Transport for Wales

AMLWCH TO GAERWEN - RYR

Longlist of Rail Options

SEPTEMBER 2022

CONFIDENTIAL

Transport for Wales

AMLWCH TO GAERWEN - RYR

Longlist of Rail Options

REPORT (DRAFT) CONFIDENTIAL

PROJECT NO. 70094560

DATE: SEPTEMBER 2022

WSP

4th Floor
6 Devonshire Square
London
EC2M 4YE

Phone: [redacted]

Fax: +44 20 7337 1701

WSP.com

QUALITY CONTROL

Issue/revision	First issue
Remarks	First issue
Date	September 2022
Prepared by	[redacted]
Signature	
Checked by	
Signature	
Authorised by	
Signature	
Project number	70094560
Report number	
File reference	

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

Transport for Wales (TfW) is developing a Strategic Outline Case (SOC) for the reinstatement of the former Amlwch to Gaerwen railway on Angelsey, as part of the Restoring Your Railway (RYR) Ideas Fund 3.

At this early development stage, the priority of the SOBC is to build the strategic case and identify options which can meet the strategic transport requirements.

Cost estimating and demand forecasting will help identify the scope and scale of potential opportunities, and be used to help decision makers in selecting schemes to take forward through further stages of development.

This appendix describes the longlisted rail options, and identifies any major engineering or operational constraints which may impact on cost or deliverability complexity, and therefore be differentiators when scoring each comparatively.

A separate report describes the bus options.

1.2 APPROACH

Whilst the RYR proposal is based on the reopening of the former route between Amlwch and Gaerwen shown in Figure 1-1, consideration of alternative routes was given to provide context for the scheme.

Two options were selected for the long list, as shown in Figure 1-2.

1. The former alignment between Amlwch and Gaerwen – the 'inland' route
2. An alternative alignment between Amwlch and Gaerwen – the 'coastal' route

Figure 1-1 – Former Anglesey Central Route (Extract from Railway Track Diagrams)

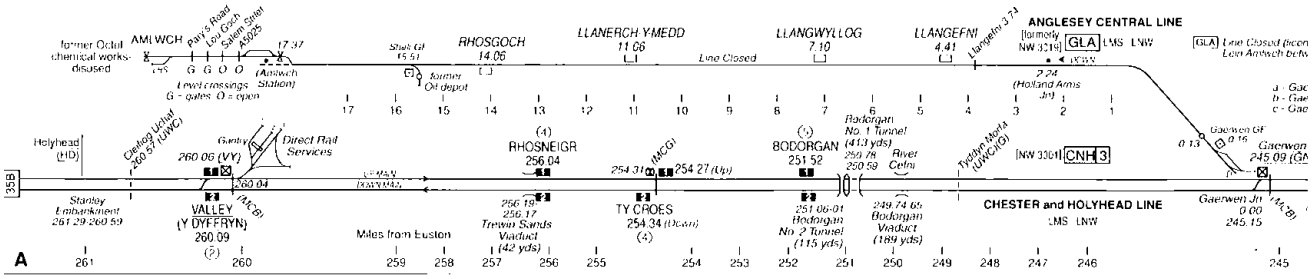
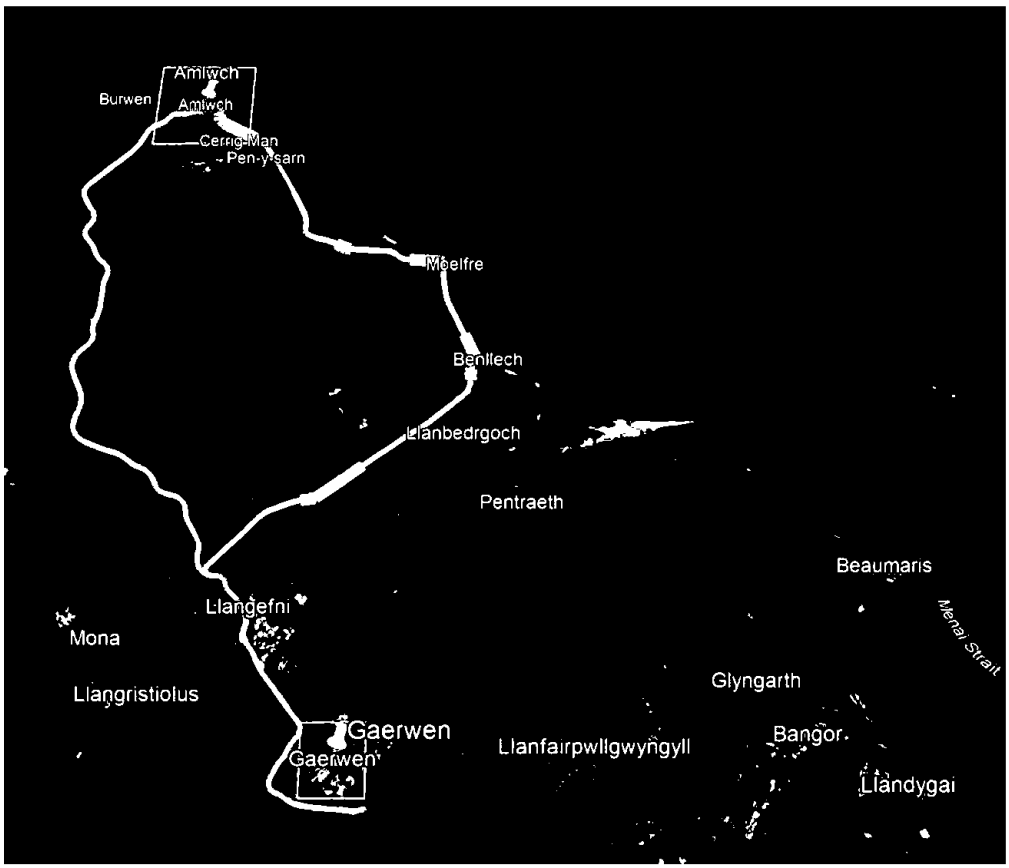


