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Feasibility Report

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NORTH SOUTH WEST WALES FEASIBILITY

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Executive Summary

Transport for Wales (TfW) has an aspiration to improve the North to South transport offering in West Wales by exploring the potential for re-opening the disused rail routes between Bangor to Afon Wen and Aberystwyth to Carmarthen. This study will focus on Bangor to Afon Wen only.

The remit of this particular project is to carry out a feasibility study into the reinstatement of the disused railway line between Bangor and Afon Wen. The study will be split into the following key five route sections: -

	Route Section	Approximate Length (km)
A	Bangor to Caernarfon	14.6
B	Caernarfon to Dinas	4.6
C	Dinas to Penygroes	6.3
D	Penygroes to Bryncir	8.7
E	Bryncir to Afon Wen	9.5
	Total Length	**43.7**

Table 0-1 – Summary of route section lengths

Since its closure in the 1960s, the former alignment has been reused for different alternative uses – from road schemes to steam heritage railways to business/farming use. Therefore, the proposal is to consider the advantages of using Light Rail and Tram/Train technology to allow services to be reinstated along this corridor, by minimising the impact of the areas where the existing alignment has been lost.

The Feasibility Study has identified a potential indicative preferred route (with other options identified where appropriate) for the whole length between Bangor and Afon Wen (~43.7km).

Wherever possible the route of the reopened railway has been proposed along the former railway corridor, on the basis that for a large proportion of the overall route this corridor often remains within Welsh Government or Local Authority ownership – or is being used for a transport function already, either as an Active Travel Route or by a heritage railway

During the study each part of the former route has been indicatively assessed or categorised for the Significance of Intervention Works required – as per **Table 1-2** in Section 1 of this report – against both Public Perception/Impact and Engineering Challenge criteria. Although the assessment has been undertaken at a high level without site surveys or inspections – and therefore inevitably will be coarse and subjective in nature – an overview of the route as presented below indicates that only approximately a third of the overall route has been initially assessed to have Minimal intervention issues. A quarter of the overall route is provisionally assessed as having either High or Very High intervention issues, predominately arising from the requirement for significant engineering interventions (e.g. where a significant viaduct structure is required over the

A55 road constructed since the railway closed in 1960s/1970s) or where a large number of residential/commercial businesses would be impacted by the reopening of the line (e.g. where they have been built over the former trackbed in the past 50 years).

Section	Total Length (km)	Minimal (Green)	Moderate (Yellow)	High (Orange)	Very High (Red)
A	14.6	27%	45%	22%	6%
B	4.6	0%	63%	27%	10%
C	6.3	61%	33%	6%	0%
D	8.7	84%	11%	5%	0%
E	9.5	0%	100%	0%	0%
Overall Route	**43.7**	35%	50%	12%	3%

Table 0-2 – Summary of proposed intervention works categories per route section

Across the overall route, the number of road interfaces will be a significant challenge with a total of 79 roads (public roads, private access roads and famer access routes) crossing the former alignment. This is a high density of road/rail interfaces across the route – averaging nearly 2 road interfaces each kilometre across the route. The nature of the proposed road interface interventions varies across the route – with largescale remodelling of roundabouts proposed in Section A and to a lesser extent in Sections B and C, whilst farmer access crossings predominate in Sections C, D and particularly E.

Route Section	Reconfigure highway inc roundabout	Traffic Light Controls	Stop/Give Way	Stop/Give Way with gates
A	6	6	5	0
B	2	0	9	0
C	2	2	4	7
D	0	1	4	9
E	0	2	5	15
Overall Route	**10**	**11**	**27**	**31**

Table 0-3 – Summary of proposed intervention works at road interfaces per route section

Table 0-4 summarises significant civil engineering interventions envisaged from the desktop studies undertaken in the Feasbility Study. It should be noted that later studies will identify a signficiant number of assets – e.g. culverts and underbridges within heavy undergrowth – which have not been able to be recorded in this Feasibility Study.

Route Section	Underbridge		Overbridge		New Retaining Walls/ Embankment works
	Retain / Repair	Replace / New	Retain / Repair	Replace / New	
A	0	4	1	6	4
B	0	4	0	7	1
C	0	3	0	1	1
D	4	6	0	2	0
E	6	1	0	0	0
Overall Route	**10**	**18**	**1**	**16**	**6**

Table 0-4 – Summary of proposed civil and geotechnical intervention works per route section

The route additionally interfaces with a number of existing residential and commercial properties, which have either been established since the closure of the railway or expanded onto the former railway infrastructure since the railway was closed. Inevitably the interfaces are more numerous in the northern sections of the route, particularly in the Caernarfon area.

Further details are shown below.

Route Section	Building/ Business interface
A	Water Treatment Works; Nursery; Local businesses in Vaynol Tunnels; 3rd party farmland for alternative route (south of Vaynol Tunnels); Allotments (east of Y Felinheli); Large number of businesses in Caernarfon, including - Local Car Dealer; Morrisons Petrol Station; Morrisons Supermarket; Balaclava Car Park; Crown Street businesses
B	Welsh Highland Railway; Land associated with local residence (between Pont Seiont and Bontnewydd, near Hendy Farm)
C	3rd party farmland for alternative route (around Groeslon)
D	3rd party farmland for alternative route (around Bryncir)
E	Timber Yard (between Bryncir and Ynys); 3rd party woodland for alternative route (2 locations required, between Ynys and Llangybi); Residential Property, Relocated local business, 3rd party land for alternative route (all around Chwilog village)

Table 0-5 Summary of potential building/business interfaces per route section

Due to the large number of interfaces along the former railway route, as summarised above, the Feasilbility Study does currently propose the operation of the Tram-Train vehicles in Tram mode for the whole length of the route – with proposals to switch into Tram mode occuring directly after the Tram-Trains leave the Network Rail infrastructure at Menai Bridge Junction (near Bangor) or Afon Wen Junction. This will limit the maximum line speed achievable.

Route Section	Train Running	Tram (integreated on-street and segregated on-street)	Tram (off-street)	Total Length
A	2.7km	0.25km (Felinheli) 0.15km (Balclava Car Park	11.5km	14.6km
B	0	0.4km (St Helens Road)	4.25km	4.6km
C	0	0	6.3km	6.3km
D	0	0	8.7km	8.7km
E	0.5km	0	9km	9.5km
Total	**3.2km (7%)**	**0.8km (2%)**	**39.7km (91%)**	**43.7km**

Table 0-6 – Summary of train vs tram running

A number of stations have also been indicatively proposed along the route – see Section 4.5. Therefore it is recommended that a timetable study is prepared for the overall West Wales North-South route in due course, to confirm whether the achievable linespeeds in Tram mode are acceptable – or whether alternative heavy rail interventions are required in order to allow the operation of the vehicles in Train mode at higher speeds for some of the route.

There are locations along the route where the introduction of the new route will impact on the existing cycle route. Where it has not been possible to accommodate the cycle route this will need to be relocated as shown in the table below. A survey of possible routes shall be undertaken at a later stage.

Route Section	Length of cycle route requiring diversion
A	0.9km (Through Felinheli)
B	4.6km (Whole length of section)
C	0.3km (South of Dinas Station)
D	0km
E	0km (Cycle route follows local roads in this section)

Table 0-7 – Summary of cycle route requiring diversion

1. Introduction

1.1. Scheme Overview

Transport for Wales (TfW) has an aspiration to improve the North to South transport offering in West Wales by exploring the potential for re-opening the disused rail routes between Bangor to Afon Wen and Aberystwyth to Carmarthen as shown in the map below.

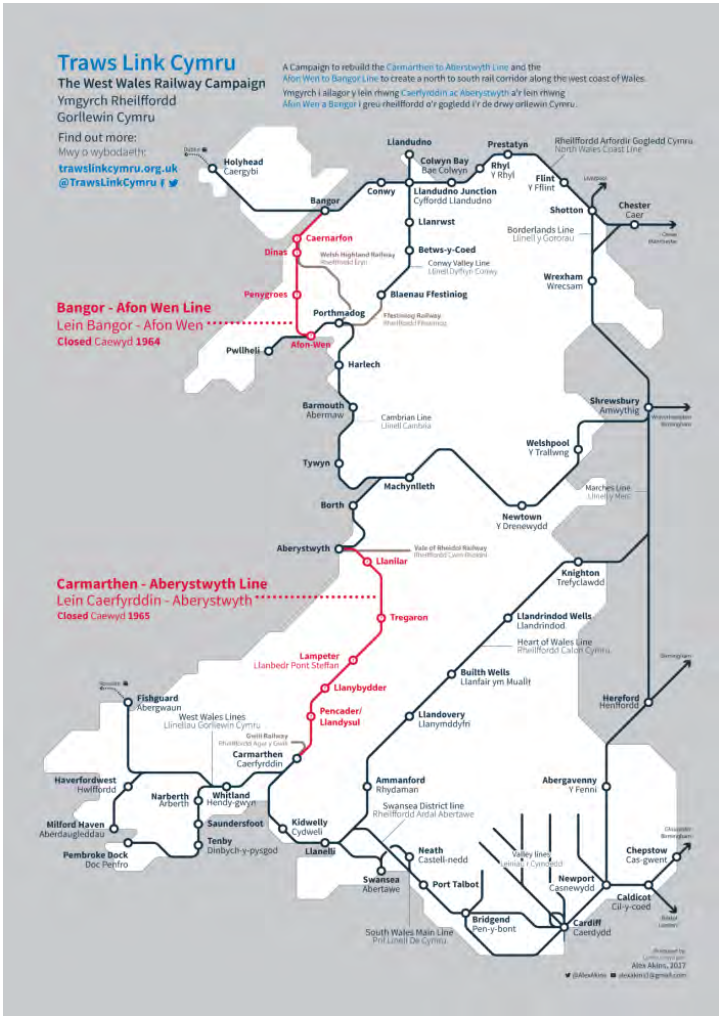

Figure 1-1 – Example of West Wales railway reopening proposals[1]

A Welsh Transport Appraisal Guidance (WelTAG) stage 1 study has recommended the review of reopening these 'missing links' in the longer term, to both improve local services within the Gwynedd, Ceredigion and Carmarthenshire council areas - but also facilitate the aspiration of supporting longer distance journeys between North and South Wales.

[1] https://trawslinkcymru.org.uk/en/campaign

1.2. Scope

The remit of this particular project (ECS3 – Work Package Order 222) is to carry out a feasibility study into the reinstatement of the disused railway line between Bangor and Afon Wen. Note that the reopening of Carmarthen to Aberystwyth is not part of this study, but has been reviewed previously[2].

Since its closure in the 1960s, the former alignment has been reused for different alternative uses – from road schemes to steam heritage railways to business/farming use. Therefore, the proposal is to consider the advantages of using Light Rail and Tram/Train technology to allow services to be reinstated along this corridor, potentially minimising the impact of the areas where the existing alignment has been lost.

A number of key assumptions for the proposed route have been identified by TfW: -

- The route will be standard gauge to be compatible with mainline infrastructure.
- The route will be single track with passing places, suitable to reliably operate an hourly train service as minimum, between Bangor, Caernarfon and Porthmadog, but capable of later upgrade to 30 min interval services.
- The rolling stock using the route will be high floor, to be compatible with standard height mainline platforms.
- Maximum design speed will be 75 mph.
- Minimum radii of horizontal curves will be 50m, unless agreed otherwise.
- The Light Rail vehicles will use standard P8 wheel profile.
- The Light Rail vehicles will be electrically powered, using catenary with batteries to permit discontinuous operation.

The scope of this Feasibility Study is to review the track alignment and major civil engineering interventions required only in order to reinstate the former railway. Any consideration of other infrastructure aspects such as electrification, signalling, telecommunication, drainage, active travel diversion routes, rolling stock depots, maintenance depots, stations etc. will not be undertaken within this Feasibility Study, and therefore must be assessed within any future studies undertaken.

It is noted that the route will provide a local public transport service in the area, therefore wherever possible an alignment which provides access to the towns and villages along the route will be prioritised. However future modelling will be required on the train service to be offered, and an exercise undertaken to understand the trade-off between the benefits of additional stations/tram halts to serve the local population against the disadvantage of extended journey times incurred by longer distance travellers.

[2] https://trawslinkcymru.org.uk/en/feasibility-study-2018/

The study will be split into the following key five route sections: -

Route Section		Approximate Length (km)
A	Bangor to Caernarfon	14.6
B	Caernarfon to Dinas	4.6
C	Dinas to Penygroes	6.3
D	Penygroes to Bryncir	8.7
E	Bryncir to Afon Wen	9.5
	Total Length	**43.7**

Table 1-1 - Summary of route section lengths

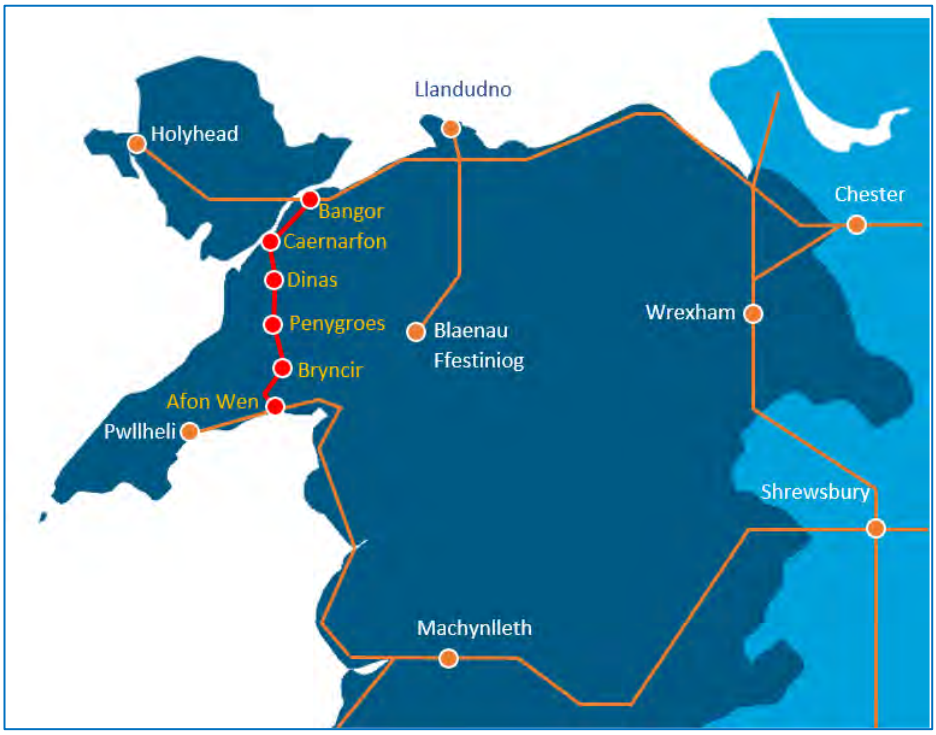

Figure 1-2 – Overview of mainline railways within North Wales, showing the proposed Afon Wen to Bangor route in red split into five Route Sections

1.3. Feasibility Report Structure

The report has been prepared to identify the optimal alignment for a light-rail connection between Afon Wen and Bangor based upon a high-level desk-top study, which identifies wherever practicable obstructions along the former railway alignment impeding reopening, together with any options identified to remove or avoid those obstructions.

This report includes the following:

- History of the Route (Chapter 2);
- Summary of Previous Studies (Chapter 3);
- Identification of Design Parameters to be adopted in study (Chapter 4);
- Interfaces and Constraints (Chapter 5);
- Junction design - Bangor and Afon Wen (Chapter 6);
- Route Alignment Review (Chapters 7 to 11 – with each chapter covering a different Route Section);
    - Identification of Obstructions
    - Summary of Potential Options to Remove/Avoid Obstructions
    - Identification of Preferred Route and Implications on Future Operations
- Environmental Review (Chapter 12)
- Overall Summary of Study (Chapter 13)

1.4. Feasibility Assessment Criteria

During the Route Alignment Review in Sections 7 to 11, for each obstruction identified the report will always identify an option - the base option - which follows the disused rail route, as in the majority of cases that is likely to provide an option with fewer land ownership or engineering interventions.

Nevertheless, in the intervening 50 years plus since the railway closed, the former alignment has been obstructed and lost in a number of locations by new developments, roads and the removal of original structures. Therefore, at certain locations an option following the disused rail route may be highly impractical or expensive to achieve. At these obstructions alternative option(s) have been developed which consider: -

- Removal of the obstruction through land purchase and the relocation of existing properties or infrastructure (e.g. diverting of active travel paths, relocation/demolition of buildings);
- Diverting the proposed route using a new segregated railway alignment around the obstruction; and/or
- Diverting the proposed route using integrated on-street running along a suitable highway alignment.

The options will be indicatively assessed for the perceived level of effort required to implement the option (i.e. the scale of the engineering challenge to be overcome), and the impact on the surrounding local community associated with each option identified.

The assessment criteria will be split into two distinct categories: -

- Public Impact/Perception
- Engineering Challenge

Table 1-2 overleaf was utilised during the Feasibility Study to categorise the level of impact for both Public Impact/Perception and the degree of Engineering Challenge categories. For each part of the route, the higher of the impact levels from the two categories will be shown on the Feasibility Study drawings – for example in a section owned by Welsh Government or the Local Authority with no significant impact on the surroundings (therefore Minimal or Green impact for Public Impact/Perception) but where there is a need to replace an existing underbridge (indicated as a High or Amber impact for Engineering Challenge), the overall impact level for this location would be shown as High or Amber.

It is assumed that land will need to be purchased for the whole route, however for simplicity the purchase (or transfer) of land understood to be owned by the Local Authority or Welsh Government is not shown as a specific requirement. However, locations where private businesses would require relocation or amendment for the option to be progressed are indicated, as the land ownership requirements are assumed to be more onerous in these cases. A review of Land Ownership for the overall Bangor to Afon Wen route is shown in section 13.

Assessment Criteria	Level of Impact	Description / Colour coding
Public Perception	Minimal impact on the locality - e.g. – • the proposed railway can co-exist alongside the existing cycle path, and/or • no 3rd party land-take beyond Local Authority/ Welsh Government land	Minimal (Green)
	Impact to existing use of land, however minimised - e.g. - • visual/noise impact on local residents can be minimised (e.g. through planting or screening), or • alternative replacement facilities provided – e.g. slight loss of farmland but access maintained, provision of replacement allotments, relocation of cycle route etc.	Moderate (Yellow)
	Significant impact - e.g. - • private dwellings or small business requiring the moving of the residents/business • closure of road, but with appropriate alternative access and diversion route provided	High (Amber)
	Major impact on the locality - e.g. - • purchase of private land occupied by large commercial or industrial business which would require relocation or permanent closure • closure of road with significant lengthy diversions	Very High (Red)
Engineering Challenge	Route currently used as cycle route or farmland and will require minimal preparation - e.g. - • Vegetation clearance and minor regrading • Removal/relocation of active travel path • Improved fencing along route	Minimal (Green)
	Minor civil interventions required - e.g. - • Install new road crossing – new traffic lights/stop signs • Minor retaining walls to support small embankment/cutting • Minor regrading of existing earthworks • Relocation of access roads/allotments/land boundaries	Moderate (Yellow)
	Significant civils works required - e.g. - • Single-span under or over bridges • Major retaining walls • Demolition/relocation of single, small buildings	High (Amber)
	Large-scale civil interventions required - e.g. - • Multi span bridge/viaduct • Demolition of large scale buildings • Constructing integrated on-street railway tracks with associated highway and utility diversions	Very High (Red)

Table 1-2 – Categorisation of Significance of Works

Assigning each obstacle with a severity score will allow each route and solution to be provisionally ranked as well as summarising any benefits or drawbacks.. At this early feasibility stage a preferred option shall be indicated, although it is noted that a more formal optioneering design stage should be undertaken in critical and constrained areas, as the current desktop exercise has been required to make a large number assumptions (on a wide range of areas), including:-

- Ordnance Survey mapping data can provide sufficient information to inform discussions on obstructions and alternative routes in the absence of more detailed topographical surveys (this does mean a relatively low level of accuracy for exact building and infrastructure locations etc.).
- Existing embankment and cutting conditions along the former rail route are sufficiently good to permit the reopening of the railway without significant geotechnical interventions (no existing geological or geotechnical information has been reviewed).
- The former railway alignment did not have any significant flooding interfaces, and therefore no significant drainage or flood prevention requirements are present.
- The proposed hourly train service can be provided with a single track railway, subject to the future provision of short double track sections at stations and other targeted locations as identified later when the train service provision is understood.
- Proposed localised highway alterations such as new traffic light junctions, or localised closure of roads within Caernarfon can be achieved without other significant highway interventions.
- Active travel routes can be relocated to other parallel routes with minimal overall impact where necessary, without significant engineering or cost implications.
- Land ownership for the required proposed alignment can be obtained through the appropriate Transport and Works Act Orders and/or other planning and regulatory processes.

Upon the selection of the preferred options across the whole route from Bangor to Afon Wen, a review of the resultant Land Ownership and Environmental implications for the proposed works at Feasibility Study stage was undertaken – See section 12 and 13.

Due to the sources of information used on this study i.e. Google Maps, Lidar, OS Maps there are areas where it is difficult to identify the details of an obstruction and an assumption has been made in relation to the works required. Further detailed surveys will need to be carried out in these areas. A summary of the unknown/possible obstructions can be found in Appendix C.

2. History of the Route

The line between Bangor and Afon Wen was made up originally of three separate lines – Bangor to Caernarfon (opened in 1852), the Caernarfon Town Line (opened last in 1870) and Caernarfon to Afon Wen line (opened in 1867), all of which were taken operated by the London North Western Railway (LNWR).

Figure 2-1 – Map showing former route between Afon Wen and Caernarfon[3]

In turn the LNWR was absorbed into the London, Midland and Scottish (LMS) railway as part of the grouping of the railways in 1921. The railway was double track between Bangor and the south of Caernarfon, with the remaining route then single line south of the junction with the Llanberis line to Afon Wen. Passing places were provided at the majority of the stations south of Caernarfon, with freight, local passenger and some excursion summer trains using the line.

The line between Caernarfon and Afon Wen was closed to passengers on the 7th December 1964 following the publication of "The Reshaping of British Railways" (or Beeching) Report, however the section between Bangor and Caernarfon remained open until closure to passengers on 5th January 1970.

Following closure of the line, the vast majority of the track bed was developed into an active travel cycle route – in many locations forming part of the National Cycle Network

[3] http://www.disused-stations.org.uk/c/caernarvon/index.shtml

Route 8, known as Lôn Las Cymru. The section between Dinas and Caernarfon was taken over by the Welsh Highland Railway preservation railway, who extended their narrow gauge route along this section in 1997. In other locations road schemes have encroached onto the former track bed, or private businesses and properties have been built on the former alignment.

3. Summary of Previous Studies

There has been a long held aspiration by Gwynedd County Council to reopen the Bangor to Caernarfon section of the former railway, with a wider desire to see the overall Bangor to Afon Wen railway reopened. In May 2000 a report commissioned by Gwynedd County Council and The Welsh Development Agency was published called “Re-opening of Passenger Railway Lines - Feasibility Study Phase 1”, which reviewed opportunities to reopen the Bangor to Caernarfon and Caernarfon to Llanberis former railway lines. This report recommended the reopening of the Bangor to Caernarfon section as a standard gauge railway, with 10 significant/moderate constraints identified along that section (e.g. reopening tunnels, loss of route to road building) to be overcome. (The Caernarfon to Llanberis line was proposed to be reopened as a narrow gauge railway, connecting into the Welsh Highland Railway for a short section south of Caernarfon). The findings of the above report have been reviewed and used in the preparation of this Feasibility Study.

TfW have advised that a WelTAG 1 study has been completed for the wider review of North to South connections in West Wales, which recommended that in the short to medium term attention is focused on bus-based solutions – which will be developed under parallel commissions to this project. However, the WelTAG 1 study did additionally propose the development of options for longer term rail-based solutions, noting these would be longer term schemes due to the scale of investment required to implement rail services along these corridors.

4. Identification of Design Parameters

4.1. Standards and Guidance

The following standards, codes and guidance have been used where applicable to this stage of the design. Any future design stages shall also consider these.

- National and European Standards and Codes of Practices
- Light Rail Safety Standards Board LRSSB
- Rail Safety Standards Board (RSSB)
- ORR Safety Principles and Guidance
- ROGS (Rail and Other Guided Systems)
- Network Rail Company Standards/Specifications
- Network Rail Guidance of Project Advice Notes (PANs)
- Design Manual Roads and Bridges (Trunk Roads)
- Manual for Streets (All non trunk roads)
- Active Travel Act Guidance (Welsh Government)
- Transport for Wales Company Standards and PANs – at present TfW are adopting Network Rail Standards

4.2. Tram-Train Vehicles

At present the only Tram-Train which is operational in the United Kingdom is the Rotherham extension of the Sheffield Supertram system, which extends the original extensive cross city tram routes. However, TfW as part of the Core Valley Line Programme is also adopting Tram-Train principles for extensions to the existing system, and are currently testing and commissioning the Stadler Citylink Class 398 Metro Vehicles (see Figure 4-1) into service.

Since the Class 398 units are variants of the Class 399 Tram-Train units in use by Sheffield Supertram, it is currently assumed that the Tram-Train vehicles procured for the Bangor to Afon Wen reopening are also likely to be based upon this Stadler Citylink type.

The rolling stock procurement would need to be considered alongside the depot location for the daily cleaning, regular maintenance and heavy maintenance/examinations required. The nearest existing depot operated by TfW is Machynlleth (accessed via the Cambrian Lines from Afon Wen), with stabling facilities also available at Holyhead (accessed via the North Wales Main Line reversing at Bangor). Therefore, a new depot or stabling point may need to be constructed along the new route.

Whilst the original Class 399 units have a 750V DC and 25kV AC capability, the TfW Class 398 is bi-mode – i.e. operating on 25kV AC electrification and on-board batteries. Therefore on-street running for the Class 398 will be through use of batteries and no Overhead Line Equipment – rather than in Sheffield where the existing tram DC electrification system is used.

Figure 4-1 – Image of Class 398 Tram-Train[4]

The rolling stock parameters used for this study are based upon the Class 398 as follows: -

Parameter	Value Used
Vehicle Length	40.07m
Vehicle Height	3.865m (with pantograph in rest position)
Vehicle Width	2.65m (3.65m kinematic envelope)
Maximum Speed	60mph (train mode) 45mph (tram mode)
Minimum Radius	50m (radius can be reduced to 25m, however there may be issues with this radius on grooved tracks with P8 wheel profile)
Maximum Gradient	6%
Wheel profile	Heavy Rail P8
Floor type	High Floor

Table 4-1 - Tram-Train Parameters

Since the adoption of Tram-Train operations has been limited to date, the design rules for Tram-train infrastructure are not currently well-established. For the purposes of this Feasibility Study track alignment design criteria for Manchester Metrolink has been adopted, as the service runs on both street and segregated infrastructure. These criteria were in turn derived from multiple sources, including the Network Rail Track Design Handbook and Docklands Light Railway Engineering Design Manual.

[4] *https://news.tfw.wales/resources/x5a7e-y8yw1-bu0di-8jhp5-0paks*

The principal high-level design criteria for Horizontal Alignment are as follows: -

Minimum Radius	Unit	Desirable	Limiting	Exceptional
Street Running	m	100	50	25
Ballasted Track	m	200	150	120

Table 4-2 - Tram-Train Radius

The above horizontal alignment criteria have been adopted in the review of the suitability for following the former railway alignment, and also in developing alternative alignments where the previous railway corridor has been lost due to the subsequent construction of buildings or infrastructure. However detailed permanent way alignment design criteria will need to be developed further and then adopted for later approval in principle and detailed design phases.

4.3. Signalling

The operation of the Tram-Train vehicles in conventional Train mode, will require the implementation of conventional Heavy Rail Signalling for those sections. Since the Tram-Trains would be operating at higher speeds, the driver would be reliant on the signalling system controlling the movement of trains in these sections and other controls (such as lineside fencing and level crossing systems) to prevent the access of members of the public and road vehicles onto the system. To enable the safe operation of the railway in this mode would require the adopting of conventional 'vital signalling' used across the national railway network - designed to Fail-Safe principles, as a Wrong Side Failure of vital equipment could directly endanger rail traffic.

For the operation of the Tram-train vehicles in Tram mode, the underlying principle will be the use of line of sight operation. In this mode of operation a tram should be able to stop before a reasonably visible stationary obstruction ahead from the intended speed of operation by using the service brake[5]. In order to operate on Drive-on-Sight Principles a tram vehicle has enhanced braking systems to the guidance given in BS EN 13452, requiring:

- Service braking: being the normal operating conditions, generally using only the primary braking system, supplemented as necessary under heavy loads and / or at low speeds by the mechanical braking system.
- Emergency 3: Hazard braking - where the maximum braking effort is applied in order to bring the tram to a standstill in as short a distance as practicable. The Hazard brake is an 'all or nothing' brake and should be revocable by the action of the driver deselecting it.
- Security brake: A brake with a higher level of system integrity than Emergency 3, applied by the use of an emergency button and irrevocable until the tram is at a standstill and a specific reset is undertaken[6].

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[5] *Light Rail Guide (LRG) 1.0 - Tramway Principles and Guidance (TPG), Light Rail Safety and Standards Board (LRSSB), Issue 2, 01/03/2021*

[6] *Tramway Design and Construction, https://resources.lrssb.org/resource/tramway-design-and-construction), Light Rail Safety and Standards Board (LRSSB), Issue 1, 01/03/2021*

Therefore for the sections of infrastructure adopting Drive-on-Sight operations, the Light Rail signalling can be minimised as it is no longer needed to ensure the separation of vehicles in the same manner as the Heavy Rail solution. For locations where some regulation of trams is required - e.g. long single line sections or at junctions - then 'non-vital' signalling can be provided using optical signals. In these cases any Wrong Side Failure of the signalling would not cause an accident as the Tram-Train must still be capable of stopping ahead of an obstruction using emergency brakes – e.g. on a single track section if two Tram-Trains entered the same section the line speed would be controlled and sighting improved (e.g. through vegetation clearance) such that the two Tram-Trains would still stop with sufficient safety separation when the drivers observed the other Tram-Train[7].

This does require that the speed of the Tram-Train must always be commensurate with the local conditions, including in poor visibility at night. It is noted the proposed Bangor to Afon Wen railway will be predominantly single track railway, with in places long curved sections of track. The existing railway corridor is also heavily vegetated, after over 50 years since the closure. Therefore the suitability of Drive-on-Sight Principle must be explored via the risk assessment process prior to introduction – with a suitable, relatively low, new maximum line speed selected to ensure the ability for the tram to stop.

Therefore the 45mph maximum speed limit for Tram-Trains operating in Tram mode may not in practice be possible, and lower line speeds introduced to enable Drive-on-Sight Principles to be used. Consequently, if significant lengths – or all - of the Bangor to Afon Wen railway are proposed to be operated in Tram mode, journey times will be extended accordingly.

4.4. Transition between Tram and Train mode

The proposed Class 398, or equivalent Tram-Train vehicles, can operate either in Train mode under conventional signalling or in Tram mode under Tramway (often Line of Sight based) signalling controls.

When the Tram-Train is ready to transition from conventional train to tram mode, the driver would activate a switch within the cab to engage Drive-on-Sight mode – which would mean the Tram-Train would operate with enhanced tram braking characteristics, have a reduced top speed restriction (maximum of 45mph), and activates hazard amber warning lights/extend wing-mirrors or cameras as required for Tram operation. The driver would additionally select a route destination using the cab controller (if this option is used) and then activate the Tram Ready To Start (TRTS) button in the cab. This would then interact with any Tram Signalling system employed, and request the next Tram signal for any single line section to show a proceed indication once the system determines it is safe to do so.

In reverse, the driver will activate a switch in the vehicle cab to disengage Drive-on-Sight mode, which would disengage the Tram characteristics (e.g. the reduced speed, enhanced braking characteristics, warning lights etc.) and verify the operation of all

[7] *Light Rail Guide (LRG) 1.0 - Tramway Principles and Guidance (TPG), Light Rail Safety and Standards Board (LRSSB), Issue 2, 01/03/2021 – Section 8.5*

mainline signalling safety systems such as the Automatic Warning System (AWS), Train Protection Warning System (TPWS) and Global System for Mobile Communications-Railway (GSM-R).

It is understood that this transition from Train to Tram (or vice-versa) mode can only be undertaken when the vehicle is stationary – the length of time the transition operation is not at present known, but as a minimum a 1 minute period is presumed. Therefore there may be benefits to proposing the transition occurs at a point where a station is proposed, and thus the transition period would occur in parallel with the dwell time at the station for passengers to alight/board. At present however due to the large number of constraints along the route – primarily the number of road crossings along the route - the preferred solution is that the Tram-Trains operate in Tram mode effectively the whole length of Afon Wen to Menai Bridge. Consequently at present the transition points from Train to Tram are indicatively shown just past the mainline railway connection location, which are not conveniently located near proposed station locations.

The figure below shows a potential layout of a transition point between Tram and Train modes.

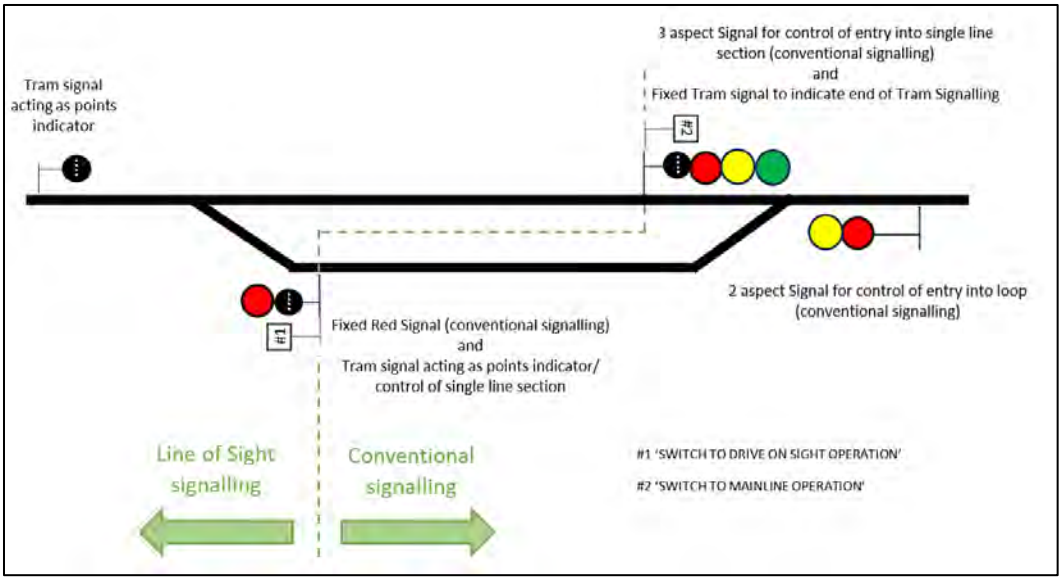

Figure 4-2 – Transition between tram and train mode

4.5. Heavy Rail / Light Rail Comparison

As the proposed vehicles are able to run in both Tram mode and Train mode there may be occasions throughout the route where it would be beneficial to switch between the two. It should be noted that the vehicle will need to be at a stop and the driver will need to manually change mode. This will inevitably take time and potentially negate any benefit from changing modes.

The mode used will need to consider several factors

- Location of stations – if the aspiration is to provide stations within populated areas that are easily accessible, this will require the construction of the railway through congested, constrained urban areas

- Intersections – where there are numerous intersections with highways, the cost required to install traditional heavy rail level crossing to maintain the higher speed will be substantial. It should be noted that there may be difficulty in opening new level crossings with the aspiration of the Office of Rail and Road (ORR's) and the wider railway industry to reduce the number of road/rail interfaces on safety grounds. It may also be difficult to close highways in certain locations, with limited cost-effective diversion routes.

Heavy Rail	Light Rail
Unable to navigate congested urban areas with tight radii without significant interventions	Able to navigate congested urban areas with the ability to run integrated on-street
Stations will need to be located away from populated areas which would prove difficult to access.	Ability to locate stations in more accessible locations
Can attain greater speeds	Lower speeds required when navigating congested areas
Greater costs to install signalling and level crossing equipment	Simpler junction requirements

Table 4-3 - Heavy vs Light Rail Comparison

4.6. Safeguarded Route Cross Section

For the Feasibility Study development, the width of a corridor to safeguard for the future railway reinstatement has been determined from appropriate standards to ensure appropriate and safe maintenance access. Options both excluding an active travel path and including an active travel path alongside the proposed new railway have been included. The active travel path width selected has been 3m. This is consistent with an assumption of less busy secondary shared use active travel paths (i.e. cyclists and pedestrians using the same route), as per Appendix G, guidance DE403 of the Active Travel Act Guidance. Wherever possible, active travel paths widths of 3m with 1m verges either side should be considered.

For the railway route, at present the Network Rail Standards and Best Practices have been adopted to provide a minimum of a walking route along one side of the railway, a position of safety on the opposite side of the railway and safeguarding of Overhead Line Equipment. These minimum widths will have to be provided for locations where the Tram-Train is operating in conventional Train mode, as the vehicle will not be able to stop in time if maintenance staff are unable to move to a place of safety. However with lower line speeds and the use of the vehicles in Tram mode adopting Drive-on-Sight practices, there may be some scope to reduce the required corridor width requirements in discrete locations, subject to review and assessment.

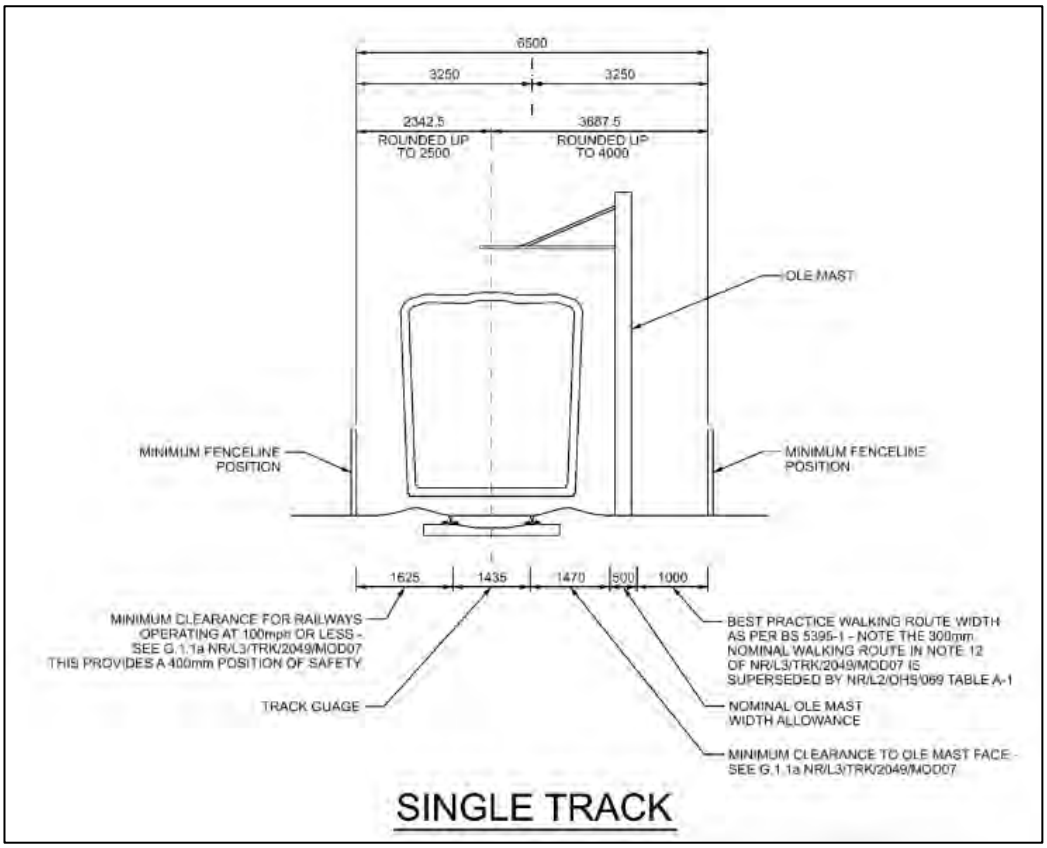

Figure 4-3 - Proposed Safeguarded corridor cross section - single track

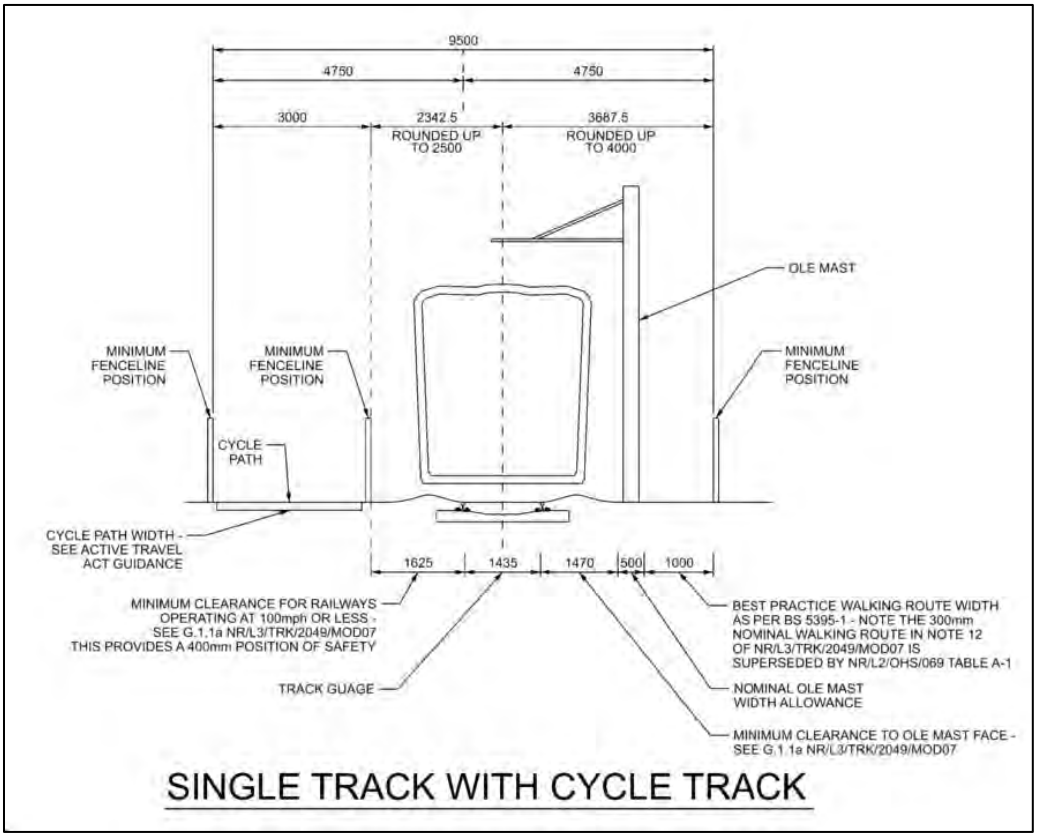

Figure 4-4 – Proposed Safeguarded corridor cross section - single track with adjacent cycle track

For locations where the vehicles are operating in Tram Mode, the different types of tram running have been defined in the LRSSB-LRG-1.0 Tramway Principles and Guidance[8] as follows

- ‘Integrated on-street’ tramways where the part of the highway occupied by the rails may also be used by other road vehicles or by pedestrians
- ‘Tram gates’ where only trams (and buses if permitted) travel along a short length of road that preceded an integrated on-street system
- ‘segregated on-street’ tramways or ‘tram-only streets’ where part of the highway occupied by rail may be crossed by pedestrians, but is not normally shared with other road users
- ‘off street’ tramways where the alignment of the track is wholly separate from the highway, sometimes referred to as ‘tramroad’

Wherever practicable, the vehicles are proposed to operate in Tram mode along ‘off-street’ alignments which will often be fenced off from members of public – and therefore the safeguarded corridor cross-sections will be similar to the Heavy Rail cross-sections above.

‘Segregated on-street’ tramways will be the next optimal alignment choice, reducing the interactions with other motor vehicles and therefore minimising potential journey delays and road traffic accidents. There will however in this scenario be interactions with cyclists and pedestrians, which will raise safety risks to be managed appropriately.

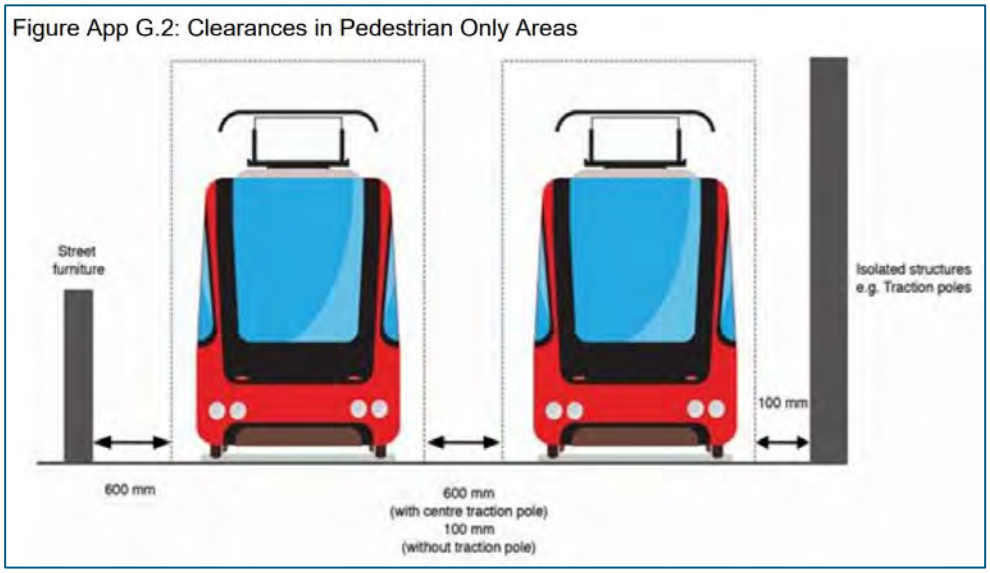

Figure 4-5 – Segregated on-street corridor clearances[9]

[8] Section 2.36 of https://resources.lrssb.org/download/tramway-principles-and-guidance-tpg

[9] Appendix G, Figure G.2 of https://resources.lrssb.org/download/tramway-principles-and-guidance-tpg

'Integrated on-street' running will require different safeguarded cross-sections, with the Tram-Train vehicles occupying highway lanes which should be a minimum of 3.65m[10] width.

