



## **Crossrail Project Representative**

Crossrail Joint Sponsor Team

### **Semi-Annual Construction Report 19**

**17 September 2017 – 31 March 2018**

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**Semi-Annual Construction Report 19**

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Note: This report relies on the information set out in CRL's Period 13 reports augmented by more current information received by PRep during the course of our routine discussions with CRL since the Period close on 31 March 2018. Note that information emerging after the close of Period 13 is subject to formal confirmation by CRL. This report is supplemented by our weekly reports to JST and regular meetings with JST staff.

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## Contents

<b>1.</b>	<b>Executive Summary</b>	<b>4</b>
<b>2.</b>	<b>Overview of Costs</b>	<b>7</b>
2.1.	AF CDC and Intervention Points	7
2.2.	Risk & Contingency	7
2.3.	TfL Contingency	8
2.4.	ONW Costs	9
<b>3.</b>	<b>SACR19 Overview (up to 31 March 2018)</b>	<b>11</b>
3.1.	Health and Safety	11
3.2.	Milestones and Strategic Achievements	11
3.3.	Key concerns (September 2017 to April 2018)	12
3.3.1.	Anchor Milestones not achieved in Period	12
3.3.2.	On Network Works	13
3.3.3.	Rolling Stock and Depot (RSD)	13
3.3.4.	Regulatory Approvals & Assurance	14
3.3.5.	EDT in Zones 1 & 2 (started 26 February 2018)	15
3.3.6.	Zones 3 & 4 Infrastructure Delivery	15
3.3.7.	Tunnels and Stations	16
3.3.8.	Operations	17
<b>4.</b>	<b>Forward Look (from 1 April 2018)</b>	<b>19</b>
4.1.	Schedule	19
4.1.1.	MOHS Refresh	19
4.1.2.	Anchor Milestones for SACR20 period	19
4.1.3.	T Minus check point system	20
4.2.	Stage 2 Phase 1 Opening – 20 May 2018	20
4.3.	Stage 2 Phase 2 Opening – start date to be confirmed by CRL	20
4.4.	Stage 3 Opening – 9 December 2018	21
4.4.1.	Dynamic Testing in Zones 1 & 2 (continuing from 26 February 2018)	22
4.4.2.	Zones 3 & 4 Infrastructure Delivery	22
4.4.3.	OLE Energisation in Zones 3 & 4 (scheduled start 21 May 2018)	23
4.4.4.	Dynamic Testing in Zones 1, 2, 3 & 4 (scheduled start 11 June 2018)	23
4.4.5.	Infrastructure Completion for Trial Running (scheduled start 5 August 2018)	24
4.4.6.	ONW	24
4.4.7.	Rolling Stock	25
4.4.8.	Assurance	26
4.4.9.	Tunnels and Stations	26
4.4.10.	Handover and Operations	27
4.4.11.	Trial Running, Trial Operations and Service	28
4.5.	Stages 4 & 5 (19 May 2019 and 8 December 2019)	29

<b>Appendix A CIM</b>	<b>32</b>
A.1 Crossrail Investment Model	32
<b>Appendix B Commentary on CRL’s SACR19 Report</b>	<b>34</b>
<b>Appendix C Undertakings and Assurances (U&amp;As)</b>	<b>37</b>
C.1 Undertakings & Assurances – Central Section	37
C.1.1 C660/C520 Custom House PA/VA (D25) Assurance 465	37
C.1.2 Farringdon Station (East Ticket Hall) D25 Assurances	37
C.2 Undertakings & Assurances (U&A) Surface Section	38
C.2.1 Abbey Wood Substation (UKPN) Fixed Noise (D25) Assurances	38
C.2.2 Shenfield Sidings – D25 Assurances	39
<b>Appendix D Milestones SACR19 and SACR20</b>	<b>40</b>
D.1 SACR19 Milestones	40
D.2 SACR20 Milestones	41
<b>Appendix E Glossary of Terms</b>	<b>43</b>

## 1. Executive Summary

This report is our independent assessment of the issues that have arisen during the SACR19 period and our assessment of risks to the Staged Openings of the Crossrail project.

### Health and Safety:

H&S performance has been good during the period and all KPIs are well within target.

### Financial:

The Intervention Points have not changed during the SACR19 period. Costs have increased significantly during the period such that the AFCDC at P50 has increased by £420m from £12,303m to £12,723m. The AFCDC at P50 now exceeds IP2 by £211m, thereby confirming the formal breach of IP2. The P80 AFCDC is £12,790m and the P95 AFCDC is £12,855m. The new Quantified Cost Risk Assessment (QCRA) at P50 increased to £475m, of which £340m is Unresolved Trends.

CRL continues to carry out its detailed assessment of potential delivery pressures and cost scenario planning, initiated in the latter part of the SACR19 period, to identify the threshold for funding above IP2. CRL, Sponsors and HM Treasury are in discussion to finalise the package to fund CRL to completion.

The total On Network Works (ONW) forecast cost (AFC plus VNs) at SACR19 is £2,530m, but we expect this to increase to reflect the £54m of additional NR funding. The ONW final forecast outturn cost (FFOC) reduced by £74m from £2,450m at SACR18 to £2,376m at SACR19, to reflect the agreed cash funding. CRL has indicated that there are further cost pressures in a number of NR contracts.

### Schedule:

The refreshed MOHS 2018 was issued by CRL in February 2018. Although Stage Opening dates were retained, most activities have been compressed and milestones have been re-baselined. This is the last update to be carried out by CRL. The schedule had been revised and re-issued in April in previous years, but the update was brought forward this year as the number of delays across the programme had reduced its usefulness as a baseline document. Our view remains that the new MOHS was highly ambitious.

CRL has recently advised that Trial Running and Trial Operations target dates will be delayed and merged into 'Combined Trials' which are scheduled to commence on 1 October 2018. In addition a new 'Reliability Growth' period is due to commence on 11 September 2018. These revised dates will allow more time for construction blockades and additional dynamic testing windows. The revisions will also take account of new dates for transition testing at NR interfaces. Details are not available yet so we report on MOHS 2018 dates (5 August 2018 and 9 September 2018) but future Periodic Status Reports will monitor the new dates and related milestones.

CRL face a number of significant challenges during the remainder of 2018, and there remains a high risk that Stage 3 Opening may be delayed or the opening will be sub-optimal.

**Progress:**

A reduced form of Stage 2 Opening (known as Stage 2 Phase 1) was implemented on 20 May 2018. Planning for this scenario started in mid-2017, in recognition of the likely lack of availability of the BT ETCS software which would allow Class 345 services to Heathrow Airport. Detailed plans for the introduction of all Stage 2 services (known as Stage 2 Phase 2) have yet to be confirmed, but there is consensus at targeting February 2019. Schedule proximity to Stage 3 Opening is a concern.

A combination of historical schedule pressures, large outstanding workload, unrealistic performance demands, access and logistics challenges and unexpected, schedule-impacting, incidents conspired to increase pressure still further on all Stage 3 delivery workstreams in the SACR19 period.

The prioritisation of resources to achieve dynamic testing in Zones 1 & 2 on 26 February 2018 had a significant impact upon the ability to deliver fixed infrastructure in Zones 3 & 4. Poor installation progress in Zones 3 & 4 and practical difficulties with the transition between “construction” and “dynamic testing”, inherent in the split day/night delivery approach at the time, influenced CRL’s decision to adopt Blockade Working. Delivery now takes place in a repeating 2 week working cycle, split between 11 day construction “blockades” and 3 day dynamic testing “windows”.

Systems and installations have already been identified which will not be complete ahead of Trial Running (e.g. Tunnel Ventilation) and absolute completion dates, and minimum requirements for formal Handover have not been fully agreed between CRL and RfL.

Stations completion continues to experience considerable challenges, with fit-out works delayed by contractor’s poor performance, lower than planned levels of resource and productivity, and programme changes. Late delivery of Station systems is driving delay into the completion of Phase 3 integration testing. Most stations will require Sectional Completion as full Handover will not be possible before the relevant IM takes possession. ██████████ Station is at serious risk of not being complete for Stage 3 Opening. CRL is seeking schedule improvements from the Tier 1 contractors.

The time available for completion and the opportunities for delay mitigation in order to achieve Stage 3 Opening are reducing. Successful completion of dynamic testing ahead of Trial Running is a fundamental prerequisite, and this relies upon the ability to make good progress, yet to be demonstrated, with the integration of ██████████ systems. Opportunities to improve general train reliability could become more limited due to the possibility of decreasing the Trial Operations period.

Pressure is increasing upon RfL to accommodate CRL delivery shortcomings and to absorb the schedule pressures arising from incomplete works.

**RSD & Operations:**

Progress of the Rolling Stock and Depot (RSD) schedule has not met its forecast in SACR19. Stage 2 Opening was required to be split into two phases due to delays in the train’s TCMS development, and its TCMS version required for Stage 3 Opening has also been late, albeit the delays to the infrastructure have lessened the impact of this particular delay.

There have also been delays to the Bringing Into Use of sections of OOC Depot. However, the impact has been diminished by the delays to the overall project, and the Depot has been able to support train testing and Stage 2 Phase 1 services.

The Operator (MTR-C) and the IMs have adequate plans to ensure they can receive the railway for Trial Operations, and are meeting that plan in the majority of activities. However, they are being impeded by the slow progress of key deliverables from CRL's Tier 1 contractors. These are technical training, O&M manuals, and asset information. This could affect the IM's, and in particular RfL-I's, ability to take control of the railway at the start of Trial Running, or affect performance once passenger operations have begun.

**Assurance:**

The flow of assurance evidence to RAB(C) and the AsBo is behind schedule. This means that the timely submission of the Safety Justifications into the Central Section's Technical File for submission to the ORR is at risk.

The Tier 1 contractors were assessed as to how they were positioned with regards to fulfilling contract completion requirements. As well as the deliverables described above the contractors must also improve upon 3 D models, as-built drawings, consents, H&S Files and certification of works.



## 2. Overview of Costs

### 2.1. AFDCD and Intervention Points

The intervention points, IP0, IP1 and IP2 have not changed during the SACR19 period and remain at £11,672m, £11,912m and £12,512m respectively.

The P50 AFDCD has increased by £420m in the SACR19 period, from £12,303m to £12,723m, as shown in Figure 2 - 1 below. The predominant cause for this increase is attributed to additional risk allowances and cost pressures identified by CRL through its Q4/Period 13 QCRA. Overall, the principal cost increase contributions during the SACR19 Period are increased forecast costs for Systemwide Main Works (██████████), Whitechapel station (██████████), Plumstead & Woolwich fit-outs (██████████), Farringdon station (██████████), Paddington station (██████████), Bond Street station (██████████), Intermediate Shafts (██████████), Communications & Control Systems (██████████), and a net increase across all other areas (██████████).

At SACR19, the P50 AFDCD was £211m above IP2, and the P80 AFDCD of £12,790m exceeded IP2 by £278m. The P95 AFDCD at SACR19 is £12,855m which exceeded IP2 by £343m, and a deterioration of £448m since SACR18 (£12,407m). Consequently, further funding will need to be put into place to prevent the Sponsor Funding Account (SFA) falling into deficit, which CRL is currently forecasting to occur in Period 8 2018/19. CRL will be requesting, as a part of the SACR19 process, the remaining £156m of the TfL contingent funding in Period 4 2018/19 to ensure that the remaining works are funded to the end of 2018/19.

(£ millions)	SACR 18 Period 06	SACR 19 Period 13	Delta	Movement
<b>Forecast</b>	<b>11,924</b>	<b>12,247</b>	<b>323</b>	up
Project Risk	0	0	0	same
Sector Risk	0	0	0	same
Delivery Risk	83	0	-83	down
<b>Subtotal</b>	<b>12,007</b>	<b>12,247</b>	<b>240</b>	up
Programme Risk	292	472	180	up
Board Risk	4	4	0	same
<b>AFDCD total</b>	<b>12,303</b>	<b>12,723</b>	<b>420</b>	up
IP0	11,672	11,672	0	same
<b>IP0 Headroom</b>	<b>-631</b>	<b>-1,051</b>	<b>-420</b>	down
IP1	11,912	11,912	0	same
<b>IP1 Headroom</b>	<b>-391</b>	<b>-811</b>	<b>-420</b>	down
IP2	12,512	12,512	0	same
<b>IP2 Headroom</b>	<b>209</b>	<b>-211</b>	<b>-420</b>	down

Figure 2 - 1~ Growth of AFDCD since SACR18

### 2.2. Risk & Contingency

CRL's Current Control Budget (CCB) provides for a total value of £12,507m, which is £216m below the P50 AFDCD and £283m below the P80 AFDCD. The total contingency available to CRL was £220m at the end of the SACR19 period, which is insufficient to cover the unresolved



trends of £340m. CRL is proposing that the CCB will be increased by £283m, from £12,507m to £12,790m, to ensure that it has sufficient budget to cover the P80 AF CDC forecast (£12,790m).

CRLs Quantitative Cost Risk Assessment (QCRA) identified a total forecast risk exposure at P95 of £607m (an increase of £125m since SACR18). At P50, the overall contingency budget of £220m is inadequate to cover the risk exposure at P50 of £475m (by £256m), or at P95 of £607m (by £388m).

Overall in the SACR19 period, the AF CDC has increased by £420m. During the same period risk exposure has increased by £97m, an increase of 26% over the SACR19 period.

Description	£ million	
	P50 Risk Exposure	P95 Risk Exposure
SACR18	378	482
SACR19	475	607
SACR Period Increase	97	125
% Increase	26%	26%

Figure 2 - 2 ~ Increase in P50 and P95 Risk Exposure

As shown in Figure 2 - 2; the increase in the difference between P50 and P95 is indicative of the increased level of uncertainty identified by CRL in its Q4/P13 QCRA detailed contract review.

Our review of the Q4/P13 QCRA indicates that CRL has carried out a comprehensive assessment of risk and cost pressures for the ultimate completion of the programme. The independent Jacobs commercial review team appointed by the JST attended the CRL Period 13 QCRA completion meeting on 9 April 2018 and has also carried out its separate review. In summary, CRL has undertaken a full QCRA review in which known delivery issues have been identified and allowances included. However, we expect costs may increase later in 2018 due to continuing cost pressures on Systemwide activities and delays at some stations such as

██████████. ██████████ CRL has not included an allowance for commercial disputes ██████████ in the Q4/P13 QCRA.

