

PACE 1 (ES1) Study Package E – Westerleigh to Bristol Parkway

Project name: Birmingham to Exeter Corridor

Document ref: 175662-NRD-WST-SWB-REP-EMF-000002

Issue: P02

PACE Phase: 1 (ES1)

Network Rail Design Delivery

www.networkrail.co.uk



Document control

Issue	Date	Produced by	Details
P01	11/05/2022	Various	Unsigned copy for DPE/CRE comments
P02	22/06/2022	Various	First signed issue

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Executive Summary

Network Rail Design Delivery have been engaged by Wales and Western Investment Directorate to produce a PACE Ph1 (ES2) Engineering Study for the Birmingham to Exeter Corridor, to ascertain opportunities to support growth along the route.

This builds upon the TSS (Train Service Specifications) developed by the Network Rail Capacity Analysis team, and the subsequent Technical Engineering Report (175662-NRD-EMF-REM-000001) prepared by NRDD.

NRDD have undertaken a multi-disciplinary (Buildings, Civils and Geotech; E&P CS, Track and Signalling) output definition study to define the options to be progressed to the next design phase (PACE Ph1 [ES2]) for Package E (Westerleigh to Bristol Parkway). The recommendations are summarised in Table 0.1

Table 0.1 – Summary of recommendations

Package	Option		Recommendation
	E3: Westerleigh Junction Remodelling		Do not progress
	E4: Westerleigh Junction High Speed Triple Tracking		Progress
E: Westerleigh to Bristol	E6: Quad-Tracking at-Grade (Junction Transferred to Coalpit Heath)		Progress
Parkway	E7: New Connection to	Main alignment (existing grade separation)	Do not progress
	Westerleigh Branch Line	Alternative alignment (new dive- under structure under the GWML)	Progress



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Definitions and Abbreviations

Acronym	Definition
ATF	Autotransformer Feeder
ATP	Automatic Train Protection
AWI	Advance Warning Indicator
B/C	Culvert
B/F	Footbridge
B/O	Overline Bridge
B/U	Underline Bridge
BGS	British Geological Survey
CARRS	Civils Asset Register and Reporting System
CCZ	Current Collector Zone
CEM	Contractor's Engineering Manager
CRE	Contractor's Responsible Engineer
CS	Contact Systems
CSM-RA	Common Safety Method for Risk Assessment and Evaluation
E&P	Electrification and Plant
ELR	Engineer's Line Reference
FPC	Foot Path Crossings
GWML	Great Western Main Line
GWR	Great Western Railway
H&SbD	Health and Safety by Design
HABD	Hot Axle Box Detector
HST	High Speed Train (InterCity 125)
IDC	Interdisciplinary Check
IDR	Interdisciplinary Review
IECC	Integrated Electronic Control Centre
LED	Light Emitting Diode
LX	Level Crossing
MARI	Miniature Aspect Route Indicator
MR	Midland Railway
NR	Network Rail
NRDD	Network Rail Design Delivery
NRG	National Records Group

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Acronym	Definition	
NS	New Street	
OCLZ	Overhead Contact Line Zone	
OLE	Overhead Line Electrification	
OSS	Overspeed Sensor System	
PACE	Project Acceleration in a Controlled Environment	
PPF	Putting Passengers First	
PSB	Power Signal Box	
REFOS	Running Edge to Face of Steel	
RINM	Rail Infrastructure Network Model	
RYR	Restoring Your Railway	
S&C	Switches and Crossings	
SORAT	Signal Overrun Risk Assessment Tool	
SPS	Small Part Steelwork	
SSSI	Site of Special Scientific Interest	
STC	Single Track Cantilever	
TDNS	Traction Decarbonisation Network Strategy	
TM	Temple Meads	
TOC	Train Operating Company	
TPWS	Train Protection Warning System	
TSS	Train Service Specifications	
TTC	Twin Track Cantilever	

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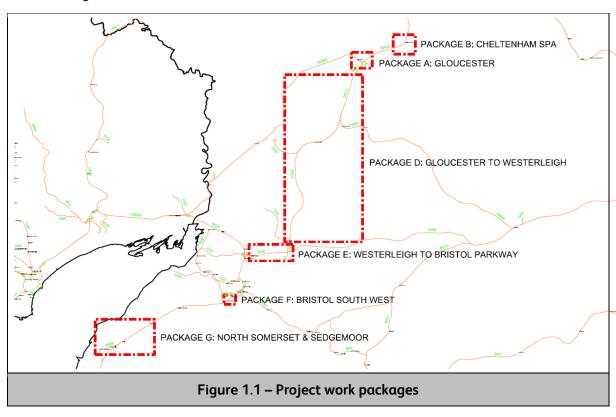


1 Introduction

Network Rail Design Delivery have been engaged by Wales and Western Investment Directorate to produce a PACE 1 Engineering Study for the Birmingham to Exeter Corridor, to ascertain opportunities to support growth along the route.

This builds upon the TSS (Train Service Specifications) developed by the Network Rail Capacity Analysis team, and the subsequent Technical Engineering Report (175662-NRD-EMF-REM-000001) prepared by NRDD.

The present report covers. Package E (Westerleigh to Bristol Parkway). Packages A (Gloucester Area), B (Cheltenham Spa Area), D (Gloucester to Westerleigh), F (Bristol South West) and G (North Somerset and Sedgemoor) are independently covered in 175662-NRD-WST-XXX-REP-EMF-000001. The approximate geographical location of the packages is shown in Figure 1.1.





2 Background and Brief

Network Rail Wales & Western Strategic Planning team have undertaken studies of the Birmingham to Bristol and Bristol to Exeter corridors with key stakeholders to make the case for change to support growth along the route. This has been supported by the Network Rail Capacity Analysis team who have developed a series of iterative Train Service Specifications (TSS) to meet the future aspirations of the stakeholders.

In order to deliver the TSS, the railway infrastructure needs upgrading and enhancing at key locations to improve both capacity and performance of the network. A number of work packages were then identified, A to H, that provided a high-level definition of the infrastructure interventions required.

NRDD prepared a Technical Engineering Report (175662-NRD-EMF-REM-000001) to identify the Engineering considerations for each of the interventions, the risks, constraints and opportunities that need to be explored in the PACE 1 feasibility stage, effectively setting out the requirements for the present exercise.

The options listed in Table 2.1 are evaluated in this report.

Table 2.1 – Package E: PACE 1 option summary

Package	Option	Description
	E3: Westerleigh Junction Remodelling	A fully grade separated junction (flyover) with four tracking
E: Westerleigh	E4: Westerleigh Junction High Speed Triple Tracking	An at-grade, value for money three-tracking solution
to Bristol Parkway	E6: Quad-Tracking at-Grade (Junction Transferred to Coalpit Heath)	An at-grade four tracking solution
	E7: New Connection to Westerleigh Branch Line	A fully grade separated junction (diveunder) with four tracking



3 Assumptions

The present report is based on the assumptions listed in Table 3.1, made by NRDD. Some further assumptions are explicitly or implicitly included as part of the report and sketches. A Design Decision Log is included in Appendix F.

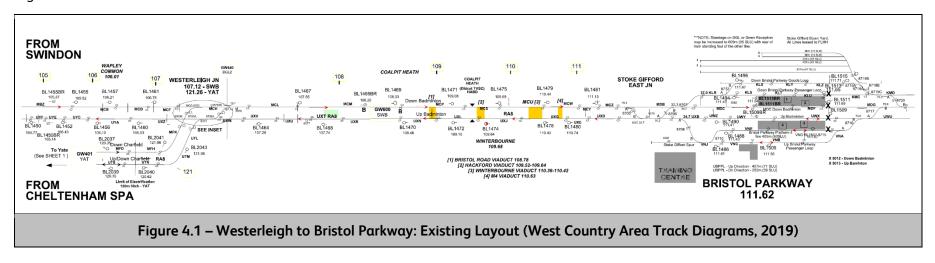
Table 3.1 – Assumptions

Discipline	Section	Assumption	Action to close out
All	All	Only Civils, Geotech, Track, Signalling and E&P CS have been involved in the production of the present report.	Full feasibility shall be undertaken to determine multi-disciplinary engineering impacts
All	All	All packages are CSM significant and interoperable	CSM-RA processes to be followed, including engagement with the relevant independent assessment bodies.



4 Existing Infrastructure

The following existing infrastructure features have been identified by the different engineering disciplines. The existing layout is shown in Figure 4.1.



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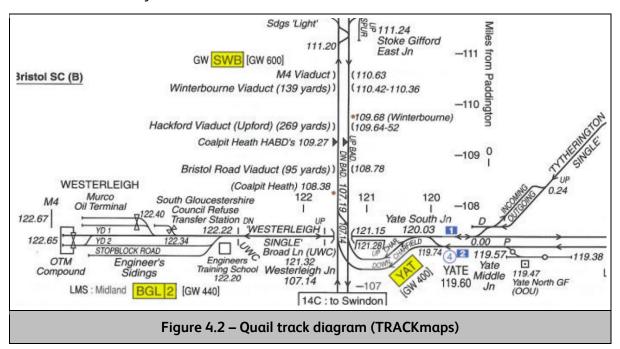
4.1 Track

The South Wales and Bristol Line, SWB ELR, running between Wootton Bassett and Patchway Junctions comprises high speed twin track railway configured as the Up and Down Badminton lines predominantly for Great Western Railway services between London and South Wales. The lines are overhead electrified

At Westerleigh Junction (107M 14c) near Yate, the Up and Down Charfield lines, YAT ELR, join the Badminton lines by means of a 40mph double junction that allows services to/from the Midlands to reach Bristol Parkway station and further destinations in the South West of England. Thus, Westerleigh Junction is a nationally strategic junction of intercity and freight routes. The lines are partially electrified with OLE overrun protection.

From Yate South junction, the BGL2 ELR continues southwards as the Westerleigh single line to the freight terminal, passing beneath the Badminton lines via a grade separated junction. This was the route of the former Midland line to Bristol and the corridor is wide enough for twin track railway.

In the Westerleigh Junction area, the SWB linespeed is 100mph which increases to 120mph on the Up Badminton and to 125mph on the Down Badminton after the junction in their respective directions. Due to the tight radius track curvature, the YAT linespeed is restricted to 40mph from the double junction, gradually increasing to 65mph and then 100mph just south of Yate South junction as the curvature eases.



The railway is elevated on a series of long embankments and viaducts, some of which are listed, above the surrounding countryside.

With respect to track gradients, the SWB falls at a constant 1 in 300 towards high mileage and the YAT rises at approximately 1 in 150 to meet it at Westerleigh junction. Gradients will become an important factor in the grade separated junction options, particularly for freight traffic.

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Figure 4.3 – Aerial view of Westerleigh Junction (RouteView)



4.2 Signalling

The signalling system is controlled as follows:

- Controlling Signalling Centre: Thames Valley Control Centre
- Control Media: DeltaRail IECC Scalable Version 2
- Interlocking Area: Bristol (CIXL 10), VIXL 25 and VIXL 26
- Style of interlocking: Alstom Smartlock SMT400T.

The interlocking was commissioned on 30/08/2016 and controls from Stoke Gifford via Westerleigh to the boundary with Gloucester PSB on the BGL2.

New track side equipment control equipment and data links were provided as part of the resignalling scheme so new additional point and signal TFMs should not pose a problem.

The signalling alterations will require the provision of new point machines, signals, train detection sections power supply alterations and data changes in the interlocking and the IECC equipment in the Thames Valley signalling Centre at Didcot.

The signalling interlocking equipment is new and should not pose any alteration difficulties.

However, the data volume of the interlocking should be checked if any of the proposals are taken forward.

The NRG source records reviewed to inform the production of the present report are included in Appendix D.

4.3 Buildings, Civils and Geotech

The length of SWB impacted by the proposed changes is approximately 4km long.

The desk study information used in the assessment of Package E was gathered from the following sources:

- Environmental information from Geo-RINM
- Earthworks and structures databases (JBA / CARRS)
- Sectional Appendix
- Hazard Directory

The desk study information has been evaluated and summarised within the following sketches, which are included in Appendix C.

- 175662-NRD-WST-BGL-SKE-ECV-050001
- 175662-NRD-WST-SWB-SKE-ECV-050001
- 175662-NRD-WST-YAT-SKE-ECV-050001

Information considered within the desk study is listed in Table 4.1. Desk data is based upon information obtained in March 2022 and records or asset conditions may change in the future.

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Table 4.1 – Information considered (Buildings, Civils and Geo)

HERITAGE	SUSTAINABILITY
Designated Items	Flood Risk (5 - 250 Year Return)
Listed Buildings	Protected Species (Plants)
War Memorial Schedule	Protected Species (Animals)
Tree Preservation Order	Invasive Non-Native Species (Plants)
Ancient Monuments	Invasive Non-Native Species (Animals)
Conservation Areas	Unprotected Priority Species (Plants)
Other Heritage	Unprotected Priority Species (Animals)
Railway Heritage Committee	Ecological Survey Points
Area of Archaeological Importance	Protected Species License Point
STRUCTURES/ GEO	SSSI England
Structure Id	Special Areas of Conservation
Track Access	Ramsar
Earthworks Id	National Nature Reserves England
Earthworks Hazard Category	Environmentally Sensitive Area
Earthworks Type	Sites of Nature Conservation Interest
Earthworks Risk	Tree Preservation Orders
Geology	Special Protection Areas
Mining Referral Layer	National Parks
Landfill Referral Layer	Country Parks
Drainage	National Trails
Buried services returns	Contaminated Land

A sample of the desk study, at Westerleigh Junction, is shown in Figure 4.4.

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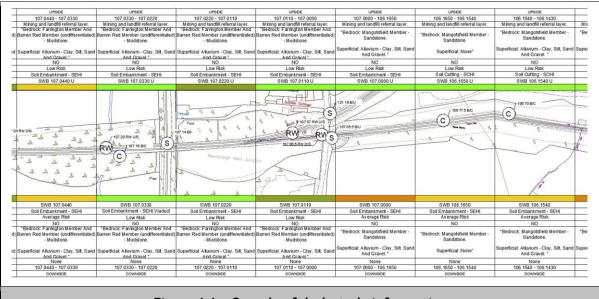


Figure 4.4 – Sample of desk study information

Limited geological data is currently available for the Site. A historical BGS borehole ST68SE34 located approximately 500m west of the dive under indicates a weathering profile to competent bedrock. It is also unclear what level the borehole is in relation to the railway. There is no in situ testing, strength descriptions or laboratory testing available however the log indicates that the clay in the first 5 ft was progressed with an auger whereas between 5 – 15 ftbgl core drilling was undertaken. The log indicates a likely weathering profile between 5 and 10 ftbgl based on the increasing rock content in the description i.e. "Marl [clay] pieces of Sandstone" becoming "Shaley Marl". This is likely to represent increasing strength with depth before reaching a likely more competent strata described as Rock Marl at 10 ftbgl.

As part of the information gathering process, Stage 1 mining reviews have been undertaken and buried services requested for the site area considered. Due to time constraints, these have not been examined in detail and need to be reviewed at the next design stage to inform design.

4.4 Electrification and Plant (Contact Systems)

Westerleigh Junction (YAT ELR) connects the cross country route at BGL2 ELR to the South Wales Main Line (branch of GWML) at SWB ELR. On the main line (SWB ELR), The junction is located approximately at approximately 107m 450yds; SWB ELR.

Currently, the South Wales Main Line is electrified with Series 1 OLE, with overrun protection running from the mainline into the junction, terminating at structure YAT/171/420 located at 120m 1290yds; YAT ELR on Westerleigh Junction.

The Up and Down Badmintons in the areas in relative proximity to the Westerleigh junction include STC, TTC and Portal structures, with the overrun protection present on the Charfield lines including predominately TTC structures, all OLE equipment in this area are a part of the Series 1 design range.

Table 4.2 provides the OLE parameters specific to the Series 1 OLE design range.

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Table 4.2 – Series 1 OLE system parameters

Max speed	225km/h / 140mph	
Particular	Catenary	Contact
Tension	13kN	16.5kN
Specification	19/2.1mm	BS EN 50149
Make-up of wire	DIN 48201	Solid
Material	Bronze II	CuAg
Diameter	10.50mm	13.20mm
Cross sectional area	65mm²	120mm²
Ambient temp range	-18°C to +40°C	
Set up temperature	20	0°C

4.4.1 Identified Constraints

With respect to any proposed modifications to the railway infrastructure at Westerleigh Junction, the following are key aspects to the existing OLE infrastructure that will need to be considered

- OLE wire run design compliance. For example, this needs to be considered under the following circumstances
 - O Proposed track realignment design of existing (i.e., track slues and lifts to confirm new staggers, wire heights, MSO, max offset, REFOS, gradients etc)
- OLE infrastructure available adjustability and existing foundations to accommodate any interventions as a result of track realignment
- OLE infrastructure available adjustability and existing foundations to accommodate any interventions as a result of track realignment
- Passive Provision for future electrification of proposed new track design
- There are currently no overbridges in the vicinity of Westerleigh Junction, however any proposal for overbridges will need consideration for required clearances in line with GL/RT1210 and 27715 Mod 4.
- The removal and location of the switch from the main (Up Badminton) towards the junction will require consideration for the removal and redesign of the require OLE overrun protection.
- Overhead Contact Limiting Zone (OCLZ). For example, this needs to be considered under the following circumstances
 - o Proposed new track design proposals adjacent to existing track
 - o Proposed track realignment design of existing (i.e., Slue & Lifts)

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5 Proposed Options

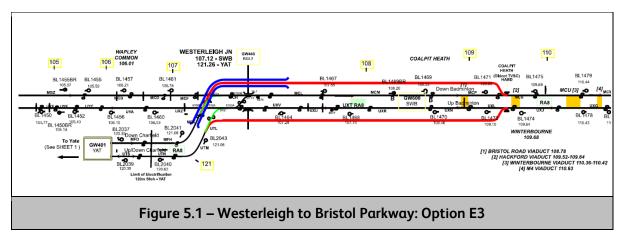
This package details four intervention options to upgrade Westerleigh Junction and the route between Bristol Parkway and Westerleigh, to address the requirements of the Bristol to Birmingham TSS. The following four options are evaluated:

- Option E3: Westerleigh Junction remodelling, including partial quad-tracking and a new fly-over the GWML.
- **Option E4**: Triple tracking, keeping a similar operational model to the existing with higher speed crossings, and the junction transferred to Coalpit Heath.
- **Option E6**: Quad-tracking at grade, with the unction transferred to the Coalpit Heath area.
- Option E7: New connection to the Westerleigh Branch Line, with two alternatives:
 - o Main alignment: Use of the existing at-grade separation.
 - o Alternative alignment: New dive-under to cross the main lines.

It is also recognised that these proposals may also provide additional capacity to the Great Western Main Line. The following sections provide the multi-discipline engineering information identified as part of the present study.

5.1 Option E3: Westerleigh Junction Remodelling

Option E3 entails the remodelling of Westerleigh Junction, by grade separating the Up Main and Down Charfield with a new fly-over. Partial four-tracking east of Winterbourne cutting for approximately 2 miles may provide operational benefit by allowing segregation of GWR and CrossCountry services as well as fast and slow services. The proposed layout is shown in Figure 5.1.



5.1.1 Track

This option investigates the possibility of grade separating Westerleigh Junction by means of a flyover, to carry the Down Charfield line over the Up and Down Badminton lines.

This is shown on Track drawings 175662-NRD-WST-SWB-DRG-ETR-050301 and 050302, included in Appendix A.

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The existing Westerleigh junction is removed and four track running proposed to approximately 109M 40c, whereupon the Up and Down Charfield lines reconnect into the respective Badminton lines via high speed S&C prior to Winterbourne cutting.

The obvious benefit of this option is that the pathing conflict of the Down Charfield occupying the Badminton lines is removed. Westerleigh Junction is also removed alleviating maintenance and reliability issues at this strategically important junction on the rail network.

Four track running allows the separation of services closer to Bristol Parkway increasing the capacity of the lines, with turnout speeds of 75mph. The constraint of track curvature still exists however on the YAT ELR round to Yate South junction, which is approximately R=370m (min.), however the linespeed can be increased to 55mph from 40mph now that the S&C has been removed.

The Badminton lines are largely unaffected by this proposal except to renew Westerleigh junction in its current format with plain line and the installation of 2No. NR60 G switches to form the new Charfield line connections. OLE overrun protection would be needed on the Up Charfield (facing moves) only.

One of the major challenges of this option is to construct the new flyover while keeping services running. The flyover alignment is therefore offset towards the outside of the current Down Charfield curve approaching Westerleigh junction until it crosses above the Main lines and ramps back down to the level of the Down Badminton. At this early design stage without reliable level information, engineering judgement has been used to determine the length of flyover ramp either side of the intersecting structure to achieve the rail-over-rail level difference (including for OLE) required. Once the flyover and associated track has been constructed, a staged possession would be required to realign the track at either end onto the flyover structure, before the existing junction is recovered.

During design development it was agreed to offset the outer two tracks (Charfield lines) 10m from the existing Badminton lines to minimise the disruption to the OLE structures and where underbridges / viaducts exist, to construct new, separate spans to avoid rebuilding existing structures. This minimises structural alterations and disruption to existing services and also allows clear segregation to allow maintenance of each separate structure. Embankment widening and land acquisition will be required in any event to enable the proposal.

The Up Charfield runs parallel to the Up Badminton, offset by 10m before curving round the former Westerleigh junction and requiring a staged connection into the existing track. Some land acquisition and new underbridge structures will be required.

5.1.2 Signalling

The signalling proposal for Option E3 is outlined in drawing 175662-NRD-WST-SWB-SKE-ESG-050301, included in Appendix D.

The proposal is for a new running junction between the Badminton line (SWB) and the Charfield Lines (BGL2) located approx. 2.25 miles to the west of the existing Westerleigh junction.

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This new junction would enable a new Up Charfield line to run parallel to the Up Badminton to the west of the existing Westerleigh junction, where it would swing to the north to connect with the existing Up Charfield line just south of the Westerleigh road bridge.

In the Down direction the new Down Charfield would depart from its existing alignment just south of the Westerleigh Road bridge and then sweep in a right-hand curve over the SWB on a new bridge, to run parallel to the SWB to the new trailing junction 2.25 miles to the West.

The "C2" Yate to Westerleigh line is unaffected by this proposal, but a review of the C2 method of working should be undertaken as a reasonable opportunity.

5.1.2.1 Upford Viaduct: New Junction

The proposal sees a new facing up direction 75mph turnout that starts the new Up Charfield line. On approach to this, revised signalling will be provided that display flashing aspects for the Charfield line. Signal BL1480 is the second signal after departing Bristol Parkway station and the flashing double yellow aspect it would display will give early indication of the Charfield route being set. This will aid driveability and speed regulation of trains.

BL1474 signal which becomes the protecting signal for the new junction is already equipped with an ATP loop. It will not require to be fitted with TPWS (exclusion code C).

There is a MCPO in the area on the approach to BL1474 which may need modification. However, this mainly applies to Swindon bound electric trains which have come from Bristol TM via Filton

An alternative of splitting distants (not sketched) could be applied to the Up direction junction. However, this has been discounted due to the lack of any cost effective improvement to the information given by the flashing aspects.

The track design allows 100mph on the new Up Charfield. However, for driveability issues, the practical line speed will be less.

The new Down direction junction is a straightforward trailing arrangement. The existing signal BL1471 will require TPWS TSS and OSS and also an ATP alteration. The signal BL2049 will require TPWS TSS & OSS

Similarly to the Line speed on the Up Charfield, the Down Charfield line speed will be less than as designed for driveability.

New signals will be placed in parallel to the existing signals on the SWB wherever possible subject to sighting.

Coalpit Heath HABD may require additional sensors on the new Charfield lines and are subject to TOC discussion.

Facilities for turn back as per existing Westerleigh junction will not be reproduced at Upford. Any train that requires to come from Yate bound for Swindon via the SWB will have to run round at Stoke Gifford.

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5.1.2.2 Yate area

Trains leaving Tytherinton will require a new trailing crossover at Yate station in order to gain the Down Charfield . This route presently takes place by running wrong direction over the Up Charfield to Westerleigh and then over a trailing crossover on the SWB

Elevated PL signal BL 6565 may be considered for replacement with a main head to allow heavy stone trains from Tyherington to exit the branch line with better knowledge of the state of the line ahead. As a minimum a new MARI is required for the routes from that signal.

A proposal for a new Down loop line between Wickwar and Yate is shown in this sketch for completeness if that option is taken Up. The signalling on the Down line is therefore raised to 4-aspect to allow for better continuity and spacing of signalling between Yate and Upford on the new alignment.

5.1.2.3 Common items

Gradients considered in the sketch are subject to future refinement of the Track design. This will affect braking considerations. The sketch has used GK/RT 0075 Appendix A. Of interest will be the profile of the gradients on the new Down Charfield in respect of train handling especially the stone trains from Tytherington. This will also be considered as part of a driveability review.

Speed change meterages to be confirmed with track during future development stages. This will facilitate TPWS detailed design.

Train detection throughout is axle counter. All new train detection will be axle counters of a compatible type.

New signals will be LED type also of a compatible type for readability as the existing units.

All new and amended signal positions are subject to signal sighting assessment.

The provision of TPWS is shown as indicative in the sketch and will require refinement in subsequent design stages. This also applies to signal OSS and AWI TPWS.

Automatic Train Protection is only in use by GWR Class 80x units on the SWB The system is still mandated for use post Clapham. This equipment is apparently in short supply.

The line speed on the Up SWB between Stoke Gifford and Westerleigh Jnc. is 100mph. It is possible that

this could be raised to 125mph in the Up direction if required to improve timings. Further consideration of this is recommended.

The line speed on the Down SWB between Chipping Sodbury and Westerleigh Inc is 120mph, with a dip to 100mph at the junction and then rises to 125mph. Further consideration of raising this to 125mph is recommended.

Point operating equipment will be selected in line with NR policy.

OLE equipment, signage and track mounted equipment is subject to development. This includes the provision of IBJs needed for immunisation purposes. It is assumed that no

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plans for OLE will be required on the new Charfield lines apart from overrun de-wirement protection and pantograph raising at Upford jnc.

Several items of lineside furniture - location cases etc will have to be repositioned.

Power supply provision for the additional equipment will require review and strengthening as required.

Junction risk assessments and SORAT to be carried out.

The client in cooperation with the Route Asset Manager (Signals) will be able to advise any other E810 reasonable opportunity renewals as part of the development process.

5.1.3 Buildings, Civils and Geotech

The following concept sketches, included in Appendix B, show indicative proposals of infrastructure changes to accommodate the proposed track alignments for Option E3.

- 175662-NRD-WST-SWB-SKE-ECV-050301
- 175662-NRD-WST-SWB-SKE-ECV-050302
- 175662-NRD-WST-SWB-SKE-ECV-050303
- 175662-NRD-WST-SWB-SKE-ECV-050304
- 175662-NRD-WST-SWB-SKE-ECV-050305

The proposed infrastructure highlighted within the concept sketches have been considered at a high level only, to help inform the potential scale of intervention necessary. These could significantly change once greater information is known at the next design stage.

The following considerations below summarise the concept design approach for Options E3. These are also applicable to Options E4, E6 and E7;

- For any widening of embankments or cuttings it has been assumed a 30 degree earthwork slope will be provided, unless stated otherwise within specific sketches. An indicative extent of earthwork has been shown on these sketches, alongside the existing NR boundary to indicate where land purchase may be required. Later design development may improve this slope angle or could provide alternative solutions such as sheet piles to limit land take.
- B&C sketches exclude any temporary boundaries or land take required for construction, such as haul roads and compound areas.
- It is assumed that where proposed lines and/or significant realignment of track will be undertaken, a continuous position of safety will be provided (see design decisions DD20 & DD35 for details). The position of safety is assumed to be 2.3m where < 100mph and 3m where > 100mph from the nearest running rail to any slope or cutting edge. For simplicity, 2.3m has been used throughout for the sketches.
- Existing bridge structures affected by the works have been highlighted in the sketches. A recommendation for their widening, replacement or new adjacent structure has been made.

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The Design Decision Log 175662-NRD-WST-XXX-LOG-EMG-000001 included in Appendix G contains greater detail of decisions made, and items that should be included within any estimate.

Existing infrastructure affected by the proposals is tabulated within Appendix I. In addition, the following is to be noted within the sketches specific to Option E3

- Additional retaining wall included to the Southwest of structure SWB 109 27.5 BU (Down side) to limit land take adjacent to existing property.
- 108 78.5 BU has two additional large single-track three-span structures (one Up side / one Down side) to accommodate the new alignment.
- On Up side to the West of structure 108.52.5 BU it may be necessary to provide a retaining wall close to the existing land boundary to accommodate existing property boundaries.
- There are two large buildings identified within the sketch between structures 108 26.25 and 108 52.5 BU on the SWB (Down side). It is proposed that these are demolished, as it is unlikely any realignment could accommodate them fully.
- There have been historic earthwork failures close to structure 107 71.5 BU which could require further remedial works and should be investigated further at the next design stage.

5.1.3.1 Fly-Over Construction

For Option E3, two separate sketches have been produced to illustrate the fly-over proposal at Westerleigh Junction, covering both Enabling and Permanent Works.

5.1.3.1.1 Enabling Works

Enabling Works are shown on sketch 175662-NRD-WST-SWB-SKE-ECV-050304, included in Appendix B, and which outlines the indicative works required for the fly-over such as:

This sketch outlines the indicative enabling works required for Option E3 fly-over such as:

- Compound areas;
- Site accesses;
- Earthworks:
- Potential need to relocate OLE lineside equipment to the east of Westerleigh Road;
- The protection of listed structures;
- Amendments to existing retaining walls / wingwalls along Westerleigh Road.

5.1.3.1.2 Permanent Works

Two options have been proposed for the Civil Engineering permanent works of the junction, both of which are shown in sketch 175662-NRD-WST-SWB-SKE-ECV-050305.

• North of site (same for both options): generally, embankment widening is required leading to a three-span underbridge to carry the railway over Westerleigh Road. The structure is to be constructed to avoid Dolphine Cottage, a listed structure. There is a relay room (identified within the enabling works drawing) which may require

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relocation if adequate access to the room around the proposed bridge piers cannot be provided.

South of site: a multi span viaduct structure is required both to the East and West
of Westerleigh Road. Noting that existing YAT and SWB underbridges are
approximately 6m above existing road level, the southern crossover will be circa
12m above road level. Options 1 and 2 only differ in how the proposed crossover
goes over the SWB, namely:

Option 1

A line of piles is to be positioned either side of the SWB, within the cess. However; the construction methodology would need the line of piles to project onto the Down Yate. As such, and in order for this option to be viable whilst maintaining an Up and Down to the YAT, it would be necessary to construct the north site (all works north of the SWB) first, commissioning the northern line to become the YAT Up, whilst the existing YAT Up then temporarily becomes the YAT Down.

These piles will support a reinforced concrete wall constructed either side of the line, and precast beams installed over the SWB to form a portal structure. This portal structure will then carry the proposed YAT Down over the SWB.

Option 2

A truss overbridge will be constructed offline in land between the YAT and SWB. New Substructures will be constructed then the bridge launched over the SWB and highway during possession. This will allow both the north and south works to be constructed concurrently, saving significant programme time to that of Option 1.

Both options will necessitate temporary closures of the highway for key phases of the programme.

5.1.4 Electrification and Plant (Contact Systems)

Track design proposal option E3 involves quad tracking of the mainline as it approaches a proposed redesign of Westerleigh Junction, specifically, this design involves proposing a switch off the Up and Down Badmintons, at approximately 176.39km (SWB ELR) chainage. The turnout off the main lines clash with some existing OLE structures and would require the redesign of OLE in approximately 2 OLE spans in the vicinity of the proposed switches.

With the introduction of new tracks either side of the existing electrified up and down mainlines, there will be a requirement to confirm the OCLZ of the existing electrified lines against the new track. In line with NR/L2/ELP/21085, "conductive parts and equipment on a.c. electrified railways shall be assessed to determine if they are located within the OCLZ and/or CCZ.", this is to enable identification of any conductive parts that fall within the OCLZ zone that may be subject to becoming energised in the event of broken contact wire, and as a result provisions will need to be considered (i.e. bonding). In addition to the proposed quad tracking, there are proposed track alignment changes to the existing mainlines, which may result in changes to line speeds, as a result this will introduce a requirement to review the OLE wire grading against the proposed changes as the wire grading limits are a function of line speed. The existing OLE structure on the mainline

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should be able to accommodate the required modifications with respect to the proposed track realignments.

With the currently electrified mainlines and the new track design proposals, considerations will need to be made for potential passive provision for future electrification of the proposed lines and required minimum REFOS values. "New structures should have a nominal running Edge to Face of Steel (REFOS) dimension of 2.5m, where reasonably practicable". From review of the existing OLE design in the area, the existing REFOS values for the structures should be able to accommodate the proposed track changes of the mainline. And therefore, it is expected that apart from the areas where the branch off is proposed, and the redesign of Westerleigh junction, no removal or additional structures will be required to accommodate the realignment of the existing mainlines. Inspite of this, adjustments to the existing OLE will be required to ensure they remain compliant against the new track position; this will require onsite adjustments, and possibly replacement of SPS componentry.

For the quad tracking either side of the existing badminton mainlines, the proposed new track positions are offset approximately 10m from the existing electrified badminton lines, this provides sufficient distant to comfortably place OLE structures to accommodate passive provision for future electrification of the new tracks.

For the junction, the proposed track design locates the C.L of the Down Charfield at up to approximately 8m from the existing C.L at OLE structure YAT/172/216/DC, the proposed track then gradually merges to the existing track position as it approaches the Westerleigh road underbridge. This is also the case for the Up Charfield, however the proposed track C.L at YAT/172/216/DC against the existing is much greater at up to approximately 14m. Overrun protection is present on the Charfields, and consist of STC and TTC structures, in the event this track design proposal is selected, the existing OLE overrun protection at the junction will have to be removed and there will be no requirement for overrun protection at this location.

With the removal of the overrun protection at the junction, there will be a requirement for overrun protection from the proposed branch off from the Up Badminton. Overrun protection is to be designed in lined with NR/L2/ELP/27715/02.

With respect to the B&C design, several bridges have been proposed on the mainlines. With respect to bridges, the main interface with OLE to be considered is the required mechanical and electrical clearances between the conductor and bridge soffit. Required OLE clearances against a bridge are to be inline with NR/L2/ELP/27715/04, and as both designs develop, a level of interfacing will be required to achieve an optimum solution, which will most likely require modifications to the OLE. Currently, there is aerial ATF in the area, therefore as it stands, this will be the governing factor in determining the minimum bridge soffit height, however there is an opportunity to lower the ATF height (i.e., aerial insulated, grounded) to enable further optimization of the bridge design and bridge soffit height, this interface between B&C and OLE designer will need to take place as the design develops. In the event the ATF can be lowered to a height lower than the catenary height, then options to achieve clearance against the respective catenary wire can be explored. Specifically, the current guidelines with respect to required clearances are that clearances of 600mm between the bridge soffit and conductor are to be satisfied, if this cannot be achieved, the required

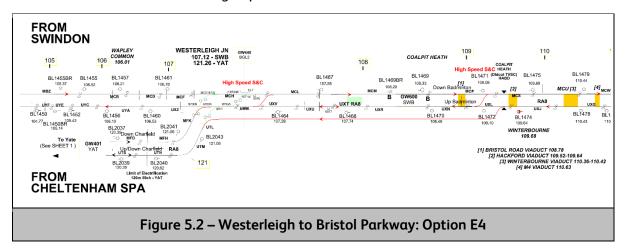
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clearance can be reduced to 370mm (basic clearance), on the condition solid contact wire can be spliced into the catenary wire in the areas around the respective bridge. If this is still unachievable, a further reduction of 270mm clearance (functional) can be applied provided there is spliced in contact wire, and a CSM-RA is carried out. Options to reduce the catenary and contact wire height to further optimize the bridge design can also be explored, this is to be considered as part of the interface between OLE and B&C as a single option design develops. Also, any proposed changes to existing line speeds would require a revaluation of the existing contact wire gradients, as the guidance governing wire gradients are based on linespeed, this is document in NR/L2/ELP/27715/01, which states "For speeds, up to and including 125mph (200km/h) the design values for gradient shall not exceed 1:5 times the line speed in miles per hour. The design values for changes in gradient shall not exceed 1:10 times the line speed in miles per hour." In addition, the inclusion of any new OLE structures and any changes to the signalling design will require a signal sighting assessment in line with relevant standards (i.e., NR/L2/SIG/10157).

5.2 Option E4: Westerleigh Junction High Speed Triple Tracking

Option E4 entails a simplified remodelling of Westerleigh Junction, providing higher speed S&C and bi-directional Up Main and Up side third track for approximately 2 miles. This effectively transfers the existing junction to the Coalpit Heath area, but providing additional resilience with the high-speed S&C.



5.2.1 Track

Option E4 represents a value-for-money, at-grade, three-tracking solution to the issues at Westerleigh junction.

This is shown on Track drawings 175662-NRD-WST-SWB-DRG-ETR-050401 and 050402, included in Appendix A.

The concept is to provide an additional track on the Up side by means of a high speed 75mph turnout low mileage of Winterbourne cutting that runs parallel to the Up Badminton and eventually curves round to become the Up Charfield. This enables separation of services closer to Bristol Parkway.

Westerleigh junction in its current form is removed and replaced with a single lead turnout connecting the Down Charfield with the Up Badminton, which becomes a bi-directional line.

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Two further high speed crossovers are provided, one in close proximity to the single lead to enable movements straight onto the Down Badminton from Down Charfield, the second crossover being located close to the Up side turnout prior to Winterbourne cutting. This provides layout flexibility with a bi-directional track (formerly Up Badminton) with two unidirectional tracks on the outside with two crossing points onto the Down Badminton to suit the operational requirements. The operational viability of this layout would need detailed analysis to ensure the required capacity and segregation of services.

The advantage of this option is construction and land acquisition only occur on the Up side, including embankment widening and additional underbridge structures. Some of the existing junction constraints are removed, including the maintenance liability of a double junction with switch diamond by replacement with a single lead turnout. Creation of a bidirectional section on the Up Badminton allows 75mph high speed crossover onto the Down line and 75mph onto the Up Charfield.

The constraint of the YAT ELR curvature still remains however which limits the speed. Refinement of this alignment and size / placement of the single lead S&C should be further optimised in the next design stage to increase the junction speed.

5.2.2 Signalling

The signalling proposal for Option E4 is outlined in drawing 175662-NRD-WST-SWB-SKE-ESG-050401, included in Appendix D.

5.2.2.1 Proposal

The proposal is for a new up direction junction between the Badminton line (SWB) and the Charfield Lines (BGL2) located approx. 2.25 miles to the West of the existing Westerleigh junction.

This new junction would enable a new Up Charfield line to run parallel to the Up Badminton to the existing Westerleigh junction, where it would swing to the north to connect on a new alignment (initially parallel to the existing Up Charfield line) to just south of the Westerleigh Road bridge.

In the Down direction the new Down Charfield would depart from its existing alignment just south of the Westerleigh Road bridge and then sweep in a right hand curve on a new alignment slightly to the east of the present curve and join the SWB on the Up line. A new trailing crossover is to be provided in place of the existing crossover to allow Down Charfield trains to gain the Down Badminton line at a higher speed than at present.

The "C2" Yate to Westerleigh line is unaffected by this proposal, but a review of the C2 method of working should be undertaken.

5.2.2.2 Upford Viaduct: New Junction

The proposal sees a new facing Up direction 75mph turnout that starts the new Up Charfield line. On approach to this, revised signalling will be provided that display flashing aspects for the Charfield line. Signal BL1480 is the second signal after departing Bristol Parkway station and the flashing double yellow aspect it would display will give early

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indication of the Charfield route being set. This will aid driveability and speed regulation of trains.

BL1474 signal which becomes the protecting signal for the new junction is already equipped with an ATP loop. It will not require to be fitted with TPWS (exclusion code C).

There is a MCPO in the area on the approach to BL1474 which may need modification. However, this mainly applies to Swindon bound electric trains which have come from Bristol TM via Filton

An alternative of splitting distants (not sketched) could be applied to the Up direction junction. However, this has been discounted due to the lack of any cost effective improvement to the information given by the flashing aspects.

The track design allows 100mph on the new Up Charfield. However, for driveability issues, the practical line speed will be less.

The down direction arrangements at the junction are unlikely to require alteration. However, SORAT and junction assessment will be required.

Down direction line speeds form Yate will require driveability assessment which will potentially reduce the effectiveness of the 50mph capable tailing crossover.

Coalpit Heath HABD may require additional sensors on the new Charfield lines and are subject to TOC discussion.

Facilities for turn back as per existing at Westerleigh junction will remain thus allowing turn back movements with the exception of the move from BL6576 to the Up Charfield.

5.2.2.3 Yate Area

Trains leaving Tytherington will require a new trailing crossover at Yate station in order to gain the Down Charfield. This route presently takes place by running wrong direction over the Up Charfield to Westerleigh and then over the trailing crossover on the SWB

Elevated PL signal BL 6565 may be considered for replacement with a main head to allow heavy stone trains from Tytherington to exit the branch line with better knowledge of the state of the line ahead. As a minimum a new MARI is required for the routes from that signal.

A proposal for a new Down loop line between Wickwar and Yate is shown in this sketch for completeness if that option is taken Up. The signalling on the Down line is therefore raised to 4-aspect to allow for better continuity and spacing of signalling between Yate and Westereligh on the new layout.

Common items

Gradients considered in the sketch are subject to future refinement of the Track design. This will affect braking considerations. The sketch has used GK/RT 0075 Appendix A.

Train detection throughout is axle counter. All new train detection will be compatible axle counters.

New signals will be LED type of also compatible for readability as the existing types.

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All new and amended signal positions are subject to signal sighting assessment.

The provision of TPWS is shown as indicative in the sketch and will require refinement in subsequent design stages. This also applies to signal OSS and AWI TPWS.

Automatic Train Protection is only in use by GWR Class 80x units on the SWB The system is still mandated for use post Clapham. This equipment is apparently in short sUpply.

The line speed on the Up SWB between Stoke Gifford and Westerleigh Jnc. is 100mph. It is possible that this could be raised to 125mph in the Up direction if required to improve timings. Further consideration of this is recommended.

The line speed on the Down SWB between Chipping Sodbury and Westerleigh Inc is 120mph, with a dip to 100mph at the junction and then rises to 125mph. Further consideration of raising this to 125mph throughout is recommended.

Point operating equipment will be selected in line with NR policy.

OLE equipment, signage and track mounted equipment is subject to development. This includes the provision of IBJs needed for immunisation purposes. It is assumed that no plans for OLE will be required on the new Charfield lines apart from up direction overrun dewirement protection at Upford jnc. and Down Charfield direction pantograph raising at Westerleigh.

Several items of lineside furniture - location cases etc will have to be repositioned.

Power supply provision for the additional equipment will require review and strengthening as required.

Junction risk assessments and SORAT to be carried out.

The client in cooperation with the Route Asset Manager (Signals) will be able to advise any other E810 reasonable opportunity renewals as part of the development process.

5.2.3 Buildings, Civils and Geotech

The following concept sketches, included in Appendix B, show indicative proposals of infrastructure changes to accommodate the proposed track alignments for Option E4.

- 175662-NRD-WST-SWB-SKE-ECV-050401
- 175662-NRD-WST-SWB-SKE-ECV-050402
- 175662-NRD-WST-SWB-SKE-ECV-050403

Option E3 section 5.1.3 provides further information about the general design concept approach taken.

Existing infrastructure affected by the proposals is tabulated within Appendix I. In addition, the following is to be noted within the sketches specific to Option E4

• 108. 78.5 BU has an additional large single-track structure (Up side) to accommodate the new alignment.

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- On Up side to the West of structure 108.52.5 BU it may be necessary to provide a retaining wall close to the existing land boundary to accommodate existing property boundaries.
- There have been historic earthwork failures close to structure 107 71.5 BU which could require further remedial works, albeit the failure was on the Down side and the proposed works are on the Up.

5.2.4 Electrification and Plant (Contact Systems)

The option E4 track proposal includes providing a turnout from the Up Badmington at approximate 176.39km (SWB ELR) chainage, this will run adjacent to the Up Badminton on its approach to Westerleigh Junction as it becomes the Up Charfield. This option also provides a new track profile for Westerleigh junction, realigning the existing Up and Down Charfield up to approximately the Westerleigh road underbridge.

The proposed turnout from the Up Badminton clashes with several existing OLE structures located on the Up Badminton Cess, this would require removal and redesign of the OLE in this vicinity. Beyond this, the new line is comfortably offset from Up Badminton line centre line; and would therefore introduce no issues with respect to enabling passive provision for future electrification of this new line, however there will no longer be a requirement to retain the existing overrun protection at Westerleigh junction. Instead, the overrun protection will be required from the turnout from the up. The extent of overrun protection is to be in line with NR/L2/ELP/27715/02, which states "The length of overrun protection may also be calculated by the legacy rule of 7.5m per km/h, using the line speed of the non-wired track, and a minimum of 1 span of equipment."

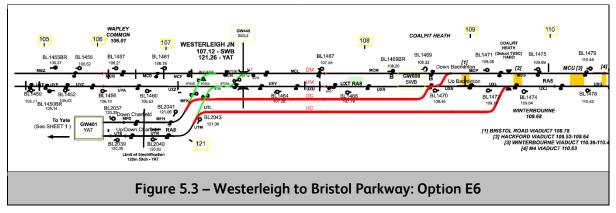
This option also includes a realignment of the existing switch crossing between the Up and Down Badminton and will therefore require modifications to the OLE to accommodate this; in general, OLE structures on the mainline (excluding the areas around the proposed switches off the mainline and Westerleigh junction), will not be required to be removed.

5.3 Option E6: Quad-Tracking at-Grade (Junction Transferred to Coalpit Heath)

Option E6 is an at-grade four-tracking solution of approximately 2 miles located east of Winterbourne cutting, to provide operational benefits by allowing segregation of GWR and CrossCountry services as well as fast and slow services. Two new additional tracks are provided to enable the service segregation and maximise the opportunity for fast services to overtake. Westerleigh Junction is relocated towards high mileage and reconfigured with high-speed S&C to minimise the duration of conflicting train paths as the tracks converge through Winterbourne cutting. The layout is shown in Figure 5.3.

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The proposed layout is a refinement of the one shown in the PACE 0 Technical Engineering Report, locating the proposed two tracks to the North of the existing Up Main. This presents several constructability benefits (e.g. limited impact to operations during construction, reduced impact to the existing OLE, etc.).

5.3.1 Track

Option E6 considers a four-tracking solution that removes the existing Westerleigh junction and relocates it closer to Bristol Parkway with a high speed S&C layout.

This is shown on Track drawings 175662-NRD-WST-SWB-DRG-ETR-050601 and 050602, included in Appendix A.

Westerleigh junction is removed and the Charfield lines curve round to run parallel to the Badminton lines on the Up side. The lines are offset by 10m to allow separate structures to be constructed alongside existing, and ensuring minimal disruption to the OLE structures. Land acquisition is required on the Up side only. Tight radius curvature remains on the YAT ELR that limits the linespeed to 55mph that increases to 100mph once parallel with the Badminton lines.

Four tracking enables separation of services closer to Bristol Parkway, and the lines converge via a new high-speed S&C layout fit for 75mph in the Down direction and 100mph in the Up direction. Optimisation of the S&C location is to be considered in the next design stage to minimise the impact on the underline structure design.

5.3.2 Signalling

The signalling proposal for Option E6 is outlined in drawing 175662-NRD-WST-SWB-SKE-ESG-050601, included in Appendix D.

5.3.2.1 Proposal

The proposal is for a new junction between the Badminton line (SWB) and the Charfield Lines (BGL2) located approx. 2.25 miles to the West of the existing Westerleigh junction.

This new junction would enable a new Up Charfield line to run parallel to the Up Badminton to the existing Westerleigh junction, where it would swing to the north to connect on a new alignment (initially parallel to the existing Up Charfield line) to just south of the Westerleigh Road bridge.

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In the Down direction the new Down Charfield would depart from its existing alignment just south of the Westerleigh Road bridge and then sweep in a right-hand curve on a new alignment slightly to the east of the present curve and run between the new up Charfiled and the existing Up Badminton.

A new trailing crossover is to be provided at Upford to allow Down Charfield trains to gain the Down Badminton line

The "C2" Yate to Westerleigh line is unaffected by this proposal, but a review of the C2 method of working should be undertaken.

5.3.2.2 Upford Viaduct: New Junction

The proposal sees a new facing Up direction 100mph turnout that starts the new Up Charfield line. On approach to this, revised signalling will be provided that display flashing aspects for the Charfield line. Signal BL1480 is the second signal after departing Bristol Parkway station and the flashing double yellow aspect it would display will give early indication of the Charfield route being set. This will aid driveability and speed regulation of trains.

BL1474 signal which becomes the protecting signal for the new junction is already equipped with an ATP loop. It will require to be fitted with TPWS and OSS (not shown)

There is a MCPO in the area on the approach to BL1474 which may need modification. However, this mainly applies to Swindon bound electric trains which have come from Bristol TM via Filton

An alternative of splitting distants (not sketched) could be applied to the Up direction junction. However, this has been discounted due to the lack of any cost-effective improvement to the information given by the flashing aspects.

The track design allows 100mph on the new Up Charfield. However, for driveability issues, the practical line speed may be less.

The down direction arrangements at the junction are such that 75mph capable points are to be used.

SORAT and junction assessment will be required.

Down direction line speeds form Yate will require driveability assessment which will potentially reduce the effectiveness of the 100mph capable track design between Westerleigh and Upford.

Coalpit Heath HABD may require additional sensors on the new Charfield lines and are subject to TOC discussion.

Facilities for turn back as per existing at Westerleigh junction will not be reproduced at Upford so run round will be required at Stoke Gifford.

New signals will be placed in parallel to the existing signals on the SWB wherever possible subject to sighting.

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5.3.2.3 Yate Area

Trains leaving Tytherington will require a new trailing crossover at Yate station in order to gain the Down Charfield. This route presently takes place by running wrong direction over the Up Charfield to Westerleigh and then over the trailing crossover on the SWB

Elevated PL signal BL 6565 may be considered for replacement with a main head to allow heavy stone trains from Tytherington to exit the branch line with better knowledge of the state of the line ahead. As a minimum a new MARI is required for the routes from that signal.

A proposal for a new Down loop line between Wickwar and Yate is shown in this sketch for completeness if that option is taken Up. The signalling on the Down line is therefore raised to 4-aspect to allow for better continuity and spacing of signalling between Yate and Westereligh on the new layout

Common items

Gradients considered in the sketch are subject to future refinement of the Track design. This will affect braking considerations. The sketch has used GK/RT 0075 Appendix A. Of interest will be the profile of the gradients on the new Down Charfield in respect of train handling especially the stone trains from Tytherington. This will also be considered as part of a driveability review.

Train detection throughout is axle counter. All new train detection will be axle counters of a compatible type.

New signals will be LED type also of a compatible type for readability as the existing units.

All new and amended signal positions are subject to signal sighting assessment.

The provision of TPWS is shown as indicative in the sketch and will require refinement in subsequent design stages. This also applies to signal OSS and AWI TPWS.

Automatic Train Protection is only in use by GWR Class 80x units on the SWB The system is still mandated for use post Clapham. This equipment is apparently in short supply.

The line speed on the Up SWB between Stoke Gifford and Westerleigh Jnc. is 100mph. It is possible that

this could be raised to 125mph in the Up direction if required to improve timings. Further consideration of this is recommended.

The line speed on the Down SWB between Chipping Sodbury and Westerleigh Jnc is 120mph, with a dip to 100mph at the junction and then rises to 125mph. Further consideration of raising this to 125mph throughout is recommended.

Speed change meterages to be confirmed with track during future development stages. This will facilitate TPWS detailed design.

Point operating equipment will be selected in line with NR policy.

OLE equipment, signage and track mounted equipment is subject to development. This includes the provision of IBJs needed for immunisation purposes. It is assumed that no

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plans for OLE will be required on the new Charfield lines apart from up direction overrun dewirement protection at Upford jnc. and Down Charfield direction pantograph raising at Westerleigh.

Several items of lineside furniture - location cases etc will have to be repositioned.

Power supply provision for the additional equipment will require review and strengthening as required.

Junction risk assessments and SORAT to be carried out.

The client in cooperation with the Route Asset Manager (Signals) will be able to advise any other E810 reasonable opportunity renewals as part of the development process.

5.3.3 Buildings, Civils and Geotech

The following concept sketches, included in Appendix B, show indicative proposals of infrastructure changes to accommodate the proposed track alignments for Option E6.

- 175662-NRD-WST-SWB-SKE-ECV-050601
- 175662-NRD-WST-SWB-SKE-ECV-050602
- 175662-NRD-WST-SWB-SKE-ECV-050603

Option E3 section 5.1.3 provides further information about the general design concept approach taken.

Existing infrastructure affected by the proposals is tabulated within Appendix I. In addition, the following is to be noted within the sketches specific to Option E6.

- 108 78.5 BU has an additional large single-track structure (Up side) to accommodate the new alignment.
- On the Up side to the west of structure 108 52.5 BU it may be necessary to provide a retaining wall close to the existing land boundary to accommodate existing property boundaries.
- There have been historic earthwork failures close to structure 107 71.5 BU which could require further remedial works, albeit the failure was on the Down side and the proposed works are on the up.

5.3.4 Electrification and Plant (Contact Systems)

Track proposal option E6 proposes a four-track solution with turn outs from the mains with both branching off onto the same cess of the existing up badminton, with the current profile of Westerleigh junction removed. The two proposed lines branch off the mains at approximately 175.6km and 174.5 (SWB ELR), and continues towards to become the Up and Down Charfield. With this proposal, the existing overrun protection on the Westerleigh junction (YAT ELR) will no longer be required, and there will be a requirement to provide overrun protection for the new turnout from the up badminton. The double tracking is located approximately 9m away from the Up Badminton, removing any issues related to OLE clearances and OCLZ zone, and also provides passive provision for future electrification, however the two sets of switches running off the Up Badminton clash with approximately

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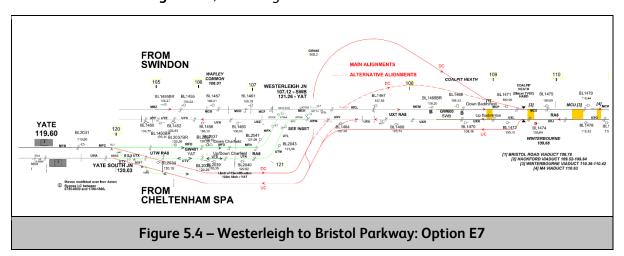
3 OLE structure foundations on the Up Badminton Cess, which would therefore require removal and redesign of the OLE in this area.

This track option provides a new track profile as the two new tracks become the YAT lines, this option will require removal of the existing OLE (overrun protection). This proposal also involves an amount of track realignment of the Up and Down Badminton at approximately 171.754km (SWB ELR). Based on the existing OLE setup, the existing OLE structures on the mainline outside the switch area and Westerleigh junction that is impacted by the track realignment should have available adjustability to accommodate the track design.

5.4 Option E7: New Connection to Westerleigh Branch Line

Option E7 makes use of the existing grade separated junction between the GWML and Westerleigh Branch. The existing Westerleigh junction constraint is compounded by the low linespeed on the curve round to Yate. This option seeks to remove this constraint by using the more direct Westerleigh branch with flatter curves to the GWML to increase the linespeed. The freight route to Westerleigh fuel depot must be preserved. Two track alignments are considered:

- Main alignment, making use of the existing grade separation.
- Alternative alignment, involving a dive-under structure under the GWML.



5.4.1 Track

Option E7 is a fully grade separated (diveunder) remodelling with four tracking.

5.4.1.1 Main Alignment

The initial concept was to investigate using the existing Westerleigh Single route as a means of grade separating the junction since this already passes beneath the Badminton lines.

This is shown on Track drawings 175662-NRD-WST-SWB-DRG-ETR-050701 to 050704, included in Appendix A.

The Up and Down Charfield would realign onto the freight only corridor from Yate South Junction, the Down Charfield passing beneath the Badminton lines before curving round on new alignment to rise and rejoin the Down Badminton. The Up Charfield leaves the

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Westerleigh corridor, curves round on new alignment and rises to meet the Up Badminton. The current Westerleigh Junction would be removed.

Whilst the existing junction constraints are removed, this option still requires tight radius curvature on the Down Charfield once it passes beneath the Badminton lines such that the linespeed is only marginally increased to 60mph and the minimum radius is R=395m with maximum permitted design values for cant and cant deficiency. The alignment of this route would require extensive land acquisition through farmland.

The Up Charfield would also require new alignment and leaves the Westerleigh corridor much sooner in order to curve round and join the Up Badminton and is also constrained by curvature to 60mph.

There is still a requirement for freight services to access Westerleigh depot, therefore a turnout has been provided off the proposed Down Charfield before it leaves the corridor and curves round. In order for freight services to leave Westerleigh depot they need to cross from the Down to Up Charfield so a new crossover has been provided. Since the Charfield lines separate to align either side of the Badminton lines, the distance between the turnout and crossover for freight moves is considerable meaning freight travelling in the Up direction would occupy the Down Charfield 'wrong-road' for approximately 1km which would impose an operational restriction. Refinement of the track layout could reduce this distance in the next design stage but nevertheless the operational restriction is still undesirable.

5.4.1.2 Alternative Alignment

Once the constraints covered in section 5.4.1.1 became known during the design development, an alternative version of Option E7 was developed that sought to remove the operational and speed constraints.

This is shown on Track drawings 175662-NRD-WST-SWB-DRG-ETR-050711 to 050713, included in Appendix A.

As per the original concept, the Up and Down Charfield lines are realigned from Yate South Junction onto the Westerleigh corridor, continuing the existing linespeed of 100mph. A crossover and turnout is provided that allows freight to continue down the Westerleigh branch and return via the Up Charfield. The S&C is in close proximity such that the operational constraint of crossing the Down Charfield is minimised and occurs over a length of approximately 150m.

Both Charfield lines leave the corridor and cut across farmland on new alignment, the Up line steadily rising to meet the Up Badminton via a high speed S&C unit. Preliminary design shows this at 50mph but further refinement in the next stage should enable 75mph, constrained only by the S&C turnout speed.

The Down Charfield lines continues to fall and passes beneath the Badminton lines via a new diveunder structure that cuts through the existing embankment, before steadily rising to meet the Down Badminton. This alignment is shown in preliminary design with a minimum linespeed of 65mph but it is expected that refinement in the next stage of design

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would be able to achieve 75mph, constrained only by the S&C turnout speed connecting to the Down Badminton.

The existing junction is removed and replaced with plain line. The YAT lines between Westerleigh and Yate South Junctions would also be removed. During design development the possibility was raised of keeping these lines and the junction as a holding point for freight or stopping services, allowing the high speed intercity services to bypass using the diveunder. Yate South junction would need completely reconfiguring to allow this and the maintenance liability of the Westerleigh junction in its current format would remain.

Overall, this option presents a significant opportunity to remove the operational, linespeed and maintenance constraints of the existing junction.

5.4.2 Signalling

The signalling proposals for Option E7 are outlined in the following sections.

5.4.2.1 Main Alignment

The signalling proposal for Option E7: Main alignment is outlined in drawing 175662-NRD-WST-SWB-SKE-ESG-050701, included in Appendix D.

The proposal is for a new running flat junction between the Badminton line (SWB) and the Charfield Lines (BGL2) located approx. 2.25 miles to the west of the existing Westerleigh junction.

This new junction would enable a new Up Charfield line to run parallel to the Up Badminton to approx. 0.5miles to the west of the existing Westerleigh junction, where it would swing to the north to connect with the existing Up Charfield line just south of Yate Station.

In the down direction the new Down Charfield would depart from its existing alignment at Yate south to follow the former Midland Railway [MR] line to just south of the SWB overbridge and then sweep in a right-hand curve to run parallel to the SWB to the new trailing junction 2.25 miles to the West.

The "C2" Yate to Westerleigh line is to be connected to the new Down Charfield just south of the SWB overbridge with a new junction. This line would then be controlled by TCB as opposed to its existing C2 method of operation.

5.4.2.1.1 Upford Viaduct: New Junction

The proposal sees a new facing up direction 75mph turnout that starts the new Up Charfield line. On approach to this, revised signalling will be provided that display flashing aspects for the Charfield line. Signal BL1480 is the second signal after departing Bristol Parkway station and the flashing double yellow aspect it would display will give early indication of the Charfield route being set. This will aid driveability and speed regulation of trains.

BL1474 signal which becomes the protecting signal for the new junction is already equipped with an ATP loop. It will not require to be fitted with TPWS (exclusion code C).

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There is a MCPO in the area on the approach to BL1474 which may need modification. However, this mainly applies to Swindon bound electric trains which have come from Bristol TM via Filton

An alternative of splitting distants (not sketched) could be applied to the Up direction junction. However, this has been discounted due to the lack of any cost-effective improvement to the information given by the flashing aspects.

The track design allows 100mph on the new up Charfield. However, for driveability issues, the practical line speed will be less.

The new down direction junction is a straightforward trailing arrangement. The existing signal BL1471 will require TPWS TSS and OSS and also an ATP alteration. The signal BL2049 will require TPWS TSS & OSS

Similarly to the Line speed on the up Charfield, the down Charfield line speed will be less than as designed for driveability.

Coalpit Heath HABD may require additional sensors on the new Charfield lines and are subject to TOC discussion.

Facilities for turn back as per existing Westerleigh junction will not be reproduced at Upford. Any train that requires to come from Yate bound for Swindon via the SWB will have to run round at Stoke Gifford.

5.4.2.1.2 Yate Area

The Charfield lines are constructed on the former MR line and this requires a revision of the layout at Yate south. A new junction — Westerleigh New is proposed where the Up/Down Westerleigh branches from the new alignment just to the north of the SWB overbridge. To enable trains to exit the Westerleigh branch and regain the Up Charfield, a new set of points is proposed at another new junction — Nibley.

However, an alternative position for this crossover is at Yate station which gives a train leaving Tytherington to gain the Down Charfield much earlier than at Nibley. It also allows better access for maintenance.

A short section of bidirectional running is therefore inevitable between Yate and Westerleigh New.

Elevated PL signal BL 6565 is proposed for replacement with a main head BL2029 to allow heavy stone trains from Tytherington to exit the branch line with better knowledge of the state of the line ahead.

A proposal for a new down loop line between Wickwar and Yate is shown in this sketch for completeness if that option is taken up. The signalling on the down line is therefore raised to 4-aspect to allow for better continuity and spacing of signalling between Yate and Upford on the new alignment.

The GPL BL6562 becomes redundant and may be recovered. This would allow alterations to the proposed down Yate loop such that BL2023 and BL2071 to become automatic signals.

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Replacement signalling facilities are provided to turnback Engineering Machines e.g. Tampers that depart from the up/down Westerleigh line requiring to proceed to Bristol.

5.4.2.1.3 Westerleigh Branch

At present the line to Westerleigh oil terminal is operated under C2 provision. With the major alterations in the area, there is a reasonable opportunity to improve the method of operation to TCB. This would only require one extra signal at the oil terminal to allow trains on the line in the up direction.

On the line there are two level crossings which need to be reviewed for protection suitability.

In particular Broad Farm FPC will require the protecting signal that would normally be at the end of the branch to a position to its south. This will minimise the potential trespass risk if a long train waiting to leave the line straddles the crossing if the branch exit signal was placed in the former position.

5.4.2.1.4 Common Items

Gradients considered in the sketch are subject to future refinement of the Track design. This will affect braking considerations. The sketch has used GK/RT 0075 Appendix A.

Of interest will be the profile of the gradients on the new Down Charfield in respect of train handling especially the stone trains from Tytherington. This will also be considered as part of a driveability review.

Train detection throughout is axle counter. All new train detection will be axle counters of a compatible type.

New signals will be LED type also of a compatible type for readability as the existing units.

All new and amended signal positions are subject to signal sighting assessment.

The provision of TPWS is shown as indicative in the sketch and will require refinement in subsequent design stages. This also applies to signal OSS and AWI TPWS.

Automatic Train Protection is only in use by GWR Class 80x units on the SWB The system is still mandated for use post Clapham. This equipment is apparently in short supply.

The line speed on the up SWB between Stoke Gifford and Westerleigh Jnc. is 100mph. It is possible that

this could be raised to 125mph in the up direction if required to improve timings. Further consideration of this is recommended.

The line speed on the down SWB between Chipping Sodbury and Westerleigh Inc is 120mph, with a dip to 100mph at the junction and then rises to 125mph. Further consideration of raising this to 125mph is recommended.

Speed change meterages to be confirmed with track during future development stages. This will facilitate TPWS detailed design.

Point operating equipment will be selected in line with NR policy.

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OLE equipment, signage and track mounted equipment is subject to development. This includes the provision of IBJs needed for immunisation purposes. It is assumed that no plans for OLE will be required on the new Charfield lines apart from overrun de-wirement protection and pantograph raising at Upford jnc.

Several items of lineside furniture - location cases etc will have to be repositioned.

Power supply provision for the additional equipment will require review and strengthening as required.

Junction risk assessments and SORAT to be carried out.

The client in cooperation with the Route Asset Manager (Signals) will be able to advise any other E810 reasonable opportunity renewals as part of the development process.

5.4.2.2 Alternative Alignment

The signalling proposal for Option E7: Alternative alignment is outlined in drawing 175662-NRD-WST-SWB-SKE-ESG-050702, included in Appendix D.

The proposal is for two new running junctions between the Badminton line (SWB) and the Charfield Lines (BGL2) located approx. 0.75 miles and 2.25 miles to the west of the existing Westerleigh junction.

The new up junction 0.75 miles to the west would enable a new Up Charfield line to swing to the north to connect with the existing Up Charfield line just south of Yate Station.

In the down direction the new Down Charfield would depart from its existing alignment at Yate south on a new cut that would curve to the west and cross underneath the SWB by means of a new underbridge and then run parallel to the SWB to the new trailing junction 2.25 miles to the west.

The "C2" Yate to Westerleigh line is to be connected to the new Down Charfield just south of the Nibley road overbridge with a new junction. This line would then be controlled by TCB as opposed to its existing C2 method of operation.

5.4.2.2.1 Westerleigh Junction – Revised position and improved diverging speed of Up Badminton turnout.

The proposal sees a new facing up direction 50mph turnout that starts the new Up Charfield line. On approach to this revised signalling will be provided that will display flashing aspects for the Charfield line starting at BL1472. This will aid driveability and speed regulation of trains. BL1468 becomes the junction signal vice BL1464 which becomes an automatic signal.

An alternative of splitting distants (not sketched) could be applied to the Up direction junction. However this has been discounted due to the lack of any cost effective performance improvement to the information given by the flashing aspects.

A new ATP loop is required for BL1468

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5.4.2.2.2 Upford Viaduct: New Trailing Junction

The new down direction junction is a straightforward trailing arrangement. The existing signal BL1471 will require TPWS TSS and OSS and also an ATP alteration. The signal BL2049 will require TPWS TSS & OSS

The line speed on the down Charfield line speed will be less than as designed for driveability and will have to be assessed jointly with the TOCs.

Coalpit Heath HABD may require additional sensors on the new down Charfield line and is subject to TOC discussion.

Facilities for turn back as per existing Westerleigh junction will not be reproduced at Upford or the repositioned Up Junction at Westerleigh. Any train that requires to come from Yate bound for Swindon via the SWB will have to run round at Stoke Gifford.

5.4.2.2.3 Yate Area

The Charfield lines are constructed on the former MR line and this requires a revision of the layout at Yate south. A new junction (Nibley) is proposed just south of the road overbridge with the same name to allow the Up/Down Westerleigh to branch from the new alignment at this point. To enable trains to exit the Westerleigh branch and regain the Up Charfield, a new crossover is proposed at this junction

However, an alternative position for this crossover is at Yate station which gives a train leaving Tytherington to gain the Down Charfield much earlier than at Nibley.

A short section of bidirectional running is therefore inevitable between Yate and Nibley

Elevated PL signal BL 6565 is proposed for replacement with a main head BL2029 to allow heavy stone trains from Tytherington to exit the branch line with better knowledge of the state of the line ahead.

The GPL BL6562 becomes redundant and may be recovered. This would allow alterations to the proposed down Yate loop such that BL2023 and BL2071 to become automatic signals.

A proposal for a new down loop line between Wickwar and Yate is shown in this sketch for completeness if that option is taken up. The signalling on the down line is therefore raised to 4-aspect to allow for better continuity and spacing of signalling between Yate and Upford on the new alignment.

Replacement signalling facilities are provided to turnback Engineering Machines (e.g. tampers) that depart from the up/down Westerleigh line requiring to proceed to Bristol.

5.4.2.2.4 Westerleigh Branch

At present the line to Westerleigh oil terminal is operating under C2 provision. With the major alterations in the area, there is a reasonable opportunity to improve the method of operation to TCB. This would only require one extra signal and minimal extra train detection at the oil terminal to allow trains on the line in the up direction.

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On the line there are two level crossings which need to be reviewed for protection suitability. Broad Farm FPC will be approx.. 1000m from the junction signal and it is thought that this will be sufficient to minimise the potential trespass risk if a long train is waiting to leave the line and is straddling the crossing. This will be confirmed in future development stages.

5.4.2.2.5 Common Items

Gradients considered in the sketch are subject to future refinement of the Track design. This will affect braking considerations. The sketch has used GK/RT 0075 Appendix A. Of interest will be the profile of the gradients on the new Down Charfield in respect of train handling especially the stone trains from Tytherington. This will also be considered as part of a driveability review.

Train detection throughout is axle counter. All new train detection will be axle counters of a compatible type.

New signals will be LED type also of a compatible type for readability as the existing units.

All new and amended signal positions are subject to signal sighting assessment.

The provision of TPWS is shown as indicative in the sketch and will require refinement in subsequent design stages. This also applies to signal OSS and AWI TPWS.

Automatic Train Protection is only in use by GWR Class 80x units on the SWB The system is still mandated for use post Clapham. This equipment is apparently in short suppy.

The line speed on the up SWB between Stoke Gifford and Westerleigh Jnc. is 100mph. It is possible that

this could be raised to 125mph in the up direction if required to improve timings. Further consideration of this is recommended.

The line speed on the down SWB between Chipping Sodbury and Westerleigh Inc is 120mph, with a dip to 100mph at the junction and then rises to 125mph. Further consideration of raising this to 125mph is recommended.

Speed change meterages to be confirmed with track during future development stages. This will facilitate TPWS detailed design.

Point operating equipment will be selected in line with NR policy.

OLE equipment, signage and track mounted equipment is subject to development. This includes the provision of IBJs needed for immunisation purposes. It is assumed that no plans for OLE will be required on the new Charfield lines apart from overrun de-wirement protection and pantograph raising at Upford jnc.

Several items of lineside furniture - location cases etc will have to be repositioned.

Power supply provision for the additional equipment will require review and strengthening as required.

Junction risk assessments and SORAT to be carried out.

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The client in cooperation with the Route Asset Manager (Signals) will be able to advise any other E810 reasonable opportunity renewals as part of the development process.

5.4.3 Buildings, Civils and Geotech

The following concept sketches, included in Appendix B, show indicative proposals of infrastructure changes to accommodate the proposed Alternative Alignment for Option E7.

- 175662-NRD-WST-SWB-SKE-ECV-050701
- 175662-NRD-WST-SWB-SKE-ECV-050702
- 175662-NRD-WST-SWB-SKE-ECV-050703

Option E3 section 5.1.3 provides further information about the general design concept approach taken.

Existing infrastructure affected by the proposals is tabulated within Appendix I. In addition, the following is to be noted within the sketches specific to Option E7

- On Up Side to the west of structure 108.52.5 BU it may be necessary to provide a retaining wall close to the existing land boundary to accommodate existing property boundaries.
- There are two large buildings identified within the sketch between structures 108 26.25 and 108 52.5 BU on the SWB on the Down side. It is proposed that these are demolished, as it is unlikely any realignment could accommodate them fully.
- There have been historic earthwork failures close to structure 107 71.5 BU which could require further remedial works.
- The SWB down is to pass beneath the SWB. The position on the dive under is located at a position of a previous earthwork failure.

5.4.3.1 Main Alignment

No Civil Engineering commentary is provided for the main alignment.

5.4.3.2 Alternative Alignment

The existing embankment is approximately 8m high, and therefore there would be minimal excavation below the existing toe of embankment, for the tunnel itself.

The dive under structure is approximately 90m long and highly skewed to the SWB. It is possible for this curved structure to be installed in a similar manner to Werrington Grade Separation project whereby the SWB could be closed, the track removed, and the embankment cut to allow pushing / sliding through of an offline precast concrete portal within the void created. The excavated surface would need to be prepared with a ground slab to allow such a slide. Once installed the area would be backfilled to allow reinstatement of the SWB.

The above would require a competent formation level. Where piling or ground improvement is required any closure of SWB would need prolonging to provide appropriate foundations for the prefabricated portal / box to bear on.

If significant foundations are required an alternative option is to close the SWB and

- contiguous pile along the line of the dive under (possibly changing to tied sheet piles on the approaches) to form the abutment / tunnel walls.

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- create a bridge deck span (approximately 8m clear square span) integralised with the piled walls, and then reinstated the SWB onto the new bridge deck
- The ground below the new bridge deck can be excavated below the deck, whilst the SWB remains open. Dependant upon ground conditions the floor slab of the tunnel may have to be piled to competent ground.

Ground investigation would be required to ascertain ground strength parameters to confirm whether there is sufficient ground bearing resistance to seat the structure on shallow foundations on material at 5 mbgl or whether ground improvement or piling will be required to target deeper more competent strata.

5.4.4 Electrification and Plant (Contact Systems)

5.4.4.1 Main Alignment

Track design proposal E7 proposes to remove the existing junction at Westerleigh and provide a new connection to the Bristol and Gloucester line. This option proposes branching off from the up badminton at approximately 176.099km (SWB ELR) before its approach to the Up Charfield. This option also includes a connection from the Down Charfield to the down badminton at approximately 176.099km (SWB ELR) chainage. This proposal would require the removal of the existing overrun protection at Westerleigh junction and introduce a requirement for overrun protection from the proposed branch off the up badminton. Additionally, the proposed distance between the down badminton and the proposed adjacent line is approximately 8m, which provides sufficient clearance to remove any issues related to OCLZ and also sufficient scope for passive provision for future electrification. The quad tracking areas in this design will have no impact on the existing OLE, the main areas where the OLE is impacted is at the proposed switches off the mains, and Westerleigh junction.

To conclude, there are no constraints that would prevent the OLE to be modified and accommodate the proposed track design.

5.4.4.2 Alternative Alignment

This proposal includes switches on the Up and Down Badminton towards a new junction that connects to the BGL2 lines. The proposed switch from the Down Badminton that is located at approximately 174.490km (SWB ELR); and the switch clashes with up to 3 OLE structures; therefore, this design proposal would require the removal of these structures and an OLE redesign in this respective vicinity. this branch of the Down Badminton then continues along the existing cess side of the Down Badminton and sits approximately 8m away from the track centre line of the down badminton, providing sufficient distance to accommodate future electrification of this line.

This design proposal also provides a switch off from the Up Badminton as a connection to the BGL2 lines, this connection is located approximately at 173/008km (SWB ELR). This branch off the Up Badminton does clash with at least one existing OLE structure, and therefore a removal and replacement of this structure is required in the event this option is progressed.

This design also proposes the removal of the existing Westerleigh junction, which will mean a removal of the existing overrun protection present at the junction. There will still however

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be a requirement for overrun protection, this will be required from the proposed branch off the Up Badminton.

In addition, any changes to line speeds on the existing electrified routes will require the existing OLE to be assessed to accommodate these changes. This option also proposes the branch off from the down badminton to pass through the Midland Railway Underbridge. If this option is pursued, consideration for passive provision for electrification in terms required electrical clearances would need to be considered in line with GL/RT1210 and 27715 Mod 4.

With respect to bridges, the main interface with OLE to be considered is the required mechanical and electrical clearances between the conductor and bridge soffit. Required OLE clearances against a bridge are to be in line with NR/L2/ELP/27715/04, and as both designs develop, a level of interfacing will be required to achieve an optimum solution, which will most likely require modifications to the OLE. Currently, there is aerial ATF in the area, therefore as it stands, this will be the governing factor in determining the minimum bridge soffit height, however there is an opportunity to lower the ATF height (i.e., aerial insulated, grounded) to enable further optimization of the bridge design and bridge soffit height, this interface between B&C and OLE designer will need to take place as the design develops. In the event the ATF can be lowered to a height lower than the catenary height, then options to achieve clearance against the respective catenary wire can be explored. Specifically, the current guidelines with respect to required clearances are that clearances of 600mm between the bridge soffit and conductor are to be satisfied, if this cannot be achieved, the required clearance can be reduced to 370mm (basic clearance), on the condition solid contact wire can be spliced into the catenary wire in the areas around the respective bridge. If this is still unachievable, a further reduction of 270mm clearance (functional) can be applied provided there is spliced in contact wire, and a CSM-RA is carried out. Options to reduce the catenary and contact wire height to further optimize the bridge design can also be explored, this is to be considered as part of the interface between OLE and B&C as a single option design develops.



6 Interfacing Projects

Several interfaces with other projects currently under development have been identified and are listed in Table 6.1. The information has been provided by the Client, expanded with internal knowledge by NRDD.

Table 6.1 – Interfacing projects

Project	Status	Dates	Summary	Disciplines
Bristol to Birmingham and Bristol to Exeter Corridor Studies	Development	Studies completed 2021	Strategic studies completed in 2021 and endorsed by key stakeholders, which have proposed both train service and infrastructure improvements,	All
Greater Bristol Strategic Study	Development	Study to be completed 2022	Area-wide strategic study building on outputs of Bristol Corridor studies. In partnership with Western Gateway Sub-national Transport Body, West of England Combined Authority, local authorities and operators. Developing proposals for passenger and freight service improvements and associated infrastructure requirements.	All
Restoring Your Railway (RYR) proposal for a new station at Bristol Road, Stonehouse	Development	Study to be completed 2022	RYR scheme led by Stroud District Council promoting a new station north of Cam & Dursley, also considering a South of Gloucester option.	None
Bristol area timetable enhancements inc partial MetroWest	Confirmed		2 nd tph BTM to Gloucester Second train every 2 hours Gloucs to Worcester	All
Cross City Line South new trains	Confirmed		Introduction of class 730 stock on Cross City Line South services	All
Birmingham – Worcs/Hereford new trains	Confirmed		New class 196 trains replacing current 170's between Bristol and Worcs/ Hereford	Non
CrossCountry enhancements	Confirmed		Additional capacity on XCountry services through longer class 170s to Cardiff and greater use of HST fleet. Extension of some Bristol starters to Exeter.	None

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Project	Status	Dates	Summary	Disciplines
Cheltenham to Cardiff timetable enhancement	Confirmed		1 tph Cheltenham to Cardiff	None
Gloucester resignalling phase 1	Confirmed		Renewal of the interlocking and panel at Gloucester PSB, transferring these onto modern technology platform. This is in preparation for the proposed future stages of resignalling.	
West Midlands new stations	Confirmed		New stations at Hazelwell, Moseley, and Kings heath between Kings Norton and Birmingham NS on the Camp Hill line to be serviced by 2 tph services	Unknown
Exeter Life extension	Confirmed	CP6	Upgrade of signalling equipment around Exmouth to Topsham/ Exeter area and between Cogload and Taunton East Junct and Totness to Aller Junc.	None
University station redevelopment	Development		Redevelopment of University Station to significantly increase passenger capacity and improve access to the university and Hospital.	None
Midlands Rail Hub	Development		Additional 1tph Birmingham MS to Cardiff Additional 1 tph BMS to Bristol TM Additional 1 tph BMS to Hereford/ Worcs	Signalling
MetroWest Severn Beach (previously Phase 1a)	Delivered		Hourly services on the Severn Beach Line to Bristol Temple Meads Half hourly from Avonmouth to Bristol Temple Meads	None
MetroWest Bath & Westbury (previously Phase 1a)	Development		Half hourly services from Bristol Temple Meads to Bath to Westbury	None
MetroWest Portishead Line (previously Phase 1b)	Development		Re-opening of the Portishead Line providing an hourly service between Portishead and Bristol Temple Meads with new stations at Pill and Portishead.	None
MetroWest Portway Station Promoted by Bristol City Council	Development		As part of the MetroWest Severn Beach Line, half hourly services will call at a new station at Portway and will serve the adjacent Park and Ride site	None

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Project	Status	Dates	Summary	Disciplines
MetroWest Henbury Line (previously Phase 2)	Development		Re-opening of the Henbury Line with new stations at Henbury, North Filton and Ashley Down, providing an hourly service from Bristol Temple Meads to Filton Abbey Wood and onto North Filton and Henbury.	
MetroWest Yate & Gloucester Line (previously Phase 2)	Development		Half hourly services between Bristol Temple Meads and to Gloucester via Yate	All
Filton Bank electrification	Development		Continuation of electrification on all lines from Bristol Parkway to BTM	E&P CS
Charfield Station	Development (GRIP 4)		New station at Charfield located between Yate and Cam & Dursley	All
Gravity/ Huntspill reconnection	Development	Potential 2025	Reconnection of historic freight site potentially to include both passenger and freight services	Unknown
Traction Decarbonisation Network Strategy (TDNS) and Regional Decarbonisation Strategies	Development		Phased programme of network decarbonisation including Filton Bank electrification (see above) as part of first tranche.	None
Abbottswood Junction Enhancement	Development		Improved Junction capacity to accommodate enhanced train services	None
Bristol Temple Meads Masterplan	Development		Station upgrade to increase capacity and provide improved passenger facilities including two new platforms and two new station entrances	None
Bristol Temple Meads Eastern Entrance	In delivery		Ongoing work to create a new entrance to link the station to the new University of Bristol campus and Temple Quarter by extending the existing subway through the wall at platforms 13 and 15.	None
North Cotswolds Line transformation	Development		Improved off-peak connectivity between Worcester and Oxford/ London	None

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Project	Status	Dates	Summary	Disciplines
Wells and Corondale LX closures/ FB construction	Development		Potential closure of two pedestrian level crossings with associated construction of FB near to Weston Milton station.	None
Step-Free Stations Led by the West of England Combined Authority	Development		The West of England 10-Year Rail Delivery Plan contains an aspiration to make all stations in the West of England step-free and fully accessible by 2030. The current programme of works will deliver step-free access at five stations which were identified as an initial priority in a recent bid by the West of England Combined Authority to the levelling up Fund:— Lawrence Hill, Parson Street, Stapleton Road, Oldfield Park, Bedminster. This work will build on the outputs from a recent programme of station accessibility audits.	None
Access for All Mid-Tier Station Enhancements Led by the West of England Combined Authority	Development		Works to deliver station enhancements for improved wayfinding, seating and shelters at Freshford, Lawrence Hill, Nailsea & Backwell, Parsons Street, Patchway, Severn Beach, Stapleton Road, and Yate. These works will be delivered in two phases, with outline design being undertaken first, followed by detailed design and construction.	None
Gloucester new route from G333 signal				None
Track renewals Group of 673A/B	Development		Renewal of 673A/B points.	None
Bristol Area Re-Signalling	Snagging			None

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7 Putting Passengers First

Putting Passengers First strategies are embedded within this report, as a result of this design process which aims to deliver a better service for passengers, freight, customers and stakeholders. Some PPF key considerations are listed below:

- Increased capacity for freight and passenger services;
- Enhanced operational resilience;
- Line speed improvements.

8 Health and Safety by Design

Network Rail H&SbD principles have been applied throughout the design of this scheme, aligning with ORR's strategy for Health and Safety by Design (Strategy for the regulation of health and safety risks: Chapter 12) and ensuring progressive assurance and compliance with CDM Regulations 2015 and CSM-RA. The following elements summarise some key considerations which NRDD has implemented to guarantee the quality and safety of this design. Refer to the Designer's Risk Assessment in Appendix H for a comprehensive list of all identified hazards and the proposed elimination/mitigation measures.

- Stage 1 mining reports have been completed to understand the risk of historical mining sites;
- Desk studies have been undertaken to understand the risk of contaminated land;
- Conservative 30° slope regrades have been assumed for the earthworks; this shall be further investigated at the next design stage to identify further risks and opportunities.



9 Conclusions and Recommendations

The following conclusions and recommendations are made as an outcome of the present study. These shall be validated with site surveys and a full, multi-discipline engineering feasibility exercise.

Package E: Westerleigh to Bristol Parkway

Option E3: Westerleigh Junction Remodelling

The main benefit of Option E3 is that the pathing conflict of the Down Charfield occupying the Badminton lines is removed. Westerleigh Junction is also removed alleviating maintenance and reliability issues at the junction. However, the constructability of the fly-over structure is particularly challenging and will significantly disrupt railway traffic during construction. Subject to cost estimation and Value Management, this option is not recommended to be further explored.

• Option E4: Westerleigh Junction High Speed Triple Tracking

Option E4 represents a value-for-money, at-grade, three-tracking solution to the issues at Westerleigh junction. The main advantage of this option is construction and land acquisition only occur on the Up side, including embankment widening and additional underbridge structures. Whilst operationally similar to the existing arrangement, some of the existing junction constraints are removed, including the maintenance liability of a double junction with switch diamond by replacement with a single lead turnout.

Subject to cost estimation and Value Management, this option is recommended for progression.

• Option E6: Quad-Tracking at-Grade (Junction Transferred to Coalpit Heath)

Option E6 is a refinement of the one shown in the PACE 0 Technical Engineering Report, locating the proposed two tracks to the North of the existing Up Main. This presents several constructability benefits (e.g. limited impact to operations during construction, reduced impact to the existing OLE, etc.).

Two new additional tracks enable service segregation and maximise the opportunity for fast services to overtake. Westerleigh Junction is relocated towards high mileage The reconfiguration of Westerleigh Junction towards the High Mileage, with a high-speed S&C will minimise the duration of conflicting train paths as the tracks converge through Winterbourne cutting.

Subject to cost estimation and Value Management, this option is recommended to be further explored.

• Option E7: Quad-Tracking at-Grade (Junction Transferred to Coalpit Heath)

• Main alignment: Whilst the existing junction constraints are removed, this option still requires tight radius curvature on the Down Charfield. The alignment of this route would require extensive land acquisition through farmland. The Up Charfield would also require new alignment, also constrained by curvature to 60mph. There is still a requirement for freight services to access Westerleigh depot; freight travelling in the Up direction would occupy the Down Charfield 'wrong-road' for approximately 1km which would impose an operational restriction.

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 Alternative alignment: Whilst this alternative required the provision of a dive-under structure under the GWML, it provides greater radii curves, maximising speed and operations on the Charfield lines. Furthermore, the S&C is in close proximity such that the operational constraint of crossing the Down Charfield is minimised and occurs over a length of approximately 150m.

The alternative arrangement presents a significant opportunity to remove the operational, linespeed and maintenance constraints of the existing junction, and is therefore recommended for progression over the main Option E7 alignment.



Appendix A – Track Drawings

- Package E: Westerleigh to Bristol Parkway
 - 175662-NRD-WST-SWB-DRG-ETR-050301 Option E3 (1/2)
 - o 175662-NRD-WST-SWB-DRG-ETR-050302 Option E3 (2/2)
 - o 175662-NRD-WST-SWB-DRG-ETR-050401 Option E4 (1/2)
 - o 175662-NRD-WST-SWB-DRG-ETR-050402 Option E5 (2/2)
 - 175662-NRD-WST-SWB-DRG-ETR-050601 Option E6 (1/2)
 - o 175662-NRD-WST-SWB-DRG-ETR-050602 Option E6 (2/2)
 - 175662-NRD-WST-SWB-DRG-ETR-050701 Option E7: Main arrangement (1/4)
 - 175662-NRD-WST-SWB-DRG-ETR-050702 Option E7: Main arrangement (2/4)
 - 175662-NRD-WST-SWB-DRG-ETR-050703 Option E7: Main arrangement (3/4)
 - 175662-NRD-WST-SWB-DRG-ETR-050704 Option E7: Main arrangement (4/4)
 - 175662-NRD-WST-SWB-DRG-ETR-050711 Option E7: Alternative alignment (1/3)
 - 175662-NRD-WST-SWB-DRG-ETR-050712 Option E7: Alternative alignment (2/3)
 - 175662-NRD-WST-SWB-DRG-ETR-050713 Option E7: Alternative alignment (3/3)



Appendix B – Civils Sketches

- Package E: Westerleigh to Bristol Parkway
 - o 175662-NRD-WST-BGL-SKE-ECV-050301 Option E3 (1/5)
 - 175662-NRD-WST-BGL-SKE-ECV-050302 Option E3 (2/5)
 - 175662-NRD-WST-BGL-SKE-ECV-050303 Option E3 (3/5)
 - 175662-NRD-WST-BGL-SKE-ECV-050304 Option E3 (4/5)
 - 175662-NRD-WST-BGL-SKE-ECV-050305 Option E3 (5/5)
 - 175662-NRD-WST-BGL-SKE-ECV-050401 Option E4 (1/3)
 - 175662-NRD-WST-BGL-SKE-ECV-050402 Option E4 (2/3)
 - o 175662-NRD-WST-BGL-SKE-ECV-050403 Option E4 (3/3)
 - 175662-NRD-WST-BGL-SKE-ECV-050601 Option E6 (1/3)
 - 175662-NRD-WST-BGL-SKE-ECV-050602 Option E6 (2/3)
 - 175662-NRD-WST-BGL-SKE-ECV-050603 Option E6 (3/3)
 - 175662-NRD-WST-BGL-SKE-ECV-050701 Option E7 (1/3)
 175662-NRD-WST-BGL-SKE-ECV-050702 Option E7 (2/3)
 - o 175662-NRD-WST-BGL-SKE-ECV-050703 Option E7 (3/3)



Appendix C – Civils Desk Studies

- Package E: Westerleigh to Bristol Parkway
 - o 175662-NRD-WST-BGL-SKE-ECV-050001
 - o 175662-NRD-WST-SWB-SKE-ECV-050001
 - o 175662-NRD-WST-YAT-SKE-ECV-050001

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Appendix D - Signalling Sketches

- Package E: Westerleigh to Bristol Parkway
 - o 175662-NRD-WST-BGL-SKE-ESG-050301 Option E3
 - o 175662-NRD-WST-BGL-SKE-ESG-050401 Option E4
 - o 175662-NRD-WST-BGL-SKE-ESG-050601 Option E6
 - o 175662-NRD-WST-BGL-SKE-ESG-050701 Option E7: Main alignment
 - o 175662-NRD-WST-BGL-SKE-ESG-050702 Option E7: Alternative alignment



Appendix E – Existing Signalling Information

- S7608/02/008-DG1
- S7608/2/010-CX1

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Appendix F – Progressive Assurance IDC/IDR Certificate

• 175662-NRD-WST-XXX-IDC-EMF-000001

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Appendix G – Design Decision Log

175662-NRD-WST-XXX-LOG-EMG-000001

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Appendix H – Designer's Risk Assessment

175662-NRD-WST-XXX-RSA-SSD-000001

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Appendix I – B&C Works Required for Each Option

Table I.1 Structures

Structure ID	Asset type	Construction type	Obstacle crosses	E3	E4	E6	E7
SWB							
106 70 B/C	Culvert	460mm e/w pipe.	watercourse	Not affected	Not affected	Not affected	Not affected
106 77.5 B/C	Culvert	460mm e/w pipe. Brickwork headwalls	watercourse	Not affected	Not affected	Not affected	Not affected
107 05.5 B/U	Underbridge	Brick single span arch, with stonework abutments, wing walls, and parapets.	Highway/road	Bridge will be unaffected but significant works to wingwalls / abutments will be required - see separate site sketch	Not affected	Not affected	Not affected
107 05.5 RW D/S	Retaining wall (downside)	Concrete two stepped cast wall with steel ground anchors. Wall face coated.	N/A	Affected by permanent and temporary works - refer to separate site sketch	Not affected	Not affected	Not affected
107 07 RW U/S	Retaining wall (upside)	Concrete two stepped cast wall with steel ground anchors.	Parallel to the track	Affected by permanent works - possibility to be decommissioned	Affected by permanent works - possibility to be decommissioned	Affected by permanent works - possibility to be decommissioned	Not affected
107 14 B/I	Intersection bridge	Masonry arch viaduct		Unaffected existing structure with new single line structures on the up and down side - refer to Westerleigh Junction option 1 and 2 sketches	Unaffected existing structure with new single line structure on the up side	Unaffected existing structure with new double line structure on the up side	Not affected
107 17 RW U/S	Retaining wall (upside)	Stone and wire mesh	Parallel to the track	Likely to be decommissioned or significantly changed to accommodate new viaduct	Not affected	Not affected	Not affected
107 19 B/C	Culvert	Brick arch culvert. Culvert length: 40m. Dense vegetation prevents safe access.	Perpendicular to the track	Assume to be extended both sides	Assume to be extended	Assume to be extended	Assume to be extended
107 20 RW U/S	Retaining wall (upside)	Dense vegetation surrounding the wall. Embankment appears stable.	Parallel to the track	Decommissioned by earth works	Decommissioned by earth works	Decommissioned by earth works	Not affected
107 26 RW D/S	Retaining wall (downside)	Concrete wall with kee klamp guard rail fixed along top. Steel sheet piles with timber post & wire stranded fence behind. Concrete wall with kee klamp guard rail fixed along top.	Parallel to the track	Decommissioned by earthworks - opportunity to replicate in new location if there is a need to limit land take	Not affected	Not affected	Not affected
107 34.25 B/U	Underbridge	Brick arch. Brick ballast walls leaning away from parapet ends/track. Concrete block walls remain solid. Abutment is stone. Foundations/handrails are well maintained. All vegetation has been cleared.	Farmers access	Extension of arch on both up and downside	Arch extension upside	Arch extension upside	Arch extension upside
107 46 B/C	Culvert	Concrete culvert with a length of 40m.	Perpendicular to the track	Assume to be extended both sides	Assume to be extended on the up side	Assume to be extended on the up side	Assume to be extended on the up side
107 63.5 B/C	Culvert	Metal manhole with a water depth of 400m. 460mm pipe into the ground.	Into the ground	Assume to be extended both sides	Assume to be extended on the up side	Assume to be extended on the up side	Assume to be extended on the up side

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Structure ID	Asset type	Construction type	Obstacle crosses	E3	E4	E6	E7
107 71.5 B/U	Underbridge	Single span brick arch underbridge with metal handrails. Abutments are bonded masonry construction. Bonded masonry splayed wingwalls with blue-brick copings at all four corners. No downpipes or other drainage features.	Farmer's access	Extension of arch on both up and downside	Arch extension upside	Arch extension upside	Arch extension downside
107 72.5 B/C	Culvert	18" EW pipe	Perpendicular to the track	Assume to be extended both sides	Assume to be extended on the up side	Assume to be extended on the up side	Assume to be extended on the downside
108 11.5 B/U	Underbridge	Superstructure - composite metal beams and concrete decks. Substructure - stone and small brick pilasters and concrete ballast walls.	Pathway blocked (as shown in images on the attached pdf)	Existing bridge to remain. New single underbridge on both up and downside	Existing bridge to remain. New single track underbridge on upside	Existing bridge to remain. New double track underbridge on upside	Existing bridge to remain. New single track underbridge on downside
108 26.25 B/F	Footbridge	Riveted Wrought Iron. Parapet sheeting. Galvanised steel sheets cover the majority of span 2 main girders	Pathway above tracks	New footbridge	New footbridge	New footbridge	New footbridge
108 51 B/C	Culvert	18" earthenware pipe with a length of 35m.	Perpendicular to the track	New head walls both side	New headwall upside	New headwall upside	New headwall downside
108 52.5 B/U	Underbridge	Masonry arch underbridge. The arch soffits are brick construction. The rest of it is large dressed stones.	Highway/road	Existing bridge to remain. New single underbridge on both up and downside	Existing bridge to remain. New single track underbridge on upside	Existing bridge to remain. New double track underbridge on upside	Existing bridge to remain. New single track underbridge on downside
108 63.5 B/C	Culvert	Brick built. 0.91 Brick barrel - chamber d/s end.	Into the ground	New head walls both side	New headwall upside	New headwall upside	New headwall downside
108 78.5 B/U	Underbridge	Brick built arch, three span masonry arch.	Highway/road	Existing bridge to remain. New 85m 3 span structure single track on both sides	Existing bridge to remain. New 85m 3 span structure single track on up side	Existing bridge to remain. New 85m 3 span structure double track on up side	Not affected
109 09.5 B/U	Underbridge	Brick arch underbridge with new concrete parapets.	Pathway beneath bridge	Extension on both sides	Extension on up	Extension on up	Not affected
109 27.5 B/U	Underbridge	Steel and stone with metal handrailing	Road beneath	Existing bridge to remain - single track structure to upside and downside - with additional retaining wall (approx. 50m) on the SW side to prevent land take to private property	Existing bridge to remain - single track structure to upside	Existing to be replaced and an additional new single bridge on upside (opportunity for track to redesign to mitigate at next design stage)	Not affected
109 52.75 B/V	Viaduct	Brick arch viaduct with brick masonry spandrel walls, piers and abutments	Pathway and vegetation	Not affected	Not affected	Not affected	Not affected
109 71 B/O	Overbridge	Concrete beams/cill beams, bearings. Masonry abutments/wing walls, concrete & masonry parapets.	Overbridge for road	Not affected	Not affected	Not affected	Not affected
109 71.25 RW D/S	Retaining wall (downside)	Brick built. It is 2m from the nearest running line on the downside of the track. It is made up of wet laid random stone above the track. The wall is 1.4m high throughput with a small return to the high mileage end. The wall is 500mm wide. The wall is approximately 6.2m long.	Parallel to the track	Not affected	Not affected	Not affected	Not affected

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Structure ID	Asset type	Construction type	Obstacle crosses	E3	E4	E6	E7
YAT							
120 03 B/C	Culvert	Concrete deck	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
120 32.5 B/U	Underbridge	Half steel trough deck and half precast concrete	Accommodation	Unaffected	Unaffected	Unaffected	Unaffected
120 33 RW U/S	Retaining wall (upside)	4m retaining wall	NA	Unaffected	Unaffected	Unaffected	Unaffected
120 56.5 B/C	Culvert	2'' steel	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
120 63 B/U	Underbridge	Brick	Highway	Unaffected	Unaffected	Unaffected	Unaffected
121 15 B/X	Infilled bridge	*****	NA	Unaffected	Unaffected	Unaffected	Unaffected
121 19 B/U	Underbridge	Brick built	Highway	Bridge will be unaffected but significant works to wingwalls / abutments will be required - see separate site sketch - New single track 3 span bridge to north	Bridge will be unaffected but significant works to wingwalls / abutments will be required - New single track 3 span bridge to north	Existing bridge will become redundant - but can remain in place. New Double track bridge to the north	Unaffected
BGL 2							
120 03 B/C	Culvert	Concrete Deck	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
120 39 B/O	Overbridge	Wrought iron main girders, parapets and cross girders with brick jack arches. Wingwalls and abutments constructed from stone.	Overbridge for road	Unaffected	Unaffected	Unaffected	Unaffected
120 53.5 B/C	Culvert	The culvert is a 5' stone barrel, with associated stone headwalls and wingwalls at both elevations.	Watercourse	Unaffected	Unaffected	Unaffected	Extended to upside
120 54 B/C	Culvert	18'' Stone arch	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
120 62 B/C	Culvert	18" Stone Culvert	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
120 66 B/U	Underbridge	Stone arch	Accommodation road	Unaffected	Unaffected	Unaffected	Unaffected
120 76 B/C	Culvert	Masonry	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
121 02 B/U	Underbridge	Stone arch	Accommodation track	Unaffected	Unaffected	Unaffected	Unaffected
121 26 B/C	Culvert	1.3m stone arch	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
121 31 B/C	Culvert	1.1m Armco pipe side culvert	Watercourse	Unaffected	Unaffected	Unaffected	Unaffected
121 47.75 B/O	Overbridge	Dressed stone arch overbridge with stone parapets	Overbridge for road	Unaffected	Unaffected	Unaffected	Unaffected
121 55 RW U/S	Retaining wall (upside)	Natural rock retaining wall	NA	Unaffected	Unaffected	Unaffected	Unaffected

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