Figure 1-2 - Overview of Route Options



This document describes the long list of rail options considered for the North to South Wales geographical area.

The options were developed by considering how rail solutions could serve the key populations of the study through either existing routes, the reinstatement of historic routes or the creation of new alignments. These options were grouped into corridors for the purpose of this analysis to allow for comparisons between routes, and also bus options. These therefore do not reflect how a commercial service would be operated.

1.3 ASSUMPTIONS

A number of assumptions have been carried forward from previous studies, and further validation is required as the study progresses and some assumptions do not follow current heavy rail practice. These assumptions have been agreed with the client as suitable for this stage of work, to understand the potential benefits of innovative solutions in reducing delivery costs.

These assumptions are:

- Light Rail loading is assumed as ½ RL loading.
- 100 km/h(62 mph) and 140 km/h(87 mph) are attainable top speeds for the vehicles.
- The former alignments are suitable for both heavy and light rail and hence don't require analysis other than where there are obvious constraints.
- The former alignments are suitable for reaching top speeds of 100 km/h(62 mph) and 140 km/h(87 mph).
- It is taken there are no reasons preventing the former alignment from being used and they will be suitable for re-use.
- New sections of route can be constructed with exemption from National Technical Rules (NTRs) and National Technical Specification Notices (NTSNs).
- New sections of route are single track with passing loops
- At grade crossings may be suitable where the route is not crossing a major highway, noting ORR is currently trying to remove level crossings on the mainline network and each will be subject to ensuring appropriately safe solutions are implemented. As such this may not be an acceptable solution.
- Grade separation is needed where the route crosses major highways.
- Track gradients up to 10% are suitable for light rail vehicles, but it is not known for what distance this can be applied.
- Minimum track radii can be 25 m, however larger radii should be used where possible to decrease journey times and reduce rail wear and noise.
- Stations will be located at the major towns as indicated by the scope.
- Where heritage railways have reclaimed parts of the route, dual running (heritage and new services) will be feasible. This is a risk that requires further validation at the next stage of development.
- There will be a generic track cross section that will be largely consistent along each of the alignments.

Taking into account the topography of the study areas, in some locations the gradients are unsuitable for heavy rail, without construction of bridges, tunnels, embankments and cuttings. For these examples, options which are suitable for light rail have been considered. In some circumstances the light rail solutions also include elements of on street running.

2 LONG LIST OF OPTIONS

This section describes the rail options considered in the long list for the scheme. The intent is to provide an alternative alignment to the former route which can be used for comparative purposes, and a number of sub-options have also been developed.

At this stage, only a very high level of design has been undertaken and further development would be required at later stages.

Full Route Options

The long list comprises two full route options which are shown in Figure 1-2 above:

1. The former alignment between Amlwch and Bangor – the 'inland' route
2. An alternative alignment between Amwlch and Bangor– the 'coastal' route

The coastal route was selected following an initial review of the market data and travel patterns on Anglesey (from the North Wales Regional model, Figure 2-1) which showed that Llangefni, Bangor and Holyhead are key destinations (by car) from Amlwch. Across the data, there are destinations to the centre of Anglesey, east and west of Amlwch, and to the mainland. As one route cannot serve all the locations, a route to the east of Amlwch via the coast was selected as the alternative route, as it could serve a different population whilst continuing to call at Llangefni and Bangor.

Whilst a route to Holyhead would likely see a strong demand for public transport, it would be unlikely to provide a good comparator to the former Anglesey Central Railway route. Note that this route has been covered in the separate North-West Wales SOBC.

Figure 2-1 - Destinations from Amlwch (Top 10)

Amlwch	72.53		Amlwch	369.48
Bull Bay	18.48	**1**	Llangefni	330.14
Bangor	16.49	**2**	Bangor	199.09
Cemaes	16.42	**3**	Holyhead	193.68
Penysarn	15.28	**4**	Bull Bay	172.34
Porthaethwy	14.84	**5**	Penysarn	165.26
Llangefni	10.97	**6**	Cemaes	151.89
Benllech	10.06	**7**	Rhosybol	101.60
Rhosybol	9.33	**8**	Benllech	91.54
Llanerchymedd	8.20	**9**	Llanerchymedd	66.39
Holyhead	8.12	**10**	Porthaethwy	58.60