**2.3. TfL Contingency**

The Crossrail Project Development Agreement (PDA) defines TfL Contingency as: ‘The aggregate capital funding to be provided by TfL (if required in accordance with this Agreement) as set out in the column headed "TfL Contingency" in the Funding Schedule.’

A formal request for £444m was made by CRL in its SACR18 report and by letter on 11 December 2017. Payments are shown in the Crossrail Investment Model (CIM) between Periods 141 and 145 (January to May 2018); these have been received. The balance of £156m is shown in the CIM as being transferred in August 2018.

The CIM indicates a negative closing balance from Period 151 (October 2018). CRL is in discussion with Sponsors regarding additional funding. The maximum balance shown is £238.5m which is greater than the AF CDC P50 breach of £211m. CRL has advised that some

of the very early costs of Crossrail before December 2008 (£28m) were expended before the creation of the SFA calculations in the CIM and these are included in the CIM as pre-SFA funding risk.

**2.4. ONW Costs**

At SACR19, the total AFC and Variations funding for NR ONW was £2,530m. This is in line with confirmed funding arrangements with Sponsors. Total Secured Funding for NR ONW at SACR19 was £2,835.4m, as a consequence of NR securing recoveries in respect of other NR projects etc, as shown in Figure 2 - 3.

During the SACR19 period, CRL’s proposals detailed in its SACR18 report with respect to funding the remaining Variation Notices have been implemented. NR has entered into two Grant Funded Agreements with the DfT providing £112m (in two separate tranches of £28m and £84m each). CRL and NR have terminated the Delivery Incentives Agreement and entered into a funding agreement that contributes £22m, and NR has confirmed its £20m contribution to complete the required £154m provision.

In addition to this £154m funding; during the later part of the SACR19 period, NR initiated the request for an additional £54m funding from the CP5 Portfolio Board to cover existing cost pressures. This additional funding application, which has been accepted in principle by the NR portfolio board, will potentially increase the FFOC (P80) to £2,430m.

Description	SACR19 Source of Funding			
	DfT £m	CRL £m	NR £m	Total £m
KD1A - OTP	2,049.0	-	-	2,049.0
CRL Managed Risk	110.0	-	-	110.0
Portfolio Board Funding	217.0	-	-	217.0
Approved £154m VNs	112.0	22.0	20.0	154.0
<b>NR Current Funding</b>	<b>2,488.0</b>	<b>22.0</b>	<b>20.0</b>	<b>2,530.0</b>
[REDACTED]				
[REDACTED]				
[REDACTED]				
[REDACTED]				
[REDACTED]				
[REDACTED]				
<b>Sub Total</b>	<b>-</b>	<b>118.9</b>	<b>186.5</b>	<b>305.4</b>
<b>TOTAL SECURED FUNDING</b>	<b>2,488.0</b>	<b>140.9</b>	<b>206.5</b>	<b>2,835.4</b>

Figure 2 - 3 ~ NR ONW Secured Funding

At SACR19, the base NR Total Cost was £2,835.4m, as shown in Figure 2 - 4. CRL has applied a cost sensitivity analysis resulting in a range of £2,830m to £3,006m for potential NR costs as at SACR19.

Description	Cost Sensitivity			
	SACR 19 £m	Low £m	Mid £m	High £m
SPOT AFC - Gross excluding Risk	2,901.6	2,886.5	2,932.9	3,015.5
Risk	0.0	0.0	0.0	0.0
Efficiencies	-24.3	-21.9	-9.7	0.0
Recoveries (Residual)	-18.1	-13.1	-11.8	-9.1
Targeted Savings	-23.8	-21.5	-9.5	0.0
<b>Cost Grand Total</b>	<b>2,835.4</b>	<b>2,830.0</b>	<b>2,901.9</b>	<b>3,006.4</b>
Total Secured Funding	2,835.4	2,835.4	2,835.4	2,835.4
Funding Gap	0.0	-5.4	66.5	171.0

Figure 2 - 4 ~ NR ONW Cost Summary

The CRL estimate for the ONW FFOC at SACR19 is £2,376m, a reduction of £154m from the previous SACR period due to additional Variation Notices being cash funded and therefore not constituting NR Programme Costs. This exceeds the CRL-NR Programme Protocol DfT Intervention Amount of £2.3bn by £76m. The FFOC is subject to estimated pain share adjustment of £70.4m, which results in a Forecast to the RAB of £2,305.6m, which exceeds the DfT Intervention Price of £2.3bn by £5.6m, as shown in Figure 2 - 5. CRL has indicated that there are further cost pressures in a number of NR contracts.

Description	£ million	
	SACR18	SACR 19
AFC plus VN Allowance	2,296	2376
Pain/gain share	-59	-70
Scope Impacts & VNs	154	0
Total Forecast to RAB	2,391	2,306
DfT Intervention Price	2,300	2,300
Headroom to DfT Intervention Price	-91	-6

Figure 2 - 5 ~ FFOC Headroom for DfT Intervention Price

## 3. SACR19 Overview (up to 31 March 2018)

### 3.1. Health and Safety

The RIDDOR AFR increased to 0.09, which is slightly higher than at SACR18, and the Lost Time Case AFR fell from 0.19 to 0.17. The leading indicator HSPI improved from 2.53 to 2.59, with all contractors beating the target of 2.00. All KPIs remained well within target which is to be applauded during a period when energisation was implemented and there has been an increase in the number of fit-out subcontract packages. Focus will need to be maintained, as a number of recent high potential near misses indicate that hazards and miscommunications may continue to bring risks over the coming months.

### 3.2. Milestones and Strategic Achievements

The refreshed Master Operation Handover Schedule (MOHS 2018) was signed off by CRL and its partners on 16 February 2018, presented to JST and PRep on 19 February 2018, and presented to Sponsor Board on 22 February 2018. This is the last update to be carried out by CRL. The schedule had been revised and re-issued in April in previous years, but the update was brought forward this year as the number of delays across the programme had reduced its usefulness as a baseline document.

Although Stage 3, 4 and 5 Opening dates were retained, most activities and milestones have been re-baselined. All milestones scheduled for the SACR19 period are contained in Appendix D.1. Most are green RAG (on time) because they had been completed by mid-February so the MOHS dates and the Actual dates were equivalent. Details regarding missed milestones are given elsewhere in this report.

In addition to achieving some targeted Milestones, there are a number of other strategic achievements worthy of note during SACR19:

- Commencement of Dynamic Testing in Zones 1 & 2 on 26 February 2018;
- First Class 345 Full Length Unit travelling under power;
- Completion of all Final Design Overview reviews;
- Completion of Crossrail works at Ilford Depot.

The principal ONW achievements in the SACR19 period were:

- Christmas blockade delivered successfully, including Stage M signalling data change;
- OOC depot lines 1 and 2 commissioned;
- Gidea Park sidings commissioned and brought into use;
- Track connections made to CRL COS, followed by signalling data change and commissioning at Pudding Mill Lane;
- Abbey Wood station was opened to the public;
- West stations platform extensions completed for Stage 2;
- Hayes & Harlington Bay Platform brought into use for Stage 2.

NR completed seven Key Dates in the SACR19 period:

- KD9 – submission of the Track Access Agreement to the ORR;
- KD12 – infrastructure complete to allow access to OOC Depot;
- KD15 – SE Spur infrastructure complete;
- KD20 & 21 – Anglia signalling upgrades commissioned;



- KD29a & b – Pudding Mill Lane infrastructure and signalling completed for dynamic testing.

One Key Date was deferred; KD33 for the supply of traction power from Kensal Green to the central operating section (COS) to allow the COS works to progress further.

NR has achieved completion of Key Output 4 (KO4 – infrastructure readiness for Stage 2 testing) in the SACR19 period in advance of the CRL Stage 2 Opening. CRL and NR are establishing two new Key Output dates, KO6A and B, to cover the residual works required for Stages 4 and 5 respectively.

### 3.3. Key concerns (September 2017 to April 2018)

#### 3.3.1. Anchor Milestones not achieved in Period

The Anchor Milestones contained in Figure 3 - 1 are important milestones from the refreshed MOHS (February 2018) which were scheduled to be complete (EDBL) in the SACR19 period but have been delayed. The Actual/Forecast date is shown as at Period 13 (end of SACR19) but in some cases they have been delayed further since Period 13.

ID	Anchor Milestone	EDBL	EDBL	P13 Actual / Forecast	CRL Reforecast
A681	SS&P Provision of GSMR Interface for Dynamic Testing in Zones 1 & 2	30-Oct-17	30-Oct-17	02-Mar-18	02-Mar-18
A146	Stage 1a complete progressive Introduction of Class 345 (RLU) into Passenger Service on GE	15-Mar-18	20-Mar-18	27-Mar-18	27-Mar-18
A745	Safety Assessment Report substantially complete (AsBo)	31-Mar-18	31-Mar-18	31-Mar-18	07-Jun-18
A682	SS&P Provision of GSMR Interface for Dynamic Testing in Zones 1 to 4	29-Mar-18	10-Jun-18	27-Apr-18	31-May-18
A693	-A693 WBP ATFS energised	31-Mar-18	31-Mar-18	27-Apr-18	23-May-18
A711	-A711 PSD Ready for Dynamic Testing in Zone 1	31-Mar-18	09-Apr-18	09-May-18	30-Jul-18
A339	ONW - OOC - KD33 Traction Power Infrastructure incl. SCADA control from Kensal green ATFS to Westbourne Park ATS	28-Feb-18	28-Feb-18	21-May-18	28-May-18

Figure 3 - 1 ~ Important Anchor Milestones not achieved in SACR19 Period

ID - A681 for the delivery by Stations, Shafts and Portals of the GSM-R interface was achieved later than re-forecast, but this has not affected dynamic testing progress in Zones 1 & 2. GSM-R service is not strictly required until Trial Running. For Rail Systems milestones beyond the SACR19 cut-off, as at the date issue of this report Milestone A693 was achieved ahead of schedule, and the remainder (A682, A711 and A339) are on target.

ID - A146: The forecast date is one week behind the late date, but its original completion date was 19 September 2017. The delay was caused by the trains requiring a longer time than expected to reach minimum standards of reliability, which in turn meant that RfL and MTR-C slowed their acceptance of the C345 trains. There was no detriment in service, as a corresponding number of C315s were retained to operate the train paths.

ID – A339 ref ONW KD33: See Section 3.3.2 of this report.

All milestones scheduled for the SACR19 period are contained in Appendix D.1.

### 3.3.2. On Network Works

At SACR19 the ONW was 94% complete, including Variation Notices, and remains on target to achieve the milestones required for operational readiness of the railway. The remaining stations work is being procured, with works programmed by NR to complete late 2019.

The cost of the Enhanced Stations (West) continues to remain uncertain. NR has tendered two packages for these works, with contracts due to be awarded in June and July 2018 respectively with planned completion of both packages in December 2019. The Tenders are presently being assessed by NR and any impact on the ONW AFC has yet to be quantified. We understand there may be delays to the scheduled contract award dates.

At the end of the SACR19 period, NR reported that all works are on schedule to achieve Key Dates and Key Outputs, with the exception of the following, none of which represents any current critical risk.

Stage 3; KD33 (Enable energisation of COS from Kensal Green as pre-requisite for dynamic testing in advance of Stage 3 introduction of Crossrail services (30 March 2018):

Stage 5; KO5A (Full Infrastructure Capability from Shenfield to the Central Core Area at Pudding Mill Lane) and KD22 (Route clearance & all other infrastructure, including stabling & sidings updates, complete to support Stage 4 Dynamic Testing) (10 September 2018):

Stage 5; KO5B (Full Infrastructure Capability from Reading to the Central Core Area at Westbourne Park to support the operation of new Crossrail trains across the full Crossrail Network) and KD24 (Infrastructure complete to support Stage 5 Dynamic Testing) (10 September 2018):

### 3.3.3. Rolling Stock and Depot (RSD)

█ schedule at the start of SACR19 was to continue to develop the following activities:

- The TCMS v6 software with its ETCS capability so that the trains would be able to start Stage 2 on 20 May 2018. This would be supported by joint testing between BT and Alstom and Alstom’s laboratory in Charleroi.
- Recognising that there is a significant risk to completing the planned level of software functionality for Dynamic Testing, plan to incorporate CBTC functions into an earlier software release, to reduce the risk of functional software not being available for COS Dynamic testing.
- The depot works would complete the following:
  - CTOC area by October 2017;
  - Section A to be BIU with signalling by November 2017;
  - Section B to be BIU with signalling by January 2018.

█ did not make sufficient progress with its TCMS v6 software to give confidence that Stage 2 as planned (4 TPH between Paddington and Heathrow using C345 FLUs) could be achieved. CRL therefore concluded that Stage 2 would have to be split into 2 phases. Phase 1 (2 TPH C345 RLUs between Paddington and Hayes and Harlington, plus 2 TPH C360 between Paddington and Heathrow) started on 20 May 2018. RLUs were used instead of FLUs, as they were already approved for passenger service. Phase 2 is the original service, and will start at a date to be determined. Its delay will cause significant additional workload to RfL and CRL at critical points leading up to Stage 3 Opening, the opening period of passenger operations at Stage 3, and preparations for Stage 4 Opening.

The development of the software for Stage 3 has been behind programme during SACR19, and the train would not have been available to support the Dynamic Testing programme as planned at the end of SACR19. The impact of the delay was lessened by the problems encountered in other areas of the programme, discussed in Sections 3.3.5 and 3.3.6.

The depot works have also been delayed as follows:

- CTOC area was completed on 18 December 2017. The delay was mitigated by MTR-C continuing with its existing arrangements at the time.
- Depot A was BIU with partial signalling on 1 March 2018. The delay to the train programme mitigated the impact.
- Depot B was not BIU in the period. Again, the delay to the train programme mitigated the impact.

**3.3.4. Regulatory Approvals & Assurance**

The change in status<sup>1</sup> of regulatory approvals during SACR19 is shown in Figure 3 - 2.

