the team and the stakeholders to ensure that the product that is constructed meets the project requirement established by the team and the stakeholders		
Project Safety	Yes & No	Project construction safety is a responsibility of the contractor and the airport does not want to take on the contractor's liability for safety. That being said, the airport does have a Health and Safety Section, and other airport personnel that observe and report on safety issues.		

B.5.4 Contract Management

46. What contracting strategies does the SFIA use for its capital projects? Please use the table below.

Contracting Strategy	Types of Projects Using Strategy	Size of Projects Using Strategy	Benefits of Strategy	Drawbacks of Strategy
Design/ Bid/Build	Maintenance and repair projects, infrastructure/system upgrades, office/space remodels, standalone facilities	\$500K - \$20M	These are projects that usually require a high level of airport specific institutional knowledge done by in-house staff, so	Planned project schedules often impacted by other high priority projects resulting in schedule slippage.

			there is little to no learning curve	
Design/ Build (D-B)	Large capital projects	$5M - > $1B	Integrated design and scheduling enables faster overall project delivery and more effective use of project budgets, able to deliver the Airport's vision	
Construction Manager/General Contractor	Large Capital Projects	$5M - > $1B	Contractor engaged during design process	Have to manage multiple contracts between the Airport and the A&E and the Airport and the Contractor
Public Private Partnership (PPP)	N/A			

47. If the SFIA has used D-B, what conditions guided the SFIA to consider it?
    The D-B approach has allowed the airport more flexibility in implementing large capital projects. The way the program has been structured it has also enabled us to have greater stakeholder engagement throughout the project so the airport ends up with a project greater user and operator satisfaction.

48. If the SFIA has used PPP, what conditions caused the SFIA to pursue such a model?
    The airport has not used the PPP model.

49. Did the use of alternative contracting methodologies improve project success? If yes, please describe what aspect of that methodology made a difference.
    The methodology itself makes some difference, however the biggest factor in project success is the collaborative nature of the approach to programming, design, and construction and addressing the needs all of the stakeholders including in-house staff and management, designers, contractors, and construction manager team.

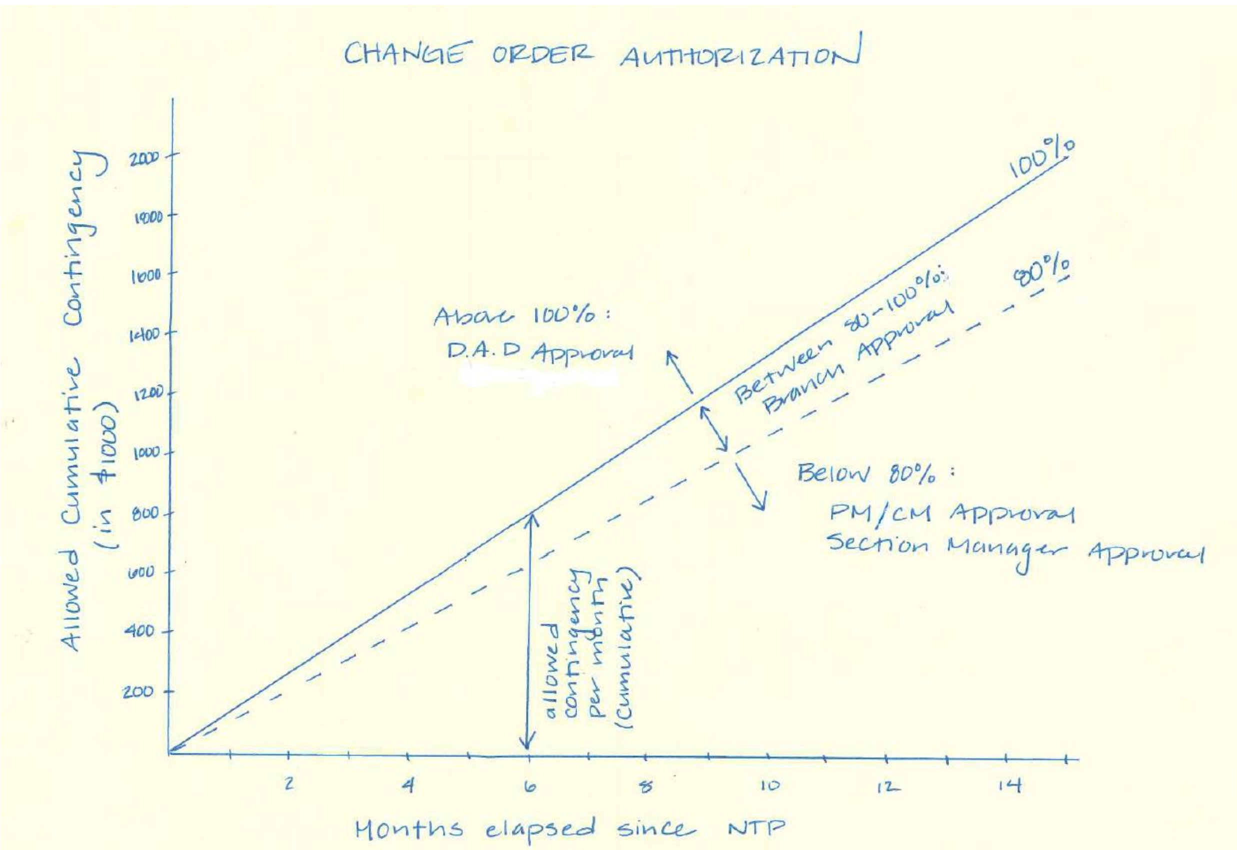
50. Please share the SFIA's change order approval authority via an attachment showing the signature authority and approval thresholds?

