MOTT MACDONALD

Aberystwyth to Carmarthen Rail Reinstatement

Feasibility Study

19th September 2018

Transport for Wales
367590-WTD-CAR-3201

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Contents

Tables

Figures

Photos

Maps

Executive summary

Transport for Wales (TfW) commissioned Mott MacDonald to undertake a feasibility study into the reinstatement of a modern heavy railway link and attractive passenger rail services between the towns of Aberystwyth and Carmarthen.

The study was funded by the Welsh Government in recognition of the 'Case for Change' in the improvement of the strategic connections between Aberystwyth and Carmarthen, as identified by the WelTAG Stage One: Outline Case Report of November'16, and their wish to further explore the opportunities suggested by the previous Route Scoping Study of September'15.

Whilst this study broadly confirms the technical feasibility of reinstating a modified route and train service, it also highlights a number of key constraints/impacts to be resolved, and confirms the environmental importance and sensitivity of much of the route.

The identified scheme is believed to be close to optimal (within fixed constraints), but true viability would only be determined once the scheme has been more fully reconciled, through further detailed study, and in close consultation with the relevant local and statutory stakeholders.

Particular challenges include:

- **Cors Caron:** Identification of appropriate engineering solutions to address anticipated dynamic displacement and settlement issues related to the peat geology, whilst also being fully compatible with the environmental protection of the bog, and its flora and fauna.
- **Carmarthen Afon Towy Crossing and A484 Closure:** Resolution/mitigation of the impacts of the required A484 link bridge closure to through traffic, and potential flood risk impacts of new bridge(s) across the Afon Towy.
- **Accommodation of the Gwili Railway Preservation Company:** Where it has been determined that the Gwili Railway could not continue to operate in its current form, the availability and cost of appropriate re-provision at another location.
- **Mitigation of extensive Flood Risks:** Measures required in regard to the significant lengths of the route that are within Flood and Tan15 Development advice zones.
- **Property Impacts:** There would be some level of unavoidable residential property loss, together with noise and visual impacts on several communities along the route.
- **Environment and Consents:** The route passes through, or close to, a large number of sites and features which are protected by a range of statutory designations, which would require careful consideration during the planning and implementation of the project.
- **Ground Conditions, Residual Structures and Earthworks:** In advance of in-depth investigation, the specific measures required to bring the historic infrastructure back into use cannot be fully determined. Similar ground condition risks exist in regard to major new works, such as the Pen-Y-Banc Tunnel, Llanfarian cutting, and other new earthworks and structures related to the various deviations from the historic route.

Subject to the satisfactory resolution of the above, initial operational assessments have determined that the reinstated route could provide a regular hourly train service between Aberystwyth, Llanilar, Tregaron, Lampeter, Llanybydder, Pencader and Carmarthen, with an end to end journey time of around 85 minutes.

It is suggested that these services may be most economically and beneficially provided by extension of existing services on the adjoining routes (e.g. the Manchester to Carmarthen services), with local infills to the achieve higher (hourly) frequencies where required.

On the basis of these assumed services, and an opening year of 2024, initial demand assessments indicate that the reinstated railway service could attract up to 370,000 trips in its first year of operation, rising to 425,000 and 489,000 in the assessment years of 2027 and 2037 respectively.

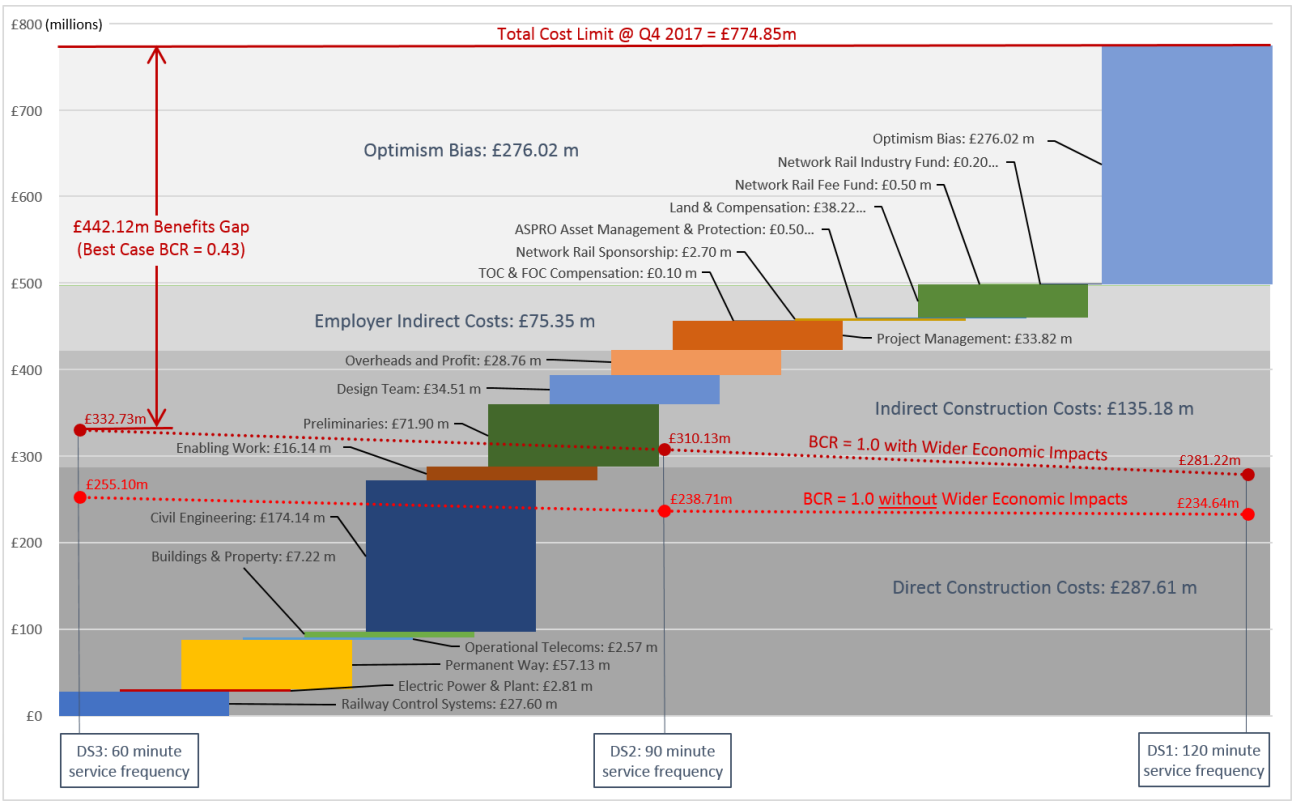

Figure 1: Affordability Summary

Figure 1 provides an 'Affordability Summary' of relevant scheme financial and economic factors (also provided at a larger scale as Figure 39) , as determined by the Capital Cost, Economic, and Wider Economic Impact assessments which were undertaken as a part of the study, to advise:

- A total cost build-up of £775 million (@ Q4 2017 prices) for the assumed single core option, incorporating two passing loops, and configured to the delivery of a 60 minute service frequency in accordance with the findings of the technical study (as DS3). It should be noted that there are a range of specific assumptions and exclusions to this cost build-up (see section 5.1 and Appendix F).
- To the current level of scheme maturity, the cost build-up includes an optimism bias uplift of £276m, which is a general risk allowance reflecting HM Treasury/DfT guidance. Were the scheme to be progressed further, risk allowances would more appropriately be defined via quantified risk assessment to the particular challenges of the scheme, noting that this may identify a need for higher contingency values than given above.
- Considering a standard range of costs and benefits (to PDFH v.5.1) a CAPEX affordability limit (to a BCR of 1.0) has been determined in the range of £230m to £255m, dependent on the service interval adopted.
- By extension of the above assessment to include Wider Economic Impacts, CAPEX affordability limits (to a BCR of 1.0) were subsequently raised to a range of £281m to £333m, again dependent on the service interval adopted.
- Economic Assessments to a range of 60, 90 and 120 minute service intervals demonstrate little sensitivity (£16m total variance) to improved frequencies against the standard

assessment, with an increased (if still moderate) impact of £47m total variance, once Wider Economic Impacts are included.

- Even with overall journey times reduced by around a quarter (n.b. an undeliverable reduction from 85 to 65 minutes), separate time sensitivity tests also show only moderate impacts, with a Maximum NPV increase of £42m.
- A best case BCR of 0.43, or a £442m benefits gap to the assessed total scheme for a target BCR of 1.0 (as the point at which economic costs and benefits are equal).

Where the above demonstrates the absence of any realistic prospect of either improving the economic benefits of the scheme, or reducing its overall cost, it is readily apparent that the scheme does not present a positive economic case. As such the scheme is only likely to be progressed in regard to wider societal needs, and strategic aims, the consideration of which is beyond the scope of this study.

Low local population levels (and levels of business, leisure, tourism activity, etc.) impose the key constraint on realistic demand levels, and thus achievable economic benefit. The achievement of a core BCR of 1.0 would require demand to more than double from the forecast, as shown relative to local populations in Figure 2 below.

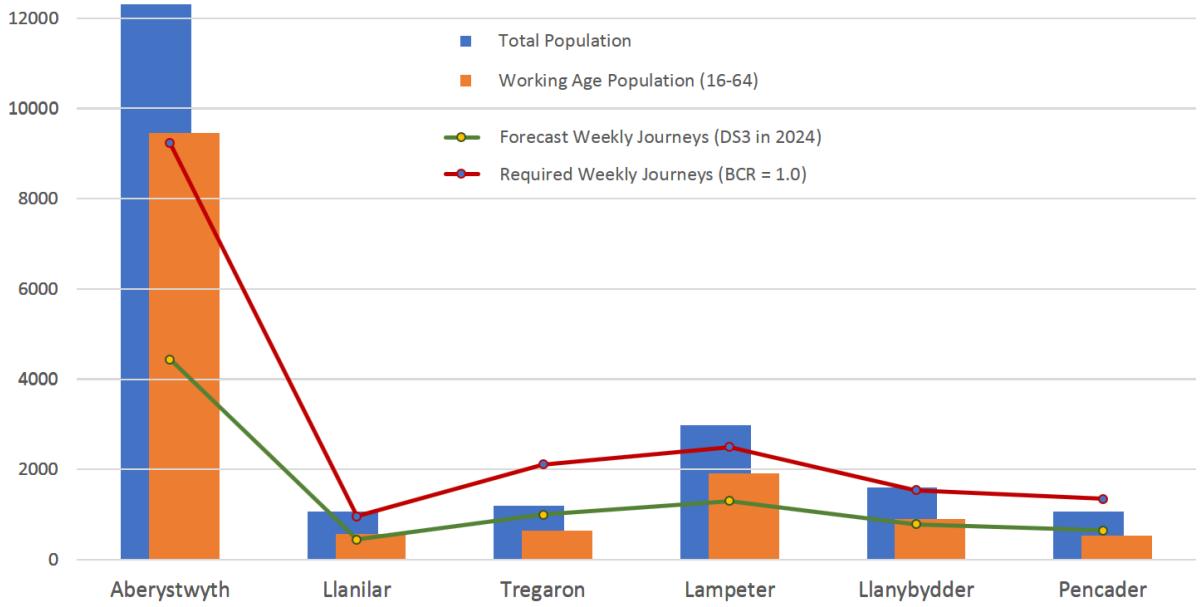

Figure 2: Forecast & Required Journeys per Week versus Local Population

To the original context of the WelTAG Stage One: Strategic Outline Case Report for *"Improving Strategic Transport Connections between Aberystwyth and Carmarthen"*, the completion of the study is useful in directly addressing many of the noted key risks, uncertainties, adverse impacts and constraints attributed to a new rail route. Workable solutions are presented to various of the issues raised, although concerns relating to the capital costs, environment, insufficient population, and the continued operation of the Gwili Railway are confirmed.

Where the WelTAG Stage One "Case for Change" remains to be addressed, it is hoped that the findings of this study will provide useful benchmarks for cost and BCR comparison to the alternative options that have been recommended to be taken forward. In this regard, it should be noted that whilst the study has attempted to provide a comprehensive high level overview of principal issues and approaches, significant further detailed work would be required to fully define a deliverable scheme.

1 Introduction

Transport for Wales (TfW) has commissioned Mott MacDonald to undertake a feasibility study into the reinstatement of a modern heavy railway link, and attractive passenger rail services, between the towns of Aberystwyth and Carmarthen.

The study was funded by the Welsh Government in recognition of the 'Case for Change' in the improvement of the strategic connections between Aberystwyth and Carmarthen, as identified by the WelTAG Stage One: Outline Case Report of November'16, and their wish to further explore the opportunities suggested by the previous Route Scoping Study of September'15.

As shown in Figure 3, the study considers a single core option, linking to new stations within the settlements of Llanilar, Tregaron, Lampeter, Llanybydder and Pencader. In the interests of minimising costs and impacts, this core option follows the historic railway route to the maximum extent that is practicable within current constraints and obstructions.

This document sets out the findings of the study, building off existing evidence, and a range of more detailed technical work, to advise:

- An Outline Development Remit (As Section 2), which provides a full summary of currently assumed requirements for the scheme.
- A discipline by discipline overview of the principal Technical Considerations as would affect the reinstatement of the railway (As Section 3), across:
    - Railway Alignment
    - Civil Engineering
    - Railway Systems
    - Railway Operations
    - Environment and Consents
    - Flood Impacts
    - Tunnelling (the Pen-Y-Banc Tunnel), and
    - Accommodation of the Gwili Railway
- An end to end Route Overview (As Section 4), setting out how a modern heavy railway might best be provided, whilst highlighting the principal challenges and impacts along the route.
- An indication of scheme Capital Cost Limits to be met in producing economic outcomes (As Section 5).
- An economic appraisal of the likely demand and revenue levels for the reinstated train service, together with an estimate of the Present Value of Benefits (As Section 6).
- An extended assessment considering the Wider Economic Benefits of the scheme (As Section 7).

A summary of conclusions is also provided (as Section 8), with a range of supporting drawings and documents included as Appendices, as:

- Appendix A - Drawings
- Appendix B - Geotechnical Desk Study Report
- Appendix C - Works Schedules
- Appendix D - Economic Appraisal Tables
- Appendix E - Wide Economic Impact Tables
- Appendix F - Capital Cost Estimate

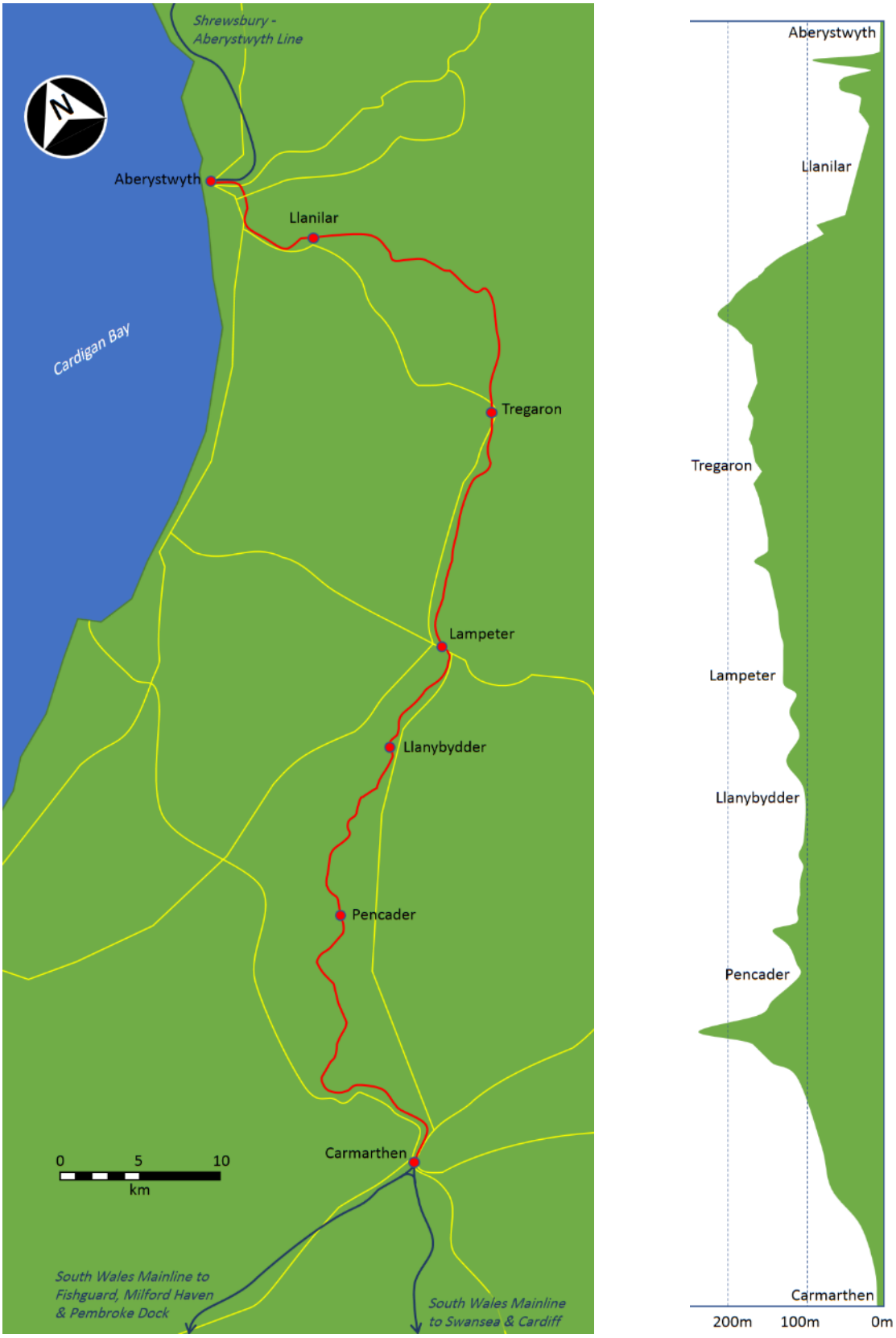

Figure 3: Route Outline & Indicative Ground Profile

2 Outline Development Remit

The following provides an Outline Development Remit setting out requirements, outputs, targets and constraints as are currently assumed, and as may materially affect the identification, development and assessment of a reinstated Railway line between Aberystwyth and Carmarthen.

2.1 Context

A WelTAG Stage One: Strategic Outline Case Report for "Improving Strategic Transport Connections between Aberystwyth and Carmarthen" was produced in November'16. The report sets out the Case for Change as follows:

> "OVERALL THE STUDY AREA SUFFERS FROM POOR ACCESS TO SERVICES AND JOBS (WELSH INDEX OF MULTIPLE DEPRIVATION (WIMD) 2014) AND CONSEQUENTLY THE NATIONAL TRANSPORT FINANCE PLAN 2015 – EVIDENCE BASE (2015) IDENTIFIES THE IMPORTANCE OF REDUCING JOURNEY TIMES ALONG THE ROAD CORRIDORS IN MID WALES AND IDENTIFYING WHERE LONG DISTANCE PUBLIC TRANSPORT SERVICES CAN PLAY A ROLE IN IMPROVING ACCESSIBILITY.
>
> THE HIGHWAY NETWORK FORMS THE BACKBONE OF THE TRANSPORT NETWORK WITHIN THE STUDY AREA DUE TO THE LACK OF RAIL INFRASTRUCTURE BETWEEN ABERYSTWYTH AND CARMARTHEN. HOWEVER, GIVEN THE IMPORTANCE OF THE HIGHWAY NETWORK IN PLACES IT FALLS BELOW APPROPRIATE STANDARDS (CEREDIGION COUNTY COUNCIL – LOCAL GOVERNMENT PERFORMANCE 2012/13).
>
> THERE IS AN OPPORTUNITY TO INTRODUCE GREATER INNOVATION, INTEGRATION AND COLLABORATION TO IMPROVE CONNECTIONS BETWEEN ABERYSTWYTH AND CARMARTHEN, AS WELL AS THE SETTLEMENTS IN BETWEEN, IN ORDER TO REVERSE THE TREND IN THE DOMINANCE OF THE PRIVATE CAR AND DIFFICULTIES ACCESSING EMPLOYMENT AND SERVICES.
>
> RECENT INVESTMENTS IN THE TRAWS CYMRU SERVICE HAVE SHOWN THAT CONSIDERABLE GROWTH IN PATRONAGE CAN BE ACHIEVED, FOR EXAMPLE ALONG THE CORRIDOR THE FORMER X40 SERVICE (NOW THE TRAWS CYMRU T1 SERVICE) HAD 102,000 PASSENGERS IN 2010/11 WHICH GREW TO 235,000 IN 2013/14 WHEN ROUTE BECAME THE T1 SERVICE. THE PATRONAGE GREW FURTHER TO 240,000 IN 2014/15".

Extract 1: The Case for Change
(Source: WelTAG Stage One: Strategic Outline Case Report)

The report considered six options, including a new rail route (**Option B**), although this is not recommended to be taken forward, in preference of:

- **Option A** (do-minimum)
- **Option C** (regional bus service enhancements),
- **Option E** (regional highway improvements) and
- **Option F** (multimodal option)

Option D (local and community transport enhancements) is also non-preferred.

In assessing the new rail route option, key risks, adverse impacts, constraints and dependencies were noted as follows. Where various uncertainties and information gaps are noted, items where the conclusion of this study provides an improved understanding are marked with an asterix (*):

KEY RISKS:

- REQUIRES A HIGH LEVEL OF CAPITAL INVESTMENT. THE CURRENT ESTIMATED TOTAL PROJECT COSTS ARE £750M.*
- OPTION B WOULD REQUIRE SIGNIFICANT SUBSIDY. THE WELSH GOVERNMENT HAS PROVIDED ARRIVA TRAINS WALES WITH £700M BETWEEN 2011/12 AND 2014/15 IN FRANCHISE SUBSIDY PAYMENTS, INCLUDING FUNDING FOR SERVICES ADDITIONAL TO THOSE WITHIN THE FRANCHISE. ARRIVA TRAINS WALES, WHOSE SUBSIDY PER PASSENGER KILOMETRES GREW TO £0.131 IN 2013-14.
- ANY POTENTIAL NEW RAIL SERVICE WOULD BE DEPENDENT ON THE NEED TO BE FULLY INTEGRATED WITH THE REGIONAL AND LOCAL BUS SERVICES, AS WELL AS WITH COMMUNITY TRANSPORT SERVICES.
- WOULD BE DEPENDENT ON A RANGE OF FUNDING SOURCES, WHICH ARE UNCERTAIN PARTICULARLY GIVEN THE FUTURE LOSS OF EU MONIES.
- A NUMBER OF LARGE SCALE TRANSPORT OPTIONS ARE CURRENTLY IN THE WELSH GOVERNMENT'S INFRASTRUCTURE DELIVERY PROGRAMMES, SUCH AS THE METRO, THE M4 MOTORWAY, TIDAL LAGOON SWANSEA BAY (SUBJECT TO APPROVAL) AND WYLFA NEWYDD NUCLEAR PLANT, WHICH WOULD REQUIRE SIGNIFICANT CAPITAL FUNDING AND RESOURCES.
- OPTION B WOULD REQUIRE A FULL FEASIBILITY STUDY TO PROVIDE ROBUST CONSTRUCTION COSTS, LAND ACQUISITION COSTS, AS WELL AS PRELIMINARY ENVIRONMENTAL AND BUSINESS CASE ASSESSMENTS.*
- LAND ACQUISITIONS.*
- ENVIRONMENTAL CONSIDERATIONS.*
- DISPERSED SETTLEMENTS AND LOW POPULATION DENSITY ARE A POTENTIAL RISK TO ENSURING THE POTENTIAL RAILWAY LINE HAS SUFFICIENT POPULATION CATCHMENT TO BE ECONOMICALLY VIABLE. THIS LEVEL OF INFORMATION IS NOT AVAILABLE AT THIS STAGE.*
- ROUTE UNCERTAINTIES MAKE IT DIFFICULT TO FULLY UNDERSTAND THE ENGINEERING CONSTRAINTS AND POTENTIAL COSTS, AND ASSOCIATED IMPACTS, PARTICULARLY FOR THE RAIL ROUTE TO SERVE ABERYSTWYTH.*
- PUBLIC AND POLITICAL ACCEPTABILITY PARTICULARLY AT THE NORTHERN END WHERE THE FORMER RAILWAY LINE HAS BEEN DEVELOPED.

Extract 2: Key Risk of New Rail Route
(Source: WelTAG Stage One: Strategic Outline Case Report)

ADVERSE IMPACTS:

- POTENTIAL IMPACT ON PROTECTED ENVIRONMENTAL SITES ALONG THE ROUTE.*
- IMPACT ON RESIDENTS AND BUSINESSES LOCATED ALONG THE POTENTIAL ROUTE, ALTHOUGH THIS WOULD BE LOCALISED TO THOSE IMMEDIATELY AFFECTED WITH POTENTIAL BENEFITS FOR THE WIDER COMMUNITIES.*
- IMPACT ON THOSE RESIDENTS AND BUSINESSES LOCATED ALONG THE ROUTE, DUE TO INCREASED NOISE POLLUTION.
- IMPACT ON LOCAL COMMUNITIES DURING CONSTRUCTION.
- WOULD REQUIRE A HIGH LEVEL OF CAPITAL INVESTMENT, WHICH WOULD HAVE IMPLICATIONS ON THE DELIVERY OF OTHER CAPITAL SCHEMES IN THE REGION FOR A NUMBER OF YEARS.

Extract 3: Adverse Impacts of New Rail Route
(Source: WelTAG Stage One: Strategic Outline Case Report)

CONSTRAINTS:

- REQUIRES A HIGH LEVEL OF CAPITAL INVESTMENT AND SUBSIDY.
- LOW POPULATION DENSITY AND DISPERSED SETTLEMENT PATTERNS.
- INFLEXIBILITY OF RAIL SERVICES.
- EXISTING PROTECTED ENVIRONMENTAL SITES ALONG THE ROUTE.*
- DEVELOPMENTS ALONG SOME SECTIONS OF THE FORMER RAIL ROUTE.*
- ROUTE UNCERTAINTIES MAKE IT DIFFICULT TO FULLY UNDERSTAND THE ENGINEERING CONSTRAINTS AND POTENTIAL COSTS, AND ASSOCIATED IMPACTS, PARTICULARLY FOR THE RAIL ROUTE TO SERVE ABERYSTWYTH.*
- EXISTING ROUTES AND STRUCTURES MAY NOT CONFORM TO CURRENT STANDARDS.*
- AT THE NORTHERN END OF THE FORMER ROUTE MUCH OF THE ORIGINAL ALIGNMENT HAS BEEN PRESERVED AS THE YSTWYTH TRAIL FOR CYCLISTS AND WALKERS.*
- GWILI RAILWAY USE PART OF THE FORMER RAILWAY LINE AND ARE KEEN TO CONTINUE TO OPERATE AS A TOURIST ATTRACTION.*

Extract 4: Constraints of New Rail Route *(Source: WelTAG Stage One: Strategic Outline Case Report)*

DEPENDENCIES:

- NETWORK RAIL DELIVERY PROGRAMMES AND RAIL OPERATOR FRANCHISE.
- WELSH GOVERNMENT PRIORITIES AND COMMITTED EXPENDITURE.
- LOCAL AUTHORITY DELIVERY PROGRAMMES, AS SET OUT IN THE JOINT LOCAL TRANSPORT PLANS.

Extract 5: Dependencies of New Rail Route *(Source: WelTAG Stage One: Strategic Outline Case Report)*

2.2 Strategic Fit

Whilst the previous WelTAG Stage One report did not recommend that a new rail route be taken forward (in favour of potential bus and/or highway improvements, as set out in 2.1 above), the overall case for change remains to be addressed, and the Welsh Government has subsequently provided limited funding for this feasibility study into the reinstatement of the rail link.

This builds off the previous "Scoping study for full feasibility study for re-opening a heavy railway between Aberystwyth and Carmarthen" Report of October 2015.

The completion of the study will better advise many of the uncertainties, unknowns, and gaps identified within the original WelTAG Stage One assessment, and if sufficiently positive may lead to its findings being revisited.

It should be noted that in the interests of making best use of limited public funds, the scope has been rationalised from that proposed within the scoping study, prioritising those issues which have the greatest bearing on the overall feasibility, and economic viability of reinstating the rail link.

The principal consequence of this is that the study has had to be closely focussed on a single core scheme, with only outline consideration of alternative options and approaches.

As such the feasibility of the core option is advised, but without confirmation that this option is fully optimised. If the scheme is taken forward, some further level of investigation and optimisation is therefore likely to be required.

2.3 Problem Definition

The improvement of transport provisions, and public transport options, within and across the West Wales region, with a view to reducing the reliance on the motor car, and enhancing the economic and social sustainability of local communities and businesses.

2.4 Project Objectives

The reinstatement of a modern heavy railway, and attractive passenger railway services, between the towns of Aberystwyth and Carmarthen, making best use of the historic railway corridor, to minimise costs, impacts and risks, whilst also optimising the economic case for reinstatement.

The overall objective of the study is to explore whether there is a realistic and viable possibility of reinstating a heavy railway link between Aberystwyth and Carmarthen, in an appropriate balance of costs/impacts to benefits across a range of WelTAG defined Social, Environmental and Economic criteria.

In considering route options and configurations the principal drivers, to be balanced in optimising viability can be summarised as follows:

i. **Provision of the most attractive passenger rail service:** achieved by maximising accessibility to the largest number of people, minimising journey times, and maximising service frequencies, subject to iii. below. This would also serve to **maximise revenue**.

ii. **Minimising environmental and community impacts**: achieved by routing/configuration to avoid sensitive sites wherever possible, or by inclusion of mitigation measures where unavoidable.
iii. **Minimum construction and operational costs:** achieved by carefully considered design, to the constraints and requirements of i. & ii. above.

2.5 Project Benefits

The reinstatement of passenger railway services across the West Wales region has the potential to facilitate a broad range of economic, social and cultural benefits, strengthening communities, businesses and public institutions (i.e. the University Campuses in Lampeter and Aberystwyth), and enhancing their long-term sustainability.

2.6 Abbreviations

AOD	Above Ordnance Datum
BCR	Benefit Cost Ratio
BOP	Box on Post
CBI	Computer Based Interlocking
CCTV	Closed Circuit Television
CFA	Continuous Flight Auger (Piles)
CIS	Customer Information Screens
DAM	Development Advice Map
DfT	Department for Transport
DISAC	Double Insulated Super Armoured Cable
DM	Do Minimum
DMU	Diesel Multiple Unit (Train)
DOO	Driver Only Operation
DS	Do Something
EIA	Environmental Impact Assessment
ELR	Engineer's Line Reference
ERTMS	European Railway Traffic Management System
ETCS	European Train Control System
FOC	Freight Operating Company
FTN	Fixed Telephone Network
GCSS	Graphical Configuration Sub System
GDP	Gross Domestic Product
GJT	Generalised Journey Time
GRP	Glass Reinforced Plastic
GSIM	Graphical Simulator
GSM-R	Global System for Mobile Communications – Railway
IOMS	Input/Output Modules
iP	Internet Protocol
IVT	In Vehicle Time
JTI	Journey Time Improvements
LLPA	Long Line Public Address
MECC	Marginal External Cost of Car
NRW	Natural Resources Wales
NSF	New Stations Fund
ORR	Office of Rail and Road
OS	Ordnance Survey
P-A	Production-Attraction
PDFH	Passenger Demand Forecast Handbook
PPW	Planning Policy Wales
PVB	Present Value of Benefits
PVC	Present Value of Costs
REB	Relocatable Equipment Building
RPI	Retail Price Index
RQD	Rock Quality Designation
SAC	Special Areas of Conservation
SCADA	Supervisory Control and Data Acquisition
SISS	Station Information and Security System
SPA	Special Protection Areas
SPT	Signal Post Telephone
SRT	Sectional Running Times
SSI	Solid State interlocking
SSSI	Site of Special Scientific Interest
TAG	Transport Appraisal Guidance (DfT)
TAN	Technical Advice Note
TBM	Tunnel Boring Machine
TFM	Trackside Functional Modules
TfW	Transport for Wales
TLC	Traws Link Cymru
TOC	Train Operating Company
TPH	Trains per Hour
TVM	Ticket Vending Machines
TWAO	Transport and Work Act Order
VfM	Value for Money
VoiP	Voice over internet Protocol
VoTs	Values of Time
WEI	Wider Economic Impacts
WelTAG	Welsh Transport Appraisal Guidance
WG	Welsh Government

2.7 Definitions

Not used.

2.8 Prioritisation and Timescales

No priorities, nor timescales, have currently been defined in relation to the scheme.

2.9 Interfaces

The scheme would be required to function as an integral part of the wider Welsh railway network, and would therefore need to be aligned with any interfacing development of train service, rolling stock or infrastructure (e.g. signalling).

2.10 Key Stakeholders

- Key Stakeholders include:
  - The Welsh Government (WG)
  - Transport for Wales (TfW)
  - Carmarthenshire County Council
  - Ceredigion County Council
  - The Department for Transport (DfT)
  - Network Rail (NR)
  - Historic Railways Estate (part of Highways England)
  - A total of 46 Town & Community Councils along the route
  - Natural Resources Wales (NRW)
  - CADW
  - Sustrans
  - TOCs & FOCs (Train & Freight Operating Companies)
  - The Gwili Railway Preservation Society
  - Traws Cymru (Local Bus Operator)
  - Local residents and businesses
  - Traws Link Cymru (TLC – West Wales Rail Campaign Group)

  To funding and timescale limitations, initial stakeholder consultation within the feasibility study has been limited to WG, TfW & TLC.

2.11 Timescale, Cost, Quality Constraints

No specific timescale, cost or quality constraints have currently been defined in relation to the scheme.

2.12 Phasing

No interim phases are anticipated, where the principal scheme benefits are anticipated to relate to the full connection of Aberystwyth to the South Wales Railway network (n.b. this is not to suggest that further benefits would not also be accrued via direct and indirect connection to the smaller settlements to both the south and north of Aberystwyth).

2.13 Geographical Boundaries

The scheme is concerned with the provision of a through railway route between the existing stations of Aberystwyth and Carmarthen, making principal use of the historic Manchester and Milford Railway corridor, defined (by Engineer's Line References (ELRs)) as :

Historic Line ELRs

CAN Carmarthen and Newcastle Emlyn Line

```
245.55   CARMARTHEN
245.65   later end of line
245.74   CARMARTHEN TOWN
246.08   Carmarthen Town goods depot
247.06   Abergwili Junction with LCL(13.25)
249.11   BRONWYDD ARMS
250.22   CWMDWYFRAN
250.57   LLWYFAN CERRIG
251.30   DANYCOED
252.14   CONWIL
255.25   LLANPUMPSAINT
260.27   PENCADER
260.61   Pencader Junction with AYT(0.00)
```

AYT Aberystwyth Branch

```
 0.00    Pencader Junction with CAN(260.61)
 1.53    BRYN TEIFY
 3.32    MAESYCRUGIAU
 7.23    LLANYBYTHER
 8.42    PENCARREG
12.27    LAMPETER
13.50    Aberayron Junction with LAB(0.00)
14.52    DERRY ORMOND
15.72    LLANGYBI
17.26    OLMARCH
19.48    PONT LLANIO
22.25    TREGARON
25.08    ALLTDDU
27.20    STRATA FLORIDA
29.31    CARADOG FALLS
32.18    TRAWSCOED
33.61    FELINDYFFRYN
35.25    LLANILAR
38.31    LLANRHYSTYD ROAD
40.31    junction with harbour lines
41.15    junction with SBA2 (95.49)
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SBA2 Welshpool to Aberystwyth

```
95.49    junction with AYT (41.15)
95.60    ABERYSTWYTH
(Miles from Whitchurch via Oswestry)
```

Reinstated Line ELRs (indicative)

CAN Carmarthen and Newcastle Emlyn Line

```
245.55   CARMARTHEN
245.65   later end of line
```

TLC1 Carmarthen and Aberystwyth Line

```
245.65   Junction with CAN(245.65)
260.18   PENCADER
268.09   LLANYBYDDER
273.12   LAMPETER
283.17   TREGARON
296.21   LLANILAR
301.24   Junction with SBA2 (94.65)
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SBA2 Welshpool to Aberystwyth

```
94.65    junction with TLC1 (301.24)
95.60    ABERYSTWYTH
(302.19 miles from Paddington via Stroud)
```

ALL CHAINAGES ARE IN Miles.Chains
(80 chains = 1 mile)

It should be noted that for the purposes of the feasibility study, chainage has been measured in kilometres from Aberystwyth station.

The historic Llandeilo, Newcastle Emlyn and Aberaeron Branch Lines are not part of the study area, although it is acknowledged that these routes provide potential opportunities for the relocation of the Gwili Railway Operations, as follows, (again defined by Engineer's Line References):

Historic Branch Line ELRs

LCL Llandilo and Carmarthen Line

```
 0.00    Carmarthen Valley Junction with LLA (17.48)
 0.24    LLANDILO BRIDGE
 2.61    GOLDEN GROVE
 5.24    DRYSLLWYN
 6.50    LLANARTHNEY
 9.14    NANTGAREDIG
12.50    ABERGWILI
13.25    Abergwili Junction with CAN (247.06)
```

CAN Carmarthen and Newcastle Emlyn Line - beyond Pencader Junction (260.61)

263.69	LLANDYSSUL
265.48	PENTRECOURT
267.63	Teifi Valley Railway maintenance depot
267.68	HENLLAN [1]
267.76	HENLLAN [2]
268.15	FOREST
268.32	PONTPRENSHITW
268.78	LLANDYFRIOG
269.45	PONT GOCH
270.67	NEWCASTLE EMLYN

LAB Lampeter and Aberayron Branch/Aberayron Branch

0.00	Aberayron Junction with AYT (13.50)
0.45	SILIAN
2.61	BLAENPLWYF
4.49	TANSARN
6.00	FELIN FACH
7.07	Green Grove sidings
8.44	CILIAU AERON
9.37	CROSSWAYS
10.28	LLANERCH AYRON
12.14	ABERAYRON

Note that the line onwards to New Quay was never completed

The feasibility and suitability of relocating the Gwili Railway to any part of these branch lines is out-with the scope of this feasibility study.

2.14 Intended Effects on Train Service Specification

It is anticipated that the reinstated railway would enable the provision of a regular hourly, or two hourly, service between Aberystwyth and Carmarthen, calling at each of the proposed intermediate stations.

2.15 Intended Impacts on Existing Train Services or Obligations

The provision of the new Aberystwyth to Carmarthen services must be achieved without significant detriment to the frequency or journey time of any existing passenger train service, accepting that some variation or modification may be desirable or necessary where the new services are provided by the extension of other existing services (e.g. the possible extension of the current Manchester to Carmarthen service to Aberystwyth).

Likely impacts, and potential mitigations, to the tourist services of the Gwili Steam Railway are to be considered as part of the feasibility study.

2.16 Intended Reliability and Availability Changes and the Effects on Train Service Performance

The provision of the new Aberystwyth to Carmarthen services must be achieved without detriment to the reliability and availability of any existing passenger train service.

2.17 Proposed Physical Changes and Known Constraints (Rolling Stock and Infrastructure)

The scheme would require the construction of circa 90km of new single track railway, with five new stations (at Llanilar, Tregaron, Lampeter, Llanybydder and Pencader), one/two passing loops (dependent on train frequency), and associated signalling, telecoms and other fixed equipment.

The train service should be deliverable using currently available rolling stock, accepting that some increase in overall train fleet size may be necessary to meet the increased service extent and mileage.

2.18 Core Options

To the limits of available funds a single core option has been considered within the initial feasibility study.

In the interests of minimising costs and impacts, this follows the historic railway alignment to the maximum extent that is practicable within current constraints and obstructions.

Where it is necessary to deviate from the historic alignment, a single alternative has been identified and developed on the basis of the best judgement of the Mott MacDonald technical team.

Subject to the economic viability of the scheme, it is anticipated that further work would be undertaken to confirm (or revise) these initial judgements in consultation with key stakeholders.

2.19 Interfaces and Dependencies on Other Projects or Franchises

No specific interfaces and dependencies on other projects or franchises, have been identified in relation to the scheme.

2.20 Application of Standards

The scheme shall generally comply with applicable Railway Group Standards and associated European and British Standards reflecting normal UK practice.

2.21 Statutory Powers Requirements

Powers to construct and operate the reinstated railway would be sought via a Transport and Works Act Order (TWAO).

2.22 Environmental Requirements

The scheme shall comply with all applicable environmental regulations and standards, reflecting normal UK practice.

2.23 Town Planning Requirements

To be determined in regard to stations, and other buildings and structures.

2.24 High Level Safety Requirements

The scheme would comply with appropriate standards, whilst ensuring that safety impacts are reduced to levels which are as low as reasonably practicable, and a safety management system would be put in place.

2.25 Other Requirements or Constraints

None identified.

2.26 Complete Client Requirement Statement

The above has been confirmed by TfW as constituting a full statement of current requirements.

2.27 References

- Improving Strategic Transport Connections between Aberystwyth and Carmarthen
  WelTAG Stage One: Strategic Outline Case Report, Arcadis, November 2016
- Scoping Study for full feasibility study for re-opening a heavy railway between Aberystwyth and Carmarthen, AECOM, September 2015
- Traws Link Cymru, West Wales Rail Campaign, Briefing Notes, August 2017
- The Manchester and Milford Railway, John Holden, The Oakwood Press; UK ed. Edition, 2007
- Passenger Demand Forecasting Handbook v4.0
- Passenger Demand Forecasting Handbook (PDFH) v5.1
- TAG Databook (July 2017)
- Welsh Government's Wales Transport Strategy (2008)
- The Network Rail Welsh Route Study, March 2016
- Priorities for the future of Welsh Rail Infrastructure, March 2016, The mid Wales Transport Partnership (TraCC)
- Wales National Transport Finance Plan 2015
- Ceredigion Local Development Plan 2007-2022
- Ceredigion for All: Our livelihoods, Our Economic Regeneration Strategy 2015
- Aberystwyth Masterplan 2006
- Carmarthenshire Local Development Plan 2014
- A strategic regeneration plan for Carmarthenshire 2015-2030

3 Technical Considerations

A conventional 'full' feasibility study would typically look to consider a broad range of potential options, across the full range of technical disciplines, before selecting a preferred option. This option would then be further developed to establish that the scheme is fully feasible, and to allow the development of a robust capital cost estimate for its delivery.

Where this is not possible within the limits of the available funding, it has been necessary to rationalise the scope, such that only a single 'core' alignment option has been developed, which was selected as 'preferred' through the best judgement of the technical team. The key consequence of this approach is that further work may susbequently be required to conclusively select a single preferred option.

This 'core' option is set out within the route description (as section 4 of this document), together with the basis of this preference. This was formally agreed with TfW within an inception workshop on 20th July'17. An overview of previously identified options which are initially non-preferred is also provided.

The following provides a summary of the principal technical considerations, and findings as would affect the reinstatement of the railway:

3.1 Railway Alignment

A fully workable end to end railway alignment has been defined, such that line speeds and journey times can be reliably assessed, whilst also enabling the identification of the full range of technical and implementation challenges to be resolved.

Recognising that the historic alignment was well engineered to provide the railway link at minimum cost, and that funds for reinstatement would inevitably be limited, deviations were only considered where present day constraints and obstructions prevent its reuse.

In considering necessary route deviations, a reasonable balance of cost to impact has been sought, recognising the need to avoid tunnelling, and other more expensive measures, as far as this is possible.

A number of significant impacts and issues are identified along the route, where initial (judgement based) choices would require further detailed consideration, in concert with relevant stakeholders.

A key output of the alignment work is to determine allowable line speed throughout the route. This is the first step in establising achievable line speed and journey time, to the wider constraints of stopping patterns, and rolling stock performance relative to the significant gradients along parts of the route (as set out in section 3.4 of this report).

Key alignment criteria can be summarised as follows:

- Ruling Gradient (Aberystwyth to Carmarthen): 1 in 38 (2.6%)
- Ruling Gradient (Carmarthen to Aberystwyth): 1 in 37 (2.7%)
- Minimum Horizontal Curve Radius: 180m
- Allowable Line Speed: 37 to 75mph

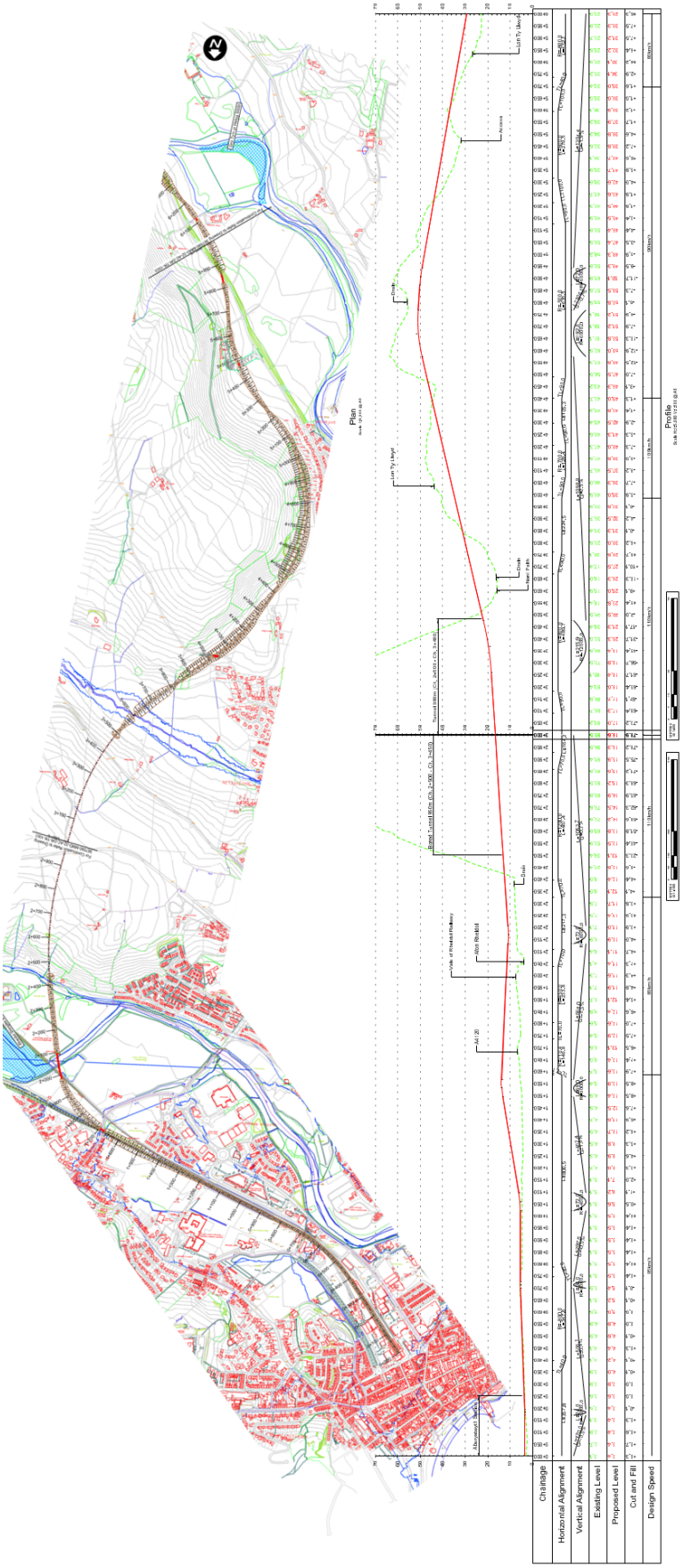


Figure 4: Example Railway Alignment (Aberystwyth to Llanfarian)

3.2 Civil Engineering

Whilst many of the historic earthworks and structures are at least partially intact, all would require detailed investigation to determine the remediation and enhancements works necessary to bring them up to current standards and requirements.

A number of new earthworks, structures and other meassures would also be required to route deviations, and where the historic infrastructure has either been removed, or does not meet the requirements of the reinstated railway, or interfacing highways, accesses, etc.

Sufficient technical definition has been provided to enable the production of a full capital cost estimate (by Chandler KBS), noting that various aspects of these are based on simplified assumptions and risk allowances, rather than more fully considered technical assessment and design as would be required to fully confirm feasibility.

Particular issues, and approaches include:

3.2.1 Crossings and Severance

A total of 147 crossings of the railway alignment have been identified, in relation to rivers, highways, cycle & footpaths, private farm, residential and business accesses, drainage culverts, etc.

These include a number of historic level crossings, and other currently at grade crossings, which to current national legislation and practice (Re: ORR's high level "no new level crossings" policy, RGD-2014-06) could not be retained, and which would therefore need to be replaced with new bridge crossings.

In the interests of minimising overall costs, wherever appropriate new grade separated crossings are typically proposed as overbridges above the railway, which is maintained at grade.

These are considered in further detail under sections 3.2.2 (Rights of Way & Utilities), and 3.2.3 (Structures) below.

3.2.2 Rights of Way & Utilities

Rights of Way and Utilities have only been considered in outline, and only to the extent that they are directly impacted by severance issues and new routes, as set out above. Utilities searches have not been undertaken at this stage.

To the limitations set out above, it has not been possible to fully confirm the feasibility/suitability of any rights of way & utilities works, with the risk that alternative/additional measures are required at some locations.

3.2.2.1 Cycle Routes

Proposed reuse of the historic railway alignment directly impacts on approximately 16.5km of dedicated cycle route, where it will generally be more practical/economic to relocate the cycle route, than to provide an alternative alignment of the railway.

In minimising impacts and costs, relocated cycle routes will mostly remain directly adjacent to the railway trace, with at grade road crossings, and sharing new/existing highway crossings of the railway to avoid the need for dedicated structures.

Of the circa 16.5km of off-road cycle route affected by the proposed railway alignment, approximately 16km of the cycle route would be re-provided off-road, with only a short section of (approximately 500m in length) to be relocated onto the B4575 north of Trawscoed to tie in to the existing on-road cycle route on the B4340 (see below)

Figure 5: Trawscoed Cycle Route Relocation

3.2.2.2 Highway and Private Access Issues

As stated in section 3.2.1 above the retention of any historic at-grade crossings is not to be allowed along the route and as such all crossings of public highways, farm accesses etc would have to be replaced by new bridge crossings, or where not possible (due to railway alignment or other factors), via alternative highway/access routes.

Where farm accesses currently utilise sections of the redundant railway, these would be reprovided alongside the new proposed alignment.

Generally the provision of new bridge crossings and retention of existing highway alignment would be provided along the route to maintain public and private access.

However, there are several instances where alteration to the existing highway network and private means of access would be necessary, as follows:

- **A485/B4342 South of Tregaron:** The alignment of the A485 south of Tregaron prior to closure of the railway line was originally such that a highway bridge of minimal skew was provided to take highway traffic over the railway line (as shown below). The railway line approach to the bridge was therefore in cutting.

  However, following closure of the railway line a highway improvement scheme was undertaken which realigned the A485, filled in the cut area and removed the bridge.

  The reinstated railway would follow the historic alignment (both vertically and horizontally) at this location and as such the cutting would need to be reintroduced.

  To reduce the skew and minimise the span (and subsequent costs) of the proposed highway bridge it is proposed to realign the existing A485 and to alter the connection with the B4342. Whilst this positively impacts on the span of the bridge required to cross the proposed railway line it does introduce a change in alignment of the A485 which may not be acceptable to the Highway Authority. As such a risk for this proposal may be that a

much greater span bridge would be required to accommodate the A485 on its existing alignment.

Figure 6: A485/B4342 Highway Modifications South of Tregaron

- **Teras Yr Osaf, Llanybydder:** Due to the proximity of the existing B4337 highway bridge (immediately to the south) there is no scope to raise the railway line sufficiently to cross Teras Yr Osaf. Similarly the highway alignment and proximity of a number of properties and businesses makes raising (or lowering) of the highway impractical.

  It is envisaged that Teras Yr Osaf would instead be stopped-up at the location of the railway crossing, with a new access provided from the B4337 to the new Llanybydder station (see section 3.2.4), as well as properties and businesses to the north of the crossing (as Figure 7 below).

  This access is currently used by the Mitsubishi Motors dealer. It is envisaged that the existing access road would need to be widened and adjacent building demolished to accommodate the station and revised access road provision.

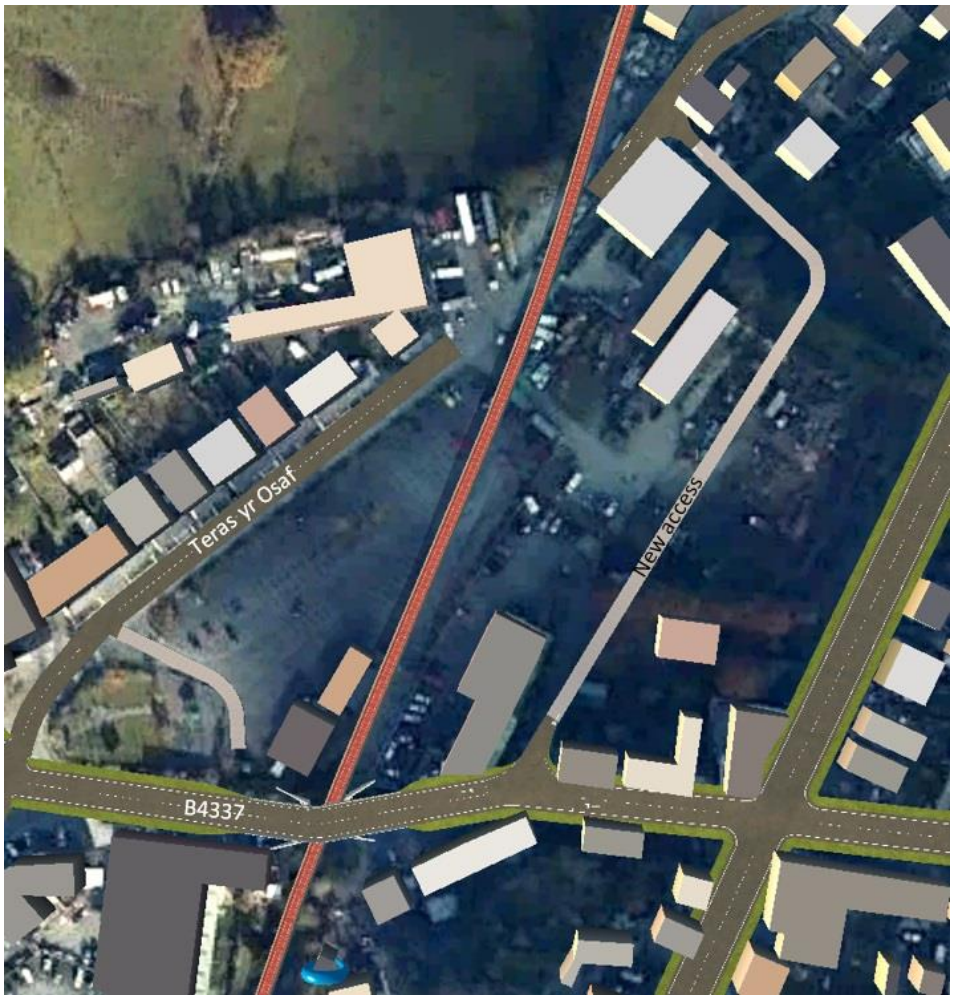


Figure 7: Tregaron Station - New Access Road Provision

- **Existing Level Crossing, Bronwydd:** A minor county road currently crosses the Gwili Steam railway via a level crossing to the south of Bronwydd. It is likely that this would need to be closed due to the increased risks posed by faster and more frequent trains.

  The road from the west is very steep with private houses on both sides, whilst closely to the east there is a Welsh Water treatment works, and a river bridge. To their close proximity, a replacement bridge would have to span both the railway and the river, which would be inappropriately expensive for such a minor road.

  As such it would be proposed to close the level crossing and stop up the existing public highway either side of the crossing, requiring traffic to take an alternative route.

  This would add an additional 2.5km to journeys from the B4301 to the Welsh Water treatment works and local farms such as Nant Ferys, the acceptability of which would need to be negotiated with the Local Highway Authority, Welsh Water and the affected farms and residents.

  Should this prove to be unacceptable, an alternative option would be to provide a new link road from the realigned B4301 adjacent to the proposed bridge spanning the Gwili Railway station level crossing (approximately 250 metres to the north) to the minor county road leading to the Welsh Water treatment works site. This would also require an additional river crossing but would reduce the additional length of the diversionary route to around 800 metres.

Figure 8: Bronwydd (south) Level Crossing – Alternative Access

- **Carmarthen Station Link:** In order to achieve the required vertical alignment of the railway line above the existing flood defence wall alongside Carmarthen railway station it would be necessary to close the southern A484 link span of the existing Carmarthen bridge above the railway (see Photo 1 below).

Photo 1: South Span of Carmarthen Bridge

It is envisaged that the main river bridge would remain open to traffic from the town centre, but only in provision of access to the railway and bus station. The existing A484 principal route through Carmarthen would be severed to the south of the river, and traffic would be required to utilise alternative routes.

Local traffic to the north of the river wishing to access the local business park in Pensarn and nearby residential areas to the south and east of the river, would be required to use the existing A40 trunk road and A4242 (Priory Street) county road (to the West and South of the closure) or the A484 county road and A40 trunk road (to the North and East of the closure), adding approximately 3km to each trip.

Commuter and non-local traffic would also have to utilise the same routes to enter/exit the town but the impact in terms of additional journey distance would be significantly less with traffic travelling to/from the South and West and East of Carmarthen only marginally impacted, and traffic to North not affected at all.

Traffic originating from the East would be worst affected with additional journey time from using the alternative (longer) A4242/A40 route, or using the A484 Priory Street alternative (lower speed) route.

As well as additional journey lengths associated with the diversion routes, the impact of severing a significant principal route through the town, and the effect that the redistribution of impacted traffic would have on the existing highway network would need to be considered in detail, and may not ultimately be acceptable to the Local Highway Authority.

Should the existing diversionary routes prove to be insufficient, a new highway link could be provided between the A4242/Morfa Lane roundabout and Pensarn Road. This would require the provision of new highway bridges over both the river and railway, as well as raising the level of the Morfa Lane roundabout to provide sufficient clearance of the river bridge over the river Towy and the existing cycle route at this location (as Figure 9).

Figure 9: Carmarthen A484 Closure – Potential Alternative Highway Link

Figure 10: Carmarthen – A4242 / Morfa Lane roundabout

An additional impact of the potential A484 closure would be the severence of the existing cycle route that crosses beyond the buffer stops at the end of the railway (Photo 2). To maintain a cycle/pedestrian link across the railway it would be necessary to tie in with the proposed station bridge that would be provided to facilitate crossing movements between platforms 1 and 2.

Photo 2: Existing cycle route – Carmarthen station

- **Carmarthen Private Car Park and Farm Land Access:** The reinstated railway would return to grade immediately to the north of the proposed railway bridge over the River Towy. This would sever the existing access to the private car park and farm land that is currently accessed off Old Station Road (shown dotted red line in Figure 11 below).

  Vertical alignment of the existing highway and proximity of adjacent properties and businesses would make it impractical to raise (or lower) the existing accesses to cross the railway line at their existing locations.

  However, utilising some of the existing land on both sides of the railway line to gain elevation would enable a new bridge crossing to be provided that would facilitate an alternative access to both the existing car park and the farm access to the east of the railway line.

  The embankments necessary to construct the proposed access road would encroach on the existing private car park land, however with the horizontal alignment of the proposed railway line moved slightly north of original at this location, it is anticipated that a signicant proportion of the private car park would remain.

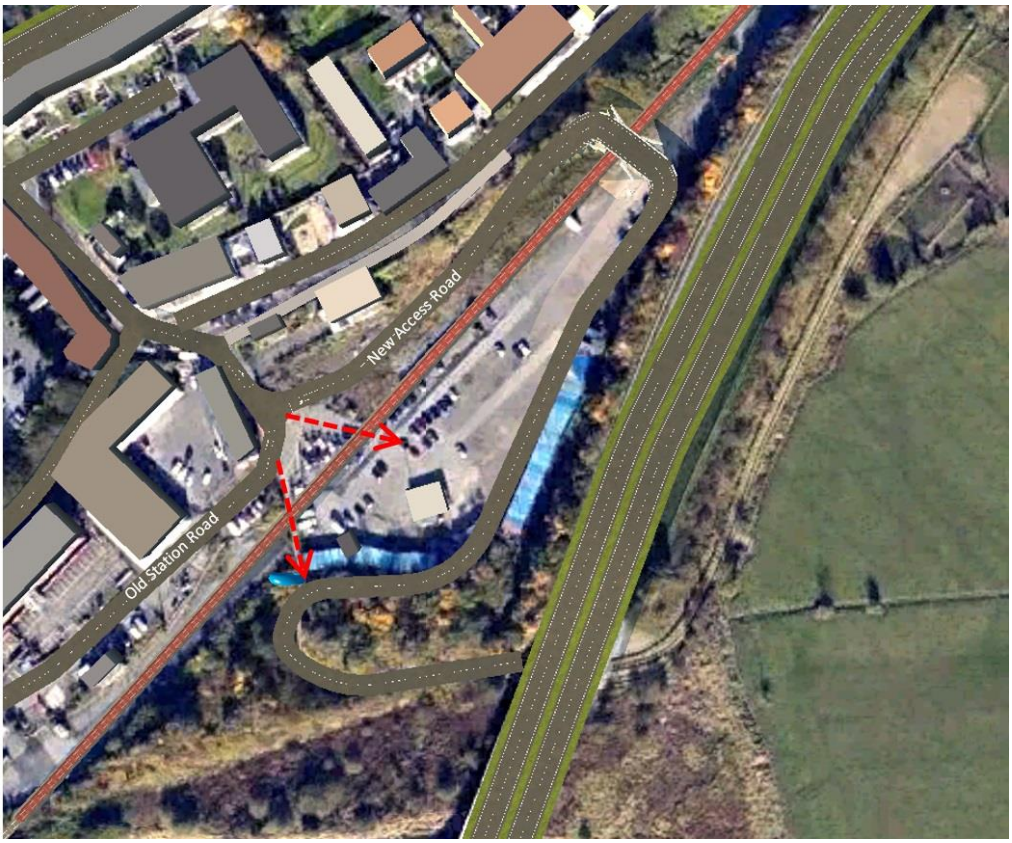


Figure 11: Carmarthen Private Car Park and Farm Access

3.2.3 Structures (Bridges, Tunnels, Culverts, etc.)

Numerous crossings, of both roads and watercourses, were situated along the historic alignment. The railway also incorporated three tunnels, two of which ease the railway alignment beneath roads, with the third connecting between two river valleys to the south of Pencader.

Some of the disused bridges have been demolished as they were constraining use of existing or proposed infrastructure. The three tunnels and several bridges survive, although within the limitations of this study, it has not been possible to assess their individual condition, nor the specific renovation/enhancement works that would be required to bring them back into use. Generic remedial measures have therefore been assumed by structure/construction type to advise the overall cost estimate.

Photo 3: A Surviving Railway Underbridge near Dolgran

Where new or replacement bridge structures are required, standard Network Rail bridge designs have been adopted to allow rudimentary costs to be determined.

The total number of structures along the route can be summarised as follows;

- Overbridges (above the railway) = 71, of which 24 are existing/refurbished, and 47 are new/replacements.
- Underbridges (beneath the railway) = 54, of which 19 are existing/refurbished, 30 are new/replacements and 5 require a new deck but have some existing substructure.
- Culverts = 16 new and 13 existing/refurbished.
- Tunnels = 4, of which 3 are existing at Tyn-Y-Graig, Llanfihangel-Ar-Arth and Pencader, and 1 new at Aberystwyth/South Gate (Pen-Y-Banc)

3.2.3.1 Overbridges

As Network Rail does not define standard overbridge details two standard construction types were selected to allow the new structures to be costed, both of which were forms of precast, pre-stressed concrete beams. Pre-cast concrete beams were selected due to their highly standardised design criteria relating span lengths to beam sizes. The two beam types chosen were:

- TY Beams - Appropriate for spans up to 22m. Used in locations with limited clearance.

- W beams - Appropriate for spans up to 42m. Used for long spans where clearance was not limited.

Figure 12: TY Beam Deck Standard Cross Section

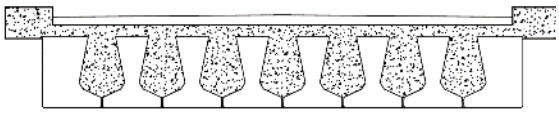
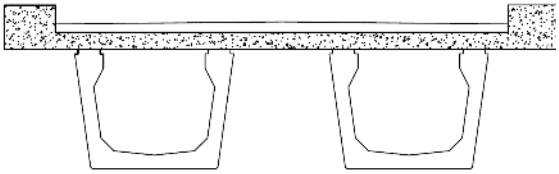


Figure 13: W Beam Deck Standard Cross Section



3.2.3.2 Underbridges

Use of the following Network Rail standard underbridge types has been assumed:

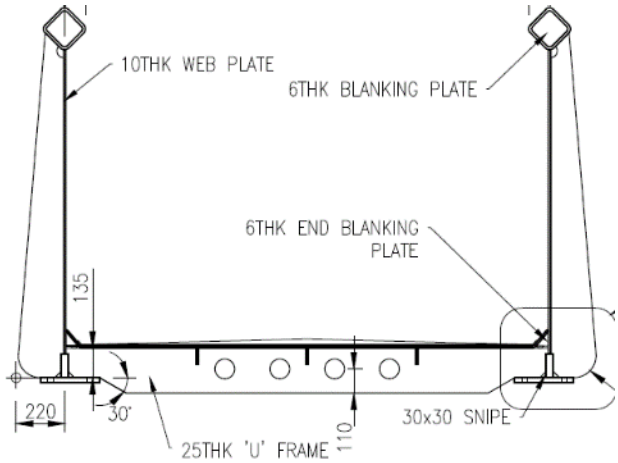
- Steel U-Frame bridge – Appropriate for spans lengths between 5m-25m. This bridge type has a very low construction depth and was used in crossing locations with limited clearance. This construction form was chosen due to its high standardisation of girder sizes, low construction depth, and versatile span length.
- Concrete Slab Bridge - Appropriate for span lengths up to 15m. Used in locations where clearance was not limited.

In the absence of detailed flood analysis where the railway is required to cross watercourses, appropriate bridge soffit heights have had to be assumed. At these locations a best estimate for which bridge type is most appropriate has been taken however there is potential that either the bridge type, or the vertical alignment of the railway would need to be revised at a more detailed stage of design.

3.2.3.3 Footbridges

There are limited locations where footbridges are required over the railways. In these locations Network Rail's non-station standard footbridge details were used. The girder dimensions do not change in relation to span lengths.

Figure 14: Network Rail Standard Footbridge Cross Section



Source: Network Rail Footbridge Superstructure Main Span General Arrangement (NR/CIV/SD/430)

3.2.3.4 Bridge Substructure

A generic abutment and pier form have been selected to allow structures with no existing substructure to be costed. The form of the generic substructures can be found within the standard detail drawings issued with this report.

All foundations along the route have been assumed to be CFA piles. It has been assumed that 6 piles would be required at all foundation locations and that these would be installed to a depth of 10m, increasing to 15m in Carmarthen due to known ground information.

Where existing features of bridge structures remain such as abutments or approach embankments it has been assumed that these can be reused. At these locations one of the standard bridge decks listed above has been adopted and generic maintenance measures for the existing parts identified.

3.2.3.5 Culverts

At locations where new culverts are required precast box culverts have been specified. These have been sized by estimating the width of the watercourse and the clearance to the railway at these locations. No hydrological modelling has been done to size these sections.

At many locations it has been difficult to determine whether existing culverts are still in place. If there was an element of doubt it has been conservatively assumed that a new culvert would be required.

3.2.3.6 Tunnels

The need for new tunnels would work directly against the economic viability of the proposed scheme, and alternative alignments at surface, or in cutting, have therefore been sought wherever possible, or the required length of new tunnels minimised, where they are unavoidable.

Where a new tunnel is required for the route out of Aberystwyth, an outline commentary of likely methodologies and issues is provided within section 3.7, although it has not been possible to fully confirm the feasibility/suitability of the tunnel works within the limits of this study, with the risk that alternative/additional measures are required.

3.2.4 Stations

The route connects into the existing stations and routes at Aberystwyth & Carmarthen, with platform provisions proposed to meet operational requirements, and to avoid conflict/constraint from the existing railway services and systems at these stations.

Five intermediate stations have been proposed at: Llanilar, Tregaron, Lampeter, Llanybydder and Pencader. Track loops for the the passing of trains between single track sections would be located at one, or more, of these intermediate stations to suit the requirements of the operational timetable.

All Intermediate Stations, would have a single platform. In the interests of economy, passing loops (where provided) would be modelled on the operation and layout at Penryn, Cornwall (as below). This configuration eliminates the need for passenger overbridges, and greatly simplifies disabled access and other station provisions.

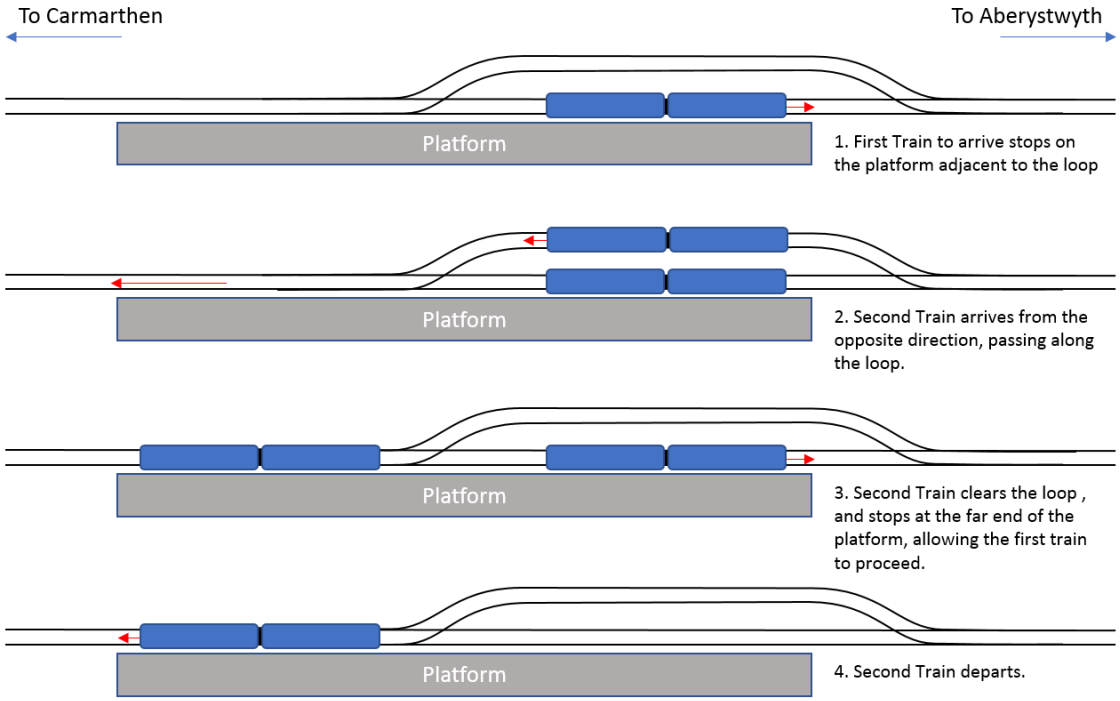


Figure 15: Intermediate Station Configuration

For the purpose of costing, it has initially been assumed that 30 car parking spaces would be provided at each station.

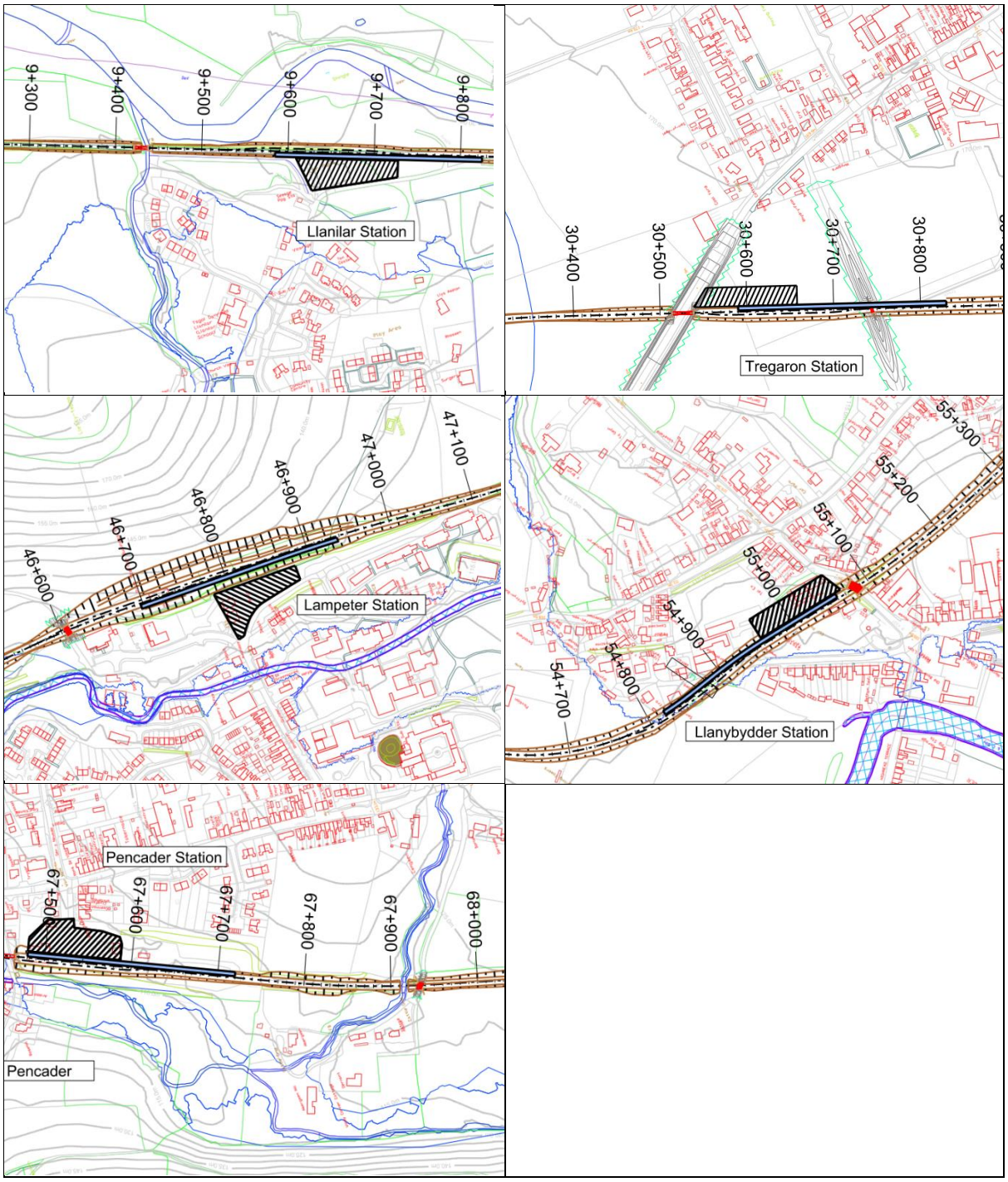


Figure 16: Intermediate Station Locations

3.2.5 Geotechnics

A high level geotechnical desk study has been undertaken, advised by an understanding of the historic issues that affected the original railway.

An earthworks schedule has also been produced, identifying in outline the likely remedial and modifications works required to existing cuttings and embankments along the route, as well as any new earthworks relating to the re-aligned route lengths, advising:

- Existing earthwork conditions
- Proposed cutting and embankment stability
- Typical structure foundation type.

To the limitations on site specific design set out above, it has not been possible to fully confirm the feasibility/suitability of all geotechnical works, with the risk that alternative/additional measures are required at some locations.

Principal issues and approaches are summarised within the sections below:

3.2.5.1 Embankments

It has been assumed that historic embankments would be incorporated into the proposed replacement earthworks. Where historic embankments remain they typically exhibited a slope angle of between 30-35° (approximately 1:1.5). The embankments were heavily vegetated in places and due to the overgrown nature and late summer walkover timing, it was not possible to evaluate slope condition or undertake a more comprehensive examination.

For the purposes of the development of a proposed route and to assess the amounts of any potential land take it has been assumed that any new embankment would be constructed with side slope angle of 1:2 (approximately 26°). It is also assumed that historic embankments would require regrading to achieve a similar slope angle. This assumption would be reviewed following classification and determination of engineering properties of fill materials used to form new earthworks and confirmation of the underlying ground conditions

Where historic earthworks were to be heightened, an assessment of the historic embankment condition and the suitability for the re-use of the embankment fill would need to be undertaken. Suitability for re-use of an earthwork would be determined following a comprehensive programme of earthwork examinations, completion of ground investigation studies and slope stability analysis along the route.

If historic embankments were deemed suitable for re-use, benching and regrading of the existing embankments would need to be undertaken to integrate with the new embankment elements.

At this stage it is assumed that the regraded slope profile would be formed from material comprising suitably compacted granular Class 1 fill or similar. However, the use of this material would be dependent on access to a ready supply of sufficient material within a practical distance.

3.2.5.2 Cuttings

Due to access constraints limited opportunities were available to undertake visual inspections of the existing soil cuttings. Where field measurements were undertaken they were typically estimated from overbridge structures that were publicly accessible. Soil cuttings appeared to have been formed at approximate angles of 30°.

Where visually inspected during site walkovers, historic rock cuts were typically cut at 60-85°. Cuttings were typically steeper on one side of the line reflecting the favourable dip direction of rock bedding and joint sets on one side of the cutting. Evidence of sliding blocks of mudstone and shales was witnessed on the up side (eastern side) of the southern portals of both the Pencader and Bryn Teifi tunnels. It is likely that as a minimum de-vegetation and scaling works would be required at these

locations, however the need for active stabilisation measures such as rock mesh or rock bolts cannot be ruled out.

Given the amount of rock cuttings present along the route and the potentially unfavourable condition of those limited number of cuttings visually inspected, it is considered that the unknown condition of the historic rock cuttings represents a significant geotechnical risk. The condition of the rock cuttings would need to be further assessed by a detailed visual inspection followed by detailed rock stability analysis to determine any stabilisation measures that may be required.

Where new soil cuttings are proposed either within sections of offline route or, on the historic route, side slope angles of 1:2 have been assumed for modelling purposes. However, the suitability of such slope angles would need to be confirmed following a detailed ground investigation and subsequent slope stability analysis. Depending on the results of such analysis shallower slope angles may be required due to the ground conditions present. Drainage works or improvements to any existing drainage may also be required to ensure slope stability.

Where steeper slope angles than 1:2 may be required due to local constraints, the results of a detailed ground investigation would allow the development of an optimal stabilisation solution such as soil nailing.

Where new rock cuttings are proposed a detailed understanding of the underlying geology and its structure is required to enable the design of the cutting. The current study has indicated that the solid geology of the route generally comprises interbedded sandstone and mudstones. Published literature and the limited visual inspection carried out indicate that the mudstones are typically thinly bedded, highly weathered with highly variable dip direction and angle. Such conditions are not necessarily favourable for the construction of steep cuttings.

Therefore, further work would need to be undertaken to assess the ground conditions and rock profile in these areas. This would initially comprise a more detailed geotechnical desk study, followed by detailed route wide inspections of existing cuttings. Following these inspections intrusive ground investigation should be undertaken to enable a more detailed understanding of the conditions of the underlying solid geology and to progress the design of the rock cuttings. Depending on the results of the investigation, rock stabilisation methods such rock bolts, anchors or rock mesh may be required to ensure the stability of the proposed rock cutting and thus avoiding excessive land take.

For the purpose of the development of an earthworks model, rock cuttings have been assumed where cuts are required in areas where no superficial materials are shown on geological mapping. Superficial and bedrock materials have been ascertained from the BGS Geoindex and relevant 1:50,000 geological mapping. However, the following simplified ground model has been assumed:

- Superficial deposits are present to a depth of 5.0m depth,
- Residual soil / weathered rock (Grade VI to Grade V) from 5-10m below ground level,
- Highly to moderately weathered (Grade IV to III) from 10-20m and slightly weathered rock to depth.

The above ground conditions result in the requirement for composite slopes with angles varying between 26° within the superficial materials to a slope angle of 76° within the Grade IV to III bedrock.

The above model is considered conservative and slope design would be critically dependant on the development of soil and rock parameters for individual cuttings resulting in a significant decrease in cut volumes.

3.2.5.3 Retaining walls & steepened earthworks

As identified in the earthworks schedule, localised retaining measures would be required in some locations, to preserve existing structures, highway assets, property etc. Such structures would vary from traditional retaining walls to steepened reinforced soil embankments.

Given the highly variable nature of the superficial geology across the route the ground conditions at the location of each structure would need to be investigated to ensure that a foundation design could be developed that achieves the required settlement tolerance. This would comprise the completion of a detailed desk study followed by intrusive ground investigations.

Given the potentially highly compressible nature of the alluvial deposits mapped along the proposed route the requirement for the use of piled foundations for any proposed bridge structure cannot be ruled out. Similarly, the use of piled retaining walls or similar may be required.

Where new embankments are proposed, steeper slopes than 1 in 2 may be used to minimise landtake and local impacts. This could be achieved by the use of reinforced soil, or other stabilisation techniques such as soil nailing, subject to intrusive ground investigations, cost benefit analysis, etc.

3.2.5.4 Drainage

It is considered that historic drainage is likely to be unsuitable for re-use, require extensive renovation or complete renewal. Drainage measures would vary considerably along the route dependant on setting but are thought likely to comprise toe drains at the base of embankments and cuttings as a minimum. Hydrological studies would be undertaken to determine the extent and capacity of drainage requirements.

3.2.5.5 Key Geotechnical Risk Items

The following key geotechnical risk items have been identified:

- **Pen-Y-Banc Tunnel:** a preliminary overview of tunnel construction methods, risks and issues is provided within section 3.7 of this report, but full feasibility cannot be confirmed without more detailed study, and the progression of further geotechnical desk studies, and some level of ground investigation.
- **Llanfarian cutting:** Rock cutting proposed at the rear of residential properties located on Lon Tyllwyd. Geological mapping indicates the route to be potentially underlain by superficial deposits comprising Glacial Till though upper slope cuts are likely to be underlain by bedrock deposits only, comprising thinly interbedded mudstones and sandstones.

  Mapping indicates potential for a favourable dip direction broadly to the south east and east though ravelling of material is considered likely and netting and bolting of slopes may be required.

  Any cut materials would need to be assessed and graded for suitability for re-use within the scheme and logistical arrangements made to consider transportation of materials from point of generation to point of requirement.

- **Afon Ystwyth/Llanilar section:** As highlighted by historic events this section of line is susceptible to flooding and appropriate measures should be taken when designing and constructing this section of the line.

  It is envisaged that the embankment along this section of the line would be incorporated into flood defence measures for the area and would therefore require acceptance by Natural Resources Wales.

  Earthwork resilience and protection measures would need to be integrated into embankment design and thought likely to comprise scour protection where in close proximity to the Afon Ystwyth. The vertical alignment of the rail line may also require adjustment relative to the height of predicted future flood events.

- **Cors Caron (Tregaron Bog):** The historic route presents significant engineering challenges, due to the soft compressible deposits below the line. Significant (if unknown) thicknesses of peat are anticipated with anecdotal evidence suggesting considerable problems were experienced during the construction and maintenance of two bridges on the route across the bog.

The construction of railway lines across thick Peat deposits was not unusual during the major Victorian period of railway construction. The usual technique used in their construction was the use of wooden fascines sometimes filled with other materials such as bales of sheep's wool effectively creating a form of floating embankment. This approach met with varying levels of success, with some sections of track experiencing significant amounts of long term settlement. It is understood that this solution was employed in the construction of the line across Cors Caron.

The effectiveness of these historic measures, and their suitability for re-use/enhancement to the needs of a modern railway cannot be reliably assessed without recourse to detailed ground investigation. It is however clear that this route section presents the highest overall risk to the viability of reinstating the railway, in the potential scale and cost of the geotechnical works that may be required (as considered further below), heightened by the extreme environmental sensitivity of the area.

Given the highly compressible nature of peat, dynamic displacement is a phenomenon that has been experienced in similar sections of railway line. As a train passes across a section of line over peat, the compression of the underlying material and relaxation of material behind the passing material forms a visible bow wave. Such dynamic displacement often results in increased maintenance requirements, and line speed restrictions. Anecdotal evidence suggests that a form of dynamic displacement (bow wave effect) may have been experienced by trains passing across Cors Caron prior to the closure of the line.

Reflecting localised flood risk, the initially proposed route alignment would raise the historic embankment heights by at least 2m. Such an increase in embankment height could result in considerable increase in both total and differential settlements, although the effective longitudinal stiffening, and load spread, provided by the increased height could be beneficial in regard to dynamic displacement.

Any increase in the vertical height of the embankment in this area would need to be kept to a minimum, and would require appropriate engineering measures to limit the amount of total and differential settlements around structures requiring deep foundations such as piles.

The most effective way to minimise the amount of total settlement would be the use of pre-cast concrete piles driven to the base of the peat. However, this solution would represent a significant capital cost, whilst problems may be experienced in driving the piles through the fascine base of the existing embankment.

An alternative, that has proved effective in stabilising existing embankments of peat is the installation of concrete columns or panels to stiffen the soils beneath the existing embankment.

This solution would also have a high capital cost and it may also prove highly difficult to install the columns through the base of the existing embankment. Furthermore, the installation of significant amounts of wet concrete into the acidic peat may have a considerable impact on the groundwater chemistry and prove unacceptable from an environmental perspective.

Given the above at this stage it is considered that the most cost effective and least environmentally disruptive solution would be to construct the embankments from reinforced earth in conjunction with light weight aggregate. The use of light weight fill would reduce the additional surcharge associated within the increase in embankment height and therefore reduce the long-term settlement. The use of light weight embankment fill combined with a reinforced soil technique would enable steeper side slopes, reducing the overall width, whilst also aiding the effective retention of the lightweight fill.

Pre-surcharging of the existing embankment should also be considered as a technique that could reduce long-term settlement further. This technique would comprise the placement of temporary fill material on the embankment to induce settlement prior to placement of the permanent fill material.

Given the significant cut fill imbalance associated with the scheme, with a significant cut surplus the opportunity may exist to use some of this material for surcharging. However, it should be noted that the costs associated with this solution could still be considerable and given the limited information on the ground conditions within the bog, and following intrusive ground investigation it cannot be guaranteed that such a solution would be a viable option.

- **De-vegetation:** Significant areas of the route have become overgrown. Growth ranges from shrubs and long grass to full size mature trees. Significant sections of the route have a predominance for mature tree growth especially on sections of embankment earthwork and cutting. It is envisaged that a substantial programme of clearance would need to be undertaken along with remediation to the underlying cutting and embankment slopes. Where a number of invasive species has been observed from the limited route walkover of this study, this would need to include specific measures for their eradication.

3.3 Railway Systems

In addition to the permanent way, supporting railway systems would be required as: signalling, telecommunications, and electrification and plant. At this stage only signalling is perceived to be material to the feasibility of the scheme, and a detailed commentary on issues and options is provided within section 3.3.1 below.

A telecommunications network would be required for the the purpose of railway operation and control, SCADA (Supervisory Control and Data Acquisition) systems in the two major tunnels, and at the new stations, as well as in support of customer information systems. To the length and remoteness of the route this would most likely be provided by use of GSM-R (Global System for Mobile Communications - Railway) and a fibre optic transmission backbone network, further detail of which is provided in section 3.3.2.

Where the railway would be operated by the use of Diesel Multiple Units until such time as the adjoining routes are electrified, electrification and plant would be limited to power supplies for trackside and station equipment, and particular plant, such as point motors and heating.

A secure signalling power supply system would be required to ensure that the signalling system has a constant source of power, this is likely to comprise of 1no. or 2no. Principal Supply Points (PSPs) each with a standby diesel generator and potentially an uninterruptible power supply (UPS). Each PSP would need to be sited at a suitable location that was easily accesible by the maintainer and allowed delivery by large vehicles such as needed for re-fuelling the generator.

3.3.1 Railway Signalling

Railway signalling approaches are complicated by the use of different signalling systems on the existing railways at either end of the reinstated route, with the Great Western Mainline into Carmarthen controlled by traditional Computer Based Interlocking (CBI) signalling, whilst the Cambrian line into Aberystwyth is the first line in the UK to be controlled by European Railway Traffic Management System (ERTMS) Level 2 (In-Cab Signalling).

The principal complication being that only rolling stock that has been fitted with in-cab signalling can operate on the Cambrian ERTMS route, whilst the through Carmarthen-Aberystwyth services would most likely/economically be provided by extension of existing Great Western mainline services, whose trains are not currently fitted with in-cab signalling.

The use of conventional signalling on the route may therefore be preferable in avoiding the need to retrofit rolling stock for ERTMS running, although this would then prevent these services from running over the final mile of Cambrian line into Aberystwyth, unless trackside signal posts are reintroduced over this route length. Whilst adding complexity this could be achieved as an overlay to the current ERTMS signalling, which is likely to be preferred to the alternative of full backward conversion of this route length from ERTMS to trackside signals (CBI or modular signalling).

Where, in the longer term, it may be expected that the Great Western mainline will move over to ERTMS, these issues may eventually become moot, subject to relative timing. Further explanation of signalling issues and approaches is provided below.

3.3.1.1 Signalling Layout

The proposed section of line between Carmarthen and Aberystwyth is approximately 91km in length and includes 7 proposed station stops, Carmarthen, Pencader, Llanybydder, Lampeter, Tregaron, Llanilar and Aberystwyth.

A preliminary signalling sketch (367590-MMD-32-XX-DR-C-1040 as Appendix A.2) has been produced to show a base option for the layout.

The base option shows the new line continuing from the existing spur at Carmarthen Station. Passing loops have been positioned at Pencader and Tregaron Stations to allow an hourly service to be

operated. The line terminates at Aberystwyth Station, and additional stations would be provided at Llanybydder, Lampeter and Llanilar however these would not require signalling and are therefore not shown on the sketch.

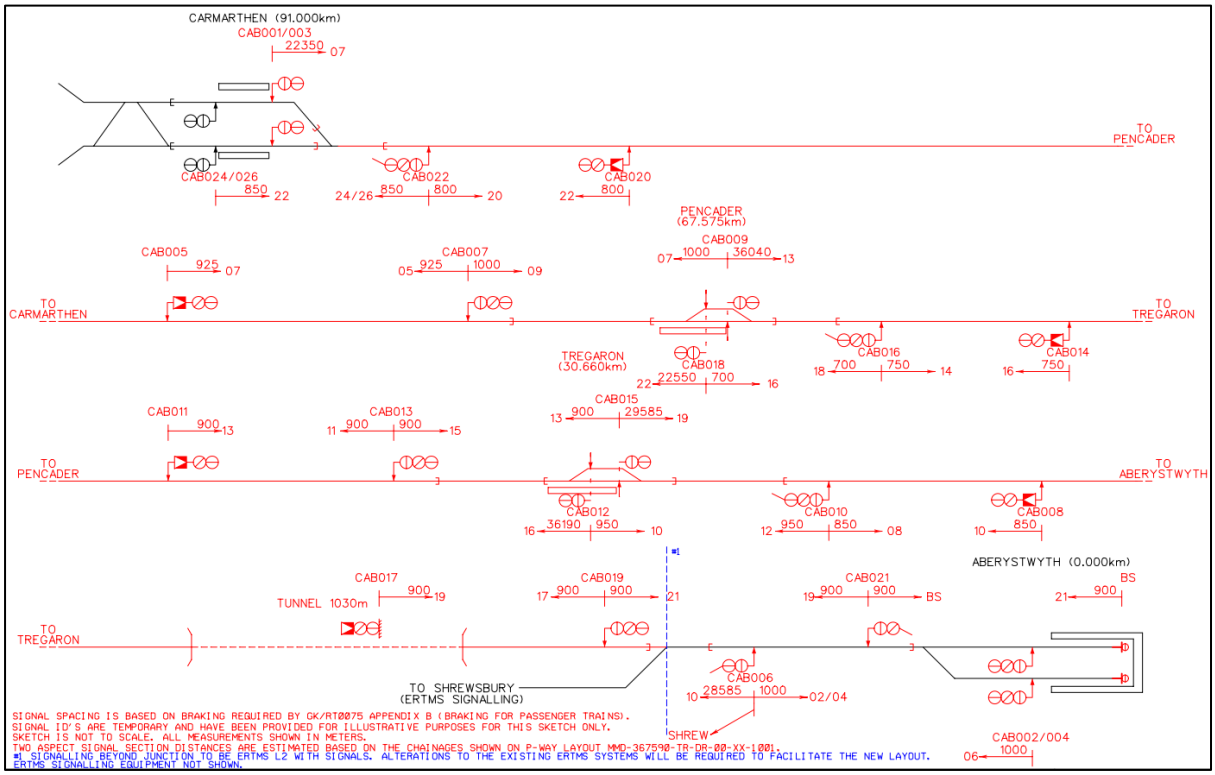


Figure 17: Extract from Preliminary Signalling Sketch

3.3.1.2 Stations

Aberystwyth Station previously had 5 platforms. Platform 3 is in use by the NR line to Shrewsbury and Platforms 4 and 5 are in use by the Vale of the Rheidol Railway. Platforms 1 and 2 were formally used by Aberystwyth oil distributers but appear to now be derelict and out of use. The sketch shows the new line utilising Platforms 2 & 3. The new line would join the existing Aberystwyth to Shrewsbury line approximately one mile out from Aberystwyth Station.

The Aberystwyth to Shrewsbury line is signalled by ERTMS L2 signalling at present. Under this scheme the signalling on the shared stretch of line would be modified to be ERTMS L2 with lineside signals. This would facilitate the use of this section of line by both fitted and non-fitted rolling stock.

At Carmarthen station, reconnection of the Aberystwyth line to the two existing platforms would be possible by re-joining at the existing Spur. New signals would be required on the end of each of the platforms to signal moves onto the new Aberystwyth line. If additional platform capacity is required, the disused platform face on the east side of the station could be brought back into use.

At Carmarthen two new platform 2-aspect starter signals would be required to signal trains out of the station. Incoming trains on the new line would be signalled into either platform via a 3-aspect signal in rear of the facing points. This signal would have an associated 2-aspect distant signal.

The two new passing loop stations at Pencader and Tregaron would have a single platform to be used by trains in both the up and down direction. This would remove the need for provision of a footbridge over the railway. 2-aspect platform starter signals would be provided for both the up and down direction. Additionally, a 3-aspect signal protecting the facing points along with a 2-aspect distant signal would be required in the up and down direction for each station. In total 6 signals and two sets of points would be required for each station.

The remaining intermediate stations at Llanybydder, Lampeter and Llanilar would be unmanned. There would be no signalling requirements for these stations.

3.3.1.3 Signal Spacing

The line between Aberystwyth and Carmarthen is suited to two-aspect signalling due to the line being single track for most of the route, with relaxed headway requirements. The position of the signals along the route is dictated by the position of the passing loops.

Braking between the signals provided has been calculated in line with the standards set out in GK/RT0075 Issue 4. The Table 1 'braking for passenger trains' was utilised along with the gradient and line-speed information provided on track layout drawings. The tables below summarise the braking distances used on sketch 367590-MMD-32-XX-DR-C-1040:

Table 1: Braking for Passenger Trains Calculation

Location	From Signal	To Signal	Line Speed (mph)	Gradient	Braking Required(m)	Braking(m)	Overbraking %	
Aberystwyth	CAB002/004	CAB006	55	Level	515	1000	94.17	
Tregaron	CAB008	CAB010	65	1:200R	698	850	21.78	
Pencader	CAB005	CAB007	45	1:50F	437	925	111.67	#
Tregaron	CAB010	CAB012	65	1:300F	784	950	21.17	
Pencader	CAB007	CAB009	60	1:67F	799	1000	25.16	
Pencader	CAB014	CAB016	60	1:300R	605	750	23.97	
Tregaron	CAB011	CAB013	65	1:300R	709	900	26.94	
Pencader	CAB016	CAB018	60	1:100R	562	700	24.56	
Tregaron	CAB013	CAB015	65	1:300R	709	900	26.94	
Carmarthen	CAB020	CAB022	60	Level	632	800	26.58	
Aberystwyth	CAB017	CAB019	65	1:400F	770	900	16.88	#2
Aberystwyth	CAB019	CAB021	45	1:100F	377	900	138.73	#2
Aberystwyth	CAB021	Buffer Stop	55	1:400F	533	900	68.86	#2
Carmarthen	CAB022	CAB022/024	60	1:200F	679	850	25.18	

Moving this signal closer moves it into a higher PSR and would mean the signal is underbraked.

#2 Signal positions constrained by the position of S&C equipment.

Carmarthen to Aberystwyth

Signal	Proposed Level	Distance	Gradient	Gradient	Design Speed	Design Speed
		to next signal	to next signal	(rounded)	(kmph)	(mph rounded down)
CAB001/003	8.5	N/A	N/A	N/A	N/A	N/A
CAB005	144.8	925	-55.05952381	1:50F	80	45
CAB007	128	1000	-78.74015748	1:67F	100	60
CAB009	115.3	N/A	N/A	N/A	N/A	N/A
CAB011	161.3	900	281.25	1:300R	110	65
CAB013	164.5	900	257.1428571	1:300R	110	65
CAB015	168	N/A	N/A	N/A	N/A	N/A
CAB017	14.7	900	-600	1:400F	110	65
CAB019	13.2	900	-121.6216216	1:100F	80	45
CAB021	5.8	900	-562.5	1:400F	95	55
BS	4.2	N/A	N/A	N/A	N/A	N/A

Aberystwyth to Carmarthen

Signal	Proposed Level	Distance	Gradient	Gradient	Design Speed	Design Speed
		to next signal	to next signal	(rounded)	(kmph)	(mph rounded down)
CAB002/004	4.2	1000	588.2352941	Level	95	55
CAB006	5.9	N/A	N/A	N/A	N/A	N/A
CAB008	166.3	850	177.0833333	1:200R	110	65
CAB0010	171.1	950	-306.4516129	1:300F	110	65
CAB0012	168	N/A	N/A	N/A	N/A	N/A
CAB014	105	750	250	1:300R	100	60
CAB016	108	700	95.89041096	1:100R	100	60
CAB018	115.3	N/A	N/A	N/A	N/A	N/A
CAB020	10	800	Level	Level	100	60
CAB022	10	850	-250	1:200F	100	60
CAN022/024	6.6	N/A	N/A	N/A	N/A	N/A

Table 2: Railway Signalling – Braking Distances

Location	From Signal	To Signal	Line Speed (mph)	Gradient	Braking Required (m)	Braking (m)	Overbraking %	
Tregaron	CAB004	CAB006	65	1:200R	698	850	21.78	
Pencader	CAB005	CAB007	45	1:50F	437	925	111.67	#
Tregaron	CAB006	CAB008	65	1:300F	784	950	21.17	
Pencader	CAB007	CAB009	60	1:67F	799	1000	25.16	
Pencader	CAB010	CAB012	60	1:300R	605	750	23.97	
Tregaron	CAB011	CAB013	65	1:300R	709	900	26.94	
Pencader	CAB012	CAB014	60	1:100R	562	700	24.56	
Tregaron	CAB013	CAB015	65	1:300R	709	900	26.94	
Carmarthen	CAB016	CAB018	60	Level	632	800	26.58	
Aberystwyth	CAB017	Buffer Stop	55	1:400F	533	800	50.09	
Carmarthen	CAB018	CAB020/022	60	1:200F	679	850	25.18	

 # Moving this signal closer moves it into a higher PSR and would mean the signal is underbraked.

Note: Braking suitable for use with passenger trains only.

3.3.1.4 Headway

Due to the design of the railway including the usage of passing loops standard headway calculations would not give an accurate depiction of how frequently train services could run. This is because the frequency of trains is constrained by the availability of the single track sections between the loops/terminal stations.

The transit time between each of the stations has been calculated based on the layout shown on sketch 367590-MMD-32-XX-DR-C-1040 and the lines speeds shown on permanent way drawings.

The results are shown in the tables below:

Table 3: Railway Signalling – Transit Times

Aberystwyth to Carmarthen	Moving Time (s)	Dwells (s)	Total Time (s)	Total Time (min)
Section 1 Aberystwyth - Llanilar	432.35	30	462.35	7 min 43 sec
Section 2 Llanilar - Tregaron	1031.86	30	1061.86	17 min 42 sec
Section 3 Tregaron - Lampeter	635.21	30	665.21	11 min 6 sec
Section 4 Lampeter - Llanybydder	362.69	30	392.69	6 min 33 sec
Section 5 Llanybydder - Pencader	566.41	30	596.41	9 min 57 sec
Section 6 Pencader - Carmarthen	1320.78	0	1320.78	22 min 1 sec
			4499.31	75 min

Carmarthen to Aberystwyth	Moving Time (s)	Dwells (s)	Total Time (s)	Total Time (min)
Section 1 Carmarthen - Pencader	1318.92	0	1318.92	21 min 59 sec
Section 2 Pencader - Llanybydder	566.41	30	596.41	9 min 57 sec
Section 3 Llanybydder - Lampeter	362.69	30	392.69	6 min 33 sec
Section 4 Lampeter - Tregaron	635.21	30	665.21	11 min 6 sec
Section 5 Tregaron - Llanilar	1031.86	30	1061.86	17 min 42 sec
Section 6 Llanilar - Aberystwyth	434.22	30	464.22	7 min 45 sec
			4499.31	75 min

To obtain a workable timetable departure times from the two terminal stations would need to be altered to allow for the shortest possible time waiting at the loops and therefore to give the shortest journey time between Aberystwyth and Carmarthen. The calculations show a theoretical route transit time of 75 minutes both from Aberystwyth to Carmarthen and vice versa (n.b. achievable journey times (circa 85 minutes) are determined in relation to further rolling stock and timetabling constraints within section 3.4).

3.3.1.5 Signalling Interlocking Options

There are three main options for the signalling technology that could be used on the reinstated route, these are a traditional CBI system, a modular system and ERTMS. A summary of each follows:

- **Traditional signalling (CBI):** A traditional signalling system could be implemented using a current generation SSI type system. This system features a central interlocking processor, connected via lineside data links to Trackside Functional Modules (TFMs). The TFMs control lineside infrastructure such as points and signals, and relay equipment status and train detection back to the central processor.

  The production of data for a traditional SSI system is labour intensive, however it can be produced and tested off-site.

  A traditional signalled solution would involve the use of standard signals and point operating devices, which require significant civil engineering solutions for on-site installation, resulting in higher overall costs.

  Due to the sparse nature of the proposed train services, train detection would be undertaken using axle counters, to avoid the requirement for regular track circuits over long distances. Track circuits are limited in length, usually to approximately 2km depending on type. Axle counter sections could be utilised for the full distance between signals, giving the advantage of significantly reduced lineside infrastructure (location cases, track circuit equipment, TFMs, cabling) when compared to a track circuit based solution.

- **Modular signalling:** Modular signalling has been developed by Siemens as a cost-effective solution for low frequency lines.

  The Siemens modular signalling solution uses a SIL4 certified WESTRACE microprocessor based interlocking system, best known for its use on London Underground's Central and Victoria lines, as well as the basis for ERTMS.

  All programming of the system is undertaken off-site using the Graphical Configuration Sub-System (GCSS) to produce the application-specific vital logic data. The Graphical Simulator (GSIM) allows engineers to simulate the logic to aide testing before installation on site.

  The WESTRACE main processor module communicates to the outside world via Input/Output modules. The range of IOMs is extensive, including signal and point operating modules among other more specific modules. IOMs can be located up to 40km away from the processor module and communicate by Fast-Ethernet over fully duplicated fibre optic links. These fibre links can also be used to allow communication with other equipment such as ETCS Radio Block Centres, WESTLOCK (SSI) interlockings, or other WESTRACE interlockings.

  Cost savings over traditional signalling solutions are achieved through the reduced requirement for copper cabling, and inefficient, expensive transformers.

  The trackside objects such as signals, points or train detection are all low power devices requiring minimal maintenance. Structure design aims to eliminate the need for substantial supports or foundations. The signals would be supplied fitted to a lightweight structure that can be easily and quickly installed and commissioned on site at ground level, without the need for lifting equipment, providing further savings.

  Train detection would be undertaken through axle counters in the same manner as a traditional signalling solution.

  Cabling is plug coupled, allowing continuity and insulation testing prior to delivery, and quick on-site installation.

  Through the use of the WESTRACE interlocking, there is a clear future upgrade path to ERTMS functionality.

- **ERTMS (European Railway Traffic Management System):** ERTMS is still in the early stages of implementation in the UK. Currently it is only in use on the Cambrian Line between Shrewsbury and Aberystwyth / Pwllheli.

  ERTMS can be implemented in three different formats, known as 'levels':

  – *Level 1* involves continuous supervision of train movement with a non-continuous communication between train and trackside (normally by means of Euro-balises). Lineside signals are necessary and train detection is performed by the trackside equipment out of the scope of ERTMS. This is mainly used to only provide train protection in the UK.
  – *Level 2* involves continuous supervision of train movement with continuous communication, which is provided by GSM-R, between both the train and trackside. Lineside signals are optional in this case, and train detection is performed by the trackside equipment out of the scope of ERTMS.
  – *Level 3* is also a signalling system that provides continuous train supervision with continuous communication between the train and trackside. The main difference with level 2 is that the train location and integrity is managed within the scope of the ERTMS system, i.e. there is no need for lineside signals or train detection systems on the trackside other than Euro-balises. Train integrity is supervised by the train, i.e. the train supervises being complete and not having been accidentally split.

The Cambrian line uses ERTMS level 2 without lineside signals. There are no installations of ERTMS Level 3 in the UK. The Cambrian line was considered to be 'separate' from the main UK rail lines and therefore a good test site for ERTMS.

With aspirations for potential through-running of services from other major Welsh towns and cities, whereby these connections use traditional signalling, ERTMS may not be a suitable solution for the proposed Aberystwyth to Carmarthen line. The ability to easily implement ERTMS on this line in the future as more of the UK rail infrastructure is re-signalled with ERTMS technology is an absolute requirement and is given by the use of a modular signalling solution.

It is therefore initially assumed that a modular signalling system would be implemented for the line giving the potential to upgrade to ERTMS in future.

3.3.2 Telecoms

A telecommunications network would be required for the the purpose of railway operation and control, SCADA (Supervisory control and data acquisition) systems in the two major tunnels, and at the new stations, including SISS (Station Information and Security System).

Due to the length and remoteness of the route train communications would be achieved by the use of GSM-R (Global System for Mobile Communications - Railway) utilising REB's and Erected Masts along the entirity of the route to maintain radio communication with the train at all times.

As tunnels are present, to maintain communications there are 2 solutions. Traditionally tunnel repeaters are installed at both mouths of the tunnel to radiate through the tunnel, however an alternitive would be a radiating waveguide cable installed through the tunnel to provide full coverage.

The FTN/FTNx transmission network would be achieved via a single fibre optic cable (traditionally 24 fibre) running from Aberystwyth to Carmarthen. This would be terminated at strategically positioned core nodes, nodes and stations to carry SCADA, Signalling, VoiP (Voice over internet Protocol) and SISS circuits.

The fibre cable previously used for this solution on such remote routes was DISAC (Double Insulated Super Armoured Cable). This could be installed at the side of the track, not required to be housed within containment, troughing, etc. due to its robustness. This is no longer available however a new type of DISAC is currently on trial for Network Rail and may provide a cost effecticve solution.

Should this not be available a standard fibre cable would need to be installed within containment throughout. The telecoms network and systems provided for the new route would interface with the existing Network Rail FTN/FTNx and GSM-R Networks, providing full diversity.

Voice communication (radio and lineside) would be controlled from a Signalling Control Centre, utilising the existing telecoms systems and technology equipped within this control centre. This would drive the most cost-effective solution for voice communication, a traditional analogue system. Should a full migration to iP be chosen, the iP Telephones (SPT's, etc) connect via a tail cable to a BOP (Box On Post) with a network switch inside.

To connect the BOP's, this has traditionally been achieved utilising blown fibre due to its size, reliability and ease of future expansion. BOP's can also provide connection points for remote SCADA and Signalling circuits. The telephones circuits would be presented at the signalling centre on a iP telephone concentrator, traditionally Cisco. Using iP telephones rather than analogue telephones provides efficiencies in terms of space and equipment required within REB's namely voice gateways and reduces the quantity of copper cables on the infrastructure however is more costly to procure/impliment.

Signalling command and control circuits would be provided over the new backbone transmission network as required to support the chosen signalling technological solution.To reduce whole life costs, third party telephone, broadband lines would not be used.

At the new stations CCTV, LLPA (Long Line Public Address), CIS (Customer Information Screens), Help Points, Induction Loop Points and TVM's (Ticket Vending Machines) would be required to enhance safety, security and the customer experience within the station. The CCTV and Help Points would be monitored and operated externally within the control room. The LLPA and CIS automatically generate information based on planned and live, real time information.

Both these systems can also be manually edited from the control room. All SISS equipment would connect to the telecommunications network via a local network switch. Dependant on existing rolling stock and platform layout, DOO (Driver Only Operation) CCTV may be required. The control room would be operated by the TOC and integrated into a Centralised Operational Control Facility.

3.4 Railway Operations

Following the definition of a full end to end railway alignment, a high-level train performance model which includes the gradient and line speed profile as well as proposed station locations was built to assess operational capabilities of modern rolling stock on the reinstated railway. The model does not initially take any cognisance of signalling restrictions that may be required, such as approach control into passing loops, and this would need to be assessed when the final position of signals, loops and stations was determined.

The model was run to establish speed profiles and provide indicative running times based on Class 150, Class 158 & Class 153 trains, which are representative of current rolling stock on the Welsh railway network, and Class 185 trains as a prospective modern replacement.

Running times were then used to develop service patterns based on station stops at Aberystwyth, Llanilar, Tregaron, Lampeter, Llanybydder, Pencader and Carmarthen, whilst also ascertaining the required number and location of static passing loops for hourly and two-hourly service frequencies.

A 'representative' timetable was then produced for nominal hourly & two hourly timetables, with confirmation of rolling stock fleet requirements for a standalone service.

Platforming, and overnight stabling requirements, constraints and implications are advised in outline at Aberystwyth and Carmarthen stations, but no consideration of through running onto the existing network has been undertaken at this stage.

3.4.1 Speed Profiles, Running Times and Timetable Construction

Figure 18 below shows the line speed profiles for three train classes in the two directions of travel (n.b. Where Class 150 & 158 trains were found to have near identical performance, the Class 150 speed profile has been omitted in the interests of clarity). The speed profile is made up of two components as:

1. **The allowable (design) speed**: which is defined by the horizontal track alignment, with low speed constraints imposed by tighter radius curves, as are required to negotiate the various topographical (and other) challenges of the hills and valleys all along the route. These are most extensive and severe within the Gwili Valley, and through the hills between Trawscoed and Ystrad Meurig.

   Straightening the alignment would in most cases require the use of heavy engineering solutions (i.e. Tunnelling, Viaducts, Deep Cuttings, etc.), which are clearly beyond the economic means of the scheme, and which would otherwise impose unacceptable levels of impacts on local communities and the environment.

2. **Rolling Stock traction and braking profiles:** which are defined by the interplay of the mechanical performance of the trains, with the route gradients and station stops.

   These show that that the steepest, and most prolonged, gradients are close the limits of what the rolling stock can cope with, with Class 153 & 158 trains decelerating through the climbs to Trawscoed (from the north) and Pencader (from the south).

   The Class 185 train's ability to maintain and increase it's speed over these (and other) route lengths, providing a journey time betterment over the older rolling stock types (see below) is notable. Similar effects can be seen in the braking profiles, where the older trains must begin to decelerate sooner in order to comply with subsequent allowable speed limits, and to come to a stop at the stations.

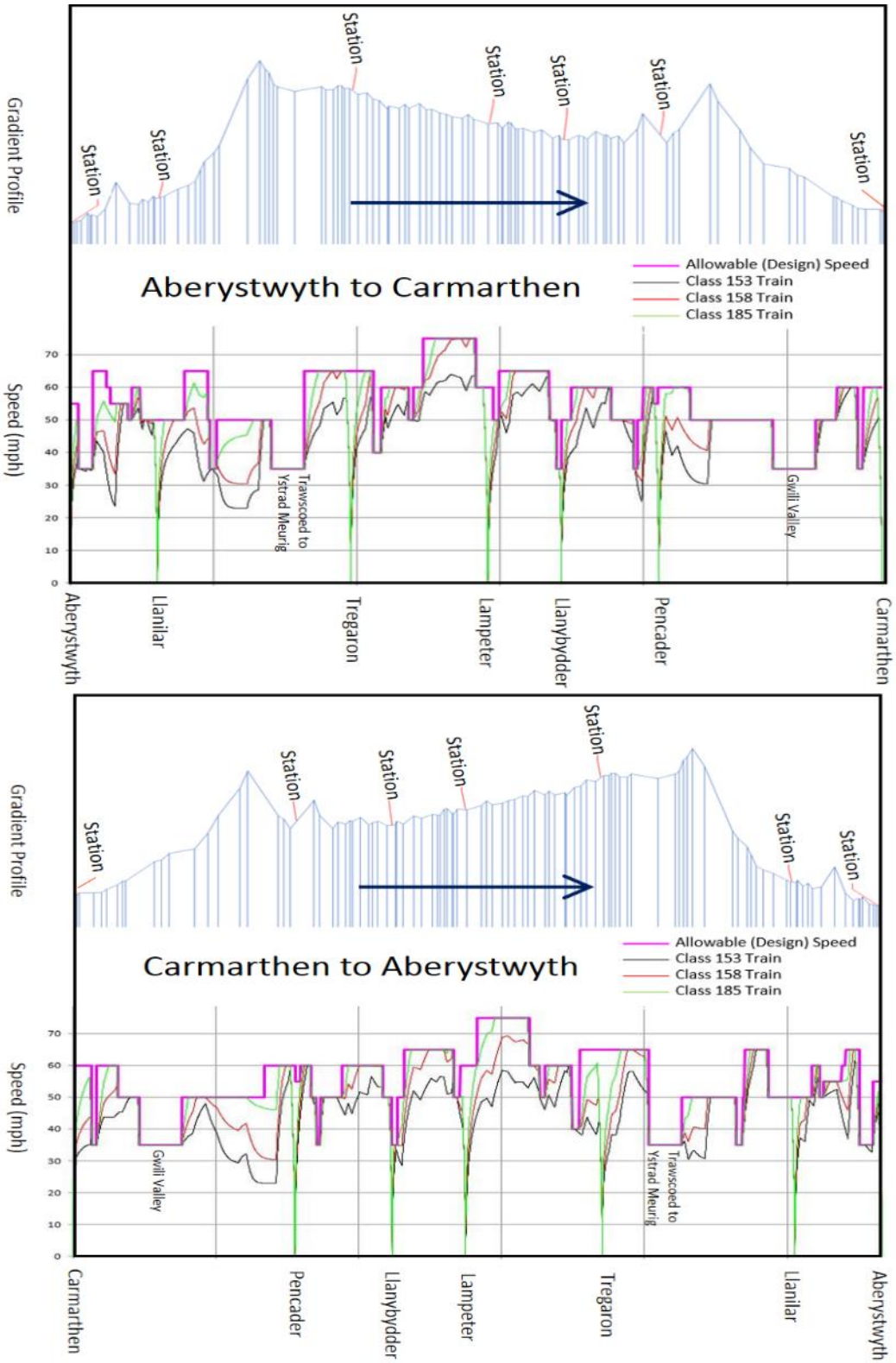


Figure 18: Line Speed Profiles to Modern Rolling Stock

The overall route speed profile by rolling stock type defines the end to end journey time as set out in Figure 19 below, as well as the sectional running times (between stations, signalling sections, etc.) which are used to construct the timetables below.

	Class 150	Class 153	Class 158	Class 185
End to End Journey Times (60 second dwell times)				
Aberystwyth to Carmarthen	84 Minutes	92 Minutes	84 Minutes	79 Minutes
Carmarthen to Aberystwyth	85 Minutes	93 Minutes	85 Minutes	81 Minutes

Figure 19: End to End Journey Times by Rolling Stock Type

It should be noted that these initial journey times are conservatively based on a 60 second dwell time at each of the intermediate station stops of Llanilar, Tregaron, Lampeter, Llanybydder and Pencader.

To a circa 85 minute end to end journey time it is apparent that the operation of a single train on an entirely single track railway, could provide a 3 hourly (180 minute) service frequency. Anything more frequent than this would require additional trains, and the facility for trains travelling in opposite directions on the single track to pass each other.

In the interest of economy of construction and maintenance, passing loops need to be limited to what is necessary in order to deliver the required operational service level, in terms of both number and length.

For a low intensity passenger railway this is typically achieved by use of static passing loops at convenient stations, such that passengers are not marooned at inaccessible locations in the event of any significant service disruption. The static passing loop being just long enough for the longest anticipated train to stop within its length, whilst the train from the opposite direction runs around it.

Where station (and hence potential passing loop) locations are defined by the settlements that they serve, timetable options are therefore effectively constrained by the overall geography of the route, such that regular clock face timings are not always achievable (e.g. half or quarter past each hour) or journey times may be longer in one direction than the other in order to maximise the use of the single line sections.

The overall effect of these interactions is that timetabling becomes an iterative process, whereby the desired service frequency advises the preferred location and number of passing loops, and is then modified/advised as the frequency that can be achieved to the particular location options that are actually available.

These issues are considered and resolved in relation to indicative timetables for 2 hourly and hourly service frequencies below.

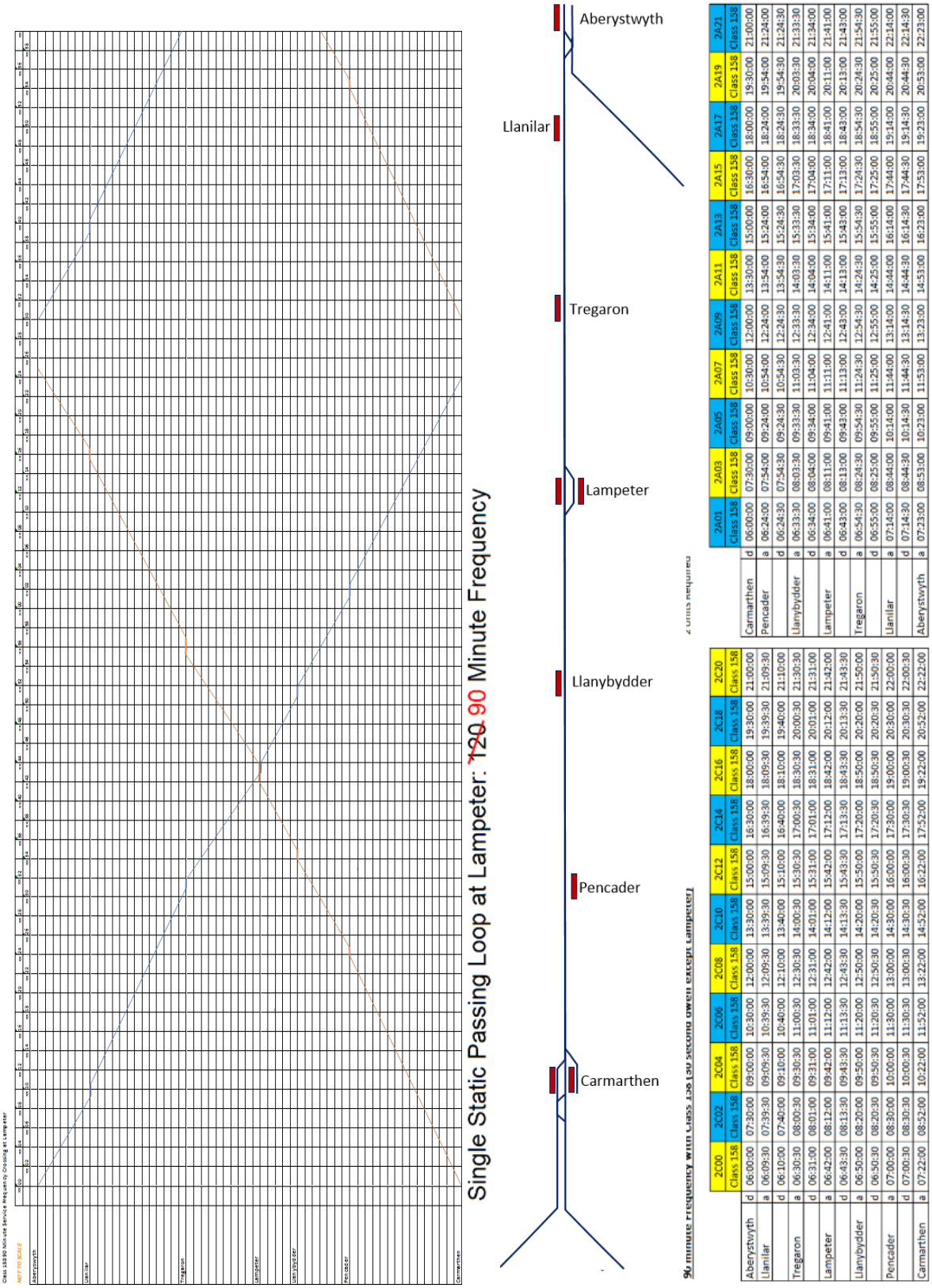
3.4.2 Nominal 2 Hourly Timetable (90 minutes achieved)

Whilst initially aimed at a 2 hourly service, by observation: if one train can provide a 180 minute service, two trains might be expected to be able to provide a 90 minute frequency, and to cross once in each of their respective trips.

This is confirmed within the train graph and timetable within Figure 20 below, where provision of a single central passing loop at Lampeter station facilitates a 90 minute service frequency by the operation of 2 units (trains).

This is based on 30 second intermediate station dwell times, and the sectional running times of Class 150/158 trains. It could not be fulfilled by slower Class 153 trains, whilst the betterment of Class 185 trains would provide improved resilience (i.e. they would be better able to recover from disruption), rather than any improvement in timetabled journey times or frequencies.

Figure 20: Timetable to 90 minute service frequency



3.4.3 Nominal Hourly Timetable

Moving to an hourly frequency the mathematical interaction of the train paths becomes a little more complex, although an obvious first step is to consider what can be achieved with two passing loops, located as close to the one third/two third points on the route as the planned station locations allow.

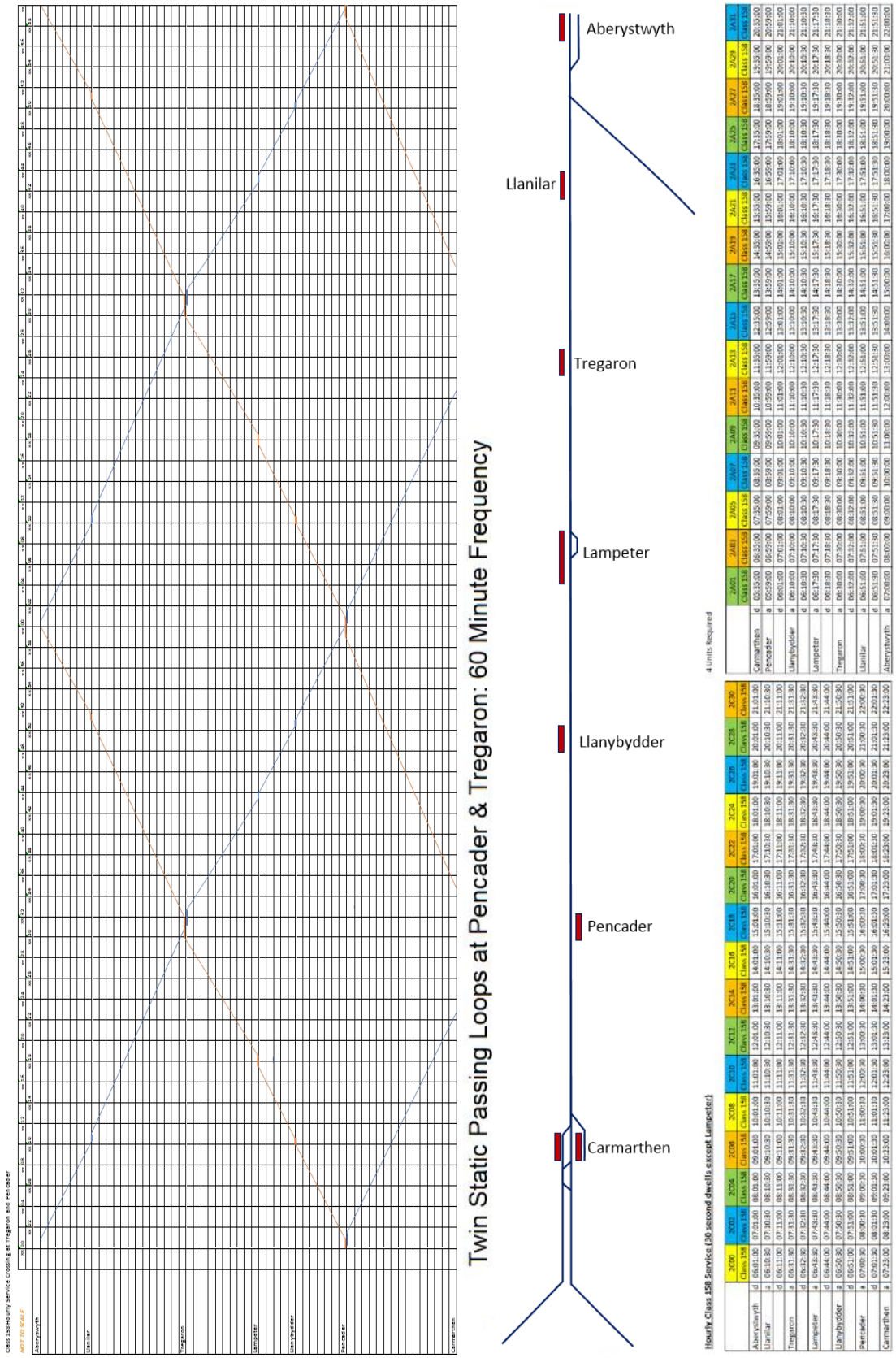
The provision of loops at Pencader & Tregaron was therefore considered, with the train graph and timetable within Figure 21 demonstrating that a 60 minute service frequency could be provided by the operation of 4 units.

Whilst the train graph might be read to infer that the service could be provided by 2 units, the turnaround time at Aberystwyth is too short to be acceptable, as directly constrained by the required passing movement within the Tregaron loop, and the overall running time from there to Aberystwyth and back again. A further consequence of this close interaction would be the need for a second platform at Aberystwyth.

This is based on 30 second intermediate station dwell times, and the sectional running times of Class 150/158 trains. Again, it could not be fulfilled by slower Class 153 trains, whilst the betterment of Class 185 trains would provide improved resilience (i.e. they would be better able to recover from disruption), rather than any improvement in timetabled journey times or frequencies.

The use of Class 185 trains might theoretically allow the reduction in fleet size to 2 units, although in reality the resilience benefits of a 4 unit service are probably of greater value, whilst the choice, and implications, would in any case be largely be defined by the necessary/preferred interaction with other train services at both ends of the route.

Figure 21: Timetable to 60 minute service frequency



3.4.4 Operational Approaches and Issues

For initial simplicity and clarity, all of the above has been considered on the basis of passenger train services acting in isolation from the services and routes at Aberystwyth and Carmarthen.

In reality both the attractiveness of the service and operational efficiency/economy would be greatly enhanced by linking these services together with other services, such that the smallest practical overall fleet of trains, provide the optimal number of direct journey opportunities to and from the route to the wider Welsh and UK railway network.

Timetabling the Aberystwyth to Carmarthen services to interconnect with the wider network at either, or both, ends becomes complicated, and is likely to require a variety of trade-offs and compromises both locally and across the wider network.

The consideration and resolution of these wider issues is beyond the scope of this study, but in local scheme terms might be expected to require compromises on train frequencies, overall journey times, and/or some level of enhanced infrastructure provision, and therefore capital and operational cost.

Similarly whilst train fleet size, stabling and maintenance issues could be considered within the isolation of the route, reality is most likely to lie in the absorption of the scheme within the wider operations of the Welsh Railways, within which their overall significance and impact is probably minimal.

As for the overall scheme, operational service choices would be determined on a cost to benefit basis, as considered further within the initial Economic Assessment (as section 6 of this report).

3.4.5 Operational Variances

In concluding these initial considerations of railway operations, it should be noted that in the interests of economy, the UK railway network is configured, maintained and operated with the minimum quantum of infrastructure that is practically required to safely and reliably run the anticipated train services.

The scheme set out within this report is defined in these terms, and is likely to require revision in respect to any change in the assumed make-up, type, or frequency of the passenger train services that are intended to operate over it.

Similarly, the route infrastructure proposed is unlikely to be directly compatible with freight train operation, due to a lack of spare track capacity, and typical variances in train speed and length relative to passenger train services.

Typical compromises that might be expected in regard to the introduction of freight services, include: discrete and separate periods of freight and passenger service operation; a reduction in the overall passenger service; and a need for additional infrastructure, which in addition to dedicated freight yards, may include the need for additional and longer passing loops at locations that are remote from stations, settlements, and other sensitive sites.

3.5 Environment and Consents

The proposed development comes under Schedule 1 of The Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2017 and so would require an environmental impact assessment. The project would also be considered a development of national significance which has particular requirements for the planning process.

This section sets out the key environmental constraints that would require consideration during the planning of the project. The significance of any environmental impacts would be screened and the scope of an environmental statement agreed with the local planning authorities.

3.5.1 Designated Sites

3.5.1.1 Sites of Special Scientific Interest

The proposed route passes through or close to a number of Sites of Special Scientific Interest (SSSIs):

- Rheidol Shingles and Backwaters (route passes though western end)
- Gro Ty'n Yr Helig (300m to east)
- Gro Ystwyth (adjacent)
- Cors y Sychnant (adjacent)
- Cors Caron (through and former railway route is designated as part of the SSSI)
- Gwaun Ystrad Caron (50m south)
- Afon Teifi (route crosses on bridge at six locations and is adjacent along several sections)
- Rhosydd Bryn Maen (route passes though)
- Glan Rhocca (170m east)
- Corsydd a Rwyth Cilyblaidd (adjacent)
- Llyn Pencarreg (adjacent)
- Afon Tywi (route crosses on bridge)

3.5.1.2 Special Areas of Conservation

The proposed route passes through or close to a number of Special Areas of Conservation (SACs):

- Grogwynion (1800m east)
- Elenydd (8km east)
- Cors Caron (through and former route is designated as part of the SAC to improve connectivity)
- Cwm Doethie - Mynydd Mallaen (11km east)
- Afon Teifi (route crosses on bridge at six locations and is adjacent along several sections)
- Afon Tywi (route crosses on bridge)

3.5.1.3 Special Protection Areas

The proposed route passes through or close to a Special Protection Areas (SPAs):

- Elenydd – Mallaen (6km east)

3.5.1.4 RAMSAR Sites

The proposed route passes through the following RAMSAR site:

- Cors Caron (through and former route is designated as part of the RAMSAR site to improve connectivity)

3.5.1.5 Implications

The presence of protected sites on and close to the proposed route has implications for the development of the route. All of the sites listed above are afforded protection due to either the physical environment or species that are present, or both. Any development that has the potential to affect any of the designation features must be assessed to determine the likelihood and significance of any impact.

Potential impacts to SAC, SPA or RAMSAR sites requires a Habitat Regulations Assessment. Any work that could affect a SSSI requires assent from Natural Resources Wales.

The most significant impacts would be to designated sites that the proposed route runs through or is adjacent to. The route forms part of the Cors Caron RAMSAR, SAC and SSSI and would require screening under the Habitats Regulations. This site is designated under RAMSAR in part for over wintering birds and as a SAC for otter which would be considered sensitive to visual and noise disturbance. The habitat itself may be susceptible to increases in air borne nutrients which can arise from vehicle exhausts.

The other designated sites which the route passes through or close to are the Afon Teifi and Towy SACs; both of which are designated for otter amongst other species and habitats. Any disturbance to otter would need screening under the Habitats Regulations.

3.5.2 Historic Environment

Effects to protected sites are more likely if the site is close to the route of the railway. There are a number of protected historical features located within 100m of the route.

Table 4: CADW listed buildings route-wide

Name	Chainage	Distance and Direction from route	Location (NGR)	Grade	Reason
Aberystwyth to Llanilar					
Aberystwyth Railway Station	0000	Start of the route	258512, 281598	II	Group value
Welsh School	0000	75m west	258447, 281558	II	Group Value
Tyllwyd and attached outbuildings	5600	90m east	259655, 277385	II	Included as a traditional farmhouse with extensive outbuildings attached, the 10-bay cow-shed is particularly unusual.
Outbuilding to North of Vicarage	9620	85m south	262498, 275311	II	Is a small earlier C19 lofted coach house and stable, and for group value with the vicarage
Llanilar to Tregaron					
Birchgrove	14380	35m east	266537, 273081	Grade II	Included as a good example of late Georgian smaller country house, with historical connections to Trawscoed estate.
Rhydgaled	20440	80m west	269518, 268653	Grade II	It is a Grade II former inn with well-presented early to mid C19 character
Tregaron to Lampeter					
Outbuilding of N of Trecefel Farmhouse	32670	60m east	266796, 258519	Grade II	Well preserved earlier C19 farm building of definite regional character
Trecefel	32670	80m east	266797, 258476	Grade II	Substantial gentry farmhouse of later C18 rare in the region

Name	Chainage	Distance and Direction from route	Location (NGR)	Grade	Reason
Olwen Farmhouse	45790	80m west	258040, 249388	Grade II	Good example of typical C19 farmhouses in the area, unusual due to the massive prominent NE stack. Marked on the 1843 Tithe map.
Lampeter to Llanybydder					
Old House with Attached Farm Buildings at Felin Fach	49580	90m north	256703, 246332	Grade II	Well preserved early C19 farmstead of a type once characteristic of the region
Plas Cottage	52820	60m south	253710, 245389	Grade II	Small well preserved C19 cottage of a type once common to region
Llanybydder to Pencader					
Multipurpose farm building at Pantygen Isaf		70m south	246226, 239826	Grade II	Well preserved C19 multipurpose farm building and as part of well-preserved group with the house.
Pantyfen Isaf	62790	95m south	246216, 239802	Grade II	Well preserved C19 farmhouse once characteristic of the district but now rarely well preserved
Yr Hen Gapel	67440	25m east	244532, 236125	Grade II	Early C19 chapel retaining much of its early character
Pencader to Carmarthen					
Pencader War Memorial	67530	95m east	244549, 236022	Grade II	Social historical interest and well detailed memorial in prominent village location
Danygraig	70050	65m north	242822, 234477	Grade II	Unaltered labourer's cottage of a type once common to the district
Milestone on A484 at former Bronwydd Arms Public House	85950	65m west	241754, 223490	Grade II	One of series of well-preserved milestones in the community
Milestone	87550	65m west	242648, 222156	Grade II	Included for transport history interest.
Former Upper Tin Mills	89680	45m north-west	242152, 220650	Grade II	Industrial archaeological interest as remnant of former tinplate works
Former Blast Furnace and attached building	89780	25m north-west	242076, 220561	Grade Ii	Industrial archaeological interest as remnant of a major welsh iron works
Section of Wall at SW corner of Parc Hinds	89930	35m north-west	241961, 220444	Grade II	Historical interest as small survival of the Priory
The Old Grammar School	89990	35m north-west	241910, 220392	Grade II	Historic interest as a former school
No.1, No.2, No. 3, The Limes, No. 6, No. 7, No. 8, and Bryn Roma	90080 - 90200	45m north-west	241830, 220322	Grade II	Part of a set of nine contemporary terraced houses, characterising architecturally ambitious expansion of town in later C19
No. 6, No. 7, No. 8, and No. 9	90290 - 90340	50m north-west	241685, 220168	Grade II	Part of development of the Parade as a fashionable residential area
Gates, gate piers, and	90360	40m north-west	241679, 220141	Grade II	Small C19 pedestrian gate of locally made ironwork

Name	Chainage	Distance and Direction from route	Location (NGR)	Grade	Reason
bollards to footpath					
Former Presbyterian College	90390	50m north-west	241645, 220131	Grade II	Unusual Tudor Gothic early Victorian building of historical importance
Sections of Medieval Town Wall	90650	75m north-west	241447, 219970	Grade II	Important remnant of the medieval walled down
Towy Bridge	90800	Immediately North	241383, 291866	Grade II	Earlier C20 concrete road bridge of considerable scale by a leading Welsh architect

Source: http://historicwales.gov.uk – interactive mapping

Table 5: Scheduled Ancient Monuments and national historic monuments route wide

Chainage	Grid reference	Name	Comment	Source
Aberystwyth - Rhydyfelin				
00000	SN5855581514	Vale of Rheidiol Railway.	19km long. Built to serve lead mines in the Rheidiol Valley but completion coincided with a decline in the lead industry. During first world war, it was used to transport timber for use in the collieries. From 1920s onward it was dependent on tourist traffic and is still used for this purpose.	National monuments record for wales)
0300	SN5877481405	Plas Crug Millstream	Weir feeding Aberystwyth town mill as old as 1280. Bus station, railway station and school along south-eastern side of road built upon line of a dam which may have accumulated a reserve of water fed by two streams.	National monuments record for wales
0625	SN58958115	Plas Crug Tower Rheidiol castle	2 storeys high, remains of 17th century manor house. Medieval castle now occupied by later building.	Welsh archaeological trusts' historic environment records
1650	SN5988980728	Biston Terrace	19th century house.	National monuments record for wales
1650	SN59838064	Llanbadarn railway station		Welsh archaeological trusts' historic environment records
1900	SN59988033	Pen-y-bont windmill	1834 earliest record of windmill, no apparent traces of mill surviving today	National monuments record for wales
2800	SN6001379849	Penlan building	Penlan building. Building marked on 1905 OS survey, no later evidence of it.	Welsh archaeological trusts' historic environment records
Rhydyfelin – Llanilar				
4700	SN5929978193	Quarry	Disused but still present	Welsh archaeological trusts' historic environment records
6200	SN59737688	Fferm Tynrhelyg	1888 earliest record of farmhouse, located adjacent to railway embankment.	Welsh archaeological trusts' historic environment records

Chainage	Grid reference	Name	Comment	Source
7750	SN6074075690	Pont Pant-mawr,	Bridge shown on OS map 1964	Welsh archaeological trusts' historic environment records
8300	SN6114875337	Cord y castell cropmark	Truncated crop marks showing two parallel stretches of double ditch, morphology is not diagnostic, could be prehistoric, Roman or later.	National monuments record for wales
9100	SN6189075670	Bridge	Pen y banc, Bridge	Welsh archaeological trusts' historic environment records
9850	SN62627530	Mill	Saw mill shown on 1977 OS map, present condition unknown	Welsh archaeological trusts' historic environment records
Llanilar – Trawscoed				
10000	SN62767529	Llanilar railway station	Opened in 1871 and closed in 1964. Two platforms and a length of iron railing survive	National Monuments Record for Wales
12500	SN6515074400	Felindyffryn Halt	Wayside halt opened in 1935, closed in 1964	National Monuments Record for Wales
12525	SN65117437	Felin Dyffryn corn mill	1851 watermill, 2 stones and ceased working in 1940.	National Monuments Record for Wales
14500	SN665730	Birchgrove Country house	Country house on the opposite side of the valley to Trawscoed Mansion	Welsh archaeological trusts' historic environment records
14500	SN6646273048	Kennels	1900 OS maps notes Birchgrove manor house kennels	Welsh archaeological trusts' historic environment records
Trawscoed – Ystrad Meurig				
14975	SN66627260	Trawscoed railway station	Opened in 1871, closed 1964	National Monuments Record for Wales
14900	SN66587266	Lisburn House	18th century washed stone slate roof country house	National Monuments Record for Wales
15300	SN66527228	Roman road	Sarn Helen, Roman road visible as parchmark in summer	National Monuments Record for Wales
15900	SN66657172	Church	Dolfor Methodist church. Formerly farmhouse, no longer in use	National Monuments Record for Wales
18160	SN6842870653	Pen-y-bont Railway house	Railway house noted on OS 1886 map	Welsh archaeological trusts' historic environment records
19400	SN69076963	Lead mine	Cwm Nant Tarw West lead mine level, dead ended tunnel dug into hillside, 19th century trial working	National Monuments Record for Wales
19400	SN69086965	Lead Mine	Cwm Nant Tarw East lead mine level, visible remains on east bank of stream including overgrown spoil tip.	National Monuments Record for Wales
19400	SN6910069600	Lead mine	Pwll caradog, 19th century lead mine	(Welsh archaeological trusts' historic environment records)
19525	SN69136952	Caradog falls railway halt	Opened in 1932, closed December 1964 due to flooding at Llanilar. Site is now a private garden.	National Monuments Record for Wales

Chainage	Grid reference	Name	Comment	Source
19550	SN69176952	Y Felin Mill	Two storey corn mill under slated roof. 18th century, bits of mill stone remain around the site.	National Monuments Record for Wales
19700	SN6925069426	Tanygraig Tunnel	78.79m long with brick portals and brick lined at each end, centre section unlined. Opened 1867, closed 1964.	National Monuments Record for Wales
19720	SN69296944	Caradog Chapel	built 1869	National Monuments Record for Wales
20570	SN6962868647	Road sign	dates from 1930 – 1965 and is cast aluminium and is pre Worboys Committee	National Monuments Record for Wales
20700	SN69726855	Quarry	Bryn Bach quarry, small quarry on 1905 OS survey map	National Monuments Record for Wales
20950	SN6970868288	Corporation Siding Signal Box	Brick building	National Monuments Record for Wales
	SN970068280	Corporation Siding	Closed 1948	National Monuments Record for Wales
22000	SN7025067500	Ystrad Meurig Castle	Medieval castle, destroyed in 1208	Welsh archaeological trusts' historic environment records
Ystrad Meurig – Tregaron				
22950	SN7109167129	Strata Florida railway station	Opened 1867, closed 1965. Two platforms, station buildings and a signal box, all have been demolished and few traces remain.	National Monuments Record for Wales
24050	SN7100066000	burial site	Iron age bog burial site	Welsh archaeological trusts' historic environment records
26400	SN7019063790	Allt ddu railway halt	Wayside halt opened in 1935, closed in 1965.	National Monuments Record for Wales
27850	SN6933062690	Chapel		Welsh archaeological trusts' historic environment records
27700	SN6940062800	Treflyn Methodist Schoolroom	schoolroom	National Monuments Record for Wales
29800	SN6811061100	Pont Cammer	Bridge	Welsh archaeological trusts' historic environment records
Tregaron – Llangybi				
30900	SN6785360076	Tregaron railway station	Opened 1871, closed 1965	National Monuments Record for Wales
32715	SN6686058650	Pont ffainc bridge	Bridge	Welsh archaeological trusts' historic environment records
35200	SN6528056940	Milk factory	Milk Factory, opened 1937, asbestos clad twin pitched rood. Steel framed asbestos-clad tower, factory and rail link closed September 1970	National Monuments Record for Wales
35240	SN6525056970	Pont llanio railway station	Opened 1871 and closed February 1965.	National Monuments Record for Wales

Chainage	Grid reference	Name	Comment	Source
36500	SN6421056350	Roman Road and Vicus west of Llanio roman fort	Buried features and earthworks representing the vicus to the west of a Roman fort	Welsh archaeological trusts' historic environment records
38900	SN6256054680	Olmarch Railway halt	Opened in 1929, closed 1965	National Monuments Record for Wales
Llangybi – Lampeter				
41250	SN6111052870	Llangybi railway station	Opened 1873, closed 1965	National Monuments Record for Wales
43200	SN5974051480	Derry Ormond railway station	Opened 1871, closed 1965 (station known as Bettws between 1871-1874)	National Monuments Record for Wales
46150	SN5801949254	Castell Olwen	Iron age hillfort	CADW Scheduled Ancient Monumnet
46900	SN5821048380	Lampeter railway station	Railway station	Welsh archaeological trusts' historic environment records
47100	SN5818048180	Lampeter Woollen mill	Woollen mill, 19th century mill shown on 1st and 2nd edition OS 25-inch maps	Welsh archaeological trusts' historic environment records
Lampeter – Llanybydder				
47650	SN5816047640	Bridge over Afon Teifi	Disused railway bridge	Welsh archaeological trusts' historic environment records
48700	SN5768146655	St James' Church	19th century church constructed between 1889-1890	National Monuments Record for Wales
51850	SN5470045760	Tan-yr-Allt Roman road	Roman Road	Welsh archaeological trusts' historic environment records
53050	SN5356645403	Pencarreg Railway Halt	Opened 1930, closed 1965. Line remained open for milk traffic until 1973	National Monuments Record for Wales
53950	SN5298044730	Castle	Castle remains, marked as castle on 1888 map, marked as entrenchment	Welsh archaeological trusts' historic environment records
Llanybydder – Llanfihangel ar Arth				
54650	SN5245044350	Pont Aber-duar bridge	OS Source – 1964,	Welsh archaeological trusts' historic environment records
54700	SN52104406	Llanybydder Railway Station	Opened in 1866; closed in 1965 although the line remained open for milk traffic until 1973.	Welsh archaeological trusts' historic environment records
59200	SN4900042000	Pant-teg Cottage	First shown on 1907 OS Map	Welsh archaeological trusts' historic environment records
60550	SN4796241167	Melin Wrdeg Mill	Denoted as corn mill in 1st and 2nd edition O.S maps, still exists	National Monuments Record for Wales
61300	SN4739040730	Railway station	Maesycrugiau Railway station, station was closed in 1965 but remained open for milk traffic until 1973	National Monuments Record for Wales
63900	SN4552039360	Smithy	Blacksmith workshop	Welsh archaeological trusts' historic environment records

Chainage	Grid reference	Name	Comment	Source
62150	SN4691640006	Castell Pyr	Iron Age Fort	CADW Scheduled Ancient Monument
Llanfihangel ar Arth – Dolgran				
64275	SN4526039130	New Quay Railway station	Originally named Cross Inn Railway station, opened 1871, renamed 1874, closed 1965.	National Monuments Record for Wales
65150	SN4470038440	Pont y bwlchos	Bridge	Welsh archaeological trusts' historic environment records
67330	SN4465036320	Glan-Nant woollen factory	Woollen Factory and mill race, 1906	National Monuments Record for Wales
67610	SN4445036100	Woollen Mill	19th century woollen mill operating between 1890-1948, mill has been demolished	Welsh archaeological trusts' historic environment records
67625	SN4447036080	Pencader railway station	Opened 1864, closed 1965	National Monuments Record for Wales
67630	SN4452036060	Pencader Station Sawmill	Saw mill and short tramway in the railway station. Saw mill water powered	National Monuments Record for Wales
Dolgran – Llanpumsaint				
73300	SN4170031950	Ysgoldy Cottage	Originally shown on 1907 OS map, present condition unknown.	Welsh archaeological trusts' historic environment records
Llanpumsaint – Bronwydd Arms				
74650	SN4157029679	Llanpumsaint Railway station	current condition unknown	National Monuments Record for Wales
75800	SN4145029580	Woollen mill	Woollen mill marked as Woollen Factory on OS 1st edition map. Converted to dwelling despite some original features have been retained.	Welsh archaeological trusts' historic environment records
80625	SN3857826384	Conwil Railway station	current condition unknown	National Monuments Record for Wales
80780	SN3864026250	Hotel	Railway hotel	National Monuments Record for Wales
81250	SN3897025910	Anti-tank rail	Anti-tank defence, 22 steel rails vertically rising in two rows up railway embankment	Welsh archaeological trusts' historic environment records
81275	SN3897025890	Pillbox	Pillbox (Type FW3-24), bulletproof pillbox, reinforced concrete with anti-ricochet wall built on large concrete raft due to falling ground towards Afon Gwili	National Monuments Record for Wales
83780	SN4100025470	Iron Works	Iron Works, Cwmdwyfran Forge, 18th Century building	National Monuments Record for Wales
83800	SN4100025460	Cwmdwyfran Forge Mill	17th Century building	National Monuments Record for Wales
Bronwydd Arms – Carmarthen				
85580	SN4176923980	Bronwydd Arms railway station	Rebuilt and operational	National Monuments Record for Wales
85650	SN4176723919	Bronwydd Arms Signal box	Llandybie signal box was moved and rebuilt on a new base in 1986 at Bronwydd Arms Station on the Gwili Railway.	National Monuments Record for Wales

Chainage	Grid reference	Name	Comment	Source
85800	SN4185023770	Pont y felin Bridge	Bridge	Welsh archaeological trusts' historic environment records
86550	SN4200023050	Anti-tank ditch	Anti-tank ditch, Carmarthen, excavation that extended from Allt Werncorgam to Pante	National Monuments Record for Wales
88150	SN4300021800	Glan-gwili bridge	Unknown earthwork.	Welsh archaeological trusts' historic environment records
88350	SN4306021600	Dol-gwili brick and tile works	Initially marked on 1st edition OS map 1890. Consisted of a long range of buildings and a large circular building to the South, presumably the kiln.	Welsh archaeological trusts' historic environment records
88950	SN4291021060	Pont Richard Einon Bridge	marked on the 1st edition Ordnance Survey map of 1890, presumably built when the railway it crosses was laid in 1852.	Welsh archaeological trusts' historic environment records
89800	SN4215820648	Carmarthen Tinplate works	constructed 1759 closed 1900.	National Monuments Record for Wales
89800	SN4211020608	Carmarthen Tinplate works	blast furnace and casting house	National Monuments Record for Wales
89950	SN4206020530	Mill	Medieval corn mill, date unknown but estimated to be 1291 if not earlier	Welsh archaeological trusts' historic environment records
90000	SN4200020500	Sowther tucying Mill	Medieval fulling mill	Welsh archaeological trusts' historic environment records
90050	SN4199020440	Lead works	Smelting Houses, lead works established 1760. Buildings demolished min 19th century for the railway.	Welsh archaeological trusts' historic environment records
90060	SN4196620445	Priory	St John's priory, existed before 1093, Conventual buildings demolished in 1781 for lead smelting works.	National Monuments Record for Wales
90400	SN4172520207	Buildings	Nos. 1-2 The Parade, row of houses that are listed buildings	Welsh archaeological trusts' historic environment records
90560	SN4164020080	Goods shed	Goods shed associated with the Old Station in Carmarthen, built in 1860,	(Welsh archaeological trusts' historic environment records)
90600	SN4165020020	St Peters Saw Mill	Appears on 1st edition OS map, disused by 1907	(Welsh archaeological trusts' historic environment records)
90650	SN4159019990	Railway Inn Public house	1888	(Welsh archaeological trusts' historic environment records)
90700	SN4154119979	Railway station	Former Carmarthen railway station opened 1860, closed 1906	(Welsh archaeological trusts' historic environment records)
90700	SN4146819917	School	Sunday school	National Monuments Record for Wales)
90800	SN4157019950	Brick and pipe works	Brick and pipe works, opened 1834	(Welsh archaeological trusts' historic environment records)

Chainage	Grid reference	Name	Comment	Source
91100	SN4127519696	Railway station	Carmarthen town railway station, operational	National Monuments Record for Wales)

Source: http://historicwales.gov.uk – interactive mapping

3.5.2.1 Implications

Any development that has the potential to affect a protected historical feature such as a listed building or scheduled ancient monument needs specific permission, from CADW for scheduled monuments or the local planning authority for listed buildings. The most sensitive sites are considered to be those features which are within the railway corridor which may need demolition or construction of railway infrastructure within or adjacent to the protected structure.

3.5.3 Noise

3.5.3.1 Background

There is a potential for nearby neighbouring properties to be affected by noise generated during operation of the rail service. Services are planned to operate from 06:00 to 22:30 and so it is anticipated that nuisance to neighbouring properties would be reduced due to the lack of night time traffic to which receptors would be more sensitive; however there may be some night time running to allow services to be at the correct station for the early scheduled departures

Carmarthen has been identified as an area subject to noise pollution arising from the trunk road network including the A40.

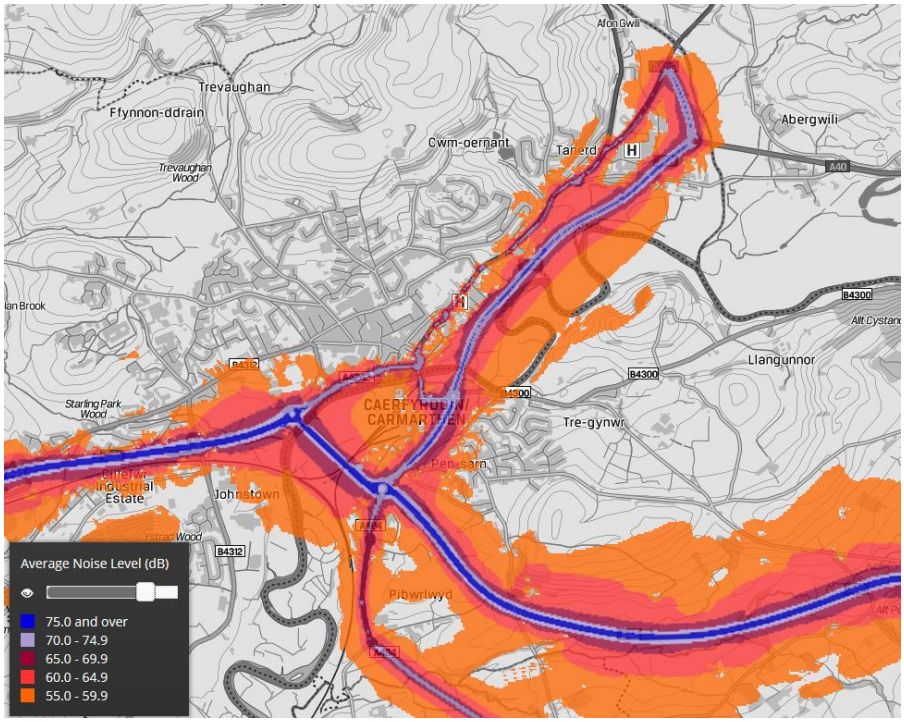


Figure 22: Average Noise Levels
Source: Welsh Government

3.5.3.2 Implications

Running train services would contribute to the existing high noise levels along the line from Carmarthen station to Abergwilli Junction and the Dol-Gwili roundabout.

A noise impact assessment would likely be required for any properties close to the line.

3.5.4 Air Quality

3.5.4.1 Background

An Air Quality Management Area has been designated by Carmarthenshire County Council in Carmarthen town centre. The railway route lies outside this management zone except where the line crosses the A484 at Carmarthen Bridge.

3.5.4.2 Implications

The effect of further air emissions from diesel engines should be assessed in terms of any impacts to the Carmarthen town centre air quality management zone.

There are not expected to be any other air quality effects along the line.

3.5.5 Greenhouse Gases

3.5.5.1 Background

It is anticipated that the new rail service would be provided by diesel powered locomotives which would emit carbon dioxide and oxides of nitrogen. It is assumed the locomotives would comply with the latest European emissions standards.

3.5.5.2 Implications

Diesel exhaust would produce greenhouse gases however it is envisaged that this would be offset as greenhouse gas emissions from road vehicles would be reduced as traffic transfers from road to rail.

3.5.6 Landscape

3.5.6.1 Background

The route passes through the Upland Ceredigion, Teifi Valley and Tywi Valley special landscape areas.

3.5.6.2 Implications

The proposed route would require a landscape and visual impact assessment.

3.5.7 Water Resources

3.5.7.1 Background

The route passes over bedrock which is generally argillaceous in nature and does not support large scale groundwater abstraction. Abstractions for local supplies are likely to be supported however, particularly where the route passes over river valleys with granular unconsolidated deposits of sands and gravels.

The proposed route passes through two groundwater source protection zones:

- Lampeter (Ffynnon Olwen); and
- Maesycrugiau.

The route runs through the inner and outer source protection zones of the Lampeter abstraction. The inner zone is defined as the 50 day time of travel to the borehole and Natural Resources Wales restrict activities that can occur within this zone to protect water resources. The route passes through the outer protection zone at Maesycrugiau which is less sensitive.

3.5.7.2 Implications

NRW would be expected to object to any development within a source protection zone which has the potential to pollute groundwater, such as fuel and chemical storage in underground tanks. The proposed railway development is not considered to pose any significant risk to water resources given that all construction activity would be managed to prevent pollution.

3.6 Flood Impacts

As set out in section 4, the historic railway route between Aberystwyth follows a succession of river valleys throughout its length as the Rheidol, Ystwyth, Teifi, Dulas, Tyweli, Aeon, Gwili & Towy.

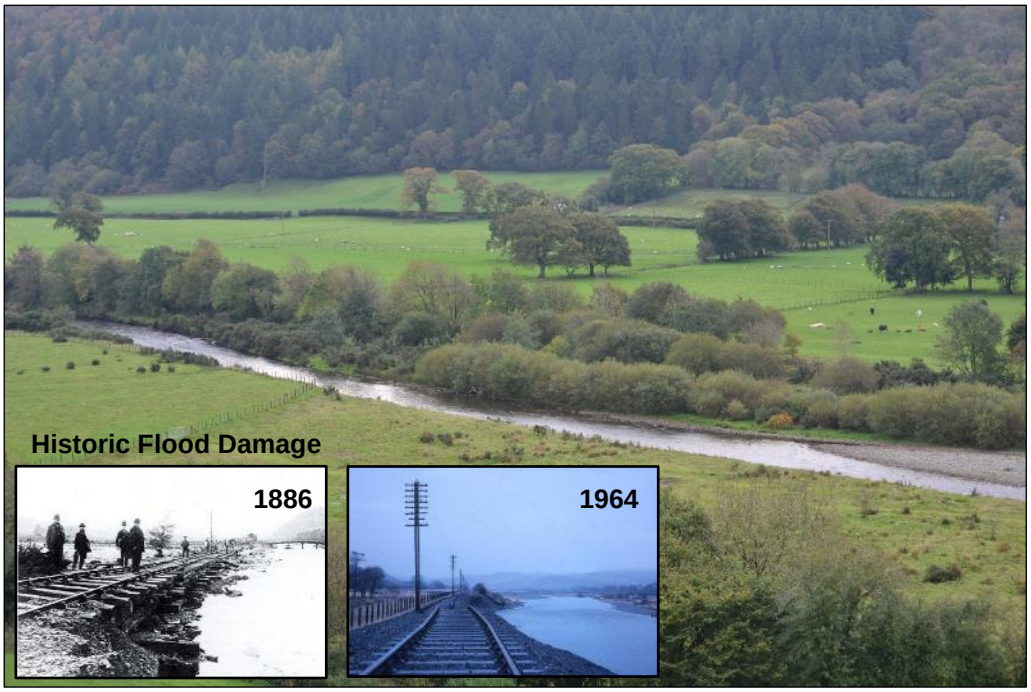


Photo 4: Afon Ystwyth Riverside Alignment (within Tree-line on far bank)

Part of the feasibility study is the consideration and identification of flooding-related constraints that may affect the choice of alignment or the feasibility of the proposed railway.

An assessment has been made using existing readily available information, with the output being a set of flood constraint plans identifying flood risk issues along the route alignment.

The flood constraints plans comprise the drawings listed below.

- Flood risk constraints Key plan drawing nos. 367590-MMD-32-XX-DR-C-0000
- Flood Zone plans Sheet 1 to Sheet 16; drawing nos. 367590-MMD-32-XX-DR-C-0001 to 0016
- Development advice zone plans Sheet 1 to Sheet 16; nos. 367590-MMD-32-XX-DR-C-00018 to 0033

The purpose of this section is to provide context and further explanation of the constraints identified on the plans. The detail and technical complexity of the assessment reflects the current stage and objectives of the development process.

The scope of the assessment is limited to a consideration of the primary sources of flood risk, (i.e. flooding from main rivers and the sea). It does not include consideration of flooding from artificial sources such as reservoirs, or local sources of flood risk such as surface water, groundwater, ordinary watercourses, or sewers and drains.

This high-level feasibility study has been prepared solely for the purposes of identifying key development constraints as may influence the choice of alignment and feasibility of the proposed railway link. Findings are directly dependent upon the accuracy and reliability of the information, correspondence and data available at the time of the assessment, with residual/variability risks remaining such that it would be inappropriate to draw any particular conclusions on the actual flooding of any property (client's or third party), or any other potential consequences of flooding. Any party

developing detailed design in the future, should not rely on assumptions made in this report but should satisfy themselves in these regards.

The assessment of the effects of climate change is based on the recommendations from Natural Resources Wales in place at the time of the study. These recommendations may change in the future, increasing the extent of predicted effects, and it is recommended that further advice should be sought should this occur during the lifetime of the project.

3.6.1 Sources of information

- Planning Policy Wales Technical Advice Note 15: Development and Flood Risk.
- Natural Resources Wales' online long term flood risk interactive maps including Welsh Government Development Advice Maps (https://naturalresources.wales/evidence-and-data/maps/long-term-flood- risk/?lang=en), accessed October 2017.

3.6.2 Planning policy

Planning Policy Wales (PPW) and Technical Advice Note 15 (TAN 15) on Development and Flood Risk, provide a framework and technical guidance for assessing the flood risks posed to and by a development in Wales.

3.6.2.1 Development Advice Zones

Figure 1 of TAN 15 defines three development advice zones (A, B and C), which are summarised in Table 6. The figure also attributes different planning actions for each of the zones.

Table 6: Development Advice Zone Classification

Zone	Sub-Zone	Description of Zone	Use within PPW and TAN 15
A		Considered to be at little or no risk of fluvial or tidal/coastal flooding	Used to indicate that justification test is not applicable and no need to consider flood risk further.
B		Areas know to have been flooded in the past evidenced by sedimentary deposits	Used as part of precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further.
C		Based Environment Agency / NRW extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal)	Used to indicate that flooding issues should be considered as an integral part of decision making by the application of the justification test including assessment of consequences.
	C1	Areas of the floodplain which are developed and served by significant infrastructure, including flood defences	Used to indicate that development can take place subject to application of justification test, including acceptability of consequences.
	C2	Areas of the flood plain without significant flood defence infrastructure	Used to indicate that only less vulnerable development should be considered subject to application of justification test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered.

Source: Planning Policy Wales Technical Advice Note 15 (TAN 15)

3.6.3 Development type

TAN 15 divides types of development into three categories: emergency services, highly vulnerable development, and less vulnerable development.

Figure 5 of TAN 15 identifies general industrial development, transport and utilities infrastructure and car parks, as "less vulnerable development".

3.6.4 Justifying the location of development

TAN 15 states that new development should be directed away from zone C and towards suitable land in zone A, otherwise to zone B.

Section 6 of TAN 15 states that new development should only be permitted within zones C1 and C2 if determined by the planning authority to be justified in that location. Development, including transport infrastructure, can only be justified if it can be demonstrated that:

> (i) its location in zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement; or
>
> (ii) its location in zone C is necessary to contribute to key employment objectives supported by the local authority, and other key partners, to sustain an existing settlement or region;
>
> and,
>
> (iii) it concurs with the aims of PPW and meets the definition of previously developed land (PPW fig 2.1);
>
> and,
>
> (iv) the potential consequences of a flooding event for a particular type of development have been considered, and in terms of the criteria contained in sections 5 and 7 and appendix 1 (of TAN 15) found to be acceptable.

3.6.5 Interpretation of flood constraint plans

3.6.5.1 Development advice zone plans

The development advice zone plans illustrate the proposed horizontal alignment of the route, overlaid onto the Welsh Government Development Advice Map (DAM).

Of the total route alignment of 92km; approximately 59km (64%) are within DAM zone A, approximately 13km (14%) are within DAM zone B, approximately 3km (3%) are within DAM zone C1, and approximately 17km (19%) are within DAM zone C2.

TAN 15 sets out the planning requirements and development advice for the different types of development in each zone. In relation to less vulnerable development such as transport infrastructure these are as follows, for each development advice zone.

- **Zone A**
  - The justification test is not applicable.
  - Surface water must be considered as set out in TAN 15.
  - There are no constraints relating to river or coastal flooding, other than to avoid increasing risk elsewhere.
- **Zone B**
  - If site levels are greater than the flood levels used to define the adjacent extreme flood outline, there is no need to consider flood risk further.
  - Surface water must be considered as set out in TAN 15.
  - Generally suitable for most development. Assessments are unlikely to identify consequences that cannot be overcome or managed to an acceptable level. It is unlikely that these would result in a refusal of planning consent on the grounds of flooding.
- **Zone C1**
  - Surface water must be considered as set out in TAN 15.
  - Development can only proceed subject to successful application of the TAN 15 justification test, including the acceptability of flooding consequences.

- **Zone C2**
  - Surface water must be considered as set out in TAN 15.
  - Development can only proceed subject to successful application of the TAN 15 justification test, including the acceptability of flooding consequences.

Due to the nature of the development proposal there would be few if any alternative route alignments that are both suitable and for which land is available. For lengths of the alignment that fall within DAM zone C1 or C2 the outcome of the justification test is likely to depend on the acceptability of flooding consequences.

3.6.5.2 Flood zone plans

The flood zone plans illustrate the proposed horizontal alignment of the route, overlaid onto extracts from the NRW flood risk maps for rivers and the sea.

The plans identify the following features:

- Areas of flood zone 2
- Areas of flood zone 3
- Flood defences
- Areas benefitting from flood defences

3.6.5.3 Flood zones

The flood zones are areas which would naturally be affected by flooding from rivers and the sea. The effects of flood defences are not taken into account in the mapping of these flood zones. Flood zones are used for strategic spatial and development planning purposes.

Flood Zone 3 is defined as the extent of a flood from rivers with a 1% (1 in 100) chance or greater of happening in any given year, or the extent of a flood from the sea with a 0.5% (1 in 200) chance or greater of happening in any given year.

Flood Zone 2 is defined as the extent of a flood from rivers or from the sea with up to a 0.1% (1 in 1000) chance of happening in any given year, and contains areas recorded to have flooded in the past.

Flood Zone 2 is important from a planning context as it forms the basis of Zone C in the Welsh Government Development Advice Map.

TAN 15 guidance on the acceptability of flooding consequences is that general infrastructure should be designed to remain flood free during the 1% fluvial flood and the 0.5% tidal/coastal flood. This is equivalent to Flood Zone 3.

However, for the ‘flood free’ scenario TAN 15 also requires that the predicted effects of climate change over the lifetime of the development are taken into account. None of the published flood zones take account of predicted climate change.

Therefore, and in the absence of any other information, for the purposes of this initial high-level assessment and feasibility study, Flood Zone 2 is assumed to represent the “design event” for which the infrastructure should be flood free.

3.6.5.4 Flood defences and areas benefitting from defences

The NRW maps show all flood defences built in the last five years to protect against river floods with a 1% (1 in 100) chance of happening each year, or floods from the sea with a 0.5 per cent (1 in 200) chance of happening each year, together with some, but not all, older defences and defences which protect against smaller floods.

As such there may be other existing flood defences that are not shown on the plans.

The hatched areas benefit from the flood defences that are shown. If the defences were not there, these areas would be flooded.

3.6.5.5 Main rivers

The NRW flood risk map shows the watercourses in Wales that are designated as main rivers. This includes any structure or appliance for controlling or regulating the flow of water in, into or out of a main river.

Main rivers are usually larger streams and rivers but also include some smaller watercourses. In Wales, main rivers are legally designated by Natural Resources Wales. Every other open watercourse in Wales is known as an 'ordinary watercourse' and falls under the responsibility of the local authority (as the Lead local flood authority).

A Flood Defence Consent is needed to carry out works in, over, under or near a main river, or in a flood plain or flood defence (including a sea defence).

Natural Resources Wales' powers to carry out flood defence works apply to main rivers only.

3.6.6 Notable constraints and areas of interest

The proposed route is particularly affected by flood risk and associated infrastructure at Aberystwyth and Carmarthen, i.e. the main conurbations on the route. Between these locations the route passes through mostly rural areas, crossing various watercourses and impinging on the flood plain at many locations, though mostly for short lengths.

3.6.6.1 Aberystwyth

Following the route alignment from Aberystwyth and commencing at Aberystwyth station, the first 2.5km (approximately) of the route is within the flood plain (flood zone 2, DAM zone C2) of the Afon Rheidol.

However, approximately the first 2km of this, as far as the Heol y Bont (A4120) highway overbridge, is existing track.

To the east of the A4120 the proposed alignment diverges from the existing track, turning south to cross the Afon Rheidol and associated floodplain. The location at which the proposed route alignment crosses the Afon Rheidol is immediately adjacent to an existing flood defence structure to the east, and also coincides with an existing railway crossing of the Afon Rheidol and an existing access road crossing of the Afon Rheidol. This means that the horizontal alignment of the proposed new rail line crosses both the existing road and existing railway line at the same location that they themselves cross the Afon Rheidol.

The bridge crossing of the Afon Rheidol would need to maintain adequate clearance (including freeboard) above the water levels corresponding with flood zone 3, with an appropriate allowance for the effects of climate change over the lifetime of the built asset. These clearances and levels would need to be agreed with NRW.

Furthermore, it is anticipated that it would be necessary to model the effects of the new rail alignment and bridge crossings, including any embankment or built assets within flood zone 2 and flood zone 3, to demonstrate that the proposals would not exacerbate flood risk or consequences for any people or property compared with the current situation.

3.6.6.2 Carmarthen

Following the route alignment from the Carmarthen end and commencing at Carmarthen station, immediately to the north of the station the alignment crosses an existing flood defence structure on the left (south) bank of the Afon Towy, a main river. The route then crosses the Afon Towy itself before crossing another flood defence on the right (north) bank.

Upstream of the proposed crossing point there is a major highway (A40) bridge crossing, and downstream of the proposed crossing point there is another existing highway (A484) bridge crossing.

The route then continues in a north-easterly direction within the flood plain of the Afon Towy (flood zone 3, DAM zone C2) for a distance of about 2km, as far as Glangwili, before turning north and exiting the flood plain.

It is reasonable to expect that NRW would not allow a breach of the existing flood defences or the introduction of flood gates in the defences. Therefore, the vertical alignment of the new track would need to clear the crest of the flood defences while allowing suitable access for inspection and maintenance of same.

The bridge crossing of the Afon Towy would need to maintain adequate clearance (including freeboard) above the water levels corresponding with flood zone 3, with an appropriate allowance for the effects of climate change over the lifetime of the built asset. These clearances and levels would need to be agreed with NRW.

Furthermore, it is anticipated that it would be necessary to model the effects of the new rail alignment and bridge crossing, including any embankment or built assets within flood zone 2 and flood zone 3, to demonstrate that the proposals would not exacerbate flood risk or consequences for any people or property compared with the current situation.

3.6.6.3 Other areas

Between Carmarthen and Aberystwyth, the route passes through mostly rural areas, crossing various watercourses and impinging on the flood plain at many locations.

The lengths of track within the floodplain are for the most part very short and the crossings are of minor (in terms of size) watercourses with narrow floodplains. These instances are too numerous to list individually, and are not expected to present large challenges or constraints.

However, there are some locations along the route where the horizontal alignment falls within the flood plain for a significant distance, or crosses a larger watercourse, confluence, or wide floodplain, or is otherwise constrained by existing development. At these locations, a greater level of assessment and constraint may be anticipated.

Examples include the following:

- Pencader, on the Afon Tyweli / Nant Gwen
- Pen Ddol, on the Afon Teifi / Nant Hust / Nant Ceiliog
- Llanybydder, on the Afon Teifi / Afon Duar
- Dolgwm Isaf, on the Afon Teifi / Nant Dolgwm
- South of Lampeter, on the Afon Teifi / Nant Hor / Nant Eiddig
- North of lampeter, on the Afon Dulas
- Olmarch Fawr, on the Afon Dulas
- Near Maes-y-derry, on the Afon Teifi
- Afon Teifi floodplain through Cors Goch Glan Teifi (Cors Caron National Nature Reserve) South of Ystrad Meurig
- Afon Ystwyth floodplain along the Lon Cambria Cycle Path, between B4340 and B4575, west of Abermagwr
- Afon Ystwyth floodplain north of Llanilar
- Afon Ystwyth floodplain south of Craig-Y-Bwlch and west of Crud Yr Awel

3.6.7 Conclusion and summary

The particular and local impacts and measures of and to the railway requirements cannot be determined without further in depth study. Further investigation would be required to better understand the flood risks and related constraints at those locations where the railway works:

- are within development advice zone C and/or flood zone 2;
- cross a watercourse; or
- cross an existing flood defence.

Natural Resources Wales (NRW) would need to be consulted to better understand these constraints and how they affect the alignment, and to confirm the scope and extent of further work that may be required as part of the development planning process. This may include confirming the following:

- crest levels of existing flood defences crossed by the proposed alignment, and the associated minimum clearances required.
- minimum levels of rail track and associated infrastructure proposed within flood zones.
- minimum soffit levels for proposed bridge crossings of watercourses.
- requirements for hydraulic modelling of the development proposals to demonstrate the effects on people and property.

Photo 5: The Afon Teifi at Pont Llanio (Alignment within the distant tree-line)

3.7 Tunnelling (the Pen-Y-Banc Tunnel)

The Pen-Y-Banc tunnel would be 1km in length and a single bore, single track rail tunnel. The track level rises from 13m to around 23m AOD through the tunnel, and with the overlying hill rising to an elevation of circa 100m AOD, the cover would be a maximum of around 90m. Groundwater conditions are not known, although the route crosses a small river just before the western portal so it is assumed the tunnel is above the main groundwater table.

3.7.1 Geology

The tunnel is expected to pass through the Trefechan Formation part of the Aberystwyth Grits Group. These are thinly interbedded turbidite sandstones and mudstone. At surface they are shown as steeply dipping beds and likely dipping into a synclinal feature. Therefore, dip angle could be shallower at the level of the tunnel. There is likely to be some Head deposits at the northern tunnel portal though not of any great thickness.

3.7.2 Tunnel sizing and shape

For a single track tunnel is expected to be in the region of between 5.8m and 7.5m internal diameter, dependent on train dimensions, speed, fixed equipment requirements and space-proofing requirements.

The tunnel shape would vary between circular to horse-shoe or curved horse-shoe depending on the excavation method. It can also vary to take advantage of the ground conditions, such as bedding and stress orientation, and to minimise excavated volume once the space-proofing is known.

It is preferable to keep the tunnel as small as possible, however the final use of the tunnel is the deciding factor. Assuming a maximum lining thickness of 300mm, depending on the diameter and the required support, the excavated volume would be between 30,000m^3 and 50,000m^3 for the 1km tunnel.

3.7.3 The expected conditions for excavation

The description of the rock at this early stage (before any investigation) is a thinly interbedded sandstone and mudstones of the Trefechan Formation.

Notable properties required for tunnelling have been estimated as follows:

Intact rock strength: The strength has not been assessed in the field, however is expected to be very weak and weak mudstones and medium strong sandstone

Rock Mass: In Geology plan 163, the ‘Aberystwyth Grits’ are described with indication of bedding 2-20cm for mudstone and 0.5 – 10cm locally 30cm for arenites (sandstones). It is not known what percentage of the mass would comprise solid pieces >10cm therefore an assumption of an RQD of 25% to 50% is made on the limited information available.

Orientation and Anisotropy: A syncline is mentioned, therefore there is the potential of unfavourable bedding orientation with respect to the tunnel alignment, changing with the tunnel advance, e.g. horizontally bedded at the crown for some distance, tunnelling along with bedding for some distance, as the syncline progresses.

Water ingress: It is assumed that the tunnel would be above the regional water table and ingress would be from percolation of surface water or localised flow through bedding.

Photo 6: Aberystwyth grits as exposed on nearby beach and of bedding near portal

3.7.4 Tunnel excavation methods

There are Two main methods of excavation for rock tunnels, Mechanical Excavation (i.e. TBM, Roadheader and peckers, ripping machines) or Drill and Blast. These are listed below along with the likelihood of being taken forward.

3.7.4.1 TBM

A hard rock Tunnel Boring Machine (TBM) would not be cost effective for 1km of tunnel. It is understood that this is the only tunnel along the route, therefore at present this method is discounted.

3.7.4.2 Mechanical Excavation (non- TBM)

Mechanical excavation using a machine such as a pecker or road header. The most cost effective type of machine would need to be sought once more detail is known. The advance could be benched in zones of weaker rock mass or where the bedding is very unfavourable and supported depending on the quality of the rock. Mechanical excavation by roadheader would be a good option if the rock mass is fractured and the intact rock strength and rip-ability is within range of the machines. If persistent beds of very strong rock are present, the predicted tool wear would affect the rate of advance. If a pecker is considered, the ratio between the required power and the size and manoeuvrability of the machine would be an important factor given the space restrictions. Based on the current limited information both of these options would be worth further enquiry.

3.7.4.3 Drill and Blast

Excavation would be carried out by drilling holes in the tunnel face and using a specialised explosive to remove 2m to 3m of rock. Benching may be possible. If the rock mass is generally weak and fractured, blasting may not be the best option, as the amount of rock pulled per blast may not be so easy to control. However this option should not be ruled out until further investigation is carried out.

Probing ahead would be recommended in both cases.

The choice of whether to opt of mechanical excavation or drill and blast would be based on rock mass characteristics, such as anisotropy, discontinuity spacing and orientation, intact rock properties, cost, machine availability, access, length of tunnel. Once these are known in more detail the final decision can be taken.

3.7.5 Tunnel support methods

All suitable tunnel excavation methods listed above (i.e. discounting TBM) require bespoke primary support by determining the rock quality at the point of excavation. The support would be determined by using one of the empirical rock mass classification systems such as the Q system or RMR system. Support varies from unlined, to a grid of bolts with mesh and sprayed concrete lining. As support types depend on the rock conditions encountered during excavation. A qualified and experienced

engineer/geologist should be present on site to determine the primary support. If the face is very weak sprayed concrete or even GRP bolts may need to be applied immediately after scaling.

Support can be locally increased for poor zones. If there is no requirement for the tunnel to be fully waterproof, water ingress can be dealt with by drainage and removal.

Once further investigation has been carried out a table of expected rock types to be encountered along the alignment can be produced for pricing purposes.

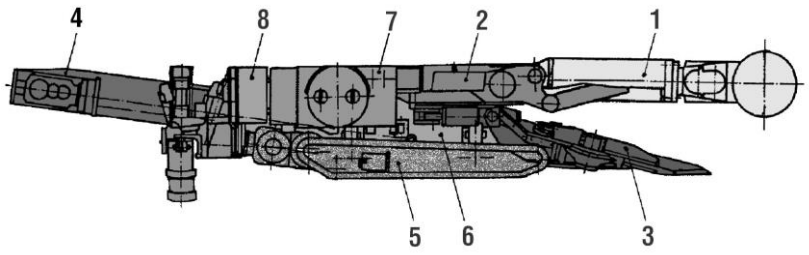
It is unlikely that a new rail tunnel could be left with only the primary support, therefore it would be expected that the tunnel would need a cast in-situ concrete lining, with nominal reinforcement. Secondary lining thickness would be in the region of 300mm.

3.7.6 Construction Duration Assessment

With all options there is the possibility of using two crews starting at each end of the tunnel and meeting in the middle, with mechanical excavation this would obviously require using two machines. In general, tunnels are excavated and supported continuously using a shift rota, therefore a day and a night shift is assumed, and 7 days a week working.

3.7.6.1 Mechanical excavation - Roadheader

The sequence for road-header excavation is a continuous process rather than cycles. The machine would have a conveyor system to remove the muck out of the tunnel and the machine advances to a set distance dependant on the length of allowable unsupported ground. Therefore, the excavation, muck gathering and removal is done simultaneously, without breaks. Once the advance is completed the cutter can either be retracted or the machine pulls back to allow room at the face for the support installation.



1 Cutter Boom, 2 Turret, 3 Loading Assembly, 4 Chain Conveyor, 5 Track drive, 6 Frame, 7 Electric Equipment, 8 Hydraulic Equipment

Figure 23: Roadheader

Different types of cutter heads are suitable for differing strengths of rock and should be chosen when further information is available. There may be a lead time for procurement. Only one face per machine.

For the highest productivity rates, assuming that one advance is possible per shift, with four shifts per day, and advances were limited to 1.5m this gives a maximum rate of circa 42m per week. This may not be achievable as there would be a lead in time, and inevitably down time and varying rock conditions. Please see Table 7 at the end of this section for likely durations. Roadheader would be expected to be one of the quicker options.

3.7.6.2 Mechanical excavation - Pecker

Tunnelling using a pecker, in the right rock conditions could be a lower cost method. However the machine would have to be powerful enough to rip or pull the rock but would have to fit and work inside the tunnel. This method would work best in a lower strength and more fractured rock, the productivity rate is generally slower than roadheader as the work is in cycles requiring a break for mucking out.

For tunnels of diameter less than 8m (such as this), the work has to be divided up into several stages to allow the machines to move out of the way for the support phase.

- Excavate
- Muck removal
- Scaling
- Removal of scaling material
- Support.

This generally allows only one advance per shift. The advance rates are dependent on the stability of the rock, but on average an advance of around 1.5m / face / shift could be possible. This would be slightly longer than excavation by roadheader.

3.7.6.3 Drill and Blast

The sequence for drill and blast is as follows:

- drill a number of holes in the face,
- pack with explosives,
- blast,
- ventilation
- scale the loose rocks,
- muck-away
- install support
- probe ahead if required

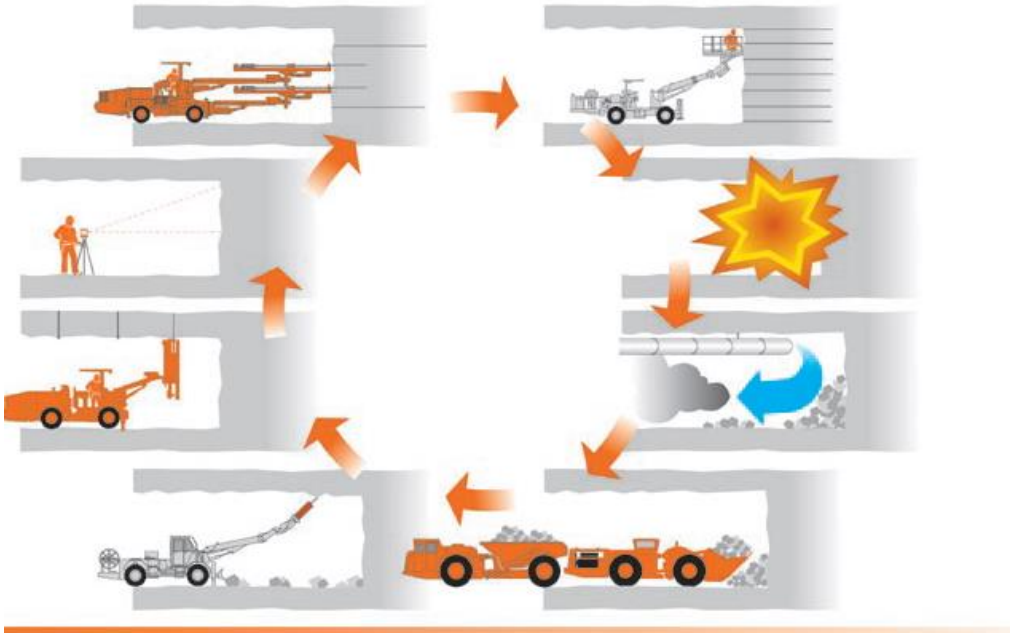


Figure 24: Drill and Blast Sequence
Source: Rock Excavation Handbook

Example plant and equipment required for drill and blast: Jumbo drilling machine e.g. Atlas Copco / Sandvik, Muck-away wagon, scaling machine e.g. backhoe and transportation of muck Truck. Ventilation hose / fans

One to two full cycles should be possible per shift depending on the rock class. Each cycle would allow an advance of 1.5 m to 3m. However with the weaker rock, although more rock is pulled with each blast there may also be over break.

Depending on the number of cycles/advance per day, rock conditions, whether both ends of the tunnel are advanced and how much was excavated, there is a degree of flexibility with all the methods. The range of durations are explained further in the following table:

Table 7: Example Durations for 1Km tunnel for 2 shifts per day (i.e. day and night shifts).

Number of working face	Advances per shift	Excavated m/shift	Number of working days	Notes
1 advancing face	1	1.5	330	bad ground conditions (e.g. Class V, IV)
1 advancing face	1	2	250	medium average conditions (e.g. Class IV)
1 advancing face	1	2.5	200	better average conditions (e.g. Class III)
2 advancing face	2	3	170	bad ground conditions (e.g. Class V, IV)
2 advancing face	2	4	125	medium average conditions (e.g. Class IV)
2 advancing face	2	5	100	better average conditions (e.g. Class III)

Two advances per shift may be unrealistic, therefore would base the range of durations on **between 8 months to a year. This does not include mobilisation, portal works or secondary lining.**

Secondary lining is estimated to take GSM=approximately 4 months depending on concrete supply and logistics.

3.7.7 Risks and considerations

Most risks can be mitigated in the design or during construction.

- Unforeseen ground. No investigation can fully determine the conditions along the tunnel alignment, there is always a risk of unfavourable conditions. This is the main risk to cost and programme.
- Planar crown, shoulder and face collapse due to bedding dip and orientation
- Slake durability, the mudstones may create difficult conditions when exposed to water.
- Swelling.
- Weathered bands of weaker rock causing over-excavation
- Faults – water ingress and weaker zones
- Ground gases - a ground investigation should show if there are any likely ground gases in these types of rock.
- Head deposits at tunnel portals may require removal depending on depth
- Licensing and Safe storage of explosives
- Machine breakdowns/ cutter and tool replacement
- Access for machines, storage, spoil and transportation
- Spoil removal and disposal
- Deformation and settlement, although considerations, the tunnel is not in a built up area and it is assumed that with the correct support this can be controlled.
- Water ingress through bedding planes – drainage and pumps should be available to deal with this during tunnelling
- Noise – although this is in a relatively rural area, blasting does have an impact that may need some regulation or restrictions.

3.7.8 Fire, Life Safety

At 1km, the Pen-Y-Banc Tunnel would be at the maximum length at which additional evacuation facilities (i.e. safe areas, and secondary means of escape) are not required.

The tunnel would however require the provision of forced ventilation in the event of a fire, such that smoke can be directed away from passenger escape routes and the emergency services point of entry (i.e. one or other of the tunnel portals).

Ventilation provision would require detailed study, to the particular characteristics and intended usage of the tunnel, but may be most economically provided by small banks of jet fans, installed within enlarged tunnel niches close to both portals (notionally 2 fans x 2 banks x 2 portals).

It is noted that bringing the historic 903m long Pencader Tunnel back into use, is also likely to require the provision of forced ventilation, which to the fixed structure of the existing tunnel are most likely to be provided by jet fans or nozzles within extended portal structures.

Figure 25: Tunnel Jet Fan

3.8 Accommodating the Gwili Steam Railway

3.8.1 The Gwili Railway today

The Gwili Railway Preservation Company currently owns, operates and maintains a 7.2km length of the historic route, running 3 to 8 trains per day to and from a station at Bronwydd Arms. The hour long trips running DOWN (Country) to Danycoed Halt in the Gwili Valley, before running UP (London) the full length of the line to Abergwili Junction (on the outskirts of Carmarthen), and then returning DOWN to the Bronwydd Arms station.

It is also understood that the Gwili Railway Preservation Company has long standing aspirations to extend its tracks and services as far north as Llanpumsaint, and already owns the historic route over this further 6.4km length.

Photo 7: The Gwili Steam Railway

3.8.2 Sharing the Gwili Valley

The confined and meandering course of the Gwili Valley provides an extended and gradual climb towards the heights of Pencader and the Teifi valley beyond. This ready-made railway compliant gradient was vital to the viability of the historic railway, and would remains so to it's economic reinstatement in the future.

Whilst the continued existence and operation of the historic route through the Gwili valley is a welcome reminder of what the railway once was, the shared use of the corridor by the steam railway, and a reinstated public passenger service would be challenging.

Recognising their origins and financial limitations, heritage and minor railways maintain and operate their infrastructure, rolling stock and services in accordance with rationalised standards and guidelines, to a variety of conditions including the limitation of train speed to a maximum of 25mph.

A public passenger railway service by contrast would have to be fully compliant with current mainline railway standards, such that they could not run on a heritage route unless it was fully upgraded to current standards.

In relation to the Gwili Railway this effectively means that the Gwili Railway Preservation Company could only continue to fully own, maintain and operate their railway if the reinstated Aberystwyth to Carmarthen railway could be provided in an entirely separate and segregated form.

One way of proving this would be to build a second track alongside the full length of the Gwili Railway to facilitate two entirely separate railways, in terms of all aspects of maintenance and operation.

However, given the tight and tortuous confines of the Afon Gwili valley this does not appear to be realistically feasible, and if attempted would in any case destroy the scenic nature of the steam railway, and most likely its continued existence as a tourist attraction.

3.8.3 Alternative Routes

If building a second track within the valley is ruled out, an entirely separate route for the reinstated passenger railway would need to be found, in order for the Gwili Railway to retain its current course.

The previous scoping study suggested that this could be achieved via a diversionary tunnel, as shown in Figure 26 below, but the practicality of such a link as a single track/bore is highly questionable.

At 3km long at least one intermediate means of emergency escape would be required, but at depths approaching 100m, vertical escape shafts would be impractical, and provision of a second full length (if potentially smaller bore) evacuation tunnel is likely to be necessary.

Without attempting to fully resolve the many complexities of such a tunnelled link, it is therefore readily apparent that it would be many times more expensive than the 1km long Pen-Y-Banc tunnel, and wholly unaffordable to a scheme of this nature.

Other more circuitous alternative surface routes might also be developed, but to the prevailing topography, would inevitably require a level of heavy engineering that would make them several times more expensive than upgrading the railway through the Gwili Valley, and re-providing the Gwili Railway at some other location.

Figure 26: Gwili Railway by-pass Tunnel *(Source: Previous Scoping Study)*

3.8.4 Other Options

To the above outline considerations, it appears unlikely that a second separate track could be provided to maintain the Gwili Railway Preservation Company, and operations, in anything similar to their current form, at their current location.

It would therefore be necessary for the heritage railway corridor and single track infrastructure to be fully taken over, and upgraded by Network Rail (or other), with the Gwili Railway Preservation Company, either:

a. **Retaining the right to operate their heritage rolling stock on some part of the overall route**. Looking to the Operational considerations set out within section 3.4, if a 90 minute service frequency is adopted there may theoretically be sufficient track capacity for a small number of the steam railway service to interleave with the regular passenger services leaving and returning to Carmarthen, over a similar route length to today.

   Where there would however be a need to provide additional passing loops and track accesses, such that the steam railway services could be held off the through line whilst the passenger services run through, this would inevitably add complexity and cost to the overall scheme track and signalling works.

   Additionally, significant resistance may be anticipated from the commercial operator of the route, in regard to regular shared running with a heritage operator who is perhaps unlikely to have the resources to fully assure the robust and reliable operation of their trains, nor to contribute to the normal levels of compensation, should their actions cause knock-on delay to the passenger railway.

   These concerns and opposition would heighten with any higher frequency of operation, and in any effective linkage of the Aberystwyth to Carmarthen services onto either of the adjoining lines, such that any impact would have potential to spread across the wider network.

   Considering these issues, the right to continue to operate on the line would most likely have to be limited to occasional, or weekend running, during periods of reduced service, or in substitution for passenger railway services. In this regard it should be noted that the Gwili's rolling stock is unlikely to be sufficiently fast to provide a straight substitution to a modern train within the normal timetable.

b. Being financially compensated, or otherwise assisted in re-establishing their operations at some other location. Consideration of the level of compensation or assistance required to re-provide equivalent facilities services at some other location is out-with the scope of this study, but would clearly be significant.

   It is however noted that various of the disused branch lines of the Aberystwyth to Carmarthen route have the potential to be reinstated for heritage use, allowing continued operation in isolation from the mainline railway, whilst perhaps also running occasional 'steam' specials on the main route.

3.8.5 ERTMS in cab signalling and Steam Trains

A further obstacle to shared running with the Gwili Steam Railway would be presented were the route to be signalled with ERTMS ETCS Level 2 in cab signalling (as has previously been undertaken on the Cambrian line to Aberystwyth (see section 3.3)), and which would limit use of the line to rolling stock that has been fitted with the requisite in-cab equipment.

Whilst there are precedents to the fitting out of Steam Locomotives with in cab-signalling, these are very limited, and related to much larger locomotives than those owned by the Gwili. In any case the equipment would be largely bespoke to each locomotive type, and come with a very high price tag.

The cost of such equipment is therefore beyond the reach of most heritage railway operators, and would most probably require public funding to have any chance of being developed, implemented, operated and maintained for/by the Gwili Railway Preservation Company.

3.8.6 Conclusion

To the above considerations, it appears most likely that the reinstatement of the passenger railway between Aberystwyth and Carmarthen, would require the closure of the existing Gwili Steam Railway.

This closure may potentially be compensated by financial (or other) assistance to re-establish the Steam Railway at some other location. The three historic branch lines may present opportunities in this regard, but further study, and consultation, would be required to establish the feasibility, cost and attractiveness of potential sites and alternative operations.

4 Route Overview

As set out in section 3.1 above, the historic railway alignment has been followed as far as possible, with deviations only considered where present day constraints and obstructions prevent its reuse.

As shown in Figure 27 below, a succession of river valleys are followed to minimise gradients and elevation, the Teifi providing the core of the route. Beyond this, four tunnels (1 new and 3 existing) are required to assist in crossing the watershed high points of the Teifi/Ystwyth and Ystwyth/Rheidol to the north, and the Teifi/Tyweli and Tyweli/Aeron(Gwili) to the south.

It is suggested that the extensive tapestry of river valleys make the historic rationale for this route readily apparent, where any more direct or coastal route would have had to be heavily engineered to maintain circa 1 in 50 ruling gradients across multiple valleys and watersheds, whilst the Cambrian Mountains practically block routes further to the east.

Whilst easing the alignment, this predominantly riparian route presents significant challenges to reinstatement in regard to extensive environmental and flood issues and constraints (sections 3.5 and 3.6 refer).

Beyond this ‘global’ view of the route a successsion of local routing decisions would have been made in connecting the principal settlements, avoiding unfavourable topography and geology, and minimising earthworks, bridges and tunnels, whilst respecting overall railway alignment and operational requirements.

In looking to reinstate the railway these same criteria apply, heightened by 21st century expectations of travel time/convenience, and environmental importance/protection. 50 years of post closure developments must also be reconciled.

The following section provides an end to end route overview of how these issues might best be addressed, with more detailed route alignment drawings provided within Appendix A to this document.

It should be noted that whilst the identified route alignment has been engineered to a reasonable level of detail, it must be considered to be wholly indicative at this stage, where significant further investigation, optioneering, optimisation and development would be anticipated prior to any scheme being implemented.

Minor road and access crossings of the railway are not individually referenced within this route description, but all would need to be grade separated with bridge structures (see 3.2.1, in relation to the ORR’s “no new level crossings policy”), as indicated on the route drawings, and set out within the highway and bridge schedules, as included within Appendix C.

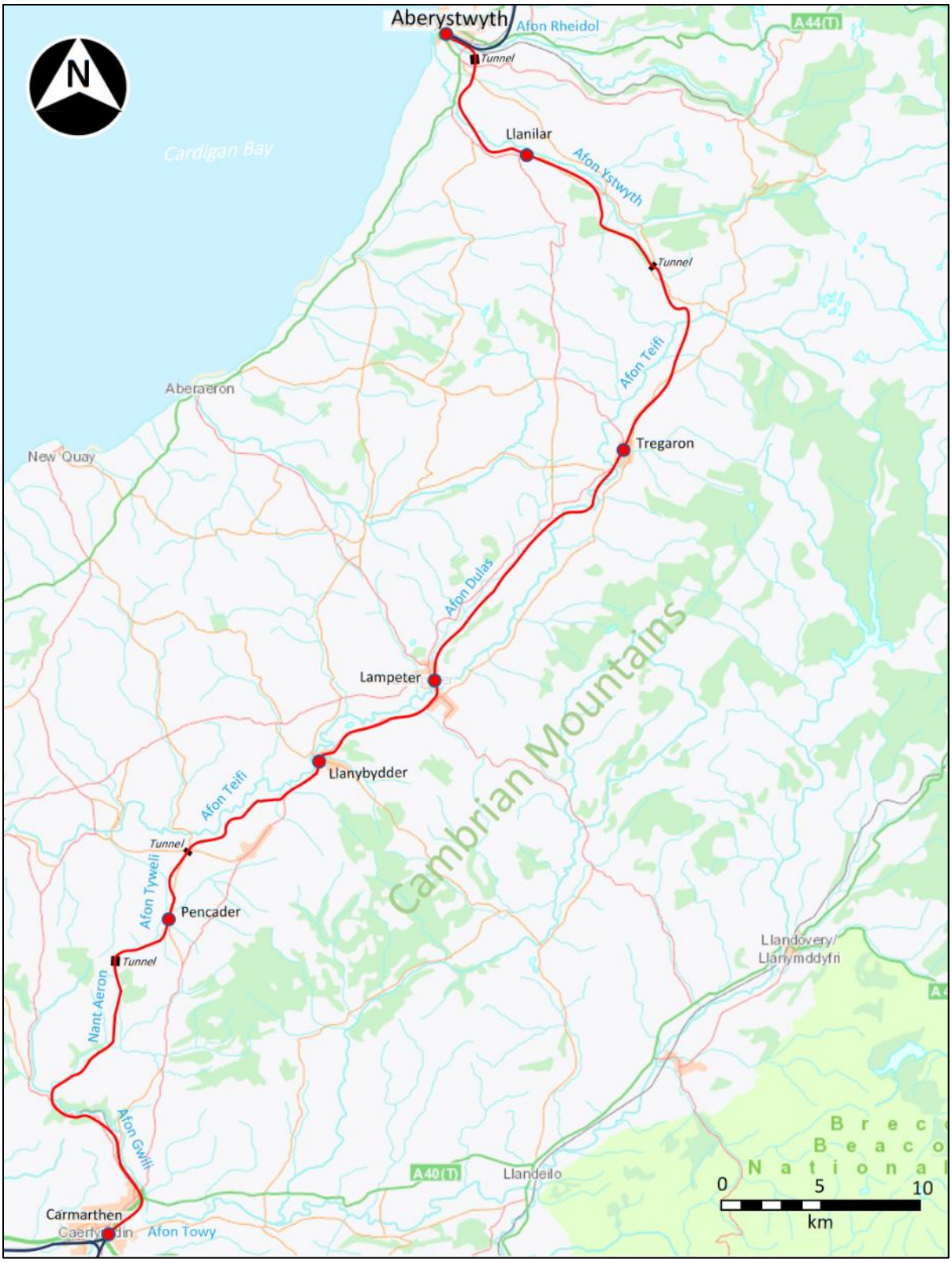


Figure 27: Route Overview by River Valley

4.1 Aberystwyth to Llanfarian (0.0 to 5.0 km)

Aberystwyth station previously had 5 platforms, but only Platform 3 is currently available for use by mainline trains. Dependent on service frequencies adopted, and general interactions between the Shrewsbury & Carmarthen trains up to two new platforms could be needed at Aberystwyth.

These could be provided by re-acquiring platforms 4 & 5 from the Vale of Rheidol Railway, and/or re-building platform 2 adjacent to the second track within the main station.

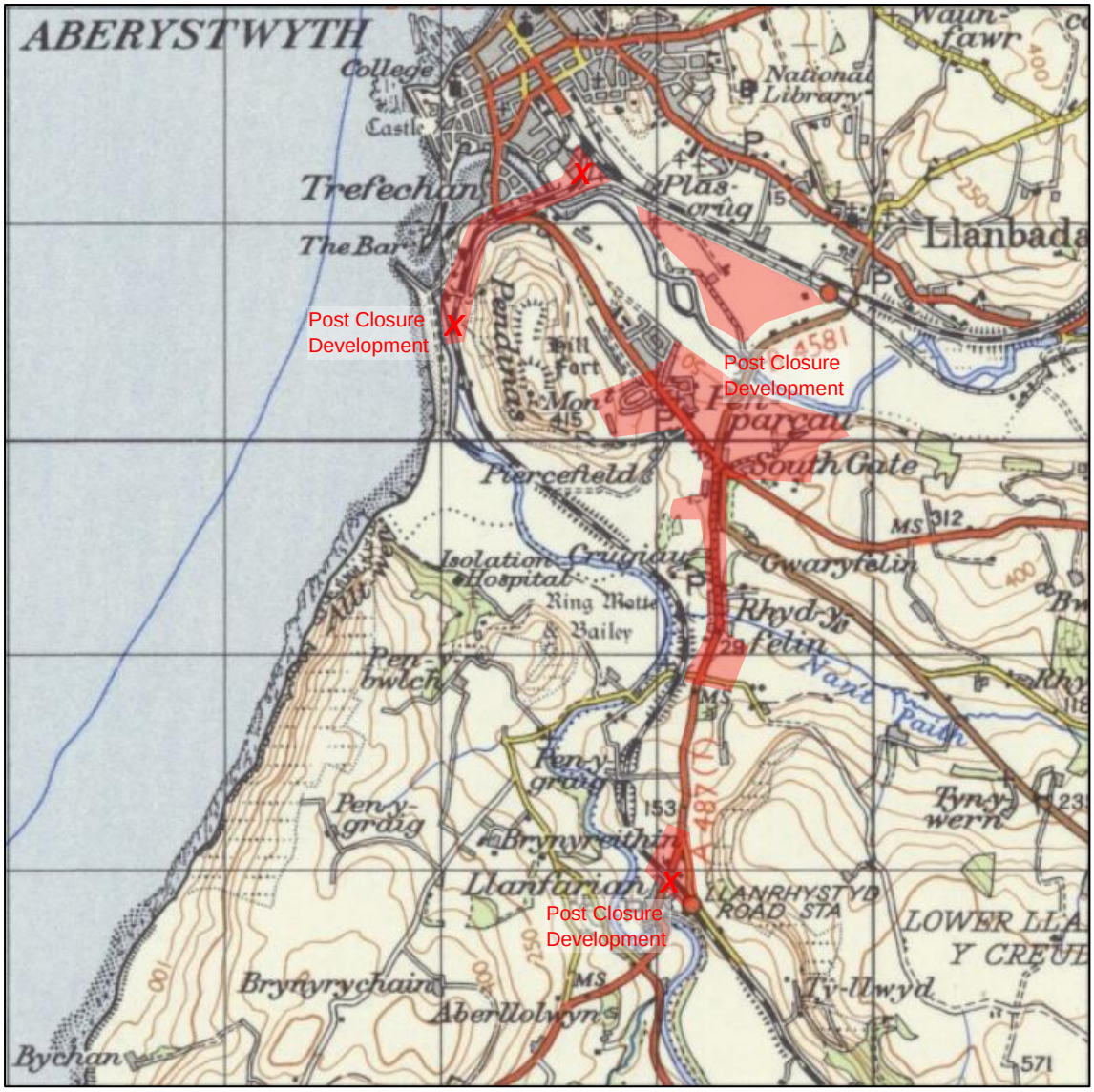
Photo 8: Aberystwyth Station Platforms

The existing railway corridor is reasonably unconstrained as it leaves Aberystwyth, and the reinstated railway to Carmarthen would share the alignment of the Cambrian Line up until it turns off to reconnect with the historic route.

The Cambrian line (to Shrewsbury) is the first line in the UK to be controlled with ERTMS (European Railway Traffic Management System), operating at Level 2 with in-cab signalling, and without lineside signal posts. This restricts use of the line to rolling stock that has been fitted with in-cab signalling.

Where the new service would most likely be provided by extension of Great Western mainline services, whose trains are not currently fitted with in-cab signalling, it has been assumed that lineside signalling would be reintroduced on shared length of the Cambrian Line, operating as an overlay to the current ERTMS control (further detail of railway signalling considerations is provided in section 3.3.1).

Map 1 below shows the historic route out of Aberystwyth, with the railway taking an immediate right turn out of the station, and crossing the Afon Rheidol to skirt around the western edge of Pendinas Hill, from where the route joined the Afon Ystwyth valley, via a series of embankments and cuttings.



Map 1: Historic Route out of Aberystwyth

(1952/1960 Ordnance Survey 1 inch to the mile maps reproduced by permission of the National Library of Scotland)

Reinstatement of the historic railway alignment is however considered to be untenable in regard to:

- Resulting need to demolish most/all of the residential properties on Felin-Y-Mor Road.
- Further significant property and access impacts on Penparcau Road, Gerddi Rheidol, and to Aberystwyth Town FC, the Army Reserve Centre and Aberystwyth Police Station.
- The need for grade separation (i.e. bridges and elevated approaches) within highly constrained locations across the A487 Penparcau Road and Park Avenue/Boulevard De Saint Brieuc Road.
- The growth of the village of Llanfarian across the historic/ideal railway alignment,

The specific alternative route proposed in the scoping study is also unlikely to be tenable, where the proposed tunnel route beneath through Pen Dinas hill, risks significant impacts on:

- Pen Dinas Camp Scheduled Ancient Monument
- Pen Dinas Local Nature Reserve
- Gweunydd Pendinas SSSI, and
- The Dyfi Biosphere

As the suggested route continues above ground to the north of Penparcau Road, further significant impacts are likely in regard to:

- The Aberystwyth Holiday Village, and adjoining residential properties in Penrheidol
- The Cylch Meithrin Nursery, and
- The Plascrug Community Primary School

Figure 28: Pen Dinas Tunnel Option *(Source: Previous Scoping Study)*

To these significant issues, further alternatives have been sought, with a more easterly route out of Aberystwyth subsequently identified, as shown in Map 2 below. This alternative route is also challenging, requiring the construction of a 1km tunnel, but would reduce direct impacts relative to the above.

Map 2: Alternative Route out of Aberystwyth

The proposed alternative route would follow the Cambrian Line for around a mile, before branching off to cross above the A4120 on a bridge. Continuing westwards across further bridge structures above the Vale of Rheidol Railway and the Afon Rheidol River.

Photo 9: Vale of Rheidol Railway Bridge across the Afon Rheidol

To avoid the Rheidol Shingles and Backwaters SSSI, the route then runs on embankment across the Aberystwyth Cricket Ground and Woodland Trust's Coed Geufron Woodland, from where it runs into tunnel through Southgate/Pen-Y-Banc Hill (See section 3.7. for further detail).

Photo 10: The North Side of Southgate/Pen-Y-Banc Hill

Photo 11: Nant Paith Valley looking Towards Llanfarian

To the south of the tunnel, the route crosses the Nant Paith Valley on embankment, before skirting the escarpment behind Llanfarian in side-long cutting to re-join the historic alignment within the Afon Ystwyth valley.

Photo 12: Route across the Llanfarian Escarpment

The route past Llanfarian would impact on woodland, and the gardens of around 15 residential properties, but has initially been preferred on the basis of best compatibility with the proposed route out of Aberystwyth, and in preference to what would most likely to be a visually and environmentally intrusive elevated route (i.e. on viaduct) across flood plain to the south-west of the settlement.

4.2 The Afon Ystwyth Valley (5.0 to 21.0 km)

From a high point behind Llanfarian the alignment would descend from the escarpment into the Afon Ystwyth valley, re-joining the historic alignment just before it crosses the river at Craig-Y-Bwlch on a replacement bridge.

Where much of the historic alignment has been incorporated into the Ystwyth cycle trail, the railway would be most economically reinstated by reclaiming and remediating what remains of the historic formation, with the cycle trail re-provided as close as is practicable alongside (see section 3.2.2.1 for further detail on general approaches to the 16.5km of affected cycle route).

Photo 13: The Ystwyth Cycle Trail near Llanilar

Where the remaining earthworks of the historic alignment form the western bank of the Afon Ystwyth for around 7km, it is clear that the naturally meandering course of the river was significantly straightened during the course of railway construction.

The repeated flood and scour damage to the railway was a direct consequence of this interaction, with the 1964 event at Llanilar ultimately precipitating the closure of the through route to Aberystwyth.

In order to reinstate the alignment over this length, specific measures would be required to reduce the susceptibility of the railway, which would include scour protection to the embankment, and possibly the raising of the alignment above a design flood level (to be determined, see section 3.6 for further details of general flood risk along the route).

Figure 29: Section of Raised Embankment within the Ystwyth Valley

Any such measures would need to take cognisance of the embankments de facto role as a flood defence to various properties in the valley, and in the avoidance of any significant detriment to the extent of the flood plain, or its flood attenuation properties.

Llanilar is likely to best be served by reproviding the station close to its historic location, taking over, or extending the car park that currently provides access to Ystwyth Trail (see section 3.2.4 for further detail of proposed intermediate stations).

As it turns away from the Afon Ystwyth to cross above the B4575, the route begins to climb along the valley side towards the old station site at Trawcoed. Given the steep topography, economic reinstatement would be dependent on making maximum use of the historic cuttings and embankments through this route length, and the Ystwyth cycle path would again be moved off-line.

Photo 14: Surviving Ivy Clad Abutment (right) of B4575 crossing

A number of residential properties have been built on and around the old Trawcoed Station site, and to the topographical constraints set out above, it is difficult to see how the old route could be economically diverted to a sufficient and appropriate extent for them all to remain habitable. Further work would be required to explore options at this site to determine the best alignment option, with the least overall impacts.

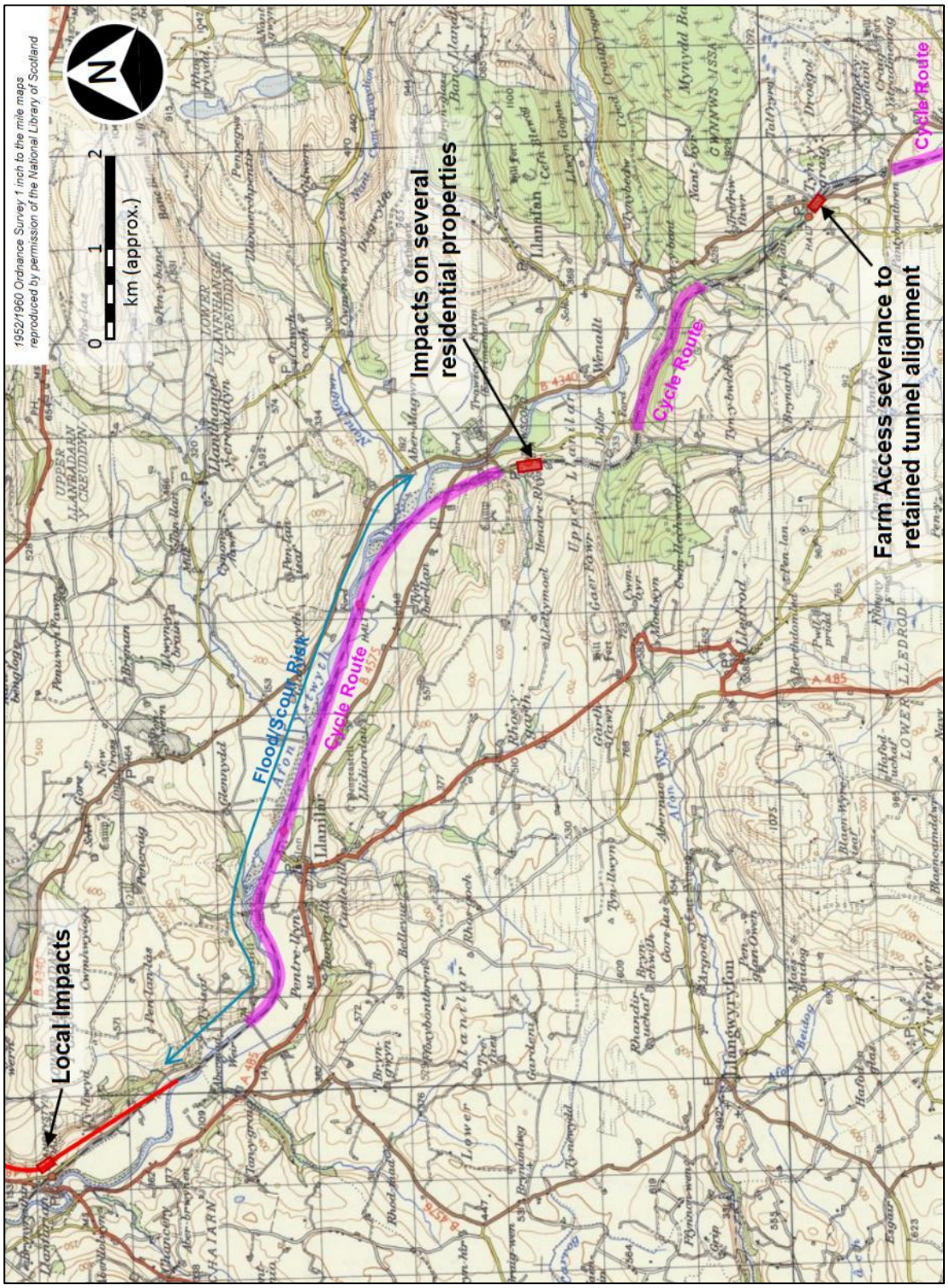
Photo 15: Residential Properties at the old Trawscoed Station site

At Tynygraig, impacts on the surrounding settlement, and the B4340, would be minimised by re-use of the 79m long Tynygraig Tunnel (Structure number AYT2/29m21ch). Internet sources (http://www.forgottenrelics.co.uk/tunnels/gallery/tynygraig.html), suggest the tunnel is well maintained

and in good condition, such that re-commissioning should be relatively straightforward, centred on the improvement of through drainage, and the reinstatement of the trackform.

Re-use of the tunnel would however result in the severance of an existing private access, and railway operation in close proximity to a number of residential properties.

Beyond Tynygraig the historic alignment is again followed, skirting the edge of the Cors Y Sychnant SSSI, before crossing beneath the B4340 to reach a high point on the watershed near Bryn Villa.



Map 3: Adoption of the Historic Route through the Afon Ystwyth Valley

4.3 Cors Caron (21.0 to 30.0 km)

From Bryn Villa, continued routing on the historic alignment is assumed, now descending into the catchment of the Afon Teifi, skirting south of Ystrad Meurig, before turning to cross the northern extremity of the Cors Caron National Nature Reserve.

Photo 16: Cycle Route on Historic Embankment near Ystrad Meurig

Having crossed to the eastern edge of the reserve, this is then followed in close proximity to the B4343 towards Tregaron. Around 7km of this route length (between B4340 and the B4343) has been taken over by the Ystwyth Cycle Trail, which would again need to be moved off-line.

Constructing the historic railway alignment across the deep peat bog of Cors Caron, proved to be a significant engineering challenge in the 1860s, with anecdotal evidence of on-going operational and maintenance challenges through to its closure in the 1960s.

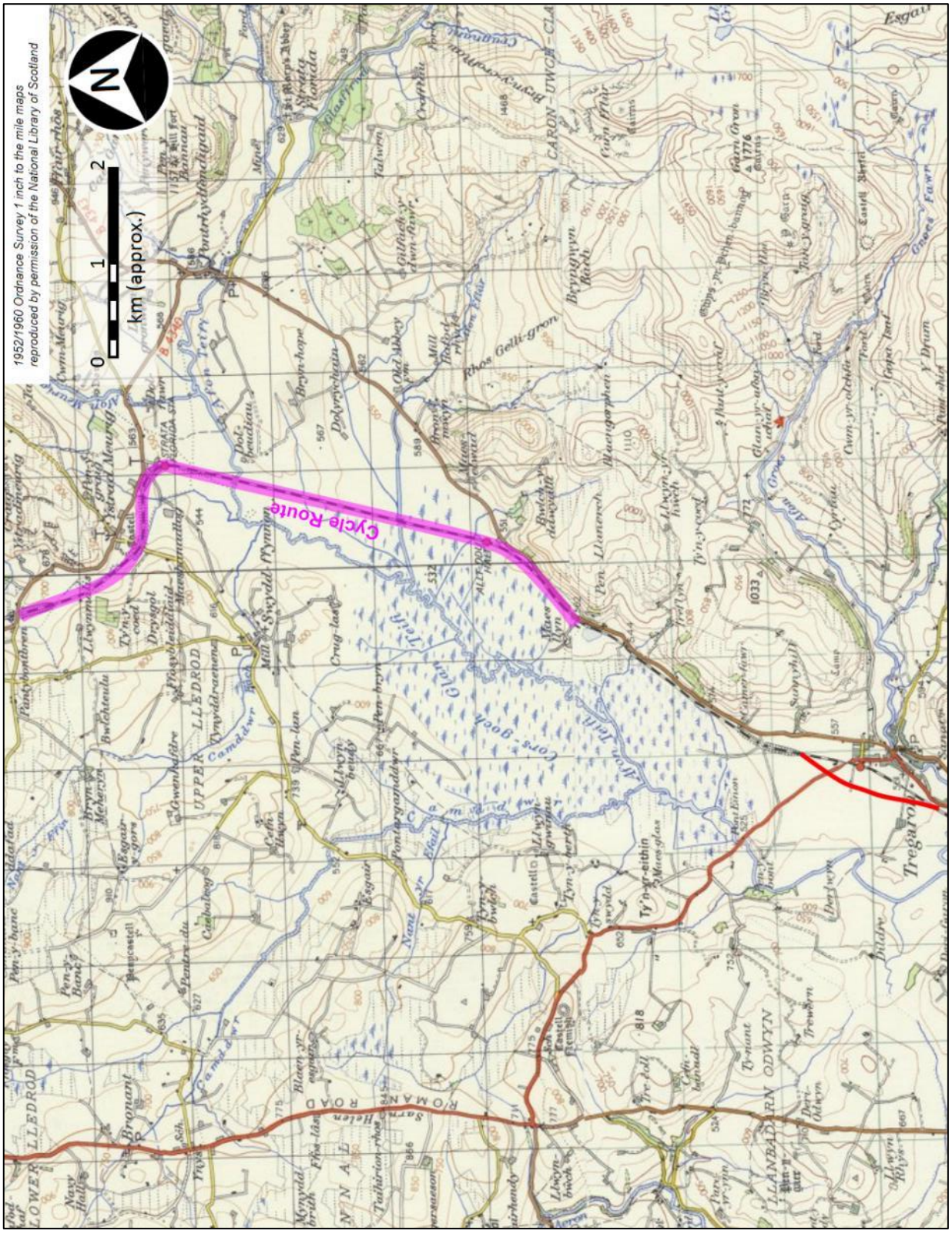
Photo 17: Cors Caron within the Afon Teifi Valley

Reinstating a modern railway on the old alignment would present similar challenges, heightened by the need to comply with current standards, whilst reconciling engineering needs against environmental requirements within what is an important and sensitive natural resource. This importance is reflected by Cors Caron's multiple statutory designations/protections as:

- A National Nature Reserve
- A RAMSAR Site
- A SSSI
- A Special Area of Conservation (as is the full length of the Afon Teifi)

Where topographical constraints make complete avoidance of Cors Caron practically impossible, and with the limited potential alternatives presenting a variety of challenges, retention of the historic alignment has initially been assumed on a 'least worst' basis in avoiding impacts on pristine bog.

Further commentary on the geotechnical issues related to this route section are provided within section 3.2.5 with parallel environmental issues set out within section 3.5.



Map 4: Adoption of the Historic Route past Cors Caron

4.4 Tregaron to Lampeter (30.0 to 46.0km)

To the immediate south of Cors Caron the historic route skirted the edge of Tregaron, with a station located in the northern part of the settlement. The section of the route within the town has since been covered over by a range of residential and commercial properties, but in the absence of any significant constraints the reinstated route would relatively simply be diverted to the west of the current settlement.

Where this diversion places the railway at some distance from the centre of Tregaron, the optimal site for the provision of a station has initially been identified as a site adjacent to the A485. This location has been selected in relation to its direct main highway access, and in initial preference to siting on the only other intersecting road, where this would direct station traffic past the Ysgol Henry Richards school.

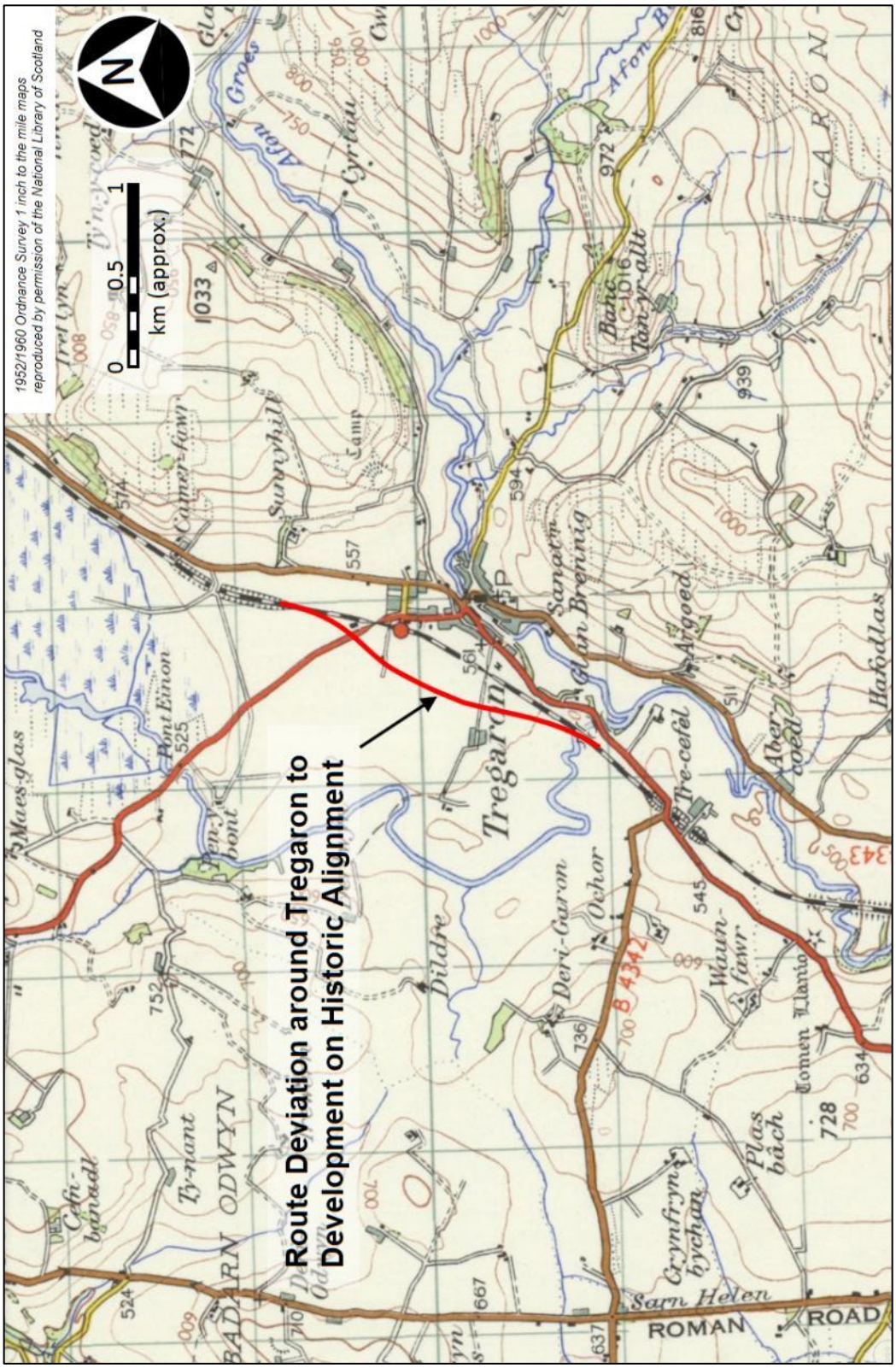
To the south of Tregaron the railway would rejoin the historic alignment as it crosses the Afon Teifi, requiring the re-alignment and grade separation of the A485 where the railway cutting has previously been backfilled to facilitate highway improvements.

The historic route appears to be largely unconstrained between Tregaron and Lampeter, and would be reacquired throughout this length. Running close to the Afon Teifi throughout, this would require the reinstatement of two bridges over the river, as well as scour and flood prevention measures.

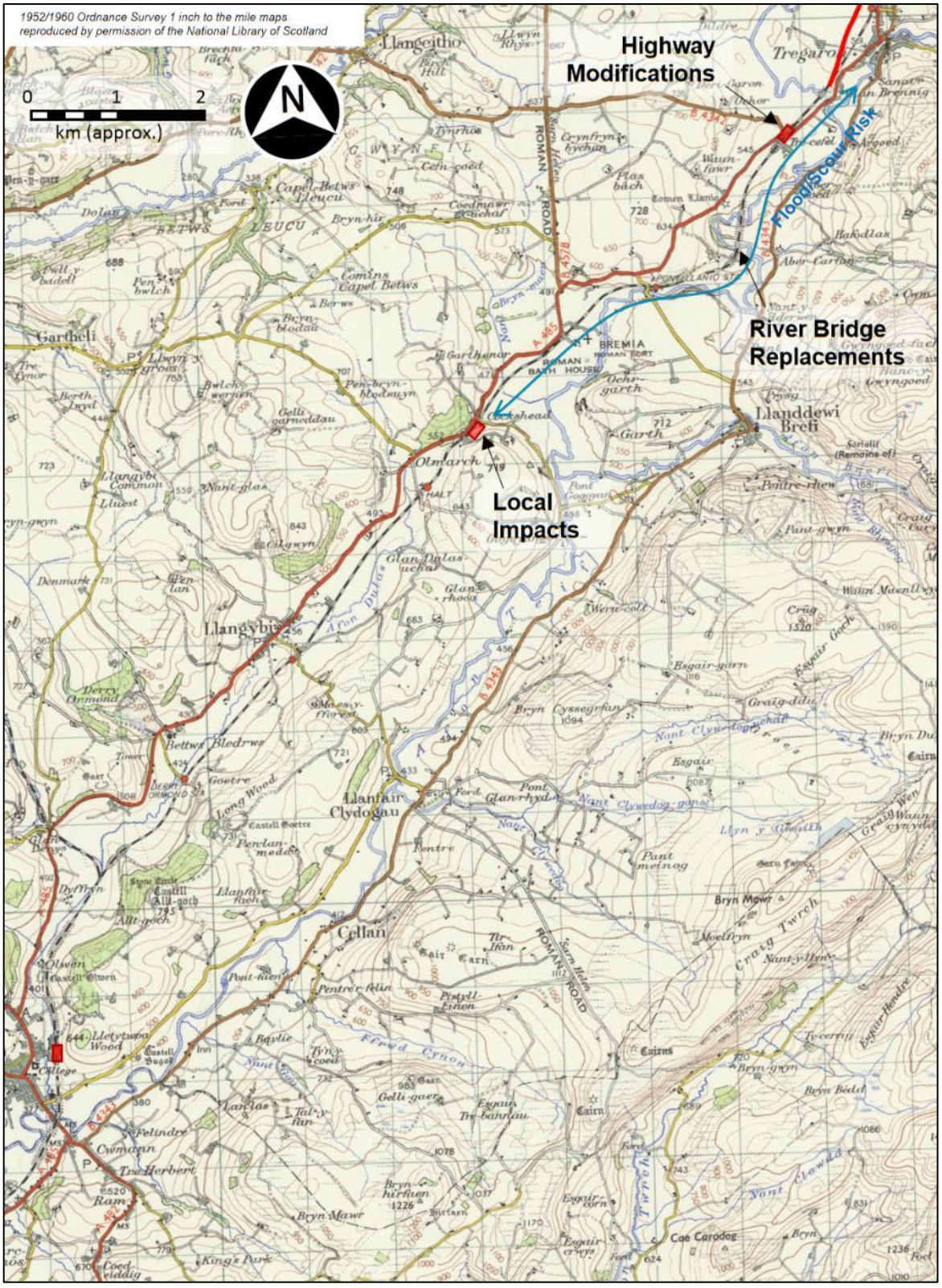
Near Olmarch the route leaves the main Teifi valley to join the smaller tributary valley of the Afon Dulas, which is followed into Lampeter. Through this length the route skirts the edge of a scheduled ancient monument (Bremia Roman Fort), whilst running through the Rhosydd Bryn-Maen SSSI, impacts and mitigations to both of which would need to be assessed and negotiated.

To more extensive agricultural use, public access to this part of the historic route is at its most limited, and it has not been possible to fully confirm the condition and availability of the old cuttings and embankments, although it is apparent that they have been removed/backfilled in some locations.

Various private accesses would need to be bridged above the railway, and a small number of residential and farm properties would also be impacted, where the reinstated railway would run in close proximity, and where it has been observed that several cuttings have been backfilled for use as farm compounds and residential gardens.



Map 5: Deviation to the Historic Route at Tregaron



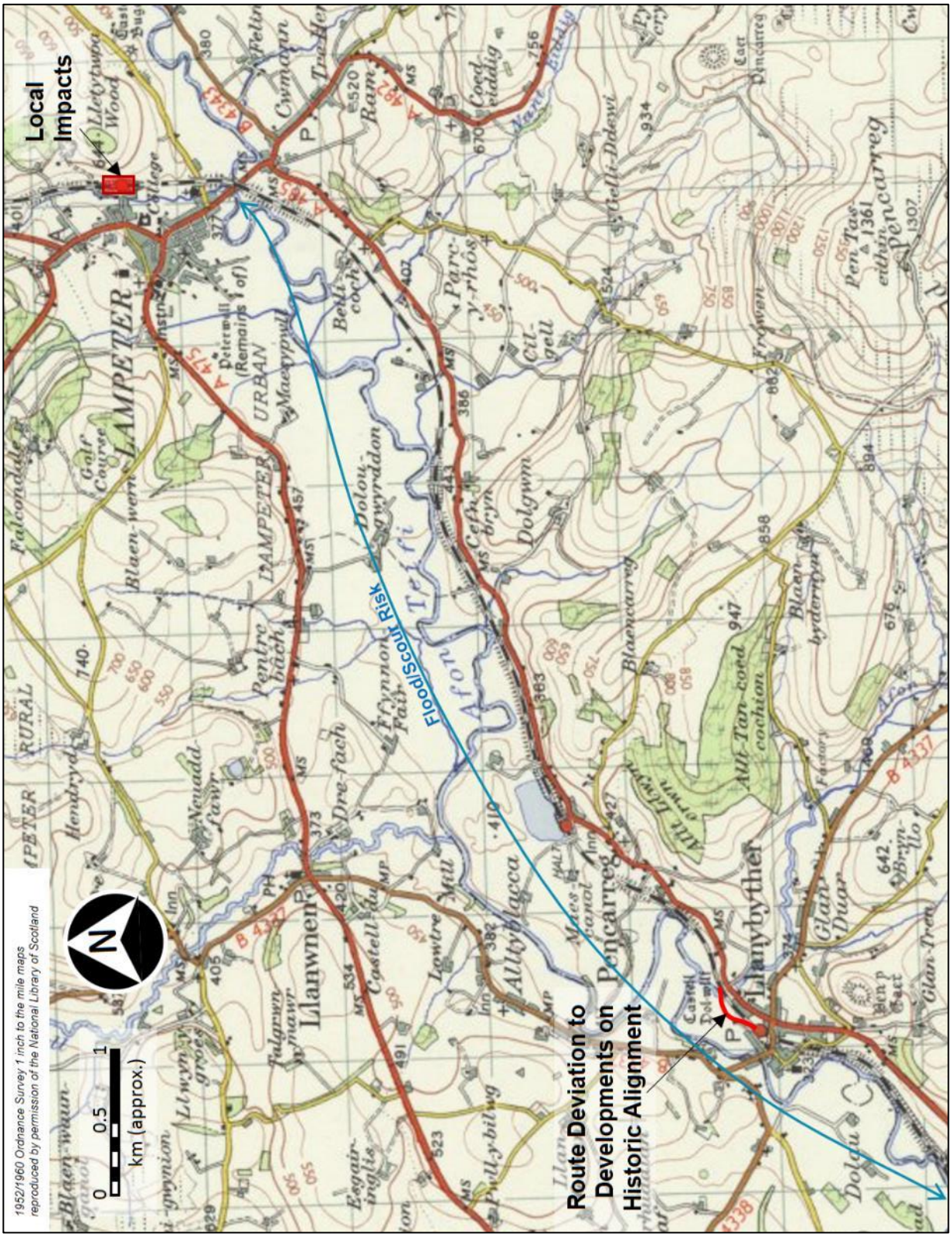
Map 6: Adoption of the Historic Route between Tregaron & Lampeter

4.5 Lampeter to Llanybydder (46.0 to 56.0km)

The historic route is largely unimpeded through Lampeter, other than the Kingdom Hall of Jehovah's Witnesses which occupies the site of the old station, and it has been initially assumed that the railway would reacquire the old alignment, with the Kingdom Hall reprovided on an alternative site. This would allow the new station to be accessed via Station Terrace, optimising connectivity with the town centre.

Photo 18: Passenger Service to Carmarthen leaving Lampeter in August 1963
(Photo by courtesy of Gerald T Robinson from his Flickr photostream*)*

Leaving Lampeter it is clear that the historic alignment would need to be raised across the A482 to maintain highway clearances, which would also require modification to the adjoining (and surviving) bridge over the Afon Teifi.



Map 7: Adoption of the Historic Route between Lampeter & Llanybydder

Photo 19: A482 & Afon Teifi Crossings Near Lampeter (Alignment to be Raised)

To the south of Lampeter the historic route rejoins the Teifi valley, and could be readopted subject to grade separation of a small number of private accesses, and measures to protect from flood and scour, where the route runs in close proximity to the river.

The historic route into Llanybydder is blocked by the Dunbia Abattoir and various other commercial and residential properties. At the expense of the relocation of transport and builders yards, an alignment does however seem to be available that would connect through the old central station site, which is currently occupied by a public car park, and car dealership.

Photo 20: Llanybydder Old Station Site

Re-provision of a station at its historic location, would clearly optimise connectivity to the town, and it is initially envisaged that the station would take over the car dealership access, which would also provide a revised access to properties to the east of the railway, allowing the Teras Yr Orsaf road to be stopped up where the reinstated railway crosses it (see section 3.2.2.2 for further details).

Heading south from the new station, the B4337 would be reinstated on a bridge above the railway, with the adjoining residential garden and the edge of the cattle market yard reclaimed to connect back into the historic route out of the town to the south.

Photo 21: Freight Train passing Llanybydder towards Carmarthen in August 1963
(Photo by courtesy of Gerald T Robinson from his Flickr photostream*)*

Where routing through the town would place the railway in close proximity to a number of residential properties, an alternative route to the west of the town was also considered, but is non-preferred in the absence of an appropriate station site, environmental/engineering challenges and costs of routing across the alluvial plain, as well as broadly equivalent residential property impacts.

Photo 22: Llanybydder – Readopted route towards Carmarthen today

4.6 Llanybydder to Pencader (56.0 to 68.0km)

South of Llanybydder the historic route would again be adopted as it continues along the Teifi valley, grade separating the various intersecting road crossings via either reinstated, or new over/underbridges.

Photo 23: Railway Underbridge Abutment near Henfaes (alignment to be raised)

At Llanfihangel-ar-Arth the historic route climbs to cross the watershed into the Afon Tyweli valley via a surviving 100m long tunnel beneath the B4336. Whilst the embankment approach into the village survives, its re-use is problematic in achieving a grade separated crossing above the B4459, whilst a number of residential and commercial properties have also been built on top of it. A minor deviation between properties to the north-west is therefore proposed, allowing the railway to bridge above the B4459, before running around the western edge of the settlement to reconnect with the northern tunnel portal cutting, which would need a minor amount of widening/re-alignment.

Photo 24: Llanfihangel-Ar-Arth tunnel from the Southern Portal

A similar small scale re-alignment of the southern portal cutting would also be required to avoid the Bro'r Orsaf road. It is noted that whilst these two re-alignments avoid any loss of residential property, the reinstated railway would still run in close proximity to a number of residences within the village.

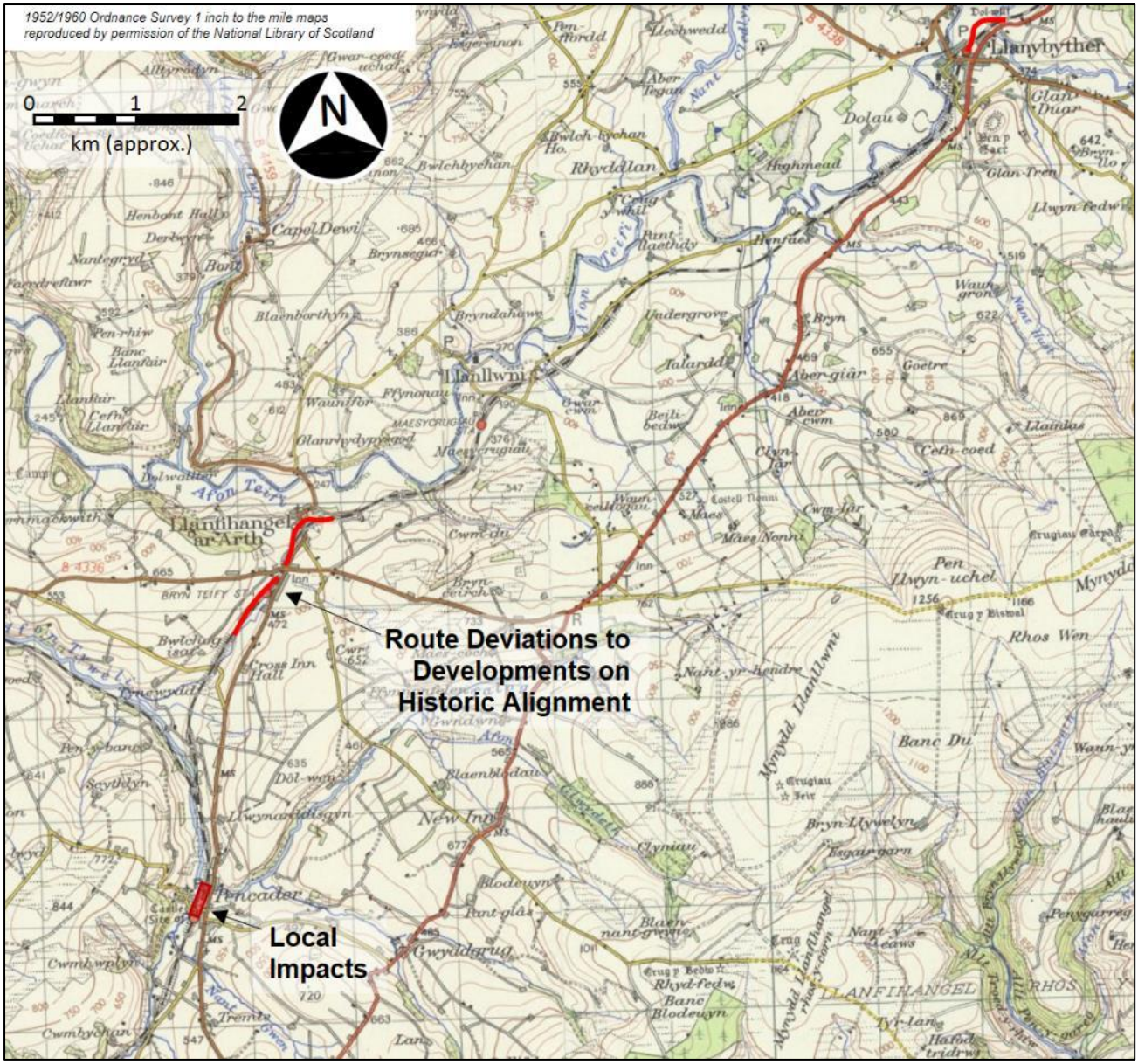
Observation from the southern portal suggests that the tunnel itself is well maintained and in good condition, such that re-commissioning should be relatively straightforward, centred on the improvement of through drainage, and the reinstatement of the trackform.

At Pencader the step sided narrow valley, a scheduled ancient monument (Castell Pencader), and other existing properties, make reinstatement of the railway on its historic alignment the only realistic choice.

Where around 100m of the historic embankment through the village has previously been removed to facilitate development, this would need to be reinstated. This would require the demolition of at least 6 of the 10 properties within the Bro Castell cul de sac, as well as the reduction of a number of residential gardens, and the chip shop car park.

Photo 25: Retained Route & Development on Missing Embankment through Pencader

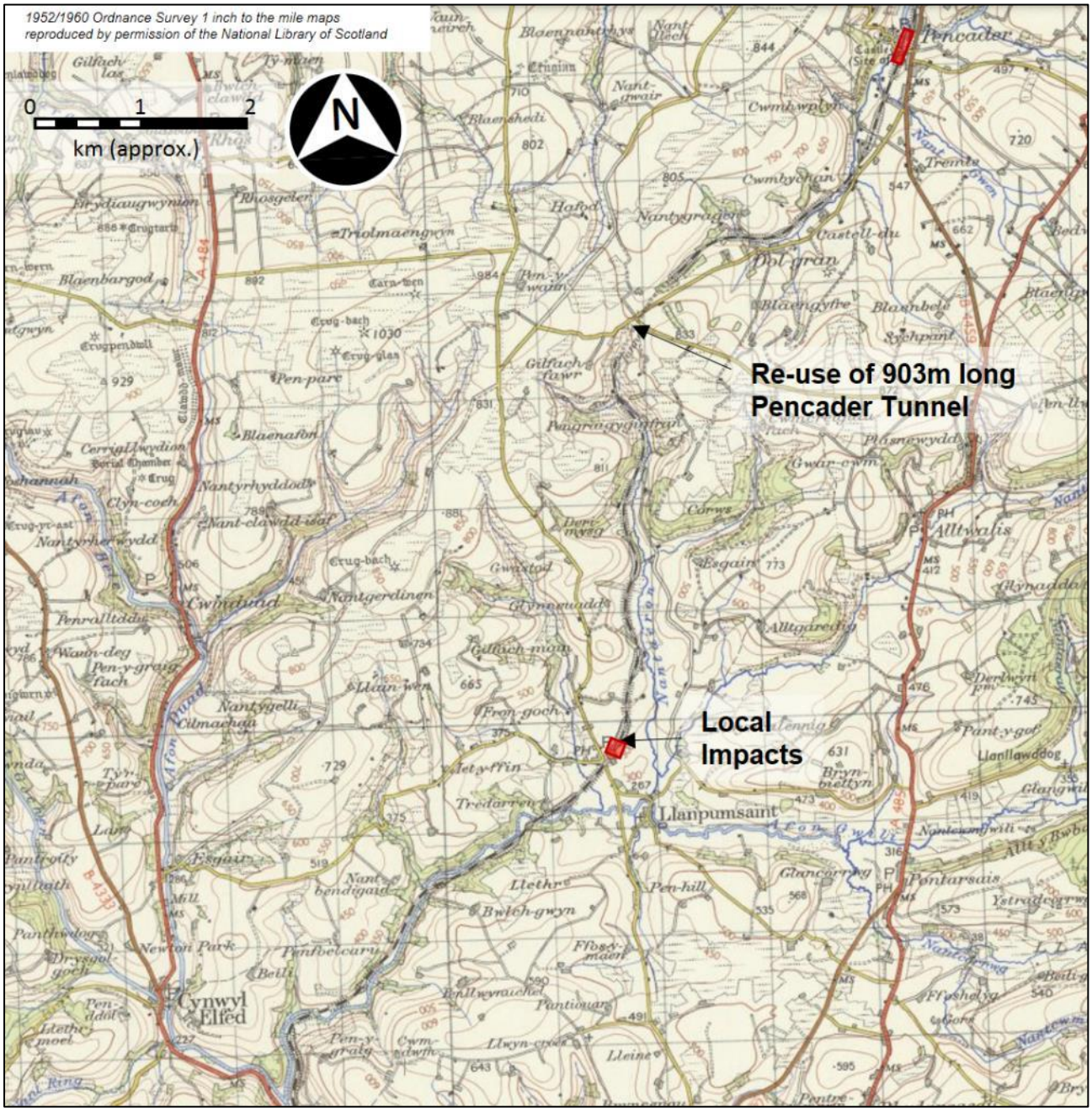
To the south of Castle Road, a new station would be provided by reclaiming the historic site off Station Road, which is currently used as a lorry park.



Map 8: Adoption of the Historic Route between Llanybydder & Pencader

4.7 Pencader to Carmarthen (68.0 to 91.2km)

South of Pencader the historic route is retained, and continues to rise towards the 903m long Pencader Tunnel. Observation from the southern portal, and Internet source (http://www.forgottenrelics.co.uk/tunnels/gallery/pencader.html), suggest the tunnel is well maintained and in good condition, such that re-commissioning should be relatively straightforward, centred on the improvement of through drainage, and the reinstatement of the trackform.



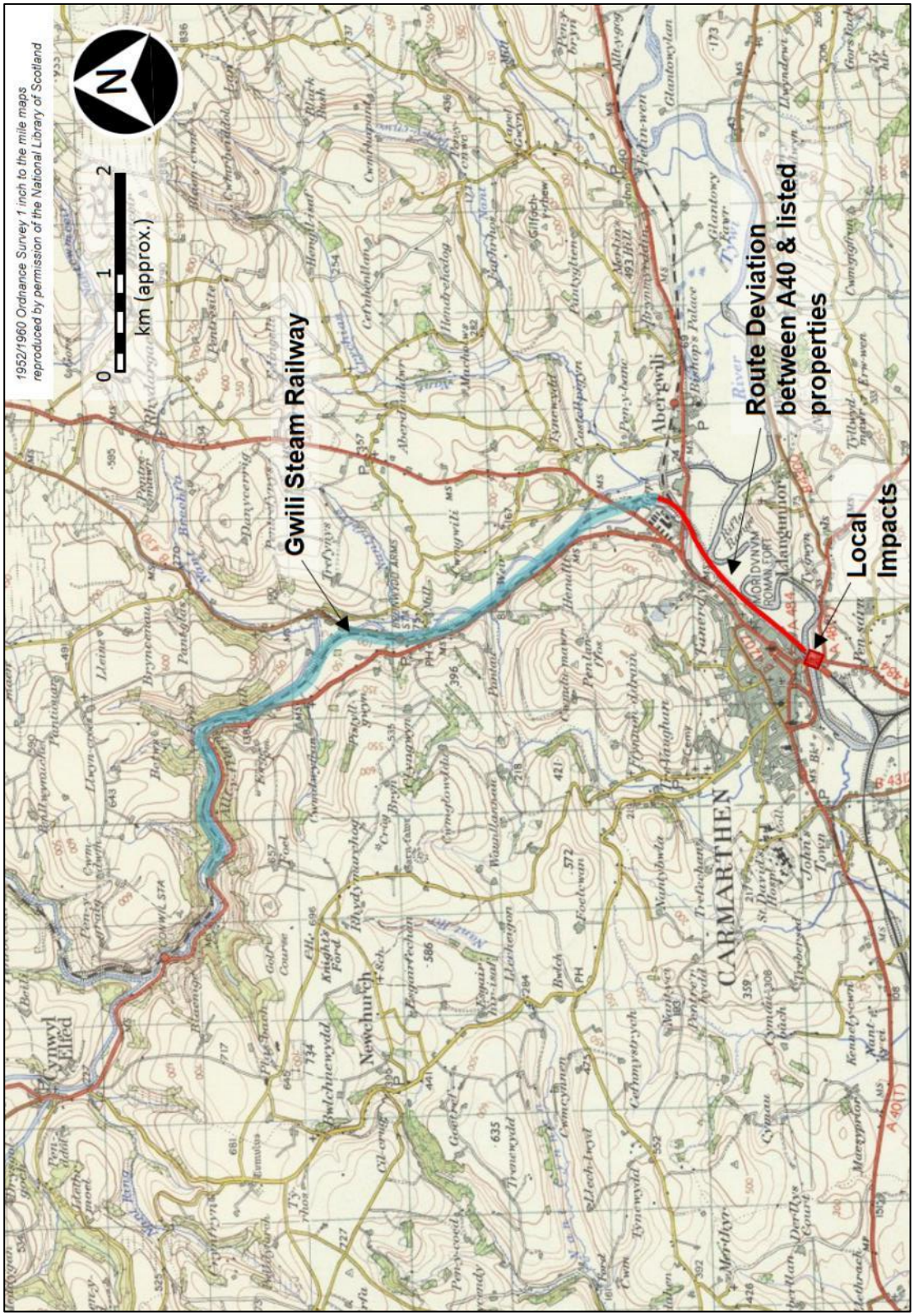
Map 9: Adoption of the Historic Route between Pencader and Cynwyd Elfed

At 903m the Pencader Tunnel is of comparable length to the proposed new Pen-Y-Banc tunnel near Abersytwyth, and to modern safety standards may require the installation of forced ventilation for smoke control in the event of an in tunnel fire. If the predominantly broad gauge profile allows, this may most economically be provided by use of in tunnel jet fans, but alternative provisions at the portals, or within the historic ventilation shafts may also be considered.

Photo 26: The Southern Portal of the Pencader Tunnel

South of the tunnel the historic route follows the Nant Aeron and Gwili valleys to the outskirts of Carmarthen, and is unobstructed other than in regard to an extended garden in Llanpumsaint, and the Gwili Steam railway, which currently operates over a 7.2km long preserved length of the historic route.

Photo 27: Wooded Embankment near Skanda Vale



Map 10: Adoption of the Historic Route between Cynwyd Elfed and Carmarthen

Photo 28: Retained Underbridge at Llampumsaint/The Railway Arms

Where the steam railway currently operates across two levels crossings, the higher speeds and frequency of the reinstated passenger trains would require these to be closed, with an alternative bridge crossing provided.

Photo 29: Gwili Railway Level Crossings

The historic route (as currently occupied by the steam railway) would be retained to the outskirts of Carmarthen, where the historic alignment has been taken over by the A40 dual carriageway.

Photo 30: Route Adjacent to the A40 around Carmarthen

Thereafter modifications to the Aber Gwili Road overbridge abutment, marginal land and car parks along the western edge of the A40 would be required to negotiate a narrow residual corridor between the A40 and nearby residential properties to connect to the location of the original location of the Afon Towy railway crossing. As this would include the removal of highway noise bunding, alternative noise abatement fencing is likely to be required.

The Afon Towy railway bridge would be reinstated (in modern form) at its historic location. It has been assumed that the River Towy crossing would be a multi span structure with three piers sunk into the river and standard U-frame sections spanning between these.

This bridge layout is quite obtrusive to the flood plain due to the number of piers, and it may be preferable/necessary to instead provide a landmark structure which would be able to span the full width of the river without ‘in river’ piers. Detailed flood risk modelling would be required to fully resolve this choice (see section 3.6.6.2 for further consideration of flood risk issues at this location).

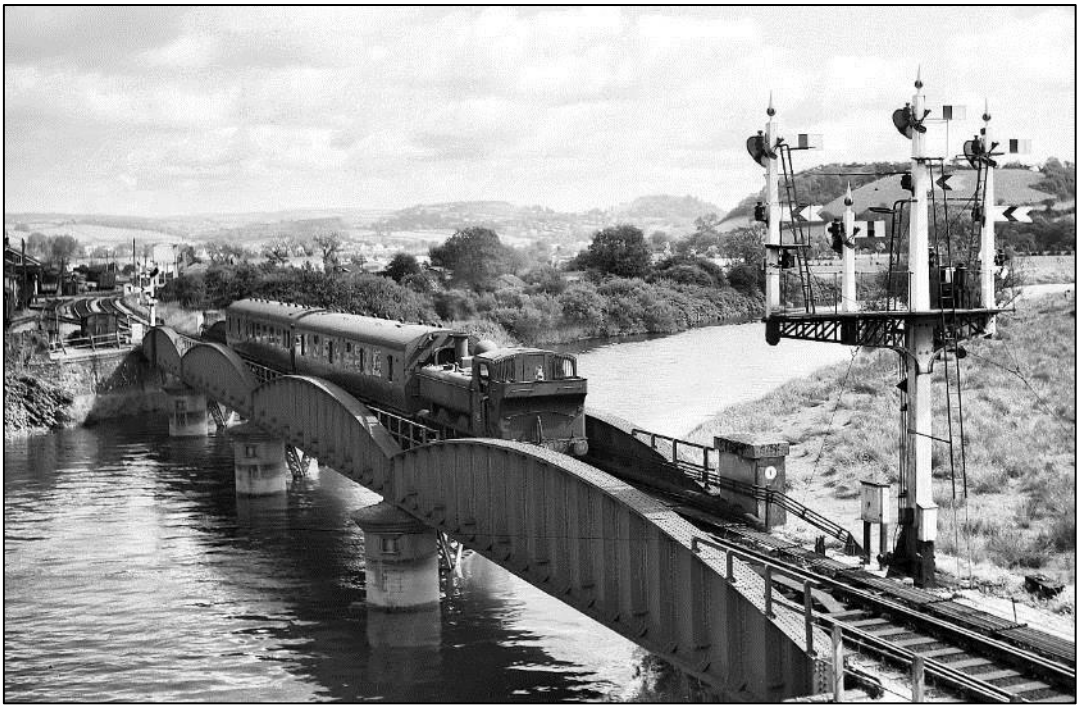


Photo 31: The Former Afon Towy Railway Bridge in 1962
(Photo by courtesy of Gerald T Robinson from his Flickr photostream)

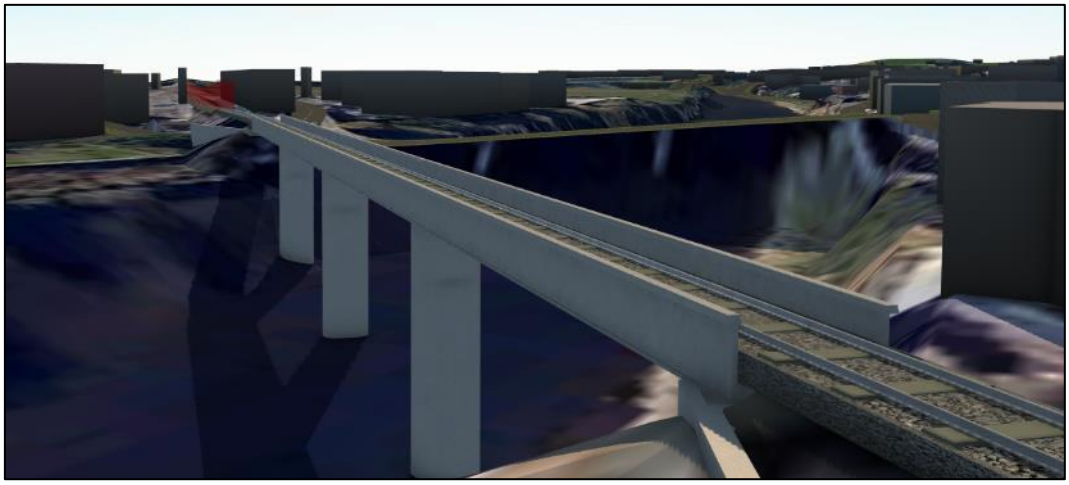


Figure 30: Replacement Afon Towy Bridge

The alignment of the railway bridge would also need to be raised to pass above a circa 2m high flood defence wall, which was built on the south bank of the river in the 1980s.

Unfortunately this raised alignment is incompatible with the southern approach to the A484 Carmarthen Road bridge, and the link bridge structure which currently carries the road above the railway would have to be removed, if a through connection to the mainline railway is to be provided.

Photo 32: Railway Vertical Alignment Conflict with Flood Wall and A482 Link Bridge

The Grade 2 listed Carmarthen Bridge would therefore be closed to through road traffic, other than in connection with the railway station and its surrounds.

Whilst this may present an opportunity to provide a more attractive pedestrian link between the town and the station, the A484 link into the town is heavily used, and the acceptability of closure would need to be explored through detailed traffic modelling.

To the risk that alternative routes may not be able to cope with the additional traffic, an outline scheme for the provision of an additional road bridge to the west of the old Carmarthen Bridge has been developed (see section 3.2.2.2 for further details).

Beyond the Towy bridge crossing the route would connect onto the existing mainline railway and station, to allow through running of services to Swansea, Cardiff and beyond.

To initial operational considerations (see section 3.4), it is unlikely that the existing two platform station would require enhancement to accommodate the Aberyswyth services, other than in the provision of passenger overbridge, in elimination of the current track level crossing.

Photo 33: Carmarthen Station

5 Capital Costs

Chandler KBS was separately engaged by TfW to undertake an assessment of the costs of the works associated with reinstating the railway between Aberystwyth and Carmarthen as set out within this report, and its supporting documents.

A cost plan report (as the principal output of this assessment) is provided as Appendix F, from which a total cost build-up of **£775m (@Q4 2017 prices)** is summarised in Table 8 below.

Table 8: Outline Cost Estimate

Ref	Group Element	Total Cost
1	**Direct Construction Works**	
1.01	Railway Control Systems	£27,600,000
1.02	Train Power Systems	£0
1.03	Electric Power and Plant	£2,807,106
1.04	Permanent Way	£57,131,671
1.05	Operational Telecommunication Systems	£2,570,510
1.06	Buildings and Property	£7,219,000
1.07	Civil Engineering	£174,141,236
1.08	Enabling Works	£16,142,080
	Direct Construction Costs	**£287,611,602**
2	**Indirect Construction Costs**	
2.01	Preliminaries (25%)	£71,902,901
2.02	Design Team (12%)	£34,513,392
2.03	Overheads and Profit (10%)	£28,761,160
	Indirect Construction Costs	**£135,177,453**
	Construction Cost	**£422,789,056**
3	**Employer Indirect Costs**	
3.01	Project Management (8%)	£33,823,124
3.02	Compensation: TOC & FOC	£100,000
3.03	Network Rail Sponsorship	£2,700,000
3.04	ASPRO Asset Management & Protection	£500,000
3.05	Land & Compensation	£38,223,088
	Employer Indirect Costs	**£75,346,213**
	Total Direct, Indirect and Employer Indirect Costs	**£498,135,269**
4	**Other Project Costs**	
4.01	Network Rail Fee Fund	£500,000
4.02	Network Rail Industry Risk Fund	£200,000
	Other Project Costs	**£700,000**
	Total Excluding Optimism Bias	**£498,835,269**
5	**Optimism Bias**	
5.01	Optimism Bias	£276,019,772
	Total Risk	**£276,019,772**
	Total Cost Limit @ Q4 2017	**£774,855,041**

Source: Chandler KBS

5.1 Assumptions and Exclusions

The cost estimate is informed by the findings of this feasibility study, supplemented by a range of assumptions, as are set out within the Chandler KBS Cost Plan Report (As Appendix F). The following costs are excluded from the estimate:

- Future price escalation.
- Environmental/ ecological protection works.
- Items/ areas of archaeological interest.
- Compensation to petrol station at Carmarthen.
- Works to listed buildings and structures.
- Treatment/ eradication of invasive species.
- Land purchase associated with the relocation of the Gwili Railway.
- Utilities costs.
- Alterations that may become necessary due to the requirements of planning authorities or other statutory requirements.
- Finance costs.
- Development costs.
- Disruption costs incurred by third parties.

Reference should be made to the Chandler KBS Cost Plan Report for a more comprehensive explanation of the basis of this cost assessment, and its related assumptions, exclusions and risks.

5.2 Application of Optimism Bias

The level of accuracy of the cost estimate is directly constrained by the current limits of the technical studies; the absence of detailed surveys, investigations and impact assessments; and works scope uncertainties in advance of full engagement with, and appropriate resolution of, local and statutory stakeholder interests and requirements.

Considering these issues, it has been assessed that the scheme is currently at a level of maturity of TfW Plan of Work Stage A, and a general Optimism Bias allowance of 66% has therefore been applied in accordance with current DfT guidance for Rail Assessment (n.b. Permanent Way and Earthworks cost elements are only uplifted by 40%, to reflect a lower level of perceived risk).

6 Economic Appraisal

Where the previous sections of this report have considered the technical feasibility, and principal options, for reinstating a modern heavy railway link, and attractive passenger rail services between the towns of Aberystwyth and Carmarthen, an assessment can now be made of the economic benefits that would be accrued from these provisions. These can then be compared with the assessed capital and operating costs to advise the overall economic case for scheme delivery.

The following provides an understanding of likely demand and revenue levels, based on assumptions around likely levels of service, and an associated estimate of the Present Value of Benefits (PVB).

Photo 34: Cambrian Line Service approaching Aberystwyth

The PVB estimate is then used to provide an indication of the likely Present Value of Costs (PVC) which would achieve Benefit:Cost Ratios (BCRs) of a predefined threshold, and a quantified input to the assessment of Value for Money (VfM).

To undertake the demand and revenue forecasting it was necessary to have a set of agreed scheme inputs, which, for this study, encompass the:

- Location of new/re-opened stations;
- Indicative frequency of service (trains per hour (tph) on an average weekday), recognising that any final decision on a preferred level of service is iterative, with ambitions to operate higher frequencies requiring additional capital infrastructure spend;
- Stopping pattern (if not all stations);
- Sectional Running Times (SRTs) between all stations on the newly re-opened sections of line;
- Indicative fare levels by market segment (Season (S), Full (F), and Reduced (R)); and
- End points of the service (e.g. would the service operate as standalone shuttle between Aberystwyth and Carmarthen or as an extension to existing services which currently, or could, terminate at either of these two stations).

For forecasting it is also necessary to understand the extent of any abstraction from existing stations [to the new stations], and the likely distribution of new trips and reassignment of existing rail trips, e.g. Aberystwyth to West or South Wales.

For the economic appraisal, it was also necessary to:

- Establish the current Do Minimum (DM) scenario for comparison against, e.g. rail-heading to Carmarthen /Aberystwyth by car or bus; and
- Convert the likely distribution of demand into equivalent road and area types for the estimation of Marginal External Cost of Car (MECC) use benefits [from mode shift to rail].

  Abstraction from different road and area types carry different MECC values, based on data obtained from the National Transport Model) and summarised in the Department for Transport (DfT) Transport Analysis Guidance (TAG).

In this initial introductory section core assumptions for the demand inputs are described. Subsequent sections then describe the methodology and outputs in more detail for:

- Demand forecasting;
- Cost estimates; and
- Economic appraisal.

6.1 The Appraised Scheme

6.1.1 New Stations

As set out in 2.17, the following stations have been assumed to be added to the National Rail network:

- Llanilar;
- Tregaron;
- Lampeter;
- Llanybydder; and
- Pencader.

The locations for these stations are shown in Figure 31, and are assumed to be at, or very close by, the original station locations prior to the line's closure in the 1960s.

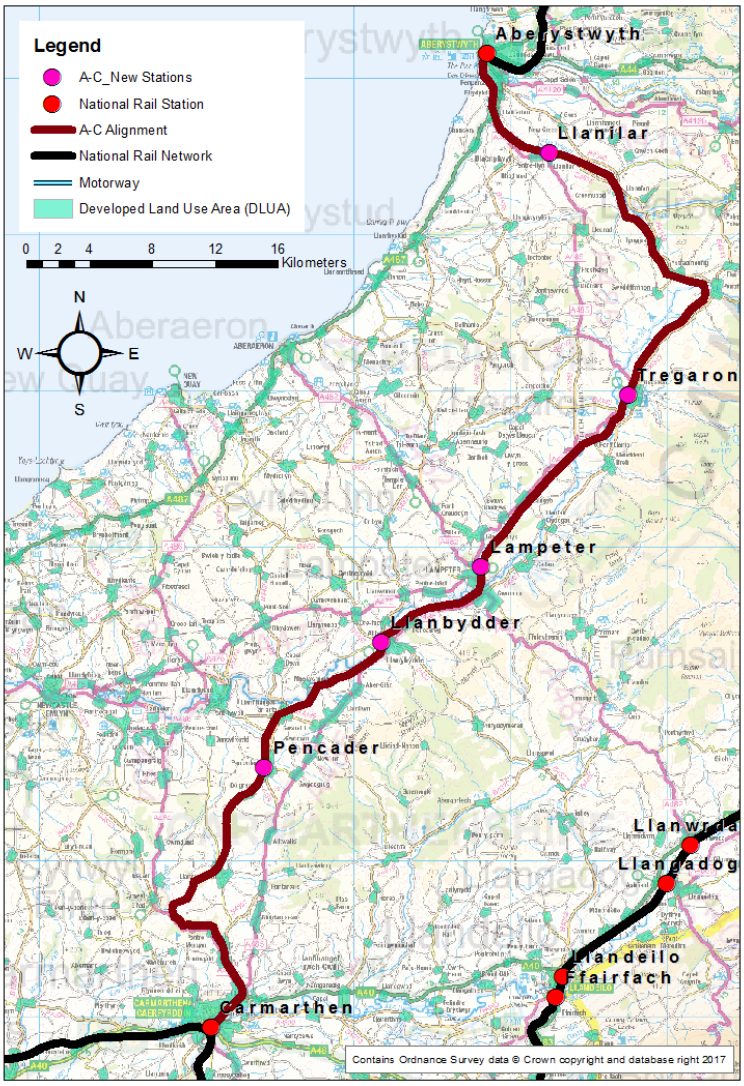


Figure 31: Route & Stations for Appraisal Purposes
(Source: Mott MacDonald)

6.1.2 Service Pattern

6.1.2.1 Frequency of Service

Reflecting the requirements set out under 2.14, the following service frequency scenarios were identified for assessment:

- **Do Something (DS) 1** – 0.5 tph in each direction (120 minute service interval);
- **DS2** – 0.67 tph in each direction (90 minute service interval); and
- **DS3** - 1 tph in each direction (60 minute service interval).

It has been assumed that all services would call at all stations. SRTs were provided by bespoke operational analysis for the route, and considered alternative rolling stock types (As 3.4).

Where the end-to-end (Aberystwyth – Carmarthen) total running time exceeds 80 minutes (indicative values based on latest operational analysis and rolling stock assumptions suggest this is likely), two sensitivity tests have been undertaken showing the incremental effect on demand, revenue, and benefits from notional 20 minute Journey Time Improvement (JTI) as tests DS1a to DS3a (e.g. to a 65 minute end-to-end In-Vehicle Time (IVT)).

It should be noted that these JTI outputs are entirely notional, and should not be taken to infer that such improvements are either feasible or affordable in regard to the alternative infrastructure, rolling stock, or other provisions that would be required to facilitate them.

6.1.2.2 Integration with Existing Services

Following analysis of the existing timetable, it has been assumed that it would be possible to join the majority of the Aberystwyth – Carmarthen services with existing services which terminate at Carmarthen or another terminus in West Wales, reducing interchange requirements and making the level of service more comparable with similar stations in the region.

For practicality, it has been assumed these are current workings from Manchester Piccadilly, via Cardiff, and Swansea, to West Wales. This was based on the assumption that connections beyond Carmarthen to Swansea, Cardiff, and England are likely to be the main source of economic benefits.

The current timetable necessitates that at the highest frequency of service (60 minute interval in DS3), there would be a requirement for a number of infill ‘shuttle’ services between Aberystwyth and Carmarthen (and vice versa).

It has been assumed that there would be no onward running north or east of Aberystwyth, (i.e. no integration with Birmingham International-Aberystwyth services). Whilst indirect connection benefits would still be accrued for travel beyond Aberystwyth (to the north & west), at least one interchange penalty would therefore remain.

As there are no service extensions from other stations such as Swansea or Llanelli there was no need to code additional frequency improvements into MOIRA and extract associated DM and DS Generalised Journey Times (GJTs), or estimate the associated operating costs.

6.1.3 Average Fare Levels

Existing MOIRA OR24 revenue and journey data was interrogated to provide a set of average fare estimates (Revenue per Journey (RpJ)) for the S, F, and R segments using comparable stations in West Wales, adjusted, where appropriate to reflect the distances for the new stations.

6.1.4 Opening and Modelled Years

For the purpose of assessment, the following has been assumed:

- An opening year of 2024; and
- Forecast years of 2027 and 2037.

6.2 Demand Forecasting

6.2.1 Overview

There are three discrete markets which required separate consideration in the demand forecasting, namely new rail demand generated by the scheme:

- At new stations;
- Between Carmarthen and Aberystwyth, and vice versa; and
- Between Aberystwyth and destinations in South and West Wales, and beyond in England where the re-opening would facilitate a better level of service than the existing routing via Shrewsbury or Birmingham.

6.2.2 New Stations

For this stage of scheme development, a trip rate based approach for the new stations has been employed.

A set of comparator stations were selected for the new stations from existing stations in the West Wales area. This was extracted from Office of Rail & Road (ORR) station usage statistics[1] and demand data from MOIRA OR24 for:

- Milford Haven;
- Haverfordwest;
- Whitland;
- Johnston;
- Narberth;
- Kidwelly;
- Clarbeston Road; and
- Clunderwen.

Under this approach, demand at stations is within a given geographic area where other factors[2] can be considered largely comparable/consistent, assumed to be a function of:

- Local population and employment;
- Proximity of addresses to the stations, as a proxy for accessibility;
- Rail levels of service; and
- Competition between stations (driven by accessibility and rail level of service).

The selected comparator stations have some defining characteristics, namely:

- The role of Haverfordwest as an attractor (i.e. destination for surrounding communities), and also serving a wider catchment for rail-heading purposes;
- Lower trip rates at Johnston, likely to be driven by competition from Milford Haven and Haverfordwest, in part facilitated by the A4076;
- Higher frequencies of service at Whitland, Clarbeston Road, and Clunderwen due to the confluence of the West Wales network at these points.

Total annual demand for these stations was taken from MOIRA OR24 and projected against Ordnance Survey (OS) AddressBase data, which provides a single point for each residential and commercial address in the UK. Assumed catchments for these existing stations and lookup tables from PDFH v4.0, as shown in Table 9. It should be noted that the station type definitions (e.g. “prime

[1] Available at: http://orr.gov.uk/statistics/published-stats/station-usage-estimates

[2] For example levels of competition for other modes.

commuter belt….") are not the key consideration in this allocation, instead a judgment on likely catchment percentages across the three distance bands is the key consideration.

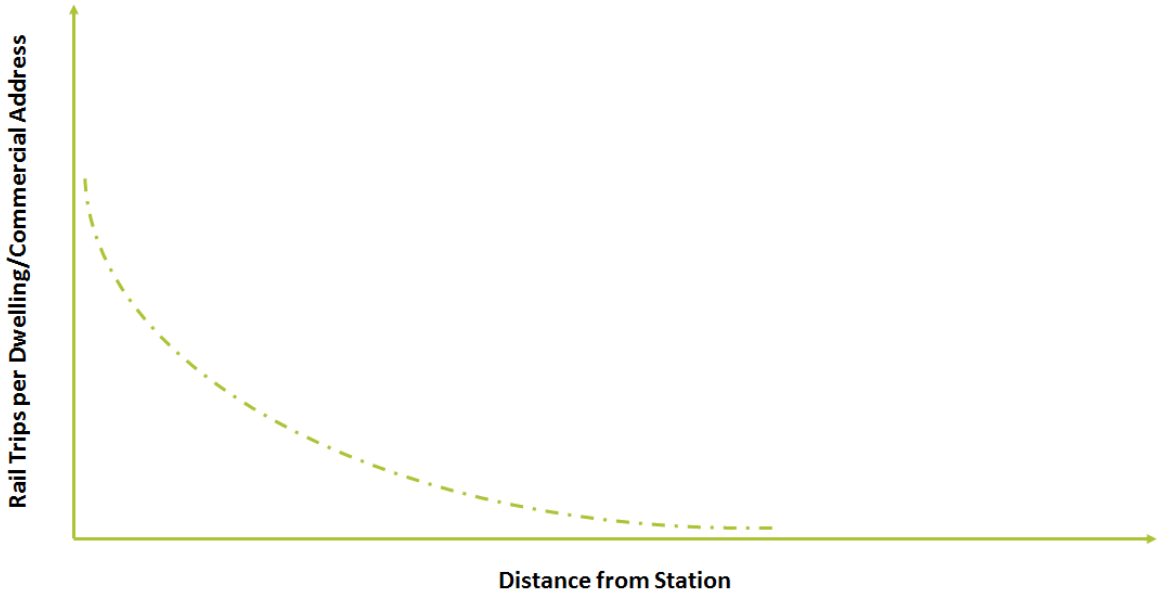
Table 9: Indicative Demand by Station Type and Access Distance

Station Type	0-800m	800m-2km	% from beyond 2km
Prime commuter belt on outskirts of urban centre	90%	9%	1%
Village areas surrounding urban centre • Clunderwen • Clarbeston Road	67%	16%	17%
Built-up areas close to urban centre	73%	18%	9%
Free-standing town: • Milford Haven • Haverfordwest • Whitland • Johnston • Narberth • Kidwelly	55%	16%	29%

Source: Passenger Demand Forecasting Handbook v4.0

To add granularity to this a standard decay curve was applied, as illustrated in Figure 32, to further split trip rates into 100m distance bands, using the percentages in Table 9 as constraints on the shape of the curve. This provided an average number of rail trips per dwelling or commercial address for a particular type of station in the region.

Figure 32: Propensity to use Rail by Distance from Station



Source: Mott MacDonald

Having estimated an average trip rate per dwelling or commercial point for existing stations, this was then used to establish a final set of comparator stations and appropriate groupings, e.g. with consistent trip rates, with average values to assist in demand estimates at the new stations. These were:

- 'Medium' stations – Haverfordwest;

- 'Small' stations – Kidwelly and Narberth; and
- 'Very small' stations – Clarbeston Road and Clunderwen.

New stations were then allocated to these different station categories based on the number of AddressBase points within the same catchments, and trip rates are then applied to the comparable number of points in each band for the new stations. For future years this includes planned development. Where this uses zone-based TEMPRO data, it was assumed that new development clusters around the existing settlements, typically within 800m, although this would be influenced by the density of existing development and the availability of suitable land for future development.

This trip rate approach ensures that the forecast rail demand reflects both the total population within the catchment of the station and the effect of proximity on likelihood of use.

A separate correction was then made to account for level of service at the selected comparator stations; for example, while the hourly service in DS3 is consistent with existing service levels at Clarbeston Road and Clunderwen, an adjustment is required to reflect lower frequencies in DS1 and DS2. This permits sensitivity of new station demand to the three DS scenarios using a standard Generalised Journey Time (GJT) adjustment for frequency/service interval and an associated elasticity of demand to GJT from the PDFH v5.1.

The outputs of this process are a set of annual demand estimates for the new stations as if they had been open in 2015, termed 'ghost demand', exclusive of any demand ramp up in the years immediately after opening (see Section 6.2.8). Table 10 summarises these initial estimates which can then be projected forward to the assumed year of opening and beyond using standard forecasting approaches. Comparators in the same 5,000 trip range[3], and not necessarily comparable on existing level of service, are provided from ORR 2015/16 station usage estimates.

Table 10: New Stations – 2015 Ghost Demand (per Annum)

Station	DS1 Demand	DS2 Demand	DS3 Demand	DS3 Comparators
Pencader	26,959	28,282	29,728	• Baglan • Pembroke
Llanybydder	32,760	34,149	40,218	• Tondu • Ton Pentre • Ystrad Rhondda
Lampeter	49,189	51,181	58,814	• Borth • Caersws • Milford Haven • Sarn
Tregaron	44,745	46,572	48,541	• Pembroke Dock • Skewen
Llanilar	16,342	16,939	17,576	• Ammanford • Ferryside • Fishguard & Goodwick • Kilgetty • Llandeilo • Llandovery

Source: Mott MacDonald

6.2.3 Carmarthen Demand

The additional demand increase at Carmarthen calculation would be limited to movements to/from Aberystwyth – demand to/from the new stations is captured in the separate forecasts shown in Table 10. To forecast demand between Aberystwyth and Carmarthen, there was a focus on selected flows[4] in MOIRA to/from Carmarthen, relating these to levels of population at the opposite end of the flow,

[3] The range for Lampeter is extended to 55,000 to 65,000 to identify comparators.

[4] Flows between Carmarthen and Milford Haven, Haverfordwest, Pembroke, Tenby, Pembrey & Burry Port, and Llanelli were selected as most comparable

and levels of service, using a simple gravity model approach (relating demand to population and distance/level of service between Carmarthen and the other station).

This produced the estimated total 2015 'ghost demand' between the pair of stations shown in Table 11. As a comparison, forecast total demand between Aberystwyth and Carmarthen, and vice versa, is approximately 80% higher than Haverfordwest to Carmarthen.

This is a result of the greater population in Aberystwyth, and the comparable, or better, frequency of service. These are offset, in part, by a longer In-Vehicle Time (IVT).

Table 11: Aberystwyth<>Carmarthen Estimated 2015 'Ghost Demand' (per Annum)

Flow	DS1 Demand	DS2 Demand	DS3 Demand
Carmarthen-Aberystwyth	4,305	4,498	4,753
Aberystwyth-Carmarthen	4,317	4,517	4,842

Source: Mott MacDonald

For the purposes of this exercise it has been assumed the only demand uplifts at Carmarthen would be to/from the new stations and Aberystwyth, in line with the assumption of interchange at Aberystwyth for further onward connections and the lack of major attractors now made accessible via the route to Machynlleth and Shrewsbury.

6.2.4 Aberystwyth Demand

The connectivity improvements are more pronounced at Aberystwyth, particularly with regard to access to other areas of West Wales, South Wales, and England. There would be some existing demand to stations in these areas from Aberystwyth, but the change can be considered so transformative that a simple elasticity based approach is not appropriate.

Instead, demand at a comparator station (Carmarthen) was examined, and a gravity model developed as per Aberystwyth – Carmarthen, to estimate the additional rail trips associated with flows such as Aberystwyth – Swansea or Aberystwyth – Cardiff.

The gravity model approach, encompassing level of service under the DS scenarios and through running assumptions, ensures that the resulting demand uplift would be reflective of both levels of population at both ends of the flow and also the GJT between them.

Table 12 shows the resulting demand estimates for Aberystwyth, which are net additional to those numbers in Tables 10 and 11. The forecasts are for an additional 165,000 to 185,000 trips per annum at Aberystwyth, adding over 50% to the current 2015/16 station usage total (322,000).

Table 12: Aberystwyth Additional 2015 'Ghost Demand'

Flow	DS1 Demand	DS2 Demand	DS3 Demand
Aberystwyth Productions	79,758	84,300	88,640
Aberystwyth Attractions	86,723	90,543	95,245

Source: Mott MacDonald

6.2.4.1 Bow Street Station

The successful application by Ceredigion County Council to the New Stations Fund (NSF) for Bow Street (east of Aberystwyth on the Mid-Wales line to Shrewsbury and Birmingham International), has been noted.

On the current working assumption that any integration with existing services is via the extension of services which currently terminate at Carmarthen, then it is considered unlikely that Bow Street would have a significant impact on the demand forecasts.

6.2.5 Demand Distribution

Revenue forecasts and economic benefit estimates both require an indicative demand distribution for the new rail journeys. The assumption that through services would be offered to key attractors in West Wales, South Wales, and England means that this was based on the identified comparator stations in West Wales (focussed on stations to Carmarthen and the east thereof as both the major attractors and also those which would be directly/better accessible via the assumed service pattern in Section 6.1.2), but with consideration of the likely proportion which route towards Aberystwyth.

This also applies for the additional demand expected to be generated at Aberystwyth and Carmarthen Stations. This additional consideration of the likely proportion of trips which would be 'internal' to the line was made with reference to other comparable circumstances in West Wales, e.g. Carmarthen to Haverfordwest or Milford Haven. The distribution which is internal to such comparator lines was simply substituted with a comparable distribution for Aberystwyth – Carmarthen using the same household and commercial address weights as per the original trip rate analysis.

6.2.6 Forecasting Framework

Having established 'ghost' demand for 2015, as if the line had been open, the standard UK rail industry Passenger Demand Forecasting Handbook (PDFH) v5.1 elasticity-based approach to forecast future demand was applied. This is sensitive to:

- The external environment, e.g. population, employment and GDP changes; and
- Competing modes.

Population is handled in a slightly different manner to permit the forecasts to be more sensitive to, and reflective of, the proximity of any new residential development to the new stations. This uses the trip rates per 100m distance band, as described in Section 6.2.2, and simply overlays additional dwellings in each band to estimate the incremental change in rail demand. Naturally, all else being equal, the closer the development to the station, the higher the additional demand.

6.2.6.1 External Environment

Consideration of the external environment includes trends in:

- Population (by age);
- Employment;
- Car ownership/availability; and
- GDP.

Outside of the population trend for new stations described in the preceding section, trends in the first three are taken from TEMPRO v7.2 datasets for Middle Super Output Areas (MSOAs) in the station catchment, and GDP forecasts are taken from the latest TAG Databook release.

6.2.6.2 Competing Modes

Trends in competing mode variables are taken from the latest edition of the TAG Databook (July 2017), and include trends in:

- Fuel costs and vehicle efficiency;
- Car times;
- Bus fares;
- Bus times; and
- Bus headways.

These are combined with appropriate elasticities using the forecasting framework from the UK rail industry's Passenger Demand Forecasting Handbook (PDFH) v5.1. (n.b. Upon implementation, rail

and bus services would of course by configured to complement, rather than compete, with each other).

6.2.6.3 Fares

A fares policy of RPI+0% for all ticket types until 2020, and RPI+1% thereafter, was assumed. The fares index is estimated in real terms, and accounts for GDP using the GDP deflator.

6.2.7 Forecasting Framework

Demand forecasting is undertaken at a station-to-station level using Production-Attraction (P-A) matrices. Excepting station facility improvements, which enter as a direct demand uplift, other factors are captured using the elasticity-based approach to demand forecasting encapsulated in PDFH guidance, using an equation of the form:

$$V_{ij}^{k} = f\left(Fare_{ij}^{k}, GJT_{ij}^{k}, Pop_{i}, Emp_{j}, FuelCost, CarTime, BusTime, Bus\ Head, BusFare, NCA_{i}\right)$$

Where:

- V_{ij}^{k} = the demand for rail between stations *i* and *j* for segment *k*
- $Fare_{ij}^{k}$ = the average fare for rail between stations *i* and *j* for segment *k*
- GJT_{ij}^{k} = the Generalised Journey Time for rail between stations *i* and *j* for segment *k*
- Pop_{i} = the population trend at production station *i*
- Emp_{j} = the employment trend at attraction station *j*
- GDP = the GDP per capita trend at attraction station *j*
- $FuelCost$ = the car fuel cost trend
- $CarTime$ = the car time trend
- $BusTime$ = the bus time trend
- $Bus\ Head$ = the bus headway (service-kms or frequency) trend
- $BusFare$ = the bus fare trend
- NCA_{i} = the proportion of non-car owning households at the production station *i*

Each of the above is combined with an elasticity for the relevant flow and ticket type (the NCA sensitivity is captured with a parameter rather than an elasticity).

Endogenous factors are considered at the station level, as are population and employment inputs. All other exogenous and competing mode sensitivities are handled at an aggregate level with time-series sourced from the TAG databook. All endogenous and competing mode variables have standard PDFH v5.0 elasticities applied to them

$$V_{ij}^{t+1} = V_{ij}^{t}.\left(\frac{X_{ij}^{t+1}}{X_{ij}^{t}}\right)^{e_x}$$

Where:

V_{ij}^{t+1} = the demand for rail between stations *i* and *j* in year *t*

V_{ij}^{t} = the demand for rail between stations *i* and *j* in year *t+1*

X_{ij}^{t+1} = the value for input X for rail between stations *i* and *j* in year *t*

X_{ij}^{t} = the value for input X for rail between stations *i* and *j* in year *t+1*

e_x = the elasticity of demand to changes in input X

6.2.8 Ramp-Up rates

Standard demand ramp-up rates in line with the latest guidance in the PDFH were applied. These are shown, for PDFH v5.1, in Table 13, and all improvements in this scheme have been taken to represent a 'major new service'.

Table 13: Recommended Demand Ramp-Ups by Intervention

Intervention	Year 1	Year 2	Year 3
Major new service	70%	85%	95%
Improvement in GJT - commute	70%	90%	100%
Improvement in GJT – non-commute	100%	100%	100%

Source: Passenger Demand Forecasting Handbook

6.2.9 Demand Forecasts

A summary of the net additional demand forecasts (Do Something minus Do Minimum), prior to the application of ramp-up, is shown in Table 14.

Table 15 then shows the additional rail revenue the scheme is expected to generate. In this regard, the scheme generates a comparatively high revenue per journey due to the comparably longer distance nature of the trips.

Table 14: Aberystwyth – Carmarthen Rail Re-Opening Net Additional Rail Trips by Scenario and Year

Year	Season	Full	Reduced	TOTAL
DS1				
2024	40,772	202,150	101,518	344,440
2027	48,431	229,369	119,894	397,694
2037	61,011	256,638	143,799	461,448
DS2				
2024	43,077	211,904	105,725	360,706
2027	51,155	240,375	124,873	416,402
2037	64,405	268,829	149,765	482,999
DS3				
2024	46,441	227,681	114,841	388,963
2027	55,186	258,440	135,683	449,309
2037	69,526	289,279	162,693	521,498

Source: Mott MacDonald

Table 15: Aberystwyth – Carmarthen Rail Re-Opening Net Additional Rail Revenue by Scenario and Year (undiscounted in 2015 prices)

Year	Season	Full	Reduced	TOTAL
DS1				
2024	£308,869	£4,576,272	£1,830,232	£6,715,373
2027	£381,762	£5,277,656	£2,239,614	£7,899,031
2037	£561,183	£6,654,880	£3,158,567	£10,374,631
DS2				
2024	£327,268	£4,800,100	£1,908,412	£7,035,780
2027	£404,425	£5,535,222	£2,335,160	£8,274,807
2037	£594,206	£6,977,915	£3,292,508	£10,864,630
DS3				
2024	£350,977	£5,094,923	£2,073,491	£7,519,391
2027	£433,874	£5,877,508	£2,538,639	£8,850,021
2037	£637,713	£7,413,942	£3,578,474	£11,630,129

Source: Mott MacDonald

6.3 Costs

6.3.1 Capital Expenditure

No major capital expenditure estimates are included in the economic appraisal; in addition to initial construction costs, this includes major infrastructure renewals which could be anticipated at least once during the 60 year appraisal period.

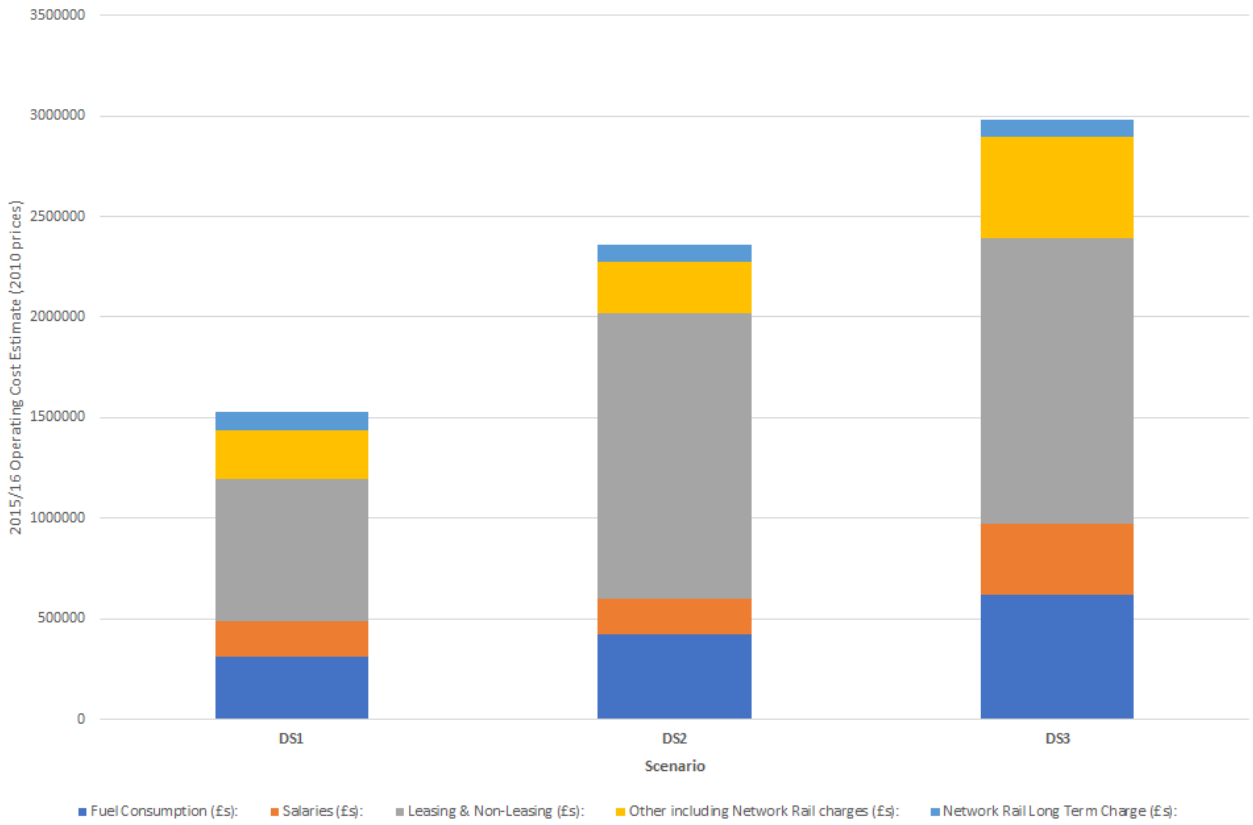
6.3.2 Operating Expenditure

The annual additional train-kms and units for each scenario have been estimated, and converted these into estimates of the cost components:

- Fuel;
- Labour:
- Leasing;
- Non-leasing; and
- Track access charges (cost on infrastructure directly incurred as a result of running services, but exclusive of major renewals and maintenance).

In addition, estimates for the ongoing station long-term charges to Network Rail have been included, based on comparable stations in West Wales.

Figure 33: 2015/16 Operating Cost Estimates by Scenario (undiscounted in 2010 prices)



Source: Mott MacDonald from published sources including Network Rail and TAG

For the economic appraisal, an adjustment of 1% per annum for optimism bias on operating expenditure was applied, and costs were converted into Present Value metric using the standard HM Treasury discounting rates, in 2010 values and prices.

6.4 Economic Appraisal

6.4.1 60 Year Appraisal Period

Demand forecasts and other inputs from the modelling are linearly interpolated between, and extrapolated from, the three modelled years of 2024, 2027 and 2037 to produce a full 60-year appraisal from the assumed opening year of 2024. Ramp-up rates on demand are carried through to the economic appraisal metrics.

All Present Value of Benefits (PVB) appraisal metrics are in 2010 values and prices.

6.4.2 Assumptions

6.4.2.1 Ticket Type to Journey Purpose Mapping

Conversion from ticket type in the demand forecasts to journey purpose for economic appraisal was undertaken, using the latest conversion factors from the TAG databook.

6.4.2.2 Values of Time

Values of Time (VoTs), for monetising all time and cost savings to users (with the latter converted into minutes in the base year) were taken from the latest TAG databook by journey purpose.

6.4.2.3 Rail Demand Cap

As per standard TAG guidance, a demand and revenue cap is applied 20 years hence from the forecast year [in 2037]. A set of sensitivity tests (DS1b to DS3b) have been undertaken, with the demand cap constraint relaxed, and demand allowed to grow in line with regional population growth, according with latest DfT thinking on this subject.

6.4.2.4 Discounting

Discount rates are taken from the latest TAG Databook release:

- 3.5% per annum for the first 30 years to 2047; and
- 3.0% thereafter to 2080.

6.4.2.5 RPI Series

All values were converted to 2010 prices using the RPI series from the latest TAG Databook release.

6.4.3 Marginal External Costs of Car Use

To estimate MECC values which are representative of the affected flows, a set of sectors (a combination of local authorities and regions) was developed, and for each sector-to-sector combination estimated the road and area type combinations from which any car-kms would be abstracted. A standard diversion factors for abstraction from car and bus to rail was applied, from the latest TAG unit.

Values, in pence per km, for the relevant road types and locations, were taken from the latest (July 2017) TAG Databook release for the following marginal external costs of car use:

- Congestion;
- Infrastructure;
- Road traffic accidents;
- Local air quality;
- Noise; and
- Greenhouse gases.

Indirect Taxation

Changes in indirect taxation revenues accruing to HM Treasury were also estimated for the changes in:

- Car-kms; and
- Public transport revenue.

6.4.4 Transport User Benefits

All changes in consumer surplus (user benefits or disbenefits) are converted into hours in the model, and monetised for the appraisal using VoTs for each journey purpose from the latest TAG Databook release.

6.4.5 Wider Economic Impacts

At this stage our economic appraisal relates to core benefits only. Within section 7 Wider Economic Impacts (WEIs) analysis has also been undertaken to produce an 'adjusted' Level 2 benefits estimate, using standard DfT guidance and/or supplementary economic modelling. A number of the demand modelling inputs and outputs described in previous sections help facilitate this extension.

6.4.6 Summary of Level 1 Economic Impacts

Table 16 summarises the resulting Level 1 economic impacts by scenario. Full economic appraisal tables are provided in Appendix D.

Table 16: Economic Appraisal Results by Scenario (discounted £ks in 2010 values and prices)

Metric	DS1	DS2	DS3
User Benefits			
Commute	22,674	28,057	34,202
Employer's Business	42,274	50,837	60,727
Other	9,339	11,201	13,295
Benefits to Society from Changes in Road Traffic Externalities			
Noise	79	83	90
Local Air Quality	12	13	14
Greenhouse Gas Emissions	590	618	665
Road Traffic Accidents	888	930	998
Non-User Benefits (decongestion)			
Commute	2,282	2,385	2,578
Employer's Business	1,923	2,010	2,173
Other	2,881	3,011	3,255
Costs and Revenues			
Rail revenue	151,583	158,754	169,902
Bus revenue	-6,672	-6,984	-7,540
Indirect Taxation	-25,204	-26,396	-28,253
Rail Operating Costs	-36,513	-55,502	-71,494
Economic Metrics			
Present Value of Benefits	51,068	65,766	82,204
Present Value of Costs	-115,159	-103,346	-95,508
Net Present Value	166,227	169,112	180,713

Source: Mott MacDonald

6.5 Indicative Cost Estimates to Produce Economic Outcomes

This section relates the PVB, and initial PVC estimates (containing selected items only), to predefined economic appraisal thresholds in order to estimate an additional PVC estimate which would satisfy these. This PVC estimate is then converted into an equivalent construction cost estimate in current (2017) prices, inclusive of:

- Undiscounting;
- Conversion from market to non-market prices;
- Conversion from 2010 to 2017 prices;
- Removal of an assumed optimism bias component of 64% (Stage 1 value for conventional rail); and
- Removal of above background inflation change in construction costs (5% versus RPI at 3%).

We do not include any additional risk adjustment in this process. Resulting estimates should therefore be inclusive of such an adjustment.

For simplicity, we exclude the subsume major renewals element into the initial construction period, albeit this element, being much further in the future, would have a substantially different discount rate (giving a smaller PVC component).

We assume a four year construction period, commencing in 2020, with the following spend profile:

- Year 1 – 20%;
- Year 2 – 30%;
- Year 3 – 30%; and
- Year 4 – 20%.

Table 17 summarises this process, and shows that, to achieve a BCR of 1.0, the initial cost estimates (inclusive of optimism bias) for all major construction elements would have to not exceed totals (in 2017 prices) of approximately:

- £234.6 million for DS1 (120 minute service interval);
- £238.7 million for DS2 (90 minute service interval); and
- £255.1 million for DS3 (60 minute service interval).

Table 17: Indicative Major Capital Costs to Produce BCR (£Ks)

DS1: 0.5tph in each direction (120 minute service interval)				
Benefit Cost Ratio Threshold	0.5	**1.0**	1.5	2.0
[A] PVB	51,068	**51,068**	51,068	51,068
[B] Initial PVC	-115,158	**-115,158**	-115,158	-115,158
[C] Target PVC [A] / BCR (discounted in 2010 market prices)	102,136	**51,068**	34,045	25,534
[D] PVC Gap [C] - [B], converting costs into positive numbers	217,295	**166,227**	149,204	140,693
[E] Cost Gap - undiscounted	327,548	**250,569**	224,909	212,079
[F] Cost Gap – non-market prices	275,250	**210,562**	188,999	178,218
[G] Cost Gap - 2017 prices	334,623	**255,981**	229,767	216,660
[H] Cost Gap - allowing for construction inflation	306,721	**234,636**	210,608	198,594
DS2: 0.67tph in each direction (90 minute service interval)				
Benefit Cost Ratio Threshold	0.5	**1.0**	1.5	2.0
[A] PVB	65,766	**65,766**	65,766	65,766
[B] Initial PVC	-103,346	**-103,346**	-103,346	-103,346
[C] Target PVC [A] / BCR (discounted in 2010 market prices)	131,532	**65,766**	43,844	32,883
[D] PVC Gap [C] - [B], converting costs into positive numbers	234,878	**169,112**	147,190	136,229
[E] Cost Gap - undiscounted	354,052	**254,917**	221,872	205,350
[F] Cost Gap – non-market prices	297,523	**214,216**	186,447	172,563
[G] Cost Gap - 2017 prices	361,700	**260,423**	226,665	209,785
[H] Cost Gap - allowing for construction inflation	331,540	**238,708**	207,764	192,293
DS3: 1.00tph in each direction (60 minute service interval)				
Benefit Cost Ratio Threshold	0.5	**1.0**	1.5	2.0
[A] PVB	82,204	**82,204**	82,204	82,204
[B] Initial PVC	-95,508	**-95,508**	-95,508	-95,508
[C] Target PVC [A] / BCR (discounted in 2010 market prices)	164,409	**82,204**	54,803	41,102
[D] PVC Gap [C] - [B], converting costs into positive numbers	262,917	**180,713**	153,311	139,610
[E] Cost Gap - undiscounted	396,318	**272,404**	231,099	210,447
[F] Cost Gap – non-market prices	333,041	**228,911**	194,201	176,846
[G] Cost Gap - 2017 prices	404,878	**278,288**	236,091	214,993
[H] Cost Gap - allowing for construction inflation	371,118	**255,083**	216,405	197,066

Source: Mott MacDonald

6.6 Sensitivity Tests

To explore the influence of key assumptions, two separate sensitivity tests were undertaken for each of DS1 to DS3:

- A reduction in the end-to-end IVT between Aberystwyth and Carmarthen to 65 minutes (DS1a to DS3a). It should be noted that these JTI outputs are entirely notional, and should not be taken to infer that such improvements are either feasible or affordable in regard to the alternative infrastructure, rolling stock, or other provisions that would be required to facilitate them; and
- Removal of the demand cap 20 years after the year of appraisal (2017). Demand, revenue, and benefits are then allowed to change in line with population. As the forecasting horizon extends to 2083, 60 years after the assumed opening year of 2024, the total national projection for Wales from the Office for National Statistics (ONS) is taken as more spatially disaggregate data is not available.

6.6.1 Demand and Revenue Impacts

Table 18 and Table 19 show the demand and revenue impacts from the reduced IVT in tests DS1 to DS3a. The results show the expected uplift in demand and revenue from the reduced IVT, as captured through the reduction in GJT through the framework described in Section 6.2.6.

As the lifting of the demand cap restriction is post-2037, the demand and revenue forecasts for DS1b to DS3b are the same as Table 14 and Table 15.

Table 18: Aberystwyth – Carmarthen Rail Re-Opening Net Additional Rail Trips by Sensitivity Test and Year

Year	Season	Full	Reduced	TOTAL
DS1a				
2024	42,705	207,405	100,560	350,670
2027	50,376	234,002	117,874	402,253
2037	62,817	259,573	139,903	462,293
DS2a				
2024	47,748	232,167	117,222	397,138
2027	56,363	261,408	136,514	454,286
2037	70,314	289,049	160,469	519,833
DS3a				
2024	51,700	249,406	125,897	427,003
2027	61,001	280,251	146,108	487,360
2037	76,034	308,815	170,781	555,629

Source: Mott MacDonald

Table 19: Aberystwyth – Carmarthen Rail Re-Opening Net Additional Rail Revenue by Sensitivity Test and Year (undiscounted in 2015 prices)

Year	Season	Full	Reduced	TOTAL
DS1b				
2024	£332,889	£4,867,569	£1,849,656	£7,050,114
2027	£410,307	£5,603,377	£2,251,648	£8,265,332
2037	£600,436	£7,041,507	£3,148,933	£10,790,876
DS2b				
2024	£364,568	£5,265,721	£2,132,605	£7,762,895
2027	£449,367	£6,060,925	£2,585,028	£9,095,320
2037	£657,490	£7,615,949	£3,590,308	£11,863,747
DS3b				
2024	£394,718	£5,630,311	£2,308,028	£8,333,056
2027	£486,387	£6,477,536	£2,792,084	£9,756,007
2037	£711,206	£8,130,286	£3,861,256	£12,702,748

Source: Mott MacDonald

6.6.2 Economic Impacts

Table 20 summarises the economic metrics for the two sets of sensitivity tests. Comparing the outputs to those in Table 16, shows that a nominal twenty minute reduction in journey time (as DS1a to DS3a) adds £30.0 - £42.0 million to the PVB and NPV.

By contrast, the removal of the demand cap 20 years after the year of appraisal (2017) (as DS1a to DS3a) has a negligible effect on PVB and NPV.

The Analysis of Monetised Costs and Benefits (AMCB) tables are contained in Appendix D [the Transport Economic Efficiency (TEE) and Public Accounts (PA) tables remain unchanged from the corresponding core scenarios detailed, also in Appendix D].

Table 20: Economic Appraisal Results by Sensitivity Test (discounted £ks in 2010 values and prices)

Metric	DS1a	DS2a	DS3a	DS1b	DS2b	DS3b
User Benefits						
Commute	30,774	36,795	43,769	21,304	28,076	34,224
Employer's Business	55,656	65,182	76,209	39,334	50,870	60,766
Other	12,489	14,506	16,788	8,383	11,208	13,304
Benefits to Society from Changes in Road Traffic Externalities						
Noise	81	90	98	77	83	90
Local Air Quality	13	14	15	12	13	14
Greenhouse Gas Emissions	607	673	722	587	618	665
Road Traffic Accidents	920	1,013	1,086	884	930	999
Non-User Benefits (decongestion)						
Commute	2,325	2,598	2,797	2,239	2,386	2,579
Employer's Business	1,960	2,190	2,358	1,888	2,011	2,174
Other	2,936	3,280	3,532	2,827	3,013	3,256
Costs and Revenues						
Rail revenue	157,889	173,625	185,981	152,551	158,839	169,993
Bus revenue	-6,696	-7,538	-8,063	-6,076	-6,988	-7,544
Indirect Taxation	-26,266	-28,875	-30,939	-25,441	-26,410	-28,268
Rail Operating Costs	-36,513	-55,502	-71,494	-36,513	-55,502	-71,494
Economic Metrics						
Present Value of Benefits	74,798	89,930	108,372	46,019	65,811	82,260
Present Value of Costs	-121,468	-118,225	-114,596	-116,128	-103,430	-98,599
Net Present Value	196,266	208,155	222,968	162,147	169,241	180,859
ΔNPV (vs. Table 16)	+30,039 (18%)	+39,043 (23%)	+42,255 (23%)	-4,080	+129	+146

Source: Mott MacDonald

7 Wider Economic Impacts Assessment

The context for analysing the wider economic impacts is informed by relevant national, regional, and local policy documentation, which is summarised in subsequent sub-sections.

7.1 National Policy

7.1.1 The Welsh Government's Wales Transport Strategy

The Welsh Government's Wales Transport Strategy (2008) sets out how the Welsh Government will deliver those areas of transport for which it is responsible. An efficient and effective transport system helps increase the number of people wanting to live, work and spend leisure time in Wales, which in turn builds strong and vibrant local economies.

The strategy highlights that transport supports the economy by connecting businesses with suppliers and customers, and enabling people to travel to work. It is critical for both manufacturing and service based businesses. Congestion costs businesses many millions of pounds a year – and improved transport, especially its reliability, is cited consistently by Welsh businesses as one of their top priorities. Improved access to education and employment also contributes to Wales' long-term prosperity. Poor access is one of the major barriers facing the jobless – particularly in rural parts of Wales.

7.1.2 The Network Rail Welsh Route Study, March 2016

The economy of Wales and the bordering regions rely on a safe, punctual, and efficient railway. Railways connect people to employment opportunities and transport goods to the marketplace. Railway-use in Wales has seen a decade of unprecedented growth, with almost 50% more passenger journeys made to, from and within Wales since 2006. Forecasts suggest that passenger growth levels will continue to be strong during the next three decades, particularly in the south east of Wales and in the north east of Wales.

7.1.3 Priorities for the future of Welsh Rail Infrastructure, March 2016

The mid Wales Transport Partnership (TraCC) highlighted that the future development of rail infrastructure should benefit all of Wales, not just focusing on key corridors. Re-opening the Aberystwyth to Carmarthen is mentioned by the South Wales Chamber of Commerce (SWCC) as a priority for the mid Wales region.

7.1.4 Wales National Transport Finance Plan 2015

An efficient, effective rail network has an important role to play in supporting the Welsh economy, enabling access across Wales and cross-border for people and freight. It also has an important role to play in enabling people to access key services, recreation and link communities across Wales. The nature of the rail network in Wales is such that it provides critical connectivity for many communities, including in rural areas and deprived communities.

7.2 Regional and Local Policy

7.2.1 Ceredigion Local Development Plan 2007-2022

Trends in service delivery, lack of suitable housing and work opportunities for emerging households can cause real problems for local rural communities. With over 60% of Ceredigion's residents living in rural areas, improving the sustainability of these communities can lead to improvements in the county overall. These issues need to be balanced with the need to promote the county's main settlements, particularly that of Aberystwyth given its national and regional status. Aberystwyth acts as a strategic

centre for central Wales and has been identified as a priority area for focused intervention by the Welsh Government and its partners to fulfil its role as the 'capital of central Wales'.

Ceredigion's current transport provision is heavily influenced by its geographic location, size, topography, rural nature, and dispersed population. At present, there is a high level of reliance on the predominant road network infrastructure servicing a high proportion of private and commercial motor vehicle journeys. Rail based public transport within the county is limited to the Aberystwyth to Shrewsbury/Birmingham Cambrian line and the Aberystwyth to Pwllheli Cambrian Coast line, with stations currently at Aberystwyth and Borth. Due to the growth in private car use, in recent years concerns have been raised about the capacity of roads and junctions to accommodate the traffic and of the lack of parking provision within Aberystwyth.

Improved public transport connectivity between Aberystwyth and its rural hinterland could help rural communities be more sustainable and encourage growth in Aberystwyth, as access to employment and education opportunities for these communities would be improved, and Aberystwyth would benefit from an increased labour supply.

7.2.2 Ceredigion for All: Our livelihoods, Our Economic Regeneration Strategy 2015

Ceredigion is rural and sparsely populated and whilst the county's remoteness is to many, an attraction; the remoteness brings with it a limited range of job opportunities, issues of accessibility – to and within the region and challenges associated with transport and communications infrastructure. Ceredigion's economy is constrained by limited road and rail infrastructure. The rurality of a county that is poorly serviced by public transport means that consistently high fuel and transportation costs are more keenly felt than in urban areas where the use of private transport is less of a necessity.

7.2.3 Aberystwyth Masterplan 2006

Aberystwyth is central to a part of Wales that is attracting a growing number people as a place to live. It has nationally and internationally significant businesses and institutions together with a strong and vibrant community keen to be involved in the future planning and development of the town. The town is recognised in national planning policy as the main centre for mid Wales. There is a growing demand for new shopping, housing and offices.

However, there is currently a low level of local train services operating from Aberystwyth. Interest has been expressed by members of the local community for the reinstatement of the Aberystwyth-Tregaron-Carmarthen railway. This would have benefits in creating a new scenic rail link to Welsh towns to the south of Aberystwyth and becoming both a functional transport link and tourist attraction.

7.2.4 Carmarthenshire Local Development Plan 2014

The main urban centres of the county are Llanelli, Carmarthen, and Ammanford. Carmarthen, in particular, serves the needs of the county's rural hinterland and as several settlements lack services and facilities, the needs of residents in these latter areas are typically met by neighbouring settlements. As such, a good transport network in the county is important.

An integrated and sustainable transport system is fundamental to the delivery of the Carmarthenshire Local Development Plan. It emphasises the importance of existing transport infrastructure, recognises the diversity of the county and highlights the variable quality and range of infrastructure provision (including highways and public transport) between the urban and rural areas. Sustainable growth in Carmarthenshire will depend on accessibility in terms of the highway network and access to public transport. For settlements to complement each other in terms of facilities offered, increased accessibility is key.

The Plan highlights the potential for re-use of closed rail routes. This supports several of the Plan's strategic objectives, such as:

- Assisting with widening and promoting opportunities to access community, leisure, and recreational facilities as well as the countryside;

- Contributing to the delivery of an integrated and sustainable transport system that is accessible to all; and
- Promoting and developing sustainable and high quality all year-round tourism related initiatives.

7.2.5 A strategic regeneration plan for Carmarthenshire 2015-2030

The Plan recognises that transportation infrastructure is the prime enabler that underpins other sectors of the economy. In particular, connectivity to the county's market towns and rural conurbations is critical to the lifeblood of the county – this is highlighted as a challenge for rural Carmarthenshire as there is still limited penetration of public transport provision and frequency of service.

7.3 Policy Summary

The importance of good transport networks and connectivity to support economic growth and development in Wales is recognised in policy documents at local, regional and national level. In particular, good public transport connectivity is key to helping rural communities, who may experience deprivation as a result of fewer employment and education opportunities. Economic growth across Ceredigion and Carmarthenshire is therefore dependent on accessibility in terms of the highway network and access to public transport. The re-opening of the Carmarthen - Aberystwyth scheme reflects the overarching policy objectives, especially as several of the documents highlight the unsustainability of car use.

7.4 Settlement and Economic Analysis

7.4.1 Introduction

This section provides a socio-economic snapshot of the settlements along the Carmarthen-Aberystwyth line to further understand demographic and economic patterns as context for examining growth plans. The settlements, for the purpose of data collection and assessment of wider economic benefits, have been defined based on creating a 2km buffer around each proposed station. The study area along the line encompasses a range of settlements, largely rural in nature with the exception of Carmarthen and Aberystwyth, which means the economic role of each is slightly different.

7.4.2 Settlements

The transport connectivity issues and facilities along the rail line vary, across both the road and rail network. Each community is considered in turn below, running north to south based on the study area map shown in Figure 31.

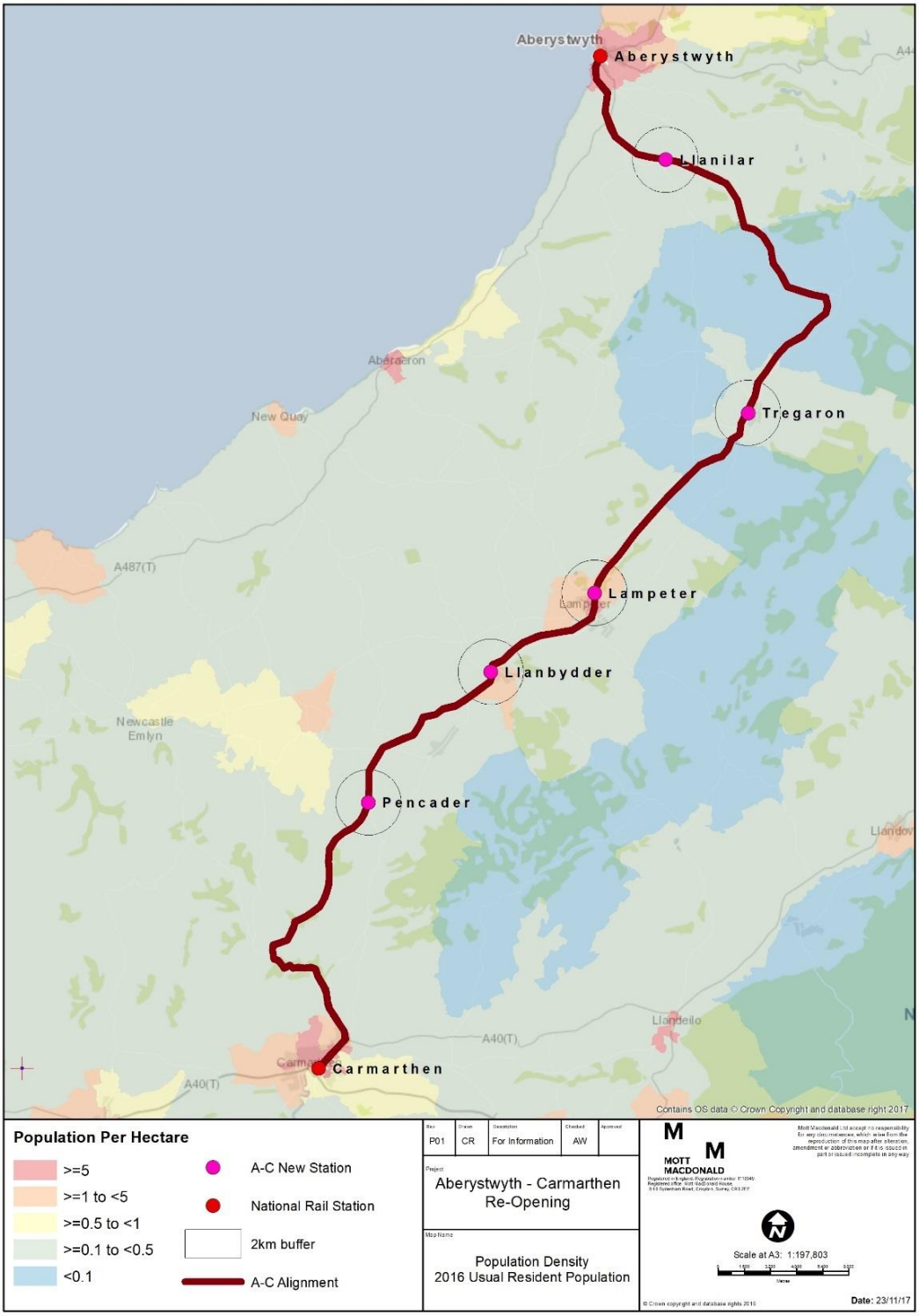
Table 21: Settlements

Settlement	Description
Aberystwyth	Aberystwyth is the principal holiday resort and administrative centre of the west coast of Wales. It is also home to the University of Wales Aberystwyth and the National Library. Since the late 19th century, Aberystwyth has been a major Welsh educational centre, with the establishment of a university college there in 1872. Today, the university has around 10,000 students (included within usual resident population for economic assessments, via use of 2011 census data).
Llanilar	Llanilar is located in the Ystwyth Valley south-east of Aberystwyth. It is a settlement of approximately 300 dwellings and has access to a good range of facilities and services, including a primary school, doctor's surgery, general store/post office, public house, garage, village hall, two places of worship, football pitch and children's play area. Llanilar railway station closed in 1964 following severe flooding in the area. The old railway yard is used as a car park for the Ystwyth Trail.
Tregaron	Tregaron is a well-established settlement, having been a centre for trade and industry for centuries. It has a wide range of facilities and services, including a primary and secondary school, doctor's surgery, general store/post office, public house, village hall, place of worship and rugby pitch. In the Western part of the settlement there is a small collection of industrial units, which houses industrial suppliers and warehouses. Within the most recent Trafnidiaeth Canolbarth Cymru Mid Wales Transportation (TraCC) Regional Transport Plan there are no formal proposals at present for major new or improved transport links in Tregaron. Tregaron's train service was withdrawn and the station closed in 1965 after the line was badly damaged by flooding. There is an approximately two-hourly bus service to Aberystwyth and Lampeter and a more sporadic service to other neighbouring small towns and villages but, as with many rural areas, there are no buses after approximately 18.00 in the evening and none on Sundays and bank holidays.
Lampeter	Lampeter is an important town for retailing, administration, judicial, education and business services. The town serves a large part of Ceredigion but also parts of Carmarthenshire and a number of nearby settlements look to it for daily needs. This wider role is recognised by the Wales Spatial Plan which has identified Lampeter as a Key Settlement within the Teifi Valley Hub. Regular bus services operate through the town, connecting Lampeter to the larger towns of Aberystwyth, Carmarthen and Swansea. Two buses a day continue beyond Swansea providing a through service to Cardiff. The local bus services are a lifeline to many people of the town, especially students of the town's university. The most recent Regional Transport Plan does not contain any formal plans at present for major new or improved transport links within the town or its immediate hinterland. The University of Wales Trinity St David has one of its main campuses in Lampeter, educating around 2,000 students. (included within usual resident population for economic assessments, via use of 2011 census data).
Llanybydder	This rural settlement is located in the north of Carmarthenshire on the border with Ceredigion. It is situated on a strategic transport corridor between Carmarthenshire and central Wales. It serves as a local centre for the area. Llanybydder is known for its monthly horse fairs, which attract dealers from both the UK and Ireland.
Pencader	Pencader is located 10km south-west of Llanybydder. It is a quiet village set in a valley with little more than 500 houses, a primary school, a few shops and two pubs. For many years it was one of the main stops on the Carmarthen - Aberystwyth rail route, and was the junction for the service to Newcastle Emlyn. The Newcastle Emlyn branch line closed in 1952 and the main line closed to passengers in 1965. The station has been demolished and the site is now used by as a lorry haulage depot.
Carmarthen	The county town of Carmarthen is located on the River Towy in the heart of Carmarthenshire. The town is strategically located at the junction of the A48 and A40 and on the London to Fishguard rail link, the town functions as a gateway to West Wales. As the major administrative centre for Carmarthenshire, the town is both a major employer in the county and a regional retail centre serving a wide rural hinterland. It is also home to a major University Campus. The town's regional retail role was reinforced in 2010 with the completion of the £75m St Catherine's Walk development.

Source: Mott MacDonald

7.4.3 Population and Demographics

The largest settlements along the line are Carmarthen and Aberystwyth, with the remaining settlements - Llanilar, Tregaron, Lampeter, Llanybydder and Pencader – rural in nature and sparsely populated. Population density in the study area is shown in Figure 34.



Source: Mott MacDonald

Figure 34: Population Density

The working age population, an indication of the available workforce, is highest as a proportion of overall population in the larger settlements of Aberystwyth and Carmarthen and in contrast smaller settlements like Llanilar and Tregaron. The figures for Aberystwyth and Lampeter are influenced by their respective universities.

Table 22: Total and working age population, 2016

	Total population	Working age population (16-64)	As % of total
Settlements			
Aberystwyth	12,315	9,462	77%
Llanilar	1,066	570	53%
Tregaron	1,182	644	54%
Lampeter	2,972	1,907	64%
Llanybydder	1,596	887	56%
Pencader	1,066	632	59%
Carmarthen	14,424	8,899	62%
Comparator areas			
Ceredigion	74,100	45,500	61%
Carmarthenshire	185,600	110,100	59%
Wales	3,113,200	1,921,400	62%

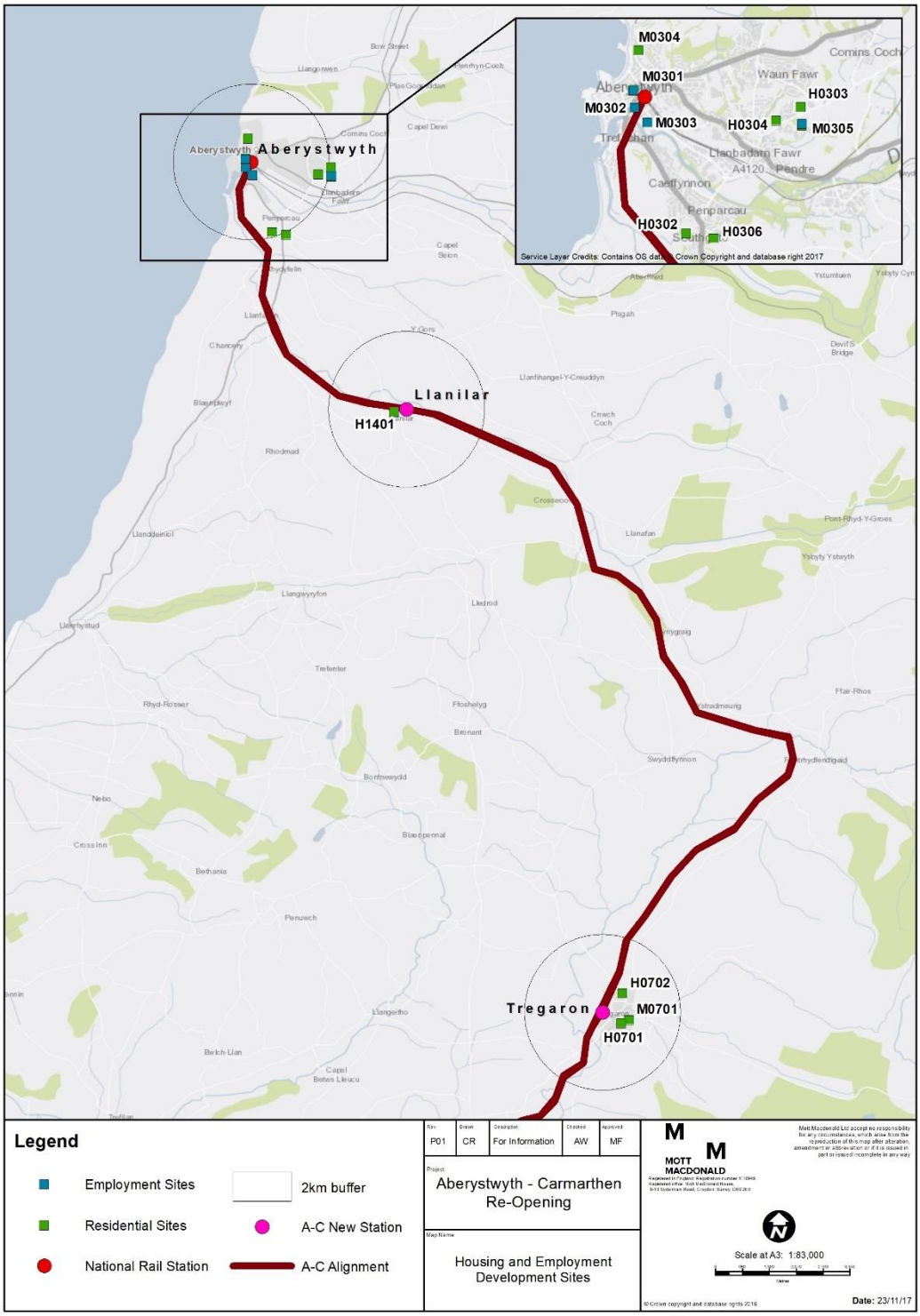
Source: Mott MacDonald

7.4.4 Identification of Development Sites

By examining local planning policy for the two districts, a number of allocated development sites for employment and housing have been identified in proximity to the proposed stations. Examining these sites further, a short-list of sites which fall in a 2km boundary of the station sites was produced. This 2km boundary was set for a number of reasons, outlined below:

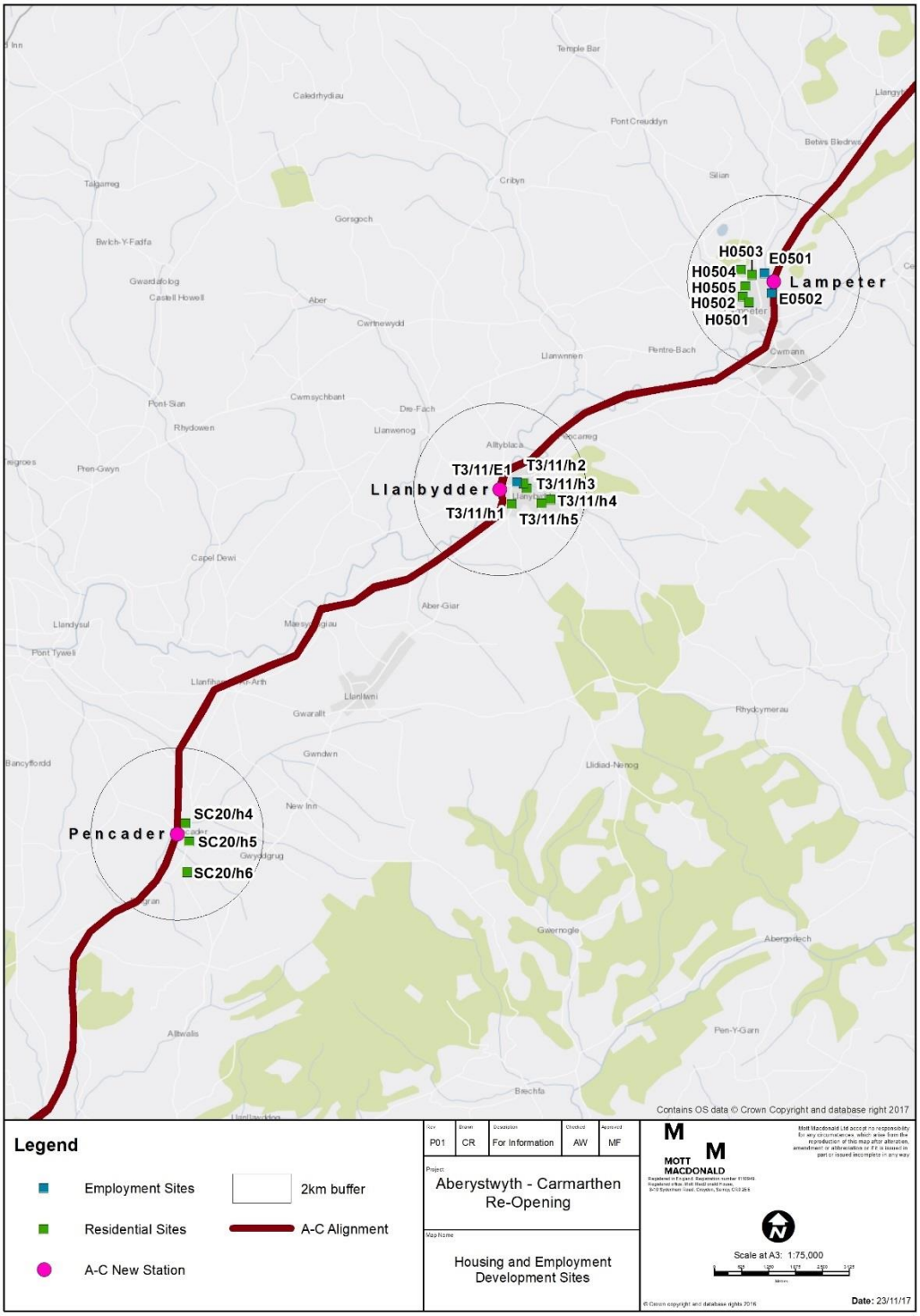
- A distance of 2km is walkable – commuters are likely to walk up to 2km, but any further is likely to require another form of transport (a bus connection, a park and ride station etc.);
- The terrain of the study area - in many places the terrain is hilly and it is unlikely people would walk further than 2km.

The figures below show the employment and housing development sites that are located near the seven station settlements.



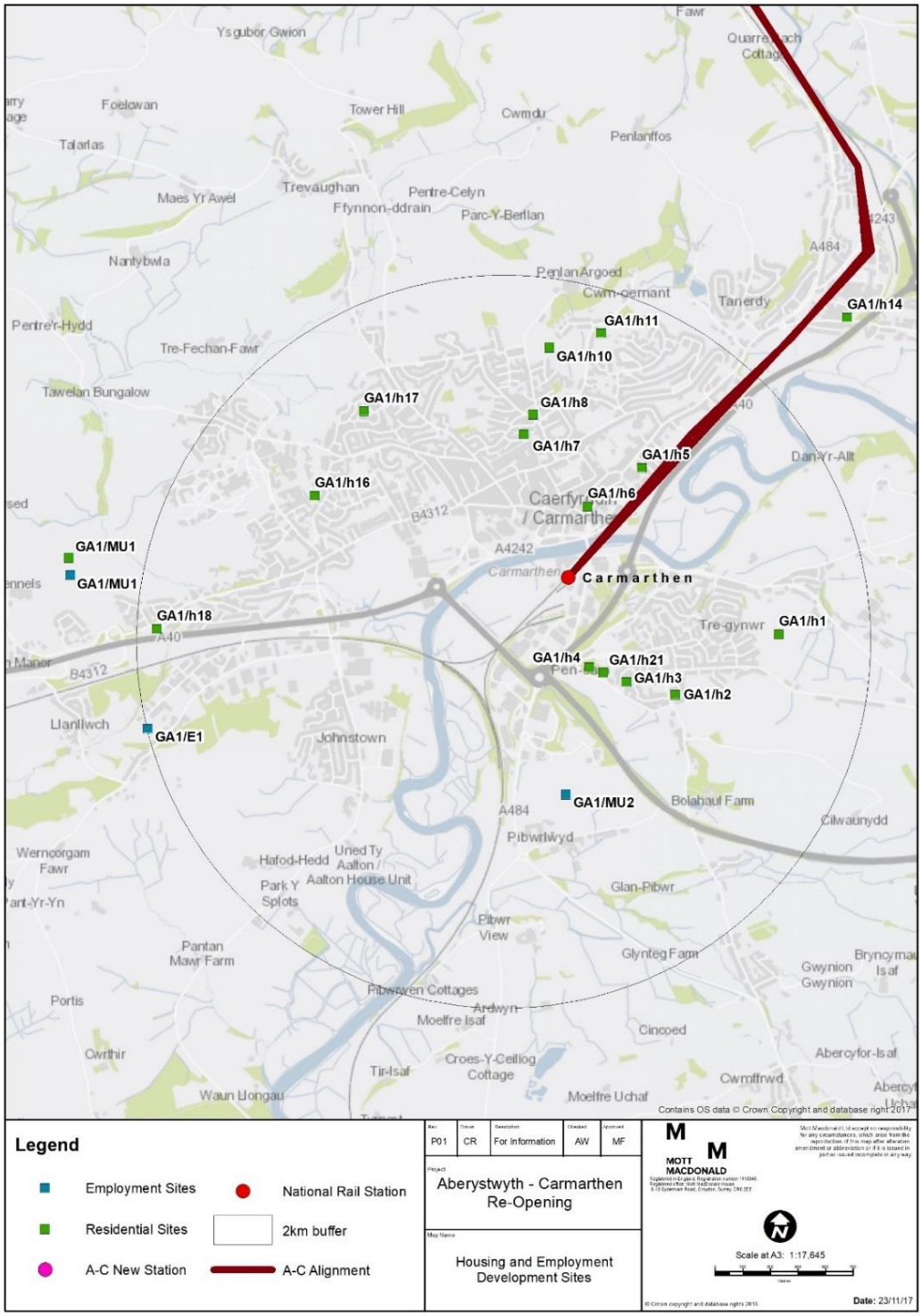
Source: Mott MacDonald

Figure 35: Development sites – northern section of the route



Source: Mott MacDonald

Figure 36: Development sites – mid section of route



Source: Mott MacDonald

Figure 37: Development sites – southern section of the route

7.4.5 Employment Sites

The details of the 10 employment sites identified are presented in Table 23. These sites will be used in calculating the wider economic benefits of the scheme. No employment sites were identified for Llanilar, Tregaron and Pencader.

Table 23: Employment development sites on allocated land within 2km of each proposed new station

Local Authority	Station	Policy no.	Site name	Site area for employment (ha)	Proposed Use (if known)	Status (if known)
Ceredigion	Aberystwyth	M0301	Old Post Office	0.17	Retail and housing	No permission
		M0302	Mill Street Car Park	1.23	Retail, Transport and Community	Site under construction – not included further in this analysis
		M0303	Park Avenue	3.67 (3,000 sqm for supermarket)	Retail, Leisure and Recreation	Part of site has permission for Aldi store, hotel and car parking.
		M0305	Llanbadarn Campus, Llanbadarn Fawr	4.54	B1a, B1b	No permission
	Lampeter	E0501	Llambed Business Park	7.97	B1, B2, B8	Over 50% of site complete
		E0502	Old Mart Site	1.07	B1	Approx. 50% of site complete
Carmarthenshire	Llanybydder		Old Foundry	0.51	B1, B8	
	Carmarthen	GA1/E1	Cillefwr Industrial Estate	4.38	B1, B2, B8	
		GA1/MU1	West Carmarthen	5.45	B1, B2, B8	Outside the 2km boundary so not included further in this study
		GA1/MU2	Pibwrlwyd	15.50	B1, B2, B8	

Source: Mott MacDonald

7.4.6 Housing Sites

Within the 2km boundary of the seven stations, there are 41 housing sites identified in the local development policy. Full development of these sites would result in over 2,100 dwellings across the study area.

The housing development considered in the demand forecasts are inclusive of projected housing and population growth from DfT TEMPRO datasets, which are used for consistency across all business case work. The forecasts will therefore be inclusive of a large proportion of the development in Table 24. TEMPRO does not however provide a high level of spatial detail for the proximity of new development to stations, particularly where MSOAs are large in predominantly rural areas. Inputs from table 24 were used to provide greater detail to the demand forecasting described in Section 6.2.6.

Table 24: Housing development sites on allocated land within 2km of each proposed new station

Local Authority	Station	Policy No.	Site Name	Area (Ha)	Units	Details
Ceredigion	Aberystwyth	M0301	Old Post Office	0.17	n/a	No permission
		M0304	Swyddfa'r Sir	0.79	n/a	Site has been sold to a developer by Ceredigion County Council.
		M0305	Llanbadarn Campus, Llanbadarn Fawr	10	450	This is part of a mixed use development with the housing element of the site to come forward after the employment uses on site have been secured.
		H0302	Piercefield Lane, Penparcau	3.90	118	Full permission granted for 49 dwellings.
		H0303	Land adjoining Hafod y Waun	4.15	129	This site is owned by the Council who are currently working up a scheme for the site the intention is to submit an application in the near future.
		H0304	Cefnesgair Llanbadarn Fawr	1.45	58	Outline application for 48 units being processed 2016.
		H0306	Land at Southgate, Penparcau	5.40	189	Development to occur in 2 phases over last part of the plan period. Hydraulic restrictions exist in relation to sewage. Major highway improvements required.
		M0303	Park Avenue	3.67	33	Planning application on part of site for 33 residential units. Further application for 24 residential units being determined.
	Llanilar	H1401	Land Opposite Y Gorlan	3.34	84	LDP trajectory: 2013-2017 (42 units), 2018-2022 (42 units).
	Lampeter	H0501	Former Lampeter Primary School	0.65	12	Discussion has commenced with regard to bringing this site forward

Local Authority	Station	Policy No.	Site Name	Area (Ha)	Units	Details
		H0502	Site rear of Ffynon Bedr	0.81	20	No known issues with regard to deliverability. Development of the site is forthcoming
		H0503	Site on corner of Forest Road	0.57	9	No known issues with regard to deliverability. Development of the site is forthcoming
		H0504	Forest Road	4.5	90	Discussion has commenced with regard to bringing this site forward.
		H0505	Land adj Maesyr-deri	4.2	105	LDP trajectory: 2013-2017 (52 units), 2018-2022 (53 units). No known issues with regard to deliverability.
	Tregaron	H0701	Land off Dewi Road	1.8	36	Application approved 02/2/2016 for 23 units.
		H0702	Land rear to Rhyd Y Fawnog	1.5	38	Discussions with the site owner have indicated that development of the site will be forthcoming.
		M0701	Cylch Caron	2.1	20	Application approved 02/2/2016,
Carmarthenshire	Llanybydder	T3/11/h1	Adj. Y Neuadd	n/a	10	
		T3/11/h2	Adj. y Bryn	n/a	10	
		T3/11/h3	Lakefield	n/a	39	
		T3/11/h4	R/O Deri, Heol y Deri	n/a	16	
		T3/11/h5	Troedybryn	n/a	23	
	Pencader	SC20/h4	Bro'r Hen Wr	n/a	7	
		SC20/h5	North of Maes Cader	n/a	37	
		SC20/h6	Adj. Tremle House	n/a	9	
	Carmarthen	GA1/h1	Penymorfa	n/a	180	
		GA1/h2	Adj. Bryn Meurig	n/a	43	
		GA1/h3	Mounthill	n/a	79	
		GA1/h4	Rhiw Babell	n/a	14	
		GA1/h5	Former Hospital, Priory Street	n/a	12	
		GA1/h6	Former BT Exchange Building	n/a	14	
		GA1/h7	Former DJK Buildings	n/a	14	
		GA1/h8	Former Health Authority Buildings	n/a	8	

Local Authority	Station	Policy No.	Site Name	Area (Ha)	Units	Details
		GA1/h10	Parc Y Delyn	n/a	35	
		GA1/h11	Springfield Road	n/a	30	
		GA1/h14	Former Coach depot	n/a	9	Outside the 2km boundary so not included further in this study
		GA1/h16	Ashgrove	n/a	20	
		GA1/h17	College Road (ext)	n/a	153	
		GA1/h18	Penybont Farm	n/a	16	
		GA1/h21	Rhiw Babell extension	n/a	16	
		GA1/MU1	West Carmarthen	n/a	1100	Outside the 2km boundary so not included further in this study

Source: Mott MacDonald

7.4.7 Settlement Summary

Land use and land allocations in the study area are shaped by the topography and terrain. This means that land availability is limited by constraints which are more pronounced in different settlements. The analysis undertaken here has shown that development sites are located close to each proposed station and would be more attractive if they are more accessible and better connected by public transport.

7.5 Future Economic Growth

Based on our research, we have identified eight employment sites and 40 residential sites which could be directly influenced by the scheme. The quantitative economic analysis of land utilisation has been undertaken using the Transparent Economic Assessment Model (TEAM) to assess high level economic impacts. TEAM, as summarised in the figure below, is a versatile tool designed to calculate the economic impact of proposed infrastructure intervention and policy measures.

It has been designed by experts in economics, economic development and regeneration and is in-line with HM Treasury Green Book principles and Homes & Communities Agency's (HCA) Additionality guidelines. The tool measures the potential stimulus to economic activity from interventions by estimating the consequential employment, salary, Gross Value Added (GVA) and investment benefits that would otherwise not have arisen.

The findings from our research have been used to deliver a high level run of TEAM. The assumptions we have used are detailed below, followed by the findings from this economic assessment. At each stage of our analysis we have endeavoured to produce conservative estimates. Further work would allow for a more detailed site-by-site approach.

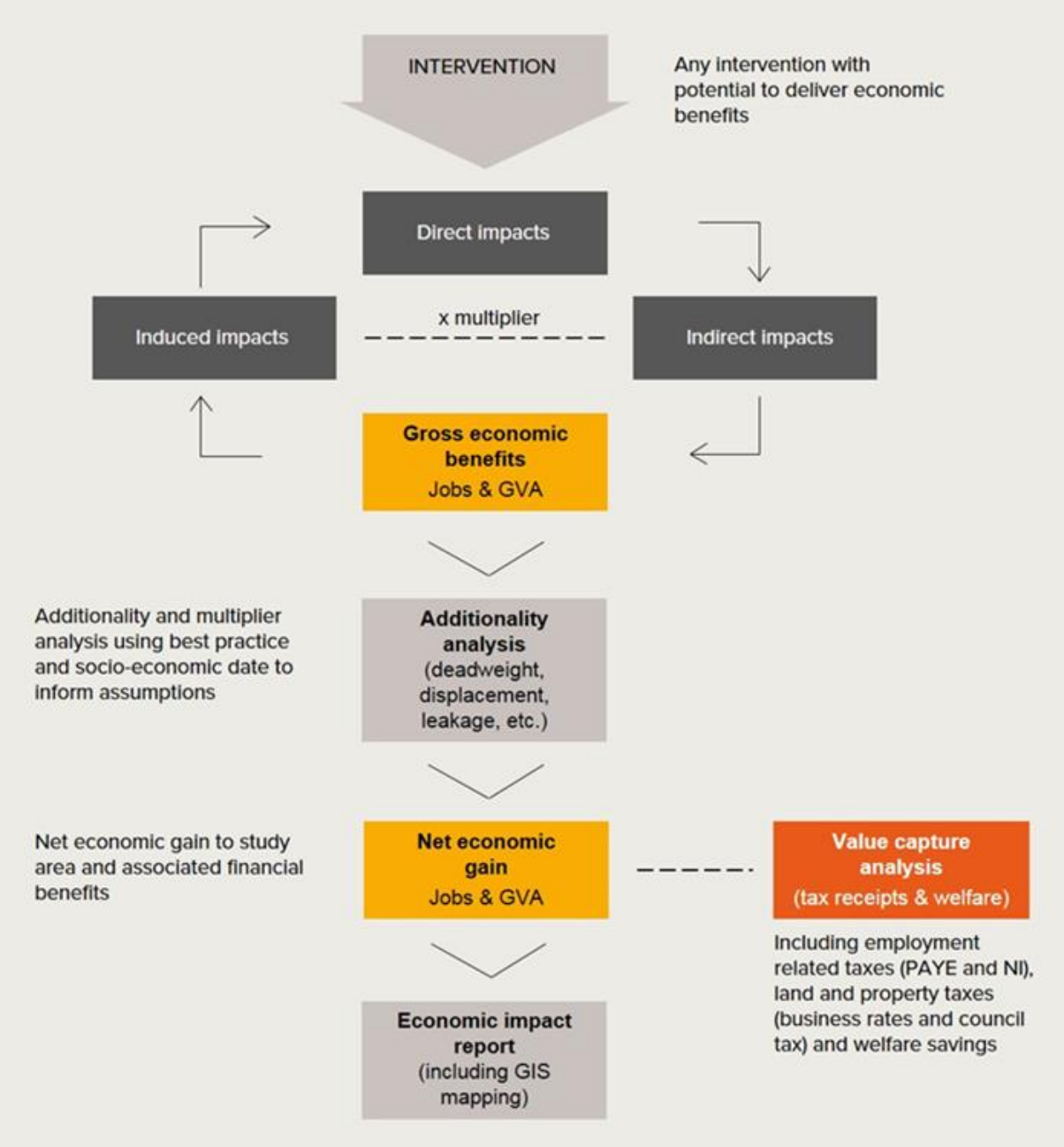


Figure 38: TEAM methodology

The potential economic benefits of the development sites identified have been assessed using TEAM through the following steps:

- Inputting the key site details as outlined in Table 23 and Table 24 into TEAM.
- Calculation of direct economic impacts through feeding the proposed uses by size through TEAM to calculate:
    - Direct effects of the sites in terms of employment and economic output (measured by GVA) of the sites being fully developed.
    - Indirect and induced effects of the sites being developed from those supported further down the supply chain and employment and activity supported by the incomes of those directly or indirectly employed (through consumption multiplier effects).

7.5.1 Employment sites

The key assumptions used in the analysis for all sites are as follows:

Table 25: Assumptions used in TEAM calculation

Effect	Level	Justification
Displacement	25%	At this point, it is not known whether any of the activity on the sites would be relocated from elsewhere in Wales. A figure of 25% has been assigned, in accordance with guidance from the HCA Additionality Guide 2014[5].
Leakage	18% Ceredigion 19% Carmarthenshire	In Ceredigion, 18% of those working in the area live outside of the boundary. In Carmarthenshire, this figure is 19%. The leakage set reflects this. This is based on Travel to Work (TTW) data from the 2011 UK census.
Deadweight	25%	It is considered to be likely that many of the jobs and GVA generated by these developments would be created without this intervention at some stage. However, it is likely that they would be developed sooner as a result of the station construction. Accordingly, a low figure of 25% for deadweight has been selected, in line with guidance from the HCA Additionality Guide.
Composite multiplier	1.29	The knock-on multiplier effects within the economy from: • Supply linkages due to purchases made as a result of the intervention and further purchases associated with linked firms along the supply chain (indirect effects). • Indirect or induced effects associated with local expenditure as a result of those who derive incomes from the direct and supply linkage impacts of the intervention. A composite multiplier of 1.29 has been applied, in accordance with guidance from the HCA Additionality Guide 2014 which states that this level is suitable when assessing B1 interventions in a local area. This multiplier models the indirect and induced economic impacts. This composite multiplier includes a supply linkage multiplier and a consumption multiplier. The supply linkage multiplier is "due to purchases made as a result of the intervention and further purchases associated with linked firms along the supply chain"[6]. The consumption multiplier is "associated with local expenditure as a result of those who derive incomes from the direct and supply linkage impacts of the intervention"[7].
GVA per worker (2016 prices)	£38,715	GVA figures have been calculated based on applying GVA per worker data for jobs which allows an estimate of the potential gross GVA impacts.
Occupancy rate	75%	An occupancy rate of 75% has been applied.
Employment density	Professional Services (B1a): 12m² of GEA/FTE Technology (B1a): 11m² of GEA/FTE R&D space (B1b): 50m² of GEA/FTE Industrial & Manufacturing (B2): 36m² of GEA/FTE Distribution centre (B8): 70m² of GEA/FTE Hotel (C1): 3m² of GEA/FTE Foodstore (A1): 18m² of GEA/FTE	Various employment densities have been used, depending on the site information given. These assumptions are based on the HCA Employment Density Guide 2015.

5 'Homes & Communities Agency (2014) 'Additionality Guide', page 30, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf
6 Ibid., page 33.
7 Ibid., page 33.

Using TEAM, calculations have been undertaken to understand the resulting land use changes and how this translates into potential job creation in and around the station settlements. These jobs are reported at a gross level only and relate to workplace employment at these sites.

In Carmarthen and Aberystwyth, much development is already taking place, suggesting the market in the area is buoyant. Both towns already have good accessibility (by public and private transport) so it is not anticipated that the re-opening of the rail line would have a significant impact on employment sites coming forward. As such, a low level of attribution (2%) has been assigned. For the remaining five settlements however, the introduction of a new station would likely boost and/or accelerate the development process. For many of these settlements, current access (both by public and private transport) is poor and a new station would make employment sites more attractive. Therefore, a 10% attribution level has been assigned. However, as this is a high-level study, analysis on a site-by-site basis has not been carried out.

Table 26: Impacts associated with development sites

Settlement	Site	Gross jobs	Gross GVA, £m	Attributed jobs	Attributed GVA, £m
Aberystwyth	Old Post Office	15	0.6	0	£0.01
	Park Avenue	129	£5.0	3	£0.10
	Llanbadarn Campus, Llanbadarn Fawr	802	£31.1	16	£0.62
Lampeter	Llambed Business Park	483	£18.7	48	£1.87
	Old Mart Site	142	£5.5	14	£0.55
Llanybydder	Old Foundry	81	£3.2	8	£0.32
Carmarthen	Cillefwr Industrial Estate	602	£23.3	12	£0.47
	Pibwrlwyd	2,139	£82.8	43	£1.66
	TOTAL	2,584	£170.1	144	£5.59

For the eight employment sites along the line, we estimate that 2,584 gross jobs would be created, of which 144 are attributable to the railway. Of the £170.1 million per annum created in gross GVA as a result of these jobs, £5.59 million per annum is attributable to the railway (2016 values and prices). Note that these estimates are the local impact, and would involve significant displacement within Wales and/or the UK, as opposed to the net additional UK impact described in Section 7.7.

7.5.2 Housing sites

Table 27 below, sets out our analysis and indicates that there are approximately 2,100 new dwelling units proposed in the seven station settlements. We have sought to attribute a proportion of these to the enhanced rail services while maintaining a conservative approach. For the two sites where there was no data provided on the number of dwellings, we have made an assumption based on Land Use Change statistics provided by the Department for Communities and Local Government[8] (DCLG).

8 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/595749/Land_use_change_statistics_England_2015-16_-_2_March_2017_version.pdf

Table 27: Station settlements and housing development

Station Settlement	Site	Number of dwelling units planned	No. dwellings attributed to rail
Aberystwyth	Old Post Office	n/a – assumed 3	0
	Swyddfa'r Sir	n/a – assumed 25	1
	Llanbadarn Campus, Llanbadarn Fawr	450	9
	Piercefield Lane, Penparcau	118	2
	Land adjoining Hafod y Waun	129	3
	Cefnesgair Llanbadarn Fawr	58	1
	Land at Southgate, Penparcau	189	4
Llanilar	Land Opposite Y Gorlan	84	8
Lampeter	Former Lampeter Primary School	12	1
	Site rear of Ffynon Bedr	20	2
	Site on corner of Forest Road	9	1
	Forest Road	90	9
	Land adj Maesyr-deri	105	11
Tregaron	Land off Dewi Road	36	4
	Land rear to Rhyd Y Fawnog	38	4
	Cylch Caron	20	2
Llanybydder	Adj. Y Neuadd	10	1
	Adj. y Bryn	10	1
	Lakefield	39	4
	R/O Deri, Heol y Deri	16	2
	Troedybryn	23	2
Pencader	Bro'r Hen Wr	7	1
	North of Maes Cader	37	4
	Adj. Tremle House	9	1
Carmarthen	Penymorfa	180	4
	Adj. Bryn Meurig	43	1
	Mounthill	79	2
	Rhiw Babell	14	0
	Former Hospital, Priory Street	12	0
	Former BT Exchange Building	14	0
	Former DJK Buildings	14	0
	Former Health Authority Buildings	8	0
	Parc Y Delyn	35	1

Station Settlement	Site	Number of dwelling units planned	No. dwellings attributed to rail
	Springfield Road	30	1
	Ashgrove	20	0
	College Road (ext)	153	3
	Penybont Farm	16	0
	Rhiw Babell extension	16	0
	TOTAL	**2143**	**89**

The relationship between rail infrastructure, rail services and land utilisation is not very well understood which is why we have erred on the side of caution when setting out our assumptions. In other words, we estimate that approximately 89 dwellings in the proposed station settlements would not be delivered without the rail stations, the increased connectivity and improved access to labour markets attractive for residents. These factors combine to make development sites in the settlements more attractive to developers and can influence the quantum, quality, timing and type of dwelling built. It is important to note that development activity on the proposed line is already underway – the proposed stations would support existing and emerging demand and would support acceleration of future development once the stations are in place.

Furthermore, there would be economic impacts arising from the expenditures of the residents moving in to the housing development. Not all of these benefits would be additional to the local economy as some residents would be relocating from within the study area. At this level of analysis, these impacts have not been calculated, however an estimate of overall residents can be made - guidance from the Welsh Government indicates that the average household size in mid-2015 was 2.29 people, meaning full construction of the housing development sites would accommodate 4,908. For the 89 houses attributed to the proposed stations, this would accommodate 204 people.

7.5.3 Construction Impact

The construction of these sites would have temporary economic impacts in terms of jobs and economic output (measured in GVA). Whilst the jobs generated by the construction of the sites would only persist during the construction period, they are likely to have a substantial impact on the local economy, with some impacts persisting in the longer term. Construction related expenditure, including local construction costs (or expenditure) directly on site through spending on goods, services, and labour, plus the wider indirect costs in the construction supply chain across the intervention areas overall would generate further expenditure in related and unrelated industries. This acts as a boost to the local and national economy and makes investment in construction particularly powerful in fuelling expansion in the economy.

These indirect jobs are part of the wider economic impact of the construction projects across the local regional economy and are ‘knock on’ economic effects generated by the construction project. These ‘knock on’ effects include:

- Indirect benefits created in the construction supply chain across the intervention areas, via the procurement of goods and services that enable housing to be constructed; and
- Induced benefits resulting from employees (both those directly employed and in the supply chain) spending their wages within each of the intervention areas.

Increased numbers of jobs and activity in the intervention area would have significant positive impacts on economic growth in the region. We note however, that many of these benefits would only be fully realised if goods and services are procured locally.

The value of the temporary construction impacts can be assessed using data on local salaries and percentage of cost spent on salaries, and standard assumptions about construction costs. We assumed that each new dwelling costs £100,000 of capital expenditure (CAPEX) to construct.

Table 28: Construction impacts of housing developments

Construction phase impact	Value	Formula	Source
Construction cost for dwellings	£8,928,000	(a)	Assumption of £100,000 CAPEX per dwelling, for xx dwellings
% of cost spent on salaries	32.43%	(b)	Annual Business Survey, ONS, 2014 (construction sector)
Salary expenditure	£2,895,629	(c)=(a)*(b)	Calculation
Average mean salary	£29,339	(d)	Annual Survey of Hours and Earnings, ONS, 2016 (Full time mean wages in construction sector)
Direct job years supported	99	(e)=(c)/(d)	Calculation
1 FTE=10 employment years	10	(f)	Best practice assumption
Direct jobs supported	10	(g)=(e)/(f)	Calculation
Leakage	19%	(h)	Origin destination statistics, ONS
Net direct FTEs	8	(i)=(g)-((g*(h))	Calculation
Composite multiplier of 1.29	0.29	(j)	HCA Additionality Guide 2014, p.35
Indirect & induced jobs	2	(k)=(j)*(i)	Calculation
Total net jobs supported	10	(l)=(k)+(i)	Calculation
Average GVA per worker in Wales	£38,715	(m)	Regional Accounts and Workforce jobs - July 2016, ONS
Total GVA supported	£400,633	(n)= (l)*(m)	Calculation

Source: Mott MacDonald

Taking the average annual salary figure in the Welsh construction sector for the latest year available, 2016 (£29,339), the direct salary expenditure would support approximately 99 direct job years. Given in standard guidance one “permanent” full-time equivalent (FTE) job is equal in regeneration effect to 10 job-years, in total, the job-years are equivalent to around 10 FTE jobs being directly created from the construction of these dwellings. Adjusting this to account for 19% leakage, we estimate that approximately 8 FTE direct jobs could be supported through the construction of the 89 dwellings.

When considering indirect and induced jobs and leakage levels, a further 2 jobs are supported. Therefore, across the entire period of the existing local planning policy projections, approximately 10 jobs and £400,000 GVA (2016 values and prices) could be attributed to the construction of the 89 dwellings which may not be brought forward but-for the proposed stations. Note that construction period benefits and disbenefits are not a standard component of transport appraisal, and these impacts cannot be considered as net additional in the conventional economic appraisal.

7.5.4 Economic Development Summary

Using the development sites identified, this section has presented additional local wider economic impacts which the scheme could facilitate. These cannot be considered as net additional at the UK level, as there is likely to be a significant volume of displacement. Using assumptions and levels of attribution attained from HM Treasury guidance, Annual Business Survey and Annual Survey of Hours and Earnings, we have calculated the following benefits:

For the eight employment sites along the line, we estimate that 2,584 gross jobs would be created, of which 144 are attributable to the railway. Of the £170.1m created in gross GVA as a result of these jobs, £5.59m is attributable to the railway.

89 dwellings in the proposed station settlements would not be delivered without the rail stations, the increased connectivity and improved access to labour markets attractive for residents.

Approximately 10 jobs and £400,000 GVA could be attributed to the construction of the 89 dwellings which may not be brought forward but-for the proposed stations.

7.6 Visitor Economy

In this section, we present current tourism levels in Ceredigion and Carmarthenshire and discuss how these might be affected by the re-opening of the rail line.

7.6.1 Visitor Economy Methodology

The overall approach to assessing tourism impacts is as follows:

- **Definition:** this involves distinguishing between tourism and recreational activities, establishing types of tourism (inbound overnight, domestic overnight and day tourists), and determining the study area.
- **Qualitative assessment:** setting out current tourism offer.
- **Quantitative assessment:** this will establish a robust data source of tourism impacts in the study area.

7.6.2 Definition of Tourism (vs. Recreation)

It is important to distinguish between tourism and recreation. Tourism impacts are unlikely to relate to the site alone but the wider area (e.g. a stretch of beach may be an important attractor to a settlement but tourism expenditure (and therefore impacts) would take place around the site, in hotels, restaurants, shops within the settlement). The table below highlights the differences between tourism and recreation – only tourism impacts will be discussed in this chapter.

Table 29: Tourism and recreation

Criteria	Tourism	Recreation
Regular everyday activities	x	✓
Duration of trips	3 hrs or more	Less than 3 hours
Distance from place of usual residence	Further away more likely to be a tourist	If local residents likely to be recreation.

Source: Mott MacDonald

7.6.3 Types of tourism

Within tourism there are three sub-sets of visitors which should be considered when identifying tourism impacts:

- **Inbound overnight:** International tourists from outside their normal country of residence (e.g. a Spaniard visiting Britain) and related spend in the UK.
- **Domestic overnight:** Trips away from home made by UK residents involving an overnight stay, taken by adults aged 16 and over and accompanying children aged up to 15. Each adult or child present on the trip counts as a trip.
- **Tourism day:** A day trip which fulfils the following criteria:
    - Duration – lasts at least 3 hours.
    - Regularity – activity not undertaken regularly.
    - Place – destination of visit is different from place where the participant lives unless the visit has involved watching live sporting events, going to visitor attractions, or going to special public events.

The distinction between different forms of tourism is important when calculating economic benefits, as different types of tourists have varying spending patterns.

7.6.4 Qualitative Assessment of Current Tourism Offer

The proposed rail line travels through scenic rural areas, popular with tourists. Table 30 presents the key tourist attractions for each of the settlements.

Table 30: Key tourist attractions for station settlements

Settlement	Key tourist attractions
Aberystwyth	Aberystwyth is a historic market town, administrative centre, and holiday resort within Ceredigion. There are multiple key tourist attractions around Aberystwyth: The Seafront: This is a visitors and locals favourite. It is a 2,000-metre length of promenade with a variety of sights and landmarks, from the harbour and marina in the south to the busy main beach and Constitution Hill at the northern end: Constitution Hill: quiet end of the Promenade. It has an Electric Cliff railway carrying people up to the top of the hill where there is a great view of the town and bay. It is one of the longest cliff railways in Britain, spanning 240 metres. At the top sits the Camera Obscura, a recreation of a popular Victorian amusement, and other hilltop attractions. Marine Terrace and North Beach: busiest section of the seafront, fronted by the Promenade and home to hotels, houses and student halls. Mainly shingle and dark sand beach with clean sea and space to sunbathe. This part is also home to Aberystwyth's pier which was constructed in 1864. It has been reduced from its peak of 242m to 90m, but houses bars, nightclubs, an ice-cream parlour, amusement arcade, snooker club and brasserie. New Promenade and South Marine Terrace: Completed in early 1900s, begins at the pier and winds around the edge of the castle grounds, passing the war memorial, St Michael's church and the Old College. The Old College is a seafront landmark which was originally built as a hotel, but is now a building of the Aberystwyth university. Aberystwyth Castle: The ruins of this castle date from the 13th century. Today's remains are the inner and middle walls of a once great castle. Also located in and around the castle grounds are a popular children's playground, picnic areas, a putting green and a crazy golf course. Ceredigion Museum: Housed in the Coliseum Theatre, the museum showcases the history of Aberystwyth and the county of Ceredigion. It includes a reconstruction of a 19th century Welsh cottage and the mechanism of the old town clock which stood at the top of the Great Darkgate Street. National Library of Wales: One of UK's copyright libraries (entitled to receive a copy of every book published in the UK), this holds vast collections, archives, galleries and displays. It was founded in 1907. It holds a collection of nearly four million books meaning the building has had to be extended a number of times to avoid running out of room. As well as books and other printed publications, there are over a million maps, along with photographs, paintings and sound and video recordings. Since 2016, it was home to the famous Nanteos Cup (claims to have various associations with Jesus Christ). Penglais Nature Park: Situated on the northern edge of the town and spans 11ha. The woodland is home to a range of wildlife and flowers. Pen Dinas Hill Fort: On the southern edge of town is this 120m hill. Once home to an Iron Age hill fort, and it said to be built at the summit back around 400BC. Aberystwyth Arts Centre There are also multiple forests, woods and parkland including Bwlch Nant-yr Arian Forest Centre (a large woodland site with a whole host of activities including walks, cycle trails and red kite feeding – 10 miles out of the town centre), and Hafod Estate.
Llanilar	Walkers and cyclists are well catered for in Llanilar as the landscape is criss-crossed with trails and rights of way. The 21 mile (34km) Ystwyth Trail connecting Aberystwyth, on the shore of Cardigan Bay, with Tregaron in the northern Teifi Valley, passes through the village. The remains of a Roman Fort can be found at Trawsgoed to be found a short way along the trail to the east of the village. Anglers are well catered for with access to the banks of the Ystwyth River close to the the village centre.

Settlement	Key tourist attractions
Tregaron	Tregaron has a number of tourist-related facilities and attractions. The Welsh Gold Centre is a major tourist attraction selling jewellery crafted from Welsh gold and includes display workshops, a jewellery showroom, exhibition galleries, a retail craft centre and café. The Red Kite Centre and local museum is located just outside the town centre and provides interpretative display material about the Red Kite and local information about the heritage of Tregaron and the surrounding countryside. The Cambria Arts Gallery (an exhibition gallery run by Cambria Arts to promote the work of artists living in and around mid-Wales) is located within the town square. Other attractions within close proximity of Tregaron include Strata Florida Abbey and the Cors Caron Bog Nature Reserve. There are a number of annual events and festivals which take place within Tregaron itself as well as in the neighbouring villages of Llandewi Brefi, Pontrhydfendigaid, and Ystrad Meurig. Tregaron is a `hub' for a wide range of visitor activities, including walking, cycling, horse-riding and birdwatching. The development of the Ystwyth Trail, in particular, is an exciting opportunity for the town, linking as it does Tregaron with Aberystwyth via a predominantly off-road cycleway, bridleway and footway.
Lampeter	Lampeter is a busy market town and is the third largest urban area in Ceredigion. Its countryside attracts walkers, and fishing opportunities on the river Teifi attracts anglers. However, the town is best known as home to the oldest university in Wales. Lampeter holds an annual agricultural show. The show involves horses and other livestock, and a vintage and carriage display. Lampeter has a thriving organic food trade and each summer celebrates the area's wealth of local produce with an annual summer food festival which attracts those from around Wales. There are a number of walks of varying length around Lampeter. One is the Lampeter Town Trail which explains its heritage and history, starting at Lampeter Rugby Club, which is one of the founder members of the Welsh Rugby Union of which there is a 'monument to the Birthplace of Welsh Rugby'. It then goes onto the War memorial, designed by W Goscombe John and the University, and explains Lampeter's connection with the attempted murder of Dylan Thomas in 1945. As well as this, Lampeter's history is a big attraction for tourists. The Romans once mined for gold near Lampeter, which is a site now managed by the National Trust consisting of an old gold mine. Visitors can experience first-hand conditions in which gold miners worked. The town was originally a Welsh settlement until it was colonised by the Anglo-Normans with the building of Lampeter Castle.
Llanybydder	Llanybydder is a small market town in Carmarthenshire. It lies on the banks of the river Teifi which is renowned as one of the best rivers in Wales for salmon fishing. It is famous for its monthly horse fairs, which attract dealers from both the UK and Ireland. It is believed to be Europe's largest horse fair. Welsh ponies are an integral part of the country's tradition.
Pencader	Pencader is a small settlement, although there are a number of holiday accommodation businesses in and around the village. The countryside surrounding the village has a number of walks and trails- the fields, valleys, woods, forestry and streams offer a variety of environments. Pencader has an annual carnival and is the centre for the Pencader Pipe Festival.
Carmarthen	Carmarthen is an attractive town set on the banks of the River Towy, with a pedestrianised shopping area and a large modern covered market. From the old Quay, narrow winding lanes lead up between old houses to the gatehouse of a ruined 14th-c Norman castle. Carmarthen is one of the oldest towns in Wales, it was first settled by Celtic tribes and later by the Romans around 75 AD, who built a wooden fort on a small escarpment above the river. No trace now remains of the original occupation, except for a Roman amphitheatre that once seated 5,000 people, discovered near Priory Street. The Carmarthen Museum, located to north-east of the town, displays many of the fine Celtic and Roman relics uncovered in the area.

Source: Mott MacDonald

7.6.5 Possible Visitor Economy Impacts of a New Station

An increase in tourism is one way in which stations can have a significant economic impact. This could include:

- Station provision could support an increase in the number of visitors from outside the region.
- Facilities in and around the stations could benefit from increased visitor spend.
- The stations could reduce a near total reliance on the car to reach these settlements.
- The stations could also become a 'hub' for travel to features such as the Welsh Gold Centre.
- Finally, by being able to use the station to get to work or training, the station widens the demand side of the labour market for those around the region who have requisite skills in the tourism and visitor economy - as well as signalling opportunities locally for young people considering a career in the industry.

- In terms of examples and evidence from elsewhere:
- Evidence from the Bamford Loop Environmental Statement in the Peak District shows how enhancements to rail services into key tourist destinations can add moderate, but beneficial, numbers of jobs and GVA to the local economy.
- The appraisal of the Moorlands and City heritage railway scheme in rural Staffordshire also demonstrated how increasing access to a tourist destination through rail service enhancements and new stations and lines can have significant local economic impacts on the visitor economy.

7.6.6 Visitor Numbers and Spend

To produce an accurate number of FTEs and GVA supported by tourism in Carmarthenshire and Ceredigion, we have used Visit Britain data. Visit Britain produces a comprehensive dataset, including inbound, domestic and day visitors. The lowest level of geography is local authority level, meaning specific data for the individual settlements is not available; however, it is useful to get an idea of the current tourism footprint of the area.

Table 31 shows the number of visitors and visitor expenditure for Ceredigion and Carmarthenshire. In both local authority areas it should be noted that coastal attractions are a significant attractor for tourist trips, and the rail line between Aberystwyth and Carmarthen would offer only limited accessibility to such destinations, primarily at Aberystwyth or via onward bus connections. However, it can help contribute towards a larger visitor offer in the area, i.e. by linking the various attractions along the route to provide a greater number and variety of interests. This could involve displacement from other areas within Ceredigion and Carmarthenshire.

Table 31: Visitor numbers and spend

	Number of visitors – Visit Britain (2010-2012 average) (m)	Proportion of total visitors	Visitor spend – Visit Britain (2010-2012 average) (£)	Proportion of total spend
Day visitors				
Ceredigion	3,580,000		£85,000,000	
Carmarthenshire	5,280,000		£115,000,000	
Wales	101,480,000	90.87%	£3,387,000,000	63.8%
Domestic overnight				
Ceredigion	530,000		£88,000,000.00	
Carmarthenshire	400,000		£65,000,000.00	
Wales	9,320,000	8.35%	£1,587,000,000.00	29.9%
Overseas visitors				
Ceredigion	30,000		£17,000,000.00	
Carmarthenshire	30,000		£7,000,000.00	
Wales	870,000	0.78%	£335,000,000.00	6.31%
Total visitors				
Ceredigion	4,140,000		£190,000,000.00	
Carmarthenshire	5,710,000		£187,000,000.00	
Wales	111,670,000	100.0%	£5,309,000,000.00	100.00%

Source: Mott MacDonald

The table shows that while overseas visitors make up less than 1.0% of the overall number of visitors to Wales (870,000), they account for 6.3% of visitor expenditure (£335 million). Both Carmarthenshire

and Ceredigion have lower proportions of overseas visitors (0.5% and 0.7% respectively) but account for higher proportions of visitor spend, particularly in Ceredigion where they account for almost 9%. Meanwhile, domestic overnight visitors make up a high proportion of visitors to Ceredigion (12.8%) in comparison to Carmarthenshire (7.0%) and the Welsh national average (7.3%). They made up for nearly half of the total spend in Ceredigion (46.3%). Day tourists are by far the most frequent type of visitor in Ceredigion, Carmarthenshire and Wales, accounting for over 85% of total visitors in all areas. They accounted for the majority of tourism expenditure in Carmarthenshire (61.5%) and close to half in Ceredigion (44.7%). This demonstrates that while visitors who stay overnight are significantly less numerous, their average visitor expenditure is far higher than for day visitors.

7.6.7 Visitor Economy Summary

By improving access to Ceredigion and Carmarthenshire, there is potential for visitor numbers to increase. Tourists would be able to make more day visits to the area from bases such as Aberystwyth and Carmarthen. It is unlikely that these increased day visits would substantially displace overnight visits, as the travel time from bases such as Cardiff and Birmingham would still entail a significant journey. As such, it is likely that both day and overnight visitors would increase. Improved public transport access would encourage more tourists, not only to the permanent attractions (such as the Welsh Gold Centre) but also to the fairs and festivals which take place around the year.

Given the spatial level of available data [local authority only], and issues with disentangling local displacement and net additional effects (i.e. what proportion of any activity forecast to take place along the line is already taking place in Ceredigion and Carmarthenshire), to quantify the increased number of visitors and associated spend, further analysis should be undertaken, including stakeholder consultation. In addition, the data suggests that any increase in overseas visitors would be marginal, and the visitor economy impacts would primarily involve displacement from other areas within Wales and the UK. These latter impacts cannot be added to the economic case metrics.

7.7 Level 2 Benefits

Results in Table 16 relate to the core 'Level 1' benefits only. Additional Wider Economic Impacts (WEIs) analysis provides an 'adjusted' set Level 2 benefits estimate using standard DfT guidance on agglomeration and labour supply. This analysis makes use of the same inputs as the demand forecasting and core economic appraisal detailed previously.

7.7.1 Level 2 Benefits - Agglomeration

Agglomeration impacts are distinct from other labour supply effects and capture the effect of workers and businesses being closer together, as measured by transport times and costs.

Agglomeration is measured by a term known as 'effective density', which provides a measure of the mass of economic activity across the modelled area and therefore reflects the accessibility of firms and workers to each other. Effective density is the metric at the zonal [sector] level that quantifies the difference in agglomeration for the DS and DM scenarios. In addition to transport supply inputs, it also includes the number of jobs by sector/industry type in each spatial sector.

The agglomeration calculations require the definition of a Functional 'Urban' Area (FUA), typically defined as the travel-to-work area from Census analysis, filtered as appropriate to remove outlying data points.

Agglomeration Impacts

Agglomeration occurs when firms, and their employees, are closer to one another and this gives rise to productivity benefits as firms are able to access a larger labour market and increased number of suppliers and partners. The benefit also includes knowledge sharing and technology spill over effects from being located close together. This is beyond those benefits measured in standard transport user benefit appraisal.

Where times and costs reduce then there is an additional monetary benefit, over and above standard transport user benefits, from an increase in productivity. This is measured in GDP and deflated and

discounted to 2010 values and prices in line with all other monetised benefits for TAG compliant appraisal.

Calculations of agglomeration benefits are made with reference to:

- Changes in the Generalised Cost (GC) of travel by all main modes for commute to work and employer's business purposes for a return tour (inbound and outbound times and costs);
- Total employment in each zone by industry type (construction, consumer services, manufacturing, and producer services);
- Agglomeration elasticities and decay parameters by industry;
- GDP(s) per worker in 2010 prices; and
- Changes in GDP(s) per worker over time.

Analysis of effective densities is undertaken at the P-A, sector-to-sector, level for the DS and DM scenarios, and then summed at the attraction sector level for each future year.

Land uses do not currently vary between the DS and DM scenarios, i.e. static clustering is assumed.

The effective density for a given sector is given by:

$$d_i^{S,k,f} = \sum_{j,m} \frac{E_j^{S,f}}{\left(g_{i,j}^{S,m,f}\right)^{a^k}} \qquad (3)$$

where:

- $d_i^{S,k,f}$ = the effective density for scenario S, employment sector k, and area i
- $E_j^{S,f}$ = the total employment for scenario S, future year f, and area j
- $g_{i,j}^{S,m,f}$ = the average generalised cost by mode m, between areas i and j,
  - for scenario S in future year f
- a^k = a distance decay parameter for each employment sector k

Inputs by purpose take a weighted average between commuting to work and employer's business with splits for Wales from the 2012 release of the National Travel Survey (NTS).

The agglomeration impact at an individual sector level is then estimated by:

$$WI1_i^{k,f} = \left[\left(\frac{d_i^{A,k,f}}{d_i^{B,k,f}}\right)^{\rho^k} - 1\right] GDPW_i^{B,k,f} E_i^{B,k,f} \qquad (4)$$

Where:

- $WI1_i^{k,f}$ = the total agglomeration impact in area i, employment sector k and future year f
- $d_i^{A,k,f}$ and $d_i^{B,k,f}$ = the effective densities for scenarios A and B, employment sector k, and area i
- ρ^k = the elasticity of productivity with respect to effective density for employment sector k
- $GDPW_i^{B,k,f}$ = GDP per worker in area i, employment sector k and future year f
- $E_i^{B,k,f}$ = total employment in area i, employment sector k, future year f, in the base scenario B

7.7.2 Effective density elasticities and decay parameters

The analysis undertaken has considered changes in total employment and GDP per worker industry type. Table 32 shows the elasticities and parameters used at this stage.

Table 32: SOC Code level elasticities and decay parameters for agglomeration

Industry Type	Effective Density Elasticity	Decay Parameter
1. Construction	0.034	1.562
2. Consumer services	0.024	1.818
3. Manufacturing	0.021	1.097
4. Producer services	0.083	1.746

Source: TAG Databook

7.7.3 Level 2 Benefits – Labour Supply

Increases in labour supply at a UK level, due to changes in transport provision, occur when individuals move into employment from economic inactivity. At a more local level labour supply effects can include displacement of such employment from elsewhere in the UK, but these cannot be included in the economic appraisal metrics, and instead should be documented in strategic case benefits.

This increase in labour supply implies a change to land use, i.e. the number of jobs changing at a given location, and existing market failures such as transport times and costs acting as barrier to the labour market.

The approach taken is:

- The change in labour supply is quantified through the standard TAG formulae, and is calculated as the tax wedge of the resulting GDP impact. The analysis only considers those jobs considered as net additional to the UK economy, rather than those displaced to/from the area.
- The standard TAG approach uses 'round trip' commuting costs for each considered mode. At this stage we have only included car, rail (inclusive of Metrolink), and bus, and we consider the mode split across these from the 2011 Census for each sector-to-sector pair, i.e. this does not change over time.
- The labour supply impact, change in jobs, is given by:

$$E^f = \sum_i \sum_j \left[-\varepsilon^{LS} \left(\frac{\left(G_{i,j}^{A,f} - G_{i,j}^{B,f}\right)\sigma_j^{S,f}}{(1-\tau_1)y_f^f} \right) W_{i,j}^{S,f} \right] \quad (5)$$

Where:

- E^f = the labour supply impact by forecast year f
- $-\varepsilon^{LS}$ = the elasticity of labour supply with respect to effective wages (net of taxes and other costs) and is set equal to 0.1
- $G_{i,j}^{A,f}$ and $G_{i,j}^{B,f}$ = the average round trip GC of commuting between areas i and j, under scenarios A and B respectively
- $\sigma_j^{S,f}$ = the average annual number of round commuting trips by a worker employed in area j (assumed to be 230.5)
- τ_1 = the average annual tax take required to convert gross earnings (y_f^f) into net earnings, for comparison with changes in commuting costs. It is estimated to be equal to 30%.
- $W_{i,j}^{S,f}$ = the number of workers living in area i and employed in area j. For the purposes of this assessment we use the 2011 Census P-A matrices as a starting point, growthed at the attraction end by observed, to 2015, and forecast, beyond 2015, using TEMPRO v7.2 data.

The GDP impact is then simply estimated by combining the number of jobs estimated from Equation (1), and the tax wedge estimated for economic case inputs by multiplying the GDP figure by 40%.

7.7.4 Level 2 Benefits – Wider Economic Impact Summary

Table 33 summarises the results of the Level 2 analysis. Across the three DS scenarios, quantification of Level 2 WEIs adds between £33.0 million and £55.0 million to the PVB and NPV. Due to ONS population projections for Wales showing population decline post-2037, the relaxation of the 20-year demand cap results in a slight fall in the PVB and NPV in DS1b and DS3b.

Table 33: Adjusted Economic Appraisal Results by Scenario (discounted £ks in 2010 values and prices)

Metric	DS1	DS2	DS3
Economic Metrics (Level 1 Benefits)			
Present Value of Benefits	51,068	65,766	82,204
Present Value of Costs	-115,159	-103,346	-95,508
Net Present Value	**166,227**	**169,112**	**180,713**
Adjusted Economic Metrics (including Level 2 Benefits)			
Agglomeration	32,719	50,230	54,514
Labour Supply	281	365	492
Adjusted Present Value of Benefits	84,068	116,361	137,210
Present Value of Costs	-115,159	-103,346	-95,508
Adjusted Net Present Value	**199,227**	**219,707**	**235,718**

Source: Mott MacDonald

7.8 Non-Traditional Benefits

In addition to the Level 1 and 2 benefits detailed in preceding sections, the scheme is also likely to result in more localised impacts which:

Entail the displacement of activity from elsewhere in Wales or the UK (preceding analysis attempts to account for this to produce a net UK effect). This localised displacement effect cannot be included within the economic case for a scheme, but can be documented/quantified in the strategic case narrative; and

Are 'proxied' by the standard Level 1 and 2 economic benefits previously described and quantified in the economic case (e.g. the monetary valuation of time savings acts as a direct proxy for economic benefits through consumer surplus theory).

An additional tier of analysis involves dynamic land use modelling, i.e. allowing land use to adapt in response to changes in transport supply. For rail schemes the common effect is to promote 'clustering' around stations. This would be expected to result in both:

Additional net UK effects, e.g. through increased agglomeration; and

Further displacement of activity from elsewhere in Wales and the UK.

These latter impacts are termed Level 3 benefits, and require the use of Supplementary Economic Modelling (SEM) techniques or dynamic Land Use Transport Interaction (LUTI) models which are not available for this commission.

This sub-section therefore focuses on the localised impacts which could be attributed to the scheme, which are suitable for the strategic case narrative.

7.9 Influence of Wider Economic Impacts on Indicative Cost Estimates to Produce Economic Outcomes

This section revisits the PVB, and initial PVC estimates (containing selected items only) to the influence of the assessed Wider Economic Benefits, on the same basis as previously set out within section 6.5.

This is to predefined economic appraisal thresholds in order to estimate an additional PVC estimate which would satisfy these. This PVC estimate is then converted into an equivalent construction cost estimate in current (2017) prices, inclusive of:

- Undiscounting;
- Conversion from market to non-market prices;
- Conversion from 2010 to 2017 prices;
- Removal of an assumed optimism bias component of 64% (Stage 1 value for conventional rail); and
- Removal of above background inflation change in construction costs (5% versus RPI at 3%).

We do not include any additional risk adjustment in this process. Resulting estimates should therefore be considered of such an adjustment.

For simplicity, we exclude the subsume major renewals element into the initial construction period, albeit this element, being much further in the future, would have a substantially different discount rate (giving a smaller PVC component).

We assume a four year construction period, commencing in 2020, with the following spend profile:

- Year 1 – 20%;
- Year 2 – 30%;
- Year 3 – 30%; and
- Year 4 – 20%.

Table 34 (as a revision of Table 17) summarises this process, and shows that, to achieve a BCR of 1.0, the initial cost estimates (inclusive of optimism bias) for all major construction elements would have to not exceed totals (in 2017 prices) of approximately:

- £281.2 million for DS1 (120 minute service interval);
- £310.1 million for DS2 (90 minute service interval); and
- £328.5 million for DS3 (60 minute service interval).

The consideration of Wider Economic Benefits would therefore increase the affordability limits of the scheme (relative to a BCR of 1.0) by between £46.58m and £77.64m dependent on the service interval adopted.

Table 34: WEI Adjusted Indicative Major Capital Costs to Produce BCR (£Ks)

DS1: 0.5tph in each direction (120 minute service interval)				
Benefit Cost Ratio Threshold	0.5	**1.0**	1.5	2.0
[A2] Adjusted PVB	84,068	**84,068**	84,068	84,068
[B] Initial PVC	-115,158	**-115,158**	-115,158	-115,158
[C] Target PVC [A] / BCR (discounted in 2010 market prices)	168,136	**84,068**	56,045	42,034
[D] PVC Gap [C] - [B], converting costs into positive numbers	283,295	**199,227**	171,204	157,193
[E] Cost Gap - undiscounted	427,036	**300,313**	258,072	236,951
[F] Cost Gap – non-market prices	358,854	**252,364**	216,867	199,118
[G] Cost Gap - 2017 prices	436,260	**306,799**	263,646	242,069
[H] Cost Gap - allowing for construction inflation	399,883	**281,217**	241,662	221,884
DS2: 0.67tph in each direction (90 minute service interval)				
Benefit Cost Ratio Threshold	0.5	**1.0**	1.5	2.0
[A2] Adjusted PVB	116,361	**116,361**	116,361	116,361
[B] Initial PVC	-103,346	**-103,346**	-103,346	-103,346
[C] Target PVC [A] / BCR (discounted in 2010 market prices)	232,721	**116,361**	77,574	58,180
[D] PVC Gap [C] - [B], converting costs into positive numbers	336,067	**219,707**	180,920	161,526
[E] Cost Gap - undiscounted	506,584	**331,183**	272,716	243,483
[F] Cost Gap – non-market prices	425,701	**278,305**	229,173	204,607
[G] Cost Gap - 2017 prices	517,526	**338,336**	278,607	248,742
[H] Cost Gap - allowing for construction inflation	474,373	**310,125**	255,375	228,001
DS3: 1.00tph in each direction (60 minute service interval)				
Benefit Cost Ratio Threshold	0.5	**1.0**	1.5	2.0
[A2] Adjusted PVB	137,210	**137,210**	137,210	137,210
[B] Initial PVC	-95,508	**-95,508**	-95,508	-95,508
[C] Target PVC [A] / BCR (discounted in 2010 market prices)	274,420	**137,210**	91,473	68,605
[D] PVC Gap [C] - [B], converting costs into positive numbers	372,928	**235,718**	189,982	167,113
[E] Cost Gap - undiscounted	562,148	**355,319**	286,376	251,905
[F] Cost Gap – non-market prices	472,393	**298,587**	240,652	211,684
[G] Cost Gap - 2017 prices	574,290	**362,994**	292,561	257,345
[H] Cost Gap - allowing for construction inflation	526,403	**332,726**	268,167	235,887

Source: Mott MacDonald

8 Conclusions

Although remnants of the historic railway between Aberystwyth and Carmarthen can be readily discerned on the ground throughout most of its length, a number of significant physical and regulatory obstacles have materialised in the 50 years since the line was closed.

In consideration of a full range of requirements and constraints, the original rationale for the selection of the historic railway alignment is readily apparent, as is the preference for its re-use (with local deviations) in the absence of any practical alternative.

The history of its original construction, and 100+years of operation, inform the challenges to be overcome in its reinstatement, heightened by 21st century expectations of travel convenience, economy, environmental importance and protection.

Whilst this study broadly confirms the technical feasibility of reinstating a modified route and train service, it also highlights a number of key constraints/impacts to be resolved, and confirms the environmental importance and sensitivity of much of the route.

The identified scheme is believed to be close to optimal (within fixed constraints), but true viability would only be determined once the scheme has been more fully reconciled, through further detailed study, and in close consultation with the relevant local and statutory stakeholders.

Particular challenges include:

- **Cors Caron:** Identification of appropriate engineering solutions to address anticipated dynamic displacement and settlement issues related to the peat geology, whilst also being fully compatible with the environmental protection of the bog, and it's flora and fauna.
- **Carmarthen Afon Towy Crossing and A484 Closure:** Resolution/mitigation of the impacts of the required A484 link bridge closure to through traffic, and potential flood risk impacts of new bridge(s) across the Afon Towy.
- **Accommodation of the Gwili Railway Preservation Company:** Where it has been determined that the Gwili Railway could not continue to operate in its current form, the availability and cost of appropriate re-provision at another location.
- **Mitigation of extensive Flood Risks:** Measures required in regard to the significant lengths of the route that are within Flood and Tan15 Development advice zones.
- **Property Impacts:** There would be some level of unavoidable residential property loss, together with noise and visual impacts on several communities along the route.
- **Environment and Consents:** The route passes through, or close to, a large number of sites and features which are protected by a range of statutory designations, which would require careful consideration during the planning and implementation of the project.
- **Ground Conditions, Residual Structures and Earthworks:** In advance of in-depth investigation, the specific measures required to bring the historic infrastructure back into use cannot be fully determined.

  Similar ground condition risks exist in regard to major new works, such as the Pen-Y-Banc Tunnel, Llanfarian cutting, and other new earthworks and structures related to the various deviations from the historic route.

Subject to the satisfactory resolution of the above, initial operational assessments have determined that the reinstated route could provide a regular hourly train service between Aberystwyth, Llanilar, Tregaron, Lampeter, Llanybydder, Pencader and Carmarthen, with an end to end journey time of around 85 minutes.

It is suggested that these services may be most economically and beneficially provided by extension of existing services on the adjoining routes (e.g. the Manchester to Carmarthen services), with local infills to the achieve higher (hourly) frequencies where required.

On the basis of these assumed services, and an opening year of 2024, initial demand assessments indicate that the reinstated railway service could attract up to 370,000 trips in its first year of operation, rising to 425,000 and 489,000 in the assessment years of 2027 and 2037 respectively.

Figure 39 provides an 'Affordability Summary' of relevant scheme financial and economic factors, as determined by the Capital Cost, Economic, and Wider Economic Impact assessments which were undertaken as a part of the study, to advise:

- A total cost build-up of £775 million (@ Q4 2017 prices) for the assumed single core option, incorporating two passing loops, and configured to the delivery of a 60 minute service frequency in accordance with the findings of the technical study (as DS3).

  It should be noted that there are a range of specific assumptions and exclusions to this cost build-up (see section 5.1 and Appendix F).

- To the current level of scheme maturity, the cost build-up includes an optimism bias uplift of £276m, which is a general risk allowance reflecting HM Treasury/DfT guidance.

  Were the scheme to be progressed further, risk allowances would more appropriately be defined via quantified risk assessments to the particular challenges of the scheme, noting that this may identify a need for higher contingency values than given above.

- Considering a standard range of costs and benefits (to PDFH v.5.1) a CAPEX affordability limit (to a BCR of 1.0) has been determined in the range of £230m to £255m, dependent on the service interval adopted.

- By extension of the above assessment to include Wider Economic Impacts, CAPEX affordability limits (to a BCR of 1.0) were subsequently raised a range of £281m to £333m, again dependent on the service interval adopted.

- Economic Assessments to a range of 60, 90 and 120 minute service intervals demonstrate little sensitivity (£16m total variance) to improved frequencies against the standard assessment, with an increased (if still moderate) impact of £47m total variance, once Wider Economic Impacts are included.

- Even with overall journey times reduced by around a quarter (n.b. an undeliverable reduction from 85 to 65 minutes), separate time sensitivity tests also show only moderate impacts, with a Maximum NPV increase of £42m.

- A best case BCR of 0.43, or a £442m benefits gap to the assessed total scheme for a target BCR of 1.0 (as the point at which economic costs and benefits are equal).

Where the above demonstrates the absence of any realistic prospect of either improving the economic benefits of the scheme, or reducing its overall cost, it is readily apparent that the scheme does not present a positive economic case.

As such the scheme is only likely to be progressed in regard to wider societal needs, and strategic aims, the consideration of which is beyond the scope of this study. Low local population levels (and levels of business, leisure, tourism activity, etc.) impose the key constraint on realistic demand levels, and thus achievable economic benefit.

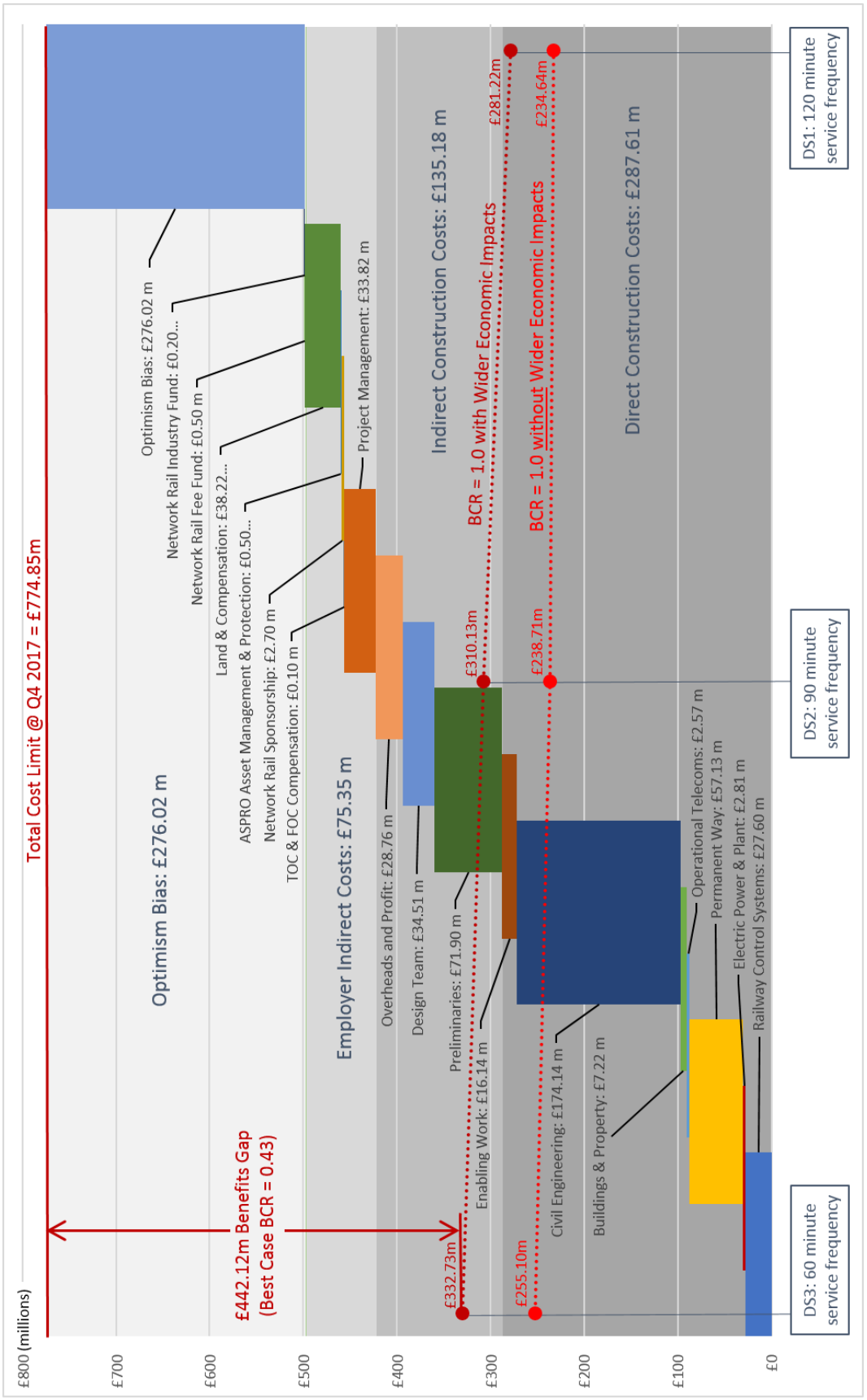


Figure 39: Affordability Summary

The achievement of a core BCR of 1.0 would require demand to more than double from the forecast, as shown relative to local populations in Figure 40 below.

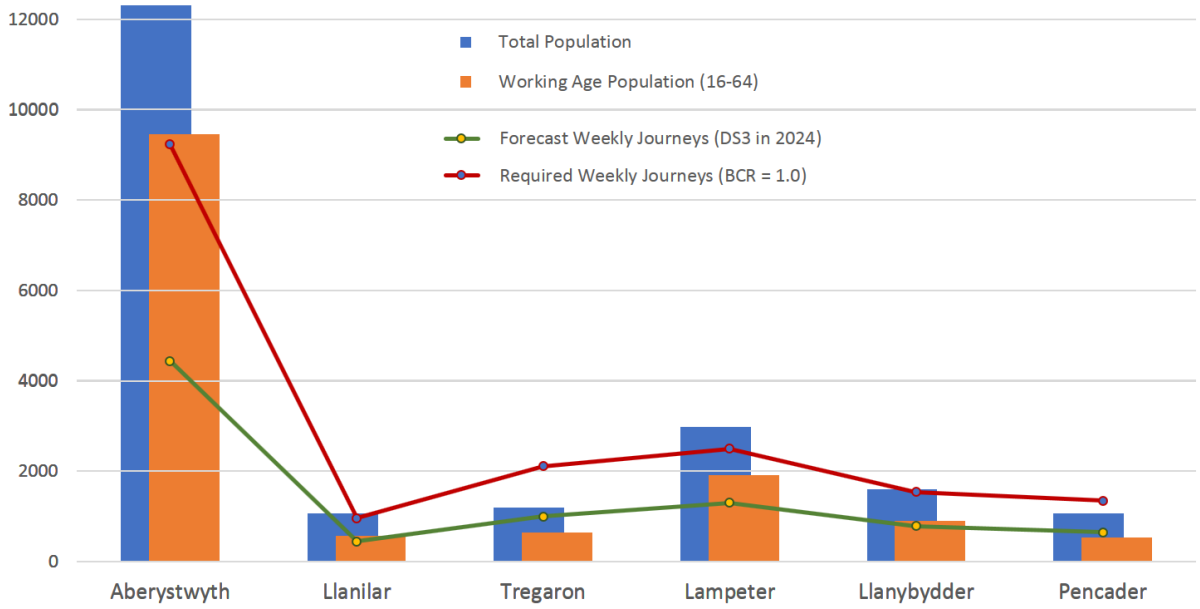


Figure 40: Forecast & Required Journeys per Week vs. Local Population

Returning to the original context of the WelTAG Stage One: Strategic Outline Case Report for *"Improving Strategic Transport Connections between Aberystwyth and Carmarthen"*, the completion of the study is useful in directly addressing many of the noted key risks, uncertainties, adverse impacts and constraints attributed to a new rail route. Workable solutions are presented to various of the issues raised, although concerns relating to capital costs, environment, insufficient population, and the Gwili Railway are confirmed.

Where the WelTAG Stage One "Case for Change" remains to be addressed, it is hoped that the findings of this study will provide useful benchmarks for cost and BCR comparison to the alternative options that have been recommended to be taken forward. In this regard, it should be noted that whilst the study has attempted to provide a comprehensive high level overview of principal issues and approaches, significant further detailed work would be required to fully define a deliverable scheme.

Appendices

A. Drawings

All Drawings are provided as separate PDFs

A.1 Plan and Profile Module Drawings

367590-MMD-32-XX-DR-C-1001	Plan and Profile Sheet 1
367590-MMD-32-XX-DR-C-1002	Plan and Profile Sheet 2
367590-MMD-32-XX-DR-C-1003	Plan and Profile Sheet 3
367590-MMD-32-XX-DR-C-1004	Plan and Profile Sheet 4
367590-MMD-32-XX-DR-C-1005	Plan and Profile Sheet 5
367590-MMD-32-XX-DR-C-1006	Plan and Profile Sheet 6
367590-MMD-32-XX-DR-C-1007	Plan and Profile Sheet 7
367590-MMD-32-XX-DR-C-1008	Plan and Profile Sheet 8
367590-MMD-32-XX-DR-C-1009	Plan and Profile Sheet 9
367590-MMD-32-XX-DR-C-1010	Plan and Profile Sheet 10
367590-MMD-32-XX-DR-C-1011	Plan and Profile Sheet 11
367590-MMD-32-XX-DR-C-1012	Plan and Profile Sheet 12
367590-MMD-32-XX-DR-C-1013	Plan and Profile Sheet 13
367590-MMD-32-XX-DR-C-1014	Plan and Profile Sheet 14
367590-MMD-32-XX-DR-C-1015	Plan and Profile Sheet 15
367590-MMD-32-XX-DR-C-1016	Plan and Profile Sheet 16
367590-MMD-32-XX-DR-C-1017	Plan and Profile Sheet 17
367590-MMD-32-XX-DR-C-1018	Plan and Profile Sheet 18
367590-MMD-32-XX-DR-C-1019	Plan and Profile Sheet 19
367590-MMD-32-XX-DR-C-1020	Plan and Profile Sheet 20
367590-MMD-32-XX-DR-C-1021	Plan and Profile Sheet 21
367590-MMD-32-XX-DR-C-1022	Plan and Profile Sheet 22
367590-MMD-32-XX-DR-C-1023	Plan and Profile Sheet 23
367590-MMD-32-XX-DR-C-1024	Plan and Profile Sheet 24
367590-MMD-32-XX-DR-C-1025	Plan and Profile Sheet 25
367590-MMD-32-XX-DR-C-1026	Plan and Profile Sheet 26
367590-MMD-32-XX-DR-C-1027	Plan and Profile Sheet 27
367590-MMD-32-XX-DR-C-1028	Plan and Profile Sheet 28
367590-MMD-32-XX-DR-C-1029	Plan and Profile Sheet 29
367590-MMD-32-XX-DR-C-1030	Plan and Profile Sheet 30
367590-MMD-32-XX-DR-C-1031	Plan and Profile Sheet 31

A.2 Signalling Scheme Sketch

367590-MMD-32-XX-DR-C-1040	Signalling Scheme Sketch

A.3 General Arrangement Drawings

367590-MMD-32-XX-DR-C-0040	Standard Bridge Designs Substructure
367590-MMD-32-XX-DR-C-0041	Standard Bridge Types Overbridge – Ty Beams
367590-MMD-32-XX-DR-C-0042	Standard Bridge Types Overbridge – W Beams
NR/CIV/SD/430	Network Rail - Non-Standard Footbridges Standard Drawings and Details Footbridge Superstructure Main Span GA
NR/CIV/SD/431	Network Rail - Non-Standard Footbridges Standard Drawings and Details Footbridge Superstructure Main Span Structural Details
NR/CIV/SD/1311	Network Rail – ‘U’ Type Underbridge Standard Drawings Steelwork General Assembly Details Square Floor
NR/CIV/SD/1321	Network Rail – ‘U’ Type Underbridge Standard Drawings Main Girder Sizes Deep Girders
NR/CIV/SD/1710	Network Rail – Concrete Underbridge Standard Drawings Cast on Site Reinforced Concrete Slab GA

A.4 Flood Risk Constraints

367590-MMD-32-XX-DR-C-0001	Flood Zone Constraints – Key Plan
367590-MMD-32-XX-DR-C-0002	Flood Zone Constraints Plan – Sheet 1 of 16
367590-MMD-32-XX-DR-C-0003	Flood Zone Constraints Plan – Sheet 2 of 16
367590-MMD-32-XX-DR-C-0004	Flood Zone Constraints Plan – Sheet 3 of 16
367590-MMD-32-XX-DR-C-0005	Flood Zone Constraints Plan – Sheet 4 of 16
367590-MMD-32-XX-DR-C-0006	Flood Zone Constraints Plan – Sheet 5 of 16
367590-MMD-32-XX-DR-C-0007	Flood Zone Constraints Plan – Sheet 6 of 16
367590-MMD-32-XX-DR-C-0008	Flood Zone Constraints Plan – Sheet 7 of 16
367590-MMD-32-XX-DR-C-0009	Flood Zone Constraints Plan – Sheet 8 of 16
367590-MMD-32-XX-DR-C-0010	Flood Zone Constraints Plan – Sheet 9 of 16
367590-MMD-32-XX-DR-C-0011	Flood Zone Constraints Plan – Sheet 10 of 16
367590-MMD-32-XX-DR-C-0012	Flood Zone Constraints Plan – Sheet 11 of 16
367590-MMD-32-XX-DR-C-0013	Flood Zone Constraints Plan – Sheet 12 of 16
367590-MMD-32-XX-DR-C-0014	Flood Zone Constraints Plan – Sheet 13 of 16
367590-MMD-32-XX-DR-C-0015	Flood Zone Constraints Plan – Sheet 14 of 16
367590-MMD-32-XX-DR-C-0016	Flood Zone Constraints Plan – Sheet 15 of 16
367590-MMD-32-XX-DR-C-0017	Flood Zone Constraints Plan – Sheet 16 of 16

A.5 Tan15 Development Advice Zone

367590-MMD-32-XX-DR-C-0018	Tan15 Development Advice Zone – Sheet 1 of 16
367590-MMD-32-XX-DR-C-0019	Tan15 Development Advice Zone – Sheet 2 of 16
367590-MMD-32-XX-DR-C-0020	Tan15 Development Advice Zone – Sheet 3 of 16
367590-MMD-32-XX-DR-C-0021	Tan15 Development Advice Zone – Sheet 4 of 16
367590-MMD-32-XX-DR-C-0022	Tan15 Development Advice Zone – Sheet 5 of 16
367590-MMD-32-XX-DR-C-0023	Tan15 Development Advice Zone – Sheet 6 of 16
367590-MMD-32-XX-DR-C-0024	Tan15 Development Advice Zone – Sheet 7 of 16
367590-MMD-32-XX-DR-C-0025	Tan15 Development Advice Zone – Sheet 8 of 16
367590-MMD-32-XX-DR-C-0026	Tan15 Development Advice Zone – Sheet 9 of 16
367590-MMD-32-XX-DR-C-0027	Tan15 Development Advice Zone – Sheet 10 of 16
367590-MMD-32-XX-DR-C-0028	Tan15 Development Advice Zone – Sheet 11 of 16
367590-MMD-32-XX-DR-C-0029	Tan15 Development Advice Zone – Sheet 12 of 16
367590-MMD-32-XX-DR-C-0030	Tan15 Development Advice Zone – Sheet 13 of 16
367590-MMD-32-XX-DR-C-0031	Tan15 Development Advice Zone – Sheet 14 of 16
367590-MMD-32-XX-DR-C-0032	Tan15 Development Advice Zone – Sheet 15 of 16
367590-MMD-32-XX-DR-C-0033	Tan15 Development Advice Zone – Sheet 16 of 16

B. Geotechnical Desk Study Report

367590-WTD-CAR-3202

Provided as a separate PDF

C. Works Schedules

C.1 Bridge Schedule

367590-WTD-CAR-3203

Provided as a separate PDF

C.2 Earthworks Schedule

367590-WTD-CAR-3204

Provided as a separate PDF.

C.3 Highways Schedule

367590-WTD-CAR-3205

Provided as a separate PDF.

D. Economic Appraisal Tables

D.1 Introduction

The following sub-sections contain standard transport economic appraisal tables with monetised benefits and cost estimates for passenger services only[9]:

- Transport Economic Efficiency (TEE), including benefits to both rail users and those arising from decongestion (under the heading 'ROAD'), alongside additional 'Private Sector Impacts' which include additional rail revenue, the quantified operating expenditure included in the appraisal (exclusive of long term renewals) and changes in bus revenue from abstraction to rail. Where revenue exceeds included operating expenditure, for the TEE table this is assumed to be offset by a reduction in subsidy so that the private sector is no better or no worse off and the consideration is transferred to the Public Accounts table;
- Public Accounts (PA), principally any operating subsidy (based on costs considered) and reductions in indirect taxation. Where revenue exceeds included operating expenditure, a net reduction in subsidy occurs; and
- Analysis of Monetised Costs and Benefits (AMCB) bringing together TEE and PA outputs with additional benefits from reductions in road traffic externalities.

[9] In the absence of specific, quantifiable, rail freight proposals, at this moment in time it is not possible to include an estimate of either the additional infrastructure costs to accommodate to these, nor the potential benefits which would be derived.

D.2 Do Something 1 – 120 Minute Service Interval

D.2.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS1**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 24,955,787		£ 2,281,588		£22,674,200	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 24,955,787	*(1a)*	£ 2,281,588	£ -	£22,674,200	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 12,219,862		£ 2,880,824		£9,339,038	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 12,219,862	*(1b)*	£ 2,880,824	£ -	£ 9,339,038	£ -

Business							
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers
Travel time	£ 44,198,268			£ 1,923,336			£42,274,932
Vehicle operating costs	£ -						
User charges	£ -						
During Construction & Maintenance	£ -						
Subtotal	£ 44,198,268	*(2)*	£ -	£ 1,923,336	£ -	£ -	£ 42,274,932	£ -
Private sector provider impacts						Freight	Passengers	
Revenue	£ 144,910,282				-£6,672,516		£ 151,582,798	
Operating costs	-£ 36,513,396						-£ 36,513,396	
Investment costs								
Grant/subsidy	-£ 115,069,402						-£ 115,069,402	
Subtotal	-£ 6,672,516	*(3)*					£ -	
Other business impacts								
Developer contributions	£ -	*(4)*						
NET BUSINESS IMPACT	£ 37,525,751	*(5) = (2) + (3) + (4)*						

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 74,701,401	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.2.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS1**

Local Government Funding	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
	TOTAL		INFRASTRUCTURE			
Revenue	£ -					
Operating Costs	-£ 89,508		-£ 89,508			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 89,508	*(7)*	-£ 89,508	£ -	£ -	£ -
Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 36,513,396				£ 36,513,396	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 151,582,798				-£ 151,582,798	
NET IMPACT	-£ 115,069,402	*(8)*	£ -	£ -	-£ 115,069,402	£ -
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 25,203,605	*(9)*	£ 2,066,670	-£ 1,065,360	£ 24,202,295	£ -
TOTALS						
Broad Transport Budget	-£ 115,158,909	*(10) = (7) + (8)*				
Wider Public Finances	£ 25,203,605	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.2.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS1

Noise	£	79,487	(12)
Local Air Quality	£	12,451	(13)
Greenhouse Gases	£	590,093	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	888,219	(17)
Economic Efficiency: Consumer Users (Commuting)	£	24,955,787	(1a)
Economic Efficiency: Consumer Users (Other)	£	12,219,862	(1b)
Economic Efficiency: Business Users and Providers	£	37,525,751	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	25,203,605	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	51,068,045	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	115,158,909	(10)
Present Value of Costs (see notes) (PVC)	-£	115,158,909	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	166,226,955	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.3 Do Something 2 – 90 Minute Service Interval

D.3.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 30,442,753		£ 2,384,922		£28,057,831	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 30,442,753	*(1a)*	£ 2,384,922	£ -	£28,057,831	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 14,212,184		£ 3,011,298		£11,200,886	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 14,212,184	*(1b)*	£ 3,011,298	£ -	£ 11,200,886	£ -

Business							
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers
Travel time	£ 52,847,398			£ 2,010,445			£50,836,953
Vehicle operating costs	£ -						
User charges	£ -						
During Construction & Maintenance	£ -						
Subtotal	£ 52,847,398	*(2)*	£ -	£ 2,010,445	£ -	£ -	£ 50,836,953	£ -
Private sector provider impacts						Freight	Passengers
Revenue	£ 151,770,098				-£6,983,990		£ 158,754,088
Operating costs	-£ 55,502,023						-£ 55,502,023
Investment costs							
Grant/subsidy	-£ 103,252,065						-£ 103,252,065
Subtotal	-£ 6,983,990	*(3)*					£ -
Other business impacts							
Developer contributions	£ -	*(4)*					
NET BUSINESS IMPACT	£ 45,863,408	*(5) = (2) + (3) + (4)*					

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 90,518,345	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.3.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

Local Government Funding	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
	TOTAL		INFRASTRUCTURE			
Revenue	£ -					
Operating Costs	-£ 93,789		-£ 93,789			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 93,789	*(7)*	-£ 93,789	£ -	£ -	£ -
Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 55,502,023				£ 55,502,023	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 158,754,088				-£ 158,754,088	
NET IMPACT	-£ 103,252,065	*(8)*	£ -	£ -	-£ 103,252,065	£ -
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 26,395,843	*(9)*	£ 2,163,642	-£ 1,115,091	£ 25,347,291	£ -
TOTALS						
Broad Transport Budget	-£ 103,345,854	*(10) = (7) + (8)*				
Wider Public Finances	£ 26,395,843	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.3.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS2

Noise	£	83,019	(12)
Local Air Quality	£	13,027	(13)
Greenhouse Gases	£	617,771	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	929,709	(17)
Economic Efficiency: Consumer Users (Commuting)	£	30,442,753	(1a)
Economic Efficiency: Consumer Users (Other)	£	14,212,184	(1b)
Economic Efficiency: Business Users and Providers	£	45,863,408	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	26,395,843	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	65,766,028	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	103,345,854	(10)
Present Value of Costs (see notes) (PVC)	-£	103,345,854	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	169,111,882	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.4 Do Something 3 – 60 Minute Service Interval

D.4.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 30,442,753		£ 2,384,922		£28,057,831	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 30,442,753	*(1a)*	£ 2,384,922	£ -	£28,057,831	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 14,212,184		£ 3,011,298		£11,200,886	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 14,212,184	*(1b)*	£ 3,011,298	£ -	£ 11,200,886	£ -

Business							
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers
Travel time	£ 52,847,398			£ 2,010,445			£50,836,953
Vehicle operating costs	£ -						
User charges	£ -						
During Construction & Maintenance	£ -						
Subtotal	£ 52,847,398	*(2)*	£ -	£ 2,010,445	£ -	£ -	£ 50,836,953	£ -
Private sector provider impacts						Freight	Passengers
Revenue	£ 151,770,098				-£6,983,990		£ 158,754,088	
Operating costs	-£ 55,502,023						-£ 55,502,023	
Investment costs								
Grant/subsidy	-£ 103,252,065						-£ 103,252,065	
Subtotal	-£ 6,983,990	*(3)*					£ -	
Other business impacts							
Developer contributions	£ -	*(4)*						
NET BUSINESS IMPACT	£ 45,863,408	*(5) = (2) + (3) + (4)*						

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 90,518,345	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.4.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

Local Government Funding	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
	TOTAL		INFRASTRUCTURE			
Revenue	£ -					
Operating Costs	-£ 93,789		-£ 93,789			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 93,789	*(7)*	-£ 93,789	£ -	£ -	£ -
Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 55,502,023				£ 55,502,023	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 158,754,088				-£ 158,754,088	
NET IMPACT	-£ 103,252,065	*(8)*	£ -	£ -	-£ 103,252,065	£ -
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 26,395,843	*(9)*	£ 2,163,642	-£ 1,115,091	£ 25,347,291	£ -

TOTALS		
Broad Transport Budget	-£ 103,345,854	*(10) = (7) + (8)*
Wider Public Finances	£ 26,395,843	*(11) = (9)*

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.4.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS2

Noise	£	83,019	(12)
Local Air Quality	£	13,027	(13)
Greenhouse Gases	£	617,771	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	929,709	(17)
Economic Efficiency: Consumer Users (Commuting)	£	30,442,753	(1a)
Economic Efficiency: Consumer Users (Other)	£	14,212,184	(1b)
Economic Efficiency: Business Users and Providers	£	45,863,408	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	26,395,843	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	65,766,028	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	103,345,854	(10)
Present Value of Costs (see notes) (PVC)	-£	103,345,854	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	169,111,882	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.5 Do Something 1a – 120 Minute Service Interval with 65 Minute IVT

D.5.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS1**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 33,099,367		£ 2,325,308		£30,774,059	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 33,099,367	*(1a)*	£ 2,325,308	£ -	£30,774,059	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 15,424,668		£ 2,936,027		£12,488,641	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 15,424,668	*(1b)*	£ 2,936,027	£ -	£ 12,488,641	£ -

Business			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
User benefits								
Travel time	£ 57,615,820			£ 1,960,191			£55,655,628	
Vehicle operating costs	£ -							
User charges	£ -							
During Construction & Maintenance	£ -							
Subtotal	£ 57,615,820	*(2)*	£ -	£ 1,960,191	£ -	£ -	£ 55,655,628	£ -
Private sector provider impacts						Freight	Passengers	
Revenue	£ 151,192,894				-£6,696,101		£ 157,888,995	
Operating costs	-£ 36,513,396						-£ 36,513,396	
Investment costs								
Grant/subsidy	-£ 121,375,599						-£ 121,375,599	
Subtotal	-£ 6,696,101	*(3)*					£ -	
Other business impacts								
Developer contributions	£ -	*(4)*						
NET BUSINESS IMPACT	£ 50,919,719	*(5) = (2) + (3) + (4)*						

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 99,443,754	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.5.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS1**

	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
Local Government Funding	TOTAL		INFRASTRUCTURE			
Revenue	£ -					
Operating Costs	-£ 92,886		-£ 92,886			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 92,886	*(7)*	-£ 92,886	£ -	£ -	£ -
Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 36,513,396				£ 36,513,396	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 157,888,995				-£ 157,888,995	
NET IMPACT	-£ 121,375,599	*(8)*	£ -	£ -	-£ 121,375,599	£ -
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 26,266,127	*(9)*	£ 2,126,085	-£ 1,069,125	£ 25,209,167	£ -
TOTALS						
Broad Transport Budget	-£ 121,468,484	*(10) = (7) + (8)*				
Wider Public Finances	£ 26,266,127	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.5.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS1

Noise	£	80,543	(12)
Local Air Quality	£	12,732	(13)
Greenhouse Gases	£	606,825	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	920,263	(17)
Economic Efficiency: Consumer Users (Commuting)	£	33,099,367	(1a)
Economic Efficiency: Consumer Users (Other)	£	15,424,668	(1b)
Economic Efficiency: Business Users and Providers	£	50,919,719	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	26,266,127	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	74,797,991	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	121,468,484	(10)
Present Value of Costs (see notes) (PVC)	-£	121,468,484	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	196,266,475	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.6 Do Something 2a – 90 Minute Service Interval with 65 Minute IVT

D.6.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 39,393,149		£ 2,597,982		£36,795,167	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 39,393,149	*(1a)*	£ 2,597,982	£ -	£36,795,167	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 17,786,601		£ 3,280,317		£14,506,284	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 17,786,601	*(1b)*	£ 3,280,317	£ -	£ 14,506,284	£ -

Business							
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers
Travel time	£ 67,372,635			£ 2,190,051			£65,182,584
Vehicle operating costs	£ -						
User charges	£ -						
During Construction & Maintenance	£ -						
Subtotal	£ 67,372,635	*(2)*	£ -	£ 2,190,051	£ -	£ -	£ 65,182,584
Private sector provider impacts						Freight	Passengers
Revenue	£ 166,087,354				-£7,537,854		£ 173,625,207
Operating costs	-£ 55,502,023						-£ 55,502,023
Investment costs							
Grant/subsidy	-£ 118,123,185						-£ 118,123,185
Subtotal	-£ 7,537,854	*(3)*					£ -
Other business impacts							
Developer contributions	£ -	*(4)*					
NET BUSINESS IMPACT	£ 59,834,781	*(5) = (2) + (3) + (4)*					

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 117,014,531	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.6.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
Local Government Funding	TOTAL		INFRASTRUCTURE			
Revenue	£ -					
Operating Costs	-£ 102,118		-£ 102,118			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 102,118	*(7)*	-£ 102,118	£ -	£ -	£ -
Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 55,502,023				£ 55,502,023	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 173,625,207				-£ 173,625,207	
NET IMPACT	-£ 118,123,185	*(8)*	£ -	£ -	-£ 118,123,185	£ -
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 28,874,876	*(9)*	£ 2,356,727	-£ 1,203,523	£ 27,721,672	£ -

TOTALS		
Broad Transport Budget	-£ 118,225,302	*(10) = (7) + (8)*
Wider Public Finances	£ 28,874,876	*(11) = (9)*

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.6.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS2

Noise	£	90,465	(12)
Local Air Quality	£	14,189	(13)
Greenhouse Gases	£	672,546	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	1,013,095	(17)
Economic Efficiency: Consumer Users (Commuting)	£	39,393,149	(1a)
Economic Efficiency: Consumer Users (Other)	£	17,786,601	(1b)
Economic Efficiency: Business Users and Providers	£	59,834,781	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	28,874,876	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	89,929,951	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	118,225,302	(10)
Present Value of Costs (see notes) (PVC)	-£	118,225,302	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	208,155,253	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.7 Do Something 3a – 60 Minute Service Interval with 65 Minute IVT

D.7.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS3**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 46,565,823		£ 2,796,974		£43,768,850	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 46,565,823	*(1a)*	£ 2,796,974	£ -	£43,768,850	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 20,319,864		£ 3,531,571		£16,788,293	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 20,319,864	*(1b)*	£ 2,796,974	£ -	£ 16,788,293	£ -

Business							
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers
Travel time	£ 78,566,872			£ 2,357,797			£76,209,075
Vehicle operating costs	£ -						
User charges	£ -						
During Construction & Maintenance	£ -						
Subtotal	£ 78,566,872	*(2)*	£ -	£ 2,357,797	£ -	£ -	£ 76,209,075
Private sector provider impacts						Freight	Passengers
Revenue	£ 177,918,904				-£8,062,598		£ 185,981,502
Operating costs	-£ 71,494,834						-£ 71,494,834
Investment costs							
Grant/subsidy	-£ 114,486,668						-£ 114,486,668
Subtotal	-£ 8,062,598	*(3)*					£ -
Other business impacts							
Developer contributions	£ -	*(4)*					
NET BUSINESS IMPACT	£ 70,504,274	*(5) = (2) + (3) + (4)*					

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 137,389,961	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.7.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS3**

Local Government Funding	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Revenue	£ -					
Operating Costs	-£ 109,419		-£ 109,419			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 109,419	*(7)*	-£ 109,419	£ -	£ -	£ -

Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 71,494,834				£ 71,494,834	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 185,981,502				-£ 185,981,502	
NET IMPACT	-£ 114,486,668	*(8)*	£ -	£ -	-£ 114,486,668	£ -

Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 30,938,508	*(9)*	£ 2,531,288	-£ 1,287,306	£ 29,694,525	£ -

TOTALS		
Broad Transport Budget	-£ 114,596,087	*(10) = (7) + (8)*
Wider Public Finances	£ 30,938,508	*(11) = (9)*

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.7.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS3

Noise	£	97,506	*(12)*
Local Air Quality	£	15,262	*(13)*
Greenhouse Gases	£	722,259	*(14)*
Journey Quality			*(15)*
Physical Activity			*(16)*
Accidents	£	1,085,508	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£	46,565,823	*(1a)*
Economic Efficiency: Consumer Users (Other)	£	20,319,864	*(1b)*
Economic Efficiency: Business Users and Providers	£	70,504,274	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-£	30,938,508	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	£	108,371,989	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	-£	114,596,087	*(10)*
Present Value of Costs (see notes) (PVC)	-£	114,596,087	*(PVC) = (10)*
OVERALL IMPACTS			
Net Present Value (NPV)	£	222,968,076	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.8 Do Something 1b – 120 Minute Service Interval without Demand Cap

D.8.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS1**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 23,543,519		£ 2,239,285		£21,304,234	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 23,543,519	*(1a)*	£ 2,239,285	£ -	£21,304,234	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 11,210,829		£ 2,827,411		£8,383,418	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 11,210,829	*(1b)*	£ 2,827,411	£ -	£ 8,383,418	£ -

Business							
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers
Travel time	£ 41,221,945			£ 1,887,675			£39,334,270
Vehicle operating costs	£ -						
User charges	£ -						
During Construction & Maintenance	£ -						
Subtotal	£ 41,221,945	*(2)*	£ -	£ 1,887,675	£ -	£ -	£ 39,334,270
Private sector provider impacts						Freight	Passengers
Revenue	£ 146,474,822				-£6,076,407		£ 152,551,229
Operating costs	-£ 36,513,396						-£ 36,513,396
Investment costs							
Grant/subsidy	-£ 116,037,833						-£ 116,037,833
Subtotal	-£ 6,076,407	*(3)*					£ -
Other business impacts							
Developer contributions	£ -	*(4)*					
NET BUSINESS IMPACT	£ 35,145,538	*(5) = (2) + (3) + (4)*					

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 69,899,886	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.8.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS1**

Local Government Funding	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
	TOTAL		INFRASTRUCTURE			
Revenue	£ -					
Operating Costs	-£ 89,873		-£ 89,873			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 89,873	*(7)*	-£ 89,873	£ -	£ -	£ -
Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 36,513,396				£ 36,513,396	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 152,551,229				-£ 152,551,229	
NET IMPACT	-£ 116,037,833	*(8)*	£ -	£ -	-£ 116,037,833	£ -
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 25,440,973	*(9)*	£ 2,054,236	-£ 970,183	£ 24,356,919	£ -

TOTALS		
Broad Transport Budget	-£ 116,127,706	*(10) = (7) + (8)*
Wider Public Finances	£ 25,440,973	*(11) = (9)*

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.8.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS1

Noise	£	77,255	(12)
Local Air Quality	£	12,289	(13)
Greenhouse Gases	£	586,598	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	884,308	(17)
Economic Efficiency: Consumer Users (Commuting)	£	23,543,519	(1a)
Economic Efficiency: Consumer Users (Other)	£	11,210,829	(1b)
Economic Efficiency: Business Users and Providers	£	35,145,538	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	25,440,973	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	46,019,364	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	116,127,706	(10)
Present Value of Costs (see notes) (PVC)	-£	116,127,706	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	162,147,070	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.9 Do Something 2b – 90 Minute Service Interval without Demand Cap

D.9.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 30,462,121		£ 2,386,251		£28,075,870	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 30,462,121	*(1a)*	£ 2,386,251	£ -	£28,075,870	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 14,221,057		£ 3,012,976		£11,208,081	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 14,221,057	*(1b)*	£ 3,012,976	£ -	£ 11,208,081	£ -

Business			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
User benefits								
Travel time	£ 52,881,106			£ 2,011,565			£50,869,541	
Vehicle operating costs	£ -							
User charges	£ -							
During Construction & Maintenance	£ -							
Subtotal	£ 52,881,106	*(2)*	£ -	£ 2,011,565	£ -	£ -	£ 50,869,541	£ -
Private sector provider impacts						Freight	Passengers	
Revenue	£ 151,850,753				-£6,987,840		£ 158,838,593	
Operating costs	-£ 55,502,023						-£ 55,502,023	
Investment costs								
Grant/subsidy	-£ 103,336,570						-£ 103,336,570	
Subtotal	-£ 6,987,840	*(3)*					£ -	
Other business impacts								
Developer contributions	£ -	*(4)*						
NET BUSINESS IMPACT	£ 45,893,265	*(5) = (2) + (3) + (4)*						

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 90,576,443	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.9.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS2**

	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
Local Government Funding	TOTAL		INFRASTRUCTURE			
Revenue	£ -					
Operating Costs	-£ 93,839		-£ 93,839			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 93,839	*(7)*	-£ 93,839	£ -	£ -	£ -
Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 55,502,023				£ 55,502,023	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 158,838,593				-£ 158,838,593	
NET IMPACT	-£ 103,336,570	*(8)*	£ -	£ -	-£ 103,336,570	£ -
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 26,409,826	*(9)*	£ 2,164,748	-£ 1,115,706	£ 25,360,784	£ -
TOTALS						
Broad Transport Budget	-£ 103,430,410	*(10) = (7) + (8)*				
Wider Public Finances	£ 26,409,826	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.9.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS2

Noise	£	83,063	(12)
Local Air Quality	£	13,034	(13)
Greenhouse Gases	£	618,114	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	930,208	(17)
Economic Efficiency: Consumer Users (Commuting)	£	30,462,121	(1a)
Economic Efficiency: Consumer Users (Other)	£	14,221,057	(1b)
Economic Efficiency: Business Users and Providers	£	45,893,265	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	26,409,826	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	65,811,036	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	103,430,410	(10)
Present Value of Costs (see notes) (PVC)	-£	103,430,410	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	169,241,446	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

D.10 Do Something 3b – 60 Minute Service Interval without Demand Cap

D.10.1 Transport Economic Efficiency

Economic Efficiency of the Transport System (TEE) — **Aberystwyth - Carmarthen Rail Re-Opening DS3**

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 36,803,414		£ 2,579,036		£34,224,378	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
COMMUTING	£ 36,803,414	*(1a)*	£ 2,579,036	£ -	£34,224,378	£ -

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	£ 16,560,404		£ 3,256,394		£13,304,009	
Vehicle operating costs	£ -					
User charges	£ -					
During Construction & Maintenance	£ -					
NET NON-BUSINESS BENEFITS: OTHER	£ 16,560,404	*(1b)*	£ 3,256,394	£ -	£ 13,304,009	£ -

Business			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
User benefits								
Travel time	£ 62,940,033			£ 2,174,079			£60,765,954	
Vehicle operating costs	£ -							
User charges	£ -							
During Construction & Maintenance	£ -							
Subtotal	£ 62,940,033	*(2)*	£ -	£ 2,174,079	£ -	£ -	£ 60,765,954	£ -
Private sector provider impacts						Freight	Passengers	
Revenue	£ 162,448,832				-£7,543,988		£ 169,992,820	
Operating costs	-£ 71,494,834						-£ 71,494,834	
Investment costs								
Grant/subsidy	-£ 98,497,986						-£ 98,497,986	
Subtotal	-£ 7,543,988	*(3)*					£ -	
Other business impacts								
Developer contributions	£ -	*(4)*						
NET BUSINESS IMPACT	£ 55,396,045	*(5) = (2) + (3) + (4)*						

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£ 108,759,863	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

D.10.2 Public Accounts

Public Accounts (PA) Table — **Aberystwyth - Carmarthen Rail Re-Opening DS3**

Local Government Funding	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Revenue	£ -					
Operating Costs	-£ 100,693		-£ 100,693			
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -				£ -	
Grant/Subsidy Payments	£ -					
NET IMPACT	-£ 100,693	*(7)*	-£ 100,693	£ -	£ -	£ -

Central Government Funding: Transport						
Revenue	£ -					
Operating costs	£ 71,494,834				£ 71,494,834	
Investment Costs	£ -				£ -	
Developer and Other Contributions	£ -					
Grant/Subsidy Payments	-£ 169,992,820				-£ 169,992,820	
NET IMPACT	-£ 98,497,986	*(8)*	£ -	£ -	-£ 98,497,986	£ -

Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 28,267,525	*(9)*	£ 2,330,316	-£ 1,204,502	£ 27,141,711	£ -

TOTALS		
Broad Transport Budget	-£ 98,598,679	*(10) = (7) + (8)*
Wider Public Finances	£ 28,267,525	*(11) = (9)*

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2010 prices and values.

D.10.3 Analysis of Monetised Costs and Benefits

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS3

Noise	£	89,914	(12)
Local Air Quality	£	14,061	(13)
Greenhouse Gases	£	665,421	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	998,572	(17)
Economic Efficiency: Consumer Users (Commuting)	£	36,803,414	(1a)
Economic Efficiency: Consumer Users (Other)	£	16,560,404	(1b)
Economic Efficiency: Business Users and Providers	£	55,396,045	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	28,267,525	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Present Value of Benefits (see notes) (PVB)	£	82,260,307	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	98,598,679	(10)
Present Value of Costs (see notes) (PVC)	-£	98,598,679	(PVC) = (10)
OVERALL IMPACTS			
Net Present Value (NPV)	£	180,858,986	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

E. Wider Economic Impacts

E.1 Adjusted AMCB Tables

E.1.1 Do Something 1

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS1

Noise	£	79,487	(12)
Local Air Quality	£	12,451	(13)
Greenhouse Gases	£	590,093	(14)
Journey Quality			(15)
Physical Activity			(16)
Accidents	£	888,219	(17)
Economic Efficiency: Consumer Users (Commuting)	£	24,955,787	(1a)
Economic Efficiency: Consumer Users (Other)	£	12,219,862	(1b)
Economic Efficiency: Business Users and Providers	£	37,525,751	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£	25,203,605	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Level 2 Benefits - Wider Economic Impacts			
Agglomeration Benefits	£	32,719,203	
Labour Supply Benefits	£	280,982	
Present Value of Benefits (see notes) (PVB)	£	51,068,045	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£	115,158,909	(10)
Present Value of Costs (see notes) (PVC)	-£	115,158,909	(PVC) = (10)
LEVEL 1 IMPACTS			
Net Present Value (NPV)	£	166,226,955	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)			BCR=PVB/PVC
LEVEL 2 IMPACTS			
Adjusted Present Value of Benefits (PVB)	£	84,068,230	
Adjusted Net Present Value (NPV)	£	199,227,140	NPV=PVB-PVC
Adjusted Benefit to Cost Ratio (BCR)			BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

E.1.2 Do Something 2

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS2

Noise	£ 83,019	(12)
Local Air Quality	£ 13,027	(13)
Greenhouse Gases	£ 617,771	(14)
Journey Quality		(15)
Physical Activity		(16)
Accidents	£ 929,709	(17)
Economic Efficiency: Consumer Users (Commuting)	£ 30,442,753	(1a)
Economic Efficiency: Consumer Users (Other)	£ 14,212,184	(1b)
Economic Efficiency: Business Users and Providers	£ 45,863,408	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£ 26,395,843	- (11) - sign changed from PA table, as PA table represents costs, not benefits
Level 2 Benefits - Wider Economic Impacts		
Agglomeration Benefits	£ 50,230,056	
Labour Supply Benefits	£ 364,586	
Present Value of Benefits (see notes) (PVB)	£ 65,766,028	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)
Broad Transport Budget	-£ 103,345,854	(10)
Present Value of Costs (see notes) (PVC)	-£ 103,345,854	(PVC) = (10)
LEVEL 1 IMPACTS		
Net Present Value (NPV)	£ 169,111,882	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		BCR=PVB/PVC
LEVEL 2 IMPACTS		
Adjusted Present Value of Benefits (PVB)	£ 116,360,669	
Adjusted Net Present Value (NPV)	£ 219,706,523	NPV=PVB-PVC
Adjusted Benefit to Cost Ratio (BCR)		BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

E.1.3 Do Something 3

Analysis of Monetised Costs and Benefits: Aberystwyth - Carmarthen Rail Re-Opening DS3

Noise	£ 89,866	*(12)*
Local Air Quality	£ 14,053	*(13)*
Greenhouse Gases	£ 665,052	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents	£ 998,037	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£ 36,779,956	*(1a)*
Economic Efficiency: Consumer Users (Other)	£ 16,550,041	*(1b)*
Economic Efficiency: Business Users and Providers	£ 55,360,020	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-£ 28,252,556	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Level 2 Benefits - Wider Economic Impacts		
Agglomeration Benefits	£ 54,513,549	
Labour Supply Benefits	£ 492,010	
Present Value of Benefits (see notes) (PVB)	£ 82,204,468	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	-£ 98,508,165	*(10)*
Present Value of Costs (see notes) (PVC)	-£ 98,508,165	*(PVC) = (10)*
LEVEL 1 IMPACTS		
Net Present Value (NPV)	£ 180,712,634	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		BCR=PVB/PVC
LEVEL 2 IMPACTS		
Adjusted Present Value of Benefits (PVB)	£ 137,210,028	
Adjusted Net Present Value (NPV)	£ 235,718,193	NPV=PVB-PVC
Adjusted Benefit to Cost Ratio (BCR)		BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

F. Capital Cost Estimate

To be provided by TfW/Chandler KBS.

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