Table 2-1 – Full Route Options

Option	Route	Mode	Description	Calling
1	Amlwch - Bangor	Rail	Reinstatement of the former Anglesey Central Line between Amlwch and Gaerwen including former stations along the route Connection to the North Wales Mainline at Gaerwen Use of the existing railway between Gaerwen and Bangor	Amlwch Rhosgoch Llanerch-Y-Medd Llangwylloch Llangefni Llanfairpwll Bangor
2	Amlwch - Bangor	Rail	A new railway corridor between Amlwch and Gaerwen, with new stations Connection to the North Wales Mainline at Gaerwen Use of the existing railway between Gaerwen and Bangor	Amlwch Benllech Moelfre Pen-y-Sarn Llangefni Llanfairpwll Bangor

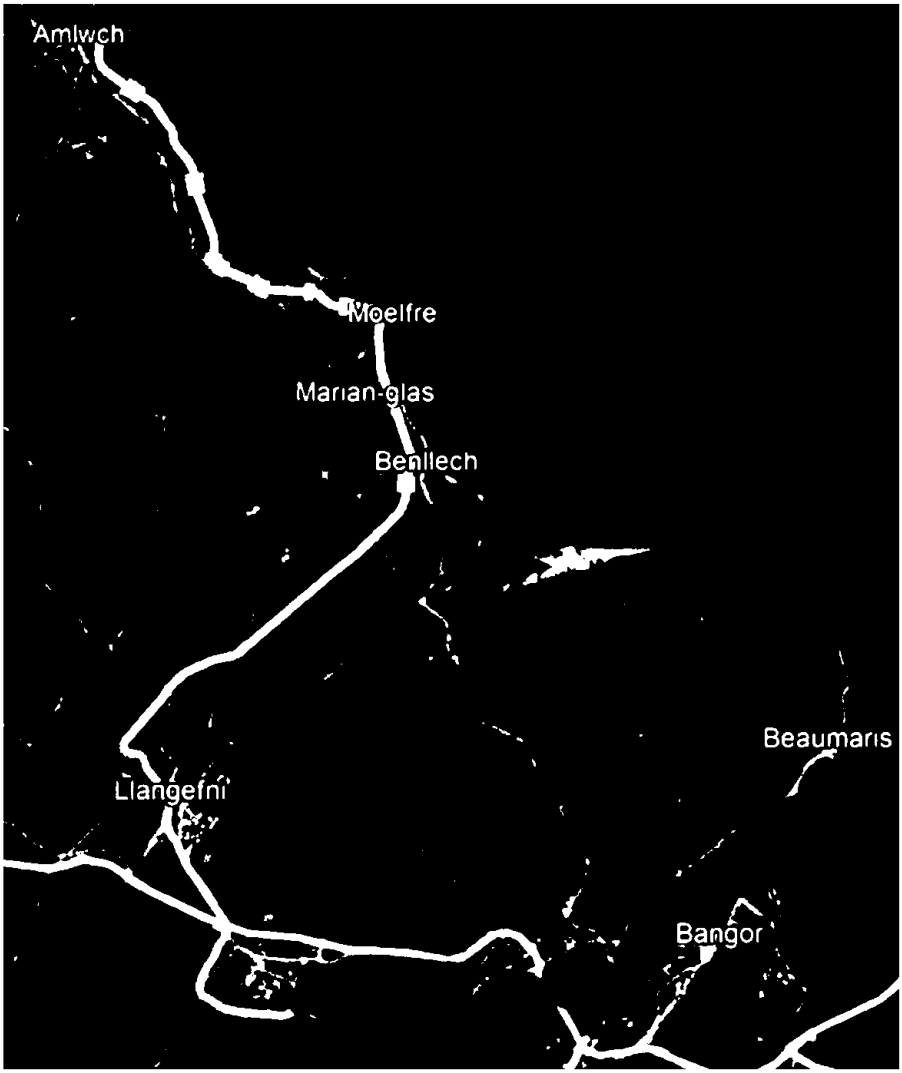
Following on from previous innovation work, both routes have been reviewed as light and heavy rail options.

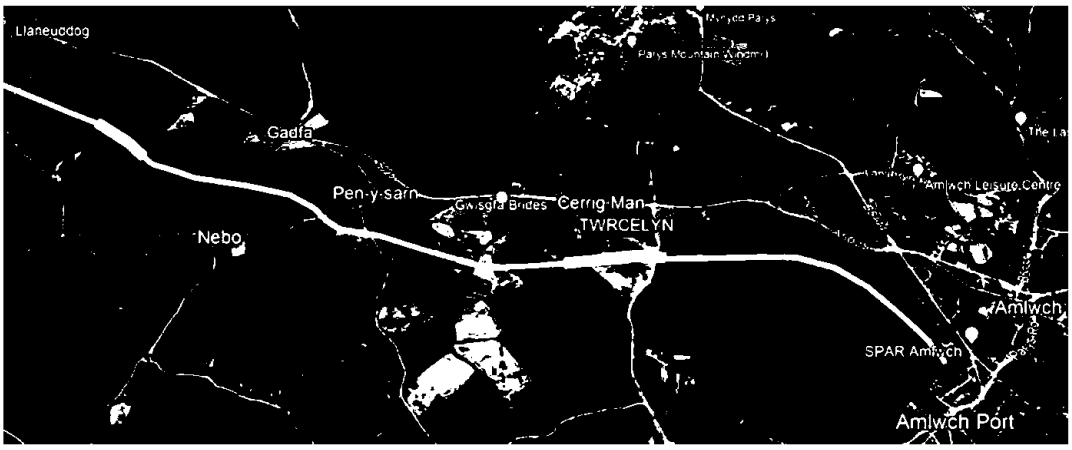
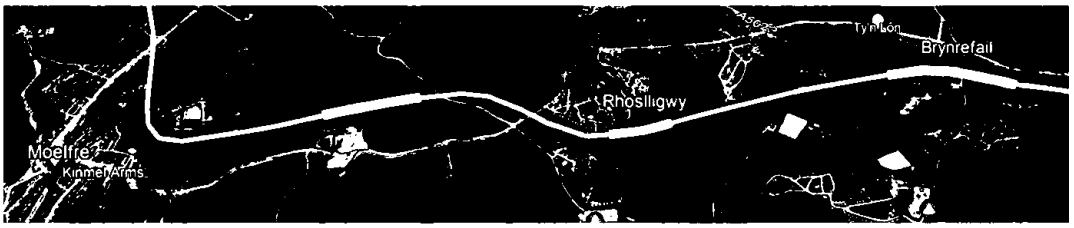
2.1 INLAND ROUTE