    The chart below shows the approval thresholds as of Q2 2015. The Airport is proceeding with using our Project Management System, Primavera Unifier, to route and review change orders, and will use a different approval threshold approach. This new threshold approach will divide the total type 1 contingency over the duration of the project, with the project team having increasing authority to approve changes as the project progresses. This new approach is not reflected in the table below, but is illustrated in the graph below.

APPROVING OFFICIAL - Authority Levels for Additive and Deductive Changes	Construction Value (See footnotes)			
	$0 - $2,500,000 [1 3]	**$2,500,001 - $10,000,000** [1 3]	**$10,000,001 - $50,000,000** [1 3]	**$50,000,000+** [1 3]
Airport Staff Construction Manager	$5,000 per month for a single CO; up to $10,000 **Up to 1.5% of Original Contract Sum or GMP: $ -**	$10,000 per month for a single CO; up to $50,000 **Up to 1.5% of Original Contract Sum or GMP: $ -**	$10,000; up to $50,000 per a month for a single CO **Up to 1.5% of Original Contract Sum or GMP: $ -**	$10,000; up to $50,000 per month for a single CO **Up to 1.5% of Original Contract Sum or GMP: $ -**
Project Manager	$15,000 per month for a single CO; up to $30,000 **Up to 3% of Original Contract Sum or GMP: $ -**	$25,000 per month for a single CO; up to $100,000 **Up to 3% of Original Contract Sum or GMP: $ -**	$50,000 per month for a single CO; up to $250,000 **Up to 3% of Original Contract Sum or GMP: $ -**	$50,000 per month for a single CO; up to $250,000 **Up to 3% of Original Contract Sum or GMP: $ -**
Section Manager [2]	Review and Sign	Review and Sign	Review and Sign	Review and Sign
Branch Manager, Director, or Program Director	$30,000 per month for a single CO; up to $50,000 **Up to 5% of Original Contract Sum or GMP: $ -**	$100,000; up to $250,000 per month for a single CO **Up to 5% of Original Contract Sum or GMP: $ -**	$250,000; up to $500,000 per month for a single CO **Up to 5% of Original Contract Sum or GMP: $ -**	$250,000 per month for a single CO; up to $500,000 **Up to 5% of Original Contract Sum or GMP: $ -**
Deputy Airport Director, D&C	Over $125,000 per change (Cumulative up to 7.5% of Original Contract Sum)**	Over $500,000 per change (Cumulative up to 7.5% of Original Contract Sum)**	Over $500,000 per change (Cumulative up to 7.5% of Original Contract Sum)**	Over $500,000 per change (Cumulative up to 7.5% of Original Contract Sum)**
Chief Operating Officer (COO)	N/A	Review and Sign (single change greater than $500K)	Review and Sign (single change greater than $500K)	Review and Sign (single change greater than $500K)
Airport Director	N/A	Over $500,000 per change	Over $500,000 per change	Over $500,000 per change

**** Limited by Commission Approval of Type 1 Contingency***

1. Each approval level has authority for an individual change valued at the lowest amount shown, up to the value specified in the Cost Reporting Period and/or up to the percentage (%) of the Original Contract Sum or Forecasted Guaranteed Maximum Price (GMP).
2. Section Managers, when applicable, must review and approve all changes.
3. Independent cost estimates are required for all individual change orders; however, the level of detail of those cost estimates is determined by the PM/CM commensurate with the complexity and amount of change order.