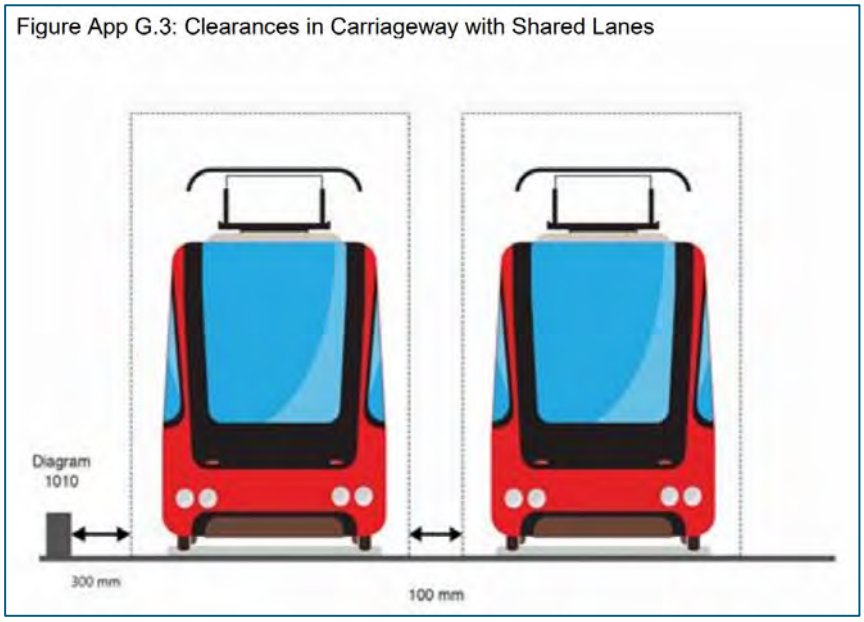

Figure 4-6 – Integrated on-street corridor clearances[11]

4.7. Stations and Passing Loops

The remit for this scheme only required the consideration for a station located within Caernarfon. The report does however highlight areas where a station may be located to serve various areas. A review of populations densities should be carried out at a later date to inform the optimum locations of stations along the route.

It is noted that the infrastructure required for the station could be significantly reduced if the Tram-Train vehicles are operating in Tram mode – as for example to allow passengers to cross the track to reach the station platform a passenger crossing at track level could be provided (equivalent to historic Station Barrow Crossings) as the vehicles are travelling slower with enhanced braking characteristics. For stations where the vehicles are operating in Train mode, most recent reopened stations provide footbridges with Access For All facilities (e.g. ramps or lifts) to cross the railway on safety grounds, which would involve a more significant engineering intervention.

[10] Section 3.30 of Section 2.36 of https://resources.lrssb.org/download/tramway-principles-and-guidance-tpg
[11] Appendix G, Figure G.3 of https://resources.lrssb.org/download/tramway-principles-and-guidance-tpg

At present the potential station sites are shown below in **Figure 4-7** and are Parc Menai, Y Felinheli, Caernarfon, Dinas, Groeslon, Penygroes, Bryncir and Chwilog.

Figure 4-7 – Map showing possible station locations along route

It is proposed that this line will be a single track however it is understood that the aspiration is to run 1 train per hour requiring the installation of several passing loops throughout this route. Locations for possible passing loops have been included within the report however these locations are not based on a timetabling review, but the availability of surrounding land. A timetabling review should be completed to establish the amount and location of passing loops along the route. Where possible, passing loops can be combined with station locations.

4.8. Timetabling and Journey Times

A full timetabling study has not been carried out as part of this feasibility report but a high level review of potential journey times based on a comparison to the journey times prior to the closure of the line has been looked in to.

The total journey time in the 1960's between Bangor and Afon Wen was 1hr and 15mins (see **Figure 4-8**).

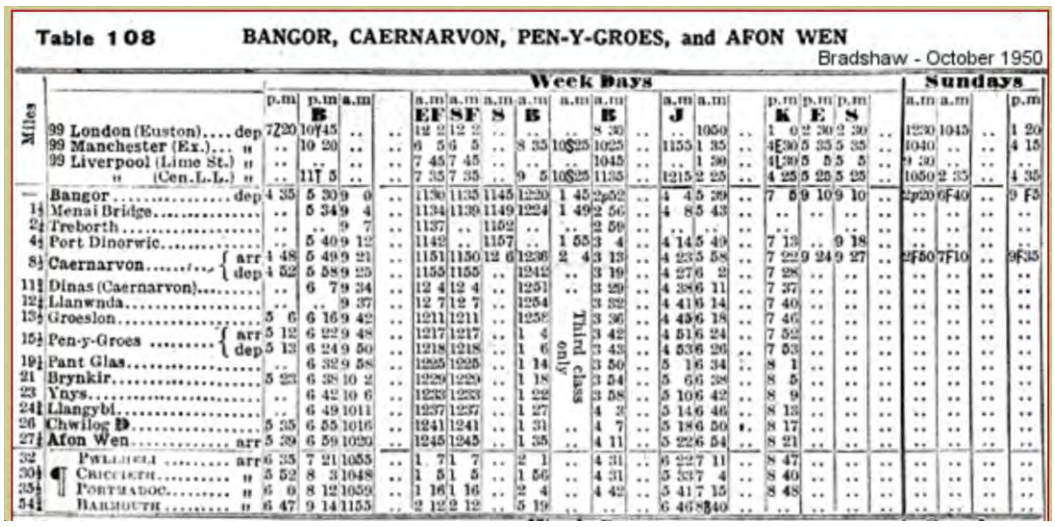

Table 108 BANGOR, CAERNARVON, PEN-Y-GROES, and AFON WEN

Bradshaw - October 1950

Week Days / Sundays

Miles		p.m	p.m	a.m		a.m	a.m	a.m	a.m	a.m	a.m		a.m	a.m		p.m	p.m	p.m		a.m	a.m		p.m
			B			EF	SF	S	B		B		J			K	E	S					
99	London (Euston) dep	7 20	10 45	..	..	12 2	12 2	..	..	..	8 30	..	..	10 50	..	1 0	2 30	2 30	..	12 30	10 45	..	1 20
99	Manchester (Ex.) "	..	10 20	..	..	6 5	6 5	..	8 35	10 25	10 25	..	11 55	1 35	..	4 30	5 35	5 35	..	10 40	..	..	4 15
99	Liverpool (Lime St.) "	..	..	..	..	7 45	7 45	..	..	..	10 45	..	..	1 30	..	4 30	5 55	5 55	..	12 30	..	..	..
	" (Cen. L.L.) "	..	11 T 5	..	..	7 35	7 35	..	9 5	10 25	11 35	..	12 15	2 25	..	4 25	5 25	5 25	..	10 50	2 35	..	4 35
—	Bangor dep	4 35	5 30	9 0	..	11 30	11 35	11 45	12 20	1 45	2 52	..	4 45	28	..	7 8	9 10	9 10	..	2 20	6 40	..	9 F5
1¼	Menai Bridge	..	5 34	9 4	..	11 34	11 39	11 49	12 24	1 49	2 56	..	4 85	43	..	..	..	..	..	..	..	..	..
2¼	Treborth	..	..	9 7	..	11 37	..	11 52	..	..	2 59	..	..	..	..	..	..	..	..	..	..	..	..
4¼	Port Dinorwic	..	5 40	9 12	..	11 42	..	11 57	..	1 55	3 4	..	4 14	5 40	..	7 13	..	9 18	..	..	..	..	..
8¾	Caernarvon { arr	4 48	5 49	9 21	..	11 51	11 50	12 6	12 36	2 43	3 13	..	4 23	5 58	..	7 22	9 24	9 27	..	2 F50	7 F10	..	9 F35
	dep	4 52	5 58	9 25	..	11 55	11 55	..	12 42	..	3 19	..	4 27	6 2	..	7 28	..	..	..	..	..	..	..
11¼	Dinas (Caernarvon)	..	6 7	9 34	..	12 4	12 4	..	12 51	..	3 29	..	4 38	6 11	..	7 37	..	..	..	..	..	..	..
12¼	Llanwnda	..	..	9 37	..	12 7	12 7	..	12 54	..	3 32	..	4 41	6 14	..	7 40	..	..	..	..	..	..	..
13½	Groeslon	5 6	6 16	9 42	..	12 11	12 11	..	12 58	..	3 36	..	4 45	6 18	..	7 46	..	..	..	..	..	..	..
15½	Pen-y-Groes { arr	5 12	6 22	9 48	..	12 17	12 17	..	1 4	Third class only	3 42	..	4 51	6 24	..	7 52	..	..	..	..	..	..	..
	dep	5 13	6 24	9 50	..	12 18	12 18	..	1 6		3 43	..	4 53	6 26	..	7 53	..	..	..	..	..	..	..
19¼	Pant Glas	..	6 32	9 58	..	12 25	12 25	..	1 14		3 50	..	5 1	6 34	..	8 1	..	..	..	..	..	..	..
21	Brynkir	5 23	6 38	10 2	..	12 29	12 29	..	1 18		3 54	..	5 5	6 38	..	8 5	..	..	..	..	..	..	..
23	Ynys	..	6 42	10 6	..	12 33	12 33	..	1 22		3 58	..	5 10	6 42	..	8 9	..	..	..	..	..	..	..
24¼	Llangybi	..	6 49	10 11	..	12 37	12 37	..	1 27		4 3	..	5 14	6 46	..	8 13	..	..	..	..	..	..	..
26	Chwilog ⊟	5 35	6 55	10 16	..	12 41	12 41	..	1 31	..	4 7	..	5 18	6 50	..	8 17	..	..	..	..	..	..	..
27¼	Afon Wen arr	5 39	6 59	10 20	..	12 45	12 45	..	1 35	..	4 11	..	5 22	6 54	..	8 21	..	..	..	..	..	..	..
32	Pwllheli arr	6 35	7 21	10 55	..	1 7	1 7	..	2 1	..	4 31	..	6 22	7 11	..	8 47	..	..	..	..	..	..	..
30½	¶ Criccieth "	5 52	8 3	10 48	..	1 5	1 5	..	1 56	..	4 31	..	5 33	7 4	..	8 40	..	..	..	..	..	..	..
35½	¶ Portmadoc "	6 0	8 12	10 59	..	1 16	1 16	..	2 4	..	4 42	..	5 41	7 15	..	8 48	..	..	..	..	..	..	..
54½	Barmouth "	6 47	9 14	11 55	..	2 12	2 12	..	5 19	..	..	..	6 46	8 40	..	..	..	..	..	..	..	..	..

Figure 4-8 – Previous timetable[12]

The previous route did have 4 more stations than what is proposed as part of this study (Llanwnda, Pant Glas, Ynys and Llangybi) therefore there will be no requirement for the tram-train to reduce speed or stop at these locations (there may be other site specific requirements to reduce speeds however i.e. road crossing) In addition to this the improved acceleration and braking capabilities of the new rolling stock and general reduction in turn around times at stations should have a positive impact on the journey times compared to pre-closure.

The use of tram-trains running in tram mode will however have a potential detrimental impact on the journey times due to the number of road interfaces including access tracks along the route restricting the ability to reach the maximum speed of 45mph as the driver will need to confirm the crossing is clear on the approach. This can be mitigated to a degree by ensuring there is sufficient sighting distance allowing the driver to see further in to the distance thus minimising the amount of speed reduction at these locations. The number of crossings in general should be reviewed with the aim to reduce the amount whilst still providing access rights.

It is likely that an average speed of 30mph could be reached for the majority of the route however in areas such as Felinheli and Caernarfon the local speed limits of the road will need to be observed.

[12] www.disused-stationsorg.uk/a/afon_wen/index.shtml

5. Interfaces and Constraints

5.1. Wheel/Rail

A key challenge when using Tram-Trains is the difference between the tramway and heavy rail wheel/rail interaction.

When a rail vehicle negotiates switches and crossing (S&C) or on certain tight curves, the back of the wheel flange provides guidance through contact with the check rail. The location of the check rail on the track is based on the back-to-back spacing of the wheelset and, although tramway and Network Rail tracks have the same nominal track gauge of 1435mm, most tram vehicle's wheelsets have a larger wheelset back-to-back spacing of 1379mm when compared to the standard Heavy Rail P8 back-to-back spacing of 1360mm. This is due to tramway wheels having a narrower flange for negotiating grooved rails on street running sections of track[13].

Consequently, the assumption proposed for this study that the Tram-Train Vehicles which will be used for this route will be fitted with heavy rail P8 wheel profiles, means that with their wider flanges the heavy rail wheel profile is not compatible with traditional tramway grooved rails without modifications. The modifications will ultimately increase the width of the grooved rails, and therefore increase the risk to motorised and non-motorised users of any shared sections of track. One of the more recently opened tram systems in Edinburgh has reported more than 400 accidents involving cyclists and tram tracks over a ten year period and compensation payments of £1.2million being paid[14], and therefore it is assumed that increasing the width of the grooved rails further for the P8 wheel profile could increase this interface risk.

On this basis, with the knowledge of the increased risks, the alignment has been designed to minimise the amount of integrated on-street running. Further investigations will be required to establish the best available mitigation measures - for instance the use of gap fillers where a replaceable, flexible rubber infill eliminates the flange groove completely (**Figure 5-1**) – at locations where on-street running cannot be reasonable avoided, particularly if road users cross the railway at a skewed angle (**Figure 5-2**).

Figure 5-1 – Example of gap filler for street running section[15]

[13] https://www.railengineer.co.uk/making-the-wheel-rail-interface-work/
[14] https://www.bbc.co.uk/news/uk-scotland-edinburgh-east-fife-62969521
[15] https://www.strail.de/en/level-crossing-systems/

Figure 5-2 – Example of skewed road/rail crossing, with gap in-fillers[16]

5.2. Traction Power

The vehicles proposed for this route operate under 25kV AC electrifications, with the addition of on board energy supply via batteries to allow operation through sections where installation of 25kV AC is not feasible. The installation of, and providing power for, the overhead line equipment should therefore be considered as part of further studies as these will present their own difficulties.

There will be scenarios throughout the route where it is not possible or practicable to install OLE due to site constraints or proximity to urban areas. In these situations, there is the opportunity for the vehicle to run on battery power however, the length of the unpowered section should be assessed to establish whether there is sufficient battery capacity for the vehicle to maintain performance. Additional power charging facilities may need to be considered in sections where 25kV AC power is not feasible. This will need to be investigated at a later stage.

5.3. Vehicles/Highways/Pedestrians

With the extensive development in the area since the closure of the line, it is inevitable that there will be interactions between the tram-train and both motorised and non-motorised users. It is therefore critical that suitable measures are put in place to manage the risk where these modes of transport interface.

The advantages of using the tram-train rolling stock is the fact that whilst in tram mode the driver uses line of sight allowing for much simpler and more cost effective solutions at intersections.

The Light Rail Safety and Standards Board (LRSSB) have produced guidance on appropriate measures to put in place at these intersections of both motorised and non-motorised users.

[16] https://www.strail.de/en/level-crossing-systems/

5.3.1. Motorised Users – public roads

Extract from LRSSB guidance[17] applicable to motorised users, includes;

'*Intersections between a road and an off-street tramway should be treated as if they were intersections between a minor road on which the road traffic is travelling, and a major road on which the tram is travelling and has priority, regardless of the volumes of road and tram traffic'*

'Conventional three-aspect signals for road vehicles and the tramway equivalent for trams should be used as described in Chapter 8.'

'A non-signalled intersection between an off-street tramway and a road should be signed as if the tramway were the major road. Stop or Give Way signs should be provided on the road approaches for road traffic, with the Tram sub-plate applied as appropriate as shown in Diagram 778.1 of the TSRGD)

Taking this guidance in to account the approach taken as part of this study is to split up intersections into minor road intersections (access tracks, low usage and low speed roads) and non-minor road intersections (busier roads, higher speeds roads).

At minor road intersections it is proposed to install a Stop or Give Way junction, such as in Figure 5-3.

Figure 5-3 – Example Give Way junction on segregated Tram Lines – Priestfield Tram Stop Car Park on West Midland Metro

At junctions with greater flows of road traffic, higher speeds and/or reduced visibility splays it is proposed to install a traffic signal-controlled junction, due to the increased risk at these interfaces. An example of this style of junction is shown in **Figure 5-4**

It should be noted that the above recommendations are not based on a Road Safety Audit, which will need to be carried out prior to any intersection design being completed.

[17] https://resources.lrssb.org/download/tramway-principles-and-guidance-tpg

Figure 5-4 – Example Traffic Light Controlled junction on segregated Tram Lines – New Swan Lane on West Midland Metro

5.3.2. Motorised Users – Authorised User access

Historically when railway lines were constructed, where the alignment crossed private access roads to individual properties or caused the division of different parts of farmland property, then level crossings were installed to retain access rights. Where the crossing points were on private land with limited known user(s), User Worked Crossings (UWCs) were constructed and an agreement entered into between the railway company and the Authorised User(s) for their operation.

It is assumed at present historic access rights across the former alignment would similarly have to be retained, and in the vast majority of cases it is likely that the provision of an overbridge/cattle creep underbridge would not be appropriate for the level of use of the crossing (either due to the amount of use by the land-owner/farmer of the crossing, and/or due to the relatively low number of trains passing the location). This however would need to be appropriately risk assessed during the later design stages.

Where the Afon Wen to Bangor line is reopened as a conventional railway system using Tram-Trains in Train mode, a new User Worked Crossing (UWC) would need to be introduced at these access points and legal agreements entered into with the designated Authorised Users. Since these are crossings operated by designated users only, there will be duties also imposed on the Authorised Users to inform all users/visitors/delivery organisations etc. of the risks associated with the crossing and the operation for their safe use. Where visibility and warning times of the approach of trains is limited, the protection at the crossings could be supplemented by Whistle Boards (UWC-W) for trains to warn of their approach, or with Telephones (UWC-T) to allow users to call the signaller for permission to cross with slow moving vehicles or animals.

A significant risk for adopting Tram-Train operation on the Afon Wen to Bangor line, is that there are not known to be precedents for the operation of Tram vehicles in rural areas where significant numbers of User Worked Crossings would otherwise be installed for a conventional railway system. However the Class 398 Tram-Train vehicle will be approved in due course for use on the Network Rail system, and therefore it is assumed that they meet all crash-worthiness criteria for operating in Train mode – with Tram mode being of equal risk, if not lower risk due to the enhanced braking, at crossings to that when the same vehicles is operating in Train mode.

If the Tram-Trains are operating in Tram mode it has been assumed in this Feasibility Study that the use of a junction with Stop signage would be appropriate – on the basis

the rail vehicle with enhanced emergency braking would be operating slowly enough to stop at any obstruction encountered. This would therefore be similar to the junction shown in **Figure 5-3** previously for public roads, but due to the likely presence of animals in the adjacent fields it is proposed that gates would also be required to prevent animals from straying onto the operational railway.

Thus the protection provision would be similar to a User Worked Crossing on Network Rail infrastructure, but with the additional safety safeguard of the Tram-Train operating with enhanced Tram mode braking if there was a trespass or misuse of the road. This does however require the Tram-Train vehicle to be able to stop if an obstruction is seen, so will limit the maximum line speed practicable to achieve line-of-sight distances.

Figure 5-5 – Example User Worked Crossing (near Aberdare, South Wales), showing signage and gates

5.3.3. Non-Motorised Users

Non-motorised users should be encouraged to use defined crossing points over the tram tracks. The crossing should be clearly marked and clearly recognisable by the use of signage, dropped kerbs and tactile markings.

Each crossing must be treated individually and would be subject to a risk assessment which considers visibility, the speed of approaching Tram Trains, and the number and type of non-motorised user flow. The most basic crossing is completely passive and only provides fixed signage and guard rails. The design of the crossing must take into account human factors, and encourage pedestrians to look before they cross.

Figure 5-6 – Example of passive pedestrian crossing (e.g. with no additional protection measures) across segregated Tram Lines – Morden Hall Park footpath crossing on London Tramlink[18]

[18] Photo by Derek Harper - https://www.geograph.org.uk/photo/2292649 used under https://creativecommons.org/licenses/by-sa/2.0/

In the event that a passive crossing is insufficient, then a standard signalled pedestrian crossing in accordance with the Traffic Signs Regulations and General Directions 2016 shall be provided. The interface to the Light Rail infrastructure shall be similar to the road crossing with the Tram Train requesting a phase to cross the pedestrian crossing.

Where there is a pedestrian crossing that is also at a road crossing, then the pedestrian crossing must be separated by fencing on the approach and guard rails provided to ensure that pedestrians are able to observe and act upon the pedestrian crossing warning signs.

Where signage and other passive controls are not deemed sufficient, active warnings and controls should be considered or construction of an alternative grade separation (i.e. underbridge or overbridge).

Table 5-1 below summarises the interventions envisaged during the Feasibility Study.

Type of Interface	Operating in Tram Mode	Operating in Train Mode
Existing Pedestrian Crossing	Install new pedestrian crossing with warning signage (see **Figure 5-6**)	Install new Footpath crossing with gates – and Whistle Boards/Miniature Warning Lights as required
Access track likely to be lightly used by Authorised User(s) only	Install Stop/Give Way Junction (see **Figure 5-3**) with gates if required to prevent animals straying onto railway (see **Figure 5-5**)	Install new user worked crossing with gates
Access track likely to be heavily used or used by slow moving vehicles	Install traffic signal controlled junction (see **Figure 5-4**)	Install level crossing with barriers/(Miniature) Warning Lights.
Lightly Used Road by members of public	Install Stop/Give Way Junction (see **Figure 5-3**)	Install level crossing with barriers and Warning Lights
Heavily Used Road	Install traffic signal controlled junction (see **Figure 5-4**)	Install level crossing with barrier and Warning Lighting – controlled by CCTV or Obstacle Detection

Table 5-1 – Summary of Road/Rail interfaces for Tram Mode and Train Mode

5.4. Active Travel Infrastructure

A high proportion of the original route between Bangor and Bryncir have been used to provide active travel paths notably Cycle Route 8. This cycle route diverts on to an alternative route south of Bryncir and does not follow the old alignment in this section.

Where the original alignment is now being used as a cycle route this study will aim to retain this alongside the new tram-train route however it may not be possible in all sections where there are existing land constraints. In this scenario, this will be noted within the report but alternative routes will not be developed. This will be a requirement for consideration and development in any future studies.

5.5. Structures

Within Section 7 to 11 of this report, where existing structures along the former railway alignment are identified these will be recorded as obstructions accordingly. It should be noted that as this study is using OS maps and LIDAR surveys it will not be possible to identify all obstructions along the route as some may be buried in heavy vegetation or obscured in other ways. This is of particular note South of Caernarvon where the sources of information were more limited. An on-site survey will therefore need to be carried out at a later date to determine the precise amount of obstructions along the route. There will also be scenarios along the route where the level of accuracy of the data used will not provide sufficient information to determine the level of intervention required – as an example it has been difficult to establish the true width of St Helens Road and whether the tram-train route can be installed whilst maintaining one lane of traffic.

5.6. Utilities

Historically utilities have been a significant cause of delays and cost increases when working on tramways and will likely have an impact on the proposed alignment. This is a particular risk in Caernarfon and Felinheli, where there will be integrated on-street running required.

There have been no utility surveys carried out as part of this study. This will need to be carried out in the next stages to allow for any refinement in the alignment.

5.7. Prevention of Unauthorised Access

Where the alignment transitions between integrated on-street running and segregated or off-street running, access prevention measures will be required to prevent the unauthorised access of motorised and/or non-motorised users onto the segregated railway sections. This will normally involve the use of signage and road markings to attempt to highlight the risks at these locations, and guide members of the public away from the railway.

The reinstatement of the former railway will require a significant review of property access rights along the alignment, as over the previous 50 years since the railway closure there will be a large number of formal and informal walking and vehicular access

rights which have been gained and exercised across the former alignment over time. This access will need to be managed appropriately to ensure the safety of members of the public, staff and passengers, but also ensure that legal access rights are retained. It is proposed where the route is running off-street that the corridor will be fenced to prevent any unauthorised access to the railway similar to the conventional heavy rail system with gates installed where required to maintain existing access rights.

6. Junction Design- Bangor and Afon Wen

6.1. Bangor Junction

The new alignment continues on to Bangor and will need to join the Chester and Holyhead line at a suitable location prior to reaching Bangor Station. This section of the report will look into the possible solutions to provide a transition on to the main line.

The original alignment for the railway line between Bangor and Caernarfon branched off the Chester and Holyhead line (North Wales Line) immediately east of the now-closed Menai Bridge Station as shown in **Figure 6-1**. The tracks between Menai Bridge Station and Caernarfon have long been lifted.

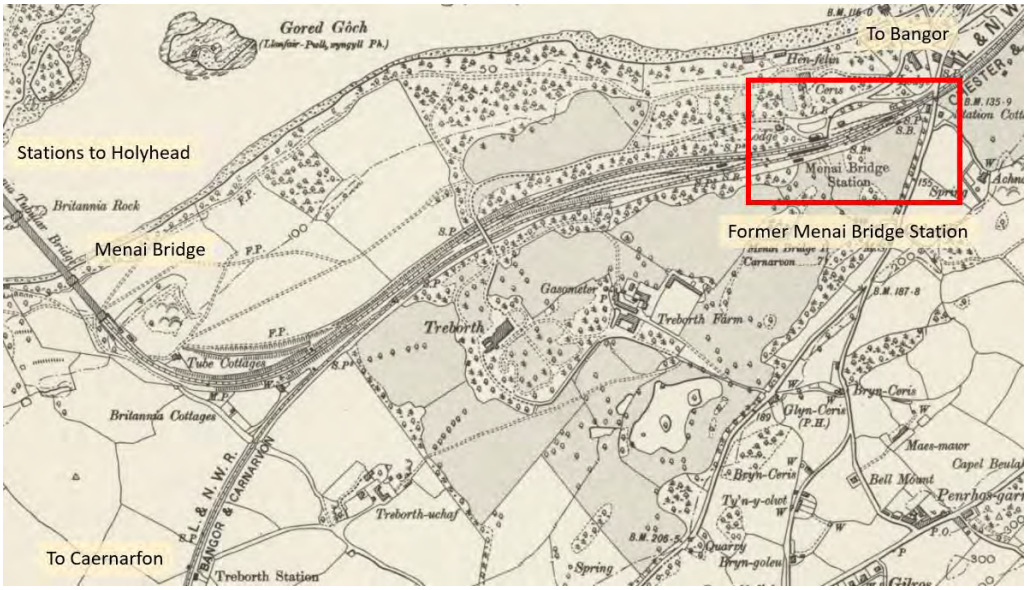

Figure 6-1 - Historic map of former alignment and main-line junction.

The lines ran roughly parallel for approximately 1km with the Bangor to Caernarfon line climbing (in the direction of Caernarfon) before diverging. At this point, the level difference was approximately 10m.

The existing line diagram, **Figure 6-2**, depicts the current track layout of the North Wales Line.

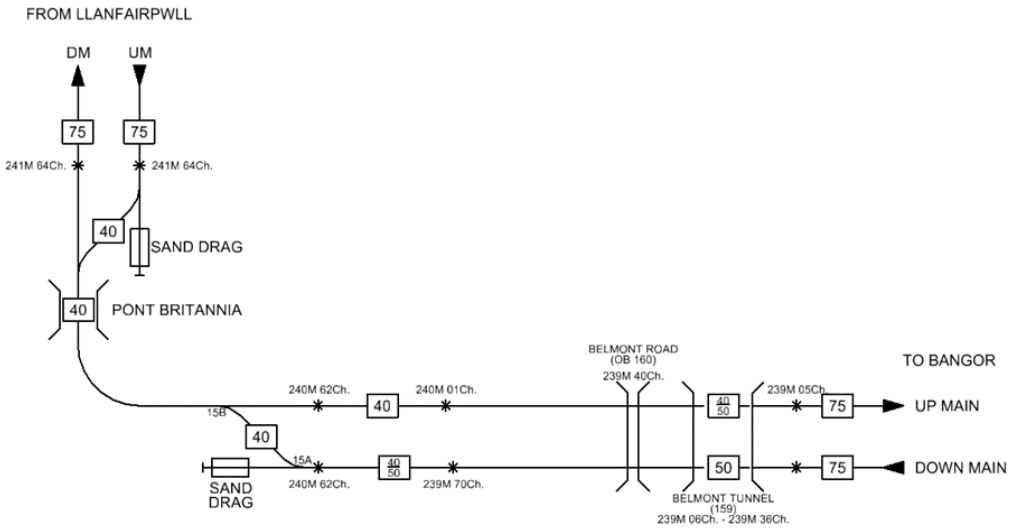

Figure 6-2 - Existing Line Diagram - North Wales Line

The proposed junction configurations fall into two distinct options with a number of sub-options which can be developed in more detail at later design stages.

Option 1 utilises the existing North Wales Line as far as the end of the 2-track section.

Option 2 follows the track bed of the former branch line, diverging from the North Wales Line at the approximate location of the former Menai Bridge Station.

6.1.1. Option 1A

This option proposes to use the existing 15A points to diverge from the main line on to the proposed Caernarfon Branch line. Figure 6-3 is a schematic representation of the line configuration.

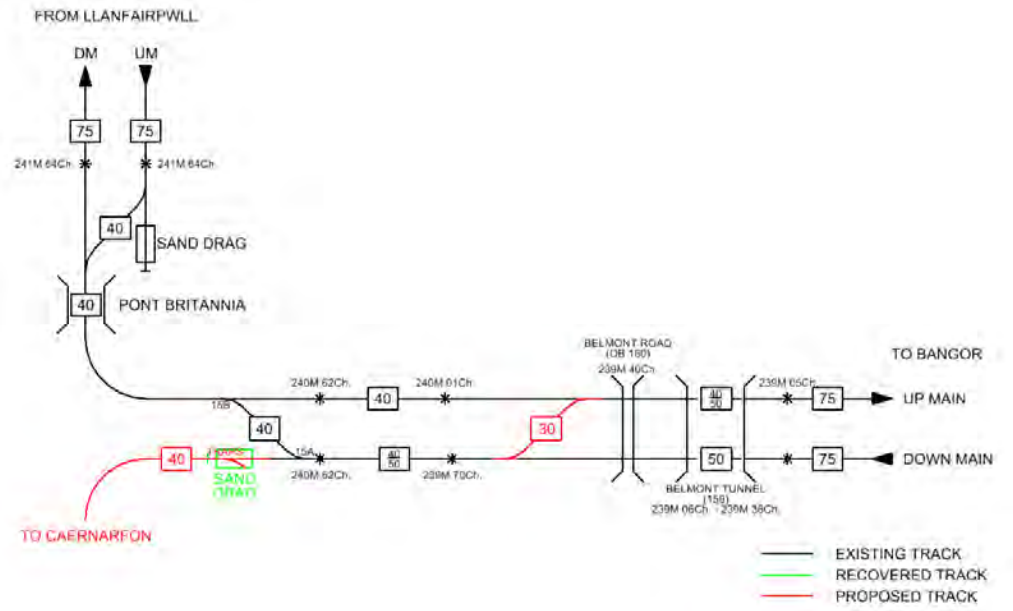

Figure 6-3 - Option 1A - Proposed Line Diagram

The existing sand drag will be removed and trap points installed to protect the main line. Although traps aren't mandated for passenger lines due to the high-level of leaf fall in the area and gradient falling towards the main line it is recommended they are considered with a suitable overrun.

The condition of 15A points will however need to be investigated to establish whether these are suitable. A cross over is also proposed on the existing tracks further east to allow vehicles access to the up main when approaching Bangor.

The difficulty with this option is that the branch line to Caernarfon is only a single track and there are no proposed passing locations on the branch line. The branch line will need to be clear to allow any vehicles to join from the main line and if this will result in the train heading west waiting on the main line potentially causing delays.

Due to the location of 15A points and the level difference between the existing main line and the proposed branch line there will be significant earthworks required to allow the track to climb to a sufficient height to cross the A55 road. It is not deemed feasible to maintain the existing main line track levels due to the topography on the western side of the A55.

6.1.2. Option 1B

This option proposes to eliminate the need for a crossover on the North Wales Line by forming a junction with the single-track section of line. **Figure 6-4** is a schematic representation of the line configuration – A set of traps has been proposed, although not strictly required from one passenger line to another, in light of a collision between two trains due to one train passing a signal at danger due to low rail adhesion caused by heavy leaf fall, they have been included here.

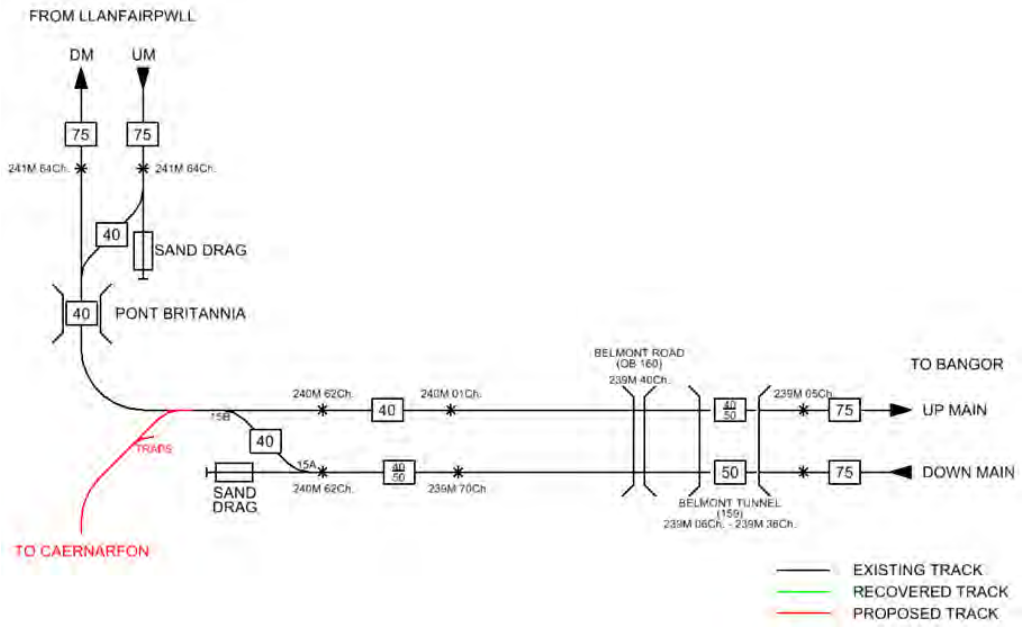

Figure 6-4 - Option 1B - Proposed Line Diagram

This option could be more economical than Option 1A as it uses fewer sets of points which saves on material cost and minimises disruption to the mainline with fewer possessions.

The principal drawbacks are that it is only a single track from Caernarfon and therefore doesn't facilitate a passing place or provide a holding area for trams transitioning from tram mode to train mode onto Network Rail infrastructure.

Additionally, the single-track section of the Menai Bridge is a significant bottleneck on the main line. This proposal would create more conflict with trains on the mainline running in both the Up and the Down direction, particularly with the absence of a passing or holding area.

This option to divert from the existing Up Main west of 15B points which would not require an additional crossover was considered however due to the level differences in this location it was not deemed feasible.

6.1.3. Option 1C

This option introduces a passing place or holding area between existing Network Rail tracks and the proposed branch to Caernarfon as depicted in **Figure 6-5**.

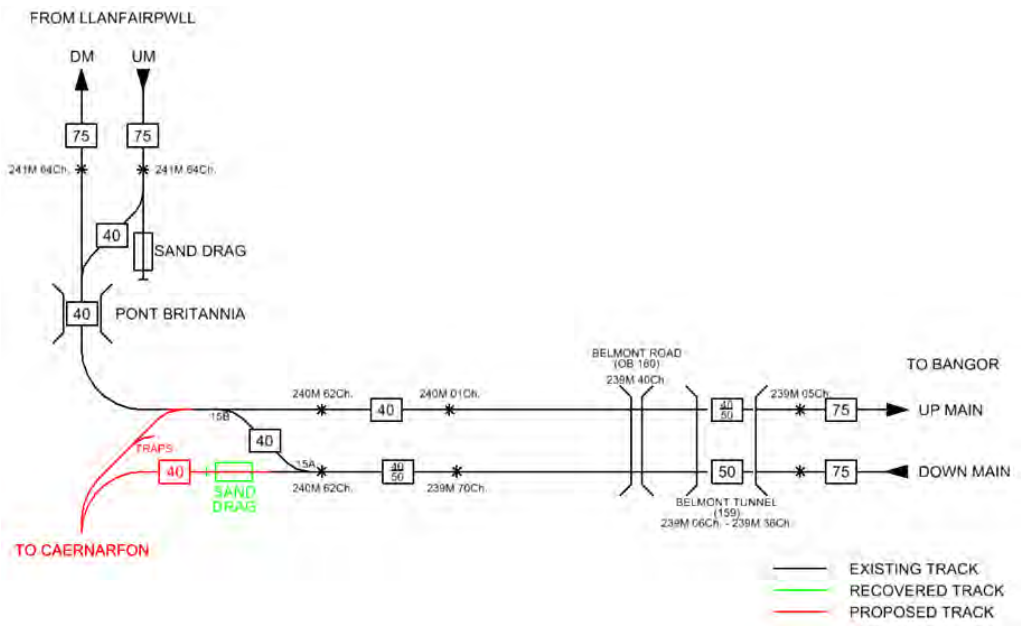

Figure 6-5 - Option 1C - Proposed Line Diagram

The connection to the Up Main line is as per Option 1B but the addition of the passing place connects into the Down Main via the existing sand drag beyond 15A points

By introducing a connection directly from the Down Main on the two-track section of the mainline, it mitigates the impact on the mainline capacity as per Option 1B. As per Options 1A and 1B this options is not deemed feasible due to the large level difference in this location.

6.1.4. Options 1A-1C Summary

The options minimise the amount of railway systems work (plain line track, points, signalling) but spanning the A55 is the key constraint.

The road is in a slight cutting where the line will most likely cross. This lends itself to being spanned by a bridge which is less risky, less disruptive, and technically less difficult to crossing vs a tunnelled route (of any method) below the road. It is therefore deemed unfeasible.

6.1.5. Option 2A

The following option follows the route of the former historic alignment where it diverged from the main line at Menai Bridge Station allowing for a more gradual gradient to reach the required levels to span the A55.

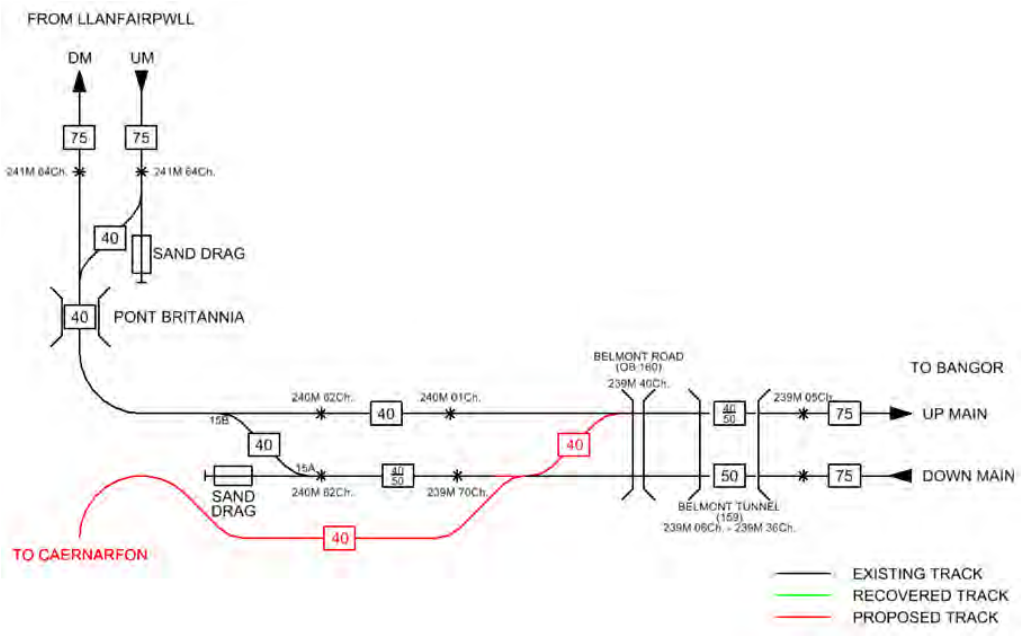

Figure 6-6 - Option 2A - Proposed Line Diagram

The single lead from the Down Main line runs along the trackbed of the former alignment before diverging from the single track that runs towards Holyhead. A crossover between the Down Main and Up Main is required to allow trains to access the Up Main while approaching Bangor Station. This solution does not provide a location for a passing/holding place thus will impact on the services on the mainline.

The condition of the former track bed will need to be investigated to establish the works required to allow the installation of the new track bed.

6.1.6. Option 2B

This option introduces an additional turnout which results in a passing place or holding area between existing mainline tracks and the proposed branch to Caernarfon minimising the impact on the mainline. It will however need to be confirmed at a later stage whether there is sufficient space available along this section to allow this.

With the addition of a passing location it may be possible to locate a new station within this area to allow quicker access between Holyhead and Caernarfon.

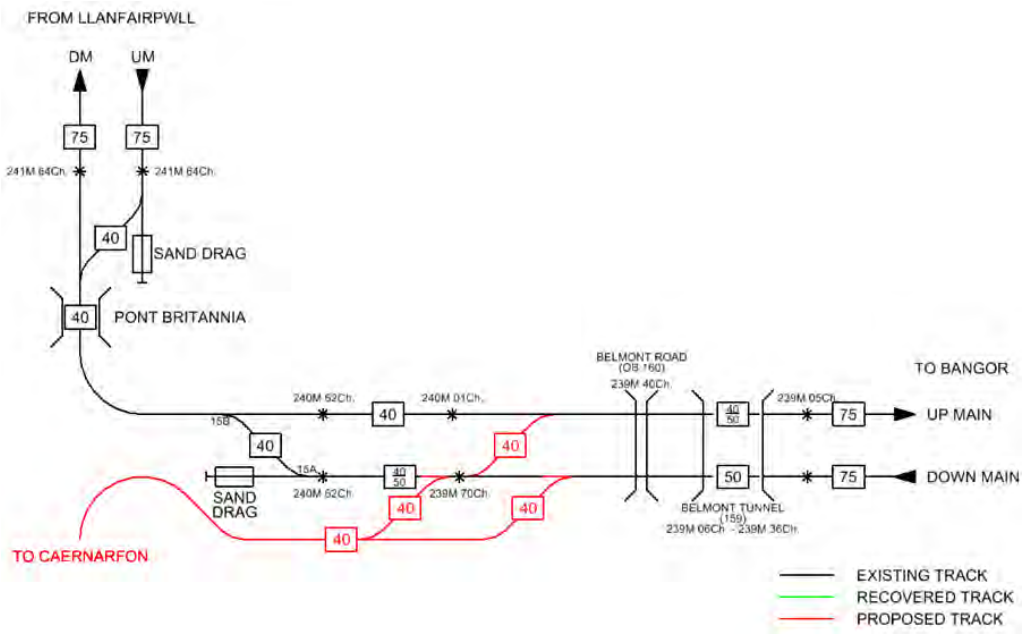

Figure 6-7 - Option 2B - Proposed Line Diagram

6.1.7. Option 2A & 2B Summary

Option 2A and 2B both provide a gradual gradient to reach sufficient level to span the A55 and is recommended for further investigation at a later stage.

Turnout and crossover speeds should be optimised for operational needs, cost, and work within site constraints.

6.2. Afon Wen Junction

This section will look at a possible triangle junction solution which would connect the line from Bryncir into the existing mainline in the area of the former Afon-Wen Junction.

The original alignment for the railway line to Caernarfon branched off the Cambrian Railway immediately west of the now-closed Afon-wen Junction Station as shown below. The track between Afon-Wen Junction and Caernarfon has long been lifted.

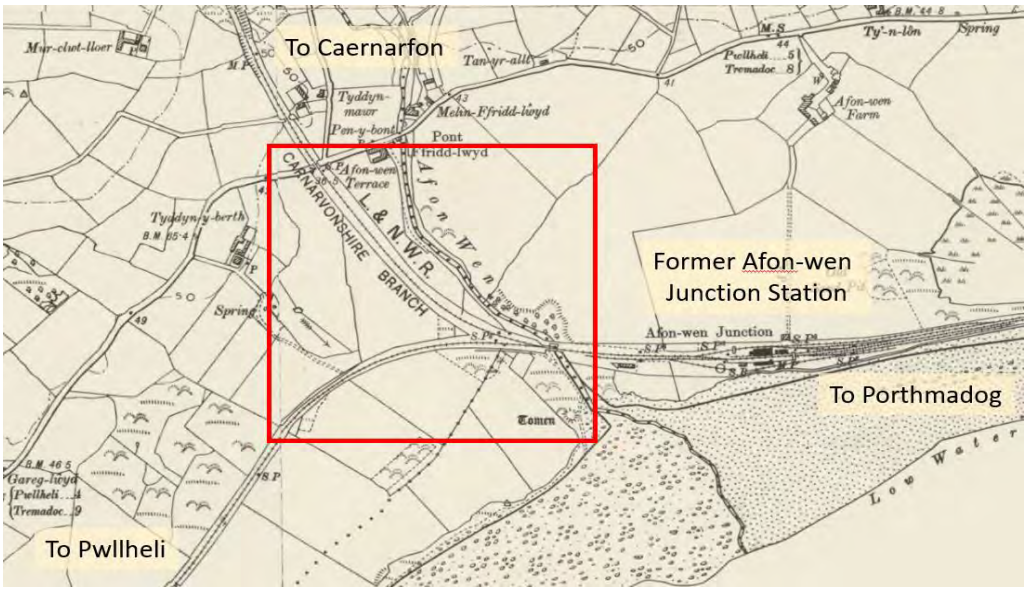

Figure 6-8 - Historic map of former Carnarvonshire Branch line and Afon-Wen Junction.