Route Option	1 – Heavy and Light Rail
Route Name	Amlwch to Bangor – Reinstatement of Former Alignment
Description	The route starts from the former station at Amlwch and follows the former alignment for around 30km to Gaerwen. From Gaerwen, it connects into the existing North Wales Line to travel the remaining 10km to Bangor.
Map	
	Existing Heavy Rail Corridor New Light Rail Ballasted Track Former Rail Corridor Ballasted Track

Key engineering constraints	At Llangefni the former alignment passes directly through the Dingle/Nant-Y-Pandy local nature reserve. An alternative routing is proposed, however the land for this diversionary route would require acquisition either by private treaty or by compulsory purchase. 

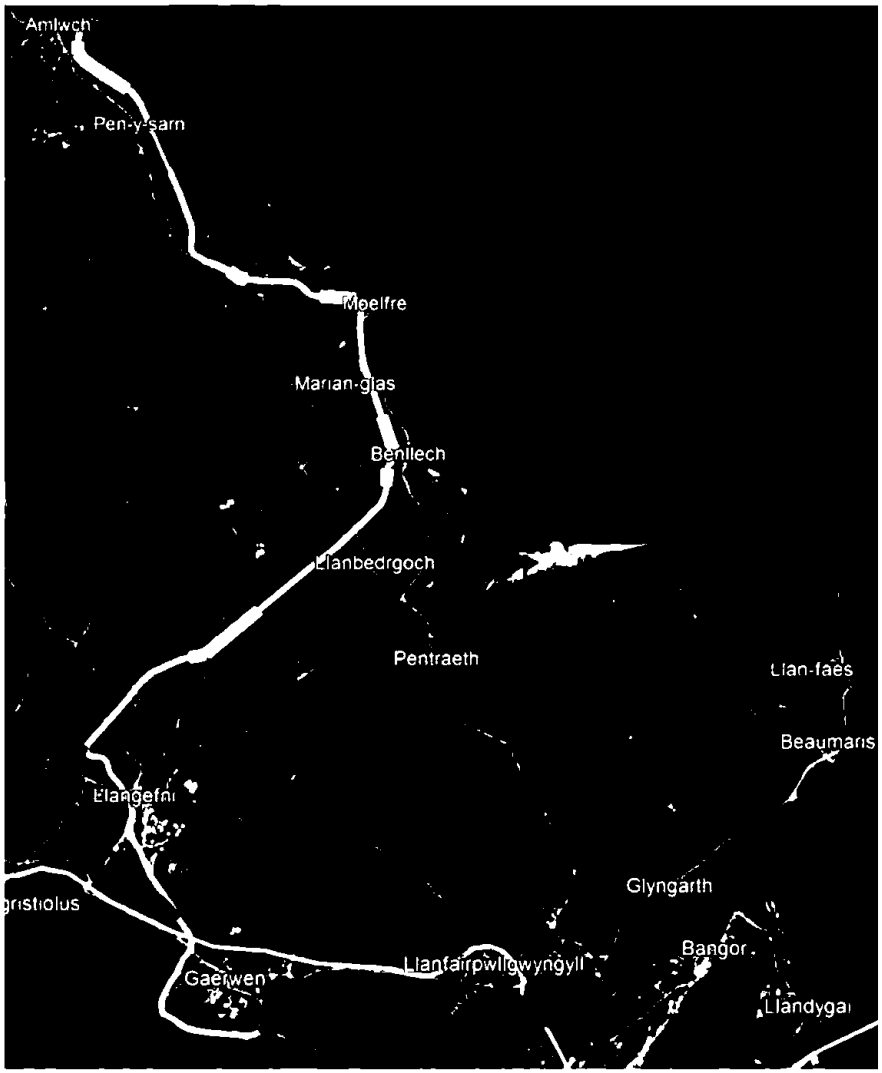
2.2 COASTAL ROUTE – LIGHT RAIL

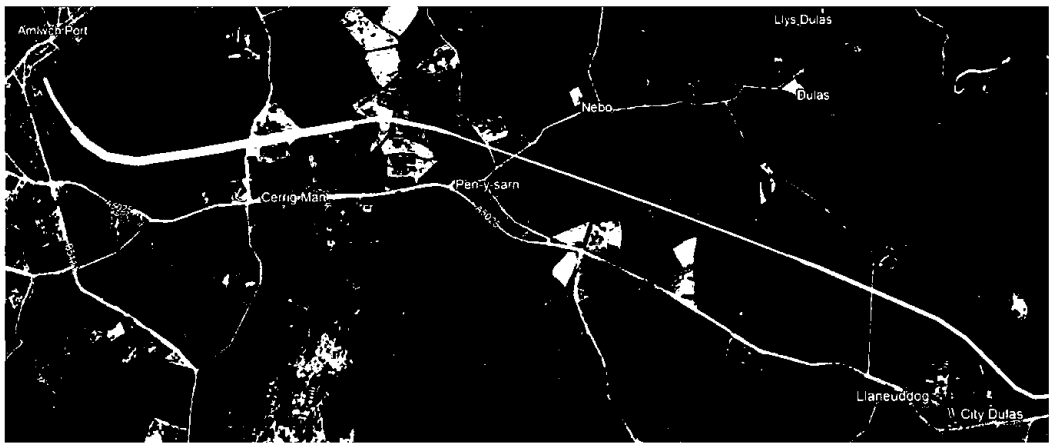
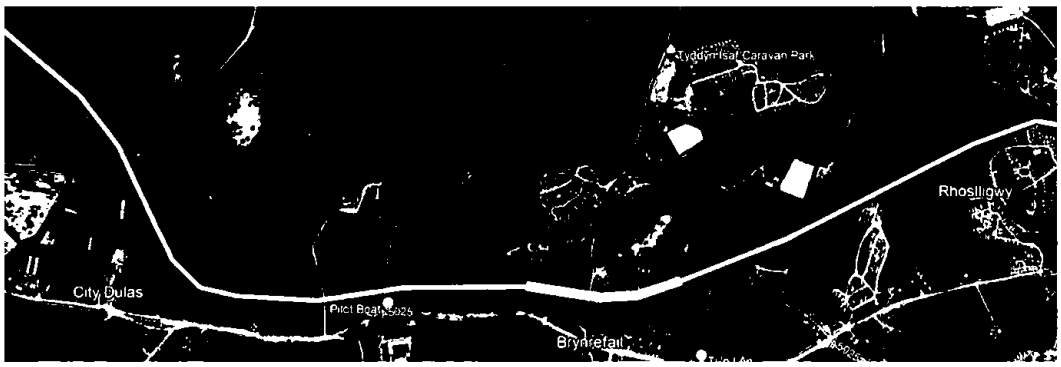
Route Option	2 – Light Rail
Route Name	Amlwch to Bangor – Alternative Coastal Route
Description	This route starts from a new station located on the east side of Amlwch and follows a new alignment for approximately 23km, connecting the coastal towns of Pen-Y-Sarn, Moelfre and Benllech before heading inland towards Llangefni. From Llangefni, the route follows the former alignment to Gaerwen, from where it connects into the North Wales Coast Line, travelling East to Bangor.
Map	
	Existing Heavy Rail Corridor New Light Rail Ballasted Track Former Rail Corridor Ballasted Track

Key engineering constraints	Between Amlwch and City Dulas, two notable cuttings approximately 0.7km and 0.4km are likely to be required to create a suitable vertical track geometry for light rail vehicles.  At City Dulas, the alignment passes close to the potential floodplain / sand bars of the Afon Goch. It is likely that some form of ground stabilisation and flood protection measures may be needed here to protect the alignment from ground movement and extreme weather events. This section is also likely to require a structure to bring it up to level with the surrounding terrain. Whilst this could be achieved with an embankment, due to the identified potential ground conditions, it may be necessary to construct a viaduct or similar structure instead.  Between City Dulas and Moelfre, there are two notable cuttings and one notable embankment of approximately 0.45km, 0.3km and 0.2km respectively.  Between Rhoslligwy and Moelfre, the alignment passes close to Aber Quarry. Land stability may be a concern here, and ground investigation risk assessment is recommended to establish any implications for the engineering design. A potential

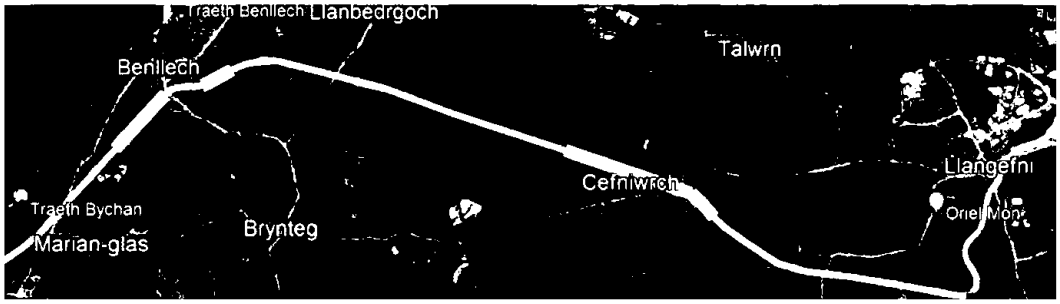
	alternative alignment is considered, however optimisation to avoid existing properties would be required. As with the inland route, the alignment though Llangefni passes through the Dingle / Nant-Y-Pandy local nature reserve. An alternative route could be considered at a later stage. 