51. Please describe any best practices you follow related to contract management or communications.

    We have a team of contract management staff which assist in contract procurement, certification, payment administration, and other areas. We also use an enterprise database system which allows for centralized contract data and reporting.

B.5.5 Document Management

52. What document management system do you use?
    We use a range of document management systems, including OpenText eDocs, Primavera Unifier, Sharepoint, and our internal file share system through Windows explorer.
53. Is it used for all projects?
    While many of the large Capital projects use OpenText eDocs and many of the internal projects use our internal file share system, our document management approach is not consistent for all projects within the Division.
54. Is a different tool used during construction?
    The Airport is trying to work with our teams to ensure that they use the Airport's systems, but often contractor's use their own systems and deliver documents to the Airport at closeout.
55. If yes how do you integrate the two systems? See answer above.
56. Are construction progress meeting minutes maintained in a database that tracks action items to completion?
    Not at the moment, but we are considering using our Project Management System Primavera Unifier, to manage meeting minutes and action items.

C. Catchall Question

57. For projects that finished on time or within budget, to what do you attribute the success? Describe any best practices not discussed above that contributed to the success and provide any written documentation explaining it (ie- contract language, procedure, workflow, etc.)
    The Delivering Exceptional Projects document (attached) answers this question, and it is provided to all proposers in our RFPs and team members. While it is important for projects to remain on time and within budget, those are not the sole criteria we use to judge the success of a project. It is the use, revenue generation, and enjoyment of the airport facility by our guests, it is the operational functionality, and the ease of maintenance and operability over time. Those all come with greater project collaboration and stakeholder engagement throughout the entire project.

End of Questionnaire

Below are general comments by Geoff Neumayr who is on vacation but performed cursory review of the Airport's response.

Partnering is a main stay in the way we manage projects. Traditional risk management looks for problems so they can be transferred to contractor for resolution. This method only leads to disputes, delays and cost over runs. Partnering works by understanding issues and the project team collectively committing to each other to resolve the issue before a problem exist.

Our management process is more in line with lean construction, not traditional project management. Our three lean focus objectives are:

1. Collaborative Scheduling using Pull Scheduling

2. Target Value Design Budgeting using a Cost Model

3. Continuous Improvement by measuring co-created measurable project outcomes via the Partnering Score Card.

Traditional Project a Management in Design and Construction has always defined value as saving time and money. This ultimately develops low quality projects that complete over budget and not on schedule. This happens because the stakeholders are not part of the management process.

As we know now we define value as getting the most for our dollars and meeting our stakeholders expectations while balancing budget and cost. Part of value is not only stakeholder satisfaction, but also includes full life cycle cost and revenue generation.

SFIA Enterprise Schedule

- Enterprise schedule software (Primavera P6 EPPM) The Airport is in the process of procuring an enterprise deployment of Primavera P6 EPPM. This tool will be used by our Program Management Consultant to help us develop an integrated master schedule for all Design & Construction project. We expect to finalize the integrated master schedule in Q1 of 2016.
    - Integrated Master Schedule (all projects in capital plan in one schedule file)
    - Contractors' Schedule Updates in one central schedule database
    - Cost-Loaded Schedules
- Cost Forecasting (Please describe method & tools) Use real-time forecasts which include estimated contract growth, trends, changes, etc. using our enterprise-wide Project Management System, Primavera Unifier
- Off-the-shelf software (Primavera Unifier as our Project Management System) Primavera Unifier was purchased as an off-the-shelf cloud-based tool, but a great amount of time and energy has been spent configuring the processes to match the way we do business.
- Project Risk Management program. The Airport does not have a formal risk management system. Each project uses a risk management approach appropriate for the needs of the project.