From Criccieth, the existing mainline alignment comprises several long straight sections which follow the coastline on the approach to the area of the former Afon-Wen Junction. In this area, the alignment transitions into a tight left hand curve approximately 0.5km in length. Beyond this, the alignment straightens again on the approach to Penychain.

The existing line diagram below depicts the current layout of the Up & Down Pwllheli Line (note due to the signalling system, line speeds are shown in kilometres per hour).

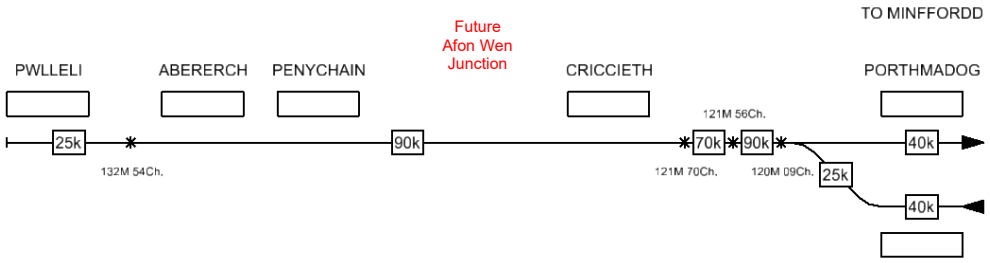

Figure 6-9 - Existing Line Diagram – Up & Down Pwllheli

6.2.1. Proposal

From Bryncir, the proposed alignment is straight which facilitates the siting of a turnout to allow the alignment to diverge and become two separate chord lines. Both proposed chord lines connect back into the existing mainline via turnouts sited on straight sections of track. A passing loop of approximately 100m in length is connected to each of the chord lines, however, the required length and Signalling requirements of these loops will need to be developed at a later design stage.

The proposed line diagram, Figure 3, depicts the proposed layout of the Up & Down Pwllheli Line and the new East & West Chord lines (and associated passing loops).

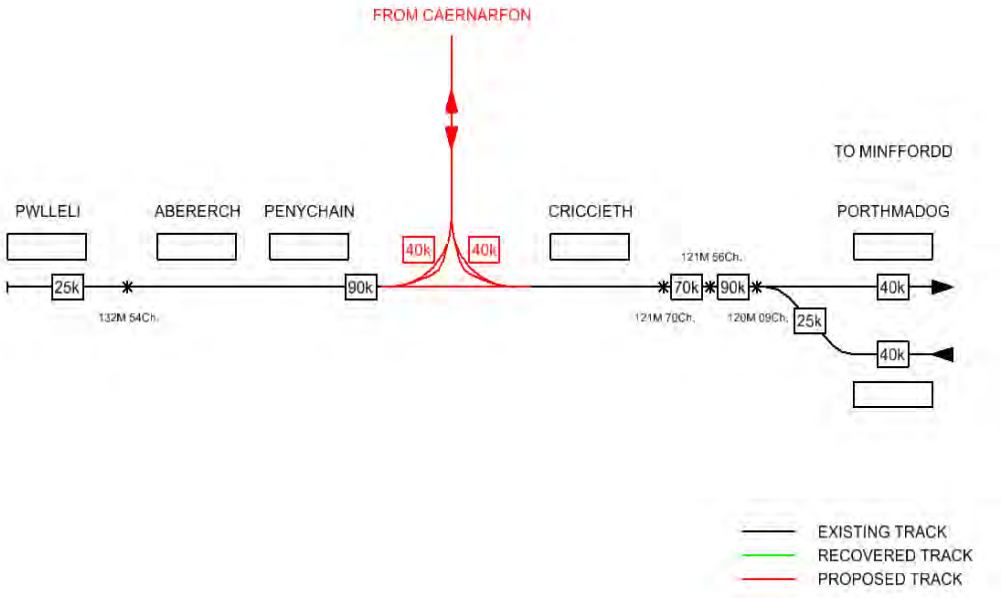

Figure 6-10 - Proposed Line Diagram

7. Route Alignment Review - Bangor to Caernarfon

7.1. Route Section Summary of Interventions/Implications

The route section between Bangor and Caernarfon has the following interventions/implications;

Proposed Intervention Categories

Section	Total Length	Minimal (Green)	Moderate (Yellow)	High (Orange)	Very High (Red)
A	14.6km	27%	45%	22%	6%

Road Rail Interfaces Interventions

Route Section	Reconfigure highway inc roundabout	Traffic Light Controls	Stop/Give Way	Stop/Give Way with gates
A	6	6	5	0

Structure Interventions

Route Section	Underbridge		Overbridge		New Retaining Walls/ Embankment works
	Retain / Repair	Replace / New	Retain / Repair	Replace / New	
A	0	4	1	6	4

Type of running lengths

Route Section	Train Running	Tram (integreated on-street and segregated on-street)	Tram (off-street)	Total Length
A	2.7km	0.25km (Felinheli) 0.15km (Balclava Car Park	11.5km	14.6km

Impact on Cycle Route

Route Section	Length of cycle route requiring diversion
A	0.9km (Through Felinheli)

7.2. . Bangor to Water Treatment Works

Chainage – 0m to 4100m **Associated Drawings – Section A Sheet 3**

7.2.1. Route Summary

The following section discusses the current state of the previous alignment providing solutions where obstructions or issues have been identified. This section has been broken down into smaller geographical areas between two distinct locations along the route. At the end of each section a summary table has been included where the works required to construct the route are shown and a recommended option is highlighted in green.

The route between the former Menai Bridge station and the current Bangor station is part of the North Wales Mainline between Llandudno Junction and Holyhead, and is a twin track railway which passes through the 592m long Belomont tunnel immediately west of Bangor station. Bangor station comprises 2 platforms, with 2 through roads between them and 2 sidings on the Down (south) side.

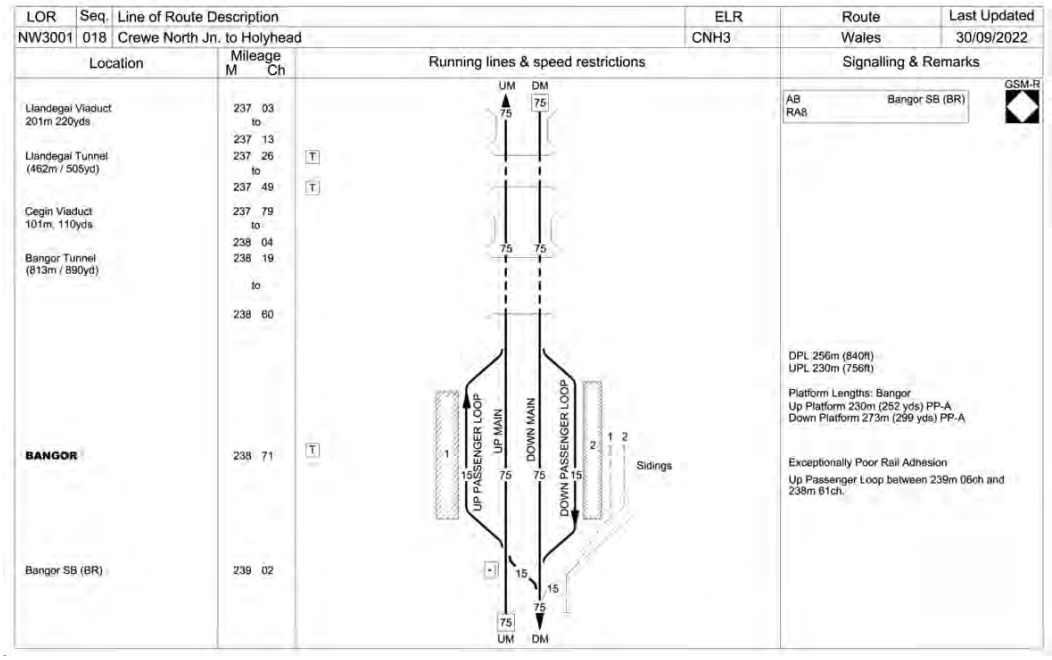

Figure 7-1 – Sectional Appendix of Bangor Station

The proposed passenger service pattern for the Afon Wen to Bangor route has not been determined yet, and trains may extend - subject to timetable capacity - to Llandudno Junction (or beyond) where services can reverse. However there is currently no ability to reverse trains at Bangor station, so if there is a requirement to terminate train services at Bangor then as a minimum signalling interventions will be required to reverse trains in Platform 1 via the existing crossover outside Bangor Signal Box at 239 miles 2 chains. This however may not be operationally practicable within the existing North Wales Main Line timetable, depending on the length of times services have to turn-around at the station whilst blocking the Up Passenger Loop. Therefore it maybe appropriate to create a new bay platform at Bangor station if services were to reverse at this station,

potentially upgrading the sidings on the south (or Down) side of the station to passenger use – but this would require signalling, permanent way and civil intervention works.

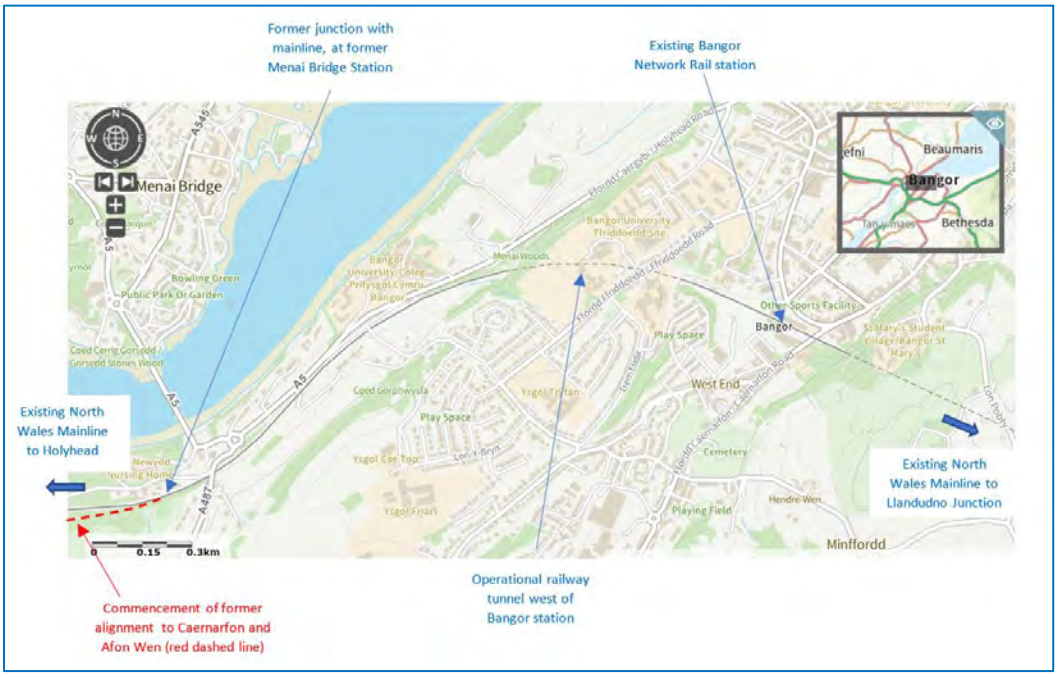

Figure 7-2 – Overview of Bangor to Menai Bridge area showing the obstructions along the route

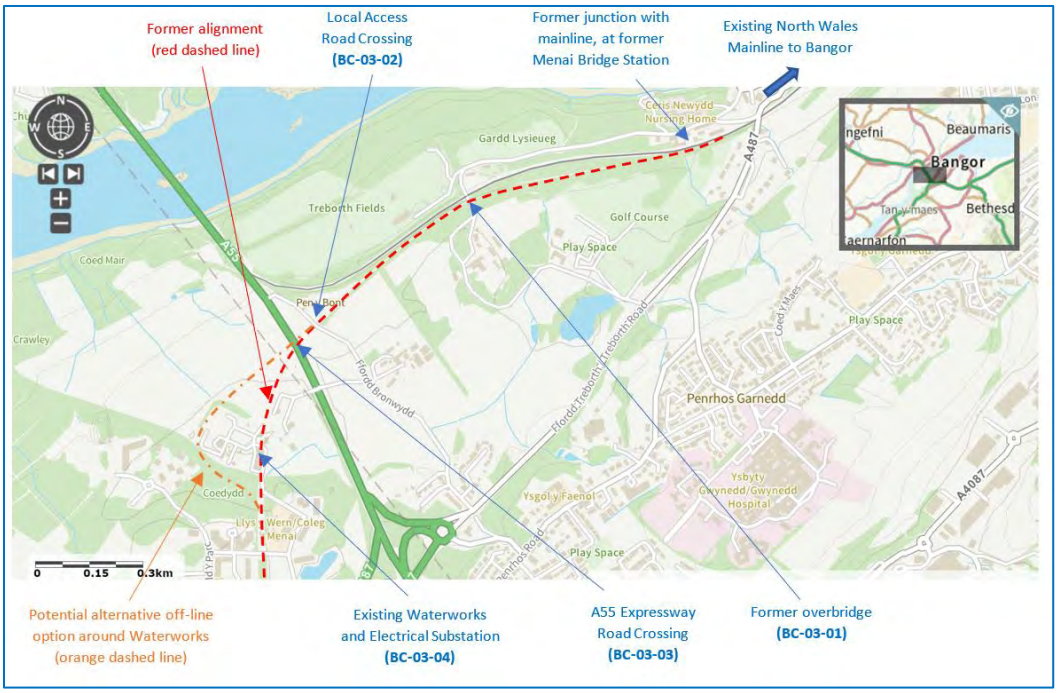

Figure 7-3 – Overview of Menai Bridge to Treborth area showing the obstructions along the route

The branch line between Bangor and Afon Wen diverts from the main line at the former Menai Bridge Station, now the site of Treborth Business Park, with nothing remaining of the original station. The line continues parallel to the mainline for a distance of approximately 1200m metres along what appears to be a footpath, but at different gradients, with the branch line being higher than the mainline. The former alignment in this area is now owned by a number of Third Party landowners. It should be noted all

available landowner details have been gathered for this study but there are parcels of land that are not currently registered with the land registry and will require additional investigations to be carried out.

The surrounding land in this area is predominantly grassland/recreational areas with a number of small businesses situated more than 100m from the proposed alignment therefore impact operational impact will be minimal.

Situated 800m west of the junction for the mainline is an overbridge which was present prior to closure of the line however it is not clear whether this is a vehicle or pedestrian overbridge. Its current condition or clearances are not currently know ***(Obstruction Number – BC-03-01).*** More detailed information is required on this structure to establish whether any works are required.

Figure 7-4 – Footbridge Crossing Alignment Obstruction Number – BC-03-01

The former alignment then crosses a local access road to Britannia Cottages – Ffordd Bronwydd – ***(Obstruction Number – BC-03-02)***, which was a formerly crossed by a bridge that has been removed. The proposed alignment will pass within 50m of Britannia Cottages which will have a negative impact on the occupiers of this property although it should be noted that the property is already situated close to the existing mainline railway and A55 expressway.

Directly afterwards, the new A55 North Wales Expressway dual carriageway has been constructed. This is a substantial obstruction ***(Obstruction Number – BC-03-03)***, which has changed the ground levels and profiles in the area significantly meaning the former alignment is no longer visible for ~50m.

Figure 7-5 – Ffordd Bronwydd crossing alignment Obstruction Number – BC-03-02

Figure 7-6 – A55 crossing alignment Obstruction Number – BC-03-03

South of the A55 the original alignment curved slightly southwards to the former Treborth Station, which is now believed to be a private property. The alignment is now completely occupied by a waste water works and electricity distribution site with its associated access road. This is a significant obstruction ***(Obstruction Number – BC-03-04)***, due to the fact that this facility now appears to straddle the original alignment.

It is assumed from the provisional desktop study that due to the extent of building across the former alignment within the water works, a number of buildings would need to be demolished and all associated pipework, electrical supplies and access routes relocated as appropriate. At this stage this is presumed to require either the temporary or permanent closure of the site, to facilitate a major reconfiguration or even relocation of the works.

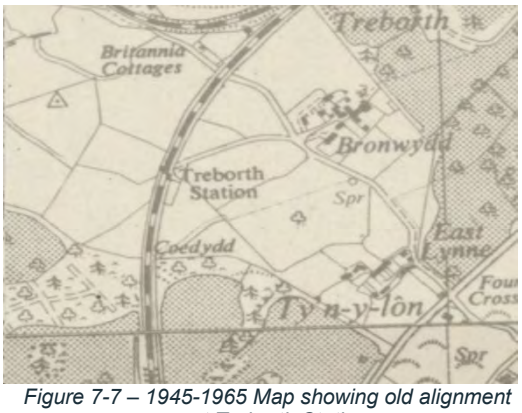

Figure 7-7 – 1945-1965 Map showing old alignment past Treborth Station

Figure 7-8 – Waterworks on alignment Obstruction Number – BC-03-04

7.2.2. Interventions

Overbridge (Obstruction Number – BC-03-01)

The current condition and clearances of this structure are unknown therefore more detailed surveys are required to understand the nature of the works required.

Ffordd Bronwydd (Obstruction Number – BC-03-02)

Vehicle access to Britannia Cottages appears to be limited to Ffordd Bronwydd which will be intersected by the new alignment and will require a vehicle crossing. Based on the likely usage in this area it is proposed to install a junction with Stop/Give Way signage. The tram-train will be required to slow down at this location however it is not believed this speed reduction will have a significant impact on overall travel times. Pedestrian signage should also be installed in this location as it is likely pedestrians will use this route to access the coastal path.

A55 North Wales Expressway (Obstruction Number – BC-03-03)

Due to the high volumes of traffic using this road and the impact an at grade junction would have on traffic flow the only viable solution at this location is to construct a bridge to span over this road. The structure would be substantial with a span of approximately 70m and a degree of skew. It is likely that the abutments of the bridge could be built in to the embankment thus reducing the overall span of the structure.

Considering the close proximity of the water works and electrical distribution unit (detailed below) there is an alternative option to avoid these businesses and reroute the alignment to the north of the water works. This would result in a shallower skew of the bridge over the A55 and ultimately a shorter span to approximately 50m.

Water works (Obstruction Number – BC-03-04)

To avoid the significant works noted to the water works and associated infrastructure, it is advised that alternative routing to avoid the waste water works are considered. Drawing 3 of Section A shows a potential alterative alignment to the north of the existing Water Works, which predominately requires the purchase of farmland, prior to re-joining the former alignment south of the water works to allow a continuation through Parc Menai Business Parc.

The advantages of the alternative route is the impact on the waste water works and its associated infrastructure is avoided, providing significant savings in capital costs and disruption to services. However, the proposed alternative route will require the adoption of a tighter radius curve (~200m radii curve) to allow the diverted route to pass around the obstruction. This will result in a limit to the maximum speed of Tram-Trains in this location – reduced from the maximum potential 45mph permitted in Tram mode.

7.2.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BC-03-01 - Overbridge	Carry out detailed surveys on existing condition and clearances	Minimal	Minimal			
BC-03-02 - Ffordd Bronwydd	Install Stop/Give Way junction at road crossing at 3600m.	Minimal	Moderate	Install Stop/Give Way junction at road crossing at 3600m.	Minimal	Moderate
BC-03-03 - A55 North Wales Expressway	Construct c. 70m skewed bridge over the A55.	Moderate	Very High	Construct c. 50m with minimal skew bridge over the A55.	Moderate	Very High
BC-03-04 - *Water works*	Relocate equipment within the water works and electricity substation or relocate entire site. Purchase 3rd party land required for the existing alignment – this will include the land from the water works, electricity distribution unit and the privately owned property. Provide alternative access to these businesses as this would be removed by the alignment – assuming the businesses can be maintained.	Very High	Very High	Purchase 3rd party land required for the alignment – this will include the unused farmland adjacent to the waterworks	Moderate	Minimal

7.2.4. Tram/Train Mode

Due to the significant extent of obstructions in this section – predominately the presence of a wastewater works on the former alignment, and the additional constraint of a significant structure to cross the A55 North Wales Expressway - it is assumed for this section of the route that the vehicle will be running in tram mode, as this will allow greater flexibility to manoeuvre around the obstacles in this section. As a result of this, a changeover section of track will be required in close proximity to the junction of the main line to allow the vehicles to change from Train to Tram mode.

7.2.5. Operational Impacts

The track alignment for the alternative route requires tighter radius curves (c. 200m) therefore the maximum speeds in this location would be lower than maintaining the existing alignment, hence increasing travelling time.

It should be considered whether there would be any benefit from constructing a station at Menai Bridge junction to allow faster journey times to Holyhead.

7.2.6. Cycle Route Impacts

At this location there is no national cycle route therefore no impact on this.

7.2.7. Conclusion / Recommendation

The waste water works and electricity distribution unit is a significant obstruction in this location with any works likely to cause sever disruption and significant costs. The alternative solution to avoid this site and reroute the alignment to the north is recommended.

7.3. Water Treatment Works to Vaynol Tunnels

Chainage – 4100m to 5100m **Associated Drawings – Section A Sheet 4**

7.3.1. Route

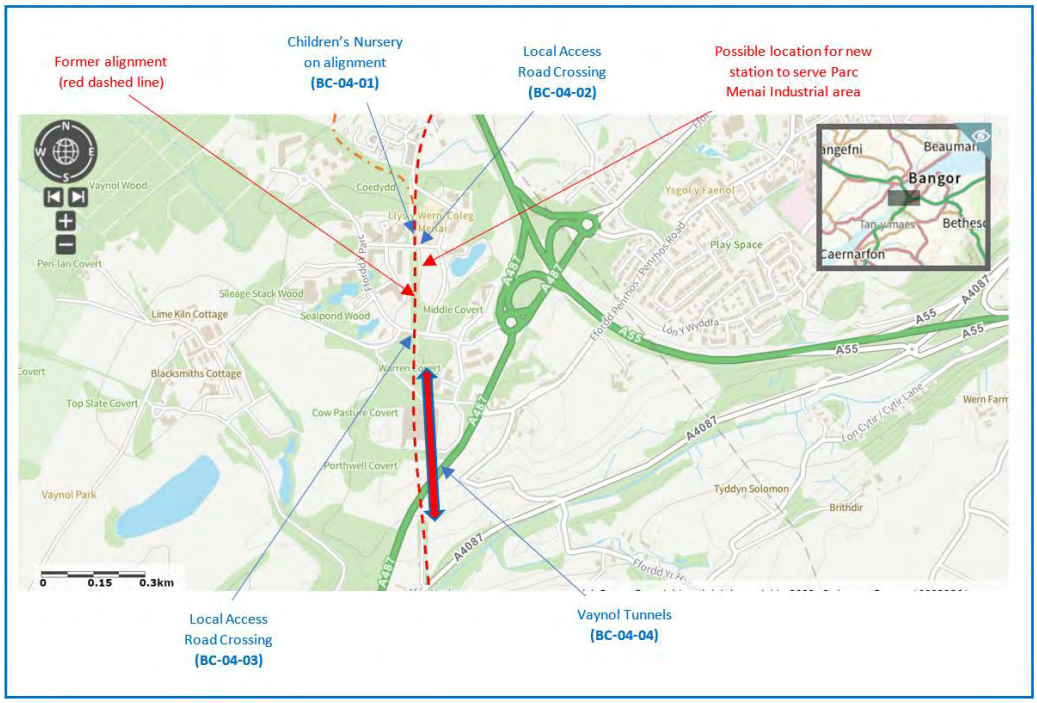

Figure 7-9 – Overview of Treborth Water Treatment Works to Vaynol Tunnels showing the obstructions along the route

The original alignment continues south undisturbed for 100m where it enters Parc Menai Business Park which has been developed on old woodland. A small wooden structure has been constructed in this location which houses a local children's nursery. (**Obstruction Number – BC-04-01**).

Figure 7-10– Children's Nursery on alignment Obstruction Number – BC-04-01

The alignment continues through the business park largely undisturbed where it is now used as a footway, however two roads, 250m apart, intersect the alignment providing access to various business (***Obstruction Number - BC-04-02 and BC-04-03)***. The alignment continues undisturbed, although heavily vegetated, for a short section before reaching the North Portal of the Vaynol Tunnels.

Figure 7-11 - Ffordd Gelli Morgan crossing alignment
Obstruction Number - BC-04-02

Figure 7-12 - Ffordd y Parc crossing alignment
Obstruction Number - BC-04-03

The Vaynol Tunnels (***Obstruction Number - BC-04-04)*** consist of two bores, 455m long currently in use by local businesses. The condition of the tunnels are unknown however as they are currently occupied it would be fair to assume that they are in fair condition. A detailed survey of the tunnels would be required to establish its current condition.

It may not be necessarily required to open both tunnel portals back up as there are potential locations for passing loops North of the tunnels. This should be reviewed taking account of the level of work required and the perceived benefits.

Figure 7-13 – Vaynol Tunnel
Obstruction Number - BC-04-03

7.3.2. Interventions

Children's Nursery (Obstruction Number – BC-04-01)

The small structure constructed to house the children's nursery will require removal/relocation to allow the continuation of the alignment.

The location of the Nursery would be a prime location to construct a station to serve the local businesses whilst also providing a passing section for the tram-trains.

Ffordd Gelli Morgan and Ffordd y Parc crossing alignment - Obstruction Number - BC-04-02 and BC-04-03

The two roads through the business park provide the only access to certain business therefore are essential routes and need to be maintained. A cost benefit analysis should be carried out to establish whether there is a case to close one of them. Taking into account the likely usage of road traffic signal-controlled junctions should be installed at both locations.

Vaynol Tunnel - Obstruction Number - BC-04-04

The condition of the tunnel bores at this stage is currently unknown but can be assumed to be in fair condition due to the occupation of the current businesses. A detailed survey of the tunnels should be carried out to establish the works required to bring the tunnel to modern standards. A gauging assessment should also be undertaken to ensure the rolling stock proposed is suitable for this tunnel. The current occupants of the tunnels will need to be relocated.

It is unlikely that there will be sufficient clearance within the tunnel to allow the installation of overhead line equipment therefore it may be necessary to run through the tunnel on battery power which will impact on travel times due to the need for lowering and raising the pantograph. This could be mitigated were there to be a station constructed in Parc Menai.

Due to the topography of the ground in this location any alternative route would require significant earthworks or deviations and has been deemed unviable. It should be noted that were the condition of the tunnel bores be found to be poor and require significant works to allow the passage of trains, alternative routes may then be considered more viable.

7.3.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required on Existing Alignment	Maintain Alignment		Works Required on Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BC-04-01 – Children's Nursery	Relocate children's nursery	High	Moderate	Due to the topography of the ground in this location any alternative route would require significant earthworks or deviations and has been deemed unviable. It should be noted that were the condition of the tunnel bores be found to be poor and require significant works to allow the passage of trains, alternative routes may then be considered more viable.		
BC-04-02 - *Ffordd Gelli Morgan*	Install traffic signalled controlled junction on Ffordd y Gelli	Minimal	Moderate			
BC-04-03 - *Ffordd y Parc*	Install traffic signalled controlled junction on Ffordd y Parc	Minimal	Moderate			
BC-04-04 – Vaynol Tunnel	Survey the condition of the tunnel bore. Carry out repairs to the tunnel bore to bring the structure to current standards Purchase 3rd party land through the tunnel. This would require the relocation of the current occupants.	High	High			

7.3.4. Tram/Train Mode

With the two road crossings in this section it would be more cost effective to run in tram mode through this section as it will allow the installation of less complex crossings in Parc Menai.

7.3.5. Operational Impacts

The area between the two access roads provides an opportunity to construct a station with an island that would serve the local businesses in Parc Menai whilst also providing a location for a passing loop. Were both tunnels opened back up this would also provide a passing location however this is not necessarily required if the station is constructed to the north.

Due to the complexity of running OLE though the tunnel and the assumed clearances, it is recommended that this section of the route is run on battery power. This would result in an impact on travel time due to the time required to lower the pantograph however this could be mitigated were a station to be located to the North of the tunnel as the time in the station can be used for this operation.

7.3.6. Cycle Route Impacts

At this location there is no national cycle route therefore no impact on this

7.3.7. Conclusion / Recommendation

At this location the previous alignment can be maintained however it is recommended that a detailed survey of the tunnel bore is carried out to establish the level of work required to meet current standards.

7.4. Vaynol Tunnels to The Incline

Chainage –5100m to 7250m **Associated Drawings – Section A Sheet 5**
Section A Sheet 6

7.4.1. Route

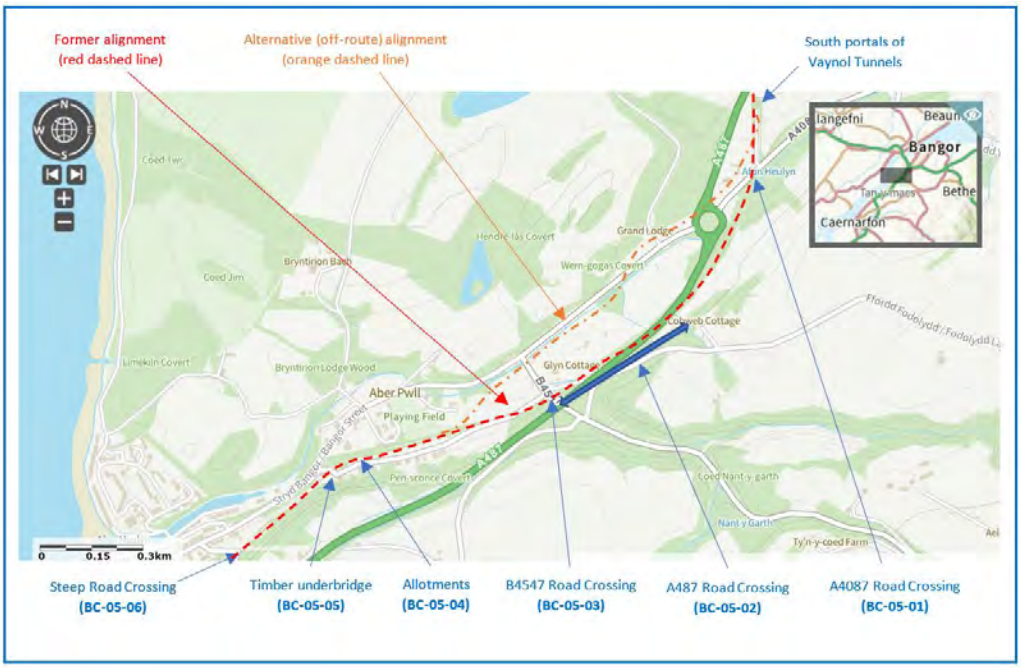

Figure 7-14 – Overview of Vaynol Tunnels to The Incline showing the obstructions along the route

The alignment leaves the south portal of the Vaynol tunnel and continues along a section of the line for approximately 150m, used as an entrance to the businesses who occupy the tunnel. The route is surrounded mainly by farmland however there is a local bed and breakfast located approximately 50m to the west.

The route then falls sharply before being intersected by the A4087 road. It is understood that there was a bridge crossing the A4087 at this location which has since been removed. (***Obstruction Number - BC-05-01)***.

Figure 7-15 – A4087 crossing alignment Obstruction Number - BC-05-01

Figure 7-16 – 1945-1965 Map showing route crossing A4087

The alignment continues south through woodland at high level before it is intersected by the A487 road ***(Obstruction Number - BC-05-02),*** a road built following the closure of

the railway that is approximately 5m below the embankment to the east. The route continues along the A487 for approximately 200m before running along farmland.

Figure 7-17 – A487 crossing alignment
Obstruction Number - BC-05-02

Continuing towards Felinheli, the route passes by a local farm before being intersected by the B4547 road (**Obstruction Number - BC-05-03).** The previous alignment passed under the road at this location via an overbridge which has subsequently been removed leaving steep gradients on both approaches to the road. As the alignment passes this junction the old route has been taken over by an access road to some residential properties with the land adjacent being predominately grass land.

Figure 7-18 – B4547 crossing alignment
Obstruction Number - BC-05-03

Part way down the access road the alignment diverts on to the cycle path which does not have sufficient width to accommodate the alignment due to the allotments that have been built adjacent to this (**Obstruction Number - BC-06-01**). To the North of the cycle path is the location of a branch line to the docks which is at a lower level.

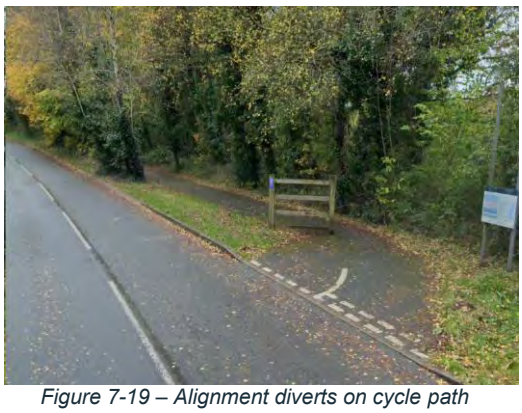

Figure 7-19 – Alignment diverts on cycle path

Figure 7-20 – Allotments along alignment Obstruction Number - BC-06-01

The narrow cycle path passes over a timber underbridge ***(Obstruction Number - BC-06-02)*** between 6850m and 6900m which does not appear to have sufficient width to accommodate the tram-train. This appears to have been installed recently to accommodate only the cycle path. The abutments of the original structure still remain however.

Figure 7-21 – Road crossing alignment Obstruction Number - BC-06-02

The alignment continues through a heavily vegetated section of the route parallel to Bangor Street where it meets a steep road ***(Obstruction Number - BC-06-03)***. It has not been possible to view the route through this section due to the vegetation therefore there may be additional obstacles in this location. The previous alignment passed under an overbridge which carried the old Padarn Railway towards the quarry – this bridge has since been removed. This is known locally as 'The Incline'. Today the cycle path is broken by the steep road and continues at different levels.

Figure 7-22 – The Incline Obstruction Number - BC-06-03

Figure 7-23 – 1945-65 map showing the previous route crossing under the Padarn Railway

7.4.2. Interventions

A4087 Road (Obstruction Number - BC-05-01)

The A4087 is a major link road between Felinheli and he A55 North Wales Expressway therefore disruption to this road should be kept to a minimum. An at grade crossing was considered at this location however due to the considerable level changes in this area it was not deemed viable therefore a bridge structure approximately 200m long would need to be constructed to cross this road.

A487 Road (Obstruction Number - BC-05-02)

The A487 is another major road in this area where an at grade crossing would cause significant disruption to the traffic flow. In addition to this, similar to the A4087 road, there are significant level differences that would require major earthworks to provide an at grade solution. It is therefore proposed to install an approximately 500m long viaduct spanning over the A487. It may be possible to, depending on the levels in the area to combine both bridges. As the structure will be required to provide suitable clearance over the A487 the structure will need to continue parallel with the A487 to bring the alignment back down to ground level. Consideration should be given to reducing the span of the structure by reducing the radius of the curves – this would however impact on the permissible speeds of the tram-trains. This route would require the purchase of 3rd party farmland to the West of the A487 and may impact on the access road in to the adjacent farm requiring an alternative access to be provided.

B4547 Road - (Obstruction Number - BC-05-03)

An at grade crossing will need to be installed as this location to maintain the flow of the B4547 and the road junction will need to be moved to the south to avoid the route and land purchased to allow this. With the likely traffic flow in this area, it is recommended that a traffic signal-controlled junction should be installed here. The access road to the farm will need to be relocated, potentially moved north along the B4547.

Alternative Route Avoiding Obstruction BC-05-01, BC-05-02 and BC-05-03

With the substantial works required to cross both the A4087 and A487 an alternative route has been considered that avoids these roads before meeting back up with the original alignment to the west of the B4547 junction. This route has been chosen as it

provides a more gradual gradient from the Vaynol tunnel to Felinheli requiring less interventions.

On exiting the south portal of the Vaynol tunnel the alternative alignment turns west towards the A487 passing by a local Bed and Breakfast taking over the existing car park which will require relocation.

The alignment continues south before meeting Felinheli roundabout which will need alterations to incorporate traffic-controlled signals on each exit to allow the tram train to pass through, possibly using tighter radius curves.

Figure 7-24 – Existing grass verge for alternative route

The alternative alignment continues along a wide grass verge for approximately 250m before crossing an access road and the B4547. This crossing will require the installation of a traffic signal controlled junction and will need to be situated at a suitable angle not to provide additional risk to road users. Afon Hylwen runs alongside the B4547 and will be to be spanned with a small underbridge.

The route continues along 3rd party land until it meets the B4547 once again. This junction will also require the installation of a traffic signal controlled junction due to the perceived traffic flows in the area. The alignment then continues across the 3rd party farmland where it meets with the existing cycle path.

Allotments (Obstruction Number - BC-06-01)

The allotments appear to encroach on the available width therefore partial purchase of this 3rd party land will be required.

Timber Underbridge (*Obstruction Number - BC-06-02)*

The timber structure installed only appears to provide sufficient width for the cycle route therefore will need to be removed and a new structure constructed in its place. The original abutments still remain and shall be considered for reuse following a detailed survey and assessment. The route in this location runs within 10m of residential properties which will need to be taken in to account. The likely use of this underbridge by road traffic should be investigated to establish whether this access is still required and potential infill carried out.

Steep Road (The Incline) (Obstruction Number - BC-06-03)

Maintaining the road whilst providing a route for the tram-train will prove difficult due to the steep gradients of the road and the requirement of a level route for the rolling stock. It will therefore be required to construct significant earthworks in this area to allow the passage of trains and install a Stop/Give Way junction. A more detailed survey of the area will be required to establish the current ground levels. Tighter radius curves should be considered to reduce the extent of earthworks required.

7.4.3. Summary of Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BC-05-01 – A4087 Road	Construct multi-span bridge over A4087. Purchase 3rd party land adjacent to A4087 to accommodate bridge and ramp. This land currently is woodland/grassland.	Moderate	Very High	Purchase 3rd party land of Bed and Breakfast Reconfigure roundabout and install traffic signal controlled junction over roundabout Install Stop/Give Way junction on access road Construct small underbridge to cross Afon Hylwen Install traffic signal controlled junction over both B4547 roads Purchase 3rd party farmland before re-joining existing alignment	Moderate	High
BC-05-02- - A487 Road	Construct multi span viaduct over A487. Purchase 3rd party land adjacent to A487 to accommodate bridge and ramp. This land currently is farmland.	Moderate	Very High			
BC-05-03 – B4547 Road	Move current junction on B4547 and portion of road south to avoid alignment. Move access road to adjacent farm Install traffic light controlled on B4547 junction. Purchase 3rd party land along local access road.	Moderate	High			
BC-06-01 - Allotments	Purchase 3rd party land currently occupied by allotments	Moderate	Minimal			
BC-06-02 – Timber Underbridge	Reconstruct timber underbridge to provide sufficient width for the proposed rolling stock.	Moderate	High			
BC-06-03 – The Incline	Install significant earthworks at 'The Incline'	Moderate	High			

7.4.4. Tram/Train Mode

The recommended alternative route in to Felinheli does require the vehicle to traverse a roundabout and several road crossings. To keep these interventions as cost effective as possible it is recommended that this section of route is run in Tram mode.

7.4.5. Operational Impacts

The recommended route in to and through Felinheli does require multiple curves with some tight radius that will require the tram to reduce its speed and ultimately impact on travel times.

This section of the route does have potential areas for the location of a station, adjacent to the B4547 for instance however, will be situated too far from the centre of the village of Felinheli to provide easy access.

7.4.6. Cycle Route Impacts

The cycle route currently runs along the alignment between 6250m and 7150m where it then diverts on to the local roads. There is insufficient space to accommodate both the tram-train and the cycle route therefore an alternative route should be found for the cycle route in the area. There are local roads and open grassland nearby that could potentially be used.

7.4.7. Conclusion / Recommendation

Maintaining the existing alignment on the approach to Felinheli will require significant earthworks and bridge structures to traverse the A4087 and A487 and is not deemed the most cost effective solution and it is therefore recommended to follow the alternative alignment to the north of the existing.

7.5. The Incline to Griffiths Crossing

Chainage – 7250m to 10550m

Associated Drawings – Section A Sheet 6
Section A Sheet 7
Section A Sheet 8

7.5.1. Route

Figure 7-25 – Overview of The Incline to Griffiths Crossing showing the obstructions along the route

Continuing through the heavily vegetated area, the alignment reaches the location of the old Port Dinorwic Station (***Obstruction BC-06-04)***. This station has been turned in to a residential property where the gardens occupy the old alignment. The building is currently Grade II listed. Adjacent to the old station building are commercial premises to the west and a residential property to the east. Both of which lie on the old alignment.

Figure 7-26 – Port Dinorwic Station Obstruction BC-06-04

Figure 7-27 – Commercial premises adjacent to Port Dinorwic Station. Obstruction BC-06-04

The alignment continues west along the cycleway before it reaches Caernarfon Road (***Obstruction BC-06-05)***, a road approximately 3m below that of the cycleway. A bridge was located here previously allowing the train to cross over the road however this has since been removed. Part of the retaining wall carrying the tracks at a higher level remain in place forming an area of grassland.

Figure 7-28 – Caernarfon Road crosses alignment Obstruction BC-06-05

Figure 7-29 – Road along alignment with former retaining wall for railway

The alignment continues parallel with Caernarfon road crossing the entrance to several houses in Menai Court (***Obstruction BC-06-06)*** and passing within 10m of other nearby residential properties. Since the closure of the line the road has been widened resulting in the alignment being taken by the carriageway (***Obstruction BC-06-07)*** with the steep embankment to the north of the road.

Figure 7-30 – Alignment crosses access road to houses Obstruction BC-06-06

Figure 7-31 – Alignment taken by road Obstruction BC-06-07

The alignment diverts off Caernarfon Road and heads behind a row of houses along an access road at the top of an embankment which is understood to be weak and has previously failed. There appears to have been several developments in this area where several properties have extended their gardens on to the old alignment (***Obstruction BC-07-01)***.

Figure 7-32 – Access Road to Residential Property's Obstruction BC-07-01

The route continues along the access road passing within 3m of the old crossing keepers house, now a residential property until it is intersected by Beach Road (***Obstruction BC-07-02)***, the site of a level crossing on the former alignment. Recent aerial photos also show a new development adjacent to the intersection whose entrance falls on the previous alignment.

Figure 7-33 – Beach Road intersects alignment Obstruction BC-07-02

Figure 7-34 – New development adjacent to the alignment

Upon crossing Beach Road the alignment joins the current Lon Las Menai Cycle route as it heads towards Caernarfon alongside Caernarfon Road. The first 400m of the cycle route is narrow with a steep embankment up to the road on the southern side and an embankment on the northern side down towards the sea with the majority of the previous alignment having been reclaimed by nature (***Obstruction BC-07-03)***.

Figure 7-35 – Steep embankment Obstruction BC-07-03

The route continues along the Lon Las Menai cycle route before reaching a metallic overbridge providing vehicle access to an adjacent field (***Obstruction BC-07-04)***. The exact height of the bridge is unknown however there does not appear to be sufficient clearance for the rolling stock. The exact use of this access should be investigated to ascertain whether this access is still required or can be moved to an alternative location.

The route emerges from the heavily wooded area on to open grass land for a length of approximately 200m before continuing through another section of dense woodland eventually emerging where it is intersected by Caernarfon Road ***Obstruction BC-08-01)*** on a skew.

Figure 7-36 – Overbridge crosses alignment Obstruction BC-07-04

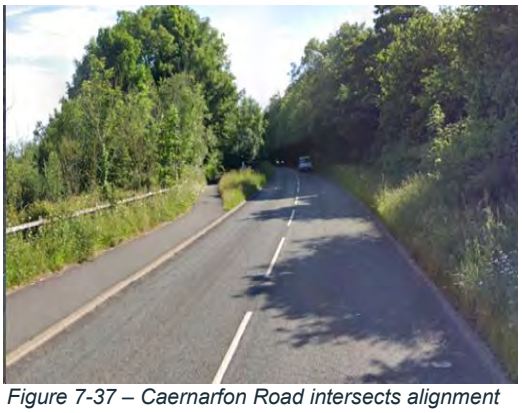

Figure 7-37 – Caernarfon Road intersects alignment Obstruction BC-08-01

After crossing the road, the alignment runs parallel with Caernarfon Road for approximately 500m through heavily wooded area (***Obstruction BC-08-02)*** before reaching Plas Menai Roundabout and the location of the former Griffiths Crossing Station, now a residential property. As this property was a previous station building the route does pass within 3m of this building.

Figure 7-38 – Heavily wooded area Obstruction BC-08-02

Figure 7-39 – Plas Menai Roundabout intersects alignment Obstruction BC-08-03

Figure 7-40 – Former Griffiths Crossing Station now a residential property Obstruction BC-08-04

7.5.2. Interventions

Former Port Dinorwic Station (*Obstruction BC-06-04)*

The buildings to the east and west of the former station building lie directly on the previous alignment and will require purchase and demolition if the existing alignment is to be maintained. It may be possible to maintain the former station building by just purchasing the gardens however the route would run within close proximity to the building as a result. A route to the north of the former station running along the station entrance was considered however this would result in all the properties being cut off and would likely make their use unviable therefore is not being proposed

Alternative route avoiding obstruction BC-06-04

Due to the loss of residential and commercial properties at this location an alternative route was considered. This could be achieved by running the route to the south of the properties avoiding the need for any demolition. This route does run through the toe of an embankment and will however require a more difficult engineering intervention in the form of a retaining wall approximately 200m long.