Stage	Status							Comment
	P7	P8	P9	P10	P11	P12	P13	
2	Red	Red	Red	Red	Grey	Grey	Grey	The key concerns at the point when Stage 2 was deferred were: <ul style="list-style-type: none"> <li>• The MTR-C SMS approval for driver training and ECS was delayed due to late delivery of the driver simulator cab.</li> <li>• BT's programme showed evidence to be submitted to the ORR regarding an APIS would be almost too late for service.</li> <li>• MTR-C SVP allowing service would likely be provided with incomplete information</li> </ul>
2-1	Grey	Grey	Grey	Grey	Green	Yellow	Yellow	<ul style="list-style-type: none"> <li>• The amber grading was due to concern whether BT would be able to provide the requisite evidence to MTR-C SVP in time.</li> </ul>
2-2	Grey	Grey	Grey	Grey	Red	Red	Yellow	<ul style="list-style-type: none"> <li>• The red grading was a result of MTR-C assuming a start date of November 2017. When that constraint was removed the grading changed to amber.</li> </ul>
3	Red	Red	Red	Red	Yellow	Yellow	Yellow	The red status was primarily caused by the slower than anticipated progress in receiving evidence and justifications from contractors, with subsequent delays to the safety justification and verification reports to be produced by CRL. CRL's AsBo had expressed concern at the rate of progress. The MSOH update resulted in the submission date to the ORR for central section APIS being moved from July to September, the additional time resulting in the amber grading. Performance of assurance is still behind schedule.
4	Green	Green	Green	Green	Green	Green	Green	No comment.
5	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	The amber status is due to the uncertainty of whether ETCS will be implemented between Paddington and Stockley Junction as planned by start of Stage 5.

Figure 3 - 2 ~ Regulatory Approvals during SACR19

<sup>1</sup> 'Grey' status shows the periods when a particular stage was not active.



**3.3.5. EDT in Zones 1 & 2 (started 26 February 2018)**

Historical late completion of Civils works continued to impact timely delivery of Systemwide in the Central Section during the SACR period, with late handover and poor access to equipment rooms and routes by Stations, Shafts and Portals compounding earlier schedule delay. Rail systems delivery in the tunnels was also affected by schedule compression, and workstreams remained under significant pressure. This was despite a planned reduction in scope in order to prioritise only those works which were absolutely necessary to support EDT.

[REDACTED]

[REDACTED] Early mitigation plans targeted a revised date of 29 November 2017 for EDT, but ultimately the time required to complete repairs and previously unfinished works, together with the lack of readiness of Rolling Stock for meaningful testing, resulted in an actual start date for EDT of 26 February 2018; the total delay to the MOHS 2017 date for EDT was almost 17 weeks. The term “EDT” was effectively withdrawn from CRL reporting, as long-accumulating schedule delays blurred the practical distinction between the originally planned “early” and later “whole system” dynamic testing.

CRL originally adopted a daily day/night alternating pattern for construction and dynamic testing. In practice, difficulties with the daily energisation of the OCS and the general handover between shifts significantly reduced time available and dynamic testing proved extremely inefficient. Poor dynamic testing progress was compounded by defective and incomplete fixed infrastructure and the lack of proven and available functionality train software. CRL prepared plans for the introduction of a form of “blockade working” as an alternative approach to completion, which is described in Section 3.3.6 below.

While some uncertainty remained in the SACR19 period with BT rolling stock delivery progress, much better visibility of software development emerged through closer joint working and improved collaboration with CRL. This provided greater confidence in Central Section delivery planning, which was reflected in MOHS 2018.

Preparation and acceptance by RAB(C) of interim safety arguments was managed by CRL to occur just ahead of the relevant progressive site energisation and dynamic testing activities in Zones 1 & 2. The resolution of concerns over the timing and quality of submissions was collaboratively managed between CRL and RAB(C) and no delay was attributable to the approvals process.

**3.3.6. Zones 3 & 4 Infrastructure Delivery**

The prioritisation of resources to achieve dynamic testing in Zones 1 & 2 had a significant impact upon the ability to deliver fixed infrastructure in Zones 3 & 4. General Zones 3 & 4 installation progress in the SACR19 period struggled to meet planned production rates and interim MOHS 2018 milestones for delivery proved to be ambitious and at risk of delay. This was a significant influence in CRL’s decision to implement “blockade working” described in Section 3.3.7 below.

Installation work in the Zones 3 & 4 tunnels continued where possible on all major rail systems. Lessons from Zones 1 & 2 were put into practice, with OCS installation and main cable delivery for both C660 Communications & Control and for C650 HV Power Systems being prioritised. Platform Screen Door installation took place when there were no conflicts with priority works and Tunnel Ventilation equipment installation continued where access was available at Stations, Shafts and Portals.

CRL planned to start the process of permanent HV Power energisation across the Central Section on 11 March 2018, bringing together Stations and Rail Systems deliverables as an integrated power distribution system. Subsequent energisations at other locations were planned to take place through a pre-determined “daisy-chain” of HV sub-station energisations (i.e. both 11kV and 22kV) on 12 consecutive weekends. The initial commissioning at Limmo did not happen because [REDACTED] installations were not ready. CRL worked with [REDACTED] to produce a mitigated programme, which limited the worst schedule impact to a small number of locations. Commissioning at Limmo successfully took place three weeks later, on 1 April 2018.

CRL recognised the increasing schedule threat to Trial Running and Trial Operations that was occurring because of ongoing delivery slippage in the SACR period. In response, CRL worked closely and collaboratively with RfL and LU, to provide visibility of progress, to secure general IM support and to explore options for completion beyond the start of Trial Running.

### 3.3.7. Tunnels and Stations

All tunnelling work was completed during the SACR 19 period and work was started on the reinstatement of the remaining tunnel access shaft at Finsbury Park, Liverpool Street. The lower capping slab has been cast, leaving a mole hole for continued access for the station fit-out contractor. The two upper level grout passages have also been backfilled. Final shaft backfilling is ahead of schedule and is forecast for completion by 24 September 2018.

The station fit-out works continue to have been delayed by contractors’ poor performance, lower than planned levels of resource and productivity and programme changes. Continued schedule pressures and further delays have also become apparent; following the recent re-baselining of MOHS in February 2018. The delays in CRL’s performance are evident from; the percentage progress reports, schedule performance curves, progress milestones and IRN completion reports across all of the station contracts.

Station schedules had been drifting, as a result of delays, lower than planned resource levels and additional scope up until Period 8, when CRL undertook a schedule re-baselining with a greater focus on the work left to completion. A review of “bottom up” schedules, the execution of a number of Supplemental Agreements and a re-assessment of the impact of additional work/scope gaps on the stations’ programmes, lead to a re-balancing of actual and planned levels of progress.

The refreshed MOHS schedule, which focused on the remaining works up to completion, became “live” in Period 11. MOHS 2018 re-baselined each of the station schedules, while still maintaining the target December 2018 opening. Contractor “buy in” to MOHS and commitment to the challenging target dates has been essential. CRL is, however, still addressing a number of Tier 2 (sub-contractor) schedules that are not MOHS compliant, with end dates either beyond MOHS target dates, or impacting the critical path and causing further potential delays.

The stations, portals and shafts broadly held their progress to plan, following the implementation of MOHS 2018, up to the close of the SACR19 period. We are, however, concerned to note that the stations each showed a deterioration in the progress reported at the close of Period 1 (2018/19). This reflects the schedule pressure and delays that continue to evolve as the “fit-out” of the new infrastructure continues towards final completion.

Progress on [REDACTED] stations has improved during the SACR19 period. [REDACTED] station, however, remains on the MOHS 2018 critical path, with a challenging, later than originally planned (August 2018), forecast completion date resolutely remaining fixed in December 2018. The station has been delayed by slow progress on complex civil works construction, particularly on the East Ticket Hall “Master Plan” shaft, and the consequential

impacts that this has had on the subsequent station fit-out. CRL has yet to secure an agreed MOHS compliant programme from the contractor that not only achieves the required MOHS 2018 dates, but also improves on and reduces the risk of failing to achieve completion for the planned 9 December 2018 opening.

Forecast completion dates have continued to slip during the SACR 19 period. Each station was set a target date of 3 August 2018 for completion, during the previous SACR period. By Period 11, [REDACTED] stations forecast completion by 8 December 2018. This forecast has been held to date (Period 1 2018/2019). [REDACTED] station forecasts completion by 30 November 2018 and [REDACTED] stations by mid to late October 2018. Only [REDACTED] station still forecasts achieving the 3 August 2018 target date.

CRL no longer measures its performance/progress using Earned Value, but now measures against the achievement of selected milestones towards completion of the remaining works. The milestones were agreed with each PM and were incorporated into MOHS 2018. CRL's performance in achieving these milestones, since their implementation, has been less than planned up to the close of the SACR period. CRL started to miss a number of these milestones, in the period immediately following their assignment. We are concerned that CRL continues to forecast further delays against planned milestones in the coming periods.

The station performance curves, while still maintaining the December 2018 opening date, are forecasting the need for increasing levels of production up to final completion. Such levels of production have not been achieved or sustained by any of the contractors to date. This leads us to believe that, while "station opening" may still be achievable in December 2018, a fully completed asset is unlikely to be achieved at all of the stations. The station performance curves have consistently tracked increasing delays at most of the stations. The actual/forecast curves continue to steadily migrate closer to, but have not yet dropped below, the MOHS 2018 [REDACTED] curve.

[REDACTED]

Delays to the stations and shafts have also occurred due to late demobilisation of the TTVS and the need for continued [REDACTED] access through the works.

The general progress of the station works, in readiness for Testing and Commissioning, is being measured by the various Tier 1 contractors' production of Installation Release Notices (IRNs). Completion of IRNs still remains significantly behind the rate required to support MOHS. There are an estimated total of 3,950 IRNs required for the Stations, Shafts and Portals (SSPs). By the close of SACR19, only 1,006 IRNs had been signed-off. This is a negative variance, against plan, of 719 IRNs. Slow delivery of the IRNs will add further risk to the completion of integration testing and the achievement of the MOHS programme.

**3.3.8. Operations**

Operations, with regard to MTR-C, has generally performed well in the SACR period, adapting its planning to take into account the metamorphosis of Stage 2 into Phases 1 and 2. Its preparations have been completed for Phase 1, which encompassed operational proving (including DOO CCTV), driver training, OOC familiarisation and submissions to its SVP.

Its plans for Stage 3 are broadly to plan with regard to safety and staff (recruitment and training of drivers, station and RCC personnel). [REDACTED]

[REDACTED]

## 4. Forward Look (from 1 April 2018)

### 4.1. Schedule

#### 4.1.1. MOHS Refresh

The refreshed MOHS 2018 was issued by CRL in February 2018. Although Stage 3, 4 and 5 Opening dates were retained, most activities have been compressed and milestones have been re-baselined. It also includes the latest plans regarding Stage 2 Opening in two phases. Our view was that the new MOHS was highly ambitious.

Since then, the programme has suffered from a number of setbacks and delays described elsewhere in this report. The accumulation of delay across all areas of delivery continues to threaten the start of Trial Running and Trial Operations, and the start date for Stage 3 Opening is becoming more vulnerable. IM readiness is becoming increasingly impacted by CRL installation completion and 'paperwork' delays, and there remains a high risk that these delays will not be manageable without impact upon Stage 3 Opening.

We note that CRL has not produced a Quantified Schedule Risk Assessment (QSRA) for SACR19 and that EVM calculations of progress have been replaced with the monitoring of milestones. Our views regarding these milestones are set out elsewhere in this report.

CRL has recently advised that Trial Running and Trial Operations target dates will be delayed and merged into 'Combined Trials' which are scheduled to commence on 1 October 2018. In addition a new 'Reliability Growth' period is due to commence on 11 September 2018. These revised dates will allow more time for construction blockades and additional dynamic testing windows. The revisions will also take account of new dates for transition testing at NR interfaces. We will monitor this new strategy and report in our PSRs during SACR20.

CRL face a number of significant challenges during the remainder of 2018, and there remains a high risk that Stage 3 Opening may be delayed or the opening will be sub-optimal.

#### 4.1.2. Anchor Milestones for SACR20 period

CRL has identified 88 Anchor Milestones to be delivered in the SACR20 period, which are listed in Appendix D.2. We should note that most have been re-forecast, after Period 13, to be delivered later than these dates; details are included in our Periodic Status Reports. In other Sections of this report, we identify those activities that we believe to have low confidence levels of being achieved, and that could have significant impacts in the delivery of the Staged Openings of the Crossrail Programme.

Schedule 3 of the PDA (established in 2008) sets out a number of milestone dates for the purposes of monitoring and reporting in the Semi Annual Construction Report. These were revised in 2013, and are listed in CRL's SACR19 report.

Four OSD linked PDA Anchor Milestones, relating to stations being available for OSD works, are yet to be completed; refer to Figure 4 - 1 below.

PDA No.	Description	PDA Date	CRL Forecast
10	Site available to commence [REDACTED] station Western Ticket Hall OSD	01-Apr-17	31-Oct-18
11	Site available to commence [REDACTED] station Eastern Ticket Hall OSD	01-Apr-17	20-Aug-18
13	Site available to commence [REDACTED] station Western Ticket Hall OSD	18-Aug-17	30-Jun-18
15	Site available to commence [REDACTED] d station Western Ticket Hall & [REDACTED] Vent Shaft OSD	20-Jul-17	30-Nov-18

Figure 4 - 1 ~ OSD Linked PDA Anchor Milestones

Three of the Anchor Milestones are to be delivered on, and one later than, their current MOHS 2018 [REDACTED] Dates. The latter milestone, [REDACTED] (East Ticket Hall) PDA AM11 is currently forecast for completion on 20 August 2018. This is just over 2 months after the MOHS [REDACTED] Date (11 June 2018). Details regarding the status of the OSDs are noted in our Periodic Status Reports.

**4.1.3. T Minus check point system**

CRL has recently indicated to Sponsors that it will be implementing a check point management system similar to the NR ‘T-Minus’ process. We will review the details of this upon receipt during the SACR20 period.

**4.2. Stage 2 Phase 1 Opening – 20 May 2018**

Stage 2 Phase 1 Opening was achieved on time. There are some snagging issues to resolve for both BT and NR, and these are expected to be completed within their current work plans.

**4.3. Stage 2 Phase 2 Opening – start date to be confirmed by CRL**

The project teams understand that they should be planning to start services by the end of February 2019, and are currently seeking to understand the detail of the key impediments to that objective.

**Rolling Stock**

CRL and RfL have prioritised Stage 3 over Stage 2 Phase 2, and to support that BT and RfL have signed a Deed of Amendment that confirms BT’s programme will reflect that priority. [REDACTED]

The current schedule shows formal ETCS testing at Heathrow being carried out in August 2018. This will demonstrate to all parties that the train borne (supplied by BT) and trackside (supplied by Alstom) equipment are fully integrated and a reliable service can be operated. There is a degree of optimism, as functional testing between the two suppliers in the Alstom laboratory has been carried out. All planned tests were completed, one of which failed. The CRL project team is content that there is a good basis for achieving compatibility between the BT and Alstom systems.