2.3 COASTAL ROUTE – HEAVY RAIL

Route Option	2 – Heavy Rail
Route Name	Amlwch to Bangor – Alternative Coastal Route
Description	The heavy rail alignment follows the same route as the light rail and hence has the same constraints, however, it additionally requires a series of cuttings, embankments, viaducts and a tunnel.
Map	

Key engineering constraints	Between Amlwch and City Dulas, a section of cutting and tunnel are needed to reduce the change in height of the track bed to make it suitable for heavy rail. The length of tunnel required is approximately 2.3 km, reaching a maximum depth of around 50m below ground level.  At City Dulas, an approximately 500 m section of viaduct is needed to cross the valley, as well as assist with the potential poor land stability due to the river that could be present in this area. This viaduct will have a maximum height of approximately 40 m above ground/sea level. Between City Dulas and Rhoslligwy, a section of cutting and roughly 200 m long viaduct are needed. This viaduct has a maximum height above ground of approximately 35 m.  Between Rhoslligwy and Moelfre the heavy rail alignment has the same potential diversion around the identified quarry as the light rail alignment. The heavy rail route also requires a cutting and embankment to even out the approach into Moelfre, similar structures would be needed on the diversion.

Between Moelfre and Llangefni there are 2 cuttings and an embankment which are shown below.



2.4 MAINLINE CONNECTION

For both routes, a connection to the North Wales Mainline at Gaerwen Junction has been assumed, in the same location as the former route. This connection would allow services to operate to Bangor station (and along the North Wales Mainline).

2.5 STATIONS

Both routes are assumed to operate between a new station at Amlwch and the existing Bangor station. The station location at Amlwch has not been assessed in any detail, but differing locations are anticipated depending on the alignment approach to the town.

Intermediate Stations

The former route included stations at Rhosgoch, Llanerch-y-Medd, Llangwyllog and Llangefni. As a starting point for this study, it has been assumed that these stations would be included in the RYR scheme, however the merits of this would need to be considered at a later stage.

The coastal route assumes the same number of stations along the alternative route, at Benllech, Moelfre, Pen-y-Sarn and Llangefni. No assessment of physical station location has been undertaken.

No station has been assumed at Gaerwen at this stage, however (as with the stations above) this would need to be considered at a later stage.

Both routes assume a call at the existing Llanfairpwll station on the North Wales Mainline.

2.6 INCREMENTAL OPTIONS

Incremental options have also been considered as part of the long list to review how the rail options could be staged. This would bring about lower capital and operational costs

The incremental options start at Gaerwen junction and follow the former alignment to Llangefni. From Llangefni, they extend to subsequent stations along either the inland or the coastal routes.

These options are intended to provide an indication as to how the full route options could be delivered in stages.

Table 2-2 – Incremental Rail Options

Option	Route	Description
Spur to Llangefni	n/a	A 7km spur from the North Wales Mainline ending at Llangefni, along the former alignment.
Extension to Llangwyllog / Llanerch-y-medd / Rhosgoch	Inland	A spur from the North Wales Mainline along the former alignment, ending at Llangwyllog / Llanerch-y-medd / Rhosgoch
Extension to Benllech / Moelfre / Pen-y-sarn	Coastal	A spur from the North Wales Mainline along the new coastal (Rail Option 2) alignment, ending at Benllech (total 17.8km) / Moelfre (total 21.4km) / Pen-y-sarn (total 28.7km)

3 RAIL OPERATIONS

3.1 INTRODUCTION

A preliminary review of the operational implications has been undertaken to identify areas of risk for the development of the Amwlch to Gaerwen scheme. It covers:

- Passing loop requirements
- Fleet sizing
- Mainline impacts

3.2 APPROACH

It is assumed that a new service between Bangor and Amlwch would be provided rather than diverting any current services towards Holyhead, however this could be explored at a later stage.

A range of service frequencies has been considered to assess how impacts would change as frequencies increase:

- ½ tph (one train every two hours)
- 1tph
- 2tph

3.3 PASSING LOOPS

The alignment between Amlwch and Gaerwen has been designed as a single-track railway and so passing loops will be required to allow services in opposite directions to pass each other. The number of passing loops increases with increasing number of services as shown below.

Table 3-1 – Number of Passing Loops Required

	Service Level		
	½ tph	**1 tph**	**2tph**
Inland Route	0	1	2
Coastal Route	0	1	3

The alignment connects onto the North Wales Mainline at Gaerwen which is double track to Bangor except for a single track section over the Britannia Bridge.

3.4 FLEET SIZING

Based on the estimated journey times and turnround times, the fleet sizes are shown in the table below. Note that these figures represent the number of trains required to operate the service, and that additional trains would be required to account for a spare train, or a train in maintenance.

Table 3-2 – Fleet Size

	Service Level		
	½ tph	**1 tph**	**2tph**
Inland Route	1	2	3
Coastal Route	1	2	4

3.5 MAINLINE IMPACT

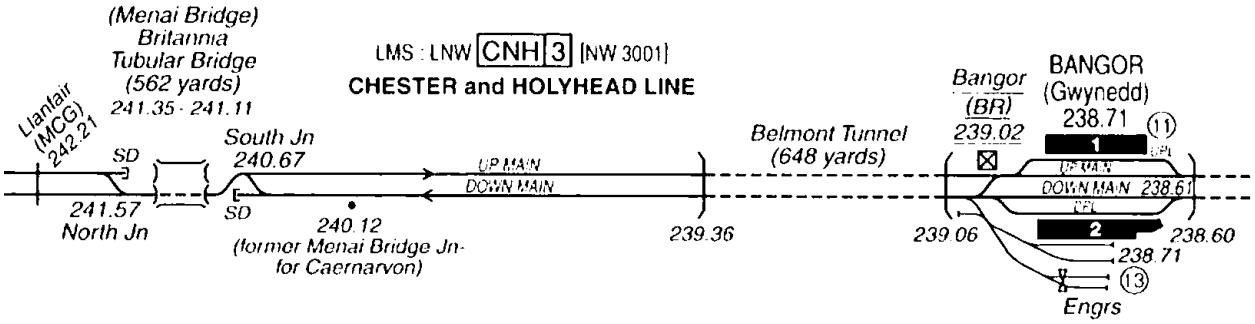
An assessment of the viability of introducing additional services onto the North Wales Mainline has been carried out, based on the December 2019 and December 2022 timetables. The December 2022 has a greater number of services than the December 2019 timetable and is therefore more constraining when considering additional services.

Table 3-3 – Feasibility of introducing additional services into the Timetable

	Service Level		
	½ tph	**1 tph**	**2tph**
December 2019	✓	✓	TT or capacity works likely needed
December 2022	✓	TT or capacity works likely needed	TT or capacity works likely needed

The analysis identified a regular path for an additional service every two hours (and for 1tph in the Dec19 TT), however a regular path was not identified for 1 or 2tph. These service patterns would likely require a timetable recast or capacity works at Bangor station (e.g. a new bay platform or a crossover to platform 2) and potentially a double junction from the mainline at Gaerwen. The diversion of Holyhead services to Amlwch could also be considered.

Figure 3-1 - Bangor Station (Source: Railway Track Diagrams)

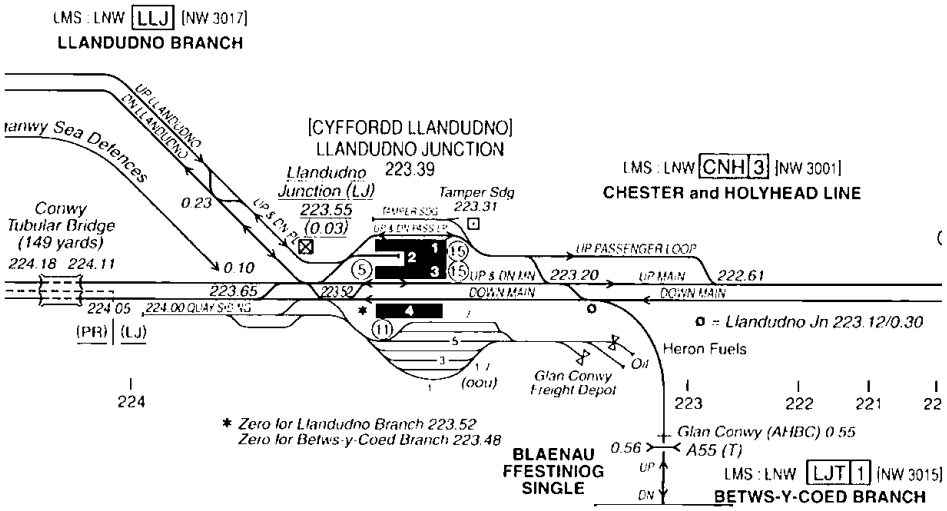


Extension to Llandudno Junction

An alternative option was explored to extend services to Llandudno Junction, which has four platforms rather than terminating at Bangor, which has two platforms. However, Llandudno Junction Station has a large number of services, and a regular path in the December 2022 timetable was not identified meaning that a timetable recast would likely be required to operate this service pattern.

Note that extending services to Llandudno Junction Station would increase the round-trip time, resulting in a greater fleet requirement of +1 or +2 trains.

Figure 3-2 - Llandudno Junction Station (Souce: Railway Track Diagrams)



3.6 SUMMARY

Both the inland and coastal route options connect to the mainline at the same location and therefore the operational impacts are similar for both two options.

The coastal route is longer than the inland route, and therefore the longer run times result in the higher fleet and passing loop requirements if a 2tph service is implemented.

This preliminary analysis has identified that capacity on the mainline would likely be available for a service every two hours, but that timetable or capacity works may be required for 1tph and above. This would need to be reviewed in greater detail at the next stage.

4 ROLLING STOCK

4.1 INTRODUCTION

An optioneering study of rolling stock options has been undertaken to identify suitable fleets for a service between Bangor and Amwlch, with an assessment of their suitability and additional considerations.

4.2 SHORTLISTED OPTIONS

A review of all fleet options in the UK (based on maximum speed, availability and infrastructure compatibility) identified the following shortlisted fleets:

1. Existing TfW fleet – Class 197
2. Legacy DMU fleets – Class 15X and Class 16X
3. Legacy EMU fleets retrofitted with batteries – e.g. Class 350s and Class 466s
4. New train solutions – RVLR & Tram-Train

4.3 SHORTLIST ASSESSMENT

The matrix below provides an assessment against the following criteria for the shortlisted options:

- Availability
- Interoperability
- Maintainability
- Affordability

Refinement of the shortlist and a preferred option would be undertaken at a later stage in the project development.

Table 4-1 – Shortlisted Fleet Assessment

Fleet	Availability	Interoperability	Maintainability	Affordability
Existing TfW Fleet - Class 197	The Class 197 fleet is a mix of 2 & 3 Car DMUs that are currently being manufactured and delivered to Keolis Amey Wales on behalf of TfW. With the ongoing production of the fleet there may be an opportunity to exercise (if available) an option to increase the contract. This will provide additional capacity adding more 'of the same'.	From an interoperability perspective the Class 197 would be the least restrictive solution as it will already be in operation on the North Wales Coast Line. The main consideration will the new infrastructure for the branch line, ensuring that the wayside equipment, signalling and track alignment is suitable for heavy rail operation.	It would be proposed that the use of a Class 197 on this route would be purely an extension of existing services, so maintenance would continue to be undertaken at Chester depot.	Assuming that any option for additional units can be exercised within the time constraints of the contract with CAF, using a Class 197 would be the least expensive rolling stock solution, allowing capital to be directed towards infrastructure.
Legacy DMU Fleets - Class 15X and Class 16X	Although there are planned releases of 15X fleets from EMR this year, there are other legacy DMU fleets that are likely to be displaced by other Operators. However, the opportunities and timescales are not yet confirmed. For example, GWR are currently considering options for branch lines, e.g. the Class 230 trial on the Greenfield to Ealing line. As a means of reducing emissions, battery solutions have now been introduced to	Similar to the Class 197, any legacy fleets introduced will have limited impact on interoperability. The operation of legacy fleets on the TfW network is a known entity. Class 158s and Class 175s currently in operation on the North Wales Coast Line are being displaced by the Class 197 DMUs - a small fleet of either build may be a favourable alternative, especially as both fleets have recently been refurbished in TfW livery.	The legacy fleets present two solutions; either will impact on CAPEX or OPEX. If a small legacy DMU fleet were introduced to purely operate the Amlwch services to Bangor or Llandudno, maintenance can be undertaken at Chester which leads to excessive ECS mileage for the fleet. Alternatively, a business case can be made for a small servicing facility to be built at either of the terminus points. Both Llandudno Jct and	The cost differential for utilising the legacy fleet will be the need for a servicing facility along the route. As a baseline, Chiltern Railways built a light maintenance facility opposite Wembley stadium to cater for fleet growth. Chiltern's Wembley Depot in 2005/6 cost £20M, a 2 road shed with stabling requiring full connectivity to the main line. As a proposed servicing facility it is assumed that the CET and

	enable hybrid diesel trains such as the Chiltern Class 168 developed by Porterbrook. This could also be considered for the Class 197.	This would require some discussion with Angel Trains in terms of aspirations for the fleet post Class 197 introduction.	Bangor have sidings available which could be assessed as a suitable location. Further investigation is also recommended as to the suitability of any sites around the Amlwch area. For any routine maintenance exams (every 2-3 months dependent on fleet mileage) units can diagrammed to Chester TMD.	CWM was included within the facility.
Legacy EMU Fleets retrofitted with batteries – e.g. Class 350s and Class 466s	An alternative option to diesel is an EMU retrofitted with batteries. There are several options being considered beyond the Vivarail solution. All the ROSCOs are now developing retrofitted battery solutions for legacy fleets such as the Siemens Class 350/2, the Class 321 or a Class 465/466. Further engagement will be required with the supply chain to understand the current status and timescales for a productionised solution.	The limitation for any battery operated fleet is ensuring sufficient capacity within the batteries to complete a journey. The speed at which it takes to charge the batteries to a sufficient level is also a major consideration. Charging methods and infrastructure play a significant role in the delivery of battery-operated services. Battery trains have high acceleration rates so assuming they can operate within the route speed requirements then integration with other services such as Class 221s and Class 197s should be acceptable. However, this will be dependent on further technical	For maintenance of a battery operated fleet, the servicing facility would be essential. The distance from the terminus point of the journey to Chester would probably be at the limit of current battery technology, meaning that it may be necessary to loco-haul the EMUs to Chester for routine maintenance.	In addition to the costs associated with the legacy DMU fleets, there are additional costs to consider for the EMU fleet, including approvals, route acceptance, charging requirements, driver training etc.

		assessment in later stages of the project.		
New train solutions - RVLR & Tram-Train	The nature of the route does lend itself to a light rail solution, however the integration onto the heavy rail network is a limitation. Any light rail or tram-train solution will require electrification which needs to be accounted for in any business case assessment.	RVLR would be an option for a captive railway from Amlwch to Gaerwen, however further investigation with the supply chain will be required to understand the operational limitations of the vehicles on heavy rail infrastructure. A tram-train solution would overcome the issue of operating on NR infrastructure. However, assuming the branch-line is electrified to continue onto the NR infrastructure a bi-mode solution would be required for the ongoing journey to Bangor or Llandudno junction.	As a completely bespoke fleet to the network, it is recommended that a small maintenance facility be accounted for in any business case assessments. A bespoke fleet would require specific maintenance requirements, lifting equipment, roof access etc.	This is considered to be the most costly option, although the costs need to be reviewed in more detail. There are 3 distinctive additional costs associated with this type of fleet: • Electrification and bi-mode operation • Additional maintenance facilities • Acceptance and introduction to service costs including route clearance, driver training etc.

4th Floor
6 Devonshire Square
London
EC2M 4YE

wsp.com