Caernarfon Road Intersection (*Obstruction BC-06-05)*

With the level difference between the cycle route and the road it will not be possible to install an at grade crossing without the need for significant earthworks over a large area to provide suitable gradients. It is therefore proposed to construct a bridge approximately 60m long to span the road, similar to the previous alignment.

Access Road to Menai Court (*Obstruction BC-06-06)*

This access road appears to be the only vehicle access for the house in Menai Court, therefore will need to be maintained. It is therefore proposed to installed a Stop/Give Way junction at the entrance to this road. It should also be noted that it is likely that the footway will require removal as part of the bridge structure therefore any crossing should provide provision for pedestrian access.

Caernarfon Road (*Obstruction BC-06-07)*

As the road has been widened since the closure of the line there is insufficient space to maintain both carriageways alongside tram-trains. One solution in this location is to use integrated on-street running where the tracks are installed in each carriageway. The advantage of using this solution is that it provides a location for a passing loop however does introduce the risk to other road users due to the embedded grooved rails.

An alternative solution would be to have a single segregated on-street line where one of the carriageways and the footpath would be taken by the alignment leaving one lane for vehicle traffic. The flow of traffic along this road would be impacted and would either need to be turned in to a one-way road in the section or traffic signals installed to allow 2-way traffic flow. Discussions will be needed with the local authority to understand the implications of this.

Residential Properties on Caernarfon Road (Obstruction BC-07-01).

There appears to be various developments along the alignment in this area where residential properties have built over the previous alignment. If the alignment does continue along this route, several properties will need to be purchased and demolished. The route in this section will pass along the top of a weak embankment that will require stabilisation works to be carried out – the exact condition of the embankment will need to be established at a later date.

An alternative to routing along the back of these properties would be to continue the integrated on-street running along Caernarfon Road. Consideration should be given to the proximity of the houses along this road to ensure there is sufficient separation between the alignment and the houses as currently the southern side of the road does not have a footpath.

Figure 7-41 – Proximity of housing on Caernarfon Road an no footpath

It is unlikely that a segregated option will have sufficient space in this area whilst still maintaining 1 lane of traffic as the road narrows. A traffic signal controlled junction will need to be installed to allow the tram to re-join the alignment. This alternative route does also increase the risk to other road users due to the increased width of the grooved tracks and residents of the adjacent properties.

Beach Road Intersection (Obstruction BC-07-02).

There are alternative roads providing access to the docks area however closure of this road is not seen as a suitable solution at this junction as this route does provide better access for larger vehicles to access the docks. Taking in to account the likely level of traffic a traffic signal controlled junction should therefore be installed. The signals should include the access to the recently constructed property adjacent to the crossing.

Embankment (Obstruction BC-07-03)

The embankment in the area runs for approximately 400m and restricts the available width for the rolling stock. A length of retaining wall will therefore need to be constructed in this area. The embankment to the north, heading towards the sea should be investigated to establish whether any stabilisation works are required.

Overbridge (Obstruction BC-07-04)

The overbridge provides access to an adjacent field however does not have sufficient clearance to allow the tram train through therefore will need to be removed. It should be investigated further whether the access needs to be maintained and whether it can be moved to a different location. If the access needs to be maintained, a Stop/Give Way junction should be installed.

Caernarfon Road Intersection (Obstruction BC-08-01)

The route emerges from the cycle path and is intersected by Caernarfon Road on a skew. This road is a major road and will need to be maintained. A traffic signal controlled junction should be installed at this location. It may be necessary in this location to reduce the skew of the intersection to minimise risk to other road users at the crossing.

Heavily Wooded Area (Obstruction BC-08-02)

The area between the A487 and Caernarfon Road is heavily wooded with no areas of open land available. To maintain the traffic flow on both roads it will be necessary to remove areas of this woodland.

Plas Menai Roundabout (Obstruction BC-08-03)

The roundabout has been constructed directly over the alignment and will need to be modified to allow the passage of the tram-train. It is proposed to run the alignment through the centre of the roundabout which will require the installation of traffic signals on all exits.

Former Griffiths Crossing Station Building (Obstruction BC-08-04)

The construction of the roundabout has limited the available width between the road and former station building. Due to the works required to the roundabout detailed above it is recommended that the alignment of the road is reconfigured which will allow the former station building to be maintained.

7.5.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required on Existing	Maintain Alignment		Works Required on Alternative Route	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BC-06-04 – Former Port Dinorwick Station	Purchase 3rd party land in the area of the old Port Dinorwic Station. Demolish residential and commercial properties adjacent to former station building.	High	Moderate	Purchase land behind Port Dinorwic Station. Construct 200m long retaining wall	Moderate	High
BC-06-05 – Caernarfon Road Intersection	Construct 60m bridge over Bangor St/Caernarfon Road.	Moderate	High			
BC-06-06 – Access Road to Menai Court	Install Stop/Give Way junction at entrance to Menai Court	Minimal	Moderate			
BC-06-07 – Caernarfon Road	Construct segregated on-street section on Caernarfon Road.	Moderate	Very High	Construct integrated on-street running along Caernarfon Road	Moderate	Very High
BC-07-01 – Residential Properties on Caernarfon Road	Purchase land to the rear of properties on Caernarfon Road. Carry out embankment stabilisation works	High	High	Maintain the on-street running to approximately 8500m where it returns to the previous alignment Install traffic signalled controlled junction to allow tram to re-join alignment	High	Very High
BC-07-02 – Beach Road	Install traffic signal controlled junction at intersection with Beach Road	Minimal	Moderate			
BC-07-03 - Embankment	Construct retaining wall approx. 400m long as there is insufficient width to accommodate the cycle route and alignment	Minimal	High			

Obstruction Number	Works Required on Existing	Maintain Alignment		Works Required on Alternative Route	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BC-07-04 - Overbridge	Demolish overbridge at 9100m and install Stop/Give Way junction.	Moderate	High			
BC-08-01 – Caernarfon Road Intersection	Install traffic signal controlled junction at road crossing on Caernarfon Road.	Minimal	Moderate			
BC-08-02 – Heavily Wooded Area	Remove wooded area between 9900m and 10300m.	Minimal	Moderate			
BC-08-03 – Plas Menai Roundabout	Reconfigure roundabout to allow the passage of tram-trains through the middle.	Moderate	High			
BC-08-04 – Former Griffiths Crossing Station	Move highway south on the western junction to avoid the former station building	Minimal	Moderate			

7.5.4. Tram/Train Mode

This section of the route requires the navigation through winding roads and across several road junctions in particular the roundabout at Griffiths Crossing. With this in mind it is recommended that the vehicle is run in tram mode for the section.

7.5.5. Operational Impacts

It is understood that this route will be used as a local service with the aim of serving smaller towns and villages along the line. It would therefore be beneficial to the area of Felinheli to provide a station in the village. There is an area of land to the west of the former station building that could be used although suitable access would need to be provided.

7.5.6. Cycle Route Impacts

The cycle route leaves the old alignment at 7150m and follows the local roads before re-joining the alignment at the former level crossing at 8600m. The route then continues adjacent to the proposed tram-train route until diverting off for a short length where it meets Caernarfon Road, re-joining once again at Griffiths Crossing.

7.5.7. Conclusion / Recommendation

A survey of the embankment to the rear of the properties on Caernarfon Road should be carried out to understand the current condition of this. Following completion of this survey the route shall be reviewed to confirm whether the running behind these properties is still achievable. Were it to be found to be highly unstable and not suitable for the passage of trains the route along Caernarfon Road should be used however it should be noted that there will be significant risks running the vehicles in such close proximity to residential properties.

7.6. Former Griffiths Crossing Station to Ffordd Y Gogledd

Chainage –10550m to 13600m

Associated Drawings – Section A Sheet 9
Section A Sheet 10

7.6.1. Route

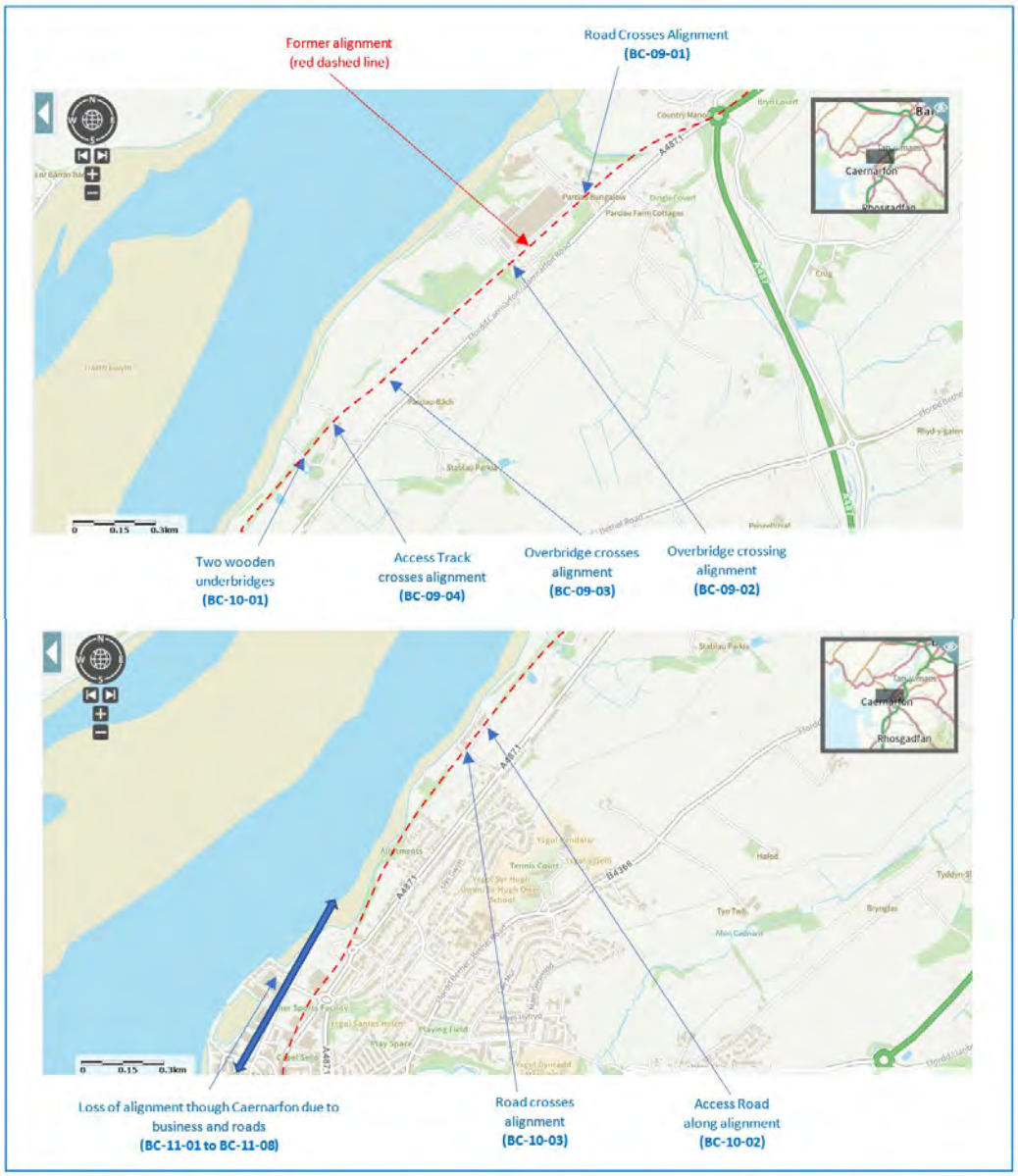

Figure 7-42 – Overview of Griffiths Crossing to Ffordd y Gogledd showing each obstruction along the route

The alignment continues along Lon Las Menai cycle route for approximately 500m where most of the alignment has now been reclaimed by nature. The route is then intersected by an access road leading to several industrial premises (***Obstruction BC-09-01)***.

Figure 7-43 – Road crosses alignment Obstruction BC-09-01

Continuing west towards Caernarfon the route is crossed by 2 overbridges (1 concrete and 1 metallic) that do not have sufficient clearance to accommodate the proposed vehicles – this will need to be confirmed following detailed surveys. The former (***Obstruction BC-09-02)*** provides access to an adjacent industrial unit. The latter (***Obstruction BC-09-03)*** appears to be in a state of disrepair and does not look like it currently serves any purpose, although this will need to be confirmed.

Figure 7-44 – Overbridge crosses alignment Obstruction BC-09-02

Figure 7-45 – Road crosses alignment Obstruction BC-09-03

Further south, the alignment is intersected by an access track between two adjacent pieces of land (***Obstruction BC-09-04)***. The alignment continues, crossing over 2no. timber underbridges (***Obstruction BC-10-01)*** which appear to have been constructed for the purpose of the cycle route only which do not provide sufficient clearance for the rolling stock. It is unclear what the purpose of these underbridges are and what they span although one is potentially an outfall of a water course which will need to be maintained. This will need to be investigated further.

Figure 7-46 – Access track crosses alignment Obstruction BC-09-04

Figure 7-47 – 2 Timber Underbridges Obstruction BC-10-01

In the area of Port Waterloo, the alignment has been taken over by an access road to serve the local properties (***Obstruction BC-10-02)*** and the cycle route has been moved approximately 8m to the South East. There is also a pumping station located on the southern side of the cycle path which restricts the available width. Another access road also crosses the alignment perpendicular in this location (***Obstruction BC-10-03)***.

Figure 7-48 – Access track along alignment Obstruction BC-10-02

Figure 7-49 – Road crosses alignment Obstruction BC-10-03

7.6.2. Interventions

Road Crosses Alignment – Obstruction **BC-09-01**

The access road into the adjacent industrial premises is the only access and will need to be maintained. Due to the likely volumes of traffic it is proposed to install a Stop/Give Way junction.

Overbridge Leading to Industrial Units – Obstruction **BC-09-02**

The overbridge to the industrial premises provides the only vehicle access road and therefore will need to be maintained. It is therefore proposed to reconstruct the bridge providing suitable clearance for the rolling stock being used. Works will also be required to the approach roads due to the increase in the road level over the alignment.

Disused Overbridge – Obstruction **BC-09-03**

The bridge does not appear to be able to carry pedestrians or vehicles due to the lack of any parapets therefore it is assumed that this is disused. It is therefore proposed to demolish this structure including the abutments.

Access Track Crosses Alignment – Obstruction **BC-09-04**

It will need to be confirmed whether the access track needs to be maintained and whether this is used by vehicles as this will impact on the proposed solution. It appears that this route is used by vehicles therefore a Stop/Give Way junction with gates shall be installed at this intersection.

Two Timber Underbridges – Obstruction **BC-10-01**

The two timber underbridges only provide sufficient width for the cycle route and will need to be removed. It needs to be confirmed the purpose of these bridges and whether they need to be maintained. It does appear that one may be a water outfall. Depending

on what their use is, it may be possible to infill the area of land below and if required a culvert can be installed. If the area cannot be infilled then new underbridges should be constructed.

Access Road Taken Alignment – Obstruction **BC-10-02**

The access road on the alignment is currently being used for parking for the property owners of the adjacent premises. There is however a pumping station located on the southern side of the cycle route which will limit where the alignment can go. It is therefore recommended that the alignment is located as close as practicable to the pumping station whilst still allowing access. The cycle route can then be located adjacent to the houses. It should be noted that the width used for the tram-train does take in to account an OLE mast which could be located prior to or after this access road allowing for a narrower width requirement for the tram-trains at this specific location.

Access Road Crosses Alignment – Obstruction **BC-10-03**

This access road appears to provide the only route on to the nearby beach and will need to be maintained. Due to the likely usage of this road a Stop/Give Way junction will need to be installed at this location.

7.6.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required on Existing	Maintain Alignment		Works Required on Alternative Route	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BC-09-01 - *Road Crosses Alignment*	Install Stop/Give Way junction on intersection	Minimal	Moderate			
BC-09-02 - Overbridge	Reconstruct over bridge leading to industrial units	Minimal	High			
BC-09-03 - Disused Overbridge	Demolish disused overbridge	Minimal	High			
BC-09-04 - Access Track Crosses Alignment	Install Stop/Give Way junction on intersection	Minimal	Moderate			
BC-10-01 - Two Timber Underbridges	Remove timber underbridges and infill	Minimal	Moderate			
BC-10-02 - Access Road Taken Alignment	Purchase land taken by access road and maintain existing alignment	High	Moderate	Divert alignment and purchase land to the south	Moderate	High
BC-10-03 - Access Road Crosses Alignment	Install Stop/Give Way junction on intersection	Minimal	Moderate			

7.6.4. Tram/Train Mode

This section of the alignment is relatively straight and free from major obstructions which would restrict the permissible speeds in this section. Due to the close proximity to Plas Menai roundabout and the centre of Caernarfon there does not appear to be any benefit to running this is train mode. Running in train mode would also require full level crossings with barriers to be installed at the road intersections.

7.6.5. Operational Impacts

This section of the route runs along open farmland which would accommodate a passing loop with some additional land purchase however it is unlikely this will be required with the proposed station in Caernarfon town centre.

7.6.6. Cycle Route Impacts

The cycle route runs adjacent to the proposed route through this section until reaches the outskirts of Caernarfon where it continues along the coast before re-joining the alignment at the new Welsh Highland Railway Station.

7.6.7. Conclusion / Recommendation

This section of the route can accommodate the new tram-train together with the cycle route however there will need to be several interventions including reconstruction and removal of several bridges together with the installation of a number of crossings. The area around Port Waterloo will impact on the local residents as parking will be impacted however realigning the route would impact on the nearby pumping station.

7.7. Caernarfon Town Centre

Chainage – 13600m to 14600m **Associated Drawings – Section A Sheet 11**

7.7.1. Route

The alignment then reaches the town of Caernarfon where all of it has been developed since the closure of the line and poses significant difficulties when navigating the route.

As the alignment reaches the outskirts of the town it passes to the rear of several residential and commercial properties which have encroached on the previous alignment ***Obstruction* BC-11-01)** before reaching its first major obstruction – Morrisons petrol station (***Obstruction* BC-11-02).** The alignment continues where it has been built on by Morrisons Supermarket and car park (***Obstruction* BC-11-03)**, the location of the previous Caernarfon Station. To the north of the supermarket and petrol station is a council owned car park mainly used for tourists. Fford y Gogledd, the main road through the town runs parallel with the supermarket on the Southern side.

Figure 7-50 – Residential and Commercial Premiss *Obstruction* BC-11-01

Figure 7-51 – Morrisons Petrol Station on alignment *Obstruction* BC-11-02

Figure 7-52 – Morrisons Supermarket on alignment *Obstruction* BC-11-03

Continuing past the supermarket the alignment has once again been built upon with Balaclava Road crossing the alignment (***Obstruction* BC-11-04)**, and a council owned car park (***Obstruction* BC-11-05)**, (Balaclava Car Park) which is one of a number of town centre car parks and is in a prime location to serve the local business in the area. It has been advised by the local council that there are potential proposals to close the Penllyn Multi Storey therefore any works that impact Balaclava Car Park will need to take this into consideration.

Figure 7-53 – Balaclava Road crosses alignment *Obstruction* BC-11-04

Figure 7-54 – Road crosses alignment *Obstruction* BC-11-05

Between the main Balaclava car park and Crown Street to the South is additional parking down a narrow corridor flanked either side by retaining walls still intact from the previous alignment (***Obstruction* BC-11-06)**. Part way down this narrow corridor is an overbridge providing pedestrian access between Bangor Street and Balaclava Road, currently with insufficient clearance.

Figure 7-55 – Balaclava car park along alignment *Obstruction* BC-11-06

The alignment then emerges on to Crown Street where the retaining wall continues on the Eastern side but is broken for a short section on the west. The street is surrounded by residential and commercial properties on both sides. An overbridge carrying vehicles along Stryd y Porth Mawr, currently signed for 3m crosses the road (***Obstruction* BC-11-07)**. The alignment continues along Crown Street before reaching Caernarfon Tunnel (***Obstruction* BC-11-08)** which was closed for a period of time following the closure of the line but has recently been opened up to traffic. The height of these is currently unknown however they are signed for 3m. It should be noted that this section of the route was historically two track.

Figure 7-56 – Overbridge crosses alignment *Obstruction* BC-11-07

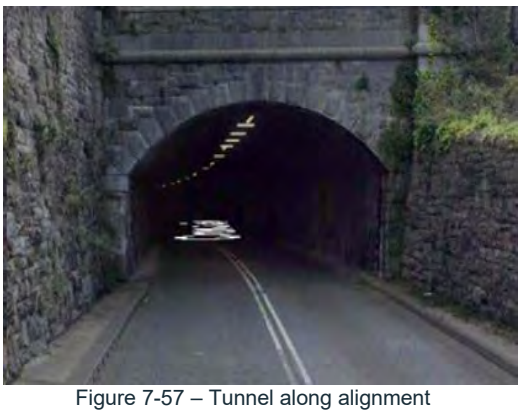

Figure 7-57 – Tunnel along alignment *Obstruction* BC-11-08

7.7.2. Interventions

***Residential and Commercial Properties (Obstruction* BC-11-01)**

The residential and commercial properties have encroached on the previous alignment and will need to be purchased to allow the alignment to continue. It may be possible to only partially purchase the land however this will need to be confirmed following a more detailed review of the route and accurate survey.

***Morrisons Petrol Station (Obstruction* BC-11-02)**

The alignment runs through the middle of the petrol station which will need to be relocated or removed to allow the tram-trains to pass.

Morrisons Supermarket (***Obstruction* BC-11-03)**,

The original alignment runs through the middle of the supermarket however it is not necessary to run the route through the supermarket building as there is sufficient space alongside the building and entrance road. The entrance road to the supermarket will therefore need to be relocated. This route will also result in an impact on the delivery area and will make this inaccessible and will need to be reconfigured.

Alternative Route avoiding Obstruction BC-11-02 and BC-11-03

As the route through the Morrisons Petrol Station and Supermarket will cause significant disruption and require the relocation/removal of the petrol station three alternative routes have been considered.

1) An alternative route is to follow the cycle route along the coastal path avoiding the Petrol Station and supermarket. This route will require the construction of a retaining wall above the existing cycle path and potentially significant sea defences. The route then continues through the existing Shell Site Car Park where it will follow the toe of the existing embankment and will require the removal of several car parking spaces. Consideration of the route should also take in to account the removal of Balaclava Car Park detailed below. The alignment runs the length of this car park before climbing and crossing the entrance of the Morrisons delivery area and Balaclava Road in to Balaclava Car Park.

Figure 7-58 – Alternative route along coastal path


Figure 7-59 – Alternative route through Shell Site Car Park

2) Upon reaching the outskirts of the town the route will divert from the footpath heading towards Ffordd Y Gogledd where it passes through residential apartments and a local small car dealership which will need to be purchased and relocated. The route then meets Ffordd y Gogledd where a traffic signal-controlled junction will need to be installed to allow the tram-trains to access the highway. This route proposes using integrated on-street running for a short section where track will be installed in each carriageway ensuring safe flow of traffic. The route continues along Ffordd y Gogledd where it meets an existing roundabout allowing traffic in to the Morrisons supermarket. This roundabout will need to be removed and a traffic signal-controlled junction installed, still allowing traffic into the supermarket.


Figure 7-60 – Car dealership on alternative route


Figure 7-61 – Roundabout in to Morrisons

Further along Ffordd y Gogledd is another larger roundabout which will also need reconfiguration with traffic signals installed on each junction. The route then turns down Balaclava Road where it enters the Balaclava Road Car Park.

Figure 7-62 – St David's roundabout heading towards Balaclava car Park

This route does avoid the disruption to the large supermarket and petrol station however does have its own difficulties as integrated on-street running historically has been difficult to install and will cause severe disruption to the highway and surrounding areas.

3) A third option has been considered which follows the route of the second alternative option along Ffordd y Gogledd however upon reaching St David's Roundabout the route follows the A4871 road avoiding the centre of town. The fact that this route will avoid the centre of the town will result in any proposed station being situated further out of town and will prove less appealing to the travelling public. The route continues as integrated on-street running over the flyover before re-joining the previous alignment after Pont Seiont Roundabout via a multi span bridge.

Balaclava Road crosses alignment (*Obstruction* BC-11-04)

Several options converge at the intersection of Balaclava Road which will require the installation of a traffic signal-controlled junction due to the likely traffic flow on the road. The impact of traffic backing up to the nearby roundabout will need to be considered when proposing the location of the crossing.

Balaclava Road car park (*Obstruction* BC-11-05)

As part of the scope, it has been requested to look at potential locations for a station within Caernarfon in a suitable location with easy access to nearby facilities. With this in mind it is proposed to use the existing Balaclava Car Park as the location of this station as it provides sufficient space to allow for an island platform. As a result the car park will now longer be able to be used and provision for parking in a new location should be considered. It is unlikely that the car park of the adjacent ASDA will be impacted.

Balaclava Road car park overbridge (*Obstruction* BC-11-06)

There are currently limited pedestrian routes from Bangor Street to Balaclava Road, one of which is the overbridge at Balaclava Car Park. As part of the station development detailed above the pedestrian access between these two roads could be maintained however it would be advised to minimise the amount of non-travelling pedestrians crossing the tram tracks. Were this overbridge removed it would encourage more pedestrians to cross the tram tracks through Balaclava Car Park increasing the risk to these people. It is therefore recommended that this bridge is reconstructed to provide sufficient clearance to the tram-train.

The alignment emerges on to Crown Street, currently a two way road, where it will continue as a segregated route resulting in the partial closure of Crown Street to vehicle traffic.

***Crown Street Overbridge (Obstruction* BC-11-07)**

Crown Street overbridge provides one of several entrances into the area within the Castle walls and could potentially be removed with minimal impact on the traffic flow. This will need to be discussed with the local authority to establish the impact on the wider road network.

Caernarfon Tunnel *(Obstruction* BC-11-08)

The line through Caernarfon Tunnel was previously two track providing sufficient clearance for those trains however since the re-opening of the road the road level has been built up resulting in a lack of available height. Works will be required to reduce the road height however surveys should be carried out prior to this to establish the tunnels invert levels to confirm available clearances. From current information the tunnels condition appears to be fair with only minor work required.

7.7.3. Summary of Route Implications and Works Required

Due to the number of possible routes in this area the summary tables have been split in to individual tables for each option

7.7.3.1. Preferred option – Off-street running through Morrisons Supermarket

Obstruction Number	Works Required on Existing	Significance	
		Significance (Public Relations)	Significance (Engineering Challenge)
BC-11-01 - *Residential and Commercial Properties*	Purchase 3rd party land where residential and commercial properties are on the alignment	High	Moderate
BC-11-02 - *Morrisons Petrol Station*	Demolish Morrisons Petrol Station Purchase 3rd party land occupied by petrol station	Very High	Moderate
BC-11-03 – Morrisons Supermarket	Reconstruct entrance road in to Morrisons Reconstruct Morrisons delivery area Partial purchase of 3rd party land occupied by Morrisons car park	High	Moderate
BC-11-04 – Balaclava Road	Install traffic signal controlled junction on Balaclava Road	Minimal	Moderate
BC-11-05 – Balaclava Car Park	Construct station in Balaclava Car Park Purchase council owned car park	Very High	High
BC-11-06 - Balaclava Road car park overbridge	Reconstruct overbridge spanning Balaclava car park	Minimal	High
BC-11-07 – Crown Street overbridge	Demolish overbridge spanning Crown Street Closure of Crown Street to vehicle traffic.	High	Moderate
BC-11-08 – Caernarfon Tunnel	Lower road level to provide suitable clearance through tunnel Carry out repairs to tunnel	Moderate	High

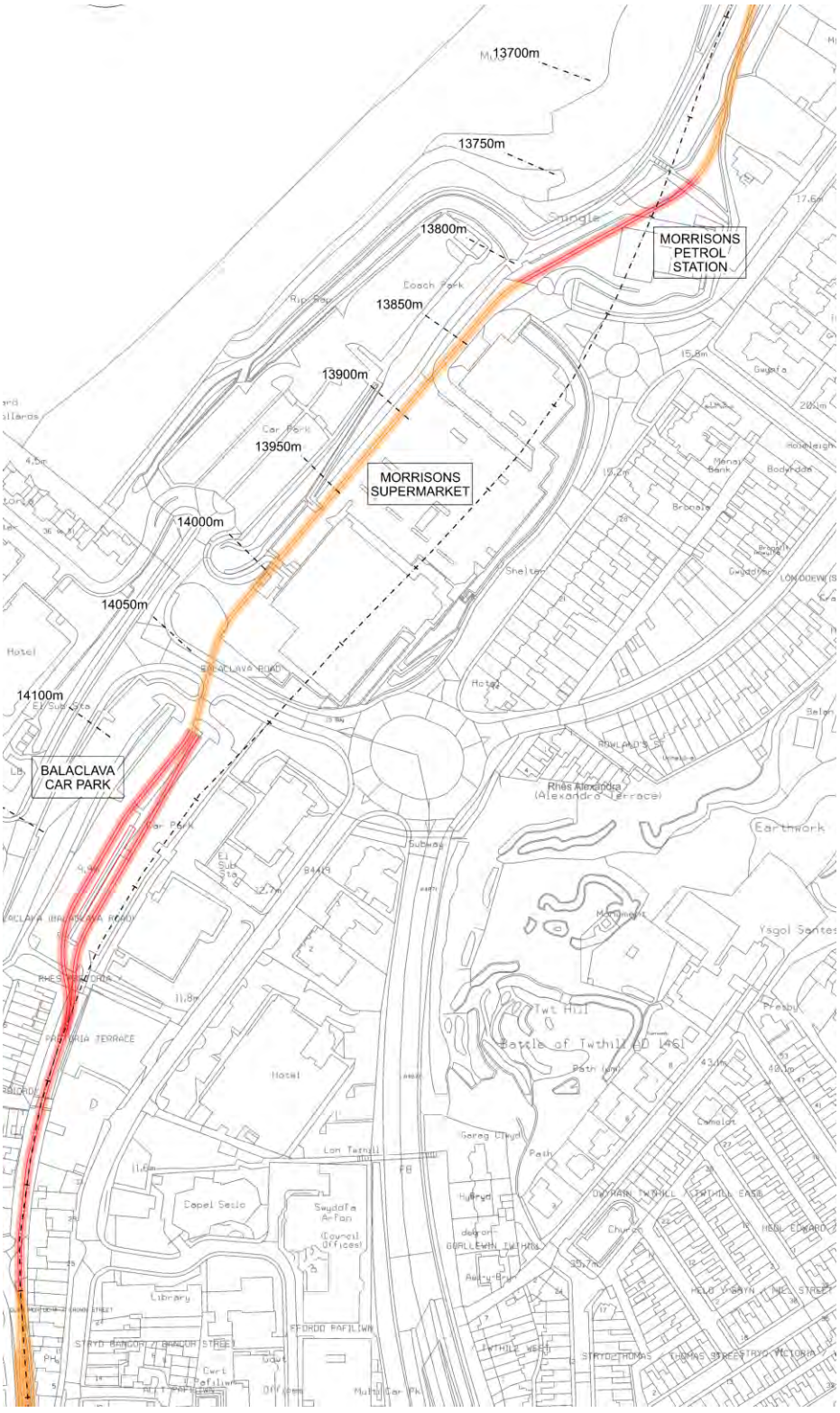

Figure 7-63 – Preferred route through Morrisons Supermarket

7.7.3.2. Alternative Option 1 – Off street running via Shell Site Car Park

Obstruction Number	Works Required on Existing	Significance	
		Significance (Public Relations)	Significance (Engineering Challenge)
BC-11-01 - *Residential and Commercial Properties*	Purchase 3rd party land where residential and commercial properties are on the alignment	High	Moderate
BC-11-02 - *Morrisons Petrol Station* **BC-11-03 - Morrisons Supermarket**	Construct retaining wall and sea defences above cycle path Partial purchase of council owned car park and removal of parking spaces Reconstruct Morrisons delivery area	Moderate	Very High
BC-11-04 - Balaclava Road	Install traffic signal controlled junction on Balaclava Road	Minimal	Moderate
BC-11-05 - Balaclava Car Park	Construct station in Balaclava Car Park Purchase council owned car park	Very High	High
BC-11-06 - Balaclava Road car park overbridge	Reconstruct overbridge spanning Balaclava car park	Minimal	High
BC-11-07 - Crown Street overbridge	Demolish overbridge spanning Crown Street Closure of Crown Street to vehicle traffic.	High	Moderate
BC-11-08 – Caernarfon Tunnel	Lower road level to provide suitable clearance through tunnel Carry our minor works to tunnel	Moderate	High

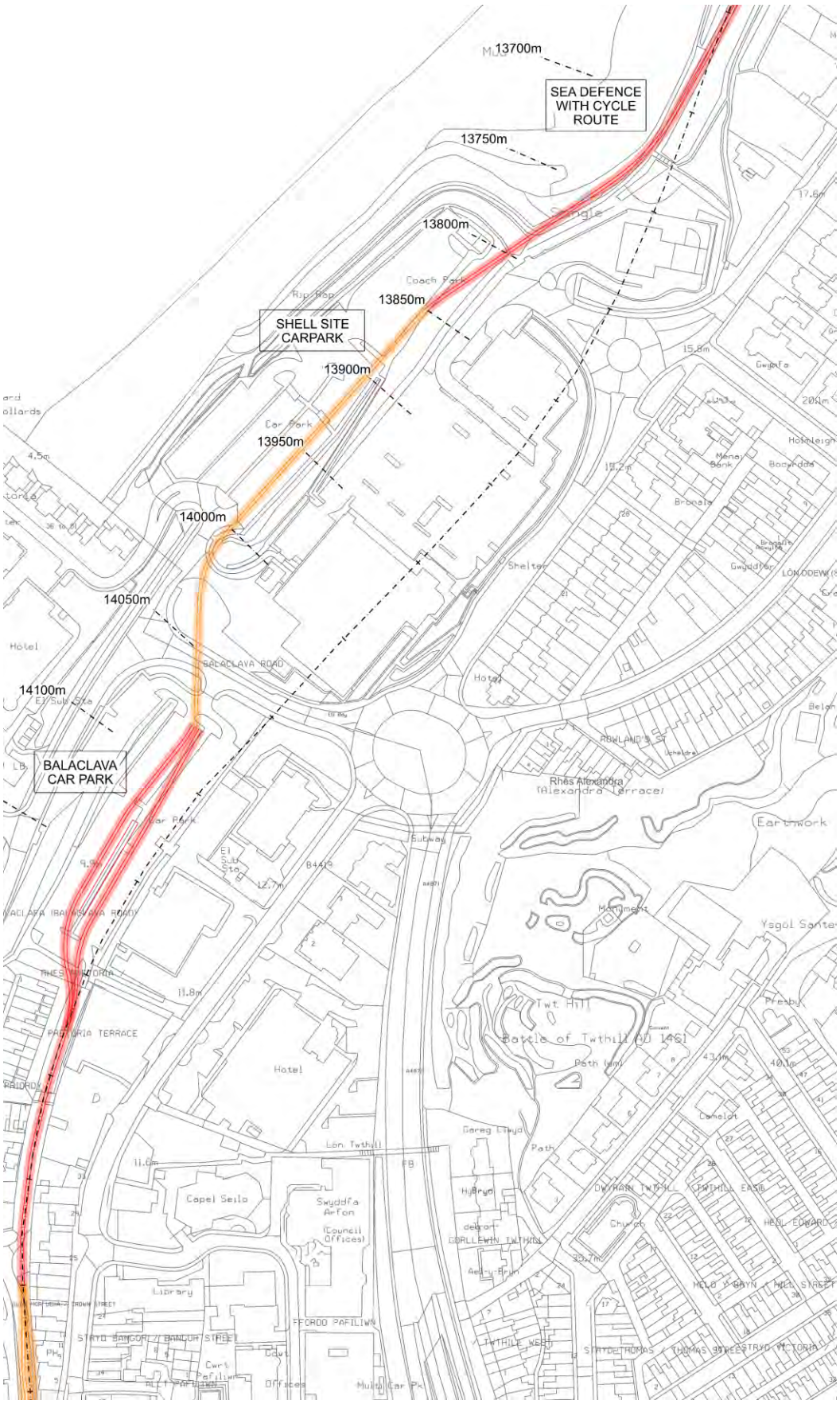

Figure 7-64 – Alternative option through Shell Site Car Park

7.7.3.3. Alternative Option 2 – Integrated on-street running via Ffordd y Gogledd

Obstruction Number	Works Required on Existing	Significance	
		Significance (Public Relations)	Significance (Engineering Challenge)
BC-11-01 - *Residential and Commercial Properties*	Purchase 3rd party land where residential and commercial properties are on the alignment	High	Moderate
BC-11-02 - *Morrisons Petrol Station*	Install traffic signalled controlled junction to allow access to highway	Very High	Very High
BC-11-03 - Morrisons Supermarket	Install 250m of integrated on-street running track		
	Remove roundabout in to Morrisons and install traffic signal controlled junction		
	Reconfigure St David's roundabout and install traffic signals at each junction		
BC-11-04 - Balaclava Road	Install traffic signal controlled junction on Balaclava Road	Minimal	Moderate
BC-11-05 - Balaclava Car Park	Construct station in Balaclava Car Park	Very High	High
	Purchase council owned car park		
BC-11-06 - Balaclava Road car park overbridge	Reconstruct overbridge spanning Balaclava car park	Minimal	High
BC-11-07 - Crown Street overbridge	Demolish overbridge spanning Crown Street	High	Moderate
	Closure of Crown Street to vehicle traffic.		
BC-11-08 – Caernarfon Tunnel	Lower road level to provide suitable clearance through tunnel	Moderate	High
	Carry our minor works to tunnel		

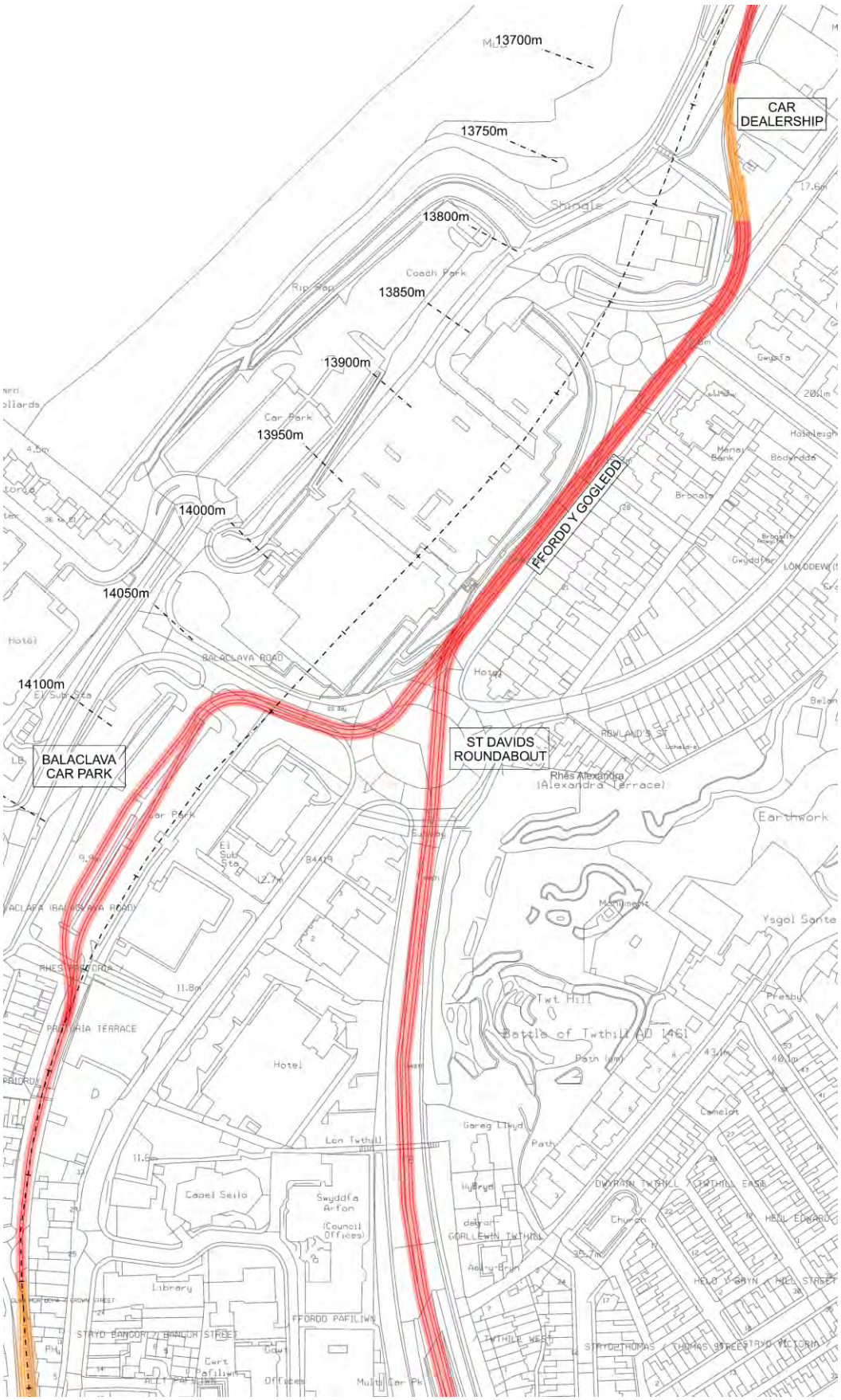

Figure 7-65 – Alternative option 2 and 3 on-street running via Ffordd y Gogledd

7.7.3.4. Alternative Option 3 – Integrated on-street running avoiding town centre

Obstruction Number	Works Required on Existing	Significance	
		Significance (Public Relations)	Significance (Engineering Challenge)
BC-11-01 - *Residential and Commercial Properties*	Purchase 3rd party land where residential and commercial properties are on the alignment	High	Moderate
BC-11-02 - *Morrisons Petrol Station*	Install traffic signalled controlled junction to allow access to highway	Very High	Very High
BC-11-03 - Morrisons Supermarket	Install 250m of integrated on-street running track		
	Remove roundabout in to Morrisons and install traffic signal controlled junction		
	Reconfigure St David's roundabout and install traffic signals at each junction		
BC-11-04 - Balaclava Road	Install 1.3km of integrated on-street running track	Very High	Very High
BC-11-05 - Balaclava Car Park	Construct multi-span bridge over Afon Seiont to re-join alignment		
BC-11-06 - Balaclava Road car park overbridge			
BC-11-07 - Crown Street overbridge			
BC-11-08 - Caernarfon Tunnel			

7.7.4. Tram/Train Mode

This section of the route runs through a highly congested area within close proximity of local businesses and residential properties. In addition to this the layout of the route will require tighter radius' to navigate certain obstruction therefore it is recommended that the vehicles run in Tram mode for this section.

7.7.5. Operational Impacts

As this section of the route is highly congested it is recommended that the where practicable, the tram will run on battery power. The exact length of section required to run on battery power shall be investigated to ensure there is sufficient capacity within the batteries to maintain the performance of the trams.

A station has been proposed to be constructed in the location of the existing Balaclava Car Park which will result in this car park no longer being used. It has been advised by Gwynedd Council that there are plans to close another multi storey in the car park which may then put pressure on the capacity of the remaining car parks in the area. A review of this shall be carried out.

7.7.6. Cycle Route Impacts

The cycle route diverts from the original alignment as it enters the centre of Caernarfon and re-joins at the South Portal of the tunnels.

7.7.7. Conclusion / Recommendation

The preferred route through Morrisons Supermarket is believed to be the optimal solution as it minimises the amount of integrated on-street running as this is believed to be a solution with the most potential to cause most difficulties. The other alternative requiring additional sea defences and retaining walls is seen as extremely challenging.

8. Route Alignment Review - Caernarfon to Dinas

8.1. Route Section Summary of Interventions/Implications

The route section between Caernarfon and Dinas has the following interventions/implications;

Proposed Intervention Categories

Section	Total Length	Minimal (Green)	Moderate (Yellow)	High (Orange)	Very High (Red)
B	4.6km	0%	63%	27%	10%

Road Rail Interfaces Interventions

Route Section	Reconfigure highway inc roundabout	Traffic Light Controls	Stop/Give Way	Stop/Give Way with gates
B	0	1	7	0

Structure Interventions

Route Section	Underbridge		Overbridge		New Retaining Walls/ Embankment works
	Retain / Repair	Replace / New	Retain / Repair	Replace / New	
B	0	3	0	7	1

Type of Running Lengths

Route Section	Train Running	Tram (integreated on-street and segregated on-street)	Tram (off-street)	Total Length
B	0km	0.4km (St Helens Road)	4.25km	4.6km

Impact on Cycle Route

Route Section	Length of cycle route requiring diversion
B	4.6km (Whole length of section)

8.2. Caernarfon Tunnel to Pont Seiont Roundabout

Chainage –14600m to 15600m **Associated Drawings – Section B Sheet 1**

8.2.1. Route

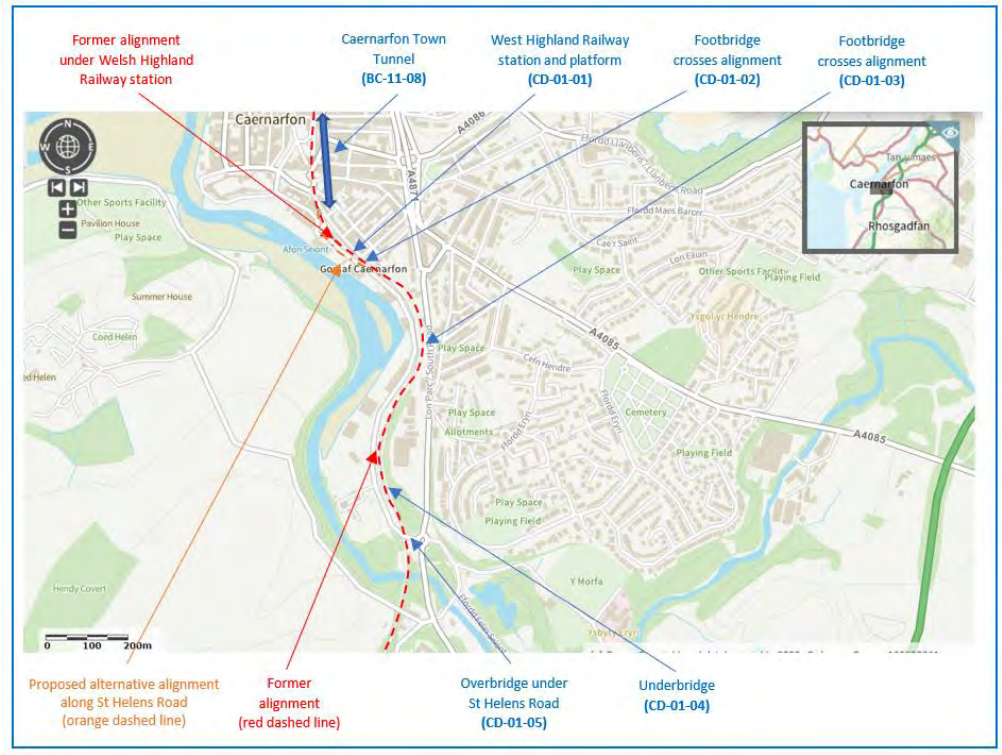

Figure 8-1 – Overview of Caernarfon Tunnel to Pont Seiont Roundabout showing the obstructions along the route

The alignment exits the South portal of the tunnel (currently Grade II listed), crossing a roundabout before being met by the new Welsh Highland Railway Station building **Obstruction - CD-01-01)** which has been recently constructed on an area of land previously used as its car park. The route between Caernarfon and Dinas has been redeveloped into the Welsh Highland Railway and the National Cycle Route 8.

Figure 8-2 – South Portal of Caernarfon Tunnel

Figure 8-3 – New Welsh Highland Railway Station Building - Obstruction - CD-01-01

The route then continues along the Welsh Highland Railway track, passing the existing buffer stops before being crossed by a metallic footbridge with masonry abutments (**Obstruction - CD-01-02)** linking St Helens Road to Segontium Terrace. Situated approximately 15m to the east of the footbridge is the start of the platform for the Welsh Highland Railway which runs for approximately 130m with two tracks to allow for the locomotive to change ends.

The existing railway runs alongside St Helens Road separated by a masonry wall approximately 2m high. The road has a footpath on both sides however on the southern side the footpath is intermittent and several business' entrances emerge directly on to the road. A number of parking bays are also located on the southern side of the road resulting in a reduction in the road width to an extent where two-way traffic flow is currently difficult. The road is on a bus route however it does not appear that this is heavily used as a through road by other traffic. Adjacent to the steel footbridge are two Grade II listed buildings.

Figure 8-4 – St Helens Road

Figure 8-5 – Two listed building on St Helens Road


Figure 8-6 – Footbridge crossing alignment Obstruction - CD-01-02


Figure 8-7 –Welsh Highland Railway Station Platform - Obstruction - CD-01-01

At the eastern end of the station platform the cycle route re-joins the alignment running alongside the Welsh Highland Railway separated by a metallic fence. The alignment is once again crossed by a metallic footbridge with masonry abutments (**Obstruction - CD-01-03)** linking St Helens Road to South Road. As this section of track was previously two tracks there is unused land to the north of the current tracks.

Figure 8-8 – Cycle route re-joins the alignment


Figure 8-9 – Footbridge crossing alignment Obstruction - CD-01-03

The alignment continues South where it reaches the location where the previous alignment diverted towards Llanberis. This was also where the old St Helens Road passed under the railway via an underbridge (**Obstruction - CD-01-04)** (see Figure 8-11). It is unclear whether the structure still exists.


Figure 8-10 – Potential underbridge Obstruction - CD-01-04

Figure 8-11 – 1945-65 Map showing previous railway passing under St Helens Road

Significant highways developments have been carried out in this area since the closure of the line with St Helens Road now crossing over the alignment via a concrete overbridge (**Obstruction - CD-01-05)**. The clearance of this new structure is currently unknown.


Figure 8-12 – St Helens Road overbridge crosses alignment Obstruction - CD-01-05

8.2.2. Interventions

Welsh Highland Railway Station and Platforms - Obstruction - CD-01-01

The Welsh Highland Railway has been built on the alignment from Caernarfon to Dinas therefore the new tram-trains will need to run alongside this for this section. It was considered to use a mixed gauge railway where the tram-trains would share the use of the line using different gauges however this was deemed to unlikely be accepted by the ORR. Removing the WHR section between Caernarfon to Dinas was also considered however this would have a significantly negative impact on the locality and was deemed unfeasible.

An alternative option and the preferred solution is to utilise St Helens road and run on-street segregated running for a short section however this does come with difficulties and significant impacts on the local businesses. The proposal will use the existing footpath on the northern side as well as a portion of the carriageway reducing the road to a single carriageway and requiring the installation of traffic controlled signals to maintain two way traffic flow. Discussions will need to be held with the local authority to determine the impacts of reducing the road to a single carriageway.

A more detailed survey of the area will need to be undertaken to establish whether the segregated track and a single carriageway can be accommodated on the current road and the resulting impact on the local area.

Steel Footbridge - Obstruction - CD-01-02

The position of the steps of the footbridge have resulted in the slight narrowing of the carriageway and with the proposal to use segregated on-street running it will be necessary to remove the footbridge. Due to the long alternative route, it is recommended to reconstruct the footbridge in a different location along the road. It may be possible to construct this further down the road using part of an existing car park.

Steel Footbridge - Obstruction - CD-01-03

This steel footbridge does not provide sufficient clearance for both the WHR and the new tram trains due to the masonry pier supporting the top of the staircase. This structure therefore will need to be demolished. It may be possible to construct the new footbridge in the same location as the existing without an intermediate support.

Potential Underbridge from previous St Helens Road Alignment - Obstruction CD-01-04

With the current sources of information it has not been possible to establish whether the underbridge crossing the previous St Helens Road still exists although aerial imagery and the presence of signage does indicate the presence of a footpath crossing under the line. Further investigation will be required to understand the status of the structure. There is a short alternative route to the existing footpath is St Helens Road is used therefore it is proposed that the footpath is closed. As a result, the structure can be infilled.

If following discussions with the local authority the footpath needs to remain, a new underbridge will need to be constructed.

St Helens Road Overbridge - Obstruction CD-01-04

The St Helens Road overbridge currently does not provide sufficient clearance for the new tram-trains and will need to be reconstructed. These works will cause severe disruption to the surrounding network at the road will need to be closed for a period of time.

8.2.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required on Existing	Maintain Alignment		Works Required on Alternative Route	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
CD-01-01 – WHR Station and platform	Install 400m of segregated on-street running track Install traffic controlled signals Reduce road to single carriageway	High	Very High	Remove WHR line between Caernarfon and Dinas and use track bed for new tram-trains	Very High	Moderate
CD-01-02 – Steel Footbridge	Reconstruct footbridge at alternative location Purchase 3rd party land to accommodate staircase	Moderate	High			
CD-01-03 – Steel Footbridge	Reconstruct footbridge in current location	Minimal	High			
CD-01-04 – Potential underbridge	Infill underbridge Close footpath	Moderate	Moderate	Construct new underbridge to maintain footpath	Minimal	High
CD-01-05 – St Helens Road Overbridge	Reconstruct St Helens Road overbridge	Minimal	High			

8.2.4. Tram/Train Mode

As the proposed route runs along St Helens road as a segregated on-street running section the vehicle will be required to be in Tram Mode.

8.2.5. Operational Impacts

With the close proximity to pedestrians along St Helens Road whilst running on-street the speed of the vehicle will need to be limited to allow for suitable braking. This ultimately will impact on the travel times throughout this section.

8.2.6. Cycle Route Impacts

The cycle route currently re-joins the alignment at the southern portal of the Caernarfon Tunnel and runs along St Helens road until joining the segregated cycle route adjacent to the Welsh Highland Railway Station. The proposed alignment utilises the existing cycle route in this location therefore a new route will need to be found.

8.2.7. Conclusion / Recommendation

This short section of the route poses one of the biggest difficulties due to the constrained nature of the site. To maintain the operation of the Welsh Highland Railway the only possible route is via St Helens road reducing the existing two way road down to a single carriageway. The existing road is very narrow in places, with commercial buildings in close proximity, and with the current sources of information it has been difficult to confirm whether the single carriageway can be maintained. Further detailed surveys will be required at a later stage.

8.3. Pont Seiont Roundabout to Bontnewydd Halt

Chainage – 15600m to 17550m

Associated Drawings – Section B Sheet 1
Section B Sheet 2
Section B Sheet 3

8.3.1. Route

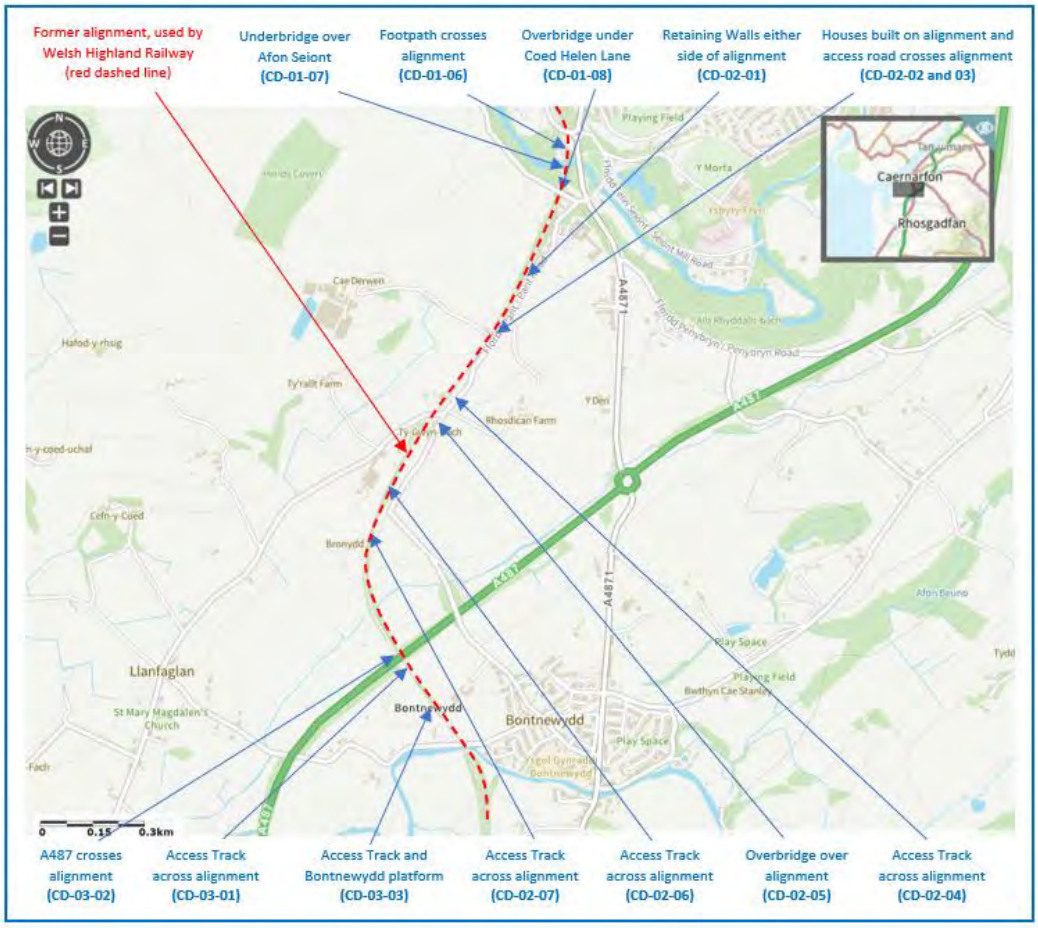

Figure 8-13 – Pont Seiont Roundabout to Bontnewydd Halt showing the obstructions along the route

As the route leaves Caernarfon the surroundings become more rural in nature. Shortly after the St Helens road overbridge there is a pedestrian crossing, crossing the railway line providing access from St Helens road to the cycle path (**Obstruction - CD-01-06)**. The alignment then continues until it reaches the River Seiont currently crossed by a multi span masonry arch bridge (**Obstruction - CD-01-07)**. This structure was constructed to carry 1 track and as a result does not have sufficient width to accommodate the proposed tram-train and Welsh Highland Railway. It is also likely that the structure has insufficient strength to carry both.

Figure 8-14 – Pedestrian crossing
Obstruction - CD-01-06

Figure 8-15 – River Seiont Underbridge
Obstruction - CD-01-07

After crossing the River Seiont the alignment reaches a narrow masonry overbridge carrying Coed Helen Lane. This structure has been strengthened with a steel frame in the past and currently does not have sufficient clearance (**Obstruction - CD-01-08)**. The lane provides the only access to Coed Helen Holiday Park.

The alignment continues towards Dinas through a cutting with retaining walls on each side restricting the available width for the passage of the tram-train (**Obstruction - CD-02-01)**. As the line emerges from the cutting it reaches the junction of Pant Road and an access road to Hendy Farm Caravan Site known previously as Hen-Dy Crossing (**Obstruction - CD-02-03)**. A residential property, is situated at the corner of the junction, probably built at the location of the crossing keepers house restricts the width of the line at this point. (**Obstruction - CD-02-02)**.

Figure 8-16 – Overbridge carrying Coed Helen Lane
Obstruction - CD-01-08

Figure 8-17 – Retaining walls along alignment
Obstruction - CD-02-01

Figure 8-18 – House on alignment and Hen Dy crossing Obstruction - CD-02-02 and CD-02-03

Approximately 200m south of Hen-Dy Crossing is an access track providing the only vehicle access to a nearby property (**Obstruction - CD-02-04)**. Continuing south a masonry overbridge carrying Pant Road crosses over the route and does not appear to have sufficient clearance for both the tram-train and the Welsh Highland Railway. (**Obstruction - CD-02-05)**

Figure 8-19 – Access track crosses alignment Obstruction - CD-02-04

Figure 8-20 – Overbridge crosses alignment Obstruction - CD-02-05

The route continues towards Dinas past several farm buildings and a local garden centre and is crossed by two access tracks with gates in close proximity, the latter providing the only vehicle access to a nearby farm. (**Obstruction - CD-02-06 and CD-02-07)**

Figure 8-21 – Access track crosses alignment Obstruction - CD-02-06

Figure 8-22 – Access track crosses alignment Obstruction - CD-02-07

The route carries on south for approximately 400m before being crossed by the newly constructed A487 - Bontnewydd Bypass concrete overbridge (**Obstruction - CD-03-01)**. The exact clearances of this concrete structure are unknown at this stage however there does not appear to be sufficient. This structure also crosses over an existing access

track which crosses the existing alignment (**Obstruction - CD-03-02)** at a high skew providing access to the adjacent fields. It is not clear whether the access track provides vehicle access.

Figure 8-23 – A487 Bontnewydd Bypass crossing alignment – Obstruction - CD-03-01 and CD-03-02

The Welsh Highland Railway Halt at Bontnewydd is located approximately 150m South of the Bontnewydd Bypass with a single platform 70m long on the western side. A pedestrian crossing leading in to the village is located at the southern end of the platform. The cycle path deviates for a short distance around the platform.

Figure 8-24 – Bontnewydd Halt and footpath crossing - Obstruction - CD-03-03

8.3.2. Interventions

Pedestrian crossing - Obstruction - CD-01-06

The pedestrian crossing provides access to from St Helens Road to the cycle path which will no longer be required as the footpath/cycle route will need to be relocated. It is therefore proposed to close the crossing and remove all equipment.

River Seiont Underbridge - Obstruction - CD-01-07

The underbridge crossing the River Seiont was only designed to accommodate a single track and as a result will not have sufficient clearances to accommodate both the WHR and Tram-Trains. This structure will therefore need to be reconstructed. Works will also need to be carried to the embankments on each approach as they will need to be widened alongside the structure.

Consideration should be given as to whether a new underbridge structure can be constructed for the Tram Trains Only whilst maintaining the existing structure.

Coed Helen Lane Overbridge - Obstruction - CD-01-08

The masonry overbridge carrying Coed Helen Lane over the alignment has previously been strengthened with a steel frame which restricts it already narrow width. This structure will require reconstruction to provide sufficient clearances. It is possible that the reconstructed bridge will increase the road level above which may impact on the adjacent roads and properties.

Retaining Walls along Alignment - Obstruction - CD-02-01

The retaining walls along the cutting currently restrict the ability to widen the cycle path to accommodate the new tram trains. Works will need to be carried out to these retaining walls however the close proximity of nearby properties should be considered.

Residential Property built on alignment - Obstruction - CD-02-02

As the property restricts the available width required for the rolling stock an intervention will be required. There are two options that have been considered. Option 1 is to maintain the existing alignment, purchase the land and demolish the house. The other option is to locally divert the road, the WHR and the alignment around property requiring. This will require the purchase of the land to the east of Pant Road

The latter option is preferred as demolishing residential properties will have a greater negative impact to the locality however a cost benefit analysis should be carried out.

Hen-Dy Crossing crosses alignment - Obstruction - CD-02-03

In conjunction with the works specified above, a new Stop/Give Way junction will need to be installed to allow access to the caravan site to be maintained.

Access track crosses alignment - Obstruction - CD-02-04

South of Hen-Dy crossing sits another residential property with the only access to the property crossing the alignment. As a result a new Stop/Give Way junction with gates will need to be installed.

Overbridge crosses alignment - Obstruction - CD-02-05

The overbridge crossing the alignment does not currently have sufficient clearance to allow the passage of both trains therefore will need to be reconstructed. Consideration should be given as to whether an at grade crossing could be installed here. This will depend on current traffic flows and the results of a road safety audit.

Access track crosses alignment - Obstruction - CD-02-06

The access track crossing the alignment between 16650m and 16700m provides access between adjacent pieces of land. It is not clear at this stage whether the land on both sides of the railway has the same owner. It is proposed to close this crossing as there is a short alternative route that can be used.

Access track crosses alignment - Obstruction - CD-02-07

This crossing provides the only vehicle access to a nearby farm therefore will need to be maintained therefore a Stop/Give Way junction with gates shall be installed.

A487 Bontnewydd Bypass crossing alignment and access crossing- Obstruction - CD-03-01 and CD-03-02

The concrete overbridge carrying the A487 has recently been constructed however it is unlikely to have sufficient clearance and will therefore need to be reconstructed. It is likely that the carriageway level will need to be increased requiring regrading of the highway on both approaches. A Stop/Give Way junction with gates shall also be installed under the structure.

Bontnewydd Halt and footpath crossing - Obstruction - CD-03-03

With Bontnewydd already having a Welsh Highland Rail halt it is recommended that tram-train station is also located here. It should be noted that the Welsh Highland Railway and tram-trains station platforms are not compatible therefore they will need to be separate. One solution for this would be to reconstruct the existing halt platform to a compliant level for the tram trains and construct a new halt platform on the eastern side of the Welsh Highland Railway Track. A pedestrian crossing shall also be installed at the end of the platform to allow access in to the village.

8.3.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required on Existing	Maintain Alignment		Works Required on Alternative Route	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
CD-01-06 – Pedestrian crossing	Remove pedestrian crossing	Moderate	Minimal			
CD-01-07 – River Seiont Underbridge	Reconstruct River Seiont Underbridge Widen approach embankments	Moderate	Very High	Construct new underbridge for tram trains only	Moderate	Very High
CD-01-08 – Coed Helen Lane Overbridge	Reconstruct Coed Helen Lane overbridge with suitable clearance	Moderate	High			
CD-02-01 – Retaining Walls	Reconstruct retaining walls	Moderate	High			
CD-02-02 – House on alignment	Reroute Pant road, WHR and alignment to avoid house Purchase 3rd Party land to the east of Pant Road	Moderate	High	Demolish house and purchase land	High	Minimal
CD-02-03 – Hen-Dy Crossing	Install Stop/Give Way junction on intersection	Minimal	Moderate			
CD-02-04 - Access track crosses alignment	Install Stop/Give Way junction on intersection	Minimal	Moderate			
CD-02-05 - Overbridge crosses alignment	Reconstruct overbridge with suitable clearance	Moderate	High			
CD-02-06 - Access track crosses alignment	Install Stop/Give Way junction on intersection	Minimal	Moderate			
CD-02-07 - Access track crosses alignment	Install Stop/Give Way junction on intersection	Minimal	Moderate			

Obstruction Number	Works Required on Existing	Maintain Alignment		Works Required on Alternative Route	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
CD-03-01 - Access track crosses alignment	Install Stop/Give Way junction on intersection	Minimal	Moderate			
CD-03-02 - A487 Bontnewydd Bypass crossing alignment	Reconstruct overbridge with suitable clearance	Moderate	High			
CD-03-03 - Bontnewydd Halt and footpath crossing	Relocate WHR platform to eastern side Reconstruct existing WHR into compliant platform for Tram-train Install pedestrian crossing	Moderate	High			

8.3.4. Tram/Train Mode

Due to the continued number of crossings in this section of the route, it is currently envisaged that the vehicle will remain running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

8.3.5. Operational Impacts

Running in tram mode does mean that the maximum speed of the vehicle in this area permitted will be 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there may be increased travelling times.

With the existing WHR halt and the relatively large village of Bontnewydd within 300m it is recommended that a new station be constructed in this location. Alterations to the existing halt will be required to allow both vehicles to stop at this station whilst also providing compliant platform heights for the each.

8.3.6. Cycle Route Impacts

With the Welsh Highland Railway now occupying the old alignment it is not possible to accommodate the cycle path along this section of the route and will therefore need to be rerouted.

8.3.7. Conclusion / Recommendation

In this section the previous alignment can be followed whilst running alongside the Welsh Highland Railway however there are a number of major structural interventions including several bridge reconstructions and retaining walls.

8.4. Bontnewydd Halt to Dinas Station

Chainage – 17550m to 19200m

Associated Drawings – Section B Sheet 3
Section B Sheet 4

8.4.1. Route

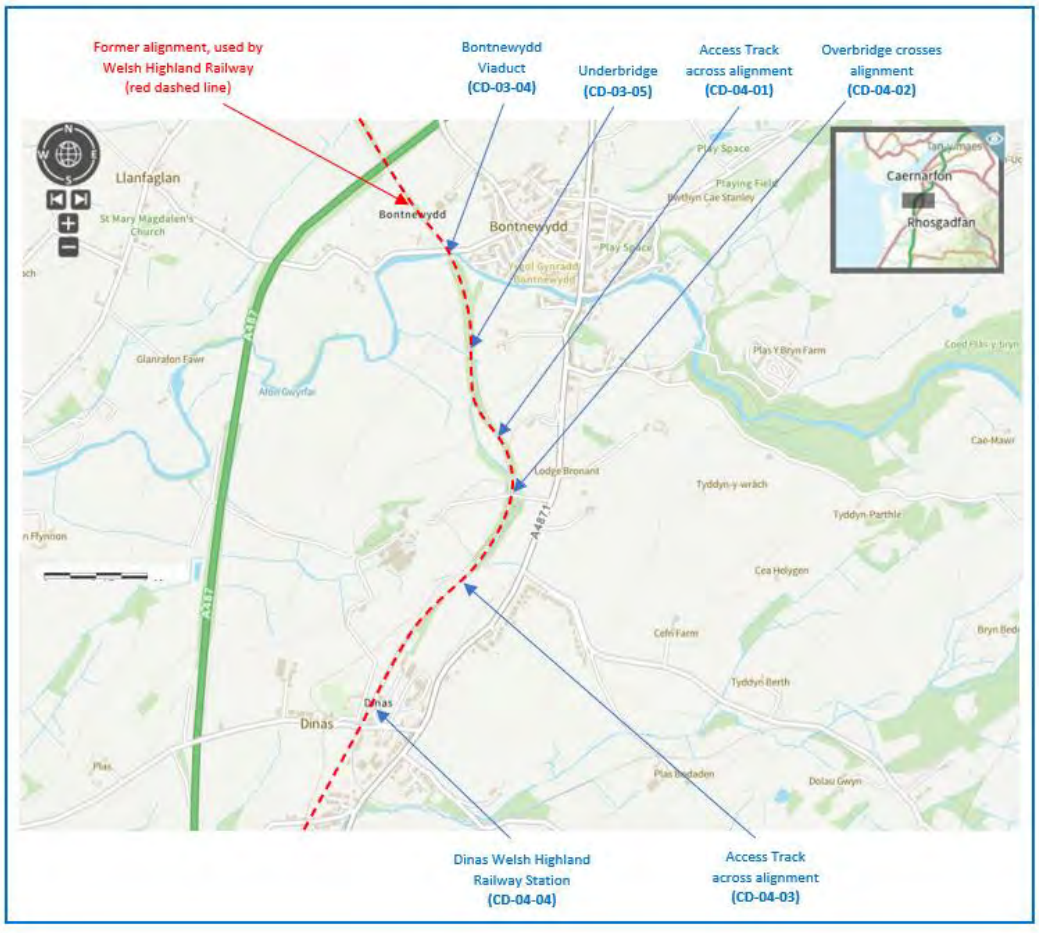

Figure 8-25 –Bontnewydd Halt to Dinas Station showing the obstructions along the route

South of Bontnewydd Halt the alignment goes over the 3-span masonry arch Bontnewydd Viaduct (**Obstruction - CD-03-04)** over the River Gwyrfai and a local road leading in to the village of Bontnewydd. This structure is Grade II Listed. Like the other structures along this section of the route, it does not have sufficient clearance to accommodate both the Welsh Highland Railway and the new Tram-Trains.

Figure 8-26 – Underside Bontnewydd Viaduct
Obstruction - CD-03-04

Figure 8-27 – Topside Bontnewydd Viaduct
Obstruction - CD-03-04

The route continues south past the village of Bontnewydd along an embankment and through predominantly rural surroundings before crossing an underbridge over an access track (**Obstruction - CD-03-05)**. The span and construction material of this structure is unknow however there is insufficient width on this structure to accommodate both vehicles. 300m further south the route is then crossed by an access track with gates providing access between fields. (**Obstruction - CD-04-01)**.

Figure 8-28 – Underbridge over access track
Obstruction - CD-03-05

Figure 8-29 – Access track across alignment
Obstruction - CD-04-01

The route continues south where it is crossed by a masonry arch overbridge leading to Plas Dinas Country House (**Obstruction - CD-04-02)**. The overbridge is narrow and only has clearance for one vehicle. Before reaching Dinas Station the route is crossed by an access track with gates between two adjacent pieces of farmland (**Obstruction - CD-04-03)**.

Figure 8-30 – Overbridge crosses alignment
Obstruction - CD-04-02

Figure 8-31 – Access track crosses alignment
Obstruction - CD-04-03

The alignment reaches the Welsh Highland Railway's Dinas Station (**Obstruction - CD-04-04**, its main operational and engineering base for the northern section of the line. The station has two platforms for passenger use to the west and two tracks to the east used as sidings. It should be noted that the platform heights do not comply with standard gauge rolling stock. A station building is situated towards the southern end of the station with a maintenance building located to the north. Previously called Dinas Junction this is the location where the WHR diverts away from the main line towards Snowdon.

Figure 8-32 – Dinas Station Platforms
Obstruction - CD-04-04

Figure 8-33 – Dinas Station Plan View
Obstruction - CD-04-04

8.4.2. Interventions

Bontnewydd Viaduct - Obstruction - CD-03-04

With Bontnewydd Viaduct being a Grade II listed structure and it being a good example of a mid 19th century railway bridge any intervention should try to minimise the impact on the structure. With that in mind it is preferred to construct a new bridge alongside the existing which will carry the tram-train only. This new structure will pass through existing farmland and will require additional land purchase as a result. The exact location of the new structure will need to be established following a detailed survey of the area and the review of the existing structure record information.

Complete reconstruction of the existing bridge was considered however due to its listed status and a feasible alternative option this was not preferred.

Underbridge over access track - Obstruction - CD-03-05

The exact dimensions of this structure is unknown however does not appear to have sufficient clearance to accommodate the two lines. It is therefore proposed to reconstruct this underbridge with sufficient width.

Access track across alignment – Obstruction – CD-04-01

This access track provides access between two adjacent fields and will likely need to be maintained as the alternative route is of significant distance and not practicable. It is therefore proposed to install a new crossing with appropriate stop signage and gates.

Overbridge leading to Plas Dinas Country House crosses alignment - Obstruction - CD-04-02

This overbridge carrying the road to Plas Dinas Country House has insufficient clearance to allow the passage of both the tram-trains and WHR therefore will need to be reconstructed.

Access track crosses alignment - Obstruction - CD-04-03

This access track provides access between two adjacent fields and will likely need to be maintained as the alternative route is of significant distance and not practicable. It is therefore proposed to install a new crossing with appropriate stop signage and gates.

Dinas Station - Obstruction - CD-04-04

Although not a largely populated area it would make sense to construct a new station here as a significant amount of infrastructure is already in place. It is proposed to move the alignment to the west and around the existing WHR platform. This platform could then be shared between the tram trains and the WHR - however as each one requires different platform heights the Tram train track level will need to be lower than the WHR. This will result in the complete reconstruction of the western platform and although causing significant disruption for a short period of time during construction the permanent solution will maintain the existing WHR alignment. Additional land may need to be purchased to the west of the existing platform to accommodate the alignment. Without impacting on the existing WHR tracks it will not be possible to install a passing loop at this location.

An alternative option was considered where the WHR tracks would be permanently moved east, turning the existing eastern platform into an island platform - however the disruption caused was considered to be too significant for the benefits derived.

8.4.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required on Existing	Maintain Alignment		Works Required on Alternative Route	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
CD-03-04 – Bontnewydd Viaduct	Construct new structure adjacent to existing. Purchase 3rd party land as a result of new alignment	Moderate	Very High	Demolish and reconstruct existing bridge with suitable clearance	High	Very High
CD-03-05 – Underbridge over access track	Reconstruct underbridge with suitable clearance	Moderate	High			
CD-04-01 – Access track across alignment	Install Stop/Give Way junction with gates	Minimal	Moderate			
CD-04-02 – Overbridge leading to Plas Dinas Country House crosses alignment	Reconstruct overbridge with suitable clearance	Moderate	High			
CD-04-03 – Access track crosses alignment	Install Stop/Give Way junction with gates	Minimal	Moderate			
CD-04-04 – Dinas Station	Reconstruct western platform of station Purchase 3rd party land to accommodate alignment	Moderate	High	Relocate WHR platform to the east. Reconstruct western platform	High	Very High

8.4.4. Tram/Train Mode

Stations at Bontnewydd and Dinas are proposed along this route and are in relatively close proximity therefore any benefit from running in train mode will likely be negated by the requirement to stop at each station.

8.4.5. Operational Impacts

This section includes the proposal to situate a station at the existing Welsh Highland Railway station at Dinas. As a result the travel times will be impacted with the need to stop at this location.

8.4.6. Cycle Route Impacts

With the Welsh Highland Railway now occupying the old alignment it is not possible to accommodate the cycle path along this section of the route and will therefore need to be rerouted.

8.4.7. Conclusion / Recommendation

This section of the route can maintain the previous alignment but does include two new bridges and the alterations to the existing Welsh Highland Railway Station.

9. Route Alignment Review - Dinas to Penygroes

9.1. Route Section Summary of Interventions/Implications

The route section between Dinas and Penygroes has the following interventions/implications;

Proposed Intervention Categories

Section	Total Length	Minimal (Green)	Moderate (Yellow)	High (Orange)	Very High (Red)
C	6.3km	61%	33%	6%	0%

Road Rail Interfaces Interventions

Route Section	Reconfigure highway inc roundabout	Traffic Light Controls	Stop/Give Way	Stop/Give Way with gates
C	2	1	3	7

Structure Interventions

Route Section	Underbridge		Overbridge		New Retaining Walls/ Embankment works
	Retain / Repair	Replace / New	Retain / Repair	Replace / New	
C	0	3	0	1	1

Type of Running Lengths

Route Section	Train Running	Tram (integreated on-street and segregated on-street)	Tram (off-street)	Total Length
C	0km	0km	6.3km	6.3km

Impact on Cycle Route

Route Section	Length of cycle route requiring diversion
C	0.3km (South of Dinas Station)

9.2. Dinas to Goat Roundabout

Chainage – 19200m to 20250m **Associated Drawings – Section C Sheet 1**

9.2.1. Route Summary

South of Dinas Station the current Welsh Highland Railway almost immediately diverts off the Afon Wen to Bangor alignment and follows the original narrow gauge route to Porthmadog via Beddgelert. The former standard gauge alignment south of Dinas to Penygroes has been adopted as part of the Lon Eifion active travel path, which is part of the wider Lon Las Cymru on the National Cycle Network (route number 8).

Although the former railway was single track in this area, there appears sufficient width to retain the active travel path alongside any new railway alignment – with the active travel path rebuilt to one side in order to provide sufficient space. However around Dinas Station where the Welsh Highland Railway and the reopened railway is proposed to co-exist (see Section 8), there is insufficient width in the existing corridor to additionally accommodate an Active Travel path. Therefore the Lon Las Cymru active travel path will need to be diverted onto another route between Caernarfon, Dinas and Llanwnda.

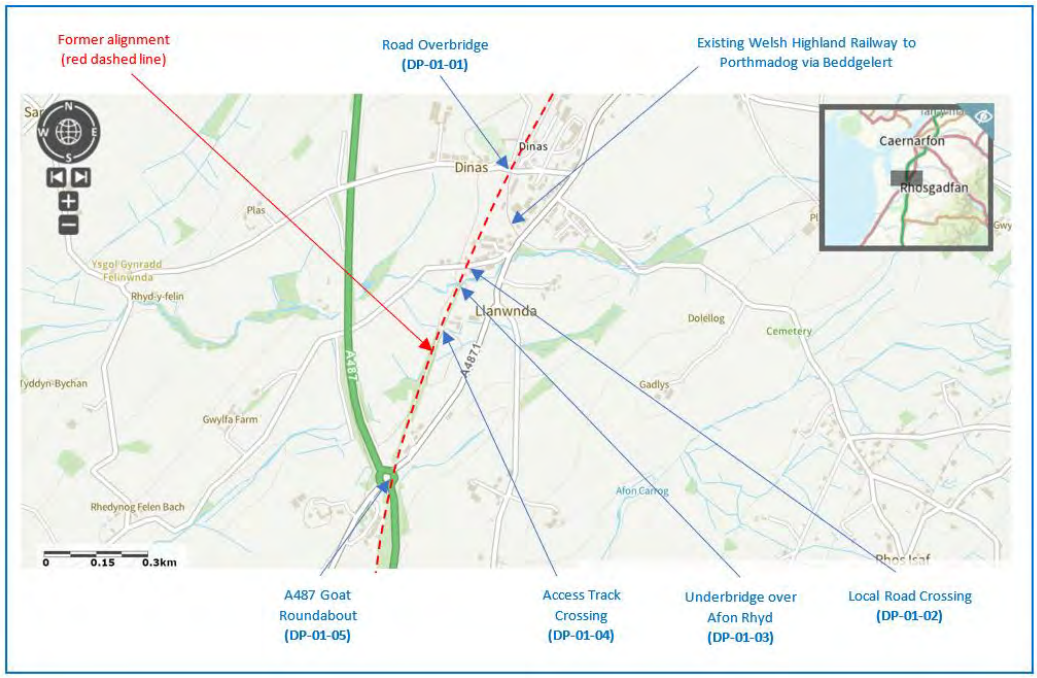

Figure 9-1 – Overview of Dinas to Goat Roundabout area showing all obstructions along the route

As shown above, the existing Welsh Highland Railway passes underneath a local road bridge called Ty'n Llan directly south of Dinas station, prior to the point where the Welsh Highland Railway diverges from the former Caernarfon to Afon Wen route. It is not clear whether this overbridge spanned one or two standard gauge tracks previously, but it is likely to need to be reconstructed to span both the existing Welsh Highland Railway line and the reopened line ***(Obstruction Number – DP-01-01)***.

The former line then proceeds in a southerly direction, crossing a local road called Glanrhyd near the hamlet of Llanwnda – this appears to be a former level crossing, as the road and former alignment are on the same level ***(Obstruction Number – DP-01-02)***.

Figure 9-2 – Ty'n Llan road overbridge Obstruction Number – DP-01-01

Figure 9-3 – Glanrhyd road crossing Obstruction Number – DP-01-02

There is an existing small underbridge ***(Obstruction Number – DP-01-03)*** across the Afon Rhyd, which appears to be an original railway structure but whose condition is unknown.

Further south, a farmers access track between two parts of their land crosses the former alignment ***(Obstruction Number – DP-01-04)***.

Figure 9-4 – Afon Rhyd underbridge Obstruction Number – DP-01-03

Figure 9-5 – Farmers Access Track crossing Obstruction Number – DP-01-04

After a further 0.5km, the former alignment is lost under the A487/A4871 Goat Roundabout ***(Obstruction Number – DP-01-05)***. The roundabout has been constructed directly over the alignment and will need to be modified to allow the reopening of the railway in due course.

Figure 9-6 – A487/A4871 Goat Roundabout
Obstruction Number – DP-01-05

9.2.2. Interventions

Ty'n Llan road overbridge (Obstruction Number – DP-01-01)

The existing overbridge would need to be reviewed for sufficient vertical clearances for a Tram-Train vehicle operating – potentially with Overhead Line present if not operating in battery mode. The overbridge would also need to be assessed for sufficient horizontal clearances, to ensure it could accommodate the new standard gauge Tram Train vehicles and the existing Welsh Highland Railway narrow gauge vehicles. In addition, it is proposed that the reopened standard gauge railway and associated station platform would be located to the west of the current Welsh Highland Railway station to minimise the disruption to the existing heritage railway, and therefore it is likely that the existing bridge would need to be widened to suit the new alignment. Consequently, there is a perceived high likelihood that the bridge would need to be reconstructed to provide the required clearances.

Glanrhyd Local Road Crossing (Obstruction Number – DP-01-02)

This road serves a number of residential and business properties in the area, and the diversion route if the crossing were closed would be relatively lengthy, and segregate these properties from the hamlet of Llanwnda. Therefore, closure of the road is not deemed practicable, and a new grade separated junction would be highly disruptive to the locality. Therefore at present – assuming the Tram-Trains are still operating in Tram mode at this location – a new road junction with Stop or Give Way signage controls is proposed.

Afon Rhyd underbridge (Obstruction Number – DP-01-03)

The condition and dimensions of the existing underbridge is not known at present, but it is likely to be insufficient width to accommodate the reopened railway and the active travel route at this location. Therefore reconstruction of the existing underbridge or construction of an additional span for the cycle route next to the existing structure is deemed required.

Farmers Access Track crossing (Obstruction Number – DP-01-04)

At present it is consequently assumed that access across the railway will be required, and a new crossing with Stop signage provided with gates.

Goat Roundabout (Obstruction Number – DP-01-05)

The roundabout serving the A487, A499 and A4871 has been constructed directly over the alignment and will need to be modified to allow the passage of the tram-train. It is proposed to run the alignment through the centre of the roundabout, which will require the installation of traffic signals to control road vehicles and indicate to the Tram-Train when to proceed. An example from Spain is shown in Figure 9-7 below. The alternative of constructing a bridge across the roundabout is judged a high cost intervention, and one which could negatively impact the residential properties which are either side of the roundabout near the former alignment. Detailed design studies may require a comprehensive remodelling of the road layout to ensure traffic flows are maintained, however the disruption caused by the limited number of Tram-Trains crossing the roundabout per hour is judged likely to be minimal.

Figure 9-7 – Roundabout with tram lines through centre and traffic light controls (Bilbao, Spain)

9.2.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
DP-01-01 Ty'n Llan road overbridge	Demolish and reconstruct bridge with suitable clearances	Moderate	High			
DP-01-02 Glanrhyd Local Road Crossing	Install Stop/Give Way junction at Glanrhyd local road	Minimal	Moderate			
DP-01-03 Afon Rhyd underbridge	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
DP-01-04 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access with gates	Minimal	Moderate			
DP-01-05 Goat Roundabout	Reconfigure roundabout to allow the passage of tram-trains through the middle. Installation of new traffic lights to control road traffic and Tram-Train interactions	Moderate	High			

9.2.4. Tram/Train Mode

Due to the number of road/rail interfaces in this section of the route, the operation of the Tram-Train in conventional train mode would result in the required opening of a number of new level crossings – including a very unusual layout at Goat Roundabout with two level crossings in close proximity. It is currently believed that this would import a level of risk into the operation of the railway in train mode which would be unacceptable. Therefore to avoid the requirement for grade separation junctions or complex Level Crossings (e.g. with Obstacle Detection measures), it is currently envisaged that the vehicle will be running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

9.2.5. Operational Impacts

This does mean that the maximum speed of the vehicle in this area permitted will be 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there may be increased travelling times.

9.2.6. Cycle Route Impacts

Through the whole section south of Dinas to Penygroes the former alignment has been adopted as part of the Lon Eifion active travel path, which is part of the wider Lon Las Cymru on the National Cycle Network (route number 8).

There appears generally sufficient width to retain the active travel path alongside any new railway alignment – with the active travel path rebuilt to one side in order to provide sufficient space (see Figure 4-3 in Section 4 for an indicative cross section for the safeguarded corridor for a new railway alongside an active travel route).

However there is insufficient width in the existing corridor between Caernarfon and Dinas to additionally accommodate an Active Travel path alongside the Welsh Highland Railway and the reopened railway – so as per the previous section, it is assumed the Active Travel route is diverted between those locations. Therefore at present it is also assumed that the Active Travel path is diverted at the start of this section, between Dinas and Llanwnda - although some of the principal pinch points (i.e. the overbridge south of Dinas station - ***Obstruction Number – DP-01-01***) could potentially be rebuilt. There is nevertheless an opportunity for the Active Travel path to quickly re-join the former line in this section, where it crosses the Glanrhyd local road ***(Obstruction Number – DP-01-02)***.

9.2.7. Conclusion / Recommendation

In this section the reopened railway would be proposed to follow the former alignment, with predominately road crossings – especially associated with the road improvement works at Goat Roundabout – being the main obstructions to be negotiated. Some small structures – an overbridge and an underbridge – would also need reconstruction.

9.3. Goat Roundabout to A487 near Bryn'rodyn Cemetery

Chainage – 20250m to 21300m **Associated Drawings – Section C Sheet 1**
Section C Sheet 2

9.3.1. Route Summary

Chainage – 20300m to 21300m

South of the Goat Roundabout, the former alignment proceeds on a north/south route towards Groeslon. Prior to the A487 road on the outskirts of Groeslon, there is relatively few impediments to reopening a railway along the former route noted.

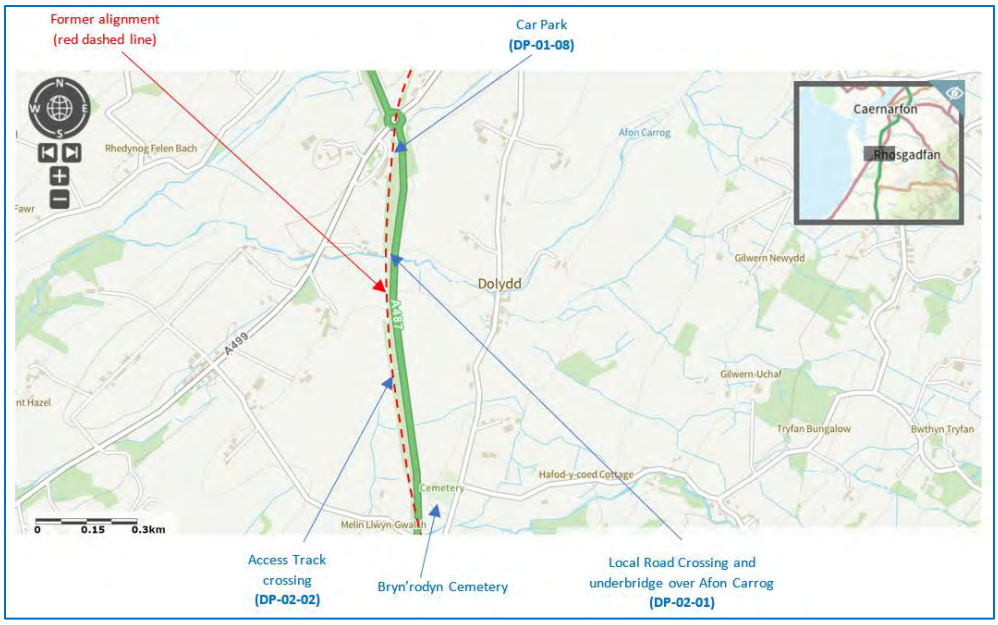

Figure 9-8 – Overview of Goat Roundabout to A487 (Bryn'rodyn Cemetery) area showing the obstructions along the route

Directly south of Goat Roundabout, the former alignment has been built over by a small car park accessed off a small residential road. It appears the parking spaces are used by the local residential houses nearby – it is not marked as a public car park ***(Obstruction Number – DP-01-08)***. The former line then proceeds in a southerly direction, crossing a local access road between the A487 and A499 serving one property ***(Obstruction Number – DP-02-01)***. Around this location the former alignment must cross over the Afon Carrog, but no obvious structure is visible from the desktop surveys. Therefore there may be a culvert at this location to be maintained.

Figure 9-9 – Car park near Goat Roundabout Obstruction Number – DP-01-08

Figure 9-10 – Local Access Road near Afon Carrog Obstruction Number – DP-02-01

Approximately 300m further south, a farmers access track to allow access to land from the adjacent A487 is encountered ***(Obstruction Number – DP-02-02)***.

Figure 9-11 – Farmers Access Track crossing Obstruction Number – DP-02-02

9.3.2. Interventions

Car Park near Goat Roundabout (Obstruction Number – DP-01-08)

The existing layout of the small car park will need to be remodelled to allow the passage of the new tram-trains.

Local Access Road near Afon Carrog (Obstruction Number – DP-02-01)

This road serves a single residence, with access also possible from the nearby A499 road. Therefore every opportunity should be taken to identify the closure of this road to vehicles – however it is also likely to form a public right of way across the former alignment, so a foot crossing may need to be maintained. In the worst case – on the assumption Tram-Trains are still operating in Tram mode at this location – a new road junction with Stop or Give Way signage controls is proposed.

Farmers Access Track crossing (Obstruction Number – DP-02-02)

It is assumed that it would be very difficult to provide continued access to the farm land without retaining this crossing. On the basis the Tram-Trains continue to operate in Tram mode at this location, then the use of a junction with Stop signage would be appropriate.

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9.3.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
DP-01-08 Car Park near Goat Roundabout	Localised land purchase Remodel car park away from former alignment	Moderate	Moderate			
DP-02-01 Local Access Road near Afon Carrog	Install Stop/Give Way junction at local access road (or install foot crossing if vehicle rights can be extinguished) Maintain culvert for Afon Carrog	Minimal	Moderate			
DP-02-02 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			

9.3.4. Tram/Train Mode

Due to the number of road/rail interfaces in this section of the route, the operation of the Tram-Train in conventional train mode would result in the required opening of 2 new level crossings. It is currently envisaged therefore that the vehicle will continue to be running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

9.3.5. Operational Impacts

This does mean that the maximum speed of the vehicle in this area permitted will be 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there may be increased travelling times.

9.3.6. Cycle Route Impacts

The Lon Eifion active travel path, which is part of the wider Lon Las Cymru on the National Cycle Network (route number 8), utilises the former alignment in this section. However from this desktop study, there appears generally sufficient width to retain the active travel path alongside any new railway alignment – with the active travel path rebuilt to one side in order to provide sufficient space – with minimal land purchases beyond the former railway corridor and minimal engineering interventions.

9.3.7. Conclusion / Recommendation

In this section the reopened railway would be proposed to follow the former alignment, with only road crossings and a small car park being the obstructions to be negotiated.

9.4. A487 near Bryn'rodyn Cemetery to Indigo Jones Slate Works

Chainage – 21300m to 23000m **Associated Drawings – Section C Sheet 3**
Section C Sheet 4

9.4.1. Route Summary

To the North and South of Groeslon the former alignment has been severed in two locations by the A487 road, and within the village of Groeslon itself the alignment has been partially lost.

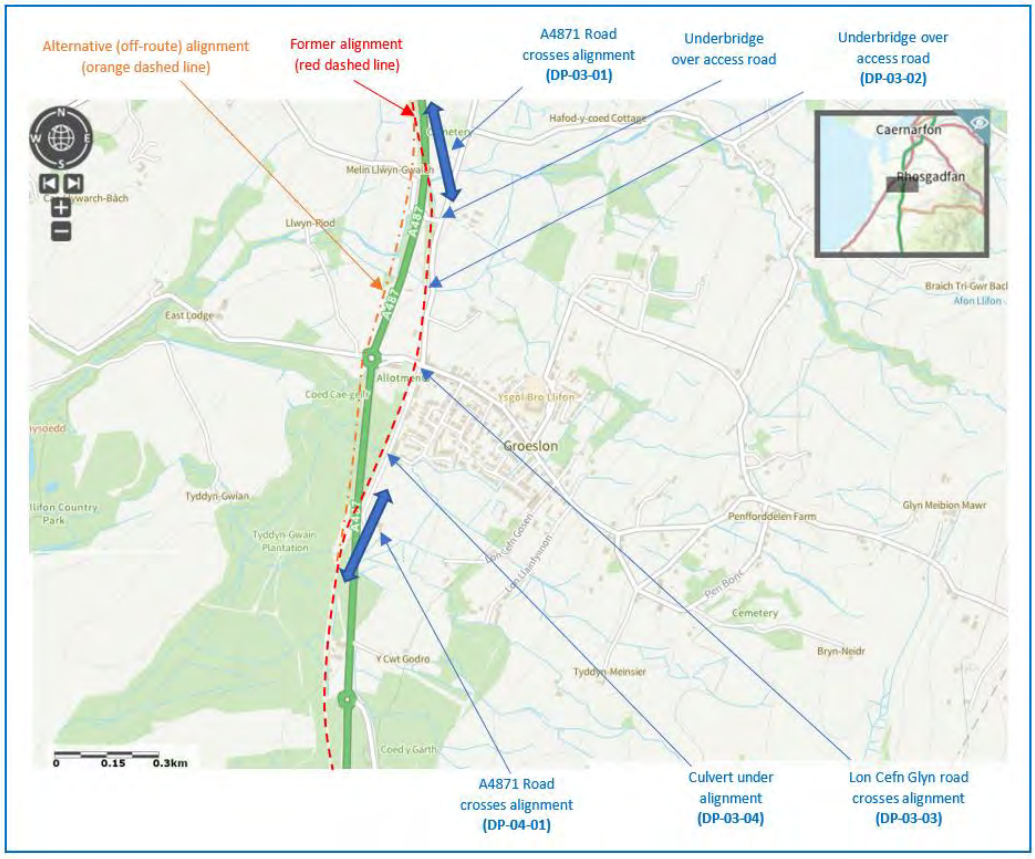


Figure 9-12 – Overview of A487 (near Cemetery) to Indigo Jones Slate Works area showing the obstructions along the route

North of Groeslon the A487 road crosses the former alignment, with a number of existing underbridges in the location crossing access roads and streams ***(Obstruction Number – DP-03-01)***. The road completely changes the previous topography at this location, which therefore means the old route is no longer obvious and would require heavy engineering works to reinstate.

The former line then passes over two small underbridges, which each cross local access roads ***(Obstruction Number – DP-03-02)***.

Figure 9-13 – A487 road crosses alignment Obstruction Number – DP-03-01

Figure 9-14 – Underbridge over access road Obstruction Number – DP-03-02

The former railway then passes through the western side of Groeslon village, with businesses and residential properties located adjacent to the former route. The route crosses Lon Cefn Glyn, which is the main road linking the village with the A487 bypass further to the west ***(Obstruction Number – DP-03-03)***. The former station was located at this location to serve the village, and it is currently presumed that a new station will be constructed to serve the locality.

The former rail route – now the Lon Eifion / Lon Las Cymru Active Travel path – then skirts the western edge of the Groeslon village, crossing at least one culvert ***(Obstruction Number – DP-03-04)***.

Figure 9-15 – Lon Cefn Glyn road crosses alignment Obstruction Number – DP-03-03

Figure 9-16 – Culvert under alignment Obstruction Number – DP-03-04

South of Groeslon the A487 road crosses the former alignment again, on a heavy skew. The Active Travel path at this location is diverted off the former rail route, such that it crosses the road at a more 90-degree angle ***(Obstruction Number – DP-04-01)***. Due to the fact the road is lower than the previous rail corridor, again the road completely changes the previous topography at this location and means heavy engineering works would be required to reinstate the former alignment.

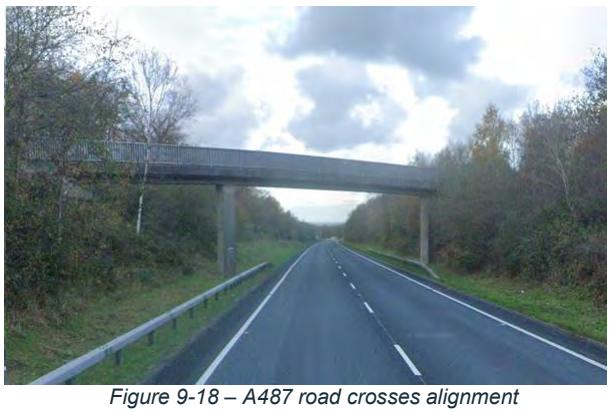


Figure 9-18 – A487 road crosses alignment Obstruction Number – DP-04-01

South of the second A487 interface, the former route heads south for approximately 500m with no significant obstacles noted. The route does pass close to the Indigo Jones Slate Works, a heritage/tourist attraction, but there is no impact noted to date on the operations at that site.

9.4.2. Interventions

A487 road crosses alignment (Obstruction Number – DP-03-01)

A significant engineering intervention would be required to reinstate the route at this location – it is thought from the desktop study that the new railway would need to pass under the A487, meaning a new heavily skewed overbridge would need to be constructed whilst ensuring the road remained open to traffic. It is noted that there are a number of obstacles in this location, with the A487 and thus the new railway interfacing with an Access Road and stream also.

Underbridge over access road (Obstruction Number – DP-03-02)

The condition and dimensions of the existing underbridge is not known at present, but it is appears to be a new deck on masonry wingwalls built more recently for the active travel route so is unlikely to be wide enough or have sufficient capacity to accommodate the reopened railway and the active travel route at this location. Therefore reconstruction of the existing underbridge is deemed required.

Lon Cefn Glyn road crosses alignment (Obstruction Number – DP-03-03)

This road is a busy road connecting the village to the nearby A487. Therefore a Traffic Signal Controlled junction is proposed at this location – with Tram-Trains crossing the road in Tram mode to minimise risks in the interaction with pedestrians and vehicles.

It would be proposed that a new Groeslon station would be constructed near this locality to serve the village.

Culvert under alignment (Obstruction Number – DP-03-04)

Similar to **Obstruction Number – DP-03-02**, the condition and dimensions of the existing culvert/underbridge is not known at present, but it would also not appear to be

able to accommodate the reopened railway and the active travel route at this location. Therefore reconstruction of the existing culvert is deemed required.

A487 road crosses alignment (Obstruction Number – DP-04-01)

Similar to **Obstruction Number – DP-03-01**, a significant engineering intervention would be required to reinstate the route at this location. However at this location from the desktop study it appears that the new railway would need to pass across the A487, meaning a new heavily skewed underbridge would need to be constructed whilst ensuring the road remained open to traffic.

Alternative Route Avoiding Obstruction DP-03-01 to DP-03-04 and DP-04-01

With the substantial works required to cross the A487 on two occasions north and south of the village, plus the interactions within Groeslon itself an alternative route has been considered. This alternative alignment would be reliant on the ability to purchase land alongside the existing A487 road, as the proposed railway in this case would follow the road corridor exactly.

Prior to crossing the A487 at ch 21300m, the alternative alignment would divert heading directly southwards, crossing a small access road on the flat with a Stop/Give Way road junction (instead of renewing an underbridge to cross the road on the former alignment). A new underbridge would be required to cross the River Llifon, before the route appears to follow the edge of small fields (potentially previously reshaped by the A487 construction). A similar Traffic Signalled Junction would be required to cross Lon Cefn Glyn road, but in this case by the A487 roundabout itself.

This location would also be appropriate for a new station to serve the village of Groeslon - although it would be a further 150m west of the former station location on the original alignment, this location may offer more space to provide a passing loop and potentially a transport interchange with parking to serve the wider communities better.

South of this, the new alignment would require another new underbridge to cross another stream, before the alternative alignment would rejoin the former alignment past the second A487 interface point.

It is currently believed that this alternative alignment – subject to land purchase – should be considered alongside (and potentially preferred to) reinstating the former route through Groeslon due to the avoidance of two substantial heavy engineering solutions to cross the A487 road.

It should be noted that this alternative route will run within the walls of the Grade I listed Glynllifon Park. Design works shall therefore consider minimising the impact on the area.

9.4.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
DP-03-01 A487 road crosses alignment	Construction of a heavily skewed overbridge under the A487 road	High	Very High	Purchase 3rd party land for ~1km alongside the A487 road Install Stop/Give Way junction at local access road Install new underbridge across River Llifon Install traffic signal controlled junction across Lon Cefn Glyn road Install new underbridge across stream	Moderate	High
DP-03-02 Underbridge over access road	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
DP-03-03 Lon Cefn Glyn road crosses alignment	Install new Traffic Signalled junction at main road	Moderate	High			
DP-03-04 Culvert under alignment	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
DP-04-01 A487 road crosses alignment	Construction of a heavily skewed underbridge to span across the A487 road	High	Very High			

9.4.4. Tram/Train Mode

Due to the continued number of road/rail interfaces in this section of the route, it is currently envisaged that the vehicle will remain running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

9.4.5. Operational Impacts

This does mean that the maximum speed of the vehicle in this area permitted will be 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there may be increased travelling times.

9.4.6. Cycle Route Impacts

Through the whole section south of Dinas to Penygroes the former alignment has been adopted as part of the Lon Eifion active travel path, which is part of the wider Lon Las Cymru on the National Cycle Network (route number 8).

Around Groeslon, there appears generally sufficient width to retain the active travel path alongside any new railway if the former alignment were followed – with the active travel path rebuilt to one side in order to provide sufficient space.

It is noted that if the alternative alignment around Groeslon were adopted, it is assumed that the Lon Eifion/Lon Las Cymru Active Travel path would remain along its current route which follows the former alignment – and therefore the alternative route would only be of sufficient width to allow the railway to operate safely (see Figure 4-3 in Section 4), without the need for an additional 3m width for the cycle path. This may reduce slightly the additional land take required.

9.4.7. Conclusion / Recommendation

In this section serious consideration should be made to adopting an alternative alignment around Groeslon, as to follow the former alignment would require two significant civil engineering interventions to cross the A487 north and south of the village. There are a number of other civil engineering interventions required if either the former or alternative alignments are followed, including new underbridges across rivers/streams and new road crossings. Land purchase will however be a significant consideration in whether the alternative alignment can be adopted.

9.5. Indigo Jones Slate Works to Penygroes

Chainage – 23000m to 25500m

Associated Drawings – Section C Sheet 4
Section C Sheet 5
Section C Sheet 6

9.5.1. Route Summary

Between Groeslon and Penygroes the former alignment is generally retained relatively unaffected, as part of the Lon Las Cymru Active Travel route. Near Penygroes however the old alignment has been completely lost, being used as part of the A487 road improvements in this location.

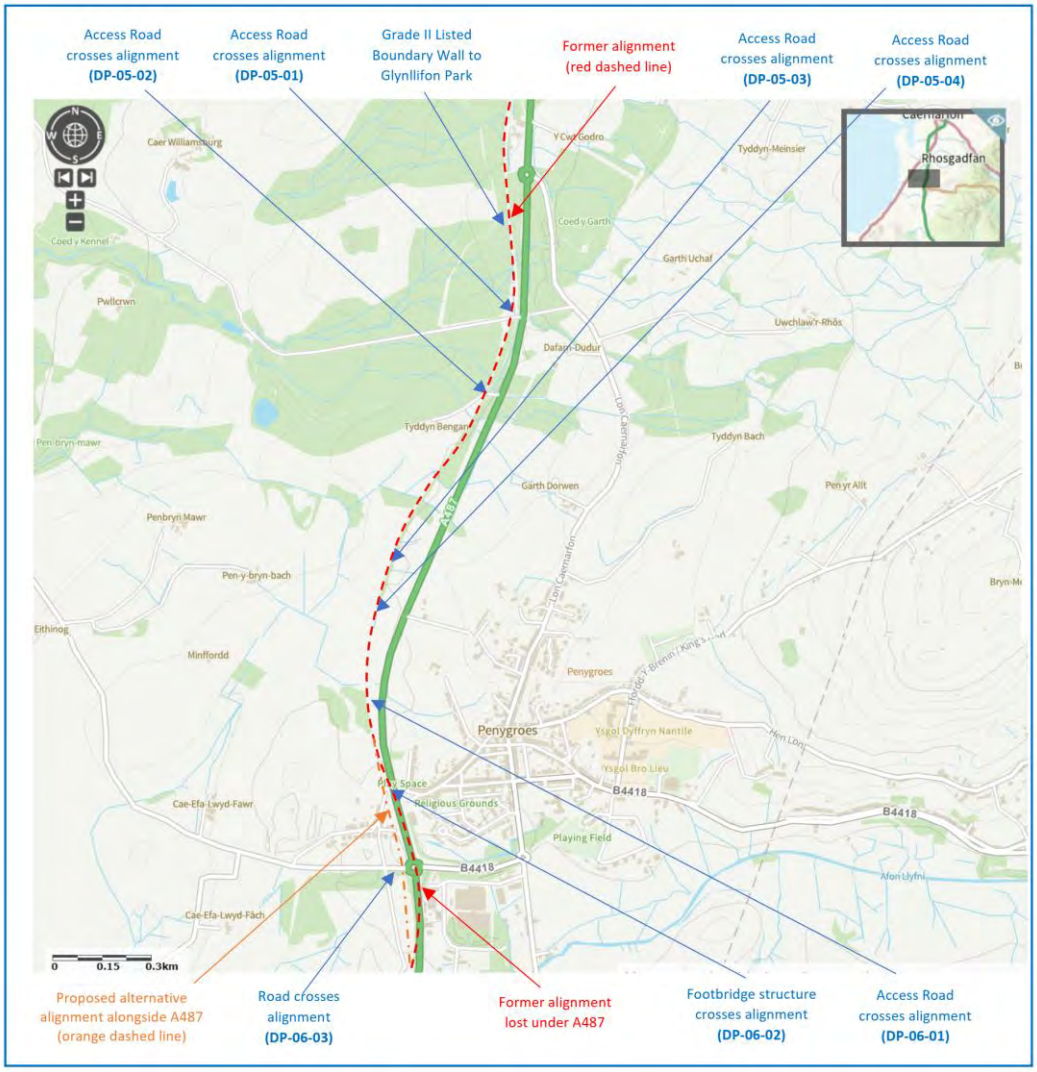


Figure 9-19 – Overview of Indigo Jones Slate Works to Penygroes area showing the obstructions along the route

South of the Indigo Jones Slate Works the former alignment run in a generally north-south orientation, parallel to the A487 road. The route passes through generally farmland, with a few small sections of woodland adjacent to the old railway.

To the west of the disused railway, the boundary wall of Glynllifon Parkland - now Glynllifon College - is Grade I Listed (Cadw Record Number 5924, designated in 1996).

This designation is not expected to impact the proposed railway reopening, but should be noted as a constraint during any proposals.

A number of existing access routes are encountered to the farmland, residential and commercial properties – with 5 access road crossings in the 1.75km south of Indigo Jones Slate Works - ***(Obstruction Number – DP-05-01, DP-05-02, DP-05-03, DP-05-04 and DP-06-01)***.

Figure 9-20 – Access road crosses alignment Obstruction Number – DP-05-01

Figure 9-21 – Access road crosses alignment Obstruction Number – DP-05-02

Figure 9-22 – Access road crosses alignment Obstruction Number – DP-05-03

Figure 9-23 – Access road crosses alignment Obstruction Number – DP-05-04

Figure 9-24 – Access road crosses alignment Obstruction Number – DP-06-01

As the former railway approaches the western side of Penygroes village the former alignment has been adopted by the A487 road during a previous road improvement scheme. The road now follows the old alignment for nearly a kilometre, and also sits over the previous station location for the village.

It is currently proposed that an alternative alignment – adopted by the Lon Las Cymru Active Travel path – which runs directly parallel to the A487 on the western side of the road is adopted.

The construction of the A487 road previously has amended the topography in the area, particularly around the concrete footbridge created during the road scheme to connect via a footpath the two segregated sections of Clynnog Road ***(Obstruction Number – DP-06-02)***. Since the former station location has been lost under the new road scheme, one potential location for a new station is next to the footbridge over the A487, as this location would allow the new railway to serve the village via the footbridge which provides access directly into the village centre to the east.

Figure 9-25 – Footbridge crosses alignment
Obstruction Number – DP-06-02

The potential alternative route alongside the A487 then runs through the very western side of Penygroes village. This will impact a small number of residential properties on Clynnog Road, as the proposed route will pass directly alongside three of these houses. Consideration of noise and visual intrusion to these properties will need specific consideration, alongside a review of the impact to the wider area.

The current Active Travel route then crosses the western leg of the A487 / B4418 roundabout ***(Obstruction Number – DP-06-03)*** – which is the minor road to Pontllyfni.

Figure 9-26 – Pontllyfni Road crosses alignment
Obstruction Number – DP-06-03

South of the roundabout, the former route continues to be lost under the A487 road for approximately 500m, with the proposal being to run along a new alignment parallel to the road (similar to the current Active Travel path).

9.5.2. Interventions

Access road crosses alignment (Obstruction Number – DP-05-01)

Access road crosses alignment (Obstruction Number – DP-05-02)

Access road crosses alignment (Obstruction Number – DP-05-03)

Access road crosses alignment (Obstruction Number – DP-05-04)

Access road crosses alignment (Obstruction Number – DP-06-01)

It is assumed that it would be very difficult to provide continued access to the farm land, residences and businesses without retaining some or all of these crossings. Since there are so many in quick succession, there may be opportunities to rationalise the number of interfaces through providing amended access routes running parallel to the new railway from a reduced number of railway/road crossings.

However it is assumed that there will need to remain at least some crossing point, and similar to previous sections on the basis the Tram-Trains continue to operate in Tram mode at this location, then the use of a junction with Stop signage is likely to be appropriate – subject to risk assessments at later design stages. Due to the risk of animals straying onto the railway, the locations would also have gates provided to prevent their incursion.

Since the operation of Tram-Trains in Tram mode is with a speed penalty to ensure that Line-of-Sight driving can be achieved, then depending on the overall timetable requirements for the route in future design studies there may be potential to convert this section to operation of the Tram-Trains in Train mode – but this would require either the closure of these crossing points with bridges, or the provision of User Worked Crossings with additional safeguards as required. At present it is presumed that the vehicles will be operating in Tram mode at these locations, as it is expected that the railway would serve both Groeslon and Penygroes villages which are only 3km apart – and therefore there would be limited opportunity to achieve higher speeds on this section in any case for stopping services at both stations.

Footbridge crosses alignment (Obstruction Number – DP-06-02)

Ideally the footbridge across the A487 – which appears a new and substantial structure from the desktop study – will be retained, so it is currently intended that the land levels in the area are remodelled and potentially the access footpaths to the footbridge locally altered to allow the new railway to be constructed. There will be a requirement for a foot crossing at this location to retain the public right-of-way. This crossing will be similar to the example shown in Figure 5-6, previously in Section 5.

It is noted that this location is one possibility for a new station, so the footpath may also be integrated into the station design as an integral foot crossing (equivalent to a station barrow crossing on the Network Rail system). The example below in Figure 9-27 only has a footpath crossing one track – but these can be extended across both tracks if a passing loop was also proposed at Penygroes station.

Figure 9-27 – View of St. Werburgh's Road Tram Stop on Manchester Metrolink, showing typical station pedestrian crossing point at end of platforms[19]

Pontllyfni Road crosses alignment (Obstruction Number – DP-06-03)

This road is a minor road connecting the coast road and the village of Pontllyfni to the A487. Due to the fact that the Tram-Trains will cross the road directly adjacent to the roundabout, a remodelling of the roundabout with appropriate Traffic Signal Controlled junctions for both the Tram-Trains and road vehicles is proposed at this location.

This is another location where a station could be constructed to serve the village. This location could serve the Penygroes Industrial area better, and have more space for a transport interchange to allow connections to better serve the wider communities in the area. However access to and from the village of Penygroes itself will be longer than a new station near Clynnog Road, which may impeded users arriving by foot.

[19] Photo by L S Wilson - https://www.geograph.org.uk/photo/2484216 used under https://creativecommons.org/licenses/by-sa/2.0/

9.5.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
DP-05-01 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates to prevent unauthorised access of animals onto the railway	Minimal	Moderate			
DP-05-02 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates to prevent unauthorised access of animals onto the railway	Minimal	Moderate			
DP-05-03 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates to prevent unauthorised access of animals onto the railway	Minimal	Moderate			
DP-05-04 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates to prevent unauthorised access of animals onto the railway	Minimal	Moderate			
DP-06-01 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates to prevent unauthorised access of animals onto the railway	Minimal	Moderate			
DP-06-02 Footbridge near Clynnog Road	Amend land levels in area Amend footpath access route to footbridge Install new footpath crossing	Moderate	Moderate			
DP-06-03 Road crossing at A487 / B4418 roundabout	Reconfigure roundabout to allow the passage of tram-trains across road near western arm of roundabout Installation of new traffic lights to control road traffic and Tram-Train interactions	Moderate	High			

9.5.4. Tram/Train Mode

This area could be considered in the future for Train operation, if the increased permitted line speeds were of benefit to lowering overall journey times across the route. However it is currently envisaged that services will call at Groeslon and Penygroes stations, thus limiting the benefits of permitting operations above the 45mph limit for Tram operations.

Therefore due to the continued number of road/rail interfaces in this section of the route, it is currently envisaged that the vehicle will remain running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions rather than traditional level crossings where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

9.5.5. Operational Impacts

The adoption of Tram mode running in this area would mean that the maximum speed of the vehicle in this area permitted will be 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there should be a wider review of journey times across the railway, to identify any issues associated with these restricted speeds.

9.5.6. Cycle Route Impacts

This section to Penygroes has been adopted as part of the Lon Eifion / Lon Las Cymru active travel path, which is part of the wider on the National Cycle Network (route number 8). There appears generally sufficient width to retain the active travel path alongside any new railway if the former alignment were followed – with the active travel path rebuilt to one side in order to provide sufficient space.

9.5.7. Conclusion / Recommendation

In this section an alternative alignment to the former alignment around Penygroes is likely to be a necessity, as the A487 has followed the former alignment for approximately 1km to the west of the village. Subject to purchasing land alongside the A487 – which is currently used by the Lon Eifion / Lon Las Cymru active travel path and therefore assumed to be practicable with local authority or Welsh Government permissions – there are very few other obstacles or impediments to reopening the railway in this area. The number of road interfaces (with primarily Farmer Access Roads) is however significant in the area, and will need careful management to reduce the overall risk to the reopened railway operations.

10. Route Alignment Review - Penygroes to Bryncir

10.1. Route Section Summary of Interventions/Implications

The route section between Penygroes and Bryncir has the following interventions/implications;

Proposed Intervention Categories

Section	Total Length	Minimal (Green)	Moderate (Yellow)	High (Orange)	Very High (Red)
D	8.7km	84%	11%	5%	0%

Road Rail Interfaces Interventions

Route Section	Reconfigure highway inc roundabout	Traffic Light Controls	Stop/Give Way	Stop/Give Way with gates
D	0	1	4	10

Structure Interventions

Route Section	Underbridge		Overbridge		New Retaining Walls/ Embankment works
	Retain / Repair	Replace / New	Retain / Repair	Replace / New	
D	4	6	0	2	0

Type of Running Lengths

Route Section	Train Running	Tram (integreated on-street and segregated on-street)	Tram (off-street)	Total Length
D	0km	0km	8.7km	8.7km

Impact on Cycle Route

Route Section	Length of cycle route requiring diversion
D	0km

10.2. Penygroes to Coedcae Newydd

Chainage – 25500m to 27000m

Associated Drawings – Section D Sheet 1
Section D Sheet 2

10.2.1. Route Summary

South of Penygroes the former alignment has been partially and completely built over by the A487 road following previous improvement works. In these locations the Lon Las Cymru active travel path has been constructed parallel to the new road construction, and it is envisaged that any reopened railway would follow similar principles.

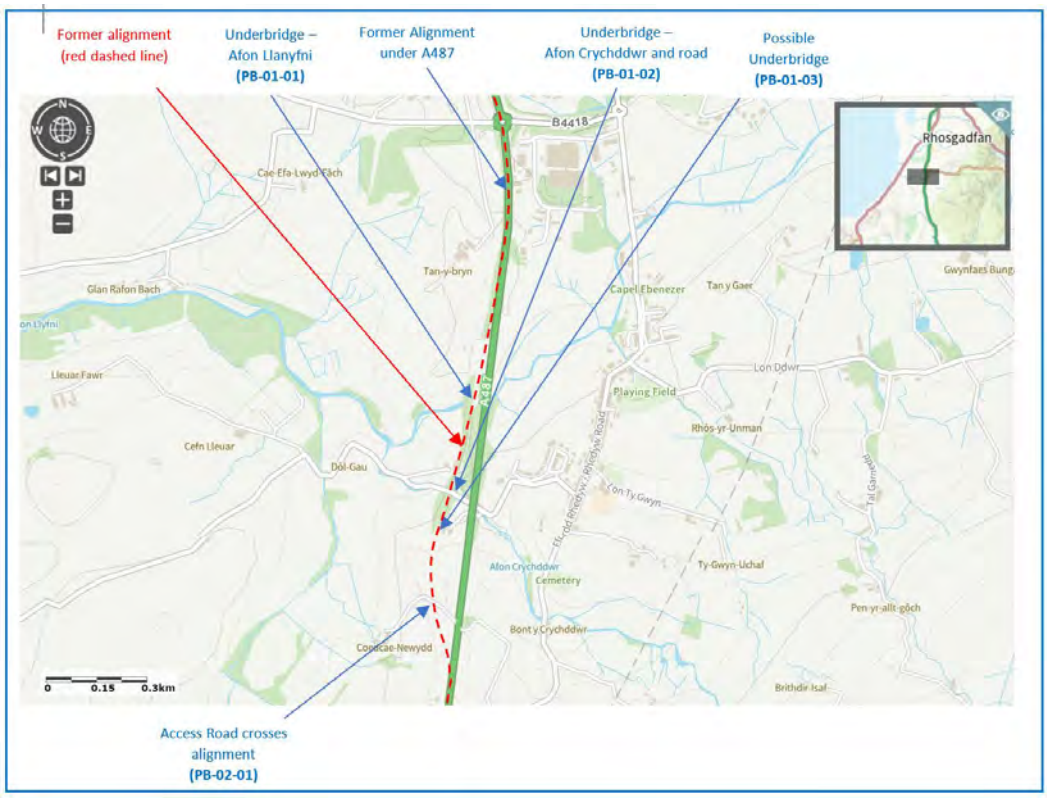


Figure 10-1 – Overview of Penygroes to Coedcae Newydd area showing the obstructions along the route

As shown above, the former alignment is constructed over by the A487 south of the roundabout with the B4418 for approximately 200m. After this point the A487 continues to head on a more direct southerly direction, whilst the former alignment diverges on a more south-westerly direction.

The former line crosses over two rivers – the Afon Llyfni ***(Obstruction Number – PB-01-01)*** and Afon Crychddwr ***(Obstruction Number – PB-01-02)*** – in quick succession. It is noted that the Afon Crychddwr ***(Obstruction Number – PB-01-02)*** bridge is a two span underbridge, crossing both the river and a local road.

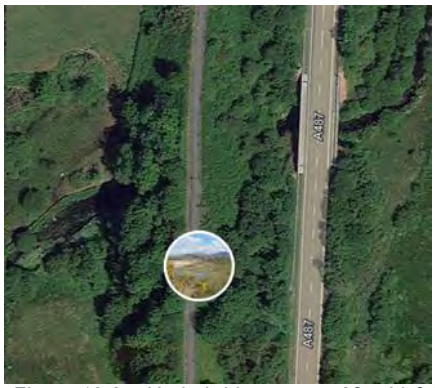


Figure 10-2 – Underbridge across Afon Llyfni
Obstruction Number – PB-01-01

Figure 10-3 – Underbridge across Afon Crychddwr and local road
Obstruction Number – PB-01-02

A third possible underbridge is located near farm buildings south of the Afon Crychddwr, but this is not visible in the desktop study as it is located within a wooded section ***(Obstruction Number – PB-01-03)***. The former railway route is then crossed by an Access Road to the Coedcae Newydd Farm ***(Obstruction Number – PB-02-01)***.

Figure 10-4 – Possible Underbridge
Obstruction Number – PB-01-03

Figure 10-5 – Local Access Road near Coedcae Newyddd Farm - Obstruction Number – PB-02-01

10.2.2. Interventions

Afon Llyfni Underbridge (Obstruction Number – PB-01-01)

This underbridge appears to be substantial existing structures from the desktop study information available, and therefore it is assumed that it has sufficient width to accommodate the reopened railway and the active travel path alongside it. Therefore at present it is assumed it may be possible to retain this structure following surveys/assessments and any repair works being completed.

Afon Crychddwr and Local Road Underbridge (Obstruction Number – PB-01-02)

This underbridge is a large structure with two spans – one spanning the river and the second span across a local road. From the desktop study information available it appears that the structure will have sufficient width to accommodate across it the reopened railway and the active travel path alongside it. It is consequently assumed that this structure can also be retained following surveys/assessments, and any repair works identified then being completed.

Possible underbridge (Obstruction Number – PB-01-03)

It has not been possible to establish the existence – or not – of an underbridge south of the Afon Crychddwr adjacent to some farm buildings from the current desktop study. A historic access appears on older maps, and therefore the condition and suitability of any structure should be investigated further in future studies.

Local Access Road to Coedcae Newydd Farm (Obstruction Number – PB-02-01)

This road serves a single farm, providing access from the nearby A487 road. It is therefore assumed that access would need to be maintained, and a suitable risk assessment would have to be undertaken to assess the use of the crossing (by both the farmers, and the number of trains at this location). It is currently assumed that the provision of a new grade separated bridge crossing would not be appropriate, and on the assumption Tram-Trains are still operating in Tram mode at this location a new road junction with Stop or Give Way signage controls with gates is proposed. However if the Tram-Trains are operating in Train mode, then the provision of a User Worked Crossing would be required with appropriate Whistle Board/Telephone protection systems.

10.2.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
PB-01-01 Afon Llyfni Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
PB-01-02 Afon Crychddwr and Local Road Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
PB-01-03 Possible Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
PB-02-01 Coedcae Newydd Farm Local Road Crossing	Install Stop/Give Way junction with gates at local access road to Farm	Minimal	Moderate			

10.2.4. Tram/Train Mode

Due to the number of road/rail interfaces in this section of the route, the operation of the Tram-Train in conventional train mode would result in the required opening of a number of new level crossings. It is currently believed that this would import a level of risk into the operation of the railway in train mode which could be considered unacceptable. Therefore to avoid the requirement for grade separation junctions or Level Crossings, it is currently envisaged that the vehicle will be running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

10.2.5. Operational Impacts

This does mean that this section of the route will also be restricted to a maximum speed 45mph in this area, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. This is one section where possibly the overall timetable requirements require higher line speeds, and thus the operation of the vehicles in train mode with suitable risk mitigation measures may need further consideration.

10.2.6. Cycle Route Impacts

Through the whole section south of Penygroes to Bryncir the former alignment has again been adopted as part of the Lon Eifion active travel path, which is part of the wider Lon Las Cymru on the National Cycle Network (route number 8).

There appears generally sufficient width to retain the active travel path alongside any new railway alignment – with the active travel path rebuilt to one side in order to provide sufficient space (see Figure 4-3 in Section 4 for an indicative cross section for the safeguarded corridor for a new railway alongside an active travel route).

Therefore at present it is also assumed that the Active Travel path will be retained alongside the reopened railway in this location, without requiring land purchase beyond the former railway boundaries or significant engineering challenges. This is subject to confirmation through topographical surveys and design work in future stages.

10.2.7. Conclusion / Recommendation

In this section the reopened railway would be proposed to follow the former alignment, with predominately the verification of the condition of underbridges being the principal concern. This does assume that the railway could be routed directly alongside the A487 south of the Penygroes roundabout without impediment, and the local access road to Coedcae Newydd farm could be crossed subject to appropriate mitigations arising from the risk assessment process being implemented.

10.3. Coedcae Newydd to Cefn Graianog

Chainage – 27000m to 29500m

Associated Drawings – Section D Sheet 3
Section D Sheet 4

10.3.1. Route Summary

South of Coedcae Newydd Farm road improvements for the A487 have again resulted in the former alignment being partially or completely lost for approximately 650m. The former route then follows a valley to the south west, before passing adjacent to Cefn Graianog Quarry.

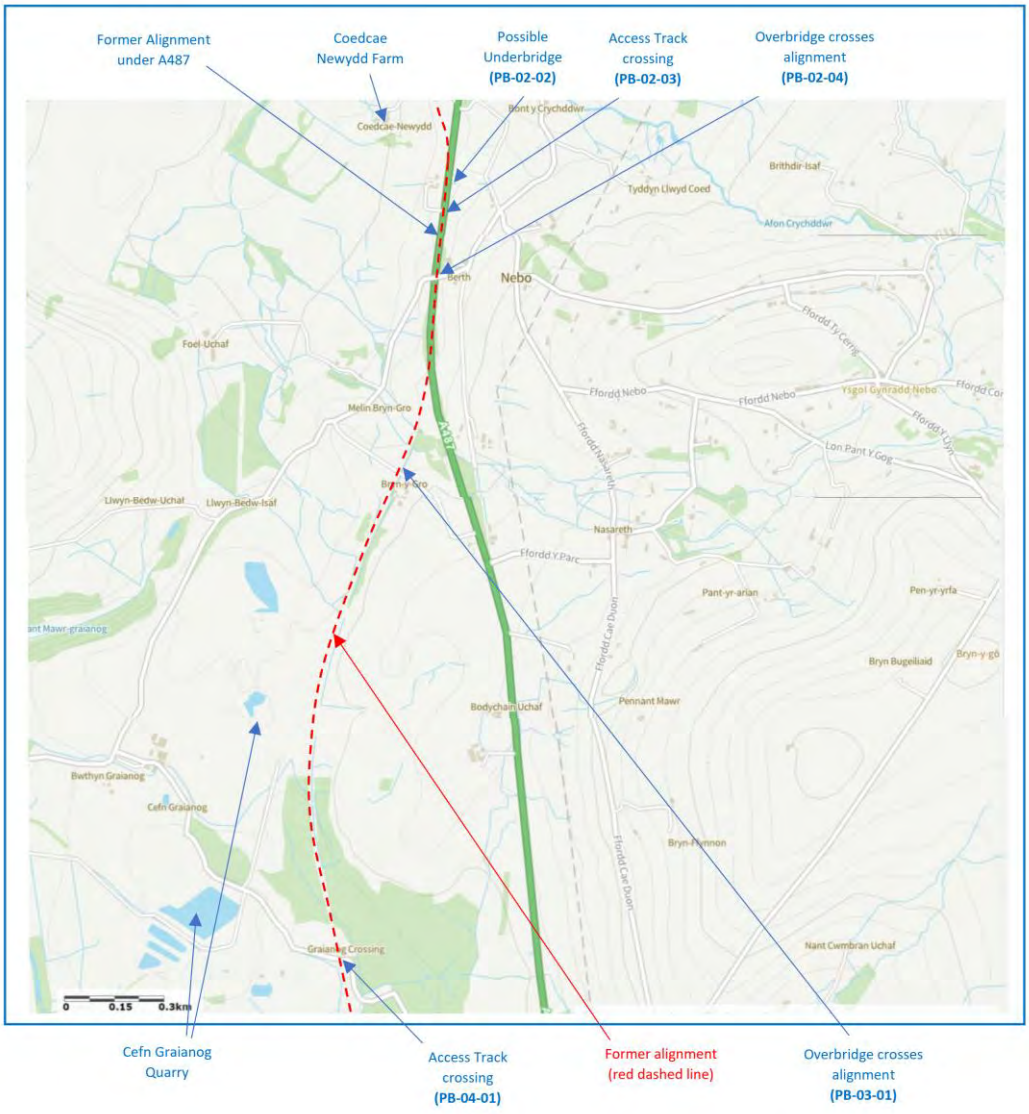


Figure 10-6 – Overview of Coedcae Newydd to Cefn Graianog area showing the obstructions along the route

As indicated above, the A487 and directly adjacent Lon Las Cymru active travel route cross over a Possible Underbridge or culvert ***(Obstruction Number – PB-02-02)*** which is adjacent to a small set of farm buildings that is accessed via Access Track off the A487 ***(Obstruction Number – PB-02-03)***. A modern concrete overbridge ***(Obstruction Number – PB-02-04)*** then crosses the A487 and active travel route near the Berth Farm, which carries a small local road.

Figure 10-7 – Possible underbridge / culvert
Obstruction Number – PB-02-02

Figure 10-8 – Access Track Crossing
Obstruction Number – PB-02-03

Figure 10-9 – Overbridge crosses alignment
Obstruction Number – PB-02-04

South of Melin Bryn-Gro Farm, the A487 deviates from the former railway alignment, with the former railway following a valley in the south-westerly direction. A stone overbridge ***(Obstruction Number – PB-03-01)*** carrying a small access road passes over the alignment, which is now occupied by the Active Travel route.

The former railway passes to the east of Cefn Graianog Quarry, which has relatively extensive workings either side of Graianog Farm. There are relatively few observable obstacles in this area – although there are potentially drainage ditches and culverts along the whole length of the former line which may need review at a later stage – until an Access Road to the Quarry and Farm is reached ***(Obstruction Number – PB-04-01).***

Figure 10-10 – Stone overbridge carrying local road
Obstruction Number – PB-03-01

Figure 10-11 – Local Access Road near Cefn Graianog
Obstruction Number – PB-04-01

10.3.2. Interventions

Possible underbridge (Obstruction Number – PB-02-02)

It has not been possible to establish the existence – or not – of an underbridge adjacent to some farm buildings alongside the A487 from the current desktop study. There appears to be a pond and stream on either side of the road, so it is presumed a culvert or bridge is located here, which should be investigated further in future studies.

Local Access Road to Farm Buildings (Obstruction Number – PB-02-03)

This road serves a single farm, providing access from the nearby A487 road, and it is currently presumed that this access would need to be maintained. Due to the constrained site with the trunk road and buildings in close proximity, the provision of a grade separated bridge crossing appears impracticable. However any road/rail interface would be impacted by the short physical distance between leaving the A487 main road and the crossing point, and would need to be subject to a risk assessment. Nevertheless, assuming the Tram-Trains are still operating in Tram mode at this location a new road junction with Stop or Give Way signage controls would be possible, mimicking the current cycle path crossing in place at present of the access road. However if the Tram-Trains are operating in Train mode, then the provision of a User Worked Crossing may also need line speed restrictions to minimise the potential risk at this location of road vehicles turning directly off the A487 into the path of a Tram-Train.

Concrete overbridge carrying local access road (Obstruction Number – PB-02-04)

The three span concrete overbridge does cross over the Active Travel path on the western side of the A487 – however the path is at a higher level than the road, and there may not be sufficient vertical headroom clearance or sufficient width for both the reintroduced railway and the cycle path at present. Therefore it is currently envisaged that some intervention will be required at this location, to amend the western span and bankseat of the bridge to accommodate the requirements of the reopened railway.

Stone overbridge carrying local access road (Obstruction Number – PB-03-01)

The stone overbridge is likely to be only sufficiently wide to accommodate a single track railway, and not both the reopened railway and the Active Travel path. Since vertical and horizontal clearances are not known at present, it is assumed that the bridge would need to be reconstructed to accommodate the new infrastructure requirements.

Local Access Road near Cefn Graianog (Obstruction Number – PB-04-01)

This road serves both the quarry and the farm in the area, and therefore is assumed to be used by a large number of Heavy Goods Vehicles. Consideration should be made into the possibility of providing a bridge at this location, to segregate road and rail vehicles.

Due to the greater risk arising from a collision between a Tram-Train and a Heavy Goods Vehicle, it is currently envisaged that as a minimum Traffic Signal controls should be introduced at this crossing – which is likely to provide more protection against misuse than a Stop/Give Way sign – on the assumption Tram-Trains are still operating in Tram mode at this location. Else a Level Crossing with barriers should be considered – especially if the Tram-Trains are operating in Train mode.

10.3.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
PB-02-02 Possible Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
PB-02-03 Local Road Crossing	Install Stop/Give Way junction at local access road to Farm	Minimal	Moderate			
PB-02-04 Concrete overbridge near Berth	Localised amendment of western span and/or foundations to western side of existing bridge to accommodate width and height of new Tram-Train Vehicles	Minimal	High			
PB-03-01 Stone overbridge near Bryn-y-Gro	Reconstruction of existing bridge to accommodate width and height of new Tram-Train Vehicles alongside existing Active Travel path	Moderate	High			
PB-04-01 Local Road Crossing to Cefn Graianog	Install Traffic Light controlled junction at local access road to Farm / Quarry	Moderate	Moderate			

10.3.4. Tram/Train Mode

Due to the number of road/rail interfaces in this section of the route, the operation of the Tram-Train in conventional train mode would result in the required opening of 2 new level crossings. It is currently envisaged therefore that the vehicle will continue to be running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

10.3.5. Operational Impacts

This does mean that the maximum speed of the vehicle in this area permitted will be 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there may be increased travelling times.

10.3.6. Cycle Route Impacts

The Lon Eifion active travel path, which is part of the wider Lon Las Cymru on the National Cycle Network (route number 8), continues to utilise the former alignment in this section. However from this desktop study, there appears generally sufficient width to retain the active travel path alongside any new railway alignment – with the active travel path rebuilt to one side in order to provide sufficient space – with minimal land purchases beyond the former railway corridor and minimal engineering interventions.

If the cycle path were diverted away from the former/new railway alignment, there may possibly be certain interventions – such as at the Concrete overbridge **(Obstruction Number – PB-02-04)** and Stone overbridge **(Obstruction Number – PB-03-01)** – where the required works would be lessened to only accommodate the new railway requirements. However this is likely to be offset by greater works and land purchases required to create a totally new cycle path route in the landscape.

10.3.7. Conclusion / Recommendation

In this section the reopened railway would need to be located alongside the A487 for a distance, and there are a number of overbridges which appear to need reconstruction in order to reopen the route. Additionally there are two road/rail interfaces and a possible culvert to be negotiated, prior to the railway being reinstated.

10.4. Cefn Graianog to Pant Glas

Chainage – 29500m to 31200m

Associated Drawings – Section D Sheet 4
Section D Sheet 5
Section D Sheet 6

10.4.1. Route Summary

South of Cefn Graianog the former route proceeds in a south/south-easterly direction towards the former station of Pant Glas.

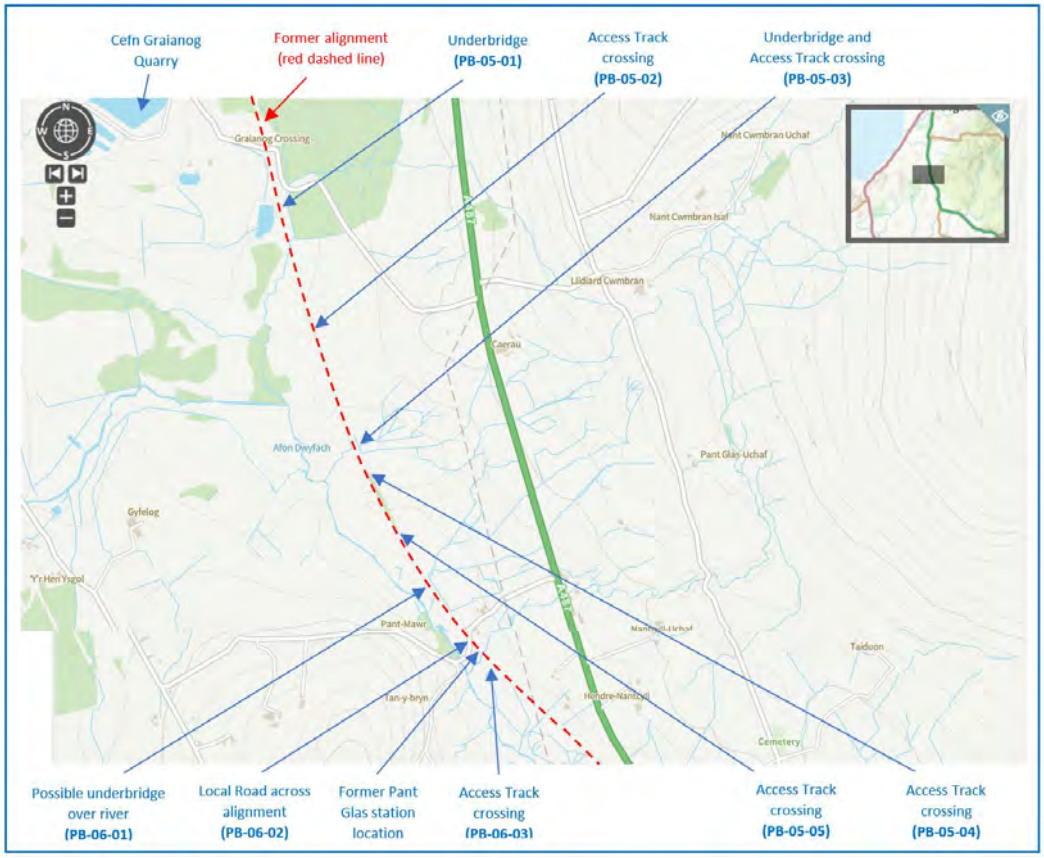


Figure 10-12 – Overview of Cefn Graianog to Pant Glas area showing the obstructions along the route

As shown above, the route passes through a predominately rural area south of Cefn Graianog, with the former railway line crossing a number of rivers and farm access routes.

In this area the historic mapping indicates that there were originally a number of underbridges – presumably generally cattle creeps or across farmer access routes – along the route, whilst modern satellite imagery suggests a larger number of farmers tracks crossing the current Active Travel path on the level. This would need to be verified during future studies.

An underbridge ***(Obstruction Number – PB-05-01)*** does appear to be present south of Cefn Graianog, followed by an Access Track Crossing between farmland ***(Obstruction Number – PB-05-02).***

Figure 10-13 – Underbridge Obstruction Number – PB-05-01

Figure 10-14 – Access Track Crossing Obstruction Number –PB-05-02

The former railway then appears to pass across an Access Track and then over an underbridge in quick succession ***(Obstruction Number – PB-05-03)***.

Figure 10-15 – Access Track and Underbridge Obstruction Number – PB-05-03

The route then crosses a further two farmer Access Tracks in the next 300m ***(Obstruction Number – PB-05-04 and Obstruction Number – PB-05-05)***.

Figure 10-16 – Access Track Crossing Obstruction Number – PB-05-04

Figure 10-17 – Access Track Crossing Obstruction Number –PB-05-05

As the former railway alignment passes to the west of the small Pant Glas hamlet, the line crosses another possible underbridge/culvert ***(Obstruction Number – PB-06-01)*** which is likely to cross a tributary of the Afon Dwyfach which is running parallel to the railway at this location.

Figure 10-18 – Possible Underbridge/Culvert
Obstruction Number – PB-06-01

The route then approaches the former station of Pant Glas, which was located either side of the local access road which still crosses the alignment ***(Obstruction Number – PB-06-02)***. A small single platform station was located just south of the former level crossing, and a siding for goods was situated just north of the level crossing. The station served a sparsely populated area, with passenger services ceasing at the station in 1957 a number of years before the line between Afon Wen and Caernarfon was completely closed in 1964[20].

To the south of the former platform site, an Access Track between farmer's fields ***(Obstruction Number – PB-06-03)*** is visible – again historic records indicate a possible underbridge or culvert at this location also

Figure 10-19 – Local Road Crossing near former station
Obstruction Number – PB-06-02

Figure 10-20 – Access Track Crossing
Obstruction Number –PB-06-03

[20] Disused Stations website - http://www.disused-stations.org.uk/p/pant_glas/index.shtml

10.4.2. Interventions

Underbridge (Obstruction Number –PB-05-01)

Underbridge (Obstruction Number –PB-05-03)

Possible Underbridge (Obstruction Number –PB-06-01)

The condition and dimensions of these existing underbridges is not known at present, but they are currently believed to be unlikely to have sufficient width to accommodate the reopened railway and the active travel route at this location. Therefore reconstruction of the existing underbridge or construction of an additional span for the cycle route next to the existing structure is deemed required.

This will be subject to further surveys and investigations in future studies.

Access road crosses alignment (Obstruction Number – PB-05-02)

Access road crosses alignment (Obstruction Number – PB-05-03)

Access road crosses alignment (Obstruction Number – PB-05-04)

Access road crosses alignment (Obstruction Number – PB-05-05)

Access road crosses alignment (Obstruction Number – PB-06-03)

It is assumed that it would be very difficult to provide continued access to the farm land, linked by these existing tracks, without retaining some or all of these crossings. Since there are so many in quick succession, there may be opportunities to rationalise the number of interfaces through providing amended access routes running parallel to the new railway from a reduced number of railway/road crossings.

However it is assumed that there will need to remain a large number of locations where access tracks will need to cross the railway, and similar to previous sections on the basis the Tram-Trains continue to operate in Tram mode at this location, then the use of a junction with Stop signage is likely to be appropriate – subject to risk assessments at later design stages. Due to the risk of animals straying onto the railway, the locations would also have gates provided to prevent their incursion.

To avoid the time penalty associated with operation of Tram-Trains in Tram mode to ensure that Line-of-Sight driving can be achieved, then operation of the Tram-Trains in Train mode with the provision of bridges or User Worked Crossings with additional safeguards could be investigated. This would depend on the train service timings required for through journeys and/or the required level of station provision along the route. For example if Pant Glas station were to be reopened, then some of the Access Track Crossing points would be within areas where the Tram-Train would be slowing for or accelerating from that station.

Local road crosses alignment near Pant Glas (Obstruction Number –PB-06-02)

This road appears relatively lightly used, and therefore at present the provision of a Stop/Give Way signage controlled junction is envisaged. Subject to risk assessment and sighting distance reviews, a traffic light controlled junction or full railway level crossing may be deemed appropriate.

10.4.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
PB-05-01 Underbridge	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
PB-05-02 Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
PB-05-03 Underbridge and Access Track Crossing	Reconstruct underbridge for additional width for new railway and existing active travel route Install Stop/Give Way junction at farmers access, with gates	Moderate	High			
PB-05-04 Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
PB-05-05 Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
PB-06-01 Underbridge	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
PB-06-02 Local Road Crossing near Pant Glas	Install Stop/Give Way junction for local access road	Minimal	Moderate			
PB-06-03 Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			

10.4.4. Tram/Train Mode

Due to the significant number of road/rail interfaces in this section of the route, it is currently envisaged that the vehicle will remain running in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

10.4.5. Operational Impacts

This does mean that the maximum speed of the vehicle in this area permitted will be 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there may be increased travelling times.

10.4.6. Cycle Route Impacts

The former route has again been adopted as part of the Lon Eifion active travel path in this area, which is part of the wider Lon Las Cymru on the National Cycle Network (route number 8). There appears generally sufficient width to retain the active travel path alongside any new railway if the former alignment were followed – with the active travel path rebuilt to one side in order to provide sufficient space.

10.4.7. Conclusion / Recommendation

In this section the former alignment can be adopted for reopening the railway. This will require a small number of underbridges to be assessed – and likely reconstructed – to permit the reinstatement of the railway alongside the Active Travel route. There are additionally a significant number of Access Track/Local Road crossings in this section, which will require consolidation if possible .

10.5. Pant Glas to Bryncir

Chainage – 31200m to 34200m

Associated Drawings – Section D Sheet 6
Section D Sheet 7
Section D Sheet 8

10.5.1. Route Summary

Between Pant Glas and Bryncir the former alignment is generally retained relatively unaffected, as part of the Lon Las Cymru Active Travel route. Near Bryncir however the old station has been converted into small businesses, and thus the alignment has been locally largely lost in its historic form.

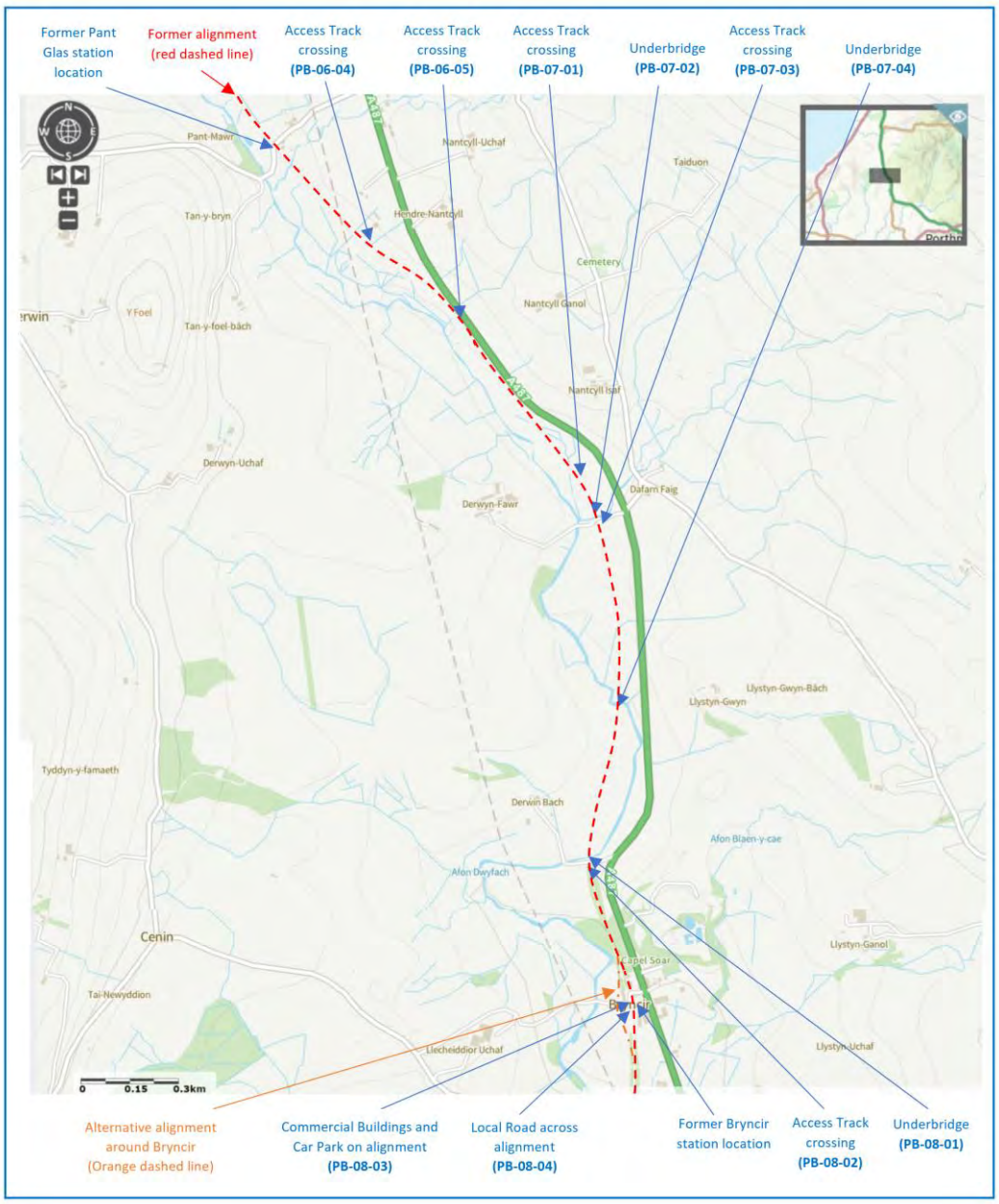


Figure 10-21 – Overview of Pant Glas to Bryncir area showing the obstructions along the route

South of Pant Glas the former alignment continues to run in a generally north-south orientation, parallel to the A487 road. The route passes through generally farmland, alongside the Afon Dwyfach.

A number of existing access routes are encountered to the farmland properties in the area – with 3 access road crossings in less than 1.5km south of Pant Glas ***(Obstruction Numbers – PB-06-04, PB-06-05 and PB-07-01***) providing access into individual fields.

Figure 10-22 – Access track crosses alignment Obstruction Number – PB-06-04

Figure 10-23 – Access track crosses alignment Obstruction Number – PB-06-05

Figure 10-24 – Access track crosses alignment Obstruction Number – PB-07-01

Near Derwin Fawr Farm the former railway crosses a tributary of the Afon Dwyfach ***(Obstruction Number – PB-07-02)***, before the fourth road/rail interface in this section is encountered - the access route to Derwin Fawr Farm itself ***(Obstruction Number – PB-07-03)***.

Figure 10-25 – Underbridge over tributary to Afon Dwyfach and Access Track crosses alignment Obstruction Number – PB-07-02 and PB-07-03

Approximately 500m further south the former alignment crosses the Afon Dwyfach ***(Obstruction Number – PB-07-04)***, before the river passes back under the railway a further 500m south again ***(Obstruction Number – PB-08-01)***.

Figure 10-26 – Underbridge over Afon Dwyfach
Obstruction Number – PB-07-04

Figure 10-27 – Underbridge over Afon Dwyfach
Obstruction Number – PB-08-01

As can be seen in the figure above, directly adjacent to the second underbridge across the Afon Dwyfach there additionally exists an Access Track ***(Obstruction Number – PB-08-02)*** providing a connection from the A487 road to the Derwin Bach Farm/Holiday Cottages.

The former railway approaches the village of Bryncir, before running along the western side of the village itself. The former station has been adopted for a number of alternative purposes ***(Obstruction Number – PB-08-03)*** – north of the former platforms is a small carpark for the Lon Las Cymru cycle route, adjacent to the former water tank for supplying steam engines with water. The station platforms remain generally in place, with the area between the platform faces now an access track to the car park and the continuation of the cycle path itself (a passing loop was previously provided at this location, hence two former platform faces being present).

Figure 10-28 – View of Water Tank towards car park
Part of Obstruction Number – PB-08-03[21]

Figure 10-29 – View of platform faces towards car park
Part of Obstruction Number – PB-08-03

[21] Photo by Les Fifoot taken in 2012 – see http://www.disused-stations.org.uk/b/brynkir/index.shtml
[22] Photo by Les Fifoot taken in 2012– see http://www.disused-stations.org.uk/b/brynkir/index.shtml

South of the former platforms, new buildings for businesses have been constructed directly adjacent to the old alignment ***(continuation of Obstruction Number – PB-08-03)*** and a local road to provide access to these businesses routed along the former alignment ***(Obstruction Number – PB-08-04)***.

Figure 10-30 – Commercial business constructed on alignment Obstruction Number – PB-08-03

Figure 10-31 – Commercial business constructed on alignment Obstruction Number – PB-08-04

10.5.2. Interventions

Access road crosses alignment (Obstruction Number – *PB-06-04*)

Access road crosses alignment (Obstruction Number – *PB-06-05*)

Access road crosses alignment (Obstruction Number – *PB-07-01*)

Access road crosses alignment (Obstruction Number – *PB-07-03*)

It is assumed that continued access to the farm land accessed by these crossings will need to be retained. This should obviously be reviewed with local landowners during further studies in order to rationalise and reduce the number of railway/road crossings where possible.

However it is assumed that there will need to remain at least some crossing points, and similar to previous sections on the basis the Tram-Trains continue to operate in Tram mode at this location then the use of a junction with Stop signage is likely to be appropriate – subject to risk assessments at later design stages. Due to the risk of animals straying onto the railway, the majority of these locations would also have gates provided to prevent the incursion of animals into the path of Tram-Trains.

Underbridges (Obstruction Number – PB-07-02)

Underbridges (Obstruction Number – PB-07-04)

Underbridges (Obstruction Number – PB-08-01)

The condition and dimensions of these existing underbridges is not known at present, but they are currently believed to be unlikely to have sufficient width to accommodate the reopened railway and the active travel route at this location. Therefore reconstruction of the existing underbridge or construction of an additional span for the cycle route next to the existing structure is deemed required. This will be subject to further surveys and investigations in future studies.

Commercial Businesses across alignment (Obstruction Number – PB-08-03)

Local Road across alignment (Obstruction Number – PB-08-04)

The commercial businesses and associated access roads directly impact the previous rail alignment, and therefore options include: -

- Purchase of the properties, to enable their reconstruction or relocation away from the former alignment, to allow the reinstatement of the railway exactly along the previous route.
- Adoption of street running, with the Tram-Trains following the access road in front of the businesses. This would require a slow speed running section, and a number of traffic light signalled controlled junctions as sighting distances are likely to be poor in this location.
- The purchase of land behind (to the west) of the commercial businesses, and the routing of the reopened railway along this new alignment parallel to the former route for a short section.

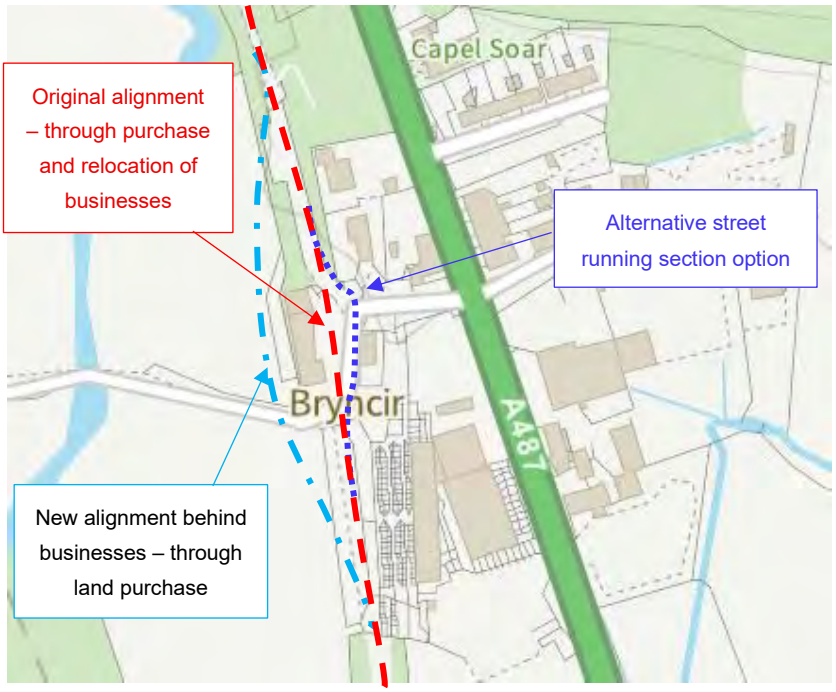


Figure 10-32 – View of Bryncir village and different options proposed

Due to the number of interfaces in quick succession, it is currently assumed that the purchase of land to provide an alternative route around the former Bryncir station would be the optimum solution. A new station could be provided on this alternative route to serve the village.

10.5.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
DP-06-04 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
DP-06-05 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
DP-07-01 Farmers Access Track crossing	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
PB-07-02 Underbridge	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
DP-07-03 Access Track crossing to Derwin Fawr Farm	Install Stop/Give Way junction at Farm access, possibly with gates	Minimal	Moderate			
PB-07-04 Underbridge	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
PB-08-01 Underbridge	Reconstruct underbridge (single span) for additional width to accommodate new railway and existing active travel route	Moderate	High			
DP-08-02 Access Track crossing to Farm	Install Stop/Give Way junction at Farm access, possibly with gates	Minimal	Moderate			

PB-08-03 **Car Park and Commercial Businesses across alignment**	Purchase car park and commercial businesses, and reconfigure or relocate these to another location away from former alignment.	High	High	Purchase land behind the current businesses and construct new route	High	Moderate
DP-08-04 **Local Access Road built along and across alignment**	Purchase access road, and reconfigure it away from former alignment Install Stop/Give Way junction where reconfigured road will cross former alignment	Moderate	Moderate	Install Stop/Give Way junction where road crosses new alternative alignment	Minimal	Moderate

10.5.4. Tram/Train Mode

Due to the continued number of road/rail interfaces in this section of the route, there remains advantages to the Tram-Train vehicle remaining in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions rather than traditional level crossings where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks. Obviously if a street running option at Bryncir was selected, then Tram mode would be mandatory – alternatively if Train mode is required in this area, then the preferred option at Bryncir of purchasing land for an alternative route behind the businesses would be in practice the only practicable option to adopt.

10.5.5. Operational Impacts

The continued adoption of Tram mode running in this area would mean that the maximum speed of the vehicle in this area permitted remains at 45mph, and this may need to be reduced at the road junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there should be a wider review of journey times across the railway, to identify any issues associated with these restricted speeds.

With several houses in close proximity of the alignment consideration should be given to constructing a station in this area.

10.5.6. Cycle Route Impacts

This section to Bryncir has been adopted as part of the Lon Eifion / Lon Las Cymru active travel path, which is part of the wider on the National Cycle Network (route number 8). There appears generally sufficient width to retain the active travel path alongside any new railway if the former alignment were followed – with the active travel path rebuilt to one side in order to provide sufficient space.

It is noted that south of Bryncir the Lon Las Cymru active travel path diverts onto local roads – so there are precedents for this, if a diversion were to assist in the reopening of the railway in future detailed design studies.

10.5.7. Conclusion / Recommendation

In this section an alternative alignment to the former alignment around Bryncir itself is likely to be a necessity, as there are various obstacles around the site of the former station. However in other locations between Pant Glas and Bryncir there are very few significant other obstacles or impediments to reopening the railway in this area. The number of road interfaces (with primarily Farmer Access Roads) is however high in the area, and will need careful management to reduce the overall risk to the reopened railway operations. Various underbridges will also need investigation and assessment to confirm the level of work required at these locations.

11. Route Alignment Review - Bryncir to Afon Wen

11.1. Route Section Summary of Interventions/Implications

The route section between Bryncir and Afon Wen has the following interventions/implications;

Proposed Intervention Categories

Section	Total Length	Minimal (Green)	Moderate (Yellow)	High (Orange)	Very High (Red)
E	9.5km	0%	100%	0%	0%

Road Rail Interfaces Interventions

Route Section	Reconfigure highway inc roundabout	Traffic Light Controls	Stop/Give Way	Stop/Give Way with gates
E	0	2	5	15

Structure Interventions

Route Section	Underbridge		Overbridge		New Retaining Walls/ Embankment works
	Retain / Repair	Replace / New	Retain / Repair	Replace / New	
E	6	1	0	0	0

Type of Running Lengths

Route Section	Train Running	Tram (integreated on-street and segregated on-street)	Tram (off-street)	Total Length
E	0.5km	0	9km	9.5km

Impact on Cycle Route

Route Section	Length of cycle route requiring diversion
E	0km (Cycle route follows local roads in this section)

11.2. Bryncir to Former Ynys Station

Chainage – 34200m to 37300m

Associated Drawings – Section E Sheet 1
Section E Sheet 2
Section E Sheet 3

11.2.1. Route Summary

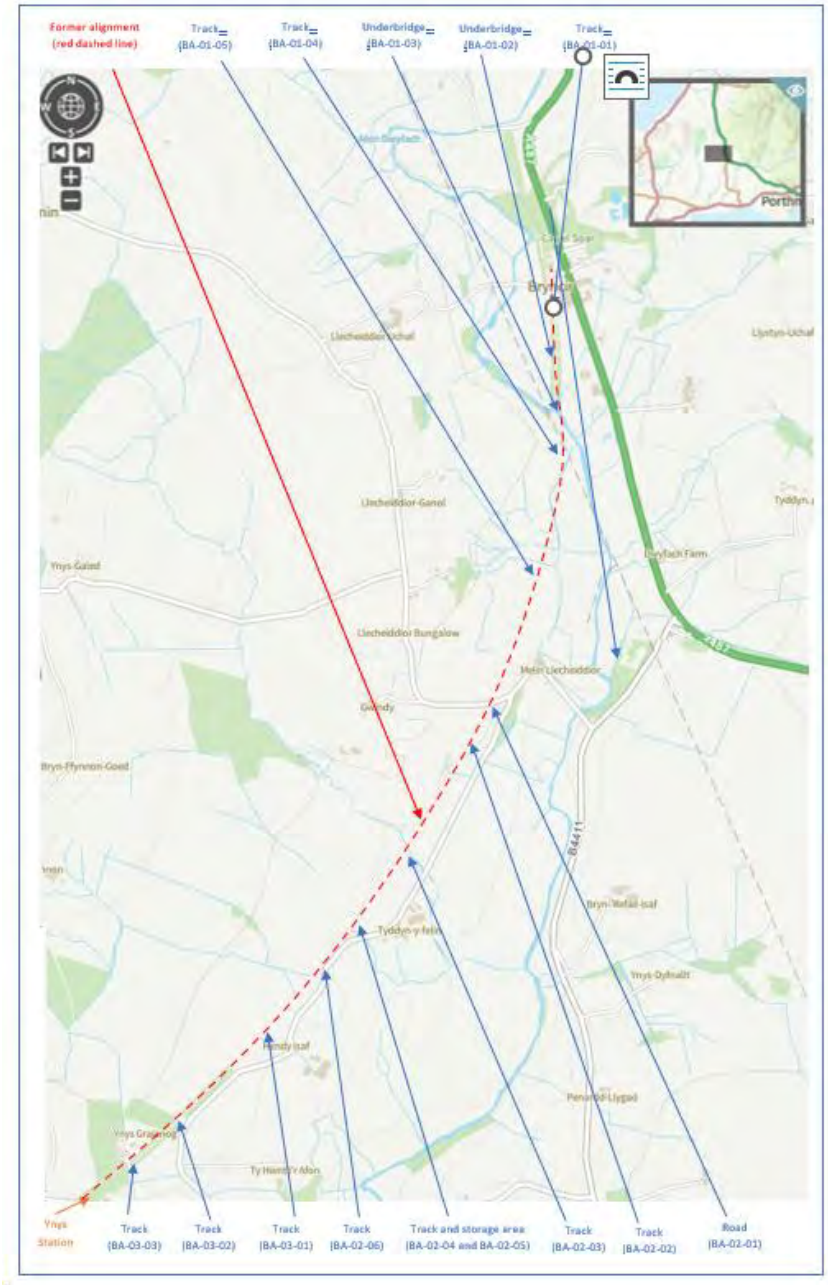


Figure 11-1 – Overview of Bryncir to Ynys Station showing obstructions along the route

Between Bryncir and Afon Wen the former alignment has been completely lost with the track bed now being used as an access track or has been taken over by farmland. As the alignment approaches Chwilog the route has been built upon by several residential and commercial properties.

As the route leaves Bryncir it is crossed by an access track from the adjacent industrial units to the nearby field **(Obstruction Number – BA-01-01).** The alignment continues south through farmland and crosses over two possible underbridges with the latter crossing over a river. **(Obstruction Number – BA-01-02 and BA-01-03)**. The exact size, condition and construction material are unknown at this stage.

Figure 11-2 – Access track crosses alignment Obstruction - BA-01-01

Figure 11-3 – Possible Underbridge Obstruction – BA-01-02

Figure 11-4 – Possible Underbridge Obstruction – BA-01-03

The route then crosses two access track crossings 400m apart between two adjacent pieces of land. **(Obstruction Number – BA-01-04 and BA-01-05)**.

Figure 11-5 – Access track crosses alignment Obstruction - BA-01-04

Figure 11-6 – Access track crosses alignment Obstruction – BA-01-05

Continuing South the route is crossed by an access road to a nearby farm **(Obstruction Number – BA-02-01)**.An overbridge was located here on the previous alignment however this has since been removed. This has however result in a slight level difference between the road and the adjacent land.

Figure 11-7 – Road crosses alignment Obstruction - BA-02-01

The alignment passes through another 2 access track crossings (**Obstruction Number – BA-02-02 and BA-02-03)** before reaching a farm who are using the old alignment as a timber storage area (**Obstruction Number – BA-02-05**. An access track also crosses the alignment at this location (**Obstruction Number – BA-02-04).**

Figure 11-8 – Access track crosses alignment Obstruction - BA-02-02

Figure 11-9 – Access track crosses alignment Obstruction – BA-02-03

Figure 11-10 – Access track crosses alignment and timber storage area Obstruction - BA-02-04 and BA-02-05

The alignment carries on south past another 4 access track crossings (**Obstruction Number – BA-02-06, BA-03-01, BA-03-02 and BA-03-03)** before reaching the location

of the old Ynys Station where it is crossed by a road. The previous station building does not appear to still exist however there a two houses on either side of the alignment which could potentially have been the old station building.

Figure 11-11 – Access track crosses alignment Obstruction - BA-02-06

Figure 11-12 – Access track crosses alignment Obstruction – BA-03-01

Figure 11-13 – Access track crosses alignment Obstruction - BA-03-02

Figure 11-14 – Access track crosses alignment Obstruction – BA-03-03

Figure 11-15 – Road crosses alignment Obstruction - BA-03-04

Figure 11-16 – Road crosses alignment Obstruction – BA-03-04

11.2.2. Interventions

Access track crosses alignment (Obstruction Number – *BA-01-01*)

Access track crosses alignment (Obstruction Number – *BA-01-04* to BA-01-05)

Access track crosses alignment (Obstruction Number – *BA-02-02 to BA-02-04*)

Access track crosses alignment (Obstruction Number – *BA-02-06*)

Access track crosses alignment (Obstruction Number – *BA-03-01 to BA-03-03*)

It is assumed that continued access to the farm land accessed by these crossings will need to be retained. This should obviously be reviewed with local landowners during further studies in order to rationalise and reduce the number of railway/road crossings where possible.

However, it is assumed that there will need to remain at least some crossing points, and similar to previous sections on the basis the Tram-Trains continue to operate in Tram mode at this location then the use of a junction with Stop signage is likely to be appropriate – subject to risk assessments at later design stages. Due to the risk of animals straying onto the railway, the majority of these locations would also have gates provided to prevent the incursion of animals into the path of Tram-Trains

Possible Underbridge (Obstruction Number – BA-01-02 and BA-01-03)

The condition and dimensions of these existing underbridges is not known at present, but it is assumed as there is no cycle route in this section that there will be sufficient width to accommodate the proposed rolling stock. It should be noted that although the width used for this study is 6.5m, this can be reduced locally to accommodate certain restrictions. The condition of the structure will need to be investigated at a later stage.

Road Crosses Alignment – BA-02-01

This road provides the only vehicle access to the nearby property therefore will need to be maintained. A Stop/Give Way junction shall be installed at this location if the vehicle is operating in tram mode and a user worked crossing if in train mode.

Timber Storage Area – BA-02-05

To allow the alignment to pass through the storage area will need to be relocated to another area of the farm.

Road Crosses Alignment – BA-03-04

The road crossing the location of the former Ynys Station is a relatively main road in the area however is likely to be lightly used based on the number of properties in the vicinity. On this basis a Stop/Give Way junction shall be installed if running tram mode and a level crossing with barriers in train mode.

11.2.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BA-01-01 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates to	Minimal	Moderate			
BA-01-02 Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
BA-01-03 Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
BA-01-04 Access track crosses alignment	Install Stop/Give Way junction at Farm access, possibly with gates	Minimal	Moderate			
BA-01-05 Access track crosses alignment	Install Stop/Give Way junction at Farm access, possibly with gates	Minimal	Moderate			
BA-02-01 Road Crosses Alignment	Install Stop/Give Way junction	Minimal	Moderate			
BA-02-02 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BA-02-03 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-02-04 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-02-05 Timber Storage Area	Relocate timber storage area	Minimal	Minimal			
BA-03-01 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-03-02 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-03-03 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-03-04 Road Crosses Alignment	Install Stop/Give Way junction	Minimal	Moderate			

11.2.4. Tram/Train Mode

Due to the continued number of access road/rail interfaces in this section of the route, there remains advantages to the Tram-Train vehicle remaining in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions rather than traditional level crossings where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

11.2.5. Operational Impacts

The continued adoption of Tram mode running in this area would mean that the maximum speed of the vehicle in this area permitted remains at 45mph, and this may need to be reduced at the junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there should be a wider review of journey times across the railway, to identify any issues associated with these restricted speeds.

11.2.6. Cycle Route Impacts

The current National Cycle Network Route 8 diverts away from the previous alignment South of Bryncir and therefore is not impacted in this section of the route.

11.2.7. Conclusion / Recommendation

Along this section of the route there are no significant obstructions that require a high level of intervention however the majority of the alignment has now been taken over as local farmland and will require a significant purchase of 3rd party land.

The number of road interfaces (with primarily Farmer Access Roads) is high in the area, and will need careful management to reduce the overall risk to the reopened railway operations. Various underbridges will also need investigation and assessment to confirm the level of work required at these locations.

11.3. Former Ynys Station to Former Llangybi Station

Chainage – 37300m to 40100m

Associated Drawings – Section E Sheet 3
Section E Sheet 4
Section E Sheet 5

11.3.1. Route Summary

Figure 11-17 – Overview of Ynys Station to Llangybi Station showing obstructions along the route

The route continues south through more farmland before being crossed by two access track crossings. (**Obstruction Number – BA-04-01 and BA-04-02)**

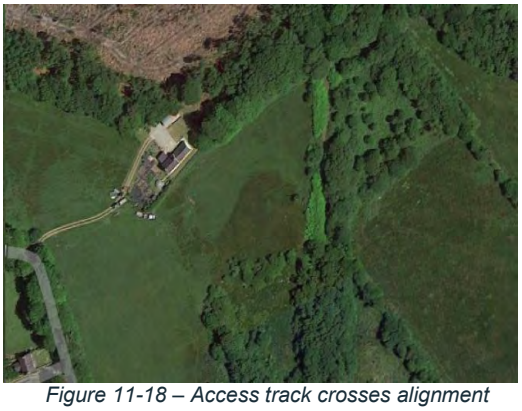


Figure 11-18 – Access track crosses alignment Obstruction - BA-04-01

Figure 11-19 – Access track crosses alignment Obstruction – BA-04-02

Approximately 400m south the alignment passes close by a number of ponds within an area of woodland (**Obstruction Number – BA-04-03)**. The exact size of the ponds and condition of adjacent land is unknown and will need to be investigated to establish current ground conditions and whether they are suitable for the proposed route.

Figure 11-20 – Ponds Adjacent to Alignment Obstruction - BA-04-03

Shortly after the first set of ponds a house is located on the previous alignment. This which was not present during the operation of the old line (**Obstruction Number – BA-05-01)**. An access road to nearby cottages also crosses the alignment at this point. (**Obstruction Number – BA-05-02)**.

Figure 11-21 – House on alignment Obstruction - BA-05-01

Figure 11-22 – Access track crosses alignment Obstruction – BA-05-02

The route continues south and is met with the former Llangybi Station, with the station building now being used as a residential property with the old track bed is now being used as the garden (**Obstruction Number – BA-05-03)**. A main road runs across the alignment at this point and was likely to have had a level crossing. (**Obstruction Number – BA-05-04)**

Figure 11-23 – House on alignment Obstruction - BA-05-03

Figure 11-24 – Road crosses alignment Obstruction – BA-05-04

11.3.2. Interventions

Access track crosses alignment (Obstruction Number – *BA-04-01 to BA-04-02*)

Access track crosses alignment (Obstruction Number – *BA-05-02*)

It is assumed that continued access to the farm land and farm buildings accessed by these crossings will need to be retained. This should obviously be reviewed with local landowners during further studies in order to rationalise and reduce the number of railway/road crossings where possible.

However, it is assumed that there will need to remain at least some crossing points, and similar to previous sections on the basis the Tram-Trains continue to operate in Tram mode at this location then the use of a junction with Stop signage is likely to be appropriate – subject to risk assessments at later design stages. Due to the risk of animals straying onto the railway, the majority of these locations would also have gates provided to prevent the incursion of animals into the path of Tram-Trains

Ponds Along Alignment - (Obstruction Number – *BA-04-03*)

There are a number of ponds which run in close proximity to the previous alignment and will likely have an impact on the surrounding ground conditions. Surveys shall be carried out to establish if the existing ground conditions are suitable for the new route.

House on alignment - (Obstruction Number – *BA-05-01*)

The house located on the alignment does not appear to have existed prior to the closure of the line and as a result has been built on or very near to the route. To avoid significant disturbance to the property owner it is proposed to locally reroute the alignment around the house. This does mean that a small area of woodland will need to be removed to allow this to happen.

House on alignment - (Obstruction Number – *BA-05-03*)

The old Llangybi Station building still exists and is currently being used as a residential property with only the garden required to be purchased to install the new track bed. The new route will however be running very close to the current property and may cause noise issues to the property owner.

Road crosses alignment - (Obstruction Number – *BA-05-04*)

The road crossing the location of the former Llangybi Station is a relatively main road in the area however is likely to be lightly used based on the number of properties in the vicinity. On this basis a Stop/Give Way junction shall be installed if running tram mode and a level crossing with barriers in train mode.

11.3.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BA-04-01 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates to prevent unauthorised access of animals onto the railway	Minimal	Moderate			
BA-04-02 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates to prevent unauthorised access of animals onto the railway	Minimal	Moderate			
BA-04-03 Ponds Adjacent to Alignment	Carry out surveys to establish ground conditions	Minimal	Minimal			
BA-05-01 House on alignment	Demolish house and continue alignment on previous route	High	Minimal	Reroute the alignment around the house which will require the remove of a small area of woodland	Minimal	Minimal
BA-05-02 Access track crosses alignment	Install Stop/Give Way junction	Minimal	Moderate			
BA-05-03 House on alignment	Reroute the alignment around the house which will require the remove of a small area of woodland	Minimal	Minimal			
BA-05-04 Access track crosses alignment	Install Stop/Give Way junction	Minimal	Moderate			

11.3.4. Tram/Train Mode

Due to the continued number of access road/rail interfaces in this section of the route, there remains advantages to the Tram-Train vehicle remaining in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions rather than traditional level crossings where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

11.3.5. Operational Impacts

The continued adoption of Tram mode running in this area would mean that the maximum speed of the vehicle in this area permitted remains at 45mph, and this may need to be reduced at the junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there should be a wider review of journey times across the railway, to identify any issues associated with these restricted speeds.

11.3.6. Cycle Route Impacts

The current National Cycle Network Route 8 diverts away from the previous alignment South of Bryncir and therefore is not impacted in this section of the route.

11.3.7. Conclusion / Recommendation

Along this section of the route there are no significant obstructions that require a high level of intervention however the majority of the alignment has now been taken over as local farmland and will require a significant purchase of 3rd party land.

The number of road interfaces (with primarily Farmer Access Roads) is high in the area, will need careful management to reduce the overall risk to the reopened railway operations. Various underbridges will also need investigation and assessment to confirm the level of work required at these locations.

11.4. Former Llangybi Station to Afon Wen

Chainage – 40100m to 43700m

Associated Drawings – Section E Sheet 5
Section E Sheet 6
Section E Sheet 7
Section E Sheet 8

11.4.1. Route Summary

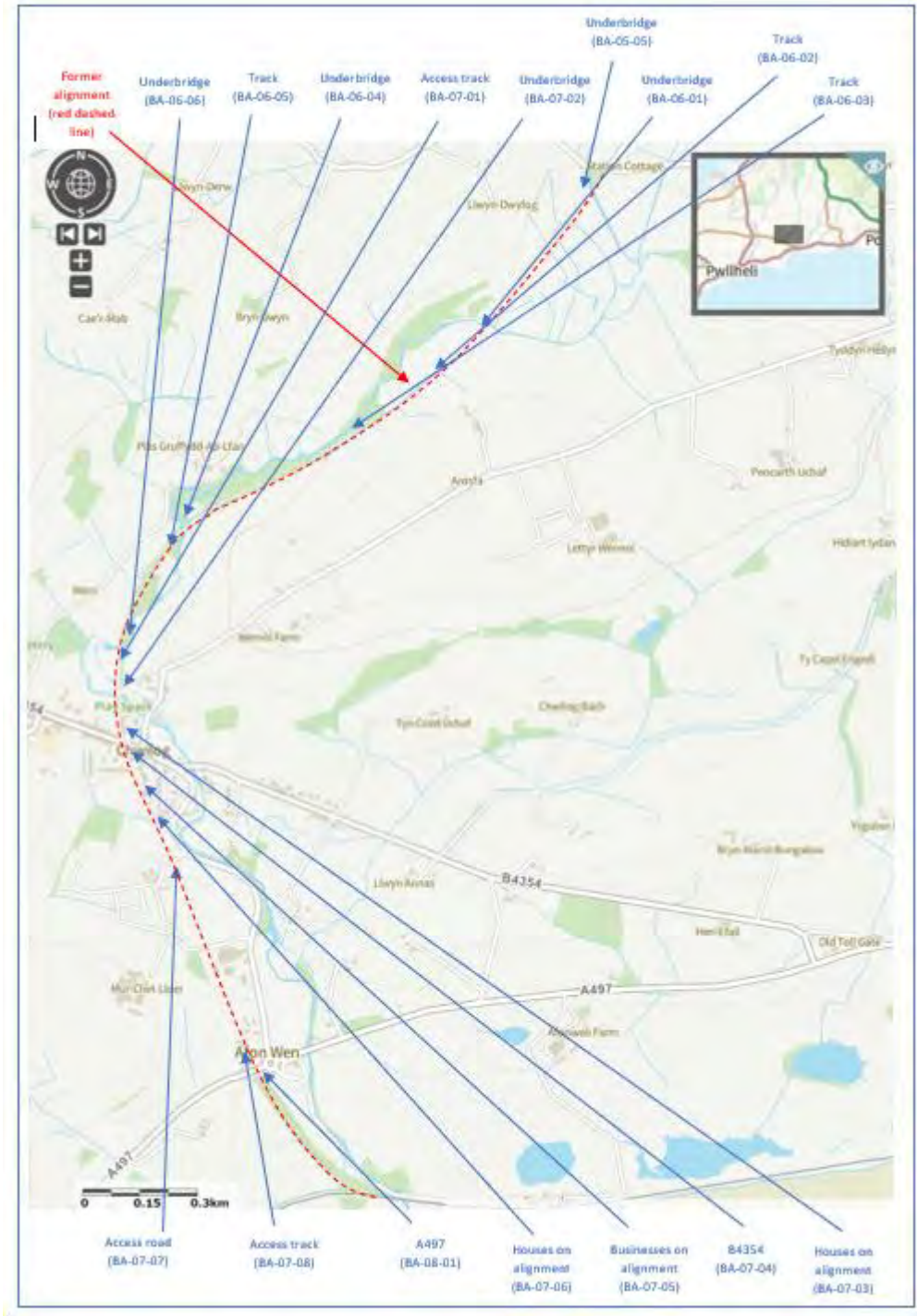


Figure 11-25 – Overview of Former Llangybi Station to Afon Wen shwoing obstructions along the route

South of the former Llangybi Station the alignment crosses over Afon Wen twice, 450m apart where there are likely to be underbridges however the condition, construction material and dimensions are unknown at this stage (**Obstruction Number – BA-05-05 and BA-06-01)**.

Figure 11-26 – Possible Underbridge Obstruction - BA-05-05

Figure 11-27 – Possible Underbridge Obstruction – BA-06-01

The route continues towards Afon Wen where it is crossed by two access tracks between adjacent pieces of land (**Obstruction Number – BA-06-02 and BA-06-03)**.

Figure 11-28 – Access track crosses alignment Obstruction - BA-06-02

Figure 11-29 – Access track crosses alignment Obstruction – BA-06-03

The alignment once again crosses over Afon Wen with a possible underbridge before being crossed by another access track shortly after. (**Obstruction Number – BA-06-04 and BA-06-05)**

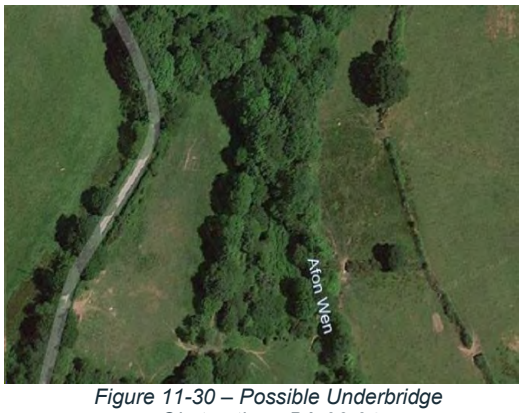


Figure 11-30 – Possible Underbridge Obstruction - BA-06-04

Figure 11-31 – Access track crosses alignment Obstruction – BA-06-05

Before reaching the village of Chwilog the route passes over another two possible underbridges over the river and is crossed by another access track. (**Obstruction Number – BA-06-06, BA-07-01 and BA-07-02)**

Figure 11-32 – Access track crosses alignment Obstruction - BA-06-06

Figure 11-33 – Possible Underbridge Obstruction – BA-07-01

Figure 11-34 – Access track crosses alignment Obstruction - BA-07-02

As the alignment enters the village of Chwilog it is met by several houses which have been built since the closure. (**Obstruction Number – BA-07-03)** This area of land was the location of the former Chwilog Station which had two sidings alongside the mainline however has since been removed. There does appear to be sufficient space alongside the houses however the alignment runs very close.

Figure 11-35 – Houses on alignment Obstruction - BA-07-03

Figure 11-36 – Houses on alignment Obstruction – BA-07-03

South of the former Chwilog station is the B4354 which was originally crossed with a level crossing that no longer exists and is now a bus turning area (**Obstruction Number**

– BA-07-04). On the southern side of the road the alignment has now been taken over by local business (**Obstruction Number – BA-07-05)**.

Figure 11-37 – B4354 crosses alignment Obstruction - BA-07-04

Figure 11-38 – Local businesses on alignment Obstruction – BA-07-05

Continuing towards Afon Wen several houses have been built on the alignment . (**Obstruction Number – BA-07-06)**. The route then passes by Ocean Heights Caravan Park and is crossed by its access road. (**Obstruction Number – BA-07-07)**

Figure 11-39 – Houses on alignment Obstruction - BA-07-06

Figure 11-40 – Access Road crosses alignment Obstruction – BA-07-07

Before reaching the mainline the alignment is crossed by an access road to a nearby farm (**Obstruction Number – BA-07-08)** and then main A497 road (**Obstruction Number – BA-08-01)**.

Figure 11-41 – Access track crosses alignment Obstruction - BA-07-08

Figure 11-42 – A497 crosses alignment Obstruction – BA-08-01

South of the A497 the alignment will join the mainline to either Porthmadog or Pwllhelli via a triangle junction. See section 6.

11.4.2. Interventions

Possible Underbridge (Obstruction Number – BA-05-05 and BA-06-01)

Possible Underbridge (Obstruction Number – BA-06-04 and BA-07-01)

The condition and dimensions of these existing underbridges is not known at present, but it is assumed as there is no cycle route in this section that there will be sufficient width to accommodate the proposed rolling stock. It should be noted that although the width used for this study is 6.5m, this can be reduced locally to accommodate certain restrictions. The condition of the structure will need to be investigated at a later stage.

Access track crosses alignment (Obstruction Number – *BA-06-02 and BA-06-03*)

Access track crosses alignment (Obstruction Number – *BA-06-05 and BA-06-06*)

Access track crosses alignment (Obstruction Number – *BA-07-02 and BA-07-08*)

It is assumed that continued access to the farm land and farm buildings accessed by these crossings will need to be retained. This should obviously be reviewed with local landowners during further studies in order to rationalise and reduce the number of railway/road crossings where possible.

However, it is assumed that there will need to remain at least some crossing points, and similar to previous sections on the basis the Tram-Trains continue to operate in Tram mode at this location then the use of a junction with Stop signage is likely to be appropriate – subject to risk assessments at later design stages. Due to the risk of animals straying onto the railway, the majority of these locations would also have gates provided to prevent the incursion of animals into the path of Tram-Trains

Houses on alignment - (Obstruction Number – *BA-07-03*)

The houses at this location have been built since the closure of the former Chwilog Station but there does appear to be sufficient space to allow the route to run alongside. The land currently being used as the garden will however need to be purchased.

B4354 crosses alignment - (Obstruction Number – *BA-07-04*)

The B4354 road runs through the village of Chwilog and is likely to be heavily used therefore a traffic signal-controlled junction will need to be installed at this location. It is likely that the bus turning circle will also require relocation.

Local businesses on alignment - (Obstruction Number – *BA-07-05*)

The local businesses have taken over the alignment for a short section and will need to be relocated. Due to the close proximity of houses in this section it is not possible to reroute the alignment.

Houses on alignment - (Obstruction Number – *BA-07-06)*

Several houses have been recently built on the old alignment however since the adjacent land is currently unused it is proposed to reroute the alignment locally around the properties.

Access road crosses alignment (Obstruction Number – *BA-07-07)*

The main access road to Ocean Heights Caravan Park crosses the alignment at this location with the usage to vary depending on the time of year. It is currently proposed to install a Stop/Give Way junction however this should be assessed due to the potential high usage during summer and the probable lack of local knowledge by the customer of the holiday park.

A497 crosses alignment (Obstruction Number – *BA-07-07)*

The A497 is a major road in this area and as a result will require a traffic signal controlled junction to be installed. It is also likely that due to the proximity to the roundabout that signals will need to be installed here also.

11.4.3. Summary of Route Implications and Works Required

Obstruction Number	Works Required On Existing Alignment	Maintain Alignment		Works Required On Alternative Alignment	Alternative Alignment	
		Significance (Public Relations)	Significance (Engineering Challenge)		Significance (Public Relations)	Significance (Engineering Challenge)
BA-05-05 Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
BA-06-01 Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
BA-06-02 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-06-03 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-06-04 Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			
BA-06-05 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-06-06 Access track crosses alignment	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-07-01 Underbridge	Undertake surveys and assessments, and undertake any repairs as required	Minimal	Minimal			

BA-07-02 **Access track crosses alignment**	Install Stop/Give Way junction at farmers access, with gates	Minimal	Moderate			
BA-07-03 **Houses on alignment**	Purchase 3rd party land	Moderate	Minimal			
BA-07-04 **B4354 crosses alignment**	Install traffic light-controlled junction	Minimal	Moderate			
BA-07-05 **Local business on alignment**	Purchase 3rd party land Relocate business	Moderate	Minimal			
BA-07-06 **Houses on alignment**	Demolish houses and continue alignment on previous route	High	Minimal	Reroute the alignment around the houses	Minimal	Minimal
BA-07-07 **Access track crosses alignment**	Install Stop/Give Way junction	Minimal	Moderate			
BA-08-01 **A497 crosses alignment**	Install traffic light-controlled junction	Minimal	Moderate			

11.4.4. Tram/Train Mode

Due to the continued number of access road/rail interfaces in this section of the route, there remains advantages to the Tram-Train vehicle remaining in Tram mode in this area, as this will allow greater flexibility to adopt road/rail junctions rather than traditional level crossings where the enhanced braking ability of the vehicle in Tram mode can mitigate a high proportion of the risks.

11.4.5. Operational Impacts

The continued adoption of Tram mode running in this area would mean that the maximum speed of the vehicle in this area permitted remains at 45mph, and this may need to be reduced at the junctions to allow the vehicle to operate safely using line-of-sight principles. Hence there should be a wider review of journey times across the railway, to identify any issues associated with these restricted speeds.

The village of Chwilog would justify the construction of a new station in the area which should be located South of the B4354 road.

11.4.6. Cycle Route Impacts

The current National Cycle Network Route 8 diverts away from the previous alignment South of Bryncir and therefore is not impacted in this section of the route.

11.4.7. Conclusion / Recommendation

Along this section of the route there are no significant obstructions that require a high level of intervention however the majority of the alignment has now been taken over as local farmland or been built upon with residential properties and will require a significant purchase of 3rd party land.

The number of road interfaces (with primarily Access Roads) is high in the area, and will need careful management to reduce the overall risk to the reopened railway operations. Various underbridges will also need investigation and assessment to confirm the level of work required at these locations.

12. Environmental Review

A review has been carried out on the proximity of the proposed route to any sites of environmental or ecological importance. The review has used publicly available resources to identify statutory designated sites for nature conservation and ancient woodland/priority habitats.

This assessment is based on desk study records only, and not supported by a walkover survey. The absence of evidence of any particular feature should not be taken as conclusive proof that the feature is not present or that it will not be present in the future. The desk study reviewed the Natural Resources Wales Database (containing Ordnance Survey Data) which provides records of ancient and veteran trees but is not an exhaustive list and other veteran woodland may be present in the area. As this assessment is a high-level overview, these limitations are not considered significant at this stage, however, can be overcome through future walkover survey(s).

The review has identified the following key sites.

12.1. Site of Special Scientific Interest, Special Area of Conservation and Nature Reserves

12.1.1. Coedydd Afon Menai

A Site of Special Scientific Interest approximately 2km west of Bangor Station and 200m north of the proposed branch line. Due to the proximity of the SSSI it is unlikely this will be impacted directly however the proximity should be considered when planning any works.

Figure 12-1 – Map showing Coedydd Afon Menai a Site of Special Scientific Interest

12.1.2. Aber Afon Seiont

A Site of Special Scientific Interest running parallel with St Helens road South of Caernarfon Centre and crossing under the River Seiont Underbridge (Obstruction CD-01-07). As major works are required on this structure there is likely to be an impact on the river below which will need to be taken in to consideration.

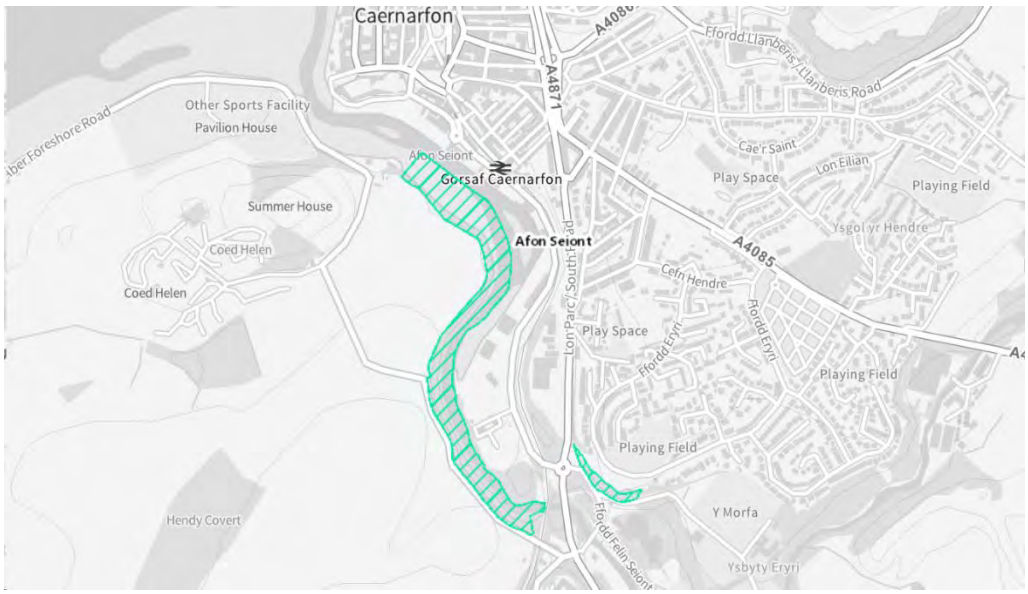


Figure 12-2 – Map showing Aber Afon Seiont a Site of Special Scientific Interest

12.1.3. Afon Gwyrfai a Llyn Cwellyn

A Site of Special Scientific Interest and Special Area of Conservation located approximately 150m south of the Welsh Highland Railway Bontnewydd Halt and is crosses by Bontnewydd Viaduct (Obstruction Number - CD-03-04). As major works are required on this structure there is likely to be an impact on the river below which will need to be taken in to consideration.

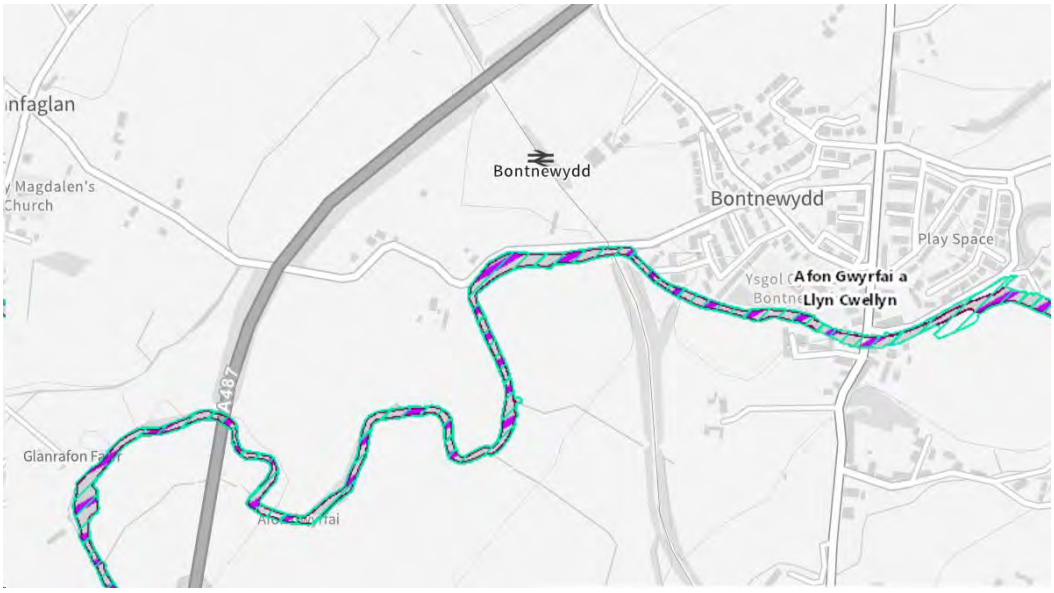


Figure 12-3 – Map showing Afon Gwyrfai a Llyn Cwellyn a Site of Special Scientific Interest and Special Area of Conservation

12.1.4. Glynllifon

A Site of Special Scientific Interest, Special Area of Conservation and National Nature Reserve located west of the village of Groeslon. The existing cycle path is currently within these sites as it crosses over to the western side of the A487 south of obstruction DP-04-01. With the preferred alignment now continuing on the western side of the A487 prior to obstruction DP-04-01 this section will also run within these designated sites and have an impact on the area.

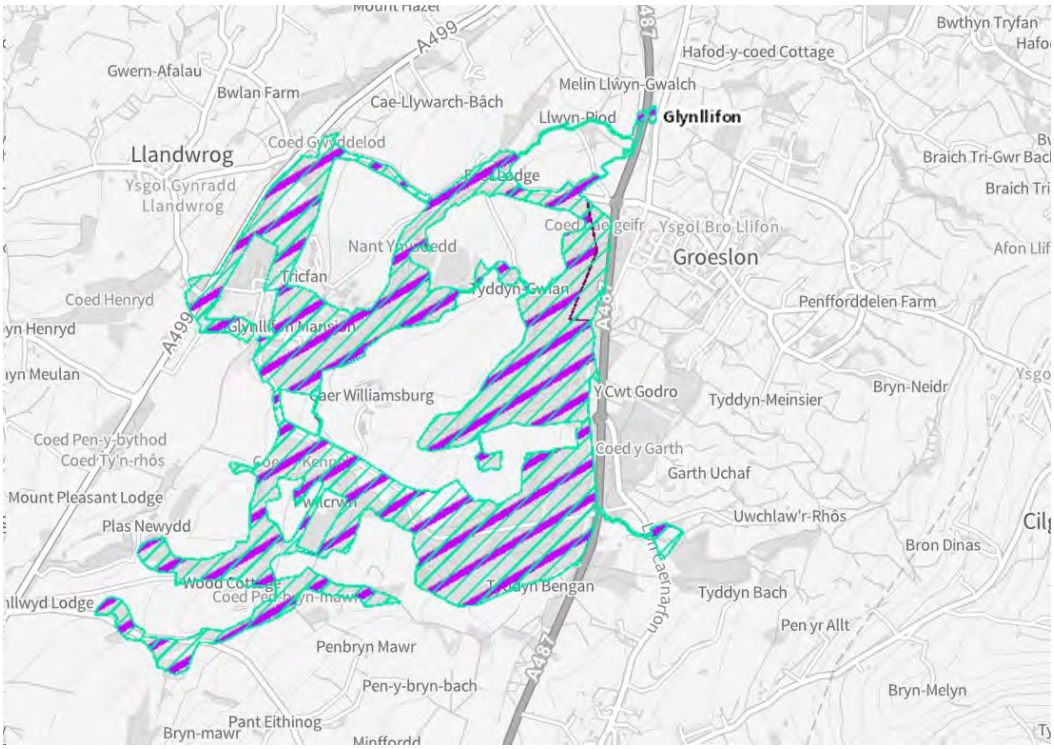


Figure 12-4 – Map showing Glynllifon a Site of Special Scientific Interest, Special Area of Conservation and National Nature Reserve

12.1.5. Cors Gyfelog

A Site of Special Scientific Interest, Special Area of Conservation and National Nature Reserve located west of the village of Pant Glas. The proposed alignment runs alongside the boundary of these sites and is likely to be impacted during construction works.

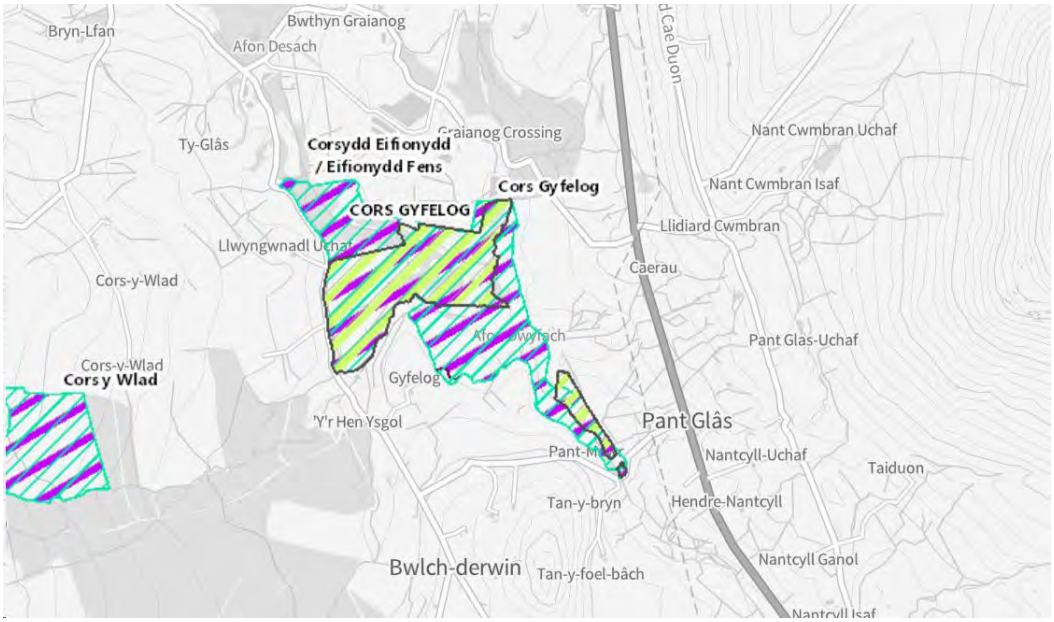


Figure 12-5 – Map showing Cors Gyfelog a Site of Special Scientific Interest, Special Area of Conservation and National Nature Reserve

12.1.6. Llystyn Isaf

A Site of Special Scientific Interest located south of the village of Bryncir. The proposed route runs along the boundary of this site and will likely be impacted by the construction works.

Figure 12-6 – Map showing Llystyn Isaf a Site of Special Scientific Interest

12.1.7. Glanllynnau a Glannau Pen-ychain i Gricieth

A Site of Special Scientific Interest and Special Area of Conservation located approximately 75m south of the proposed route. Due to the proximity of the SSSI it is unlikely this will be impacted directly however the proximity should be considered when planning any works.

Figure 12-7 – Map showing Glanllynnau a Glannau Pen-ychain i Gricieth of Special Scientific Interest and Special Area of Conservation

12.2. Woodlands

12.2.1. Former Menai Bridge Junction Station

To the north of the existing mainline is an area of ancient woodland. The proposed route does not directly impact on this area but consideration should be given to this land during any construction works.

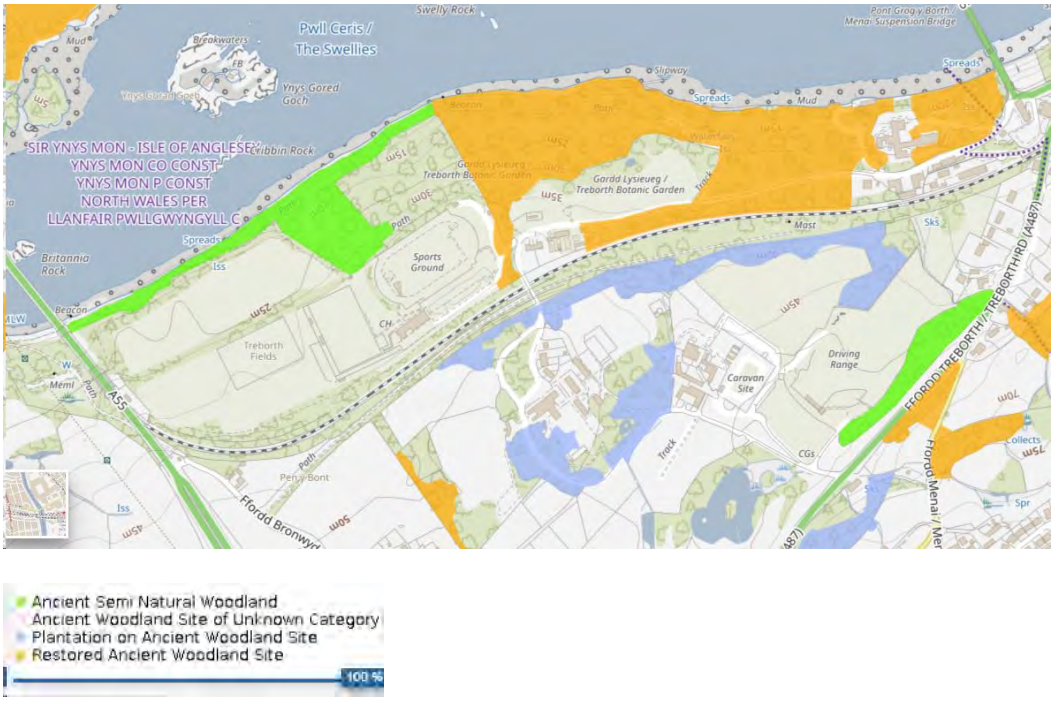


Figure 12-8 – Map showing Woodlands at Former Menai Bridge Station Junction

12.2.2. Parc Menai Buniess Park

There are several areas of ancient woodland within close proximity of Parc Mani Business park with the proposed route running through some however there has already been development in this area..

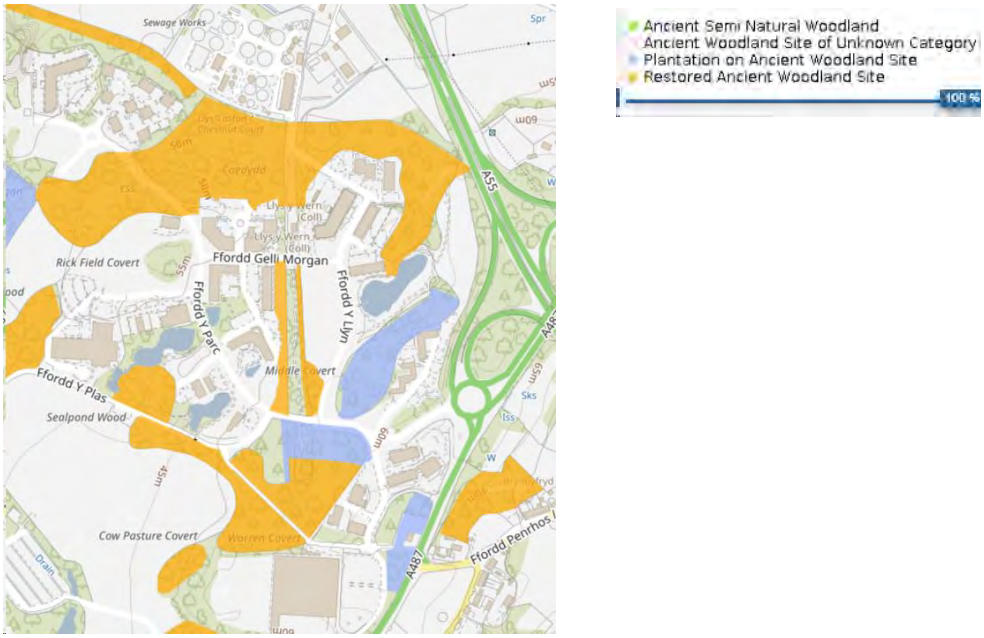


Figure 12-9 – Map showing Woodlands at Parc Menai Business Park

12.3. Area East of Felinhelli

The area east of Felinheli has several area of ancient woodland of varying categories with all proposed routes coming in close proximity but not directly disturbing the site.

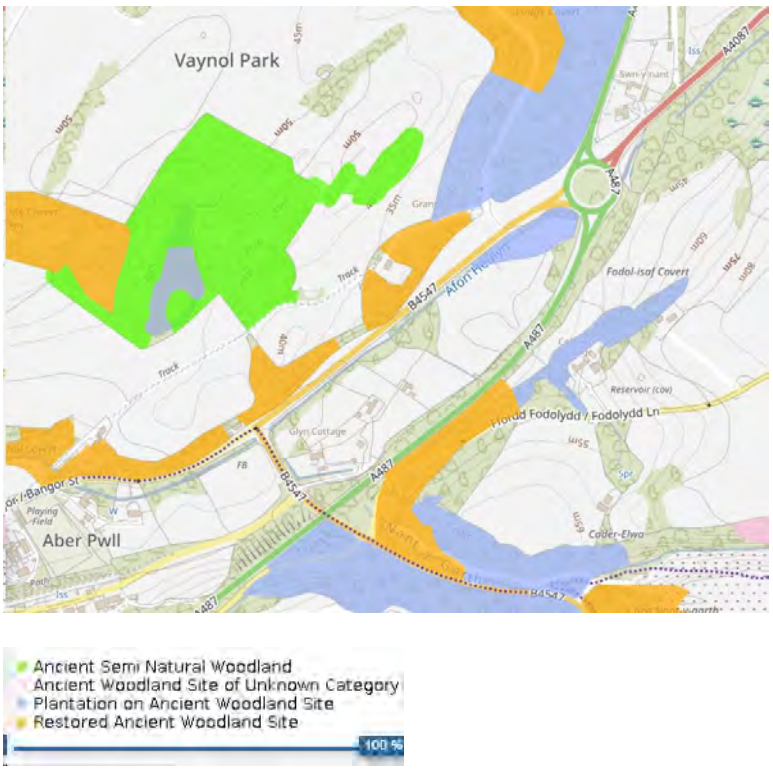


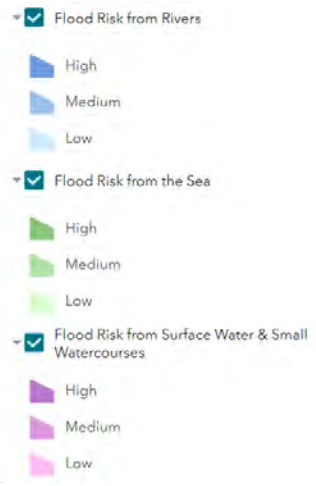
Figure 12-10 – Map showing Woodlands East of Felinheli

12.4. Tree Preservation Orders

There are several areas where the alignment will have an impact on areas of woodland and may require the removal of several trees. Checks should be carried out to establish whether there are any tree preservation order (TPO's) in place. A review of the route should be carried out if any TPO's were found. A review of TPO's has not been carried out as part of this study.

12.5. Flood Risk

A review of the flood risk in the vicinity of the alignment has been carried out using data from Natural Resources Wales. The key flood risk areas are highlighted below. A key is shown below indicating the type of flood risk and severity.



12.5.1. East of Felinheli

The area located between the Vaynol tunnels and east of Felinheli has been identified as being at high risk of flooding from the nearby river. The alternative route runs along Afon Heulyn and is likely to be impacted by flooding.

Figure 12-11 – Map showing Flood Risk East of Felinheli

12.5.2. Caernarfon Centre

The centre of Caernarfon had been identifed as a medium risk of flooding in particular the area around Crown Street and Caernarfon Tunnel.

Figure 12-12 – Map showing Flood Risk in Caernarfon Centre

12.5.3. Bontnewydd

The area around Bontnewydd has two locations at high risk of flooding in particular surface water from Bontnewydd Bypass and high risk of flooding from Afon Gwyrfai.

Figure 12-13 – Map showing Flood Risk at Bontnewydd

12.5.4. Dinas

The area to the west of Dinas is highlighted as having a high risk of flooding from a river. The alignment passes through a section of this and will need to be investigated at a later date to understand ground conditions.

Figure 12-14 – Map showing Flood Risk at Dinas

12.5.5. Groeslon

The area of Groeslon has two areas of interest in regards to flooding both at high risk. The alternative route to the west of the A487 runs through these areas and will need further investigations at a later stage.

Figure 12-15 – Map showing Flood Risk at Groeslon

12.5.6. Bryncir

The alignment in the area of Bryncir follows the river and is at high risk in several locations in the section of the route.

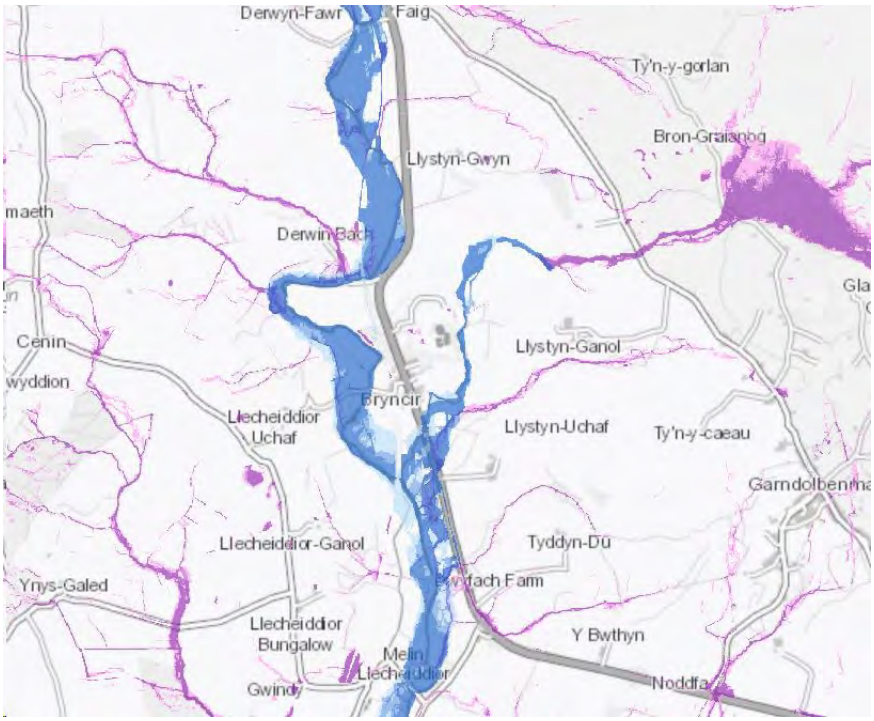


Figure 12-16 – Map showing Flood Risk at Bryncir

12.5.7. Former Ynys Station

There is a large area at medium risk of flooding at the location of the former Ynys Station

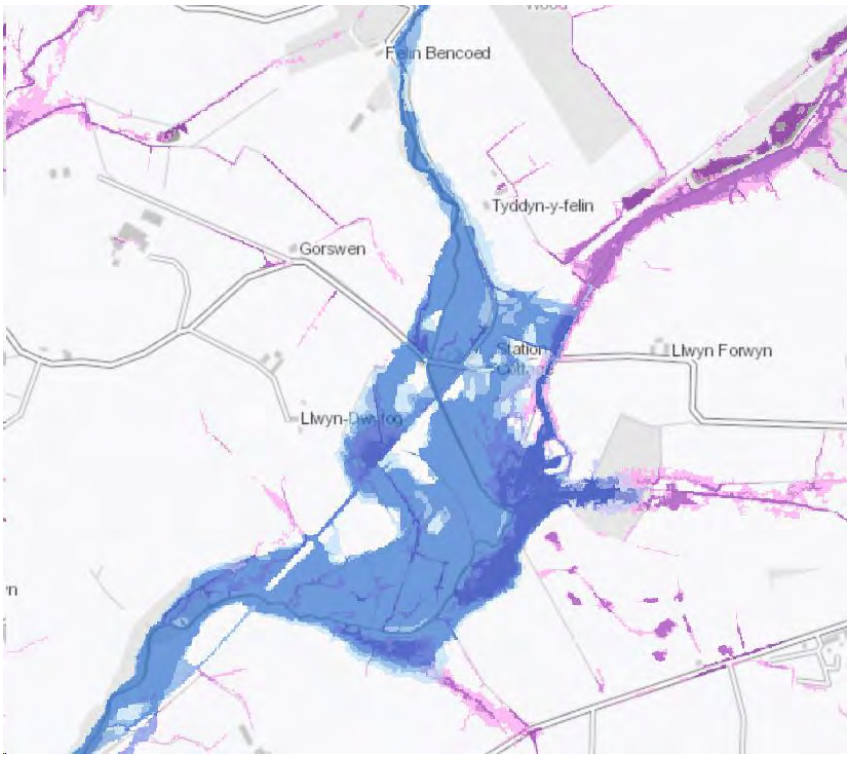


Figure 12-17 – Map showing Flood Risk at Former Ynys Station

12.5.8. Chwilog / Afon Wen

The route follows Afon Wen for a large section of the route and is at high risk of flooding

Figure 12-18 – Map showing Flood Risk at Chwilog/Afon Wen

12.6. Summary

The environmental study has identified several areas of significance along the route with a number of SSSI, SAC and Nature reserves. The majority of these are within close proximity to the route however the alignment does run through one site – Glynllifon which will need careful consideration during the design process.

A number of woodlands are encountered along the route however only one is considered significant as the route does pass through the woodland in Parc Menai Business Park.

Several flood risk areas have been identified during this study however a flood risk assessment should be carried out at a later stage to understand the implications of reinstating the alignment in these locations.

13. Land Boundary Review

Atkins were provided with land referencing data based on the alignment of the previous route where a corridor of approximately 30m was used to identify any potential land interfaces with the new route. TfW requested that Atkins review this data and if possible, reduce the corridor width and thus reduce the number of interfaces with adjacent land.

As detailed in section 4 above the proposed corridor for the new route is 6.5m for the tram-train and 3m for the cycle route where applicable. These values were used in the land refencing software to identify the landowners of all the land intersected by this route. It should be noted however that these values as well as the alignment itself are subject to change in future design stages once a more detailed survey of the route is carried out.

Plans of each route section have been produced identifying the different landowners throughout the route with each colour on the plans representing a different owner. These plans should be read in conjunction with the included land referencing spreadsheet which provides specific contact details of each landowner. See appendix D for details.

14. Summary

There are a number of challenges arising from the proposed reopening of the Afon Wen to Bangor railway, as over the intervening 50 to 60 years since the railway closed there has been widespread changes in land ownership and land use in the area.

Nevertheless the Feasibility Study has identified a potential indicative preferred route (with other options identified where appropriate) for the whole length between Bangor and Afon Wen (~43.75km).

Wherever possible the route of the reopened railway has been proposed along the former railway corridor, on the basis that for a large proportion of the overall route this corridor often remains within Welsh Government or Local Authority ownership – or is being used for a transport function already, either as an Active Travel Route (in Sections A to D) or by a heritage railway (in Section B).

During the study each part of the former route has been indicatively assessed or categorised for the Significance of Intervention Works required – as per **Table 1-2** in Section 1 of this report – against both Public Perception/Impact and Engineering Challenge criteria. Although the assessment has been undertaken at a high level without site surveys or inspections – and therefore inevitably will be coarse and subjective in nature – an overview of the route as presented in **Table 14-1** below indicates that only approximately a third of the overall route has been initially assessed to have Minimal intervention issues. A quarter of the overall route is provisionally assessed as having either High or Very High intervention issues, predominately arising from the requirement for significant engineering interventions (e.g. where a significant viaduct structure is required over the A55 or A487 roads constructed since the railway closed in 1960s/1970s) or where a large number of residential/commercial businesses would be impacted by the reopening of the line (e.g. where they have been built over the former trackbed in the past 50 years).

Section	Total Length (km)	Minimal (Green)	Moderate (Yellow)	High (Orange)	Very High (Red)
A	14.6	27%	45%	22%	6%
B	4.6	0%	63%	27%	10%
C	6.3	61%	33%	6%	0%
D	8.7	84%	11%	5%	0%
E	9.5	0%	100%	0%	0%
Overall Route	**43.7**	35%	50%	12%	3%

Table 14-1 – Summary of proposed Intervention Works categories per Route Section

As noted in **Table 14-1** the number and extent of intervention works required varies across the different Route Sections, with unsurprisingly more significant public impacts and engineering challenges recorded in the more populated and urbanised areas between Bangor and Caernarfon (Section A and north end of Section B). However the

A487 road improvement works at Groeslon and Penygroes additionally have presented challenges around both communities for utilising the former route (Section C).

Across the overall route, the number of road interfaces will be a significant challenge – see Table 14-2 - with a total of 79 roads (public roads, private access roads and famer access routes) crossing the former alignment. This is a high density of road/rail interfaces across the route – averaging nearly 2 road interfaces each kilometre on average across the route. The nature of the proposed road interface interventions varies across the route – with largescale remodelling of roundabouts proposed in Section A and to a lesser extent in Sections B and C, whilst farmer access crossings predominate in Sections C, D and particularly E

Route Section	Reconfigure highway inc roundabout	Traffic Light Controls	Stop/Give Way	Stop/Give Way with gates
A	6	6	5	0
B	2	0	9	0
C	2	2	4	7
D	0	1	4	9
E	0	2	5	15
Overall Route	**10**	**11**	**27**	**31**

Table 14-2 – Summary of proposed Intervention Works at road interfaces per Route Section

Table 14-3 summarises significant civil engineering interventions envisaged from the desktop studies undertaken in the Feasbility Study. It should be noted that later studies will identify a signficiant number of assets – e.g. culverts and underbridges within heavy undergrowth – which have not been able to be recorded in this Feasibility Study.

	Underbridge		Overbridge		
Route Section	Retain / Repair	Replace / New	Retain / Repair	Replace / New	New Retaining Walls/ Embankment works
A	0	4	1	6	4
B	0	4	0	7	1
C	0	3	0	1	1
D	4	6	0	2	0
E	6	1	0	0	0
Overall Route	**10**	**18**	**1**	**16**	**6**

Table 14-3 – Summary of proposed Civil and Geotechnical Intervention Works per Route Section

The route additionally interfaces with a number of existing residential and commercial properties, which have either been established since the closure of the railway or expanded onto the former railway infrastructure since the railway was closed. Inevitably the interfaces are more numerous in the northern sections of the route, particularly in the Caernarfon area.

In these areas, to minimise the impact on the businesses and residential properties, lengths of on-street running have been proposed – speciffically in the Y Felinheli and Caernarfon areas.

Further details are shown in Table 14-4 below.

Route Section	Building/ Business interface
A	Water Treatment Works; Nursery; Local businesses in Vaynol Tunnels; 3rd party farmland for alternative route (south of Vaynol Tunnels); Allotments (east of Y Felinheli); Large number of businesses in Caernarfon, including - Local Car Dealer; Morrisons Petrol Station; Morrisons Supermarket; Balaclava Car Park; Crown Street businesses
B	Welsh Highland Railway: Land associated with local residence (between Pont Seiont and Bontnewydd, near Hendy Farm)
C	3rd party farmland for alternative route (around Groeslon)
D	3rd party farmland for alternative route (around Bryncir)
E	Timber Yard (between Bryncir and Ynys); 3rd party woodland for alternative route (2 locations required, between Ynys and Llangybi); Residential Property, Relocated local business, 3rd party land for alternative route (all around Chwilog village)

Table 14-4 – Summary of potential Building/Business interfaces and associated Street Running proposals per Route Section

Due to the large number of interfaces along the former railway route, as summarised above, the Feasilbility Study does currently propose the operation of the Tram-Train vehicles in Tram mode for the whole length of the route – with proposals to switch into Tram mode occuring directly after the Tram-Trains leave the Network Rail infrastructure at Menai Bridge Junction (near Bangor) or Afon Wen Junction. This will limit the maximum line speed achievable, and a number of stations have also been indicatively proposed along the route. Therefore it is recommended that a timetable study is prepared for the overall West Wales North-South route in due course, to confirm whether the achievable linespeeds in Tram mode are acceptable – or whether alternative heavy rail interventions are required in order to allow the operation of the vehicles in Train mode at higher speeds for some of the route.

Route Section	Train Running	Tram (integreated on-street and segregated on-street)	Tram (off-street)	Total Length
A	2.7km	0.25km (Felinheli) 0.15km (Balclava Car Park	11.5km	14.6km
B	0	0.4km (St Helens Road)	4.25km	4.6km
C	0	0	6.3km	6.3km
D	0	0	8.7km	8.7km
E	0.5km	0	9km	9.5km
Total	**3.2km (7%)**	**0.8km (2%)**	**39.7km (91%)**	**43.7km**

Table 14-5 – Summary of train vs tram running

A number of stations have also been indicatively proposed along the route – see Section 4.5. Therefore it is recommended that a timetable study is prepared for the overall West Wales North-South route in due course, to confirm whether the achievable linespeeds in Tram mode are acceptable – or whether alternative heavy rail interventions are required in order to allow the operation of the vehicles in Train mode at higher speeds for some of the route.

There are locations along the route where the introduction of the new route will impact on the existing cycle route. Where it has not been possible to accommodate the cycle route this will need to be relocated as shown in the table below. A survey of possible routes shall be undertaken at a later stage.

Route Section	Length of cycle route requiring diversion
A	0.9km (Through Felinheli)
B	4.6km (Whole length of section)
C	0.3km (South of Dinas Station)
D	0km
E	0km (Cycle route follows local roads in this section

Table 14-6 – Summary of cycle route requiring diversion

APPENDICES

Appendix A. Drawings

Alignment Drawings

Section A	Section B	Section C	Section D	Section E
Section A Sheet 1	Section B Sheet 1	Section C Sheet 1	Section D Sheet 1	Section E Sheet 1
Section A Sheet 2	Section B Sheet 1 Details	Section C Sheet 2	Section D Sheet 2	Section E Sheet 2
Section A Sheet 3	Section B Sheet 2	Section C Sheet 3	Section D Sheet 3	Section E Sheet 3
Section A Sheet 4	Section B Sheet 3	Section C Sheet 4	Section D Sheet 4	Section E Sheet 4
Section A Sheet 5	Section B Sheet 4	Section C Sheet 5	Section D Sheet 5	Section E Sheet 5
Section A Sheet 6		Section C Sheet 6	Section D Sheet 6	Section E Sheet 6
Section A Sheet 7			Section D Sheet 7	Section E Sheet 7
Section A Sheet 8			Section D Sheet 8	Section E Sheet 8
Section A Sheet 9				
Section A Sheet 10				
Section A Sheet 11				
Section A Sheet 11 Options 1,2 & 3				

Track Junction Drawings

5225267-ATK-DRG-ETR-000001
5225267-ATK-DRG-ETR-000002
5225267-ATK-DRG-ETR-000003
5225267-ATK-DRG-ETR-000004
5225267-ATK-DRG-ETR-000005
5225267-ATK-DRG-ETR-100001

Appendix B. Master Obstruction List

Appendix C. Unknown Obstruction List

Location	Issue
Area between the incline and former Port Dinorwick Station	Heavy vegetation obscures the view of the route in this location therefore it was not possible to identify any potential obstructions in this section
Obstruction BC-10-01 – Two timber underbridges	It is unclear what the purpose of these underbridges are and what they are crossing. This will need to be confirmed as this will determine the proposal for this obstruction.
Obstruction PB-01-03 – Possible Underbridge	It has not been possible to establish the existence – or not – of an underbridge south of the Afon Crychddwr adjacent to some farm buildings from the current desktop study. A historic access appears on older maps, and therefore the condition and suitability of any structure should be investigated further in future studies.
Obstruction PB-02-02 – Possible Underbridge	It has not been possible to establish the existence – or not – of an underbridge adjacent to some farm buildings alongside the A487 from the current desktop study. There appears to be a pond and stream on either side of the road, so it is presumed a culvert or bridge is located here, which should be investigated further in future studies.
Obstruction PB-06-01 – Possible Underbridge	It has not been possible to identify the existence of this structure and will need further investigation.
Obstruction PB-06-03 – Possible Underbridge	It has not been possible to identify whether this obstruction is an underbridge or an at grade crossing. Further investigation will be to be carried out.
Obstruction BA-01-02 – Possible Underbridge	It has not been possible to identify the existence of this structure and will need further investigation.
Obstruction BA-01-03 – Possible Underbridge	It has not been possible to identify the existence of this structure and will need further investigation.
Obstruction BA-05-05 – Possible Underbridge	It has not been possible to identify the existence of this structure and will need further investigation.
Obstruction BA-06-01– Possible Underbridge	It has not been possible to identify the existence of this structure and will need further investigation.
Obstruction BA-06-04 – Possible Underbridge	It has not been possible to identify the existence of this structure and will need further investigation.
Obstruction BA-07-01 – Possible Underbridge	It has not been possible to identify the existence of this structure and will need further investigation.

Appendix D. Land Boundary Plans and Details

AtkinsRéalis UK Limited
2 Capital Quarter
Floor 2
Tyndall Street
Cardiff
CF10 4BZ