There has been delay to the current programme. Type testing of software on the train was scheduled for 23 June 2018, and is now forecast for 10 July 2018. The key milestone ‘Approval to Operate ETCS for Driver Training’ has been held at 12 October 2018. This implies that



schedule contingency has been eroded. BT's programme states that approval from the ORR for passenger service will be achieved by 19 November 2018.

The C345 RLU's will need to be replaced by C345 FLU's at some point. If this is done prior to Stage 2 Phase 2, some benefits of operational experience can be realised, and risks reduced.

### Operations

[REDACTED]

### Regulatory Approvals

There are three key approvals for Stage 2 Phase 2. They will be issued by the ORR and are:

- APIS GSM-R data to NR (achieved in period 1);
- APIS ETCS trackside to be issued to NR;
- APIS ETCS on-board to be issued to BT.

APIS ETCS trackside is scheduled to be submitted in early June, and is considered to be low risk. The APIS ETCS on-board schedule is linked to the development of the signalling programme, and so must be considered as 'amber'.

### 4.4. Stage 3 Opening – 9 December 2018

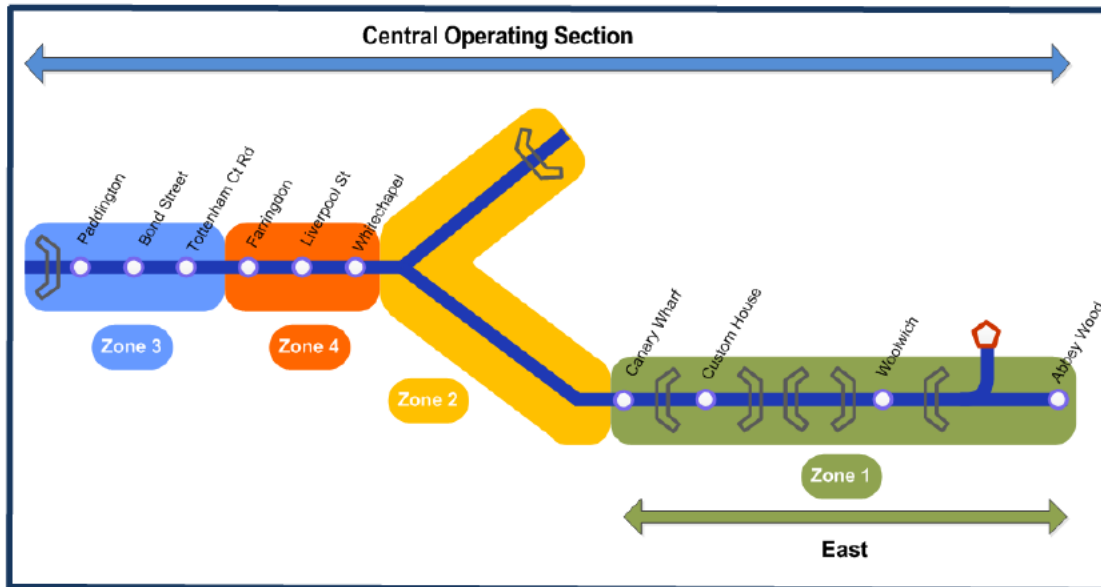


Figure 4 - 2 ~ Testing & Commissioning Zones



#### 4.4.1. Dynamic Testing in Zones 1 & 2 (continuing from 26 February 2018)

Dynamic testing in Zones 1 & 2 started on 26 February 2018 and has continued into the current SACR period, carefully segregated from ongoing installation completion and energisation readiness activities in Zones 3 & 4. Dynamic testing will be effectively confined to Zones 1 & 2 until the planned start of dynamic testing in All Zones, on 11 June 2018.

The daily day/night alternating pattern for construction and dynamic testing was replaced by “blockade working”, implemented on 25 April 2018. Blockade working comprises a repeating 2 week working cycle to operate up to Trial Running, split between 11 day construction “blockades” and 3 day dynamic testing “windows”. This approach provides opportunities to realise the significant efficiencies necessary to deliver MOHS and has flexibility for the balance between construction and dynamic testing to be adjusted to suit actual progress.

The creation of discrete dynamic testing “windows” provides for better planning and delivery of dynamic testing, in longer and dedicated time periods. However, despite these potential advantages, dynamic testing continues to make slow progress, largely limited by software functionality. CRL has recently proposed to delay the current start of Trial Running and to extend blockade working until September, principally to allow the full scope of dynamic testing to be completed, including any software modifications and re-testing. The additional time will also allow for completion of outstanding infrastructure, Phase 3 integration testing with Station Systems and delivery of assurance. Further detail is awaited.

On completion of Dynamic Test Window No. 2 on 13 May 2018 only 36 tests out of a grand total of 509 tests had been completed, 14 of which do not requiring re-testing. It is therefore vital that there is an immediate improvement in order to complete the full testing scope. Insufficient improvement leading to tests not being carried out might delay Stage 3 Opening. However, an “opening” of some description is still possible without all the tests having been completed, albeit with operational restrictions in place.

#### 4.4.2. Zones 3 & 4 Infrastructure Delivery

Zones 3 & 4 installation has continued in the current SACR period and blockade working was implemented on 25 April 2018, as described in Section 4.4.1 above. As with dynamic testing, construction in “blockades” has allowed for improved planning of installation works in longer and dedicated time periods. While the long-term performance benefits have yet to emerge some improvements are evident, and early successes include the completion of all Central Section OCS installation and assurance documentation (including IRNs) on 14 May 2018. Other delivery workstreams critical to Zones 3 & 4 energisation, such as Permanent Earthed Section (PES) installation by NR at PML and WBP have kept largely to an extremely tight schedule. See Section 4.4.3 below.

Non traction energisation critical works have also proceeded without significant impact upon MOHS. The prioritisation by █████ of █████ cable installation has led to the completion of the Crossrail Data Network (CDN) on 7 May 2018, allowing all network switches to become “visible” from the RCC. █████ completed the delivery of line-wide SCADA on the MOHS date of 30 May 2018.

The energisation progress has been further disrupted by the need to replace defective Voltage Transformers at Stations, Shafts and Portals sites. The overall schedule effect of this disruption has yet to be confirmed, but good availability of replacement units is expected to reduce impact to a minimum. The most significant downstream impact is likely to be upon the completion of permanent ventilation system Phase 3 testing, currently scheduled for September 2018.

#### 4.4.3. OLE Energisation in Zones 3 & 4 (scheduled start 21 May 2018)

First energisation of Zones 3 & 4 from PML ATFS was achieved on 22 May 2018, as the precursor to a sequence of OLE section proving and short-circuit testing. Thereafter, the Central Section is planned to be energised from Kensal Green BSP, for further short-circuit testing, prior to planned dynamic testing across all Zones from 11 June 2018. At that point, PML ATFS will be switched off-line for planned modification to its final designed state, as a feeder to both Crossrail and the NR GEML.

There are schedule risks inherent in this tightly-scheduled sequence of energisation activities, each of which requires support approval of LU and NR, and there is a possibility that the start of dynamic testing will be delayed. However, LONOs and RAB(C) safety approvals are already in place and there is also some confidence that some schedule mitigation can be achieved, based upon how CRL recovered from a range of minor delays during the Zones 1 & 2 energisation sequence.

#### 4.4.4. Dynamic Testing in Zones 1, 2, 3 & 4 (scheduled start 11 June 2018)

Dynamic testing in Zones 1, 2, 3 & 4 remains on target to start on 11 June 2018. Multiple train dynamic testing is not permitted, because evidence associated with train braking has not yet been produced by BT for incorporation into the relevant dynamic testing safety case. RAB(C) approval is not now anticipated until early July 2018. However, the number of tests able to be carried out on the Central Section is rapidly growing as software with increasing functionality emerges from BT testing at Melton Test Track.

Concerns remain with [REDACTED] installation of [REDACTED] signalling cables which is behind schedule, and while CRL is investigating recovery measures there remains a risk that dynamic testing with signalling in Zones 3 & 4 will be delayed; non-signalling related testing is still possible.

Completion works also remain outstanding at the NR GE and GWML interfaces, and signalling transition testing completion is now targeting August 2018 (for the GE) and September 2018 (for the GW). Commissioning of the GW interface facilitates the movement of trains between OOC Depot and the Central Section, and is a fundamental Trial Operations and Stage 3 Opening prerequisite, but the dates selected by CRL clash with booked NR work. DfT is assisting in resolving this conflict.

Ultimately success remains dependent upon good progress being made with the integration of [REDACTED] systems, and upon close support from various off-site testing resources. Testing in the Central Section is being complemented by off-site testing at BT's facilities at Derby, and at Melton Test Track, with satisfactory initial integration testing at Derby allowing software to be released to Melton.

Further integration support is provided through the use of the two Crossrail Integration Facilities (CIFs) located at Westferry Circus and at the Siemens offices in Chippenham. CRL committed in April 2018 to relocate the Westferry Circus CIF to Chippenham, to allow the two facilities to be operated in close proximity to one another. This will introduce significant efficiencies, simplifying in practice the process of comparing test results between what will remain independent facilities, and through the better use of scarce testing resources.

Notwithstanding the various improvement initiatives and learning of lessons from the dynamic testing windows implemented so far, there is significant pressure on the achievement of Trial Running scheduled for 5 August 2018. Four dynamic testing windows remain beyond 11 June 2018 and CRL is already preparing proposals for further testing opportunity at the expense of Trial Running and Trial Operations; as noted in Section 4.1.1.

#### 4.4.5. Infrastructure Completion for Trial Running (scheduled start 5 August 2018)

Beyond the infrastructure necessary for energisation and dynamic testing there remains a significant installation workload which CRL already recognises will not be completed in time for Trial Running. CRL has recently advised that Trial Running will be delayed; see Section 4.1.1.

The workstreams which will extend beyond the current start date (and possibly into Trial Operations) are as follows:

- [REDACTED] non-dynamic testing critical works (e.g. walkways, lighting, LV cabling);
- [REDACTED] removal of temporary works (e.g. lighting, fire main, radio);
- [REDACTED] permanent ventilation system completion and testing;
- [REDACTED] completion of testing;
- [REDACTED] completion of integration testing with Rail Systems;
- [REDACTED] completion of integration testing with Stations.

Of these, the completion of the [REDACTED] permanent ventilation system remains the most significant and difficult challenge to resolve. The current forecast completion date for Phase 3 testing has moved out to 28 September 2018, driven by delays at [REDACTED] and this is beyond the scheduled deadline of 9 September 2018 for start of Trial Operations. Investigations are taking place into the feasibility and acceptability of completing all necessary testing which will allow Trial Operations to start, but with reduced or no ventilation functionality at [REDACTED]. Ventilation system completion is strictly not required ahead of the start of Trial Running and it is possible for final testing to take place towards the end of Trial Operations.

[REDACTED] software development is now under better Siemens management control, and is seen as less of a risk than in previous periods. While the software delivery schedule is not fully aligned with MOHS, Trial Running is fully supported. Intermediate software drops synchronised with localised Phase 3 testing site requirements continue, allowing late-running Stations completion workstreams to continue without further delay.

Concerns remain with the readiness of some Stations, Shafts and Portal sites to start Phase 3 testing, and their ability to complete a substantial integration testing workload using the [REDACTED] data management infrastructure, in time for Trial Running. The [REDACTED] data network is in place and interim software drops are being phased to support actual site progress.

Sufficient time must be allowed to complete certification and prepare assurance documentation for satisfying RfL and LU (as future IMs) ahead of formal handover. Progress in these areas has previously proved difficult to achieve, not just because of the volume of work involved, but because of the limited resource availability.

Examination of past performance and of the work scope to be completed confirms that pressure is growing on the start dates for Trial Running and Trial Operations which is likely to be irresistible. CRL must intensify its efforts to agree with the IMs how the time remaining up to Stage 3 Opening is best used to the benefit of all parties.

#### 4.4.6. ONW

NR completed its ONW in respect of Stage 2 Phase 1 on time to support the CRL 20 May 2018 opening date. NR also completed, in respect of Stage 3, its Key Date 33 Energisation from COS to Kensal Green on 23 May 2018.

The principal strategic NR ONW targets for the next six months post SACR19 include:

**General**

- The transition of NR ONW to come under the NR P2R (Paddington to Reading) management operations from September 2018;

**Stage 3**

- Key Output 2 Abbey Wood to Central core; Stratford to Central core at PML; Old Oak Common to Westbourne Park, 30 June 2018;

**Stage 4**

- Key Date 22, 31 August 2018, Route clearance and all other infrastructure to support CRL Stage 4;

**Stage 5**

- West Enhanced Stations contract awards (Southall, Hayes, West Drayton, Acton Main Line, Ealing Broadway, West Ealing) June/July 2018;
- The Ilford & Romford Enhanced Stations GRIP5 detail design is due to be complete and GRIP6 Tender returns for August 2018. The corresponding GRIP6 Contract award is due October 2018.

**4.4.7. Rolling Stock**

**Rolling Stock**

There are three key areas that Rolling Stock will need to address to ensure it is ready to support passenger services. They are:

- Development of TCMS 7.2<sup>2</sup> software. The programme that prioritises CBTC over ETCS, formally agreed between BT and RfL in Period 1 2018/19, has slipped by circa 1 to 2 weeks. The slippage increases the risk of delay to the authorisation of CBTC for Trial Running, scheduled for 26 June 2018. Whether this is material will be dependent upon the progress of the C620 contract.
- Non-signalling technical issues. An example of this is the need by BT to provide the Guaranteed Emergency Brake Rate (GEBR) to Siemens, so it can complete its signalling design. BT has had [REDACTED], and the GEBR is important as it needs to be accommodated by Siemens to allow multiple unit operations. The issue is scheduled to be resolved by 14 June 2018, but the delay is likely to have caused problems for Siemens.
- Size of fleet for Trial Running. 22 trains are required to operate the full service of 24 TPH, potentially from mid-August. We consider this to be a challenging task, as each train will need to undergo fault free running and acceptance tests. There is also a need for trains as spares and possibly training. This will increase the total to at least 24. CRL will need to consider scheduling the tests that use the most trains at the end of the Trial Running period, when they are more likely to be available. This increases the pressure upon the scheduled Trial Running date of 5 August 2018.

**Depot**

Section B2 of OOC was BIU on 23 May 2018, and Section C for BIU is forecast for 11 June 2018. RfL is likely to require Section C by mid-July 2018, so at the moment the risk to capacity is manageable.

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<sup>2</sup> There are three variants of TCMS v7. TCMS v7.1 is for test purposes only, used to inform the development of later versions. TCMS v7.2 will be used for Stage 3 passenger services, and TCMS v7.3 will be used for Stage 2-2 services.

Both Sections B and C will not be signalled until 23 August 2018. Route setting agents will need to be deployed until that point, and MTR-C, RfL and BT are engaged with devising operating procedures that minimise risks to safety and performance. This is essential, as the depot will be carrying out Stage 2 services and Trail Running activities during this period. The recent success in signalling Section A has given greater confidence that the signalling software technical issues can be appropriately managed.

#### **4.4.8. Assurance**

Final Design Overview (FDO) closeout continues to frustrate CRL. FDO closure enables CRL to issue the FDO certificates that provide integrated design assurance to the Infrastructure Managers (LUL/RfL). It also initiates the Interim Acceptance process that leads up to final asset handovers to the LUL/RfL. A number of FDO certificates have now been signed off; but the closure of the remaining “red” actions and outstanding comments/omissions from the FDO reviews is taking longer than anticipated. Continued delays to the closure of FDO issues and the subsequent late issue of CRL/IM agreed FDO certification means that conclusion of CRL’s FDO process, previously planned for completion by Christmas 2017, will now extend beyond May 2018.

Ricardo Rail (RR), CRL’s NoBo/AsBo, continues to draw CRL’s attention to issues that have yet to be fully addressed by CRL, if a fully supportive Technical File and Safety Assessment Report is to be submitted to the ORR by the targeted submission date of 17 September 2018.

The NoBo now has an overview of the remaining evidence (documentary evidence, Interim Safety Verification evidence, Testing & Commissioning, etc.) required to support submission and is developing a programme with CRL that identifies the work to completion. RR acknowledges that evidence information will be released after 17 September 2018. While there is an agreement in principle with the ORR, it is understood that CRL will provide greater clarity on the progressive release of information at the next planned ORR Executive meeting. The NoBo remains concerned at being able to provide a fully supportive Technical File; but with the current focus on programming and defining the missing evidence, building a supportive Technical File submission is being de-risked progressively around known deliverables.

The Interim Safety Verification for Abbey Wood station cannot be concluded until NR supplies the remaining PRM TSI evidence. In a recent DfT/ORR liaison meeting, NR stated that evidence would be provided before Easter, but nothing has been delivered yet.

The AsBo and CRL have developed dates for the release of the remaining supportive evidence. A commitment was made by CRL to close the open Assessment Records by the end of May 2018. The AsBo remains concerned that the assurance submission schedule, is not being realised, in a timescale that will support CRL’s programme milestone for the submission of the Safety Assessment Report (SAR). This may prevent the AsBo from supporting CRL’s SAR submission to the ORR, in early June 2018, as planned. This would delay the operation and bringing into use of the new railway.

The AsBo has completed its assessment of CRL’s Engineering Safety Manual. There remain outstanding concerns that are pertinent to future activities, including finalisation of the CRL justification of safety and compliance.

#### **4.4.9. Tunnels and Stations**

The SACR19 period saw increasing schedule pressure and lower than planned levels of progress at the stations. Most of the stations failed to achieve the milestones planned for Period 1 2018/19 and a number still forecast that further milestones will be missed in the next



few periods. It is important that CRL improves its performance in achieving milestones for the delivery of both the physical works and the required documentation.

The cumulative plan and actual percentage completions, reported for stations, show further signs of delay, post SACR19. What were minor differences between the planned and actual percentage completions, reported in Period 13, started to become widening variances in Period 1. CRL must maintain its efforts to halt the recent deterioration and increase the level of productivity on all of its sites, if station opening is to be successfully achieved by 9 December 2018.

The gradients of the forecast and baseline performance curves imply that challenging levels of production will have to be achieved and sustained over the coming months, if CRL is to hit the MOHS 2018 target dates. We remain concerned that such levels of production have not been achieved, let alone sustained, to date. We anticipate that works will continue, at a number of locations, beyond the planned opening date. These works, in conjunction with any ongoing snagging works, will then have to be completed within constraints imposed by the IMs on what will have become operational stations. This will add further delay and cost.

Any further programme changes, delay, scope change or addition or unforeseen issues have the potential to directly impact CRL's ability to deliver the stations in time for the planned opening date for the new railway.

CRL will find it difficult to re-sequence the remaining activities, due to the ever reducing timescale imposed by the targeted December 2018 opening date. There is next to no float in the programme, and any further delays in the remaining months up to opening will directly impact on the schedule and potentially threaten the targeted opening date.

The evolution of Handover Execution Plans (HEPs), including arrangements for Staged Completion must be agreed with the IMs. The HEPs, together with the FDO certification, will confirm the programme for handing the assets over and reduce the risk of the IMs introducing additional scope. Comments are now being fed back from the IMs and amended HEP submissions, addressing the comments, are being re-submitted for IM approval.

Commercial close out plans are being prepared for each station. Those already approved each note that a number of third party issues still need to be resolved by the relevant PM. They also noted that substantial quantities of documentation, including "As-Built" drawings, need to be completed on all CRL projects. This will need a considerable number of man hours input from Tier 1 contractors over the next few months, and corresponding CRL/consultant resources to review and accept the documents.

#### **4.4.10. Handover and Operations**

In our last SACR report, we described how the key consideration for Operations is the readiness of RfL-I staff to take over the maintenance and operation of the railway's assets from the scheduled Handover date of 5 August 2018. It would then need to demonstrate that it is competent to operate the railway. This continues to be hampered by the delay in receiving training, O&M manuals and asset data. These areas are deemed 'red' by the Elizabeth Line Readiness Steering Group and are discussed below.

- **Training Courses**

The training schedule with regard to the C600 series of contracts remains problematic. The roll out of courses to RfL by the Contractor suffers from trainers not being available, or course material being inadequate. This has resulted in the MOHS training milestones forecasts all slipping from the MOHS 2018 schedule to 30 June 2018. There is a

significant risk that staff will not have received training in key areas before Trial Running starts.

• **O&M Manuals**

There are approximately 750 O&M manuals, of which half are critical to the IMs. As of 8 May 2018, 4 manuals have been accepted by the IMs. In response to the blockage, both LU and RfL have produced criticality lists, and CRL point to growing expertise amongst O&M authors and an increase in RfL resource as reasons for optimism.

[Redacted]

• **Asset Information**

CRL has advanced in providing the number of assets (asset information drop 1). There has been slow progress in developing the location of assets (asset drop 2). The other drops are equipment type (drop 3) and attributes (drop 4). As at 8 May 2018 RfL-I's position is:

Drop	Content	% accepted
1	Number of assets	87
2	Equipment	31
3	Location	6
4	Attributes	38

Figure 4 - 3 ~ RfL-1 Position

The lack of information, particularly concerning drop 2, could make it difficult for RfL to demonstrate that it has robust plans for maintaining the railway at the start of Trial Running.

The rate of progression of the key Handover tasks does not align with IM readiness for Trial Running, with subsequent impact upon Trial Operations. This has been highlighted again during the recently completed Completion Readiness Assessment Framework (CRAF) workshops between CRL and its contractors. The executives of the Tier 1 contractors have agreed to accelerate production<sup>3</sup>, but this will be a difficult task. There is a danger that the large mass of data concerning Handover material could act as an impediment to seeking solutions to the situation.

**4.4.11. Trial Running, Trial Operations and Service**

There are three areas that we highlight.

[Redacted]

The Trial Operations plan that details the exercises has been completed, and its successful delivery is heavily dependent upon CRL inputs. [Redacted]

[Redacted]

[Redacted] The key issue here is that assets need to be provided in sufficient time for operations and maintenance staff to become familiar, otherwise

<sup>3</sup> Crossrail Industry Group – 11 May 2018.



there is a significant risk to placing into service, or of poor performance during the initial months of passenger service.

The yellow plant schedule has slipped and the vehicles will now be commissioned during Trial Running and Trial Operations. Not having the vehicles ready for maintenance in this period means maintenance will be manual, which is slower and could reduce access for CRL should, as it seems likely, it needs to complete any works in these periods.

**4.5. Stages 4 & 5 (19 May 2019 and 8 December 2019)**

The experiences of Stage 1 and Stage 2 have shown that bringing trains and services into operation is difficult and intensive. Therefore CRL and RfL must ensure that Stages 4 and 5 are adequately resourced and managed. There is also an additional level of complexity for Stage 4 than originally planned. It is now planned to put Stage 2 Phase 2 into service during the six month gap between Stage 3 and 4.

**Ilford Depot:**

Crossrail works at Ilford Depot are now complete. The London end exit speeds issue has been resolved. The scope of work for Ilford Depot wire heights is reducing, although arrangements need to be agreed with AGA.

**Plumstead Depot:**

CRL is on target to hand over the [REDACTED] Plumstead Maintenance Facility to RfL on 2 August 2018 with full contract completion by November 2018 ready for Stage 3 Opening. Delays to Central Section completion have required [REDACTED] to operate Plumstead Railhead longer than anticipated, delaying the progressive transfer of land for Depot construction. Plumstead Old Coal Yard is being modified to provide alternative construction support facilities, to allow the Depot delivery programme to be maintained.

The Supplemental Agreement for delivery of the Stabling Sidings (under [REDACTED] has been signed-off by [REDACTED] allowing [REDACTED] to formally act as contractor for the works. The Sidings are due to be completed in March 2019, to be available to support Stage 4 Opening in May 2019.

**Power Upgrades on GE:**

During the SACR19 period, the NR GEFF project has rerun the ELSSA traction power studies and OSLO modelling to validate power capacity requirements and concluded that the full Auto Transformer (AT) is not required until May 2019. NR is presently forecasting a current estimated date for AT mode of March 2019.

**NR works:**

Productivity for the progress of the Anglia stations has been behind plan in the SACR19 period [REDACTED]. NR is implementing a revised plan to drive the works to a completion by August 2018. Naturally, there is a significant risk of stakeholder concern and reputational damage and local briefings are in hand.

NR has awarded the GRIP 5 detailed design contract for Ilford & Romford station to Atkins. An early contractor involvement contract was awarded in May 2018 using NR framework suppliers.

NR has divided the six West stations enhanced stations into two procurement packages. Tenders for both packages have been received by NR and tender assessment is progressing. NR had previously scheduled contract award in June and July 2018, but we are aware these dates are at risk. CRL and Sponsors are in discussion with NR to mitigate these risks.

CRL and NR are establishing two new Key Output dates, KO6A and B, to cover the residual works required for Stages 4 and 5 respectively.

**GWML Signalling Migration:**

NR is obliged to migrate from TPWS to ERTMS on the GWML before the expiry of an ORR derogation at the end of 2019. CRL will be affected, because a new signalling transition will be required at Westbourne Park between CBTC and ERTMS (instead of between CBTC and TPWS). Uncertainty remains with the nature and timing of NR's works, implementation of which will need to be supported by RfL.

**Rolling Stock:**

There are two elements that affect Rolling Stock in Stage 4.

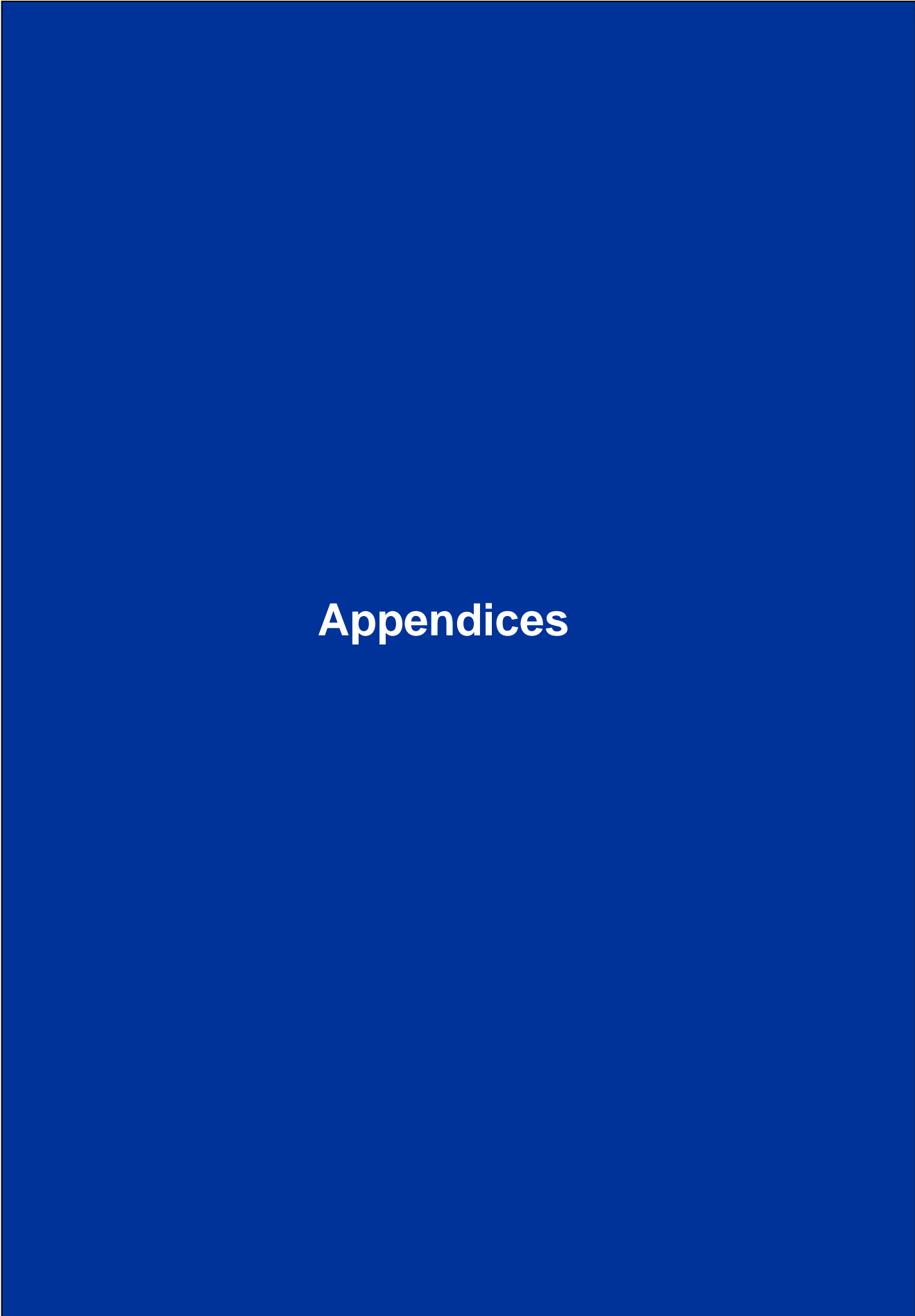
There is a neutral (non-energised) section of the railway between the COS and the GEML. If the train is held at the last signal before leaving the COS, it will straddle the section and lose power completely. There are operating procedures that mitigate that disruption for infrequent use (e.g. ECS during Stage 3) but these are not adequate for the Stage 4 timetable. The solution is a software change by BT, known as 'Packet 44', allied with trackside balizes. The work is understood, but there are a number of logistical technical issues to address. Packet 44 will need to be implemented by early April 2019 for driver training purposes.

[REDACTED]

At this point in time there are no particularly significant concerns facing Rolling Stock for Stage 5.

**Operations:**

In our last report, we said that the key factor that could affect performance is the management of the train service across the operating interfaces: for Stage 4 between the COS and the GE; and for Stage 5 between the COS and the GW. We believe the key issue will be the interface with the GW, as it is a significantly lower performing railway when compared to the GE, and the forecast performance of the COS.



**Appendices**

## Appendix A CIM

### A.1 Crossrail Investment Model

A full review of the Crossrail Investment Model (CIM) has been undertaken by the Joint Sponsor Team (JST). In support of JST in the review of the SACR19 CIM, we have carried out the following activities:

- a. Validated the input data that has been extracted from CRL's cost management system (PRISM);
- b. Provided a view on any assumptions that have been applied to the model, including use of contingency, forecast cost and pain/gain share application;
- c. Identified any issues and risks that are noteworthy for Sponsors;
- d. Verified that risk allowances align with the SACR Quantitative Risk Assessment (QRA);
- e. Identified any unusual distribution of costs;
- f. Identified any major changes from the previous SACR and check on a sample basis that changes can be traced back through the PRISM system;
- g. Verified the assessment of the pain/gain share included within the CIM.

#### **(a) Validation of Input Data from PRISM:**

CRL provided us with a spreadsheet containing data from PRISM (as at Period 13 FY2017/18) used as the source data for the CIM. We have used these tables to cross-check against the input data in the CIM. The majority of the values on the source data sheet correspond with the nominal values used in the CIM input for the Central Section. Acceptable explanations for the differences have been provided by CRL.

The CIM includes the value of £2,376m (SACR18 £2,450m) for the ONW AFC. £2,376m is in fact the Final Forecast Outturn Cost (FFOC) and is consistent with the Period 13 Board Report, as the reported cost to CRL. The reduction of £74m is due to the DfT/NR/CRL joint agreement for £154m separate funding of additional variation notices, partly offset by an £80m increase in the forecast. We also note that a new account NRAB has been created and £22m transferred from account NRAA. This reflects the termination of the remaining NR incentives and the implementation of the revised ONW funding agreement.

#### **(b) Assumptions including Contingency, Forecast Cost and Pain/Gain Share:**

We conclude from our investigations described elsewhere in this report, that assumptions that have been applied to the model, including use of contingency, forecast cost and pain/gain share application, are appropriate.

#### **(c) Noteworthy Issues and Risks:**

Noteworthy issues and risks are highlighted in the various sections of this report and, in particular, in Sections 1 and 4.

#### **(d) SACR19 QCRA:**

The CRL risk management team co-operated fully in providing information to enable us to check that the Q4/Period 13 QCRA processes are appropriate and in accordance with their procedures. We conclude from our investigations that the outputs from the Central Section QCRA models are representative of the programme, have been produced in a manner consistent with previous QCRAs and, therefore, they are directly comparable. The CRL Risk Manager has advised that a comprehensive detailed contract review has been carried out. We believe that the Sponsors can be confident that the CRL QCRA is robust and within the bounds of accuracy normally associated with this type of forecast. We can verify that risk allowances

within the CIM align with the CRL SACR19 report, and with the values in the Period 13 Board Report.

**(e) Distribution of Costs:**

We have completed a detailed check of the total forecasts and historic actual costs included in the CIM input worksheet, and compared them to the values given in the CRL Period 13 Board Report. The total for Delivery is the same but there are minor differences in the totals and Cost of Work Done (COWD) for Indirects and L&P Capex. CRL has advised that this is due to the allocation of risk and an adjustment of £1.1m identified as an end of year adjustment.

Total Indirect Costs forecast in the CIM is £1,867m, as forecast at Period 13, an increase of £30m from £1,837m at SACR18. The main reason for the increase is the increased costs following approval of the 2018/19 Business Plan and subsequent prolongation of roles due to the delays experienced across the Programme.

The total forecast cost for CH&CEO has reduced from £75m to £69m. The forecast for the CH&CEO category beyond March 2018 (CIM Periods 144 to 183) has increased from £20m in SACR18 to £22m due to re-phasing of underspends. This reserve is for Indirect Provision calculated as part of the annual budgeting process. It is for roles not foreseen in the Business Plan, redundancy costs, potential prolongation of roles and other costs that will probably be incurred, although the precise dates are uncertain. This is regularly reviewed as part of the business planning process.

The SACR19 forecast for Land & Property features a large negative spike of £98m in CIM Period 156 March 2019 (previous £106m in CIM Period 143 March 2018). This accounts for the TfL OSD rebate. The revised value is due to TfL now incurring some forecast costs since the transfer of the L&P function in March 2018. The reimbursement has been pushed back due to delays in the completion of development agreements.

We are content with CRL's explanations regarding Indirect Costs forecast.

**(f) Major Changes from SACR18:**

We have carried out a detailed comparison of the CIM inputs for SACR18 (CIM Period 136) and SACR19 (CIM Period 143). We have isolated a list of the major changes and traced these through CRL's PRISM system with the CRL Cost System Specialist. All items sampled showed alignment between the changes shown across the two Models and the details of the changes as recorded in the PRISM system. These changes are for a variety of reasons, such as new or updated Trends, Implemented Compensation Events, scope transfers, approved Change Papers, implementation of the Supplementary Agreements, and adjustments to risk allowances following the quarterly QCRA. We are content these changes reflect the correct status.

**(g) Assessment of Pain/Gain Share:**

The estimate of CRL's net commercial exposure arising from the Tier 1 contracts (including pain/gain share) has been re-assessed, with the result that an adjustment of £64m has been included in the SACR19 QCRA, a £22m reduction from the £86m opportunity in SACR18. We have reviewed these allowances with the CRL Commercial Director and we are content with the assessments.

**Appendix B Commentary on CRL’s SACR19 Report**

Appendix B contains comments on CRL’s SACR19 report where we feel they are necessary, but this should not be regarded as a detailed critique.

**CRL Section 2: Chairman and Chief Executive’s Overview:**

CRL indicate that ‘good physical progress has been made across the programme during this SACR period’. We agree that physical progress has been made but disagree that it has been good. Substantial delays have occurred during the last SACR period (e.g. DT in Zones 1 & 2 being 4 months later than planned) which have resulted in a very compressed programme, increased costs, and a reduced period for Trial Operations.

CRL state that ‘MOHS18 demonstrates the sequence of activity that will deliver the Elizabeth line on time.’ As noted elsewhere in our report, there are significant risks that may result in Stage 3 Opening or some stations not being opened on time. CRL cannot offer any guarantee that the Elizabeth line will be opened on time.

**CRL Section 2.1: Executive Summary, Sponsor Support:**

We summarise the position concerning requests for Sponsor Support in Figure B - 1. We understand CRL has been in discussions with members of JST regarding these issues.

Ref*	Possible Areas of Support	PRep Commentary
a	Provision of funding above IP2 for completion of the Crossrail works	Sponsors are sighted on the situation, and PRep is supporting Sponsors by providing additional support through its ‘Independent Crossrail Cost Review’.
b	Provision of further funding for Network Rail Crossrail works if additional cost pressures materialise in order for works to be completed	Sponsors are aware of the discussions between DfT, NR and CRL on this issue. Section 2.4 of our report describes the current status.
c	Supporting discussions with Network Rail particularly in relation to expediting Crossrail activity, power upgrades on east and west routes, at the NR transitions as well as land & property discussions	Sponsors are aware of the discussions between DfT, NR and CRL on this issue. Section 3 and 4 of our report describes the current status.
d	Ensuring timely delivery of the required deliverables from the TfL rolling stock and depot contract particularly in relation to software availability	Sponsors have visibility of the issues through the reporting of PRep, and TfL is also informed of progress through its RfL subsidiary. Senior level meetings are held between BT and TfL. CRL should describe what additional type of support it envisages Sponsors providing.
e	Confirmation of schedules and implementation plans for the public cellular networks, WiFi, Emergency Services Network, retail and advertising in the Crossrail central section	CRL states in SACR19 that TfL Tech and Data have been appointed to procure a Mobile Network Operator for On train services by end of May 2018. The IM Strategy Board is overseeing WiFi provision for Elizabeth line.  There is no further reference to Emergency Services, WiFi in stations and advertising. Retail is referred to in the context of OSD. CRL should clarify what form of support it is seeking.



f	Continuing to jointly lead and support the transition and integration of CRL into TfL	This is being managed by the Crossrail Integration Board, chaired by CRL Operations Director. We are not aware of any additional action required from Sponsors apart from the ongoing work between CRL and TfL.
g	Supporting coordinated communications in relation to the status of funding and timing of the project	This is an area for Sponsor support. We understand that the Sponsors and CRL are engaged on the matter.
h	Continue to work with CRL on refining the reporting provided to Sponsors	Members of JST meet with CRL regularly to review reporting requirements. We expect this will continue.
i	Not imposing unfunded changes or additional scope	See our note below regarding CRL's Section 3.4.

Figure B - 1 ~ Areas of Sponsor Support

**CRL Section 3.3: Quality:**

Crossrail has achieved its QPI target of 2.00 with a score of 2.10. This is good, however there are a number of contracts which are consistently within the bottom performers. These are, in descending order; [REDACTED]

With the exception of [REDACTED], which is complete, we would urge CRL to improve the performance of the contracts described above. We appreciate that this is an additional challenge at this stage of the programme, when schedule pressures can override quality processes. Nevertheless, the Works being delivered by these contracts play a key role in the performance of the railway.

**CRL Section 3.4: Cost Status, Sponsor Funding**

CRL has described unfunded scope, here and elsewhere in its report, as a contributor to the causes of change and increased costs. This item was also described in its SACR15, 16, 17 and 18 reports. We reviewed these items of scope as part of our review of SACR15, and provided a briefing note to Sponsor Board<sup>4</sup>.

**CRL Section 4: Plans for the Next Six Months:**

CRL gives an overview of its plans for the next six months including critical path analysis. Sponsors should note that CRL lists 9 key challenges<sup>5</sup>, 10 strategic schedule risks<sup>6</sup>, and 16 Stage 3 assumptions<sup>7</sup>. These describe the significant issues CRL need to resolve to achieve Stage 3 Opening on 9 December 2018.

<sup>4</sup> Unfunded Change Briefing note: Factors influencing Crossrail AFDCD, 9 March 2016.

<sup>5</sup> CRL SACR19 report page 55.

<sup>6</sup> CRL SACR19 report page 63.

<sup>7</sup> CRL SACR19 report page 64.



**Information regarding Affirmations not included within CRL SACR19 report**

There are a number of outstanding actions from previous affirmations. These are:

Description	Position
Affirmation 0020 Crossrail Resilience	The resilience plan can be proved at the conclusion of the FDO process. The evidence will be provided to Sponsors.
Staff Accommodation (SR 3.1.1.7)	<p>'Facilities are provided in the Surface Sections for training facilities, train crew, cleaning and maintenance staff to support 30 TPH utilising 240m trains in the Central Section.'</p> <p>CRL states it cannot confirm that it has met the requirement until the FDO process has been completed. If it is found that the requirement has not been met in full then CRL must Affirm what it has provided.</p>
Affirmation 026 Supporting Communication Distribution	CRL must demonstrate that it has complied with the requirements described in the Sponsors review of its affirmation.

**Figure B - 2 ~ Affirmation Status**

## Appendix C Undertakings and Assurances (U&As)

### C.1 Undertakings & Assurances – Central Section

The live contracts for the Central Section continued to upload compliance evidence into Commitments Delivery Tracker (CDT), during the SACR19 period, in accordance with their Commitments Compliance Plans (CCP).

Contracts [REDACTED] have now caught up on pending evidence, reported in Periods 11 and 12. [REDACTED] has an outstanding piece of evidence from Period 13 to upload in CDT in Period 1 (2018/2019).

We understand that BT has submitted its Undertakings Compliance Plan to RfL for approval; but it is not clear whether CRL will include BT's U&A updates in its reporting.

One PIR has been raised since the close of Period 13, relating to [REDACTED] D25 Assurances. Refer to our previous reports for further detail in respect of the Potential Incident Reports (PIRs) noted below. Details and the status of the PIRs, raised during the period, are summarised below.

#### C.1.1 [REDACTED] PAVA (D25) Assurance 465

Assurance 465 is drawn from Information Paper D25. It requires CRL to agree criteria for the performance of the public address (PA) system with a local authority prior to specifying and carrying out the detailed design of that system. The [REDACTED] PA design at [REDACTED] station is essentially complete ([REDACTED] station FDO was held in May 2017) but subsequently, following an email communication from the local authority, the London Borough of Newham, on 21 June 2016, agreement on appropriate criteria had not been reached.

The report of the noise survey, carried out in December 2017, was issued to CRL on 30 January 2018 for review. Comments have been returned and a final revised report was received in February 2018. The meeting with LB Newham took place on 20 February 2018, where the findings of the noise survey were presented and criteria discussed. The draft criteria, which were sent by CRL to LB Newham, were agreed on 8 March 2018. The process for closing this PIR has begun.

#### C.1.2 [REDACTED] D25 Assurances

Modelling and subsequent mitigation predicted that -2dB would be achieved at the east ticket hall (ETH) of [REDACTED] station. A further line of mitigation, involving operational constraints (the reduced operation of the fans, during a key hour of the morning when background noise levels are low), was being sought from RfL. RfL subsequently agreed to the operational constraints. Under this control scenario, the modelling predicted that -4dB would be achieved at the ETH and that this would represent the exercise of reasonable endeavours. This would require that a report, setting out that case, would need to be submitted to the local authority (City of London).

However, in the event that noise levels associated with tunnel ventilation, draught relief and operation of plant and equipment at a particular location are expected to be above the -5 dB

level, IP D25 requires that CRL will, prior to commencement of procurement of equipment, provide the local planning authority with additional information:

RfL accepted the operational constraint toward the end of October 2017. The fans responsible for the -4dB rating prediction were, however, procured two years ago and were installed in February this year (2018). The requisite report had not been issued to the City and a level 1 PIR was raised accordingly, by CRL.

Further work has since confirmed there was a large amount of uncertainty built into the noise modelling and, given the result was within 0.03dB of achieving -5dB, CRL now reports achieving -5dB (when including the operational constraint). CRL considers that it is now compliant, as a report no longer needs to have been sent to City of London. The PIR is now in the process of being closed out.

## C.2 Undertakings & Assurances (U&A) Surface Section

The Commitments Delivery Tracker (CDT) is used to generate reports each period setting out the actual upload of compliance evidence against what was planned and the information is presented in the Technical Director's Report (TDR). The matching of actual evidence against what was planned is used as a lead indicator for the risk of potential non-compliance. Contracts that meet their plans are considered to represent a lower risk of non-compliance than any that do not. There has been a growing concern regarding the upload of evidence from Network Rail (NR) contractors.

Two contracts, SAA3A (South East (GRIP 5-8)) and WLG4A (Old Oak Common & Paddington Approaches (OOCPA) (GRIP 5)), did not meet their targets. The reason given, for the evidence not being uploaded in Period 13, was a delay in the contractors submitting the documents to the new NR Commitments Coordinator. However, despite repeated requests for an explanation, regarding the longer outstanding items, no satisfactory responses have yet been given. A meeting has been held with NR to go through this issue and seek assurances that the outstanding information will be provided, that there have been no non-compliances with commitments in the meantime and that performance will improve from hereon.

There has been no other change, with regard to what was previously reported in Period 12. This means that:

- WOT1C West Outer Track Infrastructure (GRIP5-8) has not uploaded any evidence into CDT since Period 8;
- The D25 report that WSK1F (Stockley Main Civils) was due to upload in Period 6 remains outstanding. Also, the planned upload of evidence of consultation with Thames Water remains outstanding since Period 10;
- WLG4A (OOCPA) has still not completed the D25 and D26 tasks that were due to be uploaded in Period 4;
- WIT1A (West Inner Track Infrastructure) has still not completed the D25 and D26 tasks that were due to be uploaded in Period 4.

### C.2.1 Abbey Wood Substation (UKPN) Fixed Noise (D25) Assurances<sup>8</sup>

A level 2 PIR was raised on 14 August 2017. During the current negotiations to agree a lease arrangement between Crossrail and UKPN, for the substation at Abbey Wood, it became

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<sup>8</sup> Refer to Abbey Wood Substation (UKPN) Fixed Noise (D25) Assurances 461, 462, 463, 464 & 518.

apparent that NR's design of the substation had been carried out without knowledge of, or reference to, the D25 assurances. A meeting was held, in the first week of October 2017, with the environmental health officer from RB Greenwich to discuss the D25 assessment. NR received the UKPN D25 report from its contractor on 13 October 2017 and conducted a review, as a matter of priority. It is of concern, however, that NR had not completed and returned the PIR, setting out the corrective and preventative actions.

A D25 assessment has since been carried out. The report and associated correspondence with the equipment manufacturer on Sound Power levels has been submitted to the local authority Environmental Health Officer, who has confirmed he is happy with the report and that no further testing is required. This PIR is now closed

### **C.2.2 Shenfield Sidings – D25 Assurances<sup>9</sup>**

A level 1 PIR was raised on 24 August 2017 for failure to comply with the D25 fixed noise assurances at Shenfield siding. Under assurance 464, NR was required to provide details to the local authority of the measures undertaken to ensure that, under all reasonably foreseeable circumstances, the design process and procurement process for fixed installations is adequate to achieve compliance with the design criterion set out in IPD25 and to take the local authority's comments into account. However, no D25 assessment had been produced, but the sidings had been designed and constructed.

Assurance 518 requires that, if -5dB cannot be met, then a report setting out the reasons why must be sent to the local authority before procurement of the equipment. Without a D25 assessment done, this is not known. This, and the position on assurance 464, is further compounded by the fact that NR had submitted and had approved by Brentwood the Schedule 7 "Bringing into Use" (BiU) for the sidings. The submission of a BiU is a statement that the nominated undertaker has 'taken all reasonably practicable permanent measures for the mitigation of the effects of the work'. This cannot be known, because the D25 report had not been done.

A D25 assessment has been carried out and it confirms that, with the construction of a fence (which has already been approved under Schedule by the local planning authority), a rating of -5dB at the nearest sensitive receptor can be achieved. Brentwood Borough Council has raised no objections to the content of the assessment or the barrier design. This PIR was closed in Period 10.

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<sup>9</sup> Refer to Shenfield Sidings – D25 Assurances 461, 462, 463, 464 & 518.

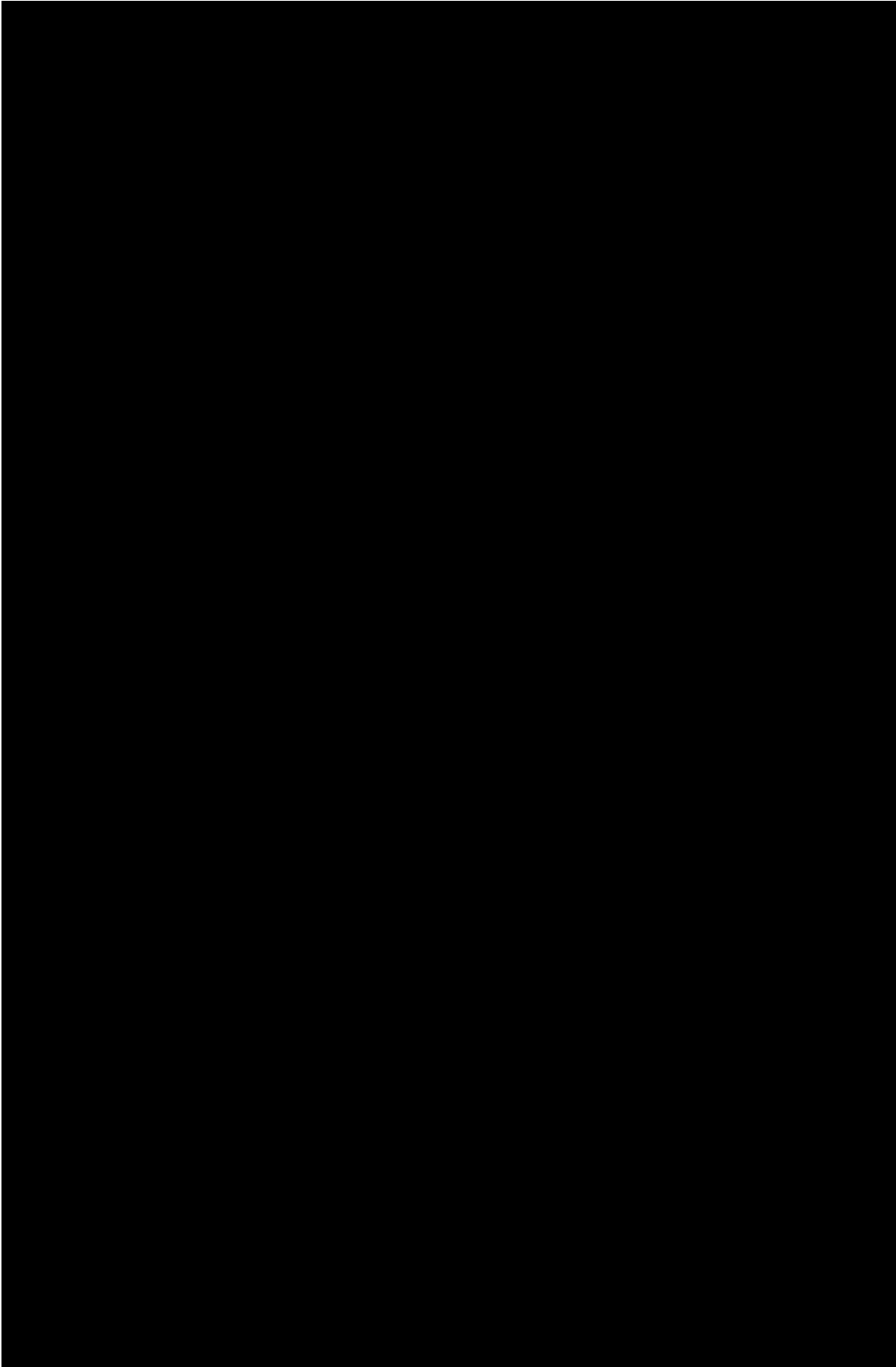




ID	Anchor Milestone	Baseline Early Date	Baseline Late Date	Actual / Forecast
A695	CBTC Auto Reverse and Isolated ETCS Testing	06-Apr-18	06-Apr-18	06-Apr-18
A698	Sys - A698 Start PSD Platform Train Interface Test (DT) in Zone 1	10-Apr-18	10-Apr-18	10-May-18
A726	C610- A726 Traction E&B complete in Zones 3 & 4	13-Apr-18	13-Apr-18	30-Apr-18
A710	C650 -A710 All 11 kV S,S&P locations energized	15-Apr-18	15-Apr-18	21-Apr-18
A715	C660 -A715 OFN re-configuration for All Zones complete	15-Apr-18	07-May-18	15-Apr-18
A535	GRIP 6 - Traction Power - New Substations in AT Mode - West	27-Apr-18	27-Apr-18	26-Sep-18
A630	C530-WOO-A630 Woolwich Handover East End to OSD	27-Apr-18	08-Dec-18	27-Apr-18
A746	Draft COS Safety Case + results from Dynamic Testing zones 1 and 2	30-Apr-18	30-Apr-18	30-Apr-18
A628	Control Team Service Infrastructure Managers Trained and Competent	01-May-18	04-Aug-18	15-May-18
A743	Training material submitted in readiness for training delivery	05-May-18	05-May-18	30-Jun-18
A557	C660 - A557 Dark Fibre Handover to C6XX (Zones 3 & 4)	07-May-18	07-May-18	07-May-18
A636	C350 - PML - Stage 3 Scenario Testing With C6xx to AC Completed	12-May-18	05-Jul-18	26-May-18
A660	SS&P Provision of DOO and Platform Finishes for Dynamic Testing in Zones 1, 2, 3, 4	15-May-18	10-Jun-18	15-May-18
A168	Stage 2 Implementation (Mixed Cl.345 / 360 Service)	20-May-18	20-May-18	20-May-18
A634	C360 - LIM - Phase 3 Integration (Scenario) Testing Period to Shaft iAC Completed	22-May-18	03-Aug-18	22-May-18
A134	C360 - ESS - Eleanor Street Shaft External Works Complete (A134) (Excludes Removal of Sstn & Reinstate)	24-May-18	03-Aug-18	24-May-18
A642	C360 - MEP - Phase 3 Integration (Scenario) Testing Period to Shaft iAC Completed	29-May-18	03-Aug-18	29-May-18
A564	C660 -A564 Linewide SCADA available in Zones 3 & 4	30-May-18	30-May-18	30-May-18
A741	Training completed for LU in support of Handover	30-May-18	30-May-18	30-Jun-18
A742	Training completed for MTR in support of Handover	30-May-18	30-May-18	30-May-18
A747	Tier 1s Submit Final ESJs to CRL	30-May-18	30-May-18	30-May-18
A645	C336 - ROP - Head House Phase 3 Scenario Testing Period to Full AC Completed	31-May-18	03-Aug-18	31-May-18
A687	C340-VDP-A687 Handover to Infrastructure Managers	04-Jun-18	07-Sep-18	18-Jun-18
A635	C360 - ESS - Phase 3 Phase 3 Integration (Scenario) Testing Period to Shaft iAC Completed	05-Jun-18	03-Aug-18	05-Jun-18
A719	C620 -A719 Signalling infrastructure ready for DT in Zones 3 & 4	07-Jun-18	07-Jun-18	07-Jun-18
A748	CRL Submit SJs to RABC	07-Jun-18	07-Jun-18	07-Jun-18
A713	C660- A713 GSM-R infrastructure ready for DT in Zones 1 to 4	08-Jun-18	30-Jul-18	08-Jun-18
A701	C610 -A701 Permanently energise OHLE Zones 3 & 4	10-Jun-18	10-Jun-18	10-Jun-18
A276	C412-BOS-A276 ETH PDA Milestone 11 Site available to commence Bond Street Station Eastern Ticket Hall OSD	11-Jun-18	12-Jul-18	27-Jun-18
A725	C610 -A725 Start Dynamic Testing in Zones 3 & 4	11-Jun-18	11-Jun-18	11-Jun-18
A700	C631 -A700 PSD Ready for Dynamic Testing in Zones 3 & 4	20-Jun-18	30-Jun-18	11-Jul-18
A696	CBTC Authorised for FLU for Trial Running	22-Jun-18	05-Aug-18	26-Jun-18
A731	C350 - PML - Ready for Final Handover to Infrastructure Manager	25-Jun-18	05-Jul-18	25-Jun-18
A640	C360 - LIM - Ready for Handover to Infrastructure Manager (IM)	29-Jun-18	03-Aug-18	29-Jun-18
A723	C610 -A723 All walkway installation complete in Zone 1	29-Jun-18	29-Jun-18	24-Aug-18
A728	C336 - ROP - Ready for Handover to Infrastructure Manager	29-Jun-18	03-Aug-18	29-Jun-18
A737	C360 - MEP - Ready for Handover to Infrastructure Manager (IM)	29-Jun-18	03-Aug-18	29-Jun-18
A160	ONW - RW - KO2 Infra.Capability Abbey Wood-Cent. Core Area at Plumstead Portal, Straford-Cent. Core Area, OOC-WB Park	30-Jun-18	30-Jun-18	30-Jun-18
A278	C435-FAR-A278 PDA Milestone 13 - Site available to commence Farringdon Station Western Ticket Hall OSD	30-Jun-18	08-Dec-18	30-Jun-18
A590	C610 -A590 Start Dynamic Testing (Zones 1,2,3 & 4)	30-Jun-18	30-Jun-18	30-Jun-18
A621	C620 - A621 Ready to Commence Transition Testing @ GEML	30-Jun-18	30-Jun-18	30-Jun-18
A709	C650-A709 All 22 kV S,S&P locations energized	30-Jun-18	30-Jun-18	30-Jun-18
A749	COS safety Case submitted to RABC (to facilitate Handover)	30-Jun-18	30-Jun-18	30-Jun-18
A620	C696 - A620 Construction Works Commence	02-Jul-18	02-Jul-18	02-Jul-18
<b>Key</b>				
	Milestone forecast to be achieved early or on time			
	Milestone forecast to be delivered late			
	Milestone forecast revised after Period 13 - to be delivered late			







## Appendix E Glossary of Terms

Abbr.	Description	Abbr.	Description
A&M	Access & Maintenance	LoNo	Letter of No Objection
ABB	ASEA Brown Boverly	LoR	Line of Route
ACJV	Alstom Costain Joint Venture	LTC	Lost Time Case
ACWP	Actual Cost of Work Performed	LTIFR	Lost Time Incident Frequency Rate
AEA	Abellio East Anglia	LU	London Underground
AFC	Anticipated Final Cost	LUL	London Underground Limited
AFC	Approved for Construction status	LV	Low Voltage
AFCDC	Anticipated Final Crossrail Direct Cost	M&E	Mechanical & Electrical
AFR	Accident Frequency Rate	MAID	Mandatory Asset Information Deliverables
AGA	Abellio Greater Anglia (now known as 'GA')	MCR	Material Control Requirement
AHU	Air Handling Units	MCS	Master Control Schedule
AIP	Approved in Principle	MENTOR	Mobile Electrical Network Testing, Observation and Recording
AIP	Approval in Principal	MEP	Mechanical Electrical & Public Health
AMS	Agreements Management System	MEPA	Mechanical, Electrical, Public Health, Architecture
APIS	Authorisation to Place into Service	MES	Mile End Shaft
ARS	Automatic Route Setting	MIRP	Maintenance Integration Review Panel
AsBo	Assurance Body - Ricardo Rail	MML	Mott MacDonald Ltd
ASLEF	Associated Society of Locomotive Engineers and Firemen	MOHS	Master Operational Handover Schedule
ATC	Automatic Train Control	MOS	Member of Staff
ATFS	Autotransformer Feeder System	MPS	Master Plan Shaft
ATO	Automatic Train Operation	MTIN	Miles Per Technical Incident Number
ATP	Automatic Train Protection	MTIN	Miles Technical Incident Number
ATS	Automatic Train Supervision	MTR SMS	MTR Safety Management System.
ATS	Auto Transformer Station	MTR-C	Mass Transit Railway - Crossrail
AWS	Automatic Warning System	MV	Medium Voltage
B&PC	Board & Programme Contingency	NCE	Notified Compensation Event
BBMV	Balfour Beatty Morgan Vinci	NCR	Non Conformance Report
BCA	Bilateral Connection Agreement	NG	National Grid
BCWP	Budgeted Cost of Work Performed (Earned Value)	NGET	National Grid Electricity Transmission
BCWS	Budgeted Cost of Work Scheduled (Planned Value)	NKL	North Kent Line
BFK	Bam Ferrovial Kier	NoBo	Notified Body
BH	Berkeley Homes	NOW	North Woolwich
BIU	Bringing Into Use	NR	Network Rail
BLL	Bakerloo Line Link	NSACS	New Sector Area Cost Summary
BMS	Building Management Systems	O&M	Operations and Maintenance
BOS	Bond Street Station	OCS	Overhead Catenary Systems
BP	Business Plan	OLE	Overhead Line Equipment
BREEAM	Building Research Establishment Environmental Assessment Methodology	OMC Building	Operations Maintenance Centre
BSP	Bulk Power Supply Point	OME	Order of Magnitude Estimate
BT	Bombardier Transportation	ONFR	On Network Functional Requirements
BT / PC	Bombardier Transportation / Prime Contractor	ONSIP	On Network Station Improvements Programme
BTH	Blomfield Ticket Hall	ONW	On Network Works
BUF	Bottom Up Forecast	OOO	Old Oak Common
C&CSC	Commercial and Change Sub-committee	OOCPA	Old Oak Common Paddington Approaches
CAR	Corrective Action Report	OPEX	Operational Expenditure
CARE	Crossrail Assurance Reporting Environment	Ops	Operations

CBTC	Communications Based Train Control	ORAT	Operational Readiness & Transfer Group
CCB	Current Control Budget	ORR	Office of Rail & Road
CCP	Commitments Compliance Plans	ORSG	Operational Readiness Steering Group
CCRB	Construction and Commissioning Rulebook	OSD	Over Site Development
CCRRB	Crossrail Construction Railway Rule Book	OSP	Operations Safety Procedures
CCSA	Contract Commercial Status Analysis	OTIS	OTIS escalators (company)
CCSC	Commercial & Change Sub-Committee	OTP	Overall Target Price
CCTV	Closed Circuit Television	PA	Public Address
CD/RA	Closed Door / Right Away	PAD	Paddington station
CDG	Competence Design Group	PCs	Principal Contractors
CDL	Central Door Locking	PDA	Project Development Agreement
CDM	Construction Design & Management Regulations	PDB	Network Rail Programme Delivery Board
CDN	Crossrail Data Network	PES	Platform Edge Screen
CDT	Commitments Delivery Tracker	PES	Permanent Earthed Sections
CE	Compensation Events	PIP	Paddington Integration Project
CEC	Chief Engineer's Communications	PIR	Potential Incident Report
CEEQUAL	Civil Engineering Environmental Quality Assessment Scheme	PLU	Plumstead
CEG	Central Engineering Group	PM	Project Manager
CEO	Chief Executive Officer	PMI	Project Manager Instruction
CFCCB	Contingency Finance Current Control Budget	PML	Pudding Mill Lane
CFO	Chief Financial Officer	PMO	Project Management Office NR
CIF	Crossrail Integration Facility	PNY	Paddington New Yard
CIS	Customer Information System	PPE	Personal Protective Equipment
CMR	Crossrail Managed Risk	PPF	Property Partnership Framework
CMS	Crossrail Management System	PPM	Passenger Performance Measurement
CoL	City of London	Prep	Project Representative
COS	Central Operating Section	PRISM	Cost Management Software
CPFR	Crossrail Programme Functional Requirements	PRM	Persons of Reduced Mobility
CPI	Cost Performance Index	PSD	Platform Screen Door
CPO	Compulsory Purchase Order	PSG	Performance Steering Group
CRAF	Completion Readiness Assessment Framework	PSR	Project Status Report
CRL	Crossrail Limited	PTYSC	Property Sub-Committee
CRV	Crossrail Requirements Variation	PWay	Permanent Way
CSCS	Construction Skills Certification Scheme	QBR	Quarterly Baseline Review
CSDE	Correct Side Door Enabling	QCRA	Quantified Cost Risk Assessment
CSJV	Costain Skanska Joint Venture	QRA	Quantified Risk Assessment
CSM	Construction Safety Management	QSRA	Quantified Schedule Risk Assessment
CSM-RA	Common Safety Method – Risk Assessment	RAB	Regulatory Asset Base
CT	Computerized Tomography	RAB (C)	RfL Assurance Board for Crossrail
CTOC	Crossrail Train Operating Concession	RAG	Red, Amber, Green Matrix
CUH / CHS	Custom House Station	RAM	Route Asset Manage.
CW	Canary Wharf	RBC	Remote Block Computer
CWG	Canary Wharf Group	RCA	Risk Control Actions
CWS	Canary Wharf Station	RCC	Route Control Centre
D&A	Drugs and Alcohol	RfL	Rail for London
DA	Development Agreement	RfL-I	Rail for London - Infrastructure
DeBo	Designated body	RFT	Right First Time
DfT	Department for Transport	RIA	Railway Integration Authority
DLO	Direct Labour Organisation	RIBA	Royal Institute of British Architects (Structure of Construction Stages)
DLR	Docklands Light Railway	RIDDOR	Reporting of Injuries Diseases & Dangerous Occurrences Regulations 1995
DOO	Driver Only Operation	RIRP	Railway Integration Review Point
DPS	Depot Protection System	RLU	Restricted Length Unit
DT	Dynamic Testing	ROC	Rigid Overhead Conductor

Dwall	Diaphragm wall	ROC	Regional Operational Centre
DWWP	Delivery of Works Within Possession	ROP	Royal Oak Portal
E&B	Earthing & Bonding	RP4.2	Review Point 4.2
EA	Environment Agency	RR	Ricardo Rail
EAC	Estimate at Completion	RRV	Road / Rail Vehicles
EB	Eastbound	RS	Rolling Stock
ECP	Employers Completion Process	RSC	Return Screen Conductor
ECS	Empty Coach Stock	RSD	Rolling Stock & Depot
EDBL	Early Date Baseline	RSSB	Rail Safety & Standards Board
EDT	Early Dynamic Testing	RTU	Remote Telemetry Unit
EED	Emergency Exit Door	S&C	Switches & Crossings
EFC	Estimated Final Cost	SA	Supplementary Agreement
EiS	Entry into Service	SACR	Semi Annual Construction Report
ELRSG	Elizabeth Line Readiness Steering Group	SAP	System Applications Products
EMC	Electromagnetic Compatibility	SAR	Safety Assessment Report
EMU	Electrical Multiple Unit	SAT	Site Acceptance Test
ERTMS	European Rail Traffic Management Systems	SCADA	Supervisory Control and Data Acquisition
ESJ	Engineering Safety Justification	SCL	Sprayed Concrete Lining
ESM	Engineering Safety Management	SCN	Sponsor Change Notice
ETCS	European Train Control System	SDG	Signalling Design Group
ETH	Eastern Ticket Hall	SDO	Selective Door Operation
EVM	Earned Value Management	SDS	Scheme Design Specification
FAR	Farringdon	SER	Signalling Equipment Room
FCCB	Finance Current Control Budget	SES	South East Service
FDC	Framework Design Consultant	SESR	South East Signalling Room
FDO	Final Design Overview	SFA	Sponsor Funding Account
FDS	Final Design Statements	SHELT	Safety and Health Leadership Team
FFOC	Final Forecast Outturn Cost	SIRP	Systems Integration Review Panel
FGW	First Great Western	SISS	Station Information and Security System
FIS	Fisher Street Shaft	SJR	Safety Justification Report
FLU	Full Length Unit	SLD	Single Line Diagrams
FoI	Freedom of Information	SMS	Safety Management System
FRAG	Fraud Risk Assurance Group	SMTA	Smithfield Market Traders Association
FTS	Floating Track Slab	SOC	Statement of Compatibility
GAF	Greater Anglia Franchisee	SONIA	Sterling Overnight Index Average
GE	Great Eastern	SOR	Systems Operation Room
GEBR	Guaranteed Emergency Brake Rate	SORBA	Shaping Architecture Company (sub cladding contractor)
GEFF	Great Eastern Furrer & Frey	SPI	Schedule Performance Index
GEML	Great Eastern Main Line	SPS	Secondary Part Steel
GFRC	Glassfibre Reinforced Concrete	SR	Sponsors Requirement
GLA	Greater London Authority	SRP	Safety Review Panel
GPE	Great Portland Estates	SSE	Scottish & Southern Electricity
GRC	Glass Reinforced Concrete	SSP	Stations, Shafts, Portals
GRIP	Governance for Railway Investment Projects	STG	Stepney Green
GSM-R	Global System for Mobile Communication - Railway	STS	Standard Track Slab
GW	Great Western	SVP	Safety Verification Panel
GWML	Great Western Main Line	T&C	Testing & Commissioning
GWR	Great Western Railway	TAP	Technical Assurance Plan
H&S	Health & Safety	TBM	Tunnel Boring Machine
HAL	Heathrow Airport Limited	TC&HSG	Testing, Commissioning and Handover Steering Group
HALARP	Heathrow Airport Limited Assurance Review Panel	TCMS	Train Control Management System
HAS	High Attenuation Sleeper	TCR	Tottenham Court Road
HAVS	Hand Arm Vibration Syndrome	TCRW	Tottenham Court Road West
HEP	Handover Execution Plans	TDR	Technical Director's Report

HIA	Heathrow Implementation Agreement	TDY	Tunnel Drive Y
HM	Her Majesty	TfL	Transport for London
HMDL	Handover Master Deliverable List	TOC	Train Operating Company
HRW	Heathrow Airport	TPA	Tunnel Planning Authority
HSPI	Health & Safety Performance Indicator	TPH	Trains Per Hour
HV	High Voltage	TPS	Train Protection System
HVAC	Heating Ventilation & Air Conditioning	TPWS	Train Protection & Warning System
IA	Interim Acceptance	TRAIL	Transport Reliability Availability Integrated Logistics
ICD	Interface Control Document	TRH	Temporary Rehousing
IECC	Integrated Electronic Control Centre	TSI	Technical Standard for Interoperability
IEP	Intercity Express Programme	TTVS	Temporary Tunnel Ventilation System
IFC	Issued For Construction	TUCA	Tunnelling & Underground Construction Academy
IFD	Ilford Yard	TWAO	Transport & Works Act Order
IM	Infrastructure Manager	TXM	TXM Plant
IOSH	Institution of Occupational Safety and Health	U&A	Undertakings & Assurances
IP	Intervention Point (0, 1, & 2)	UKPN	UK Power Networks
IR35	Inland Revenue Taxation Regulation 35	UR	Urban Realm
IRN	Installation Release Note	URT	Unresolved Trends
IRSG	International Regulatory Strategy Group	UTX	Under Track Crossings
ISJ	Interim Safety Justification	VDP	Victoria Dock Portal
ISV	Intermediate Statements of Verification	VERP	Value Engineering Review Panel
ITP	Inspection & Test Plan	VFL	Volker Fitz Patrick
ITT	Invitation to Tender	VN	Variation Notice
JST	Joint Sponsor Team	VT	Voltage Transformer
KBR	Knorr-Bremse Rail	WAD	Works Authorisation Document
KD	Key Deliverable	WBP	Westbourne Park
KE	Kinematic Envelope	WBS	Work Breakdown Structure
KG	Kensal Green	WC	World Class
KO	Key Output	WCC	Westminster City Council
KPI	Key Performance Indicator	WCCC	Whole Contract Construction Certificate
L&P	Land and Property	WHI	Whitechapel
LB	London Borough	WITI	Western Inner Track Infrastructure
LBTH	London Borough of Tower Hamlets	WOE	Western Outer Electrification
LDBL	Late Date Baseline	WOO	Woolwich Station
LFB	London Fire Brigade	WOTI	Western Outer Track Infrastructure
LIV	Liverpool Street	WTH	Western Ticket Hall
LMU	London Metropolitan University	YC	Yard Control
LO	London Over ground		