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OPERATIONS

Management Plan Volume 4 - Operations

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1 PURPOSE AND SCOPE

The Crossrail Management Plan mandates the arrangements adopted by Crossrail for the delivery of the entire Crossrail Programme in accordance with the Delivery Strategy [Ref 1]. It is arranged in four volumes.

- Volume 1 Support Directorates and Governance [Ref 2]
- Volume 2 Central Section Delivery [Ref 3]
- Volume 3 Surface Delivery [Ref 4]
- Volume 4 Operations Management Plan [this document, Ref 5]

This document is Volume 4 Operations Management Plan and describes elements of the Crossrail project for which the Operations Directorate is accountable, including the delivery of the Rolling Stock, Depot and associated Services. It mandates how the Crossrail Operations Directorate will bring the railway into operation invoking appropriate functional support plans and processes.

The Crossrail Operations Directorate has been established within the Crossrail Programme to provide the Duty Holders' perspective and to work particularly closely with CRL's Technical Directorate so that a smooth transition and handover can be achieved through the testing and trial running phases "in a manner that will oblige the Operators to accept handover of the assets and systems".

The Operations Directorate is principally concerned with whether Crossrail can be operated and maintained safely and delivers a high performing service. RfL will provide the leading role for operating Crossrail as Infrastructure Manager for the Central Operating Section routeway and through contracts for the provision of trains and their operation. CTOC, RSP and maintenance activities will be procured and appointed through contracts signed by RfL, and prior to such time as these will advise CRL on all aspects of rolling stock and depot operation and CTOC activities. More specifically, the Operations Directorate:

- 1) Should be fully engaged during design and construction and will describe how the railway is intended to be operated. In particular the operators will progressively become more involved and through the planning and delivery of testing, commissioning and trial operations assist the transfer into operations and maintenance.
- 2) Deliver the rolling stock fleet and the Old Oak Common depot to ensure the Class 345 fleet is safe, reliable and able to serve Crossrail for many years in a safe and reliable manner with high customer satisfaction.
- 3) Deliver a concessionaire to operate train services and to staff stations. Although the path for procuring concessions and franchises is well trodden, Crossrail has a number of unique features; the phased introduction of services, the complexity of the subsurface railway, the fundamental changes in operating patterns all of which make it imperative to choose the right operator, and to forge a partnership which will see the project successfully introduced.
- 4) Ensure the maintenance and maintainability is properly addressed by Crossrail such that the delivered railway infrastructure can be safely, effectively and economically maintained during operations.
- 5) Undertake the role of Infrastructure Manager for the routeway between Royal Oak Portal, Pudding Mill Lane and Abbey Wood and for Paddington, Canary Wharf, Custom House and Woolwich stations.

2 CONTEXT

2.1 Governing documents

The objectives for Crossrail are set out in the Sponsors' Requirements. These include the operational outputs which need to be achieved (e.g. service capacities, frequencies, performance, station information, etc.), and there is also an objective to achieve value for money. The Crossrail Programme Functional Requirements (CPFR) provides more detailed requirements and specifications for how the Sponsors' Requirements will be achieved, and provide detail to aid the design development stage for the infrastructure and systems. This Management Plan describes the opening strategy and other activities which are required so that Crossrail can operate fully in accordance with the Sponsors' Requirements.

2.2 Crossrail's operational stakeholders

There are a number of stakeholders who will play key roles in Crossrail's operation. These organisations include RfL (in its capacity as the Crossrail Train Operating Concession (CTOC) letting authority, the Rolling Stock & Depot contracting authority and as Central Operating Section infrastructure manager), Network Rail (in its capacity as infrastructure manager), LUL (in its capacity as infrastructure manager), the Crossrail Rolling Stock and Depot (RSD) supplier appointed for Old Oak Common depot, and the Crossrail Train Operating Company (who will operate the trains and may also have duties in respect of operating some stations).

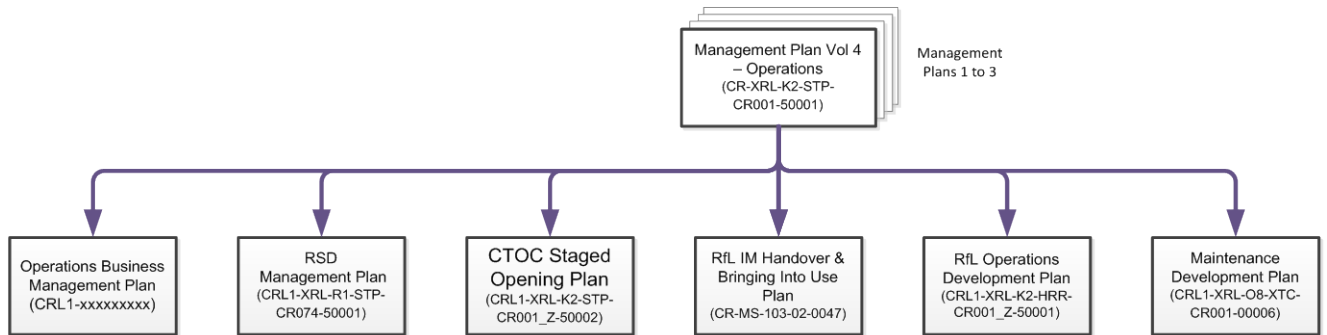
As part of Crossrail's intention to deliver a world-class affordable railway that fast-tracks the progress of London, recent work has identified a number of customer service strategies that will ensure that customers' perspective is brought to bear in developing Crossrail for passenger operation. This customer proposition workstream is summarised in Table 1:

Table 1: The customer proposition

Vision	To our passengers this means...
Crossrail will set the benchmark for passenger experience on a Metro railway service.... A step change in anything achieved before	They can rely on Crossrail to be on time every time
	The Crossrail experience feels seamless and fully integrated with the wider transport network
	Everyone can get reliable information at every stage of their journey
	They can get help when they need it from friendly, well informed staff.
	Crossrail feels safe and secure, clean and comfortable, easy to use by everyone, and modern and reflective of London.
	Crossrail feels like good value for money

2.3 Operations Directorate Bringing Into Use documents

A hierarchy of documents exists that describe specific elements of how Crossrail is brought into use from an operational perspective (as opposed to other elements that are being delivered by the Technical Directorate). See Appendix A for this hierarchy in diagrammatic form. The higher level structure of documents is shown in Diag.1 below (note that some of these documents are still in development). Additional documents that relate to these are set out in Appendix A.



Diag.1: Operations directorate key Bringing Into Use documents

2.3.1 The purpose of key Operational documents in this hierarchy:

2.3.1.1 Operations Business Management Plan

This is a list of the procedures and plans that define the way that the Operations Directorate manages its business. One such plan is the Bringing Into Use Roadmap, a diagrammatic logical flowchart showing the major functional processes in sequence, and which includes important milestones that are recognised in the Crossrail Master control Schedule. There exist lower-level component activities in Primavera P6, referred to as the Level 3 Bringing Into Use Programme activities.

2.3.1.2 RSD Management Plan

This describes the process for managing the Rolling Stock and Depot Service Provision Agreement (RSPA) and includes escalation processes. Its subsidiary documents include: the Rolling Stock and Depot Execution Plan and the Rolling Stock and Depot Assurance Acceptance Process.

2.3.1.3 CTOC Staged Opening Plan

This sets out the way in which RfL will actively manage the CTOC delivery contract. Its subsidiary documents include the CTOC Staged Opening Plan, produced by CTOC itself.

2.3.1.4 RfL IM Handover & Bringing Into Use Plan

The purpose of this plan is to describe the principles for acceptance of the infrastructure from CRL and the 'bringing in to use' of this infrastructure by RfL. It aligns with the TfL Pathway procedure.

2.3.1.5 RfL Operations Development Plan

This document largely defines how lower-level plans are developed for training up and putting into place the RfL (IM) staffing required to operate the railway (as opposed to CTOC resources who will operate the service); it also includes the Operations Concepts which describe how the railway is expected to be run, and also the newly devised Rule Book modules that define how novel aspects of Crossrail operation fit into the wider GB Rulebook.

2.3.1.6 RfL IM Maintenance Development Plan

The primary purpose of this document is to define the process, responsibilities and associated governance and assurance arrangements relating to the development of detailed maintenance plans, programmes, procedures and processes for the future Crossrail infrastructure.

3 FORWARD PLANNING FOR A SAFE OPERATIONAL RAILWAY

The Crossrail programme contains a number of interfaces across surface and tunnel sections. For viable passenger operation, it is necessary to show that the risks of operation have been mitigated over the whole route. This is done through the design and delivery processes and through coordinated and timely development of a suite of operating rules, standards and procedures which can be shown to have considered the impact on end to end operation and maintenance.

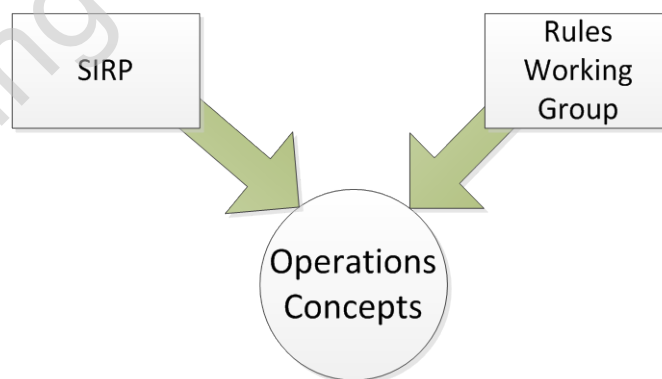
There are numerous novel features of Crossrail which will require that new procedures are developed and operated by the relevant competent personnel.

3.1 Operations Concepts

Operations Concepts [Ref 12] have been developed (and can be found on CMS), which describe how Crossrail is envisaged to operate safely and reliably as a complete railway system, in accordance with Sponsors' Requirements and the Crossrail Programme Functional requirements (CPFR) [Ref 13]. They describe the expected principles and approach for operating Crossrail and provide the overarching assumptions which will be used, once the designs have been sufficiently developed, to prepare the operators' detailed operational rule books, maintenance regimes and safety management systems and procedures.

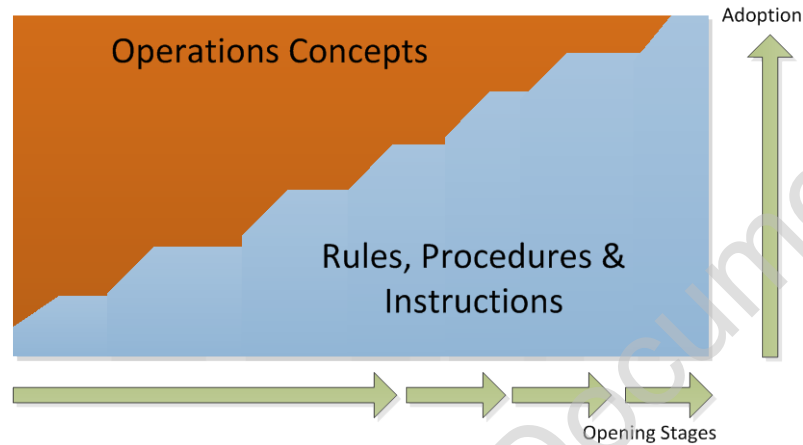
The Operations Concepts are particularly important in that CRL has broken down the scope of the programme and procured through various "contract packages", and a key purpose of the Operations Concepts is to describe how the various components (e.g. stations, depots, train operations, route control centre) work together at the interfaces. They also consider the range of situations which are reasonably expected to be encountered both on a daily basis and in emergency or perturbed situations and set out the roles and operating arrangements for Crossrail. Effective management of the safety risks will need to be demonstrated in order to operate Crossrail, and the Operations Concepts have been developed collaboratively with the relevant stakeholders to draw on existing best practice.

Operations Concepts are informed and modified by the Systems Integration Review Panel (SIRP) – which arbitrates between actual as-built designs and the Ops Concepts – and also by the Rules Working Group – which guides the production and acceptance of operational rules, procedures and work instructions (Diag.2):



Diag.2: Operations Concepts are modified by other processes

The catalogue of Operations Concepts will gradually be supplanted by Rules, Procedures and work instructions, as these become completed and signed into use, rendering the Operations Concepts of archival importance only. This is likely to be a progressive process as opening stages occur. The remaining catalogue of Reference Operations Concepts will remain in archive for audit purposes (Diag.3):



Diag.3: Transition from Operations Concepts to Rules, Procedures and Instructions

Residual risks that cannot be designed out shall be mitigated by operational rules and procedures informed by the Operations Concepts. The operational rules and procedures shall be an integral element of the IMs Safety Management Systems and safety authorisations and train operators safety certification.

3.2 Safe operations

To operate Crossrail safely it will be necessary to:

- Minimise operational risk through safe design.
- Produce operational procedures as part of a safety management system.
- Have in place a Rule Book for the route being operated which recognises the practice of existing Duty Holders.
- Have competent staff in place to operate the network – management, signalling, power control, drivers, etc...
- Establish asset management processes with a robust change control process including management of asset data, records, operating and maintenance manuals, standards and health and safety files.
- Establish a safe maintenance regime and appoint competent staff and/or contractors.
- Ensure maintenance plant, tools, test equipment and spares are provided and are safely located, stored and accessible for use by maintenance staff through a robust maintenance management regime.

An Infrastructure Manager is subject to the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended 2011) (ROGS), which require that an Infrastructure Manager has a Safety Management System (SMS), possess details of the infrastructure, and have an authorisation from ORR before it allows vehicles to travel over that infrastructure. In applying for this approval it will be necessary to demonstrate that safety risks are tolerable and As Low As Reasonably Practicable (ALARP). Authorisations are specific to particular infrastructure.

To achieve this authorisation it will be necessary to:

- Appoint an independent competent person (or body).
- Establish and maintain a Safety Management System (SMS)*.
- Establish a written Safety Verification Scheme incorporating use of common safety methods.
- Ensure a change management process is in place.
- Undertake risk assessments, implement identified measures, and review and record significant findings.
- Co-operate with other Infrastructure Managers on adjacent isolated or interconnected systems and transport operators on the same system.

Further procedures will be developed to describe the process through which RfL and LU (as Crossrail Infrastructure Managers) will accept infrastructure, maintenance manuals and operating systems.

In addition, due to European requirements for Interoperability CRL shall appoint an Assessment Body, Notified Body (NOBO) and Designated Body (DeBo).

* Note: the Crossrail Train Operating Company will need to obtain and maintain a separate SMS.

Table 2 summarises the key safety authorisations required to support the opening strategy and section 4 gives more details of the stages.

Table 2 - Key safety authorisations required

Stage	Safety Authorisation required	Responsible party
Stage 0	Safety Certificate from ORR (through approval of the safety case which sets out all the operational arrangements and procedures over the routes/infrastructure to be used/operated)	CTOC
Stage 1	Technical Specification for Interoperability compliance authorisation, including confirmation of compatibility between the train and track	Rolling Stock & Depot Provider
	Updated Safety Management System approval from ORR (for modified infrastructure/systems) as required by ROGS	Infrastructure Manager (Network Rail)
	Updated safety case (arrangements for operating new trains and also in relation to new infrastructure/arrangements at Ilford depot)	CTOC
	Safety approval at Ilford Depot as required in the Health & Safety Act	GA franchise as Depot Facility Operator
Stage 2	Old Oak Common Depot safe working arrangements as required by the Health & Safety at Work Act	Rolling Stock & Depot Provider
	Updated Safety Management System approval from ORR (for modified infrastructure/systems) as required by ROGS	Infrastructure Managers (Network Rail and BAA)
	Updated safety case	CTOC
Stage 3	Safety approval from the Notified Body, Designated Body & Assurance Body (for the new infrastructure/systems)	CRL
	Establish a Safety Verification Scheme, appoint independent competent person and obtain safety authorisation for Safety Management System from ORR as required by ROGS	Infrastructure Managers - CRL for dynamic testing, RfL and LU for trial running, trial operations and passenger operations
	Updated safety case	CTOC
	Plumstead maintenance depot safe working arrangements as required by the Health & Safety at Work Act	Depot Facility Operator
Stage 4	Updated Safety Management System approval from ORR (for modified infrastructure/systems) as required by ROGS	Infrastructure Managers
	Updated safety case	CTOC
Stage 5	Updated Safety Management System approval from ORR (for modified infrastructure/systems) as required by ROGS	Infrastructure Managers
	Updated safety case	CTOC

3.3 Crossrail Rule Book

Once trial running commences on the Central Operating Section of Crossrail, the railway will operate under the Railways and Other Guided Systems Regulations, which inter alia will require operation under a Rule Book. Rules must be developed in parallel to the design of assets such as Platform Screen Doors, ventilation, Automatic Train Operation etc.

The RSSB has been engaged to technically author the rule Book, so as to ensure consistency, as well as engagement with the IMs and CTOC from the point at which the concession starts, to ensure that there is no delay in CTOC accepting arrangements which they will have to follow.

The Rules, Procedures and Instructions which are developed will to a great extent be influenced by the detailed design chosen, and the risks identified as part of the hazard and operability study (HAZOP) process.

However, they will also be influenced by:

- Duty holders and the existing and proposed Rules that they have.
- The need to consider the processes on an end to end basis so that there is no risk of confusion.
- The need for duty holders to have agreed both the Rules, and any consequences arising from interfaces with others.
- The fitness for purpose of Rules (or components thereof) during the Opening Stages.
- The resource implications of a Rule.
- Any additional requirements arising from the testing and commissioning of the railway.

The plan is to produce a gap analysis between the current Network Rail rule book and how it is envisaged Crossrail will operate in the Central Operating Section. Once this is complete Operating procedures and rules will be written that will enable Crossrail to operate over the whole route.

4 OPENING STRATEGY

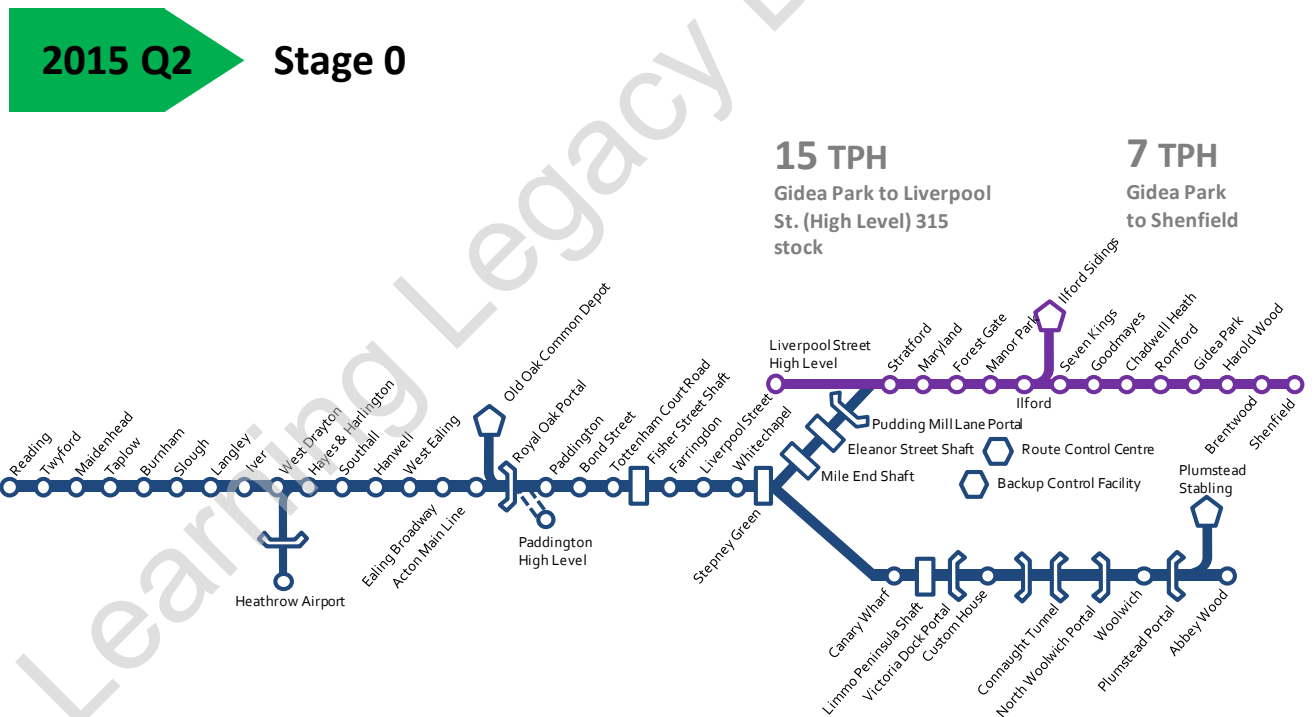
An opening strategy for Crossrail has been developed which is intended to de-risk the significant and complex activities involved in introducing new rolling stock, adding and integrating services with existing services (Greater Anglia, Heathrow Express and Great Western), introducing upgraded and new infrastructure and systems, and interfacing with other projects and also the existing operations of LU and Network Rail. It should be noted that at all stages, some trains do not call at all stations on the Great Western and Great Eastern sections.

4.1 Stage Zero

This stage is not a formal stage of Crossrail's opening strategy but has been identified as an important precursor to Stage 1. This precursor stage is when the Crossrail Train Operating Company takes over the operation of the local services on the Electric Lines between Liverpool Street and Shenfield, utilising existing class 315 rolling stock.

It is expected that sufficient drivers will be transferred to CTOC from the Greater Anglia franchise to operate the services on day 1 of the CTOC operation. These drivers would mostly be drawn from the existing groups of staff at Ilford and Gidea Park and would consequently already have knowledge of both the rolling stock involved and the depot operating arrangements at Ilford.

Stations on the GE will transfer over to CTOC in line with industry protocols. No change to NR infrastructure or operating practice is required at this stage.



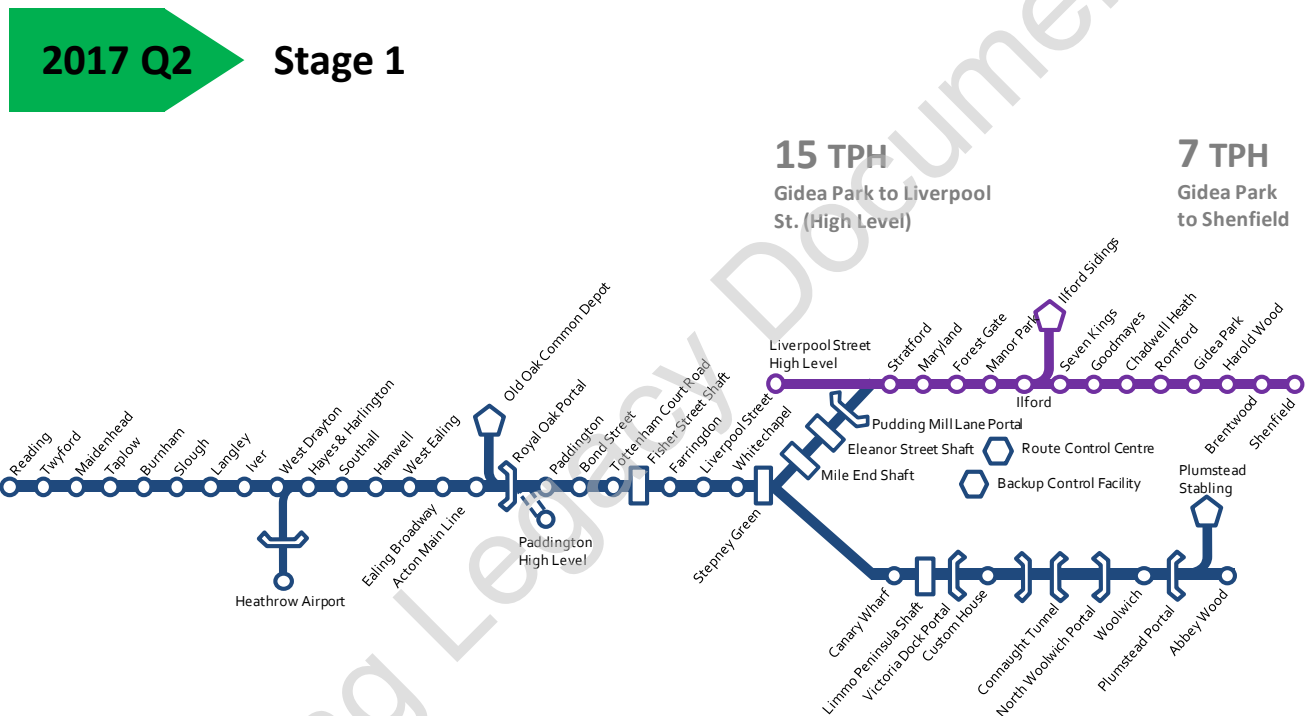
Stage 0 – Crossrail TOC commences operation on GE lines of Greater Anglia services that are planned to become Crossrail services using existing (class 315) rolling stock

Note: TPH are maximum peak period train frequencies

4.2 Stage One

Stage 1 includes the progressive introduction of Class 345 Units (Crossrail Rolling Stock) into service on the GE section. Stage 1a is reached when Class 345 Units are operating the key services that ultimately will divert into the tunnel in Stage 3. Note that whilst the majority of trains will be Class 345s there will still be a number of services on the GE section that will still be operated with Class 315 units.

The Crossrail infrastructure necessary for operation of full length units (205m) will not be in place at Stage 1 and thus the rolling stock used will be 163m length, which will need to be reconfigured for commencement of Stage 4. This stage will require the Crossrail-specific Driver Only Operation facilities to have been commissioned, stabling to have been provided (including the new sidings at Ilford LMD), and Class 345 maintenance access into the Ilford maintenance shed secured for the SP.

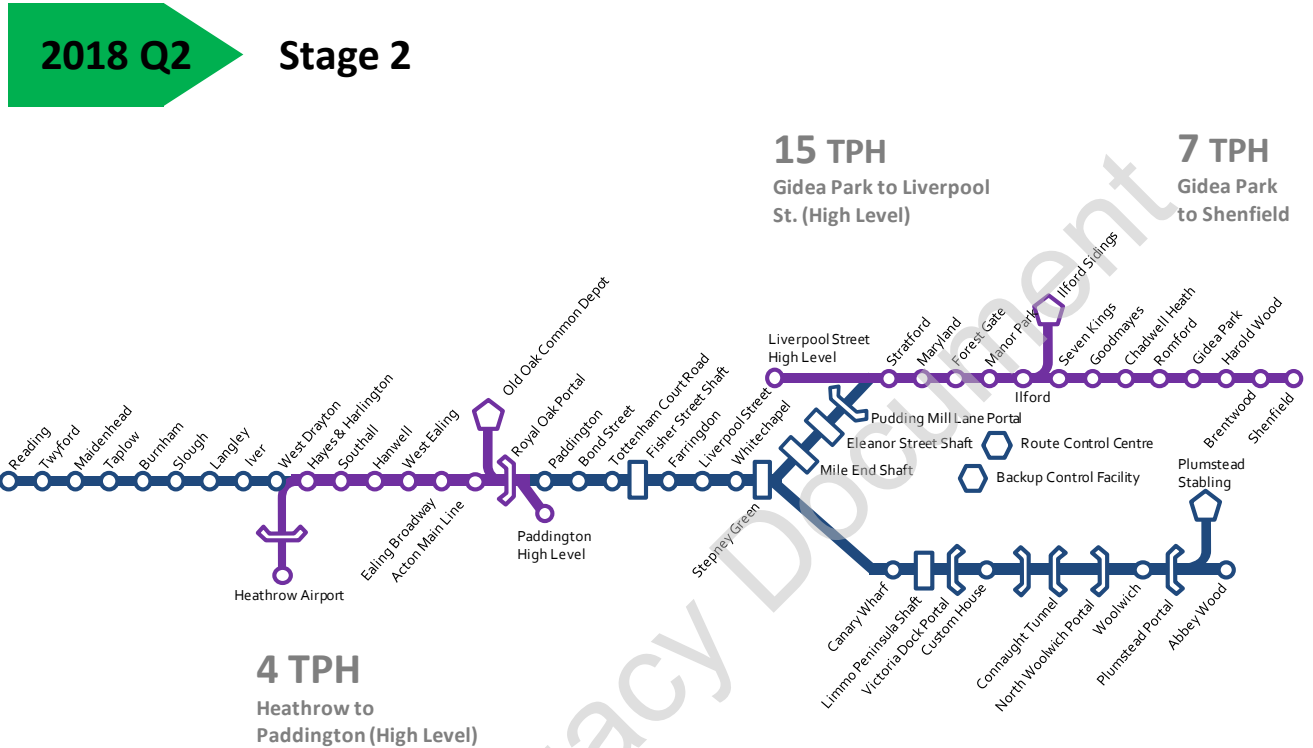


Stage 1 – Crossrail TOC introduces Crossrail train (Class 345) on GE lines

Note: TPH are maximum peak period train frequencies

4.3 Stage Two

Stage 2 includes the addition (to Stage 1) of operation of Crossrail trains on the section from Paddington (high level) to Heathrow. The depot at Old Oak Common is required for this stage.



Stage 2 – Crossrail TOC introduces Crossrail trains (Class 345) on Great Western Main Line between Paddington High Level and Heathrow Terminals

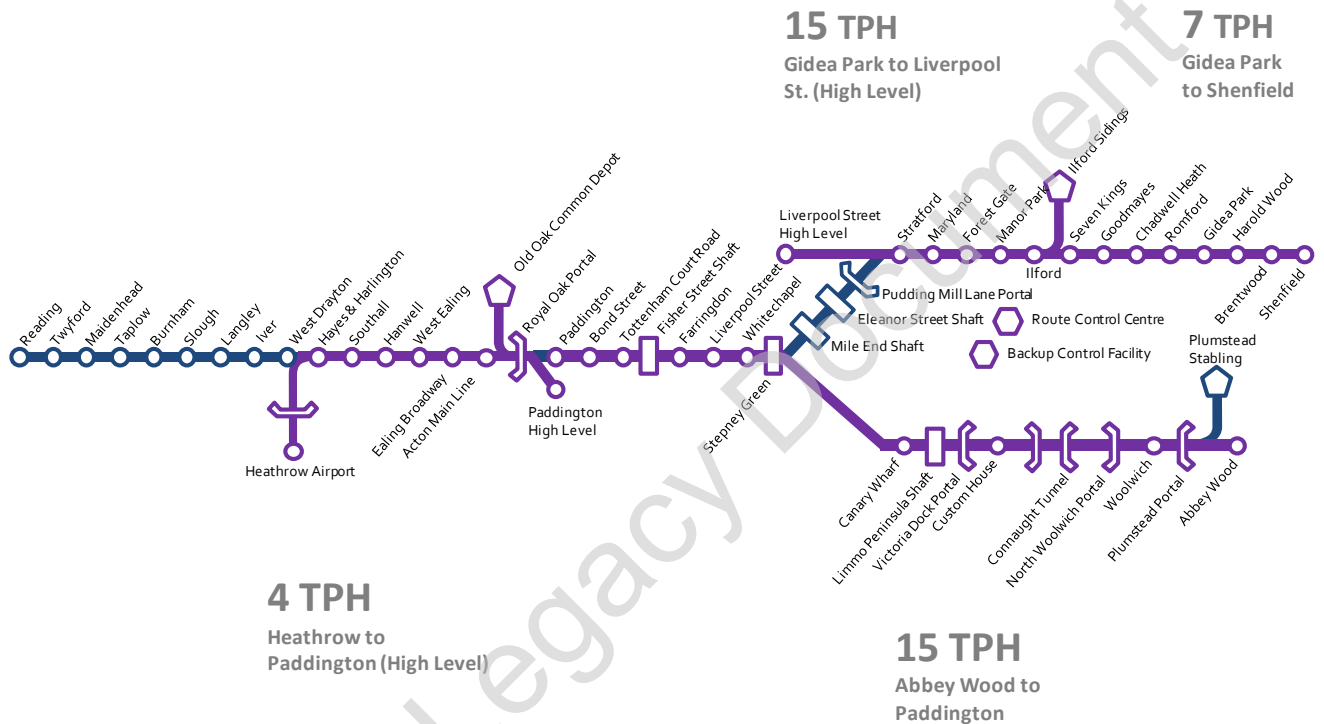
Note: TPH are maximum peak period train frequencies

4.4 Stage Three

Stage 3 adds the major part of the Central Operating Section and provides passenger services between Heathrow and Paddington to Abbey Wood using Class 345 trains. During this Stage, there are still two distinct and unconnected parts of Crossrail.



Stage 3



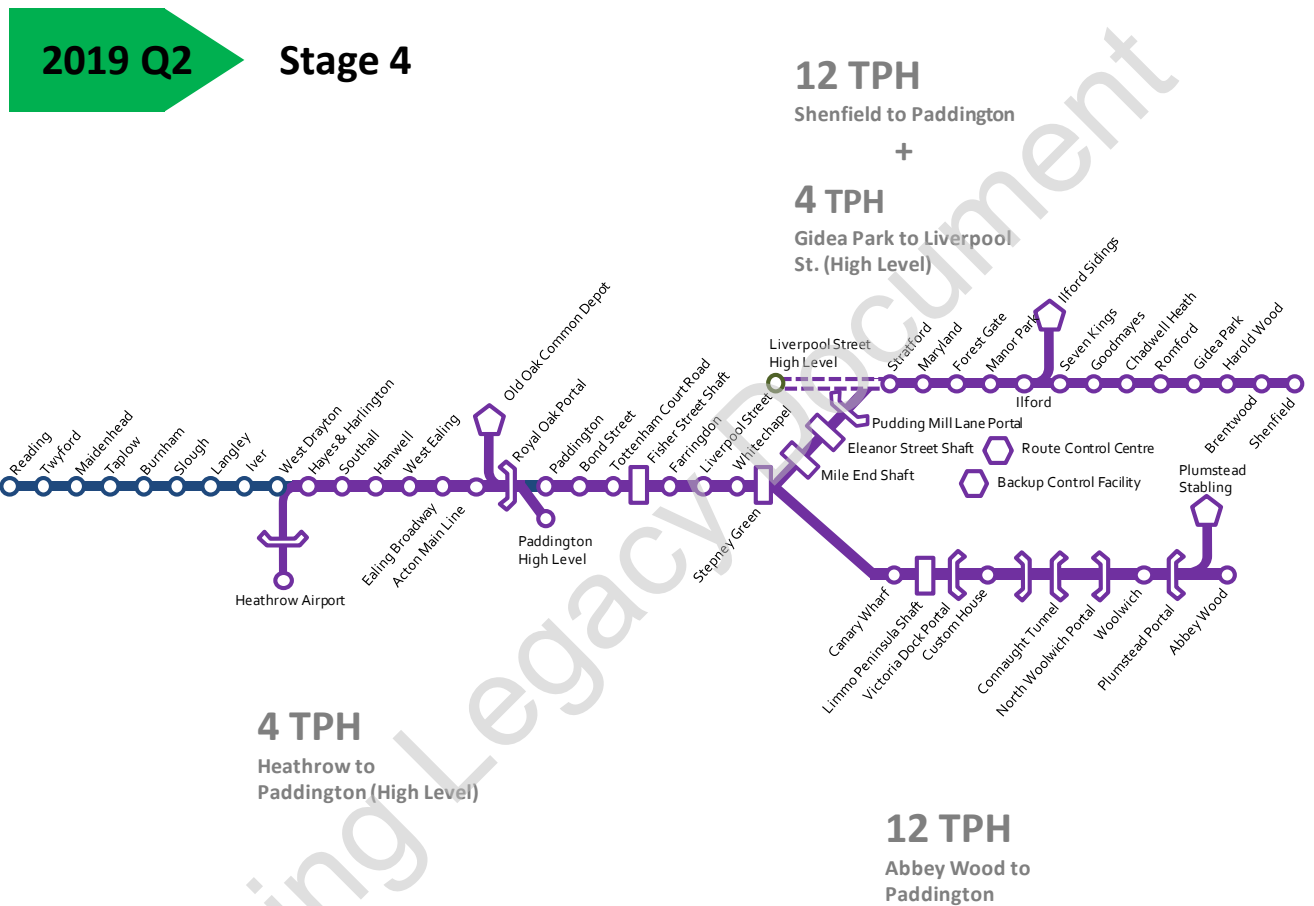
Stage 3 – As Stage 2 plus operation of Central Operating Section between Paddington and Abbey Wood

Note: TPH are maximum peak period train frequencies

4.5 Stage Four

Stage 4 connects the Great Eastern services from Shenfield into the Central Operating Section of Crossrail using full length Class 345 units.

At the east end of Crossrail the train service pattern will reflect the continued operation of a residual service into Liverpool Street High level using reduced length Class 345s. This stage will also require the full commissioning of Driver Only Operation to reflect 205m operation and the commissioning of Selective Door Opening.



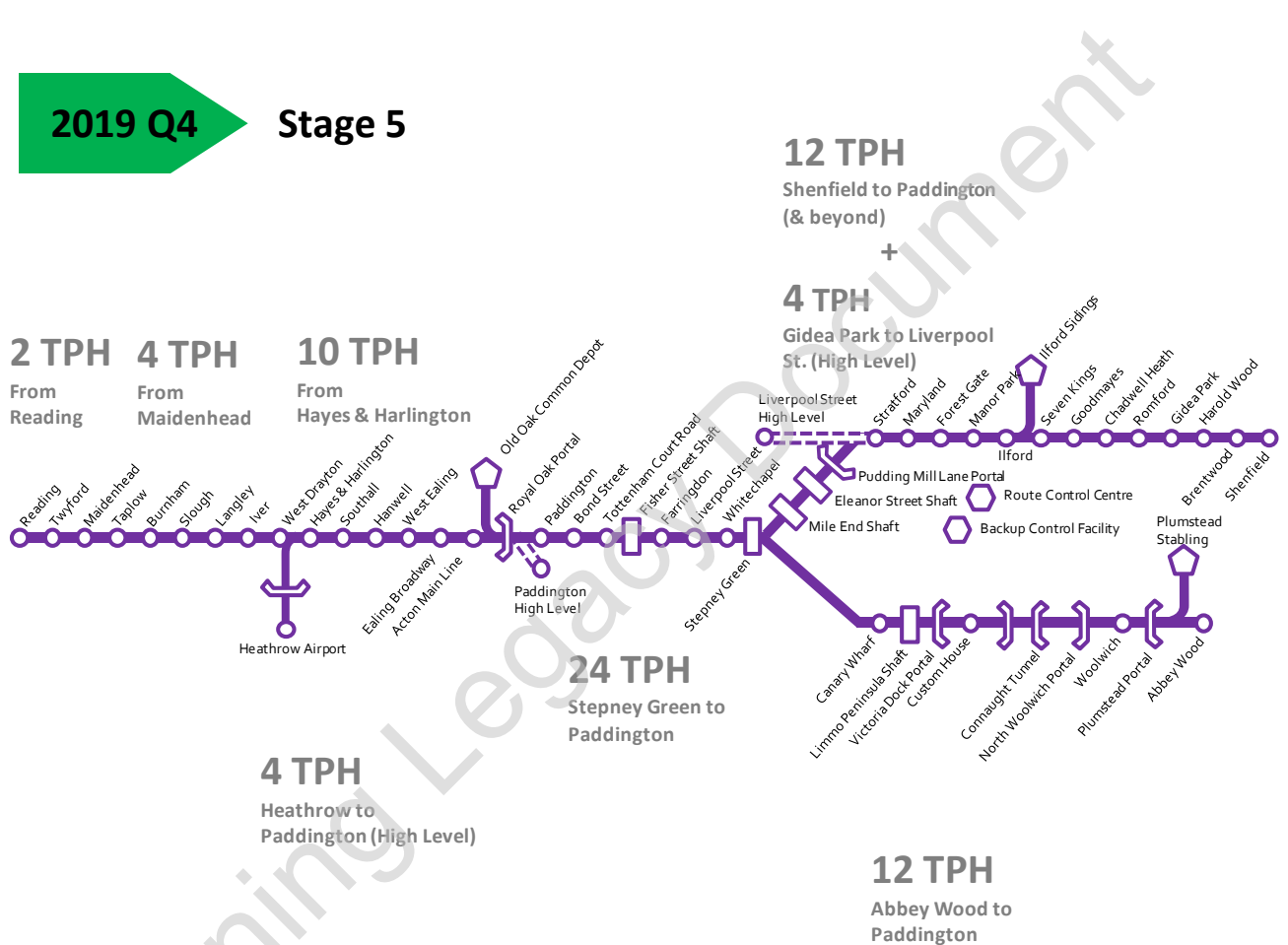
Stage 4 – As Stage 3 but integrate services on Great Eastern services with central tunnel section services

Note: TPH are maximum peak period train frequencies

4.6 Stage Five

Commercial operation commences across the whole Crossrail network.

N.b. TfL plan to substitute the reduced length Class 345 units that operate into Liverpool St High Level with full length Class 345 units which will require works to be undertaken at Liverpool Street High Level which is expected to be implemented after commencement of Stage 4 but may not be before Stage 5 operations.



Stage 5 – As Stage 4 plus integration of Heathrow services and extend to Reading

Note: TPH are maximum peak period train frequencies

4.7 Operational Responsibilities

The requirements are set out in the Sponsors Requirements and CPFR. The planned responsibilities for operating and managing Crossrail services are set out in Table 3.

Table 3: Operational responsibilities and the party delivering the asset prior to operations

Element	Role			Stage required for
	Future Infrastructure / Facility Owner	Future Operator (IM under ROGS)	Delivered by	
Rolling stock including maintenance	n/a	CTOC	RSD Provider	1
Ilford Depot & stabling sidings	Network Rail	GA Franchisee	CRL	1
Old Oak Common depot including maintenance	RfL	RSD provider	RSD provider	2
Infrastructure maintenance facilities at Plumstead depot	RfL	RfL	CRL	3
Route Control Centre	Network Rail	RfL	CRL	3
Central Section Works				
<ul style="list-style-type: none"> Shafts, tunnels and portals fabric and railway systems 	RfL	RfL	CRL	3
<ul style="list-style-type: none"> Plumstead stabling facility 	RfL	RfL	CRL	3
<ul style="list-style-type: none"> Paddington Station 	RfL	CTOC	CRL	3
<ul style="list-style-type: none"> Bond Street Station 	LU	LU	CRL	3
<ul style="list-style-type: none"> Tottenham Court Road Station 	LU	LU	CRL	3
<ul style="list-style-type: none"> Farringdon Station 	LU	LU	CRL	3
<ul style="list-style-type: none"> Whitechapel station 	LU	LU	CRL	3
<ul style="list-style-type: none"> Liverpool Street station 	LU	LU	CRL	3
<ul style="list-style-type: none"> Custom House Station 	RfL	CTOC	CRL	3
<ul style="list-style-type: none"> Canary Wharf Station 	RfL	CTOC	CRL & CWG	3
<ul style="list-style-type: none"> Woolwich Station (subject to future change notice) 	RfL	CTOC	CRL & Berkeley Homes	3
Traction Power Bulk supply	Network Rail		Network Rail	3
On- Network Works				
<ul style="list-style-type: none"> Track and systems 	Network Rail	Network Rail	Network Rail	1, 2, 4 & 5
<ul style="list-style-type: none"> Stratford & Shenfield Stations 	Network Rail	CTOC	Network Rail	4
<ul style="list-style-type: none"> All other (11) stations in northeast from Maryland to Brentwood 	RfL	CTOC	Network Rail	0
<ul style="list-style-type: none"> Heathrow station 	HAL	HAL	HAL	2
<ul style="list-style-type: none"> M Maidenhead & Slough stations 	Network Rail	GW franchisee	Network Rail	5

Element	Role			Stage required for
	Future Infrastructure / Facility Owner	Future Operator (IM under ROGS)	Delivered by	
• Reading Station	Network Rail	Network Rail	Network Rail	5
• Acton Main Line to Hayes & Harlington (6 stations)	RfL	CTOC	Network Rail	2
• All other stations in west from W. Drayton to Twyford (6 stations)	RfL	CTOC	Network Rail	5
• Abbey Wood Station	Network Rail	CTOC	Network Rail	3

The party delivering the asset prior to operations is also shown in Table 3, and the Project Development Agreement clause 3.2(e) requires that Crossrail be delivered “in a manner that will oblige the Operators [and Infrastructure Managers] to accept Handover of assets and systems”.

Key deliverables in support of a fully functional revenue earning railway are considered to be:

- 1) The successful design, construction, installation and testing and commissioning of the individual and integrated elements of the various assets.
- 2) A continuous assurance process which demonstrates to all affected parties, through provision of supporting evidence of records and certification, that the works are executed in compliance with Project Development Agreement, Sponsor’s Requirements and the Crossrail Programme Functional Requirements works information (See Crossrail’s Technical Assurance Strategy and Technical Assurance Plan).
- 3) Provision of operation and maintenance manuals, procedures and fully trained personnel.
- 4) A sequential certificated process for completed works from Handover to Final Completion that ensures all involved parties and Sponsors satisfy themselves that necessary steps have been taken to ensure the railway is fit for full operation.

The Crossrail CMS contains a range of documents that describe in detail how the above activities are carried out.

4.7.1 Assurance

During Crossrail works progressive assurance is carried out to check that assets, systems and interactions of systems being produced meet the technical standards required by CRL and the inheriting IMs.

This will necessarily create tens of thousands of interrelated assurance documents, and to assist this, the Crossrail Assurance Reporting Environment (CARE) has been developed and put into use. This allows the chain: [Contractor] → [CRL Assurance] → [IMs] to maintain correct checks and allows deficient assurance documents to be rejected and returned for correction at each stage, thus ensuring independent scrutiny.

4.7.2 Interoperability

Stage 3 includes the Crossrail Central Operating Section which has been designated as interoperable and will be verified as compliant by the CRL NOBO/DeBo. The only exception to this will be those parts of the Central stations (Bond St., Tottenham Court Road, Farringdon, Liverpool St., and Whitechapel) on the platform side of the platform screen doors which will be regarded as extensions to the existing LU stations. These parts will be verified by an independent competent person under the Railways and Other Guided Systems (Safety) Regulations 2006 (ROGS) as amended, under the existing Duty Holder’s (LU) Safety Authorisation.

4.7.3 Testing & Commissioning

Testing and Commissioning (T&C) is critical to the safe and efficient opening of Crossrail. Crossrail has produced a Project Testing and Commissioning Strategy – [Ref 15]. A Programme Testing and Commissioning Management Plan is being developed by CRL [Ref 16] and agreed with the IMs. It will contain details of accountability and responsibility for delivery, the quantum of work to be delivered, timing and assumed resources provided by each party, details of the tests, and their inter-relationship and success criteria for each of the phases of:

- (iii) Static Testing.
- (iv) Dynamic Testing.
- (v) Trial Running.
- (vi) Trial Operations.

As lower level Testing and Commissioning plans are being developed, it is important to note that during this period it will also be necessary to demonstrate the support systems such as possession management, maintenance vehicles and alarm operation proving they have been fully integrated.

4.7.4 Handover

The CRL Handover Team has created a Handover Strategy [Ref 18] which is designed to ensure a successful Handover of the Crossrail infrastructure using its own Stage-Gate process.

The Crossrail railway system is being delivered by several organisations, including CRL. This document will focus largely on those assets being delivered by CRL. Under the Project Development Agreement (PDA) [Ref 14] clause 6.2, CRL has responsibilities for overall programme management of the Crossrail works. In fulfilling this role CRL has duties in relation to the delivery of the Central Section Works and other projects. Therefore the Handover of assets not delivered by CRL (e.g by LU and NR) are included in this Handover Strategy, but to a lesser extent.

4.7.5 Maintenance

The key objectives for maintenance are set out in the RfL IM Maintenance Development Plan and its subsidiary documents as noted in Appendix A.

5 ACTIVITIES OF THE CROSSRAIL OPERATIONS DIRECTORATE

5.1 Purpose of the Operations Directorate

The role of Operations Directorate is to champion and lead Crossrail in respect that it can be operated and maintained safely and delivers a high performing service, and this was summarised in Section 1.

The Operations Directorate is led by an RfL employee on behalf of CRL and RfL and comprises RfL and Crossrail personnel working collaboratively to deliver the opening strategy. This reflects TfL's best practice learning from projects it has delivered. Activities within the Operations Directorate can generally be defined as activities that the team is accountable for, putting in place/delivering directly, or which relate to being prepared and content to "receive" deliverables from others. This includes providing professional guidance on operational matters during the design / development phase of Crossrail. Although led by RfL the Operations Directorate is an integral part of CRL and is the professional entity within CRL informing operational matters during the design and implementation phase for the duration of the project. To the extent that CRL is responsible for rules and procedures during Dynamic Testing and Trial Running this will be informed by the CRL Operations Team who will rely heavily upon their RfL colleagues for advice and 'lessons learned'.

5.2 Operations Directorate Teams

The Operations Directorate is made up of a number of teams responsible for overseeing various activities (many of which are also referred to above) necessary to bring Crossrail into operation. These activities can broadly be categorised into the following workstreams which collectively enable operations to commence:

- a) People - Recruitment/ procurement of operators (e.g. who will be responsible for drivers, signallers, etc.) and maintenance personnel. This activity will be predominantly led by RfL either directly or through CTOC.
- b) Systems & processes - Development of the rules, procedures and systems that operational and maintenance personnel will use. This activity will be predominantly led by CRL with significant input from RfL, LU and NR.
- c) Supply chain - Establishment of supplier arrangements /contracts (to support the operational and maintenance personnel) which enable the railway to be operated and maintained (e.g. power supply, spares and tools, yellow plant). The lead for this activity is to be confirmed.
- d) Secure rights - Identification of all the operational interfaces (with other parties) and approvals required (e.g. the passenger timetable) and secure agreement / approval for these. This activity will be predominantly led by RfL either directly or through CTOC.
- e) Defining operational functional requirements for the operation and maintenance of the Central Operating Section (in the form of Operations Concepts) to inform infrastructure and rolling stock design specifications and to set out further details of the roles and responsibilities of the various parties and provide context for aspects of the project which are still to be designed.
- f) Acceptance - Acceptance of the rolling stock, Old Oak Common depot, other infrastructure and systems from those delivering them. This is described in 3.3, and further details can be found in the Project Development Agreement and Memorandum of Understanding between RfL and CRL.

Table 4 gives an overview of requirements for the workstreams described above which need to be put in place for each stage.

Stage 3 is a particularly critical stage in the delivery of Crossrail as this is the stage where the central tunnel section would be handed over to the Infrastructure Managers (both RfL and LU), and is also the most complex stage in terms of interfaces and planning. It is essential that prior to this stage interfaces at Westbourne Park have been commissioned and the train plan agreed for the movement of trains from OOC to and from COS as necessary to operate the timetable

A more detailed plan of the various activities which will need to be drawn together to implement this stage is developed in IM Sequencing Handover Roadmap [Ref 9], and Crossrail's Master Control Schedule [Ref 19] and

the Memorandum of Understanding [Ref 20] between Crossrail and RfL provide more detailed arrangements and programme controls to assist with managing and coordinating the various interfaces.

There are a range of other matters associated with the opening and operation of Crossrail, which RfL is solely responsible for and which are not described in this document. These matters are still in development and include branding and marketing strategy, ticketing, the Customer Service Strategy and possible additional station enhancements on the on-network stations that will be operated by CTOC.

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Table 4: Overview of operational workstreams and staged requirements

Stage	Personnel required	Systems and processes	Supply chain	Secure rights	Acceptance
Stage 0	Drivers Station operators Performance managers	Driver training (if required) Station Staff training (GE stations)		Track access Ilford Depot access	
Stage 1	Drivers	Rule Book Driver training		Track access Ilford Depot access	Rolling Stock Train Simulator
Stage 2	Drivers Station operators Performance managers	Rule Book Driver training Station Staff training (GW 'inner' stations and BAA)		Timetable change Track access Station access (Heathrow)	Rolling Stock Old Oak Common depot
Stage 3	Drivers Station operators Performance managers Asset managers (to monitor and plan renewals & maintenance) Maintainers RCC personnel	Asset management system(s) Safety management system (s) Rule Book Driver training Station Staff training (COS stations)	Power supply Spares and tools Yellow plant CTOC accommodation at OOC depot RCC operational accommodation	Timetable change (to support trains accessing the central tunnel section) Connection contracts and Operational & maintenance agreements for NR interfaces	Rolling Stock Central tunnel section and stations Infrastructure maintenance facility at Plumstead
Stage 4	Drivers	Safety management system Rule Book Driver training		Track access Timetable change	Rolling Stock
Stage 5	Drivers Station operators	Safety management system Rule Book Station Staff training (GW 'inner' stations and BAA)		Track access Timetable change	Rolling Stock

6 ORGANISATION

The Operations Directorate has been established within Crossrail to support a coordinated and efficient approach to the design, implementation, handover and transition to operation of Crossrail. The Operations Directorate structure is described in Diag.4 with key responsibilities described in Table 5.

Diag.4: Operations Directorate Organisation

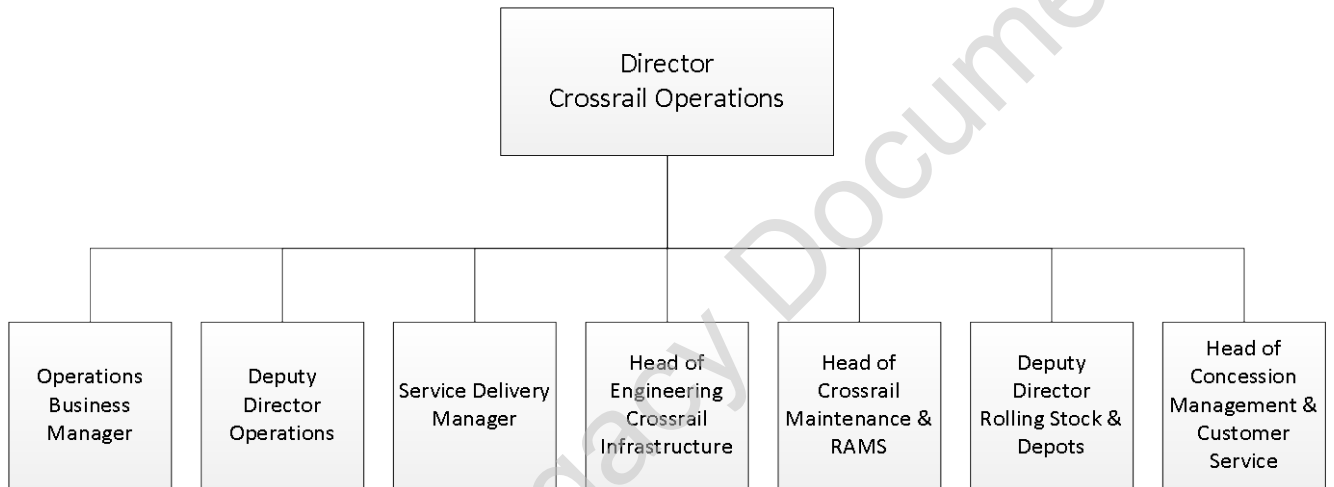


Table 5: Overview of Operations team accountabilities

Name / title	Key accountabilities	Comment
Operations Director	Leading operational planning and delivery	Crossrail and RfL role
Business Management	Programme and business management support to operations team	Crossrail role
Railway Operations	Operations concepts, operational performance and planning, readiness, rule book development and publication, delivery of route control capability.	Crossrail and RfL joint activity
Service Delivery	Development, review and delivery of the Crossrail timetable and planning of future service performance requirements	Crossrail and RfL joint activity
Engineering Infrastructure	Future Infrastructure Management team for RfL, responsible for acceptance of assets and the Safety Management System.	RfL role
Maintenance and RAMS	Development and delivery of the future infrastructure maintenance capability for RfL.	RfL role
Rolling Stock & Depot team	Management of the delivery phase of the rolling stock and depot projects, including equipment acceptance.	CRL delivery management and RfL acceptance
Concession Management and Customer Services	Management of the CTOC concession contract and integration within TfL / Crossrail, delivery and monitoring of activities that will together provide the Crossrail customer experience, design and construction management for the TfL-funded refurbishment and lift works on surface stations.	Crossrail and RfL joint activity

The governance model for the Operations Directorate is shown in Diag.5. This identifies the key escalation, reporting and financial authority routes for groups within the Operations Directorate, and interfaces to related groups within the wider Crossrail and RfL. Details of the individual meetings and their purpose is given in Table 6. Further details of the allocation of responsibilities between RfL and CRL within the Operations team have been developed in the Memorandum of Understanding that exists between CRL and RfL and are also set out in the Bringing into Use Roadmap [Ref 17].

Diag.5: Operations Directorate Governance Model

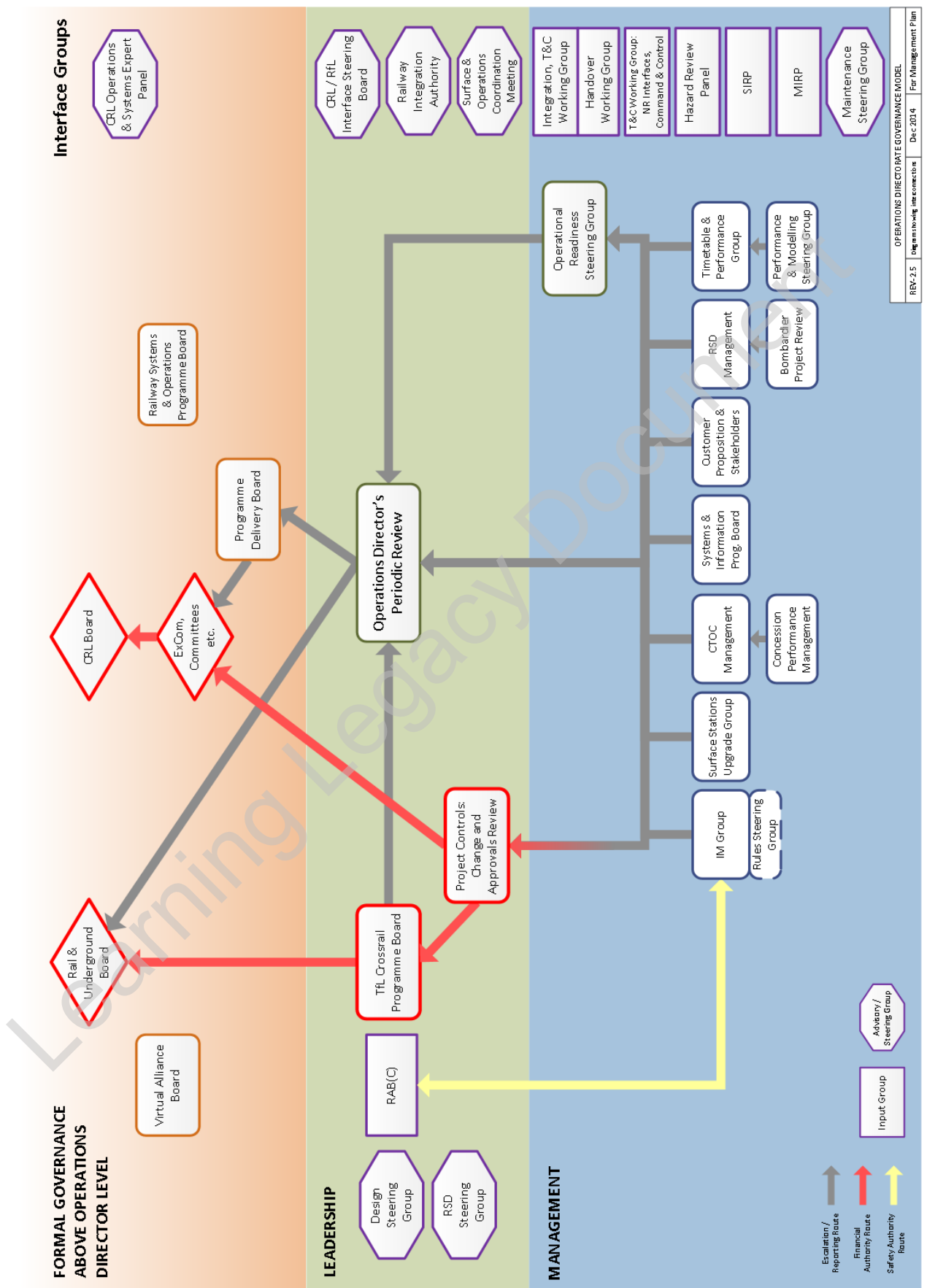


Table 6: Key Governance Meetings

	Meeting	Purpose (inter-alia)
Formal Governance above Operations Director Level	TfL Rail & Underground Board	Rail & Underground decision making meeting: - Procurement authority approval/recommendation above £5m - Budgeted Project Authority approval/recommendation above £5m - Unbudgeted Project Authority approval/recommendation
	CRL Board	To provide strategic direction for the company
	Railway Systems & Operations Programme Board	To monitor and drive forward the overall progress of operational planning and readiness activities, to monitor major risks to which affect more than one party and to develop and review mitigation plans for recommendation to CRL.
	Virtual Alliance Board	Review of Crossrail operational performance and influencing factors.
	ExCom - Executive and Investment Committee	Provide advice, assistance and recommendations to the Board in areas including: implementation of the strategy, programme delivery in accordance with the PDA, financial position, governance and assurance, reporting to sponsors and shareholders. To approve contingency release against change / risk control as permitted.
	CRL Committees, sub-committees	Various - as described within CRL Governance Structure: http://connect.crossrail.co.uk/sites/CrossrailConnect/Secretariat/Pages/CrossrailGovernance.aspx
	Programme Delivery Board	Review of project progress and performance as described through the Area Director's Report
	CRL Operations & Systems Expert Panel	To undertake independent high-level peer reviews of Crossrail's operations and maintenance plans to enable the end-to-end railway, including COS, NR surface and Heathrow infrastructure to be handed successfully into passenger operations.
Leadership	Operations Director's Periodic Review	Crossrail Operations Director decision making, direction, performance review and management of the Operations team.
	TfL Crossrail Programme Board	Review of approval / recommendation papers prior to Rail & Underground Board consideration. TfL Procurement Authority and Project Authority approvals / recommendations.
	Design Steering Group	Ensure that all design elements support the delivery of the Crossrail Customer Service Strategy; Crossrail design is coordinated and consistent and integrated within the wider transport network.
	RSD Steering Group	To monitor performance of the RSPA contract and make decisions on related items pertinent to TfL / RfL oversight.
	RAB(C) - RfL Assurance Board (Crossrail)	To act on behalf of RfL in discharging its Infrastructure Manager responsibilities to provide a competent panel to discharge the responsibilities of the Competent Person under ROGS. To carry out Safety Verification as required by ROGS.
	Project Controls Change and Approvals Review	To review and endorse potential changes and formal submissions generated by the Operations team that require external approvals, prior to commencing formal processes through CRL or RfL.
	CRL / RfL Interface Steering Board	To resolve differences and issues, and monitor interfaces between CRL and RfL.
	RIA - Railway Integration Authority	To ensure that the rail systems, rolling stock and infrastructure combined with operations and maintenance requirements deliver a safe operational railway that meets Sponsors' Requirements.
	Surface & Operations Coordination Meeting	To ensure alignment between Surface Team works (including those undertaken by NR) and the Operations Team requirements. To monitor progress, resolve interface issues and identify items where escalation for resolution is required.

	Meeting	Purpose (inter-alia)
Management	Operational Readiness Steering Group	To monitor and review the activities needed to deliver RfL's responsibilities within the Bringing Into Use Roadmap (BIUR) and ensure that Crossrail as a network is ready for operation through the various project stages, including activities of the Crossrail Train Operating Company (CTOC) and the associated activities of NR and LU.
	IM Group	To act as the Board overseeing and monitoring the plans, programme and progress in readiness for RfL becoming an Infrastructure Manager for Crossrail.
	Rules Steering Group	To endorse the proposals for the Crossrail Rule Book as developed by the Rules Working Group
	Surface Stations Upgrade Group	To monitor performance and delivery of the RfL-led surface stations lift and refurbishment delivery programme
	CTOC Management	To monitor and manage mobilisation plans for Stage 0, the Staged Opening Plan for CRL and commercial issues.
	Concession Performance Management	Periodic contract performance review and issue / risk management in conjunction with MTR.
	RfL Crossrail Systems & Information Programme Board (RSCIP)	To provide strategic direction, guidance and decision making for the Information Programme within CRL / RfL.
	Customer Proposition & Stakeholders	To review the period performance of activities that either directly, or indirectly, contribute to Crossrail delivering a step change in passenger experience on a metro railway. To track and review progress for 'Wonderwall', station enhancements including accessibility upgrades and activities to mobilise Crossrail for the start of concession in May 2015.
	RSD Management	To monitor performance of the RSPA delivery teams, ensure their integration, provide strategic direction over their forward plans and communicate current knowledge.
	Bombardier Project Review	Periodic RSPA contract performance review, issue and risk management in conjunction with Bombardier.
	Timetable & Performance Group	To review the development of the Crossrail timetable, including issues related to infrastructure, maintenance strategies, rolling stock and driver provision; to review performance issues and progress in achieving the Crossrail performance regime.
	Performance and Modelling Steering Group	To monitor compliance and co-ordinate activities in relation to the simulated demonstration of the end to end performance of the Crossrail railway.
	Integration, Test & Commissioning Working Group	To develop, agree and lead the strategy for the testing and commissioning of the Crossrail stations, rolling stock, depots, and end-to-end railway systems.
	Handover Working Group	To produce a Handover Strategy and Plan for handover of agreed elements from CRL to the Infrastructure Manager. To coordinate the handover of agreed elements in accordance with the strategy and plan.
	Test & Commissioning Working Group: NR Interfaces, Command and Control	To develop, agree and lead the strategy for the testing and commissioning of the Crossrail stations, rolling stock, depots, control centres and end-to-end railway systems for the NR interfaces.
	Hazard Review Panel	To review and determine the appropriate action for hazards: that cannot be mitigated by design and require IM or train operator to manage via operational rules and / or maintenance; hazards that remain intolerable after hazard mitigations have been implemented.
	SIRP - Systems Integration Review Panel	To validate alignment between the baseline designs and operations concepts (and sponsor change where realignment is required), provide formal operability impact assessment in support of the Crossrail Change process, monitor the adoption and development of proposed rules and procedures by relevant IM which arise from the design and integration processes.
	MIRP - Maintenance Integration Review Panel	To validate alignment between the baseline designs and maintenance concept, monitor the implementation of the design during construction and integration in respect of system maintainability by the relevant IM, and provide formal maintenance impact assessment in support of the Crossrail Change process.
Maintenance Steering Group	To manage the implementation of the Maintenance Development Plan in order to create a maintenance regime that will meet Sponsors requirements and CFPR, and to ensure alignment between integrated designs and maintenance plans.	

7 RISKS

The key strategic risks and mitigations in relation to the activities described in this management plan – bringing Crossrail into operation – are described in Table 7:

Table 7: Risks

Description	Risk impacts	Long term mitigations
Delay to CRL design progress through stage gates causes excess demands on IM review / decision making resources.	Design progress / approval is impacted further delaying CRL gates programme	Close liaison with CRL Systemwide to understand programme status and volume of approvals required. Trackers established to monitor situation.
Assets being delivered are changed without IM's / operators knowledge or that adversely impact operational costs	Increased costs to operate or maintain the railway.	Operations team consulted on all changes. Decisions based on whole life cost assessment Progressive assurance agreed with Ims
Rolling Stock is delivered late	Insufficient trains to deliver opening strategy, notably to enable Stage 3 to be tested and commissioned.	RfL / CRL project management of Service Provider contract, providing visibility of performance and opportunity for applying corrective action. Progressive assurance of SP design.
Old Oak Common Depot is late	Unable to stable trains at Old Oak Common or provide full range of train maintenance services	RfL / CRL project management of Service Provider contract, providing visibility of performance and opportunity for applying corrective action. Progressive assurance of sub-contractor design.
Failure to commission the railway at the interfaces with Network Rail	Increased costs Signalling (ERTMS) not ready, impacting performance	Progress of On-Network Works monitored through Surface / Operations liaison meeting. Escalation routes through RIA and Systems & Operations Programme Board.
The RfL Infrastructure Manager / Operator / Maintainer is not ready for operational service	Increased costs Delayed opening	Operational Readiness Steering Group established to manage progress towards each Stage opening.
Insufficient CTOC driver resources to support staged opening of Crossrail	Delayed opening Reputational damage	RfL review of CTOC Staged Opening Plan and monitoring of recruitment / training programme.
RfL customer service is not perceived as being world class / surface station investment is not maximised	Adverse reputational risk. Potential loss of revenue	Customer proposition workstream established. Surface station refurbishment works being delivered by Operations team, with control over design / output.
Inability to maintain the railway due to delays in designing and procuring maintenance support facilities / contracts (e.g. yellow plant, diagnostics)	Delay to opening Poorly maintained railway	Early development of maintenance strategy for each IM and specification of requirements. Necessary funding agreed and in place
Railway fails to perform for technical reasons as intended / required by Sponsors	Sponsor requirements not met. Reputational damage	Phased opening strategy. Effective and progressive assurance. Performance modelling Close working between Ims and Crossrail

8 REFERENCE DOCUMENTS

Ref:	Document Title	Document Number:
1.	Delivery Strategy	CR-XRL-Z-GST-CR001-00001
2.	Management Plan Volume 1: Support Directorates and Governance	CR-XRL-O4-GPG-CR001-00001
3.	Management Plan Volume 2: Central Section Delivery	CR-XRL-O4-GPG-CR001-00004
4.	Management Plan Volume 3: Surface Delivery	CR-XRL-O4-GPG-CR001-00005
5.	Management Plan Volume 4: Operations	CR-XRL-K2-STP-CR001-50001
6.	Operations Business Management Plan	In development
7.	RSD Management Plan	CRL1-XRL-R1-STP-CR074-50001 (in development)
8.	CTOC Staged Opening Plan	CRL1-XRL-K2-STP-CR001_Z-50002 (in development)
9.	RfL IM Handover & Bringing into Use Plan	CR-MS-103-02-0047 eB ref to be confirmed
10.	RfL Operations Development Plan	CRL1-XRL-K2-HRR-CR001_Z-50001 (in development)
11.	Maintenance Development Plan	CRL1-XRL-O8-XTC-CR001-00006
12.	Operations Concepts	CRL1-XRL-K2-GUI-CR001_Z-50001 to CRL1-XRL-K2-GUI-CR001_Z-50028
13.	Crossrail Programme Functional Requirement Baseline	CRL1-XRL-O8-RSP-CR001-50015
14.	Project Development Agreement	CR-XRL-Z8-AAG-CR001-50178
15.	Project Testing and Commissioning Strategy	CRL1-XRL-O8-STP-CR001-50008
16.	Programme Testing and Commissioning Management Plan	CRL1-XRL-Z-STP-CR001-50017
17.	Bringing into Use Roadmap	CRL1-XRL-K2-STP-CR001_Z-50001
18.	CRL Handover Strategy	CRL-XRL-K1-STP-CR001-50001
19.	Master Control Schedule	CRL1-XRL-Z9-STP-CR001-50001
20.	Rail for London Limited - Memorandum of Understanding dated 8 Feb 2013	CR-XRL-Z8-AAG-CR001-50468

Note: Key lower level Operations documents are referenced in Appendix A

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Valid only if viewed through the CRL Management System Portal on Crossrail Connect

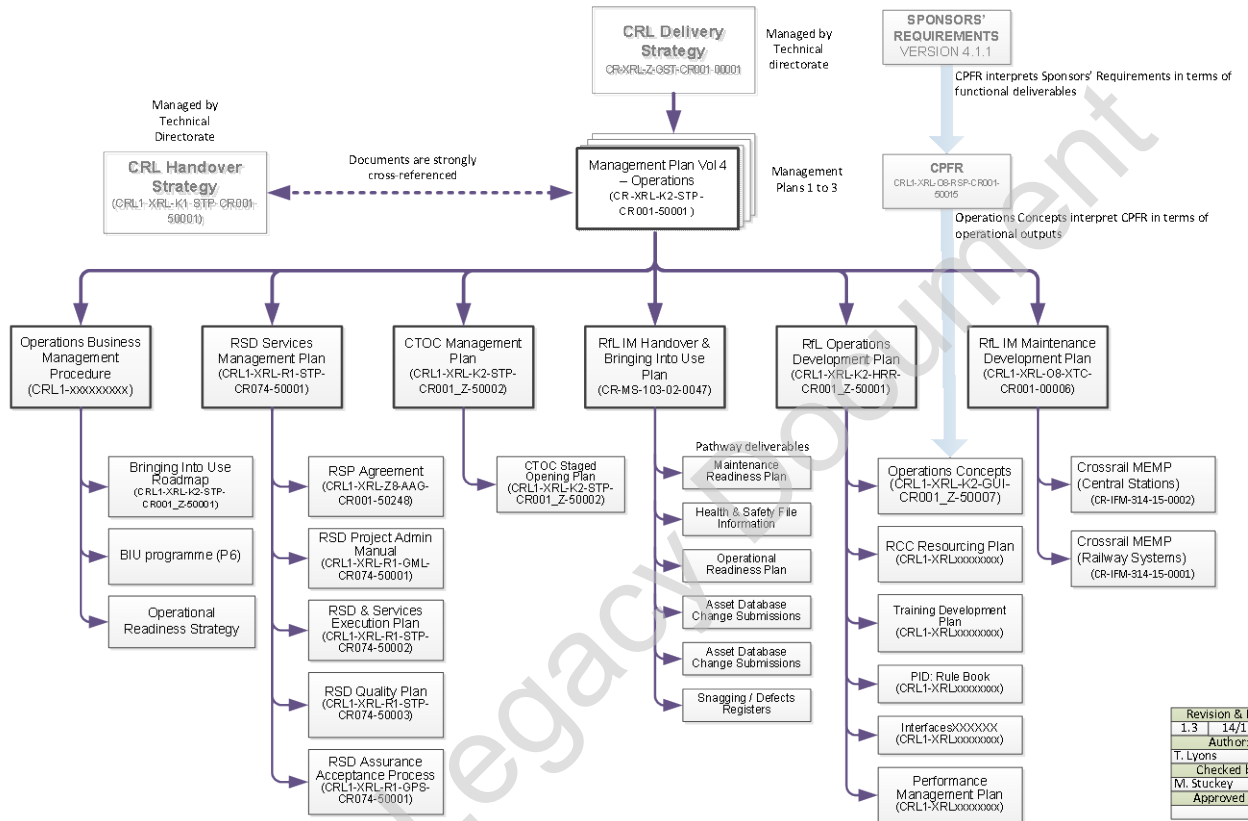
9 Standard Forms / Templates

Ref:	Document Title	Document Number:
	n/a	

Learning Legacy Document

10 APPENDIX A: HIERARCHY OF OPERATIONAL DOCUMENTS

OPERATIONS DIRECTORATE: BRINGING INTO USE DOCUMENT HIERARCHY



Note: some of the above documents are still in development.