4.3.A Options Appraisal Report

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Murphy Power Networks Ltd.

Glaslyn Cable Uprating

Options Appraisal Report

Reference: GLAS-ARUP-DS-ZZ-RP-X-0004

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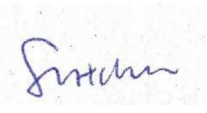
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Ove Arup & Partners International Limited
8 Fitzroy Street
London
W1T 4BJ
United Kingdom
arup.com

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		Name	Gretchen Kwong	Paul Docherty	Graham Tivey
		Signature			
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		Name	Gretchen Kwong	Juan Pablo Villagra	Graham Tivey
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1. Executive Summary

The 2012 Strategic Options Report by National Grid (Ref 2-1) addresses the imperative to enhance the electricity transmission system in North Wales, driven by contractual obligations to connect significant new generation projects. The report evaluates each of the five strategic options based on technical, environmental, socio-economic, and cost factors. Emphasising the need for ongoing detailed appraisal, consultation, and scrutiny of assumptions. The report informs National Grid's preliminary preferred option, involving an overhead line between Wylfa and Pentir and an underground cable between Wern and Y Garth; where the Glaslyn Cable Uprating Project is located. This decision strives for a delicate balance between technical feasibility, economic considerations, amenity, and environmental impacts, with visual and landscape effects and costs identified as pivotal factors influencing the decision-making process.

The scope of this project focuses on underground cable uprating and replacement between Wern CSEC at tower 4ZC044 and Garth CSEC at tower 4ZC037. This option appraisal report completed a structured analysis of options for the proposed underground cable route within the allotted Project.

National Grid have specified in the Works Information that that the definite permanent works will be built wholly within the Project Area, which is defined in 2 parts. The Primary area has been established historically and has had most surveys and investigations undertaken and is presented as such within the Site Information. A Secondary Area could also be considered if found suitable in the appraisal. This Project Area is also split into 5 sections, Section A to E, in which many route options were initially considered. A few options were then identified and drawn in the project GIS map for further consideration and analysis in this report.

This appraisal follows the general principles set out in National Grid's document 'Our approach to Options Appraisal'. This document sets out a framework by which multiple assessment criteria can be used to make project options. Several sub-topics have been scoped out of this assessment due to the nature of the project, characteristics of the section area, or because they would not be helpful in differentiating between options. The approach described in the document has been modified as outlined in this report.

Each option has been ranked within each criteria and then compared in a final table for each Project Area Section. Some options have been discarded if it is found that the route is unfeasible. A summary of the overall rankings is shown below.

Table 1: Summary of Options Ranking

Section	Option								
	1	2	3	4	5	6	7	8	9
A	Rank 1	Rank 3	Rank 2						
B	Rank 3	Rank 2	Rank 1						
C	Rank 3	Rank 2	Discarded	Rank 1					
D	Rank 1	Rank 3	Rank 2	Rank 4	Discarded	Discarded	Discarded	Discarded	Rank 5
E	Rank 1	Discarded	Discarded	Discarded					

As indicated by the table above, Options A1, B3, C4, D1, and E1 have been selected as the preferred option for each section. It is expected that minor adjustments will be made to the route during preliminary design to avoid hazards, reduce risk, and limit impact of the proposed works. Following this Options Appraisal Report, engagement will continue with relevant stakeholders and landowners. A proposed design will be put forward for the preferred route that can be taken forward to the consenting stage.

2. Introduction

2.1 Project Background

To enable power generated by a proposed offshore windfarm to reach the rest of National Grid's transmission network, upgrades will be required on the Pentir – Trawsfynydd 4ZC route to increase circuit capacity. While the overall investment comprises multiple projects, the scope of this project (collectively known as Glaslyn Cables) is to:

- Uprate existing National Grid 400kV Glaslyn Cables (4ZC Pentir - Traws Circuit 1st Circuit) by replacing the existing 1x cable per phase oil-filled 400kV Glaslyn Cable circuit from Wern SEC at tower 4ZC044 to Garth SEC at Tower 4ZC037 with new 400kV XLPE cables.
- Replace the 2 existing 132kV SPEN Glaslyn cables with new 400kV XLPE cables (Pentir - Traws 2nd Circuit) from Wern SEC at tower 4ZC044 to Garth SEC at Tower 4ZC37

The above works are designated using a pink arrow and circle in Figure 1 below.

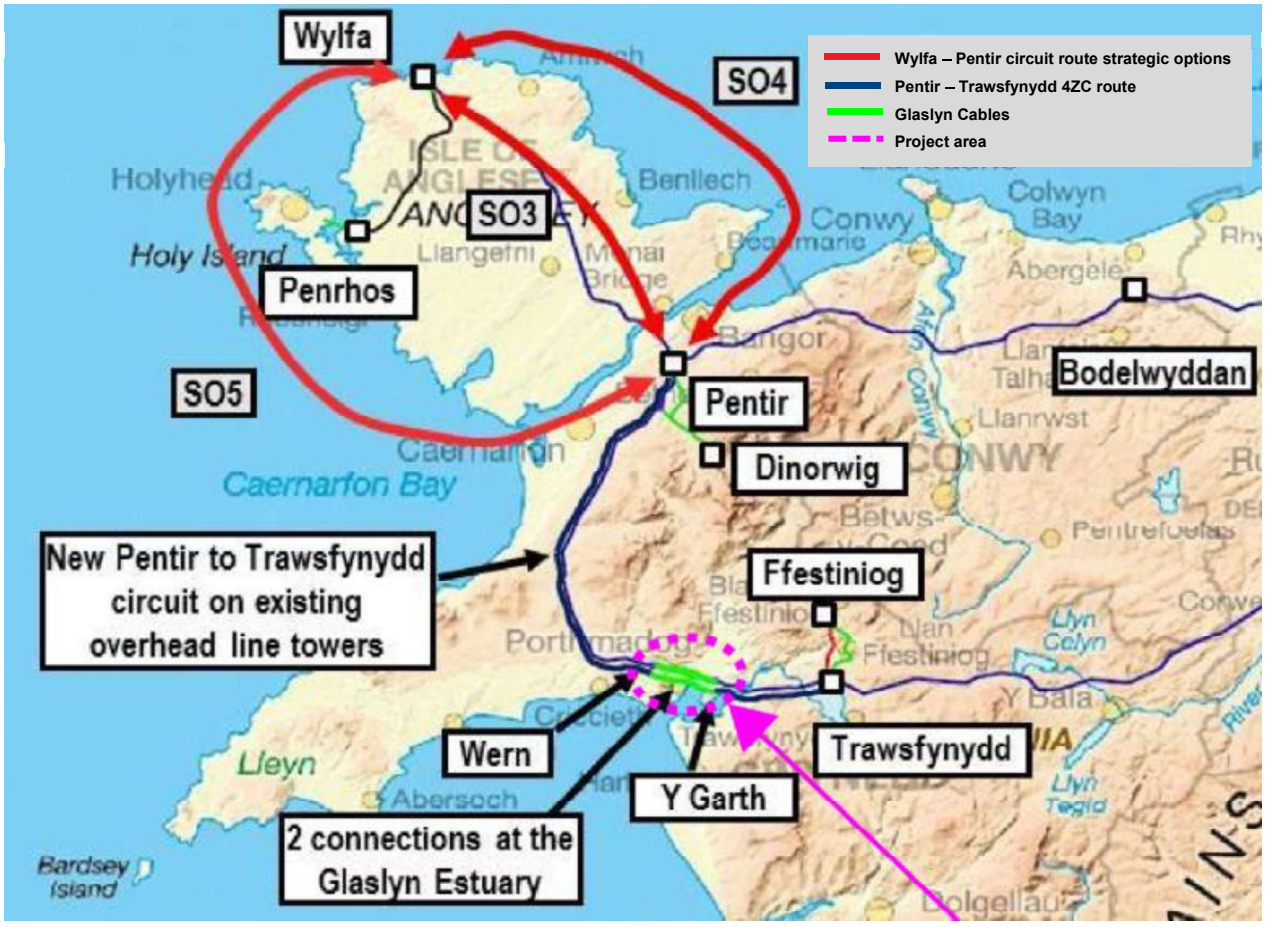


Figure 1: Location of Project along Pentir - Trawsfynydd route in North Wales

2.2 Purpose & Appraisal Constraints

The purpose of this options appraisal report is to perform a structured analysis of options for the proposed underground cable route within the allotted Project Area (described in Section 2.3 below). This options appraisal does not consider the use of different cable types outside of what has been outlined in the Project Specific Scope. Trenchless options have been considered for specific complex crossings but have not been considered for the entirety of the route. National Grid previously reviewed this project at a higher level as documented in *North Wales Connections Strategic Options Report* (Ref 2-1). Within this document, National Grid has already noted that "an underground cable between Wern and Y Garth is likely to achieve the most appropriate balance between its technical, economic, amenity and environmental obligations." This project

will eventually interface with the western tunnel headhouse near Minffordd for Snowdonia Visual Impact Provision (SVIP) project, for which an options appraisal was completed in 2020 (Ref 2-2).

2.3 Project

As part of this project, National Grid have specified in the Works Information that the defined permanent works will be built wholly within the Project Area, which is defined in 2 parts. The Primary area has been established historically and has had most surveys and investigations undertaken and is presented as such within the Site Information. The Secondary Area has no historic information available and offers the Contractor the opportunity to identify alternative routing if it would present a more advantageous approach to the Primary Area. The Primary and Secondary Areas have been shown in red and blue in Figure 2 below, respectively.

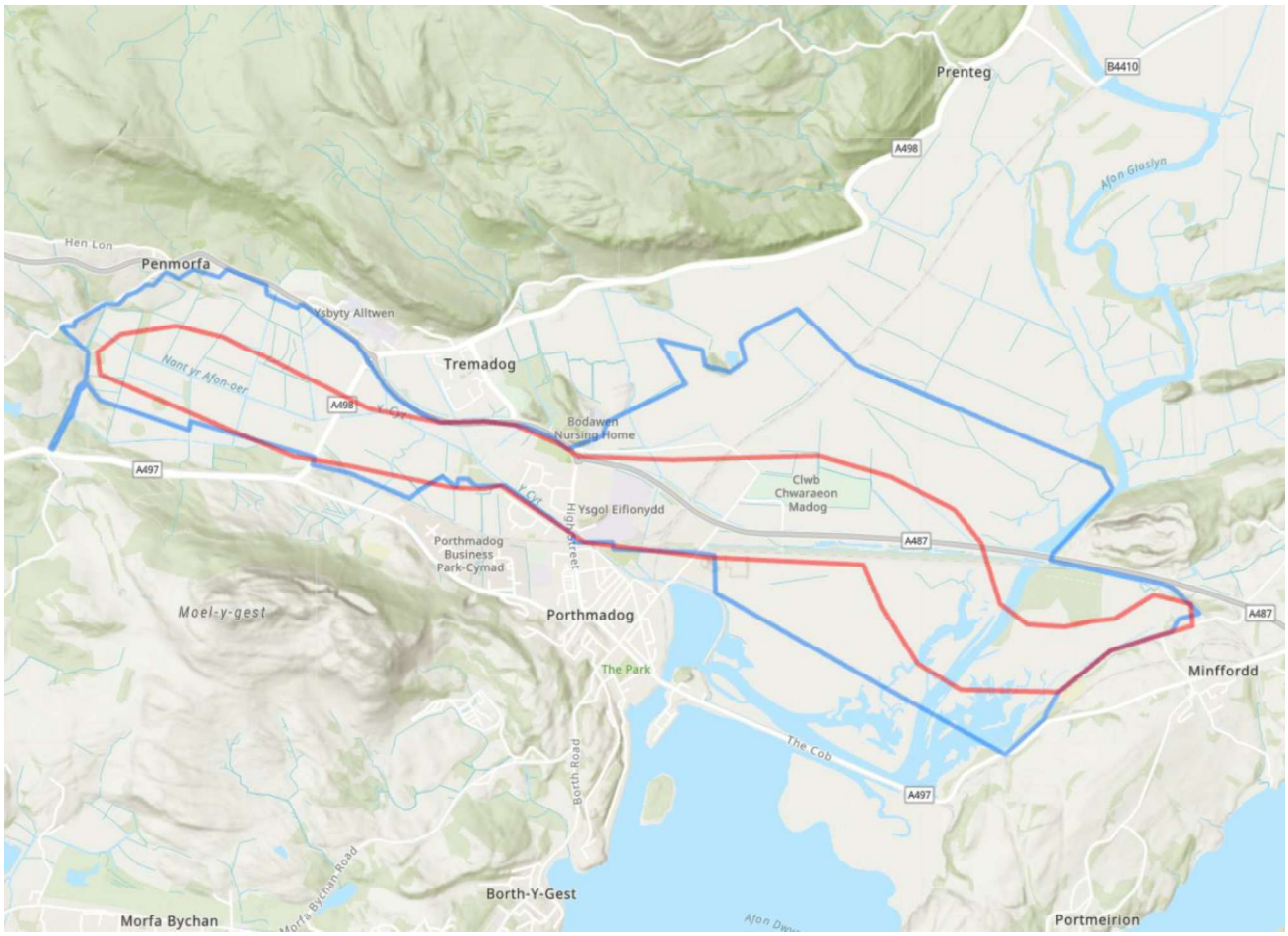


Figure 2: Primary and Secondary Project Areas

2.3.1 Sections

For the purposes of the project, and since the route will encompass a length of approximately 6km or more, the project area has been split into 5 sections, as shown in Figure 3 below.

Section A – Wern CSEC to A498

This section (shaded red in Figure 3 below) encompasses the area between Wern Cable Sealing End Compound (CSEC) and the A498 Highway. It is bound by the A487 to the north and by woodland and farmland plots north of Network Rail to the south.

Section B - A498 to Trunk Road Island

This section includes the area between A498 and the A487 Roundabout connecting the by-pass to Porthmadog High Street (shaded green in Figure 3 below). This section is south of the A487 and north of the woodland near Pensyflog and Porthmadog. The cable routes in this section will cross National Cycle Route 8, a stone circle feature used by the local community, and a playground in close vicinity to the roundabout.

An offshoot of Section B towards the southeast covers the existing alignment of the 132kV cables. Due to development in this area, the Project Area is significantly restricted at the roundabout.

Section C - Trunk Road Island to Heritage Railways

To the east of the roundabout, Section C encompasses all areas up to the interface with Snowdon Street (shaded orange in Figure 3 below). This section includes the current alignments of the existing 132kV and 400kV cables, but also includes a significant portion of land to the north of the A487 which can be considered for the proposed cable route. This section will require interface with the A487, Ffestiniog Railway (Welsh Highland Steam Railway), the Welsh Highland Heritage Railway, school playing fields.

Section D - Heritage Railway to East of Afon Glaslyn

Section D begins at Snowdon Street and encompasses all areas until after the SSSI and the River Glaslyn crossing, shown in light blue in Figure 3 below. This is the largest of the Project sections, giving flexibility to the optioneering due to the multiple constraints and major crossings within this area. At the western end, there is the Clwb Chwaraeon Madog (sports facilities) and Porthmadog Football Club. The area is then relatively open, bound to the south by the A487 Porthmadog bypass that crosses the Estuary. This section will require crossing of the by-pass and the Network Rail line before crossing the SSSI and River Glaslyn. This area is lower lying and is prone to flooding.

Section E - East of Afon Glaslyn to Minffordd

This final section includes the interface with Garth CSEC and Minffordd CSEC, shown in light yellow in Figure 3 below.

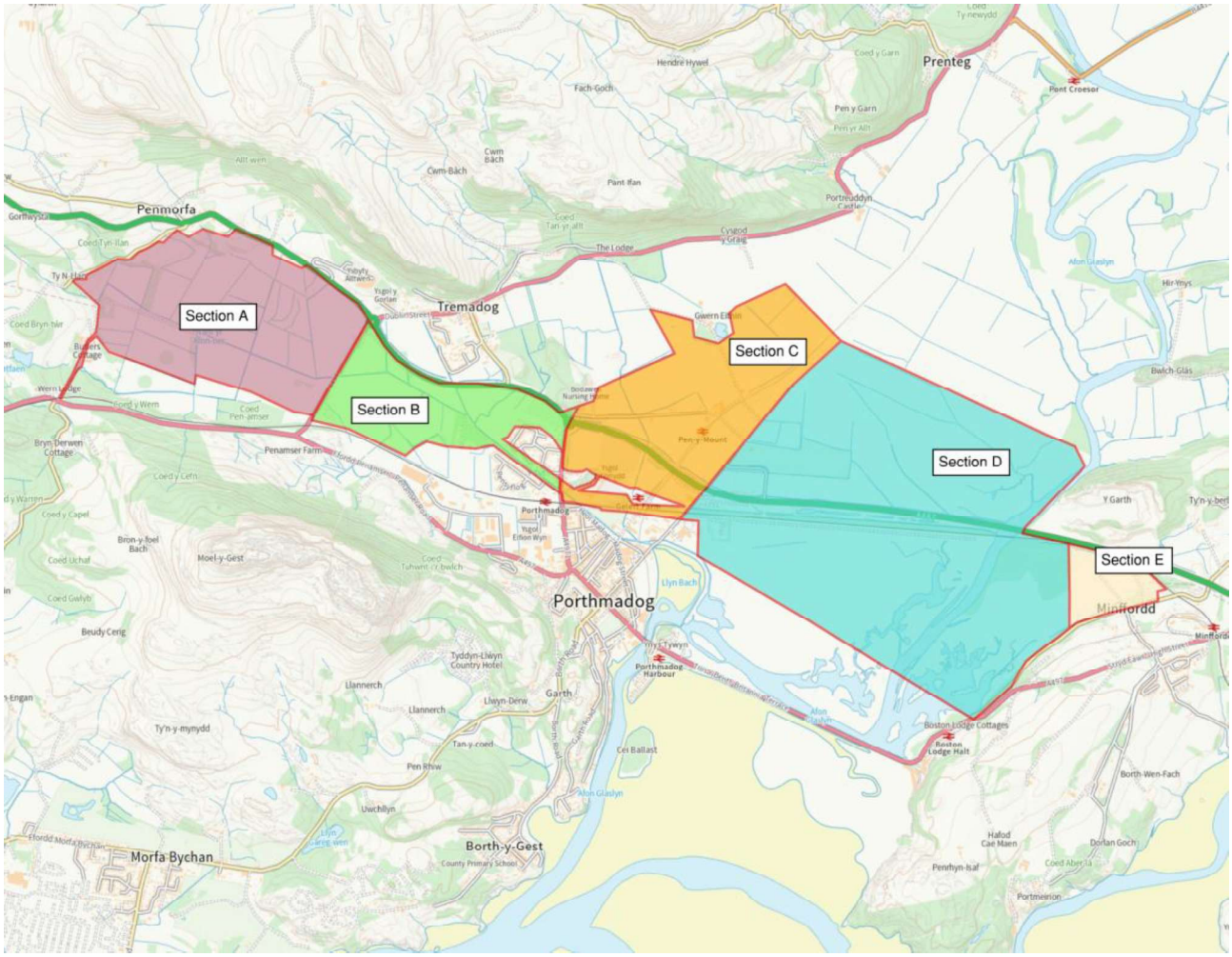


Figure 3: Project Area Sections

2.4 Overview of Design Options

Many route options were considered within each Project Area section. A few options were then identified and drawn in the project GIS map for further consideration and analysis, as shown in Figure 4 and Figure 5 below. 3 options were considered in Section A, 3 in Section B, 4 in Section C, 9 in Section D, and 4 in Section E.

As each route option connects to the adjacent Project Area sections at different points, there are some options that are only compatible with certain routes from adjacent sections. This was considered during the review and resulted in some of the options being eliminated due to impracticality.

Each option will be considered individually and scored based on the criteria described in National Grid's *Our Approach to Options Appraisal* document (Ref 2-3). It should be noted that minor deviation from the proposed alignments below is expected during design development. In the context of the assessment, it is essential to emphasise that scoring of the different routes is intended solely for guidance and to facilitate a qualitative assessment, to support the option appraisal commentary. The methodology is further explained in Section 33.3 of this report.



Figure 4: Section A and B of Design Options in GIS model



Figure 5: Section C, D and E of Design Options in GIS Model

2.5 References

- Ref 2-1: North Wales Connections Strategic Options Report – National Grid (2012)
- Ref 2-2: Visual Impact Provision (VIP) Snowdonia Project Options Appraisal – National Grid (2020)
- Ref 2-3: Our Approach to Options Appraisal – National Grid (2012)

3. Options Appraisal Methodology

3.1 Process

This appraisal follows the general principles set out in National Grid's document 'Our approach to Options Appraisal' (Ref 2-3). This document sets out a framework by which multiple assessment criteria can be used to make project options. The assessment topics and sub-topics are outlined in Table 2 below. As advocated in S2.3 of the 2012 guidance, several sub-topics have been scoped out of this assessment due to the nature of the project, characteristics of the section area, or because they would not be helpful in differentiating between options. The assessment was conducted based on the information available during the development of the report. It is noteworthy that in-depth elaboration on the environmental assessment will be developed in the Environmental Impact Assessment stage. Health and safety consideration have also been incorporated due to its importance when designing and implementing such a large construction project. This approach has been discussed and agreed with National Grid as a suitable way forward.

In this methodology, the objective is to evaluate and rank multiple route options across the assessment topics in Table 2 below. To facilitate this evaluation, a consistent scoring system is established, typically ranking from 1 (representing the best performance) to 5 (indicating the worst performance) for each topic. After reviewing the relevant data and our Route Options Selection Spreadsheet, rankings are assigned to each route option based on the option appraisal commentary within each topic. To visually represent the rankings, different shades of green are employed, with the darkest shade representing the top-performing option and the lightest shade for the lowest-performing one. This structured approach ensures a transparent and systematic decision-making process, allowing stakeholders to easily identify the best and worst options across the various evaluation criteria. This approach was discussed and agreed following review by Murphy Power Networks Ltd and National Grid.

Table 2: Appraisal Criteria Scoping

Assessment Criteria	Project Area Section					Comments
	A	B	C	D	E	
Technical						
Technical Complexity	✓	✓	✓	✓	✓	
Construction Delivery	✓	✓	✓	✓	✓	
Project Delivery	✓	✓	✓	✓	✓	
Carbon				✓		Was not considered in some sections as the options are very similar in terms of cable length and construction methodology.
Suitability of Technology				✓		Not applicable for this review, apart from a trenchless technology standpoint, which was reviewed on a case-by-case basis.
Network Capacity						The project scope has defined parameters to be met by this project.
Network Efficiency						The project scope has defined parameters to be met by this project.
Environmental						
Landscape / Visual Amenity	✓	✓	✓	✓		Not considered for Section E due to the limited area.
Ecology	✓	✓	✓	✓	✓	
Historic Environment	✓	✓	✓	✓	✓	While major historic environments are not anticipated within the actual route, it should be noted that historic environment have been observed in the vicinity.
Local Air Quality						Since the project scope requires undergrounding the cables, there is little difference for air quality for the shortlisted routes.
Noise & Vibration				✓		While this will be considered by the design, the only location where noise and vibration is expected to influence the options appraisal is within Section D due to the trenchless options and SSSI area.
Soils & Geology				✓		Initial feedback from GI suggests that the soils and land types for construction in the Primary Area are consistent enough to not be applicable for the assessment. Only considered for trenchless options in Section D.
Water	✓	✓	✓	✓	✓	While noted that Section E is still within fluvial and tidal Flood Zones, no assessment in Section E is generally required due to the limited area.
Socio Economic						

Assessment Criteria	Project Area Section					Comments
	A	B	C	D	E	
Economic Activity	✓	✓	✓	✓	✓	
Traffic Congestion	✓	✓	✓	✓	✓	
Transport Corridors	✓	✓	✓	✓	✓	
Aviation						Not applicable for the project area and options.
Defence						Not applicable for the project area and options.
Cost						
Capital Cost	✓	✓	✓	✓	✓	
Lifetime Cost						Was not considered due to lack of sufficient information during the development of this report.
Health & Safety						
Design Risk	✓	✓	✓	✓	✓	
Construction Risk	✓	✓	✓	✓	✓	
Operations & Maintenance	✓	✓	✓	✓	✓	
Demolition & Decommissioning	✓	✓	✓	✓	✓	

3.2 Data Sources

In this assessment, the information from the following sources have been used to inform the appraisal, as available at the time of production of the first version of this report. No further information has been used in producing this appraisal.

- Glaslyn Cable Crossing Desk Based Utility Report – RSK (2023)
- Glaslyn Cable Scheme Pre-Construction Information - National Grid (2022)
- FG Land Ownership Plans – National Grid (2023)
- Glaslyn Trenching & HDD Rates – Murphy Power Networks Ltd (2023)
- Glaslyn Geographic Information – DataMapWales by Welsh Government (2023)

3.3 Route Options Selection Spreadsheet

To inform the option appraisal commentary, a spreadsheet was produced to exhibit quantitative information for each route option. While this was not seen as the only driver for the selection process, it provided a useful tool which facilitated differentiation between routes which, at first, appear quite similar from a high-level. The data noted within this tool included the following:

- Cable and access road lengths
- Number of crossings of utilities, ecological/conservation areas, watercourses, hedgerows/vegetated areas
- Length of potential Open Cut Construction and Trenchless Construction
- Number of landowners affected by construction and their potential openness to the proposed works

3.4 Typical Construction Swathe

3.4.1 Good Agricultural Land Conditions

At the time of development of this report, typical construction swathes for the high-level review included a 6m between circuit centerlines and 1m between cables. The central separation could be increased to 8m to allow for 5m haul road in the centre as needed. It is estimated that up to 30m on either side of the cable swathe would be needed for temporary works, including staging and stockpiling. This provides an

approximate total construction swathe of 84m in good agricultural land installation conditions with cable depths at 1m.

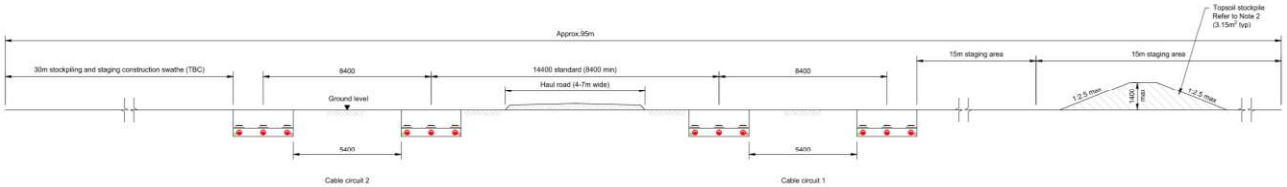


Figure 6: Typical section details

3.4.2 HDD Installation Conditions

Preliminary electrical analysis using CYMCAP software at the time of preparation of this report concluded that depth in excess of 8m from existing ground levels and cable spacing less than 10m would result in less desirable or unacceptable operational conditions and cable temperatures. Therefore, the proposed HDD route for the purposes of this options appraisal is as follows:

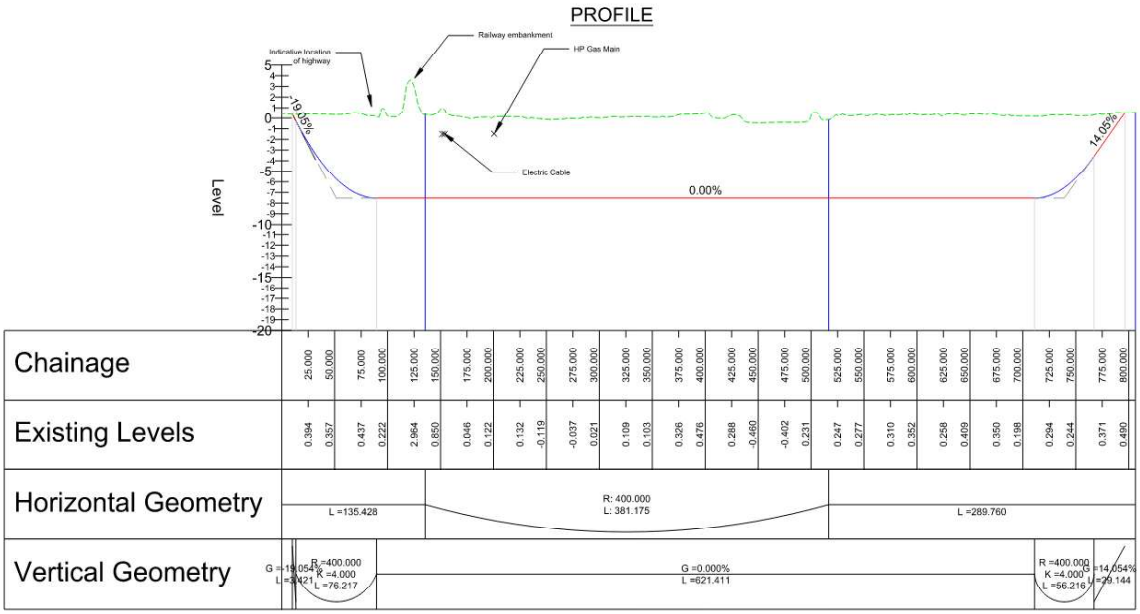


Figure 7: Curved HDD crossing profile in Section D

3.5 Stakeholder Consultation

This appraisal is based on consultation with the following key stakeholders at the time of production of the first version of this report. Consultation will be progressed with these and other stakeholders in detailed design stage. It was agreed with National Grid that engagement with Natural Resources Wales (NRW) would be deferred until the Environmental Impact Assessment phase, which will occur when the final route selection is made.

3.5.1 Welsh Heritage & Ffestiniog Highland Railway

NGET met with representatives from Welsh Heritage & Ffestiniog Highland Railway on 11th May, 2023 to discuss the project and identify preferred crossing locations. The clear preference was to cross somewhere south of the existing platform at Pen-y-Mount Station (where the track splits into two) and north of the high-pressure gas main crossing. For reference, this closely aligns with the location proposed by options C2 and C4.

‘Open Cut’ construction approach was discussed for this crossing. The stakeholder stated that they will likely self ‘assure’ the proposed design or appoint a local design house to do so when the detail cross sections and ‘make-up’ drawings become available. In this way, there will be no need for a BAPA or anything equivalent to what is being completed with Network Rail. For re-laying the track, the Welsh Heritage & Ffestiniog Highland Railway will provide supervisory support or a specialist to oversee the works.

In terms of a construction window, they identified that January to Easter weekend (no year preference, 2026, or 2027) is preferable so that the track can be re-opened for passengers. Compensation based on typical income would be required if not re-opened by this date.

3.5.2 Ysgol Eifionydd, Secondary School, Gwynedd County Council

The secondary school field crossing at the west end of Section C can be completed without issue as long as a good portion of the field is fenced off to achieve this. There was no preference on the crossing location of the A487. Preferred construction window would be during the summer holidays.

3.5.3 The Playground, Porthmadog Community Council

Due to space restrictions within the Project Area, the proposed cables will need to cross the A487 roundabout. Adjacent to this roundabout there is a playground that will need to be relocated during the proposed works. The preference from the local council is for this playground to be relocated to the northwest, adjacent to the highway boundary, if space allows.

3.5.4 Is-adran Rheoli'r Rhwydwaith - Network Management Division, Trafnidiaeth - Transport

Consultation with the highway authority was undertaken on 12th May, 2023. The roundabout crossing and the A487 crossings within Section C and D were discussed. The clear preference from the highway authority was to minimize disruption as much as possible by using trenchless methods where suitable. National Grid explained the constraints around the roundabout and that this section would likely be open cut construction. The highway authority noted the requirements for approaching these crossings and provided embargo dates for 2023.

4. Section A – Wern CSEC to A498

4.1 Overview & Baseline Condition

Within Section A the underground circuits are to be routed from Wern Cable Sealing end compound (CSEC) through a relatively open flat area of arable land that contains several drainage ditches and hedgerows. Section A ends at the interface with the A498 Highway.

As part of the Works, a new permanent access route is required to Wern CSEC from the A498 Highway. This access route is to be constructed at the same time as the new cables and was an important consideration when assessing the route.

Major assets and infrastructure in this section for consideration include the Wern CSEC, potable water mains, surface water ditches which a number of these are classified as NRW Main Rivers, existing 400kV and 132kV cables, and overhead power lines (OHL).

Three options were identified for investigation as shown in Figure 8 below. They include a route that stays south of the existing watercourse [Nant-yr Afon-oer] running from west to east, following the alignment of the existing cables (Option A1); a route that stays north of the existing watercourse and would be constructed under the OHL route (Option A2); and a route that deviates farther north (Option A3).

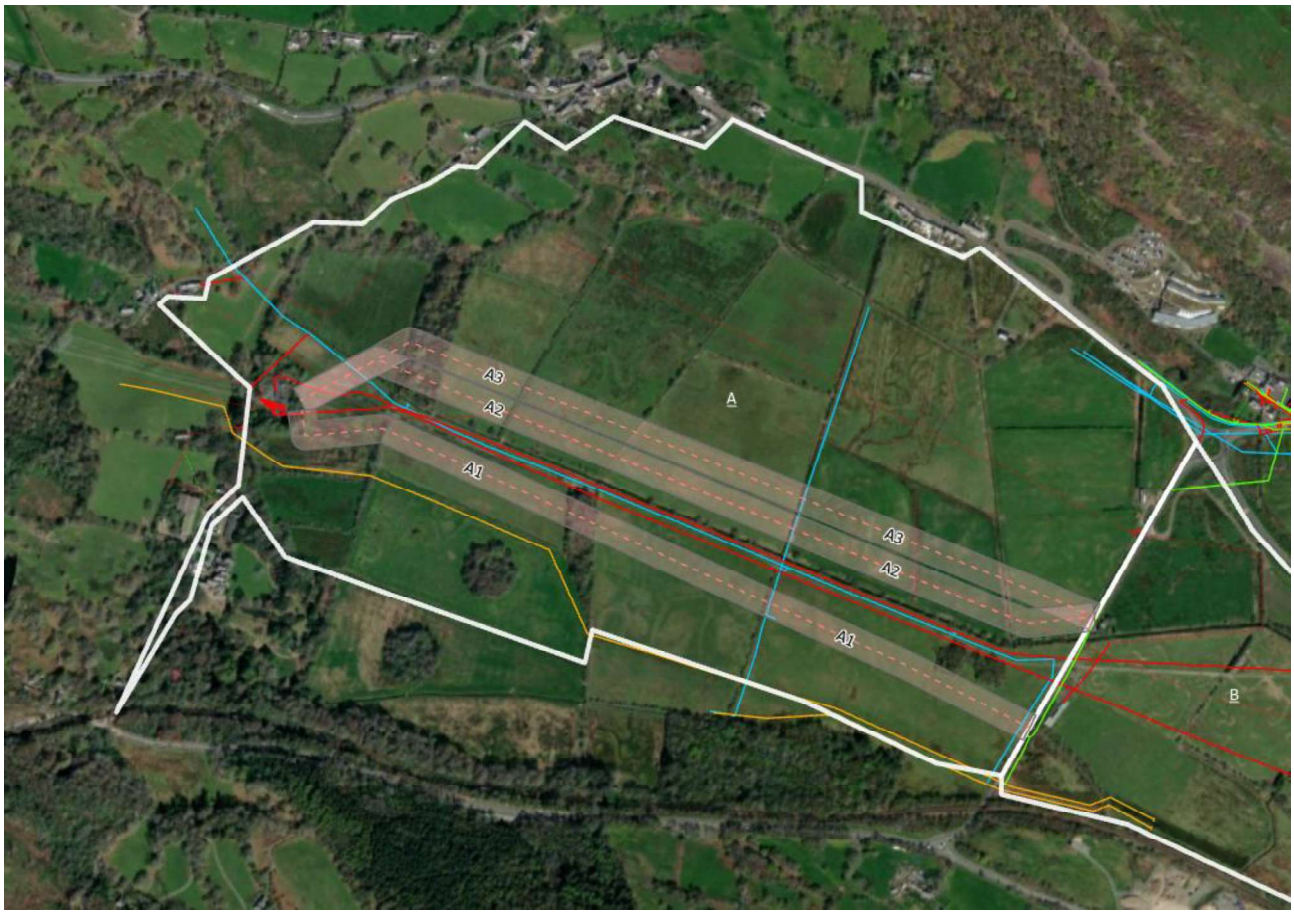


Figure 8: Overview of Section A on GIS model

4.2 Analysis

Criteria	Commentary
Technical Assessment Considerations • Technical complexity • Construction delivery • Project delivery ~~• Carbon~~ ~~• Suitability of Technology~~ ~~• Network Capacity~~ ~~• Network Efficiency / Benefits~~	Option A1 is the shortest route option considered within this section, at a length of approximately 1.17km. The route is located to the south of the ditch that runs centrally from east to west within this section. It is worth noting that the potential length of this route may be reduced if navigation around the tree is considered. The route has a total of 6 crossings, the least of all options in Section A, and is therefore considered to be the least complex from both a technical design and construction standpoint. The crossings include 2 small watercourses (at field boundaries) which are classed as NRW Main Rivers, 2 watermain crossings, and 1 existing 132kV cable route crossing. Staying to the south of Nant yr Afon-oer is advantageous as it stays away from the OHL route which is located north of the existing ditch. It is expected that this route can maintain a safe distance from the gas main, with no crossings proposed. The construction area is open farmland and therefore open-cut construction has been proposed. Trenchless options were not considered within Section A. This section is located on the same side as an existing track that runs over the existing 132kV and 400kV cables. This side is also noted by National Grid in the Works Information as the preferred access road alignment from A498. Constructing the cable route on this side would likely be less disruptive to the landowners as construction and decommissioning works can occur within the same construction swathe. Option A2 is slightly longer than Option A1, at a length of approximately 1.23km. The route is located to the north of Nant yr Afon-oer that runs centrally from east to west within this section, running parallel and in close proximity to the OHL route for approximately 900m. The route has a total of 12 crossings, including 8 field boundary watercourses, 2 watermain crossings, 1 existing 400kV route crossing, and 1 Public Right of Way (PROW). This route is considered the most technically complex due to the number of crossings and proximity along the entire length to the OHL route. Option A3 is the longest route considered, at a length of approximately 1.24km. The route is located to the north of Nant yr Afon-oer that runs centrally from east to west within this section. It also runs north of the OHL route to avoid being in close proximity. The route has a total of 13 crossings, including 9 field boundary watercourses, 2 watermain crossings, 1 existing 400kV route crossing, and 1 Public Right of Way (PROW). As this route deviates from the alignment of the OHL route, it would be less technically complex than Option A2. It is worth noting that both Options A2 and A3 cross the Nant yr Afon-oer Main River and two additional small watercourse which are also classed as Main Rivers Option A2 and A3are located on the opposite side to the existing 132kV and 400kV cables and would likely introduce additional complexity in terms of access arrangements throughout construction and decommissioning.
Environmental Assessment Considerations • Landscape / Visual Amenity • Ecology • Historic Environment ~~• Local Air Quality~~ ~~• Noise & Vibration~~ ~~• Soils & Geology~~ • Water	Option A1 crosses two hedgerows and two areas where existing trees are present. It may be possible to make minor adjustments to the route to limit tree removal, however, it is anticipated that approximately up to 50m of the route length will have existing trees that will need to be removed within the construction swathe. Option A2 crosses six hedgerows and an approximate 65m section of the route length will have existing trees that will need to be removed within the construction swathe. Option A3 crosses 7 hedgerows and an approximate 60m section of the route length will have existing trees that will need to be removed within the construction swathe. All three options A1, A2 and A3, highlight potential impacts on wildlife habitat due to the removal of trees within the construction swath. No construction is required in SSSI, SAC, or Priority Habitat areas. Noise & Vibration, Local Air Quality, and Soils & Geology criteria are also considered to be neutral for this Section as the differences between each option are minimal and any residual adverse effects during construction would likely be very minor using standard mitigation measures. Whilst parts of the route options in Section A fall within the Registered Historic Parks and Gardens area, no route options cross the Garden/Kitchen Garden area. Most of the listed buildings are located outside the Work Area. There are only few Grade II listed buildings outside the perimeter of Section A that is approximately 140m to 280m away from the Wern CSEC site. All options within Section A do not cross any conservation areas or ancient woodlands, and any adverse effect during construction assets or their setting would be very minor. The entire Work Area is within the extents of the historic landscape area, showing no differentiation between all route options. There are no scheduled monuments within the project area as well. The entire Work Area is within the extents of the Flood Zone 3, showing no differentiation between all route options. Option A1 has up to 3 existing watercourses crossings at field

Criteria	Commentary
	boundaries along the route, 2 of which are classed as NRW Main Rivers. Option A2 has up to 8 existing watercourses at field boundaries along the route and Option A3 has up to up to 9 existing watercourses, which includes crossing the Nant yr Afon-oer Main River once and two others NRW Main Rivers. Any watercourse intersection will need to be reinstated following construction as necessary.
Socio-Economic Assessment Considerations • Economic Activity • Traffic Congestion • Transport Corridors • ~~Aviation~~ • ~~Defence~~	As most of the land that the routes crosses are mainly agricultural land, construction activities for the proposed options in Section A have the potential to disrupt agricultural activities, affecting the livelihood of landowners. Options A2 and A3 intersect with a Public Right of Way, and construction activities may possibly introduce disturbance to leisure activities. It is essential to assess the extent of this disruption and its impact on the affected parties. Option A1 stands out as it would disrupt the least number of landowners and, importantly, be entering discussions with only 3 landowners who already have National Grid assets within their land. Whereas construction on the north side of the ditch for Options A2 and A3 would likely be more disruptive to the landowners because construction and decommissioning works would occur on separate plots. 5 landowners would need to be engaged for Options A2 and A3, as opposed to only 3 for Option A1. The route of Option A3 deviates farther from the plot boundary than Option A1 and A2 and would likely be more disruptive to the respective landowners. The route would also result in less useable area for the landowner after construction is complete. In terms of land acquisition, none of the options in Section A would require permanent acquisition of land except for Wern CSEC site. This means that, the land will be returned to the owner for their continued use after decommissioning and construction. However, during construction, temporary acquisition of land is necessary to build the cable corridor and install cables. This temporary utilisation of land for construction has implication for landowners and their ability to utilise their land for agriculture, and the compensation for this will be key considerations in landowner discussion and the overall project assessment. Note that the route has no open cut work within the highway, apart from at the A498 Highway crossing, which would be required with every option. There are no railway crossings to consider in Section A. None of the routes in Section A are crossing any highway, so there is no impact in traffic congestion and transport corridors.
Cost Assessment Considerations • Capital Cost • ~~Lifetime Cost~~	High level capital cost estimates for this section indicate that Option A1 is advantageous due to the reduced number of crossings and improved access. Options A2 and A3 are relatively similar with Option A2 having slightly less ditch crossings than Option A3, hence the estimated cost suggests to ranked second and third respectively.
Health & Safety Assessment Considerations • Design Risk • Construction Risk • Operation & Maintenance • Demolition & Decommissioning	Option A1 is considered to be the preferred option from a health and safety perspective due to the reduced number of service crossings and the fact that it is located farther from the OHL route which would need to be considered for Options A2 and A3. Although this option is closer to the existing 400kV and 132kV routes, these assets are underground, and the risk can be controlled by ensuring construction occurs a safe distance to the south. This is made possible by the fact that Section A1 is primarily open farmland and there is some flexibility with the proposed cable alignment and construction swathe. Option A2 is considered to be the least preferred option in terms of Health and Safety due to proximity to the OHL route across the majority of the route. This option does, however, maintain a larger offset from the existing gas main and underground HV cable routes. From an operations and decommissioning standpoint, installing the new cables away from the existing route will result in more complex access arrangements. Option A3 is preferred to Option A2 from a Health and Safety standpoint as the alignment maintains an offset from the OHL route along the Section length. However, it still requires crossing the OHL line and 400kV lines after leaving Wern CSEC. Similar to Option A2, from an operations and decommissioning standpoint, installing the new cables away from the existing route will result in more complex access arrangements.

4.3 Ranking & Conclusion

Assessment Criteria	Technical	Environmental	Socio-Economic	Cost	Health & Safety	Overall
Option A1	Rank 1	Rank 1	Rank 1	Rank 1	Rank 1	Rank 1
Option A2	Rank 3	Rank 2	Rank 2	Rank 2	Rank 3	Rank 3
Option A3	Rank 2	Rank 3	Rank 3	Rank 3	Rank 2	Rank 2

Option A1 is the preferred route within Section A1, ranking highest for all criteria. Option A2 has been ranked lower primarily due to the proximity with the OHL along the route, which resulted in adverse effects on most of the scoring criteria. Option A3 deviates quite far from the land boundary which started to increase cable length and introduce socio-economic concerns.

5. Section B – A498 to Trunk Road Island

5.1 Overview & Baseline Condition

Within Section B the underground circuits are to be routed from A498 Highway through a relatively open flat area of arable land that contains several drainage ditches and hedgerows, and Nant yr Afon-oer. The A487 Highway runs along the north of Section B which ends at the interface with the A487 Porthmadog Roundabout and along the High Street in Porthmadog.

Within the Primary area, there was no potential route that would avoid plots that requires further engagement with landowners. Major assets and infrastructure in this section for consideration include a high-pressure gas, potable water, surface water ditches, existing HV and LV cables, telecoms, and OHL.

Three options were identified in this area. Option B1 aligns with the end of Options A2 and A3, while B2 and B3 align with the end of Option A1. Option B1 runs along the northern plots while Options B2 and B3 take different routes along the southern plots. All the three options join about halfway into Section B as they enter the approach to the roundabout section. At the eastern end of this section, the cables will be restricted to a corridor that has the highway and high-pressure gas main to the north and the existing 400kV cables to the south. Within the Primary Area, the roundabout was seen as the only viable crossing point between Section B and Section C due to the town of Porthmadog to the south. In addition to this, it should be acknowledged that there may be temporary traffic disruption, and it will be imperative to develop suitable traffic management measures.



Figure 9: Overview of Section B on GIS model

5.2 Analysis

Criteria (See Table 2)	Commentary
Technical Assessment Considerations • Technical complexity • Construction delivery • Project delivery ~~• Carbon~~ ~~• Suitability of Technology~~ ~~• Network Capacity~~ ~~• Network Efficiency / Benefits~~	Option B1 is approximately 1.41km long and would intersect with options A2 and A3 at the A498 highway. Before converging with Options B2 and B3, this option follows the southern edge of the northern plots before crossing the existing 400kV cable route. Option B1 also crosses an OHL route and multiple watercourses at field boundaries. Before converging with the other options, this route is constricted by a field boundary and the highway to the north, which would require a narrower construction swathe to what is shown in the typical section described in Section 3.4. Option B1 crosses the existing 400kV line twice as opposed to only once for the other options. Since it is located farther from the existing cable route, it would likely introduce additional complexity in terms of access arrangements throughout construction and decommissioning. Option B1 is not located close to an existing track and would require new access arrangements. Options B2 and B3 are 1.45km and 1.35km, both crossing Nant yr Afon-oer respectively. These routes are the same, apart from the first section of the route, where B3 crosses the A498 highway and existing 132kV line at an angle. This option would provide more flexibility with the highway crossing location and would allow the construction swathe to avoid the golf driving range. B2 utilizes the golf driving range land for a short period before turning and heading straight north. Options B2 and B3 follow the route of the 400kV cables relatively closely as well as the route of an existing access track. Constructing the cable route on this side would likely be less disruptive to the landowners as construction and decommissioning works can occur within the same construction swathe.
Environmental Assessment Considerations • Landscape / Visual Amenity • Ecology • Historic Environment ~~• Local Air Quality~~ ~~• Noise & Vibration~~ ~~• Soils & Geology~~ • Water	Option B1 crosses five hedgerows and approximately 75m of the route length will have existing trees that will need to be removed within the construction swathe, and Options B2 and B3 both cross seven hedgerows and would require about 50m of the route length with existing trees to be removed within the construction swathe, and All three options B1, B2 and B3, highlight potential impacts on wildlife habitat due to the removal of trees within the construction swath. No construction is required in SSSI, SAC, or Priority Habitat areas. Noise & Vibration, Local Air Quality, and Soils & Geology criteria are also considered to be neutral for this Section as the differences between each option are minimal and any residual adverse effects during construction would likely be very minor using standard mitigation measures. Most of the listed buildings are located outside the Work Area. There are three Grade II LBs in Section B that is approximately 50m to 90m away from the route options, which is considered to be sufficiently far away from the proposed route. All options within Section B do not cross any conservation areas, listed buildings, or ancient woodlands, and any adverse effect during construction assets or their setting would be very minor. The entire Work Area is within the extents of the historic landscape area, showing no differentiation between all route options. There are no scheduled monuments within the project area as well. The entire Work Area is within the extents of the Flood Zone 3, showing no differentiation between all route options. There are up to 6 existing watercourses along Option B1 at field boundaries along the route, two of which are classified as NRW Main River. There are up to 5 existing watercourses along B2 & B3 at field boundaries along the route including two NRW Main River. The watercourse, Nant yr Afon-oer, is crossed with the existing 400kV lines with a substantial cable bridge. Various trenchless options have been considered for the large existing watercourse crossing with the proposed cables as noted in Appendix A. Additionally, any watercourse intersection will need to be reinstated following construction as necessary.
Socio-Economic Assessment Considerations • Economic Activity • Traffic Congestion • Transport Corridors ~~• Aviation~~ ~~• Defence~~	All of the route option in Section B primarily involve crossing agricultural land, with some overlap into an urban area near the A487 roundabout, mainly affecting agricultural activity. Construction within the northern plots of Options B1 would likely be more disruptive to the landowners than Options B2 and B3 because construction and decommissioning works would occur on separate plots. Option B1 crosses 17 plots, with 14 landowners that have positive relationship with National Grid and the other 3 would require further engagement. This is one more than Options B2 and B3 and would require engagement with landowners who have not previously had National Grid assets within their land boundary. It is important to note that none of the options in Section B involve permanent land acquisition. Instead, construction activities necessitate temporary land acquisition for building a cable corridor and installing cables. Subsequently, most land will be returned to the landowners for their continued use. During construction, landowners will potentially experience a temporary loss of access, and discussion will revolve around fair compensation for this period.

Criteria (See Table 2)	Commentary
	Both Option B2 and B3 might be crossing parts of the Madog Quads Trekking route, potential impact to the local tourism activity. All routes cross a stone circle feature used by the local community and a playground in close vicinity to the roundabout, construction activities along these routes may have the potential to disrupt leisure activities. Facilities would need to be reinstated after works are complete. Options B3 would provide more flexibility with the highway crossing location and would allow the construction swathe to avoid the golf driving range. Option B2 utilizes the golf driving range land for a short period before turning and heading straight north. All options are required to cross a Public Right of Way, National Cycle Route 8, the A498 on the western side and the roundabout on the eastern side. Construction activities around these transport corridors and traffic management measures may disrupt the local area, particularly due to its proximity to an urban area, potentially affecting the traffic congestion, unless trenchless methods are considered. Careful management of these disruptions will be essential to minimize inconvenience to residents and businesses.
Cost Assessment Considerations • Capital Cost • ~~Lifetime Cost~~	High level capital cost estimates for this section indicate that Option B3 is advantageous due to the shortest overall cable length and fewer crossings. Option B1 is ranked second with shorter HDD length while Option B2 is ranked last with the longest cable length.
Health & Safety Assessment Considerations • Design Risk • Construction Risk • Operation & Maintenance • Demolition & Decommissioning	Option B1 is considered to be slightly less preferable from a health and safety perspective due to the additional crossing of the live 400kV cables.

5.3 Comparative Ranking & Conclusion

Assessment Criteria	Technical	Environmental	Socio-Economic	Cost	Health & Safety	Overall
Option B1	Rank 3	Rank 3	Rank 3	Rank 2	Rank 3	Rank 3
Option B2	Rank 2	Rank 2	Rank 2	Rank 3	Rank 2	Rank 2
Option B3	Rank 1	Rank 1	Rank 1	Rank 1	Rank 1	Rank 1

Option B3 is the preferred route within Section B, ranking highest for all criteria. Option B1 ranked lower primarily due to being in a separate plot to the existing cables, which resulted in adverse effects on most of the scoring criteria. Furthermore, Option B1 crossed the existing 400kV line twice and did not align with the preferred Option from Section A. Finally, while Option B2 is extremely similar to Option B3, it ranked lower due to the impact on the driving range however it is noted that it provided greater flexibility at the A498 highway crossing.

6. Section C – Trunk Road Island to Heritage Railway

6.1 Overview & Baseline Condition

Within Section C the underground circuits are to be routed from Porthmadog Roundabout to Section D, which begins at Clwb Chwaraeon Madog and Porthmadog FC grounds. This route requires crossing the Heritage Railway and the A487 Highway. Major assets and infrastructure within this section include a high pressure gas main, surface water ditches, existing 400kV and 132kV cables, telecom routes, and overhead power lines. Most of the landowners within Section C have positive relationship with National Grid. However, it is crucial to emphasise the importance of engaging with the Heritage Railway for the relevant crossing.

Four options were identified for Section C. Option C1 routes south of the existing 400kV cables before heading north. Option C1 crosses the Heritage Railway farther to the north than the other options before continuing in a north-western direction to avoid the Clwb Chwaraeon Madog grounds. Option C2 follows the highway alignment and crosses the Highway at the earliest opportunity. It crosses the Heritage Rail slightly further south than Option C1 before entering the Clwb Chwaraeon Madog grounds. Option C3 follows the existing 400kV route closely to the south of the highway. It crosses the Heritage Rail before then turning north and crossing the highway. It then follows the eastern edge of Section 4. Finally, Option C4 is similar to Option C2 but crosses the highway at a point farther to the east.

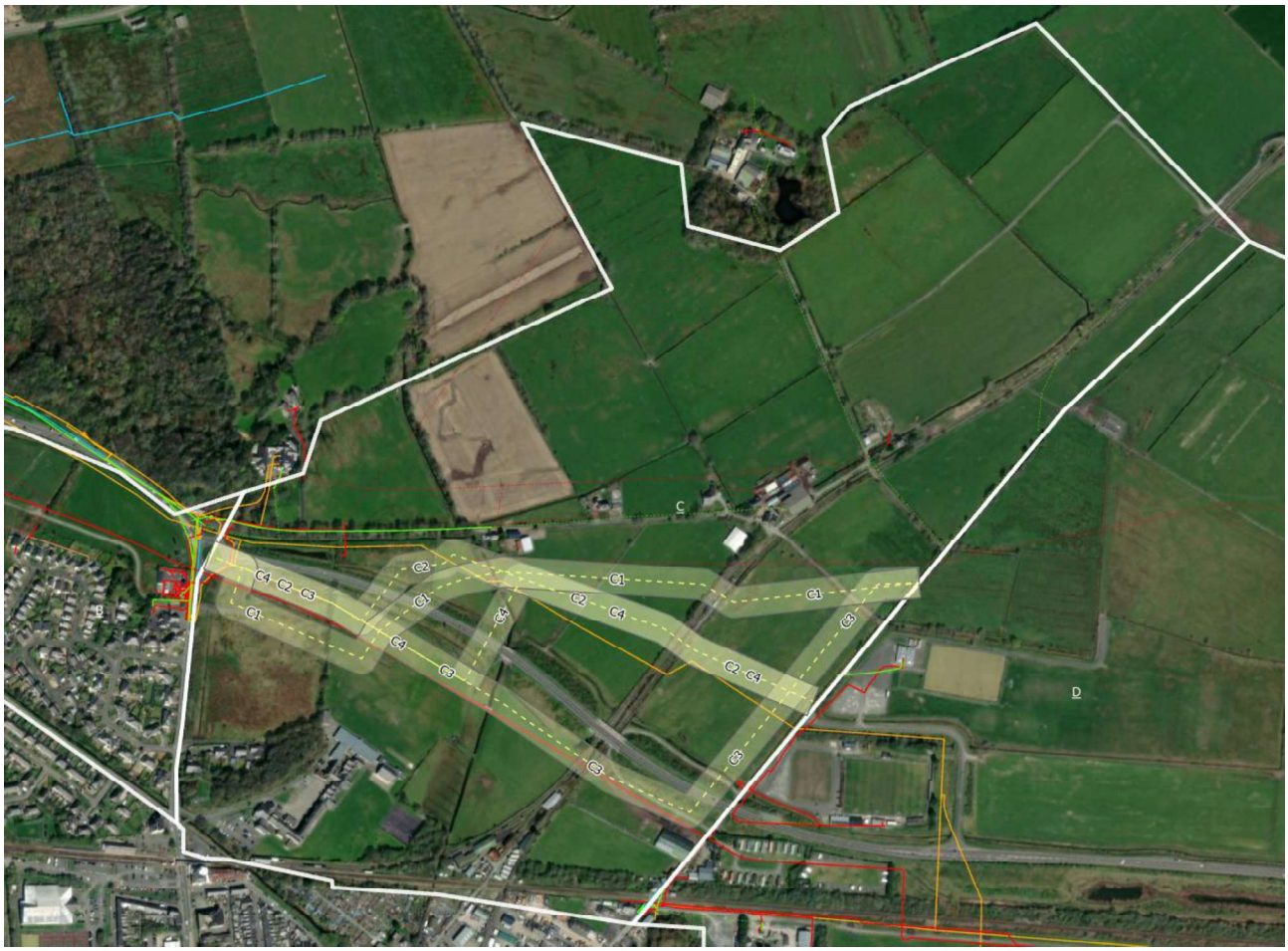


Figure 10: Overview of Section C on GIS model

6.2 Analysis

Criteria	Commentary
Technical Assessment Considerations • Technical complexity • Construction delivery • Project delivery • Carbon ~~• Suitability of Technology~~ ~~• Network Capacity~~ ~~• Network Efficiency / Benefits~~	Option C3 is the longest route option considered, at 1.17km and Option C2 is the shortest at 0.89km. Options C1 and C4 are 1.07km and 0.95km, respectively. Each route considers a trenchless method of construction under the A487 highway crossing, which is discussed further in Appendix A of this report. This analysis concluded that the optimum method of construction is HDD as it is more favourable in terms of the alignment and sustainability aspect. Option C4 is the preferred crossing location as it crosses at a location where there is more room for placement of the entry and exit pits. It is noted that Option C1 shows a slight meandering of the route to the south before crossing the A487. Upon review of the typical construction swathe and space constraints, this route offers additional flexibility to construction and eliminates a tight bend in the cables before crossing the highway. Option C3 follows the existing 400kV route for as long as possible before crossing the highway to the north. However, this route does not cross the heritage rail at the preferred location and also crosses the highway at a location where there is less room for the construction of the HDDs. In addition to the above technically complex crossings, the cables would also be nearer the existing 400kV route, and therefore this option is the least preferable. Options C1, C2, and C4 are closer to the high-pressure gas main and overhead power lines along the route, however, it is expected that these risks can be managed by maintaining a safe working distance from these assets. Of these three options, Option C4 provides the best crossing angle of the high-pressure gas main. At the heritage railway, it is expected that open cut construction will be accepted by the Heritage Railway as indicated in Section 3.5. It is also noted that their preferred crossing location would be the location shown in Option C2 and C4. Option C1 crosses slightly farther north than C2 and C4, however, this was noted as less preferable by Heritage Railway due to the fact that one of the track splits into two, which would require more extensive reinstatement. At the eastern interface, it should be noted that following the existing 400kV lines into Section D was not considered feasible as it runs through a Caravan Park before crossing the Network Rail line to the south. This route was discounted prior to this analysis as it did not offer sufficient room for construction of the typical cross section and the HDDs that would be required under the railway.
Environmental Assessment Considerations • Landscape / Visual Amenity • Ecology • Historic Environment ~~• Local Air Quality~~ ~~• Noise & Vibration~~ ~~• Soils & Geology~~ • Water	Of all the Options, Option C4 has the least impact on hedgerow boundaries and trees along the route. It is expected that six hedgerows would need to be removed and replaced and only approximately 20m of the route length will have existing trees that will need to be removed within the construction swathe. Options C2 and C1 have similar outcomes, while Option C3 is ranked as the most disruptive, likely requiring removal of additional vegetation on the verges of the highway. Any tree or hedgerow boundary removals within the construction swathe highlight potential impacts on wildlife habitat. Additionally, any watercourse intersection will need to be reinstated following construction as necessary. No construction is required in SSSI, SAC, or Priority Habitat areas. Noise & Vibration, Local Air Quality, and Soils & Geology criteria are also considered to be neutral for this Section as the differences between each option are minimal and any residual adverse effects during construction would likely be very minor using standard mitigation measures. There is a Grade II listed building in Section C located about 260m away to the nearest route option, which is considered to be sufficiently away from the proposed route. All options within Section C do not cross any conservation areas, listed buildings, or ancient woodlands, and any adverse effect during construction assets or their setting would be very minor. The entire Work Area is within the extents of the historic landscape area, showing no differentiation between all route options. There are no scheduled monuments within the project area as well. The entire Work Area is within the extents of the Flood Zone 3 and all of the options cross the NRW Main River once, showