REPORT N^{O} 1

DAWLISH ADDITIONAL LINE - ASSESSMENT

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WSP | PARSONS BRINCKERHOFF

DAWLISH ADDITIONAL LINE - ASSESSMENT

FINAL REPORT

Plymouth City Council on behalf of PRTF

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1 EXECUTIVE SUMMARY

This study was prepared in response to three objectives:

- To provide evidence for an increase in network capacity between Exeter, Paignton and Plymouth, especially in view of the resilience issues associated with the existing line between Exeter and Newton Abbot;
- To define the local rail service proposals up to 2043 and assess the implications for investment in the network, including electrification; and
- To demonstrate the predicted growth in rail demand in the South West Peninsula.

We have concluded that the Dawlish Additional Line ('DAL') provides important benefits in terms of resilience and journey time savings. We have however come to the conclusion that the DAL Service Specification can be accommodated on the existing infrastructure, with some modest enhancements to track and signalling capability.

CAPACITY & COMFORT

We have prepared a timetable which shows how the frequency of service and stopping pattern proposed by the client body can be accommodated on the existing infrastructure, with some signalling and track enhancements. However, if demand is to increase at a rate similar to that observed in recent years, this level of service will be required sooner than anticipated.

JOURNEY SPEED

The construction of a Dawlish Additional Line would allow journey times for longer-distance services, which would not call at any intermediate stations between Exeter and Newton Abbot, to be reduced. We estimate this to be in the region of 10 minutes, provided that the new railway were built to 125mph standards (or faster). Whilst this would help in attaining the PRTF aspirational journey time of 2 hours 15 minutes from Paddington to Plymouth, much more would need to be done to achieve it – above all a reduction in station calls between Exeter and Reading, and a general increase in linespeed between those two points to 125+mph. To reach Plymouth in 2 hours 15 minutes requires an average speed of 100 mph, and this is a hurdle that cannot be overcome by constructing sections of new alignment between Exeter and Plymouth alone.

RESILIENCE

The proposed new Dawlish Additional Line will, if built to modern standards, be more resilient to severe weather than the existing coastal route. It is not the purpose of this report to come to definitive conclusions on the impact that future weather-related closures will have on the railway. However, this report does discuss possible implications of future closures of the railway along the Dawlish sea wall on the growth of demand and on the utilisation of the railway in general.

2 BACKGROUND AND SCOPE

2.1 BACKGROUND

2.1.1 WSP | Parsons Brinckerhoff was commissioned by the PRTF, a consortium comprising of Cornwall Council, Devon County Council, Plymouth City Council, Somerset County Council, Torbay Council, a representative from the Stakeholder group, Heart of the South West and Cornwall and Isles of Scilly Local Enterprise Partnerships, to review the capacity case for constructing an additional railway alignment to the existing railway line which runs along the coast in the Dawlish and Teignmouth area, between Exeter St David's and Newton Abbot. This stretch of the route was seriously damaged during storms in early 2014, severing the only rail connection between Devon and Cornwall and the rest of the country for a period of over two months. Shorter closures and other restrictions such as implementation of single-line working or the banning of certain classes of rolling stock which could be damaged through being hit by waves are also a regular occurrence along this stretch of line. Moreover, the steeply-graded section between Newton Abbot and Plymouth is often disrupted by trains unable to run up the gradients during periods of wet weather and leaf-fall. As a result of the effects of global warming these problems are set to become more severe over the coming decades.

2.1.2 It is primarily the issue of resilience that has led the client body to seek options for an alternative rail alignment that would be less prone to weather-related closures. At the same time, however, the growth of demand for rail services in this part of Great Britain has outpaced many other regions, as well as official predictions. This growth is set to continue, with new housing built near the railway line at many sites, as well as the construction of a number of proposed new stations to cater for these. Capacity enhancements will therefore be required in the area in the near future, possibly sooner than anticipated in official industry documents.

2.1.3 It is with this in mind that the client body is preparing a document outlining the rail transport strategy for the next 20 years. This study contributes to this strategy.

2.2 SCOPE OF THIS REPORT

2.2.1 The scope of this report is the investigation of options for the development of rail services and infrastructure on the Devon and Cornwall main line west of Exeter St David's. A train service specification (referred to as the DAL Service Specification hereafter) for this route was provided in the Request for Quotation for this study. This is independent of the 2043 Indicative Train Service Specification quoted in the Western Route Study. This service specification would deliver a series of conditional outputs which cater for future demand growth and improve the rail service in the area in a sufficient manner. These outputs are listed below:

- Longer-distance train headways / frequencies:
  - Penzance – Plymouth 30 minute even-interval headway
  - Plymouth –Taunton 12-15 minute even-interval headway
  - Taunton – Paddington target of a 20minute even-interval headway
  - 8 tpd Paignton – Taunton
  - Taunton – Bristol target of a 20minute even-interval headway
- Local train headways / frequencies:
  - Exmouth – Paignton: 30 minute even-interval headway
  - Barnstaple – Exeter: 60 minute even-interval headway, 10 tpd extending to Honiton/Axminster and 2tpd to London Waterloo

- Exeter – Honiton/Axminster: 30 minute even-interval headway (composed of 1tph local service to Honiton/Axminster and 1tph to London Waterloo)
- Gunnislake – Plymouth: 60 minute even-interval headway

→ New local stations at:

- Cullompton (between Exeter and Tiverton Parkway)
- Wellington (between Tiverton Parkway and Taunton)
- Marsh Barton (between Exeter St Thomas and Starcross)
- Edginswell (between Newton Abbot and Torre)
- Monkerton
- Hill Barton (between Polsloe Bridge and Digby & Sowton)

→ Improve journey times between London Paddington and stations in the South West in line with the Conditional Outputs set out in the Western Route Study, such that average end to end journey speed is 100mph between London and Plymouth and 80mph between London and Truro. 1 train per hour therefore needs to achieve the following journey times:

- Truro – Paddington 3½ hours
- Plymouth – Paddington 2¼ hours
- Newton Abbot – Paddington under 2 hours
- Exeter St David's – Paddington under 1¾ hours
- Taunton – Paddington under 1½ hours

2.2.2 The focus of this report is a response to these questions:

→ How quickly the demand for rail services is set to grow in the area over the coming decades;

→ How soon will elements and/or the entirety of the service specification be required to operate to cater for the demand;

→ Whether the specification will require enhancements to railway infrastructure between Exeter, Paignton and Plymouth to be made in order to provide the necessary capacity on the line; and

→ Whether the volume of demand and the need to provide additional capacity for the DAL Service Specification (or for services over and above the specification) would necessitate the construction of a new railway alignment in addition to the section of existing line along the sea between Dawlish Warren and Teignmouth.

2.2.3 The report does not focus on the costs of the reliability issues associated with weather-related closures and restrictions applied to the existing railway. However, it does explore the impact recent major closures have had on the growth of demand in the area.

RAIL SERVICES

CURRENT TIMETABLE

2.2.4 There are six categories of rail services currently operating around and to the west of Exeter:

→ Services to London: 1tph (trains per hour) from London Paddington to Paignton or Plymouth (extended to Penzance in most hours), operated by Great Western Railway (GWR) using High Speed Trains (HST).

- Cross country services: 1tph from Edinburgh/Newcastle and Manchester via Birmingham to Paignton or Plymouth (extended to Penzance a few times a day), operated by Cross Country Trains using HSTs and Class 220/221 Diesel Multiple Units (DMUs).
- Local/semi-fast services operated by GWR using Class 143, 150 and 153 DMUs:
  - 1tph Exmouth – Exeter St David's
  - 1tph Exmouth – Exeter St David's – Paignton
  - 1tph Exeter St David's – Barnstaple
  - 1tph Exeter St David's – Plymouth
- Interregional services: a small number of services in the morning and evening connecting Penzance and Bristol/Cardiff, operated by GWR using Class150 and 158 DMUs.
- Sleeper services: 1 service 6 nights per week between London Paddington and Penzance (out of scope of this study).
- Freight services: 1-2 train paths per day from Parkandillack, Penzance or Plymouth towards the rest of the country;

DAL TRAIN SERVICE SPECIFICATION

2.2.5 The DAL Service Specification as defined by the client body consists of the following service groups:

- Long distance services:
  - 1tph Penzance – Paddington limited –stop
  - 1tph Plymouth – Paddington semi-fast
  - 4tpd Paignton – Paddington semi-fast
  - 8tpd Penzance – Paddington Semi-fast
  - 1tph Penzance – North of England Cross-Country (4tpd to start at Paignton)
  - 1tph Inter-Regional mainline service
  - 1tph Exeter St Davids – London Waterloo
- Local services:
  - 2tph Exmouth – Exeter St Davids – Paignton
  - 1tph Barnstaple – Exeter St Davids – Honiton
  - 1tph Exeter St Davids – Plymouth
  - 1tph Plymouth – Gunnislake
- A 1tph Class 6 freight path (max. speed 60 mph) operating between Exeter and Parkandillack.

2.2.6 The DAL Service Specification has been diagrammatically portrayed in Figure 1 below.

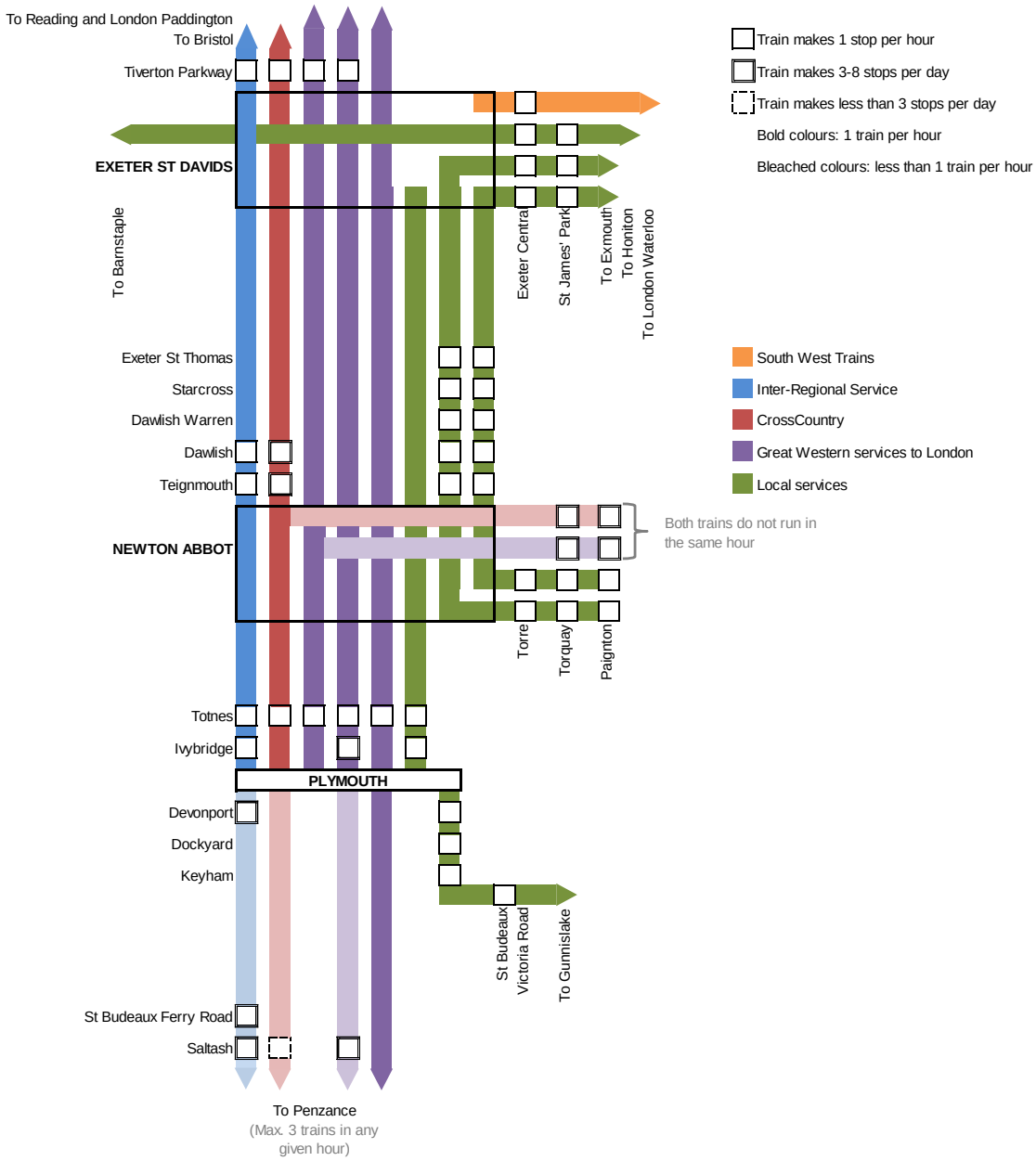

Figure 1: DAL Service Specification for the South West Peninsula

PLANNED ENHANCEMENTS

2.2.7 GWR's long-distance services are due to be operated by a new fleet of bi-mode AT300 trains from 2018/9, leading to the displacement of the HST fleet. Trains from Paddington will operate on electric power as far as Newbury (once the railway there is electrified), where they will change traction to diesel power. The opposite will happen in the reverse direction.

2.2.8 GWR has shared with us in commercial confidence its plans for the train service after the entry into service of the AT300 fleet, from 2018. Some extra services will operate, and the fast hourly service that operates between London and Plymouth (in many hours extending to Penzance) will be overlaid in many hours by a slower service between London and Exeter. Penzance will also see an increase in the number of direct trains to and from London. GWR's plan is shown in the following diagram:

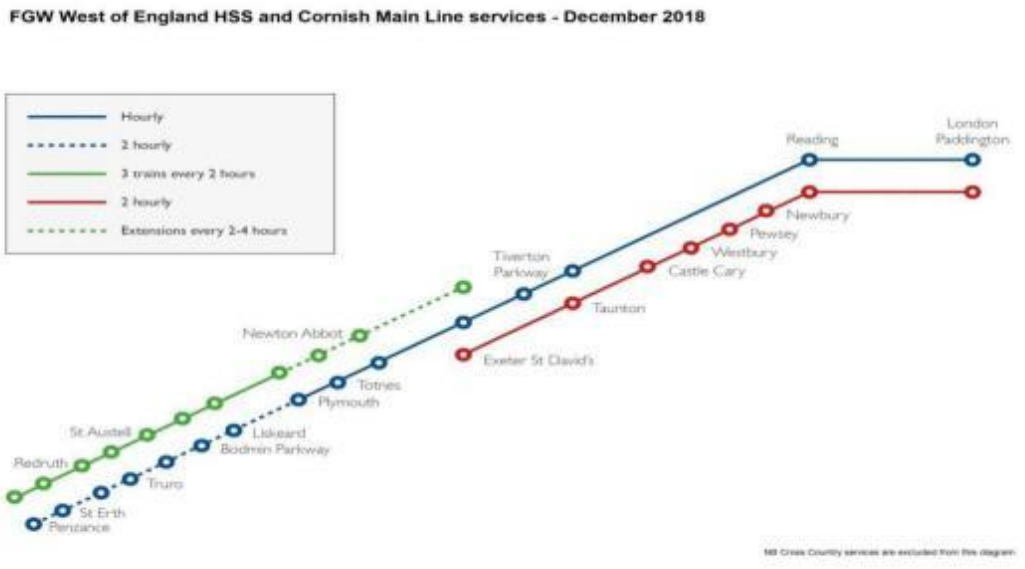

Figure 2: GWR's proposed service specification for the West of England in 2018.

2.2.9 As part of the rolling stock cascade plans following the electrification of the routes from London to Oxford and Newbury, much of the diesel class 165/6 fleet will be transferred to the Bristol and Exeter area around 2018/9, leading to the displacement of stock from there to Exeter and points to the west, as well as the withdrawal of the Class 143 'Pacer' vehicles. This rolling stock cascade provides the potential for a significant enhancement in service quality, capacity and frequency.

2.2.10 By the end of Control Period 5[1] (2019), Network Rail envisages installing 18 additional signals in Cornwall, thus providing 5 additional absolute block sections in order to reduce headways. While this enhancement will not have an impact on the core area of the study, it will improve connections between the area and Cornwall, by allowing 2 trains per hour to operate between Plymouth and Penzance.

2.2.11 The Network Rail Western Route Study (WRS)[2] proposes a number of enhancements, some of which has been appraised and assigned a rating in terms of value for money. These improvements have been deemed necessary in order to deliver the level of service Network Rail believes will be required by 2043. These are as follows:

[1] Network Rail's investment is governed by a five-year funding cycle. The funding available and the extent of infrastructure enhancements is agreed at the start of each five-year Control Period. The current Control Period 5 runs from 2014 till 2019.

[2] The Route Studies are part of Network Rail's Long Term Planning Process aimed at determining what enhancements should be carried out in different parts of the network in order to cater for demand growth. The Western Route Study, covering the area of this study, is available to view here: https://www.networkrail.co.uk/long-term-planning-process/western-route-study/

- Full resignalling of the Cornish main line in Control Period 6 (2019-2024), with the Exeter area to be completed by 2026.
- Additional loop at Whimple to provide a 2tph service between Exeter and Axminster (High value for money).
- Train lengthening on Exmouth branch (Poor value for money).
- Additional tracks between Exeter and Newton Abbot (either using existing alignment or on new alignment, depending on resilience assessment).
- Improvement of planning headways between Exeter and Plymouth/Paignton.
- Additional platform at Paignton.
- Changes to track layouts at Exeter St David's and Newton Abbot to reduce conflicting moves.
- Reinstatement of railway line between Bere Alston and Tavistock.

ECONOMY

2.2.12 Population distribution and growth in the Far SW (the Heart of the South West (HotSW) and Cornwall and Isles of Scilly (C&IoS) LEP areas) is closely aligned to the railway network, with a combined population of over 2.2m and over 1m jobs with a GVA of almost £36bn. Economic growth between 1999 – 2011 was 69.39% (compared to the UK average 62.79%), pointing to significant economic growth potential.

2.2.13 Plymouth and Cornwall rely chiefly on the railway for public transport links to the rest of the country, including London. Relative to the distance from the South East of England, the near South West (Bristol) to Far South West Peninsula divides in terms of accepted economic indicators such as disposable income; the GVA differentiator with other parts of the county will be exacerbated by HS2 and GWML electrification.

2.2.14 Service frequencies also have a significant impact on productivity and economic growth. Long waiting times are perceived by rail passengers to be up to 3.5 times longer than they are in reality.[3] Long-distance travellers are therefore deterred from using rail services for business, whereas commuters will either choose to commute by car, and/or the area within which they would seek employment will be reduced. Furthermore, work undertaken by Parsons Brinckerhoff for the Peninsula Rail Task Force (PRTF) in its "Productivity and Wider Economic Impact Study" has ratified work undertaken in 2005 by UWE, which identified that for every 100 minutes from London, productivity decreases by 6%.

2.2.15 A further issue is the impact of the closures of the coastal route through Dawlish during storms and periods of bad weather. The long closure of the route in 2014 is estimated to have had an impact of up to £1.2bn[4]. Shorter periods of disruption have a significantly smaller economic impact; however, they do work to the detriment of the economy, by leaving a perception of the unreliability of railway links to and from the area.

2.2.16 Compared to other mainlines in Great Britain, demand on the Devon and Cornwall main line has grown at a similar pace since 1998, despite the volume of investment in upgrades being lower than on many other routes. The graph below compares the number of station entries and exits at

[3] Research to this effect is summarised in the Passenger Demand Forecasting Handbook, which is available to members of the Passenger Demand Forecasting Council: http://www.atoc.org/about-atoc/commercial-activities/passenger-demand-forecasting-council/

[4] *Holding the Line?* Report for the Devon Maritime Forum (2015). http://www.devonmaritimeforum.org.uk/images/stories/DMFdocuments/DMFmeetingArchives/2014Autumn/DMF%20Storms%2013-14%20Summary%20Report.pdf Retrieved 09/02/2016.

stations on the following stretches of route:

- Great Western Main Line: Swindon to Bath and Bristol; Swindon to Swansea;
- West Coast Main Line: Northampton and Rugby to Coventry and Birmingham New Street; Rugby to Manchester via Stoke-on-Trent; Rugby to Liverpool and Preston via Crewe; Crewe to Stockport
- East Coast Main Line: Peterborough to Newcastle; Doncaster to Leeds via Wakefield.

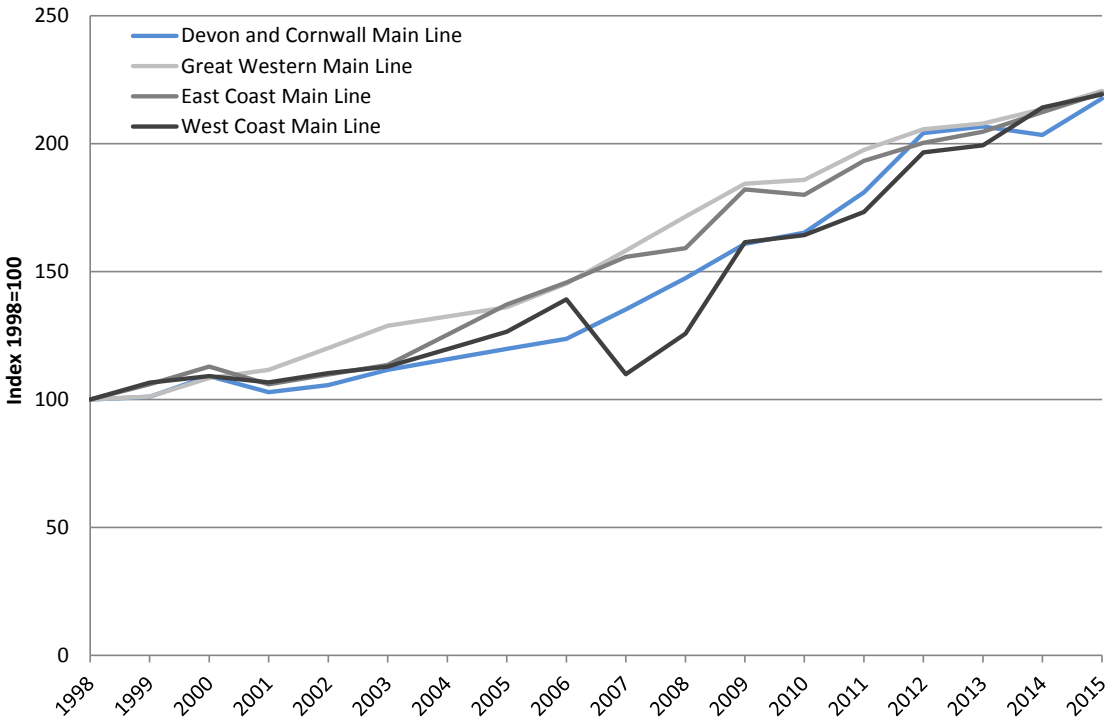

Figure 3: Indexed number of passenger journeys on various main lines in comparison to the Devon & Cornwall Main Line

2.2.17 The passenger demand growth rates based on the ORR data for Devon and Cornwall are found to be similar to the growth rates for the Great Western Main Line, the East Coast Main Line, and the West Coast Main Line. The graph above shows that demand has more than doubled between 1998 and 2015 for all four main lines, including the West Coast Main Line where demand suffered a significant drop as its upgrade was being delivered.

3 METHODOLOGY

3.1 OVERVIEW

3.1.1 The methodology developed in order to answer the questions posed in heading 2 consists of a number of steps, each of which is outlined below, and then discussed in detail in the following headings.

→ How quickly the demand for rail services is set to grow in the area over the coming decades

Data from the Office of Rail and Road showing the number of station entries and exits at stations within the study area was collected for the years 1998-2015. Three demand growth scenarios with different growth rates were derived from this data and from the WRS document in order to show how demand may increase over the coming decades.

→ How soon will elements and/or the entirety of the service specification be required to operate to cater for the demand

Each of the three scenarios was measured against the DAL Service Specification in order to check how soon services will need to have their formations lengthened or additional services will need to be added in order to cater for demand for rail services in the morning peak.

→ Whether the specification will require enhancements to railway infrastructure between Exeter, Paignton and Plymouth to be made in order to provide the necessary capacity on the line

The DAL Service Specification was developed into a timetable in order to see whether it can be accommodated within the existing infrastructure, and what enhancements would be necessary to accommodate it.

→ Whether the volume of demand and the need to provide additional capacity for the DAL Service Specification (or for services over and above the specification) would necessitate the construction of a new railway alignment additional the section of existing line along the sea between Dawlish Warren and Teignmouth.

The answer to this question constitutes part of the answer to the previous question. An additional section on the impact of weather-related closures of the railway line is provided.

3.2 DEMAND FORECASTS AND GROWTH RATES

3.2.1 According to Network Rail, the annual growth rate for rail passenger demand in the South West region is between 2.0% and 3.2%. An annual growth rate of 3.2% for Exeter and Plymouth between 2008 and 2019 is predicted in the Great Western RUS (2010), whereas growth rates of 2.0%, 2.5%, and 3.2% are predicted for journeys across Cornwall between 2013 and 2043 in the Western Route Study (2015). From the latter study, an average annual growth rate of 2.6% can be established.

3.2.2 Growth rates based on station entry and exit records from Office of Rail and Road (ORR, 2015) for stations west of and including Exeter St David's have been found to be higher than predicted by Network Rail. From 1998 to 2015 an annual growth rate of 4.7% is observed, and looking at more recent years the rate is even higher. From 2008 to 2015 the annual growth rate is 5.7%.

3.2.3 Together with the Network Rail WRS growth rate, these three rates were adopted as the basis for the demand forecasts within this study, and shall be referred to as scenarios 1, 2, and 3. Table 1 summarises the annual rail passenger demand growth rates.

		AVERAGE ANNUAL GROWTH RATE
Western Route Study (2015)	Scenario 1	2.6%
Office of Rail and Road (1998-2015)	Scenario 2	4.7%
Office of Rail and Road (2008-2015)	Scenario 3	5.7%

Table 1: Forecast Rail Passenger Demand Growth Rates. Source: Network Rail (2015) and Office for Rail and Road (2015).

3.2.4 The growth rates for each scenario have been applied to the 2015 ORR data and projected to 2043, in line with the Network Rail Western Route Study time horizon. These are shown in Figure 4 below:

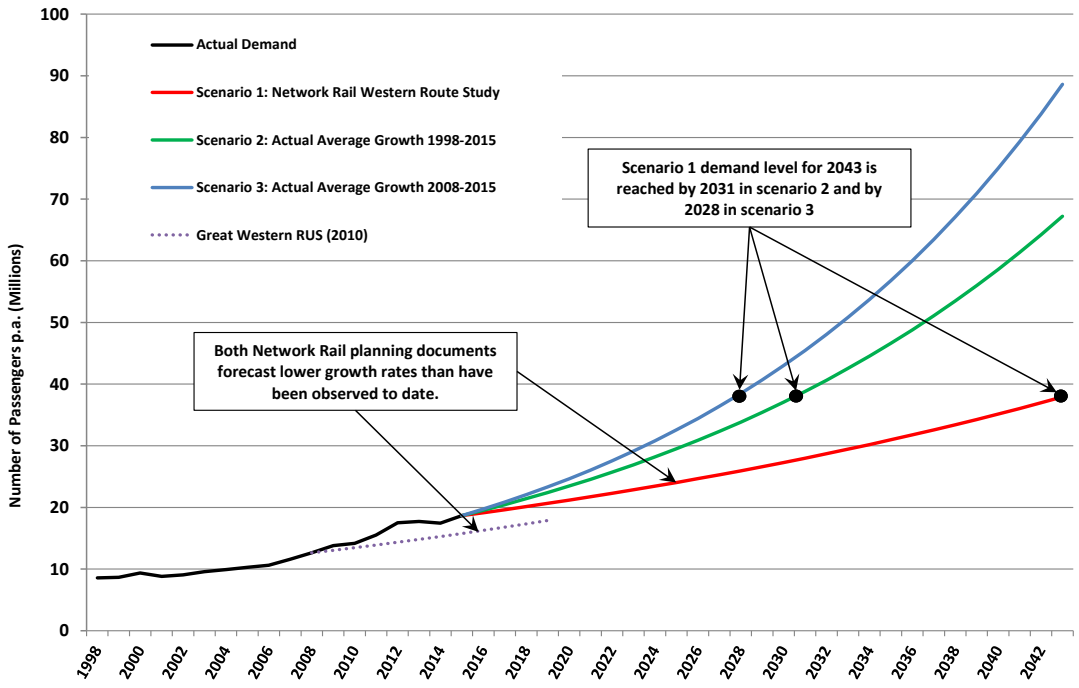

Figure 4: Demand Forecast Scenarios

3.2.5 Figure 4 illustrates that, assuming demand continues to grow at the same rate as recorded until 2015, demand will reach the 2043 level predicted by Network Rail (scenario 1) already by 2031 when comparing with the conservative Office for Rail and Road growth rate (scenario 2). Figure 4 further illustrates that the Great Western RUS (2010) demand forecast for 2008 to 2019 underestimated the rail passenger demand from 2009 to 2015.

3.2.6 The demand data suggests that, should demand grow in future at the same rate as over the past 7 or 17 years, the level of service planned by Network Rail for 2043 will be appropriate for the perceived level of demand 12 to 15 years before this date. Further improvements to the rail network – introduction of new services, better rolling stock, and additional stations to serve new housing developments – may serve to further increase the pace of demand growth. However, it must be borne in mind that the ORR data from which the growth forecasts was extrapolated already includes effects of past improvements, and therefore can be considered an appropriate estimate of future growth.

3.2.7 Demand growth can be further stimulated by increasing the frequency of service. At present the low service frequencies bring about the need – in some areas – for long-distance trains to double-up as local services and serve smaller stations. Frequency increases would first and foremost allow for a differentiation of rail services, by allowing long-distance trains to provide limited-stop, interregional connections, and leaving local trains to operate the all-stations services. This is not something that has been reflected in the creation of the DAL Service Specification.

3.3 PREPARATION OF TIMETABLE

APPROACH

3.3.1 The need to increase capacity can be dealt – in principle - in three ways. These are listed below, ordered from cheapest to most expensive:

- Add extra carriages to existing services – and/or operate them using more spacious rolling stock. This will provide a modest impulse for demand growth – attracting people who dislike crowding or - in extreme situations – those who cannot board a train due to overcrowding.
- Add new services or increase the frequency of existing ones, within the constraints of existing infrastructure;
- Enhance the infrastructure (reduction of headways, addition of extra tracks and crossovers, etc.) in order to accommodate additional services.

3.3.2 By investigating different timetable solutions, we have focused on the latter two points. Our approach to the first point is explained in Section 3.4 below.

3.3.3 The DAL Service Specification has been translated into a standard-hour timetable. We have taken the handover times at Exeter for the AT300s from London, and the Cross-Country trains to/from Bristol, as fixed. We have then sought to accommodate the service specification within these constraints. This provides the least risky approach for timetable delivery.

3.3.4 The approach to constructing the timetable was as follows:

- Attempt to create the timetable conforming to current Network Rail Operational rules;
- If this is not possible and/or delivers a sub-optimal timetable structure, then analyse what constraints must be removed and/or eased in order to provide an optimum timetable structure; and
- Analyse what other constraints must be eased in order to fulfil all conditional outputs specified by the client.

3.3.5 Network Rail stipulates the Operational Rules governing:

- Headways (the distance between trains), determined in part by the type of train and the calling pattern;
- Platforms and junction margins: the time allowed between use of a junction or platform by two trains;

- Sectional Running Times: the time a train requires to run between two timing points – these are dependent on the power and weight of each type of rolling stock; and
- Turnround times: the minimum time between a train finishing its journey and starting the next one.

3.3.6 These constraints are dictated by the layout of the track, the space between signals, and the way signalling systems work. By making changes to the infrastructure the nature of these constraints can be changed.

3.3.7 To define the Sectional Running Times, we have assumed the following rolling stock operates on different services:

- GWR services to/from London: AT300 units
- Cross Country services: Class 220/221
- Local services: Sprinter units (class 150)
- Freight: Class 6 (60mph max. speed), 1200t trailing weight

3.3.8 The timetable analysis performed as part of this study was undertaken based on a concept timetable provided by GWR. This timetable is meant to be implemented once the AT300 units are in service. Until then it is considered commercially confidential. The analysis has been shared with the client and GWR and can be obtained from them with GWR's approval.

NEW ALIGNMENT ADDITIONAL TO THE DAWLISH SEA WALL

3.3.9 The construction of a new alignment additional to the section of the line along the sea wall between Dawlish Warren and Teignmouth was also considered and the analysis is discussed in Section 4.1 of this report.

3.4 TIMING OF CHANGES

3.4.1 A further piece of analysis was undertaken in order to determine what capacity enhancements (train lengthening and/or introduction of new services) need to be implemented and by when.

3.4.2 This analysis utilised the station entry/exit data from the ORR, as well as the demand forecasts, and the DAL Service Specification. The objective of this analysis was to understand how many people will be entering and exiting trains at stations along the main line between Exeter and Penzance (and the Paignton branch) in the high peak hour (0800-0859), so as to determine whether the DAL Service Specification does provide enough capacity.

3.4.3 In order to turn data from Office for Rail and Road into daily passenger demand in the peak hour it has been assumed that 70% of the entry and exit recordings during a year are weekday recordings and of these 10% belong to the peak hour. Assuming that there are 250 weekdays a year it is possible to compare the daily passenger demand in peak hour with the available train service capacity from the 2018 timetable.

3.4.4 The formation of the trains has been assumed to be as follows:

SERVICE	2018 FORMATION (ROLLING STOCK TYPE)	2018 STD CLASS CAPACITY	MAXIMUM LENGTH FORMATION	MAXIMUM LENGTH CAPACITY
Local Exeter St David's to Plymouth	Class 150	165	3 x Class 150	495
Local Plymouth to Gunnislake	Class 150	165	3 x Class 150	495
Local Exmouth to Paignton	Class 2 x 150	331	3 x Class 150	495
Semi-fast Cardiff/Bristol to Penzance	Class 158	241	2 x Class 158	482
Long-distance Manchester/Edinburgh to Paignton	221 (5 car)	310	Class 220 + 221 (4+5 car)	510
Long-distance London Paddington to Penzance	AT300 (5+5 car)	662	AT300 (5+5 car)	662

Table 2: Standard class passenger capacities of assumed train service formations

3.4.5 As mentioned in 3.3.1, this strand of the analysis deals with the question of how long trains can and should be. For the purpose of this analysis, it has been assumed that train formations should first be extended to the maximum length possible as per Table 2, before the DAL Service Specification is implemented. The DAL Service Specification is assumed to operate with maximum length formations from its inception. The maximum length of these formations is dictated by platform lengths at stations within the study area, and the ability of different train types to operate in multiple. It is assumed that the long-distance services operate using shorter (5-car) formations to the West of Plymouth, and longer formations between Plymouth and the rest of the country.

3.4.6 Whilst this method of train crowding analysis can be considered crude, we consider it to be adequate for this initial piece analysis. It was agreed with the client body that MOIRA software, which is one of the standard tools used to assign demand to individual train services, would not be used as part of this study.

3.5 IMPACT OF WEATHER-RELATED CLOSURES

3.5.1 We have also considered the impact of closures of the railway line in the Dawlish area caused by climate change and rising sea levels on the rate of growth in demand. We have used as a guide the recent paper by Dawson et al[5] which analyses the increasing rate of occurrence of weather phenomena that necessitate the imposition of restrictions on traffic along the sea wall at Dawlish; and predicts the impacts of these in the future as greenhouse gas emissions increase. We have applied the findings of this paper to existing demand patterns to show what increasing disruptions of traffic in the future can do to rail demand growth, assuming there are no further significant upgrades to the railway line through Dawlish.

[5] Dawson D., Shaw J., Gehrels, W. R. (2016), *Sea-level rise impacts on transport infrastructure: The notorious case of the coastal railway line at Dawlish in England.* Journal of Transport Geography 51 (2016). http://www.sciencedirect.com/science/article/pii/S0966692315002197 Retrieved 29/01/2016.

4 RESULTS

4.1 TIMETABLE CONSTRUCTION

CURRENT OPERATIONAL RULES

4.1.1 With current Operational Rules in place, it was impossible to timetable all services operating as part of the DAL Service Specification standard hour. The key constraints to this were found to be:

- Long headways (6, 8 or 10 minutes) between Totnes and Plymouth: there are 6 passenger and 1 freight path per hour in the timetable – this is impossible to accommodate with a 10 minute headway;
- Lack of a crossover between the Down and Up Waterloo Lines at Exeter St David's: without this crossover trains departing Platform 3 at Exeter St David's towards Exeter Central must travel on the Down Waterloo line, preventing any trains from running between Exeter Central and Exeter St David's in the meantime. Given the pattern of services on the Exeter to Newton Abbot stretch and other constraints faced by the Exmouth to Paignton services (single track on the Exmouth branch, single junction at Newton Abbot West) this would be impossible to accommodate.
- The need for services running between Newton Abbot and Plymouth to be spaced exactly every 8/10 minutes brings about the need for the Exmouth – Paignton trains to be overtaken by faster trains at Dawlish Warren. Whilst this already is commonplace today, it does add 7 minutes to the journey time, which is a sub-optimal solution.

DO-MINIMUM ENHANCEMENTS

4.1.2 As described in point 3.3.4, the next step was to see what constraints must be lifted or eased in order to make the DAL Service Specification operationally viable. These constraints were found to be as follows:

- The headways between Newton Abbot and Plymouth need to be reduced to no more than 6/8 minutes;
- The headway following a fast train between Exeter and Newton Abbot must be reduced from 3½ to 3 minutes; and
- A crossover must be installed between the Down and Up Waterloo Lines at Exeter St David's in order to remove the need for trains from Platform 3 to run on the 'wrong' line towards Exeter Central (illustrated below).

4.1.3 These enhancements will provide enough capacity to timetable all trains contained in a typical standard hour of the DAL Service Specification. This timetable also assumes that the Network Rail enhancements in Cornwall (i.e. insertion of additional signals) have been implemented and reduce headways to between 5 and 7 minutes west of Saltash. This timetable has the following drawbacks:

- Exmouth – Paignton trains would have to stand for 7 minutes in either direction at Dawlish Warren to allow faster trains to pass, and would operate at an uneven 25/35 minute frequency;
- If any further stations were to be built between Exeter St David's and Newton Abbot, these may have an impact on the journey time of long-distance services, which will need to slow down in order to allow for local services to serve these stations;

- Journey times of long-distance trains would remain as today or be slower due to the need for them to slow down to allow for local trains to clear the track ahead of them; and
- The railway line between Exeter and Plymouth would be running near capacity almost all day, thereby meaning that performance recovery following an incident would be challenging.

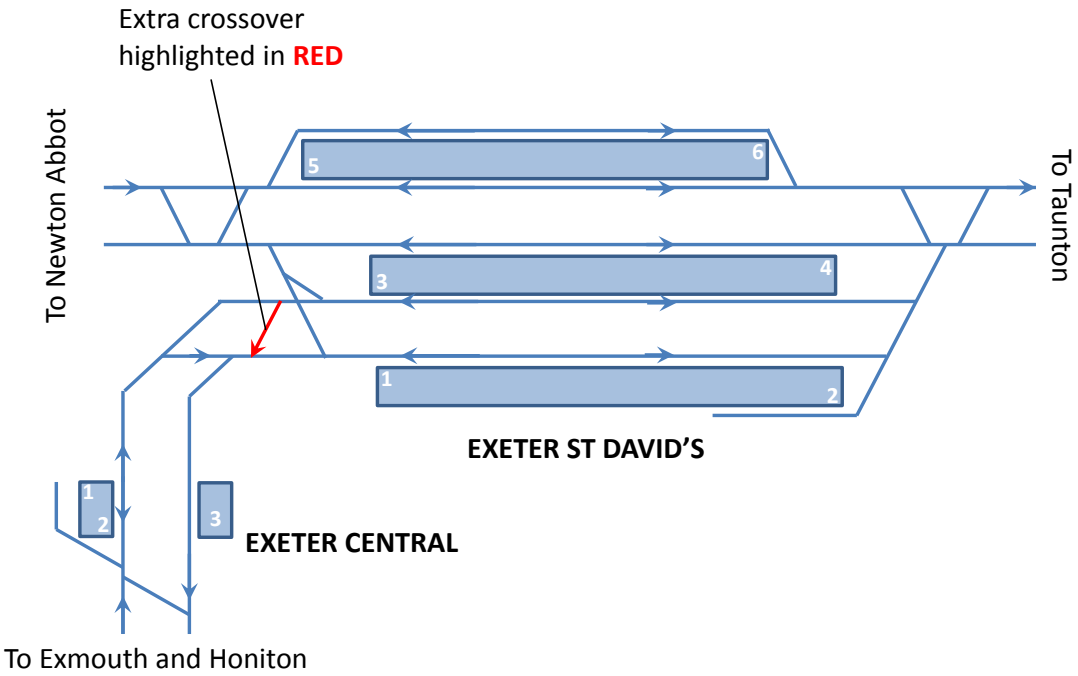

Figure 5: Location of proposed crossover at Exeter St David's. Source: Quail Track Maps – Western Route Map

FULL ENHANCEMENTS

4.1.4 Further analysis was conducted to determine what enhancements would be required to allow for the DAL Service Specification to be delivered in a more optimum way. The analysis concluded the following enhancements would have to be delivered in addition to the ones mentioned above:

- The headways between Newton Abbot and Plymouth would need to be reduced to 4 minutes in both directions, through the installation of additional signals;
- The junction with the Paignton branch at Newton Abbot West Junction would need to be enhanced to allow trains to pass each other. Whilst not absolutely necessary, an additional platform face at Newton Abbot would be desirable in order to improve performance, as it would make it easier for trains to/from the Paignton branch and trains to/from Plymouth to pass each other in case of disruption;
- Three- or four-tracking of a portion of the railway line between Exeter St Thomas and Starcross to allow local trains to be overtaken by faster trains. This investment will be particularly desirable once additional stations are built along the route. The introduction of better performing rolling stock on local services may serve to mitigate this issue to some extent at a cost lower than the construction of additional tracks; and
- An additional platform at Paignton is not absolutely necessary; however, it would be desirable as it would provide additional flexibility to the structure of the timetable.

4.1.5 These enhancements would allow for the following improvements in comparison to the do-minimum timetable specification:

- Running the Exmouth – Paignton services without the need for overtaking at Dawlish Warren and at an even frequency of 30 minutes; and
- Removing the need for fast long-distance services to slow down (or wait) to allow local trains to clear the line ahead.

IMPACT OF ELECTRIFICATION, INCLUDING NON-CONTINUOUS ELECTRIFICATION

4.1.6 Electrification from London to Newbury is to be delivered by 2019 and it is expected that electrification will gradually be extended beyond Newbury, to Westbury, Taunton and beyond. However, the delivery of a bi-mode fleet of trains which has sufficient power in diesel mode to operate on the steeply graded route to the west of Taunton, and with higher-capacity fuel tanks, means that the business case for electrification is made weaker.

4.1.7 A financial case will only be made for electrification if diesel costs rise significantly in relation to the costs of electricity. But given the delivery issues surrounding Network Rail's current commitments for electrification, it would be wrong to assume – even if a full financial case could be made – that electrification will reach Plymouth or beyond until 2026 at the very earliest.

4.1.8 An argument has been advanced for small isolated sections of electrification, for instance between Newton Abbot and Plymouth on the steeply-graded section of route. This may be able to bring some limited journey time improvements if it is possible to procure electric or bi-mode trains which have a significantly higher tractive effort than the diesel trains that will be operating on these routes in future. It is also worth noting, that AT300 units are expected to provide better performance (acceleration, top speed) when operating in electric mode.

4.1.9 This solution is deliverable in principle; however, it is not without drawbacks. It would require all services running through the area to be operated using bi-mode trains, which are more expensive to operate than either diesel or electric trains. Furthermore, the largest part of the cost of an electrification scheme is frequently the feeder station(s), and considerable cost would be necessary to install a feeder station for only a short stretch of route.

4.2 NEW ALIGNMENT ADDITIONAL TO THE DAWLISH ROUTE

THE CAPACITY ARGUMENT

4.2.1 We have also considered the construction of a new alignment for some or all of the stretch between Exeter and Plymouth. The enhancement of the existing line should allow for the DAL Service Specification to be implemented between Exeter and Plymouth; however, these enhancements will leave a railway that is full between Exeter and Newton Abbot. Furthermore, the railway will not be able to fulfil the ambitious conditional outputs with regard to journey times for long-distance services.

4.2.2 It is our opinion that the 2¼ hours journey time between Plymouth and London Paddington cannot be achieved even if a new, high-speed (125+mph) alignment is built along the entire section between Plymouth and Exeter. Indeed, the Network Rail West of Exeter Route Resilience Study[6] suggests that a fully 125mph capable alternative route between Newton Abbot and Exeter would save no more than 6 minutes of journey time compared to the existing alignment.

[6] Quoted in the Network Rail Western Route Study, p. 198

4.2.3 In order for a 2¼ hour journey time to be achieved, the construction of such an alignment would have to be coupled together either with significant linespeed enhancements between Taunton and Reading, and a review of stopping patterns of services, creating trains running non-stop at least between Reading and Exeter. The alternative would be to provide a high-speed alignment between Plymouth, Exeter and Bristol, allowing a 1 hour journey time between Plymouth and Bristol Temple Meads. Combined with a journey time of 1 hour 15 minutes between London and Bristol (to be achieved in the near future on the route via Bristol Parkway with IEP trains), this would deliver a journey time of 2¼ hours between Plymouth and London. However, the magnitude of investment required to achieve such journey times is far greater than just the construction of a new alignment bypassing the sea wall at Dawlish, or the cost of upgrading the existing alignment.

4.2.4 Also, despite the railway ending up being very busy between Exeter and Newton Abbot, the implementation of the DAL Service Specification does not necessarily require the construction of sections of entirely new alignment. If services were required over and above this DAL Service Specification, a new alignment would not be required solely from a capacity point of view. Additional capacity on the route could be generated by changing stopping patterns of services (making local trains skip-stop rather than all-stations) or by enhancing the existing line through signalling improvements or the addition of passing loops or sections of three or four-track alignment. However, this enhanced alignment would still be vulnerable to the effects of storms or cliff subsidence.

THE RESILIENCE ARGUMENT

4.2.5 The current coastal rail route between Exeter and Newton Abbot follows the coast line and has proven to be extremely vulnerable to the incursion of seawater and potential cliff falls, which recent experience has proven to be becoming a more frequent event. These events are likely to continue in line with sea level rises and climate change, and have the potential to close the rail connection to the South West Peninsula on a regular basis. It is therefore time to consider the alternatives that are needed to provide future resilience to allow the South West Peninsula to have a reliable rail service that meets the needs of the region and drives a growth in productivity.

4.2.6 Analysis recently conducted and published in the report mentioned in Section 3.5, and focusing primarily on this coastal route, suggests that currently, speed restrictions are imposed at Dawlish on an average of five days per year, and the down (westbound – nearer the sea) line is closed on four days a year[7]. Complete closures occur once every three or four years; the substantial damage caused in 2014 led to the route being closed for 2 months for repairs. In addition, the Voyager trains, operated by Cross Country, cannot operate during period of high seaspray, as the salt water interferes with the train's systems. This does not affect the older trains operated by GWR, and it is anticipated that their replacements, the AT300 trains, will also be designed so as not to be affected by this issue.

4.2.7 The same report takes analysis of meteorological trends to demonstrate that the frequency of partial or complete closures of the route is almost certain to increase. Assuming the medium greenhouse emissions scenario occurs, as specified by the study[8], the line could be subject to 34 days with timetable restrictions per year by 2040, including at least one day of full closure of the route. This assumes that no significant work to strengthen the alignment will be carried out.

4.2.8 Whereas demand for rail services has steadily risen in the South West of England, the year 2014 was the only year since 1998 (when the ORR began releasing their station entry/exit statistics) that demand dropped (by 1.61% compared to 2013). Estimates of the wider economic damage to

[7] Source: Dawson et al, p. 104.
[8] Ibid., p. 104.

Devon and Cornwall from the time of the major breach in early 2014 ranged from £5m to £20m a day[9]; however when it is a breach of significant duration – as was the case in 2014 – the impression is given that an area of the country is isolated, and it will take time for the image to be rebuilt.

4.2.9 While the capacity and journey time arguments alone may not be enough to construct a business case for the construction of an alternative alignment, it may be the case that the two combined with the need for increased weather resilience may be sufficient to provide for the alignment to be built. The recent study for Dawson et al emphasises the impact that climate change will have on the frequency of closures of the line along the Dawlish sea wall. The costs of these closures, the impact they are likely to have on the local economy as well as on demand growth; as well as the need to provide extra capacity to cater for growth should be considered in combination.

4.3 TIMESCALES FOR IMPLEMENTATION OF ENHANCEMENTS

RESULTS

SCENARIO 1

4.3.1 With an annual growth rate in passenger demand of 2.6% (scenario 1, Figure 3), the 2018 timetable will not be able to accommodate all future demand. More particularly, demand will exceed capacity at Plymouth in 2038. Demand can however be met until 2043 if the 2018 timetable is retained and capacity is increased by adding more carriages to trains servicing Plymouth, as shown below.

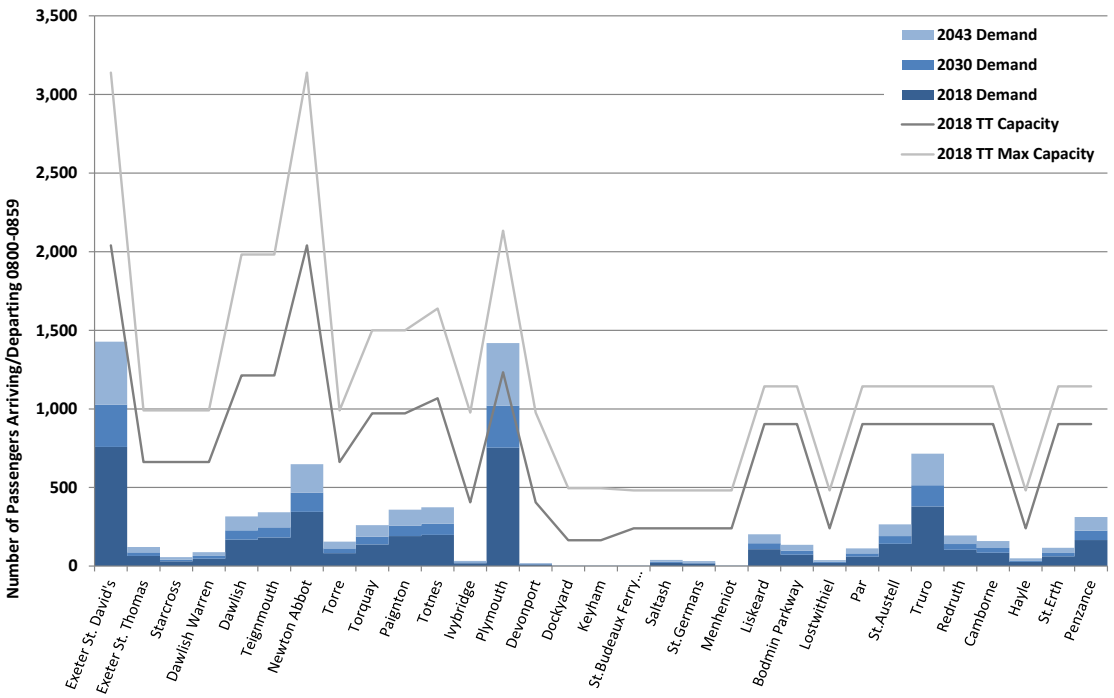

Figure 6: Demand vs Capacity: Scenario 1

[9] Source: Productivity and Wider Economic Impact Study – PTRF (2015).

SCENARIO 2

4.3.2 In case passenger demand continues to grow at the same rate as observed between 1998 and 2015 (scenario 2 Figure 4) extending trains will not be enough to accommodate all future demand. A growth rate of 4.7% (which is an average of year-on-year growth rates from 1998-2015) shows that the 2018 timetable is not capable of meeting future demand even when trains are extended to maximum length. The 2018 timetable with maximum units will be short of capacity at Plymouth by 2040 and at Truro by 2041. However, the implementation of the DAL Service Specification should provide sufficient capacity until 2043:

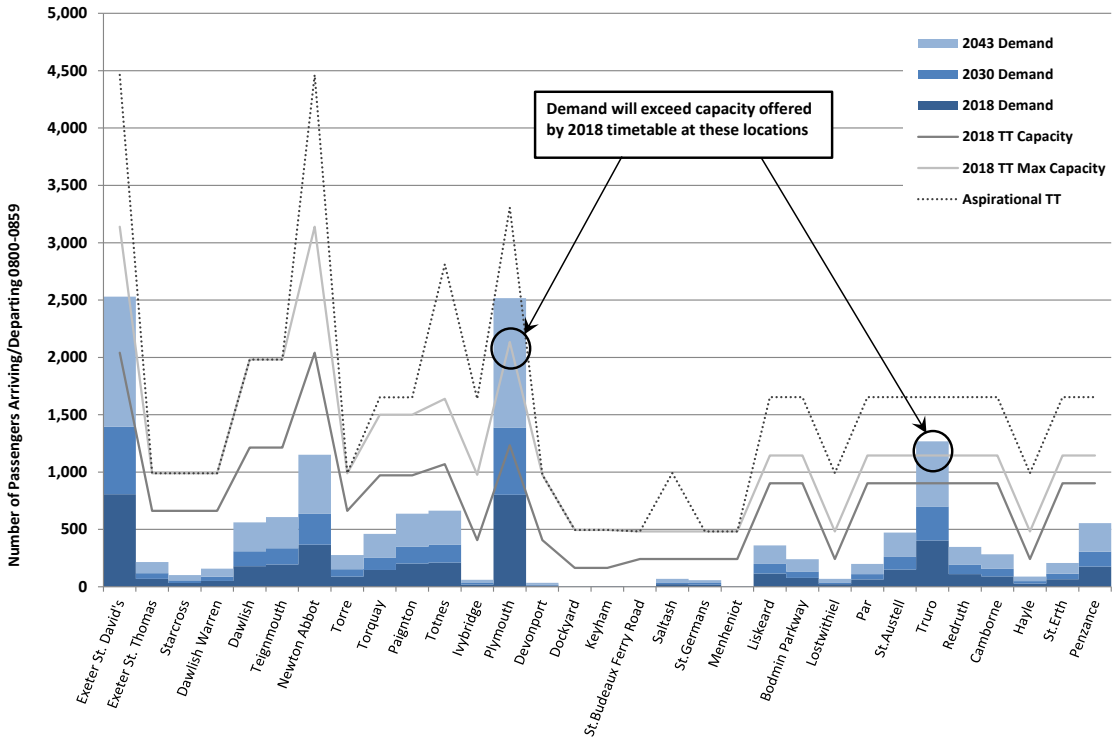

Figure 7: Demand vs Capacity: Scenario 2

SCENARIO 3

4.3.3 The annual demand growth rate has been higher in recent years (since 2008) than before. This indicates that there may be a tendency for rail passenger demand to increase more rapidly in the future. By applying a growth rate of 5.7%, which is an average of the annual year-on-year growth rates from 2008 to 2015 (scenario 3, Figure 4) it can be found that the 2018 timetable will run short of capacity by 2026 in Plymouth, by 2032 in Truro, and by 2035 in Exeter St David's. Maximising the train lengths will delay the occurrence of overcrowding at these three stations to 2036, 2037, and 2042, respectively. In this scenario, the DAL Service Specification will not be able to fully resolve the capacity problem within this time horizon. Trains running according to the DAL Service Specification will be full at Plymouth and Truro sometime between 2042 and 2043.

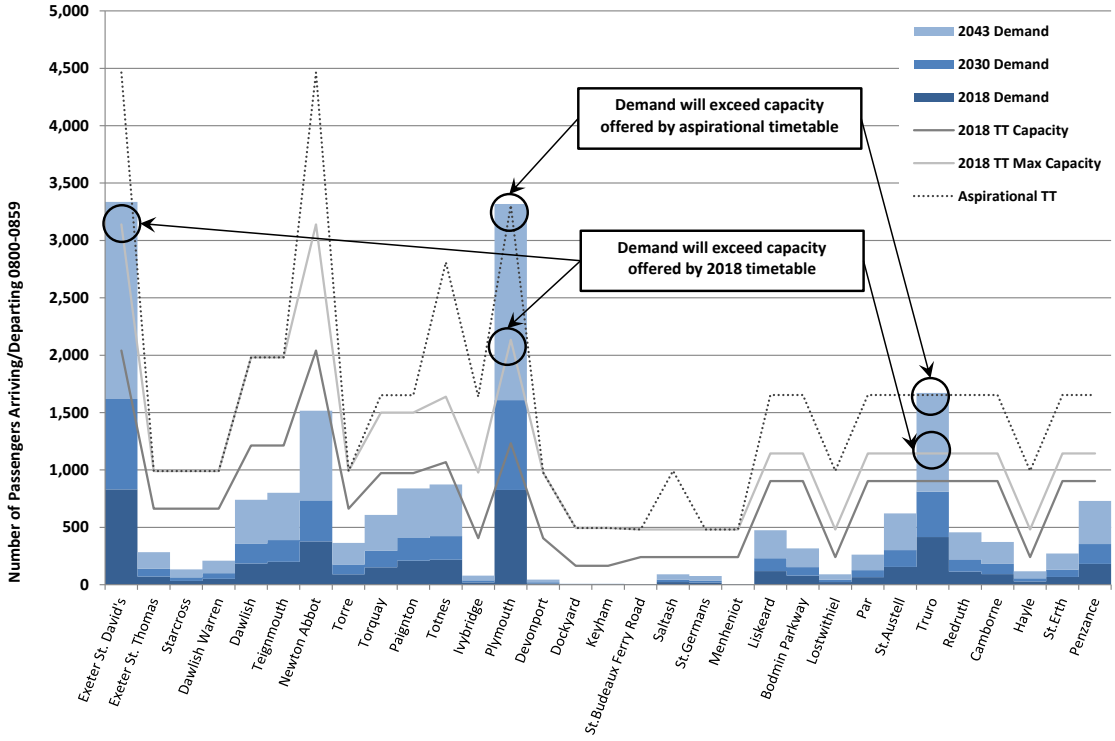

Figure 8: Demand vs Capacity: Scenario 3

CONCLUSIONS

4.3.4 Our review of demand has indicated that the DAL Service Specification will probably be required in advance of the predicted implementation date of 2043, given historic and predicted future growth trends. This should be seen as an opportunity rather than as a threat. Such a level of service could be delivered on today's railway, provided there were sufficient rolling stock and the relatively minor modifications to the infrastructure, as described above.

4.3.5 We believe that this level of service should be in place by the early-to-mid 2030s at the latest, although there is almost certainly a case for operating this intensity during the peak periods in advance of this. It is important that rolling stock choices made by operators take account of the levels of demand; given the spread of electrification throughout the country, new diesel rolling stock is going to become more expensive, and we recommend therefore that a case is made to facilitate the cascade of older, yet refurbished and modernised, rolling stock to support services throughout Devon and Cornwall.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

5.1.1 On the assumption of the delivery of additional improvements outlined in Section 4.1 of this report, the DAL Service Specification can be delivered on the Dawlish coastal route between Exeter, Paignton and Plymouth. We have not assessed its deliverability on other areas of the network in detail, but do not believe there to be any insuperable problems. On this basis, the Dawlish Additional Line is not necessary to deliver the frequency of service warranted by the DAL Service Specification. However, it must be borne in mind that the 2043 timetable will take up most of the capacity that even the upgraded line will be able to offer. It is also likely that with the majority of capacity being utilised on a daily basis, service reliability may suffer.

5.1.2 Our assessment of historic demand forecasts and growth trends suggests that demand growth rates as forecast by Network Rail are significantly lower than the rates of demand growth observed in the last two decades. If growth continues at the current pace into the future, the 2018 timetable – even with lengthened train formations - will no longer be sufficient to cater for demand by around 2036-2040. The figure below demonstrates key dates by which upgrades will need to be delivered in each of the demand growth scenarios:

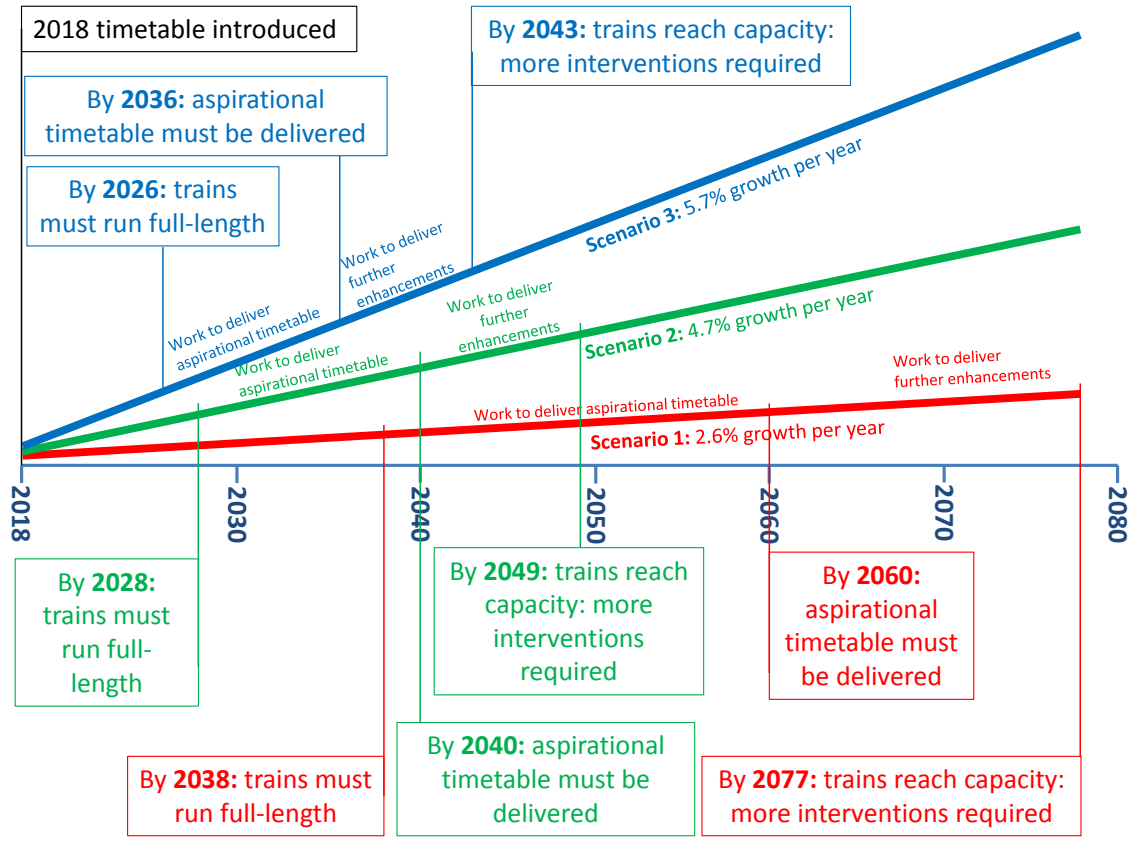

Figure 9: Timeline for the implementation of key upgrades on the Devon and Cornwall main line

5.1.3 A number of infrastructure interventions will be required to implement the DAL Service

Specification. These are as follows:

- Additional signals between Newton Abbot and Plymouth to reduce headways to 4 minutes;
- Additional crossover at Exeter St David's to remove the need for trains to run on the 'wrong' line between Exeter St David's and Exeter Central in certain instances;
- At least one section with three or four tracks between Newton Abbot and Exeter St David's to allow for fast trains to overtake stopping services without the need for the latter to stand in a loop for protracted periods of time, and to provide enough capacity for extra stations to be accommodated on the line; and

5.1.4 Additional line and platform between Newton Abbot and Newton Abbot West Junction to allow for additional flexibility during periods of disruption. Whereas the DAL Service Specification is different to the 2043 ITSS specified by Network Rail within the WRS (pp. 193 and 203), it is similar – as are the infrastructure interventions recommended by this study and the WRS. The key difference is the timescales within which these interventions are likely to be required – this study suggests these enhancements will be required between 3 and 7 years earlier than the WRS.

5.1.5 Whereas electrification of sections of the route between Exeter St David's, Paignton and Plymouth could potentially reduce journey times, it is unlikely the benefits generated by this solution would offset its cost, as well as the cost of procuring bi-mode rolling stock in addition to the vehicles already ordered by GWR. It is instead recommended that the local authorities served by the railway line pursue the procurement of additional, newer vehicles, which would offer more comfort and better performance characteristics than the units in service today.

5.1.6 It is virtually impossible given the tortuous and steeply-graded nature of the route between Exeter and Plymouth to deliver any meaningful journey time reductions through the raising of linespeeds. As such, the Dawlish Additional Line would probably permit the saving of approximately 10-15 minutes between Exeter and Plymouth; provided it were constructed to a 125mph specification, and assuming trains would run non-stop between the two cities.

5.1.7 Clearly the strongest argument for a new route is the need to provide a resilient railway to Plymouth and Cornwall, which is also able to cope with demand growth. Despite considerable expense and effort by Network Rail, it is likely there will be an increasing number of occasions when the coastal route will be disrupted or closed, and given the predictions about levels of weather-related disruption, it is not inconceivable that the route may be breached again in the future without significant upgrading. Even if, however, a new route is constructed, the coastal route will need to remain open as it provides an important link to the communities it serves.

5.2 RECOMMENDATIONS

5.2.1 This report is meant to be an initial piece of analysis regarding the capacity requirements of the section of the railway between Exeter and Plymouth. In order to determine the exact timescales and extent of the interventions, it is recommended a demand study and timetable study is carried out using MOIRA and RailSys software respectively. These software packages will allow a more accurate determination the levels of overcrowding and infrastructure investment required in future. These studies will also be able to determine whether a different timetable specification will be able to deliver more capacity, and/or similar capacity benefits at a lower cost.

5.2.2 This report has concluded that – for the time being - there is no justification for the construction of an alternative railway alignment additional Dawlish on capacity grounds alone. The case becomes stronger when capacity, journey time, and resilience benefits are considered together, as in this report, rather than in isolation. As the resilience of the route becomes clearer, the issue of a new route will need revisiting in conjunction with demand growing to such an extent that the capacity offered by the existing route is insufficient, even after all proposed upgrades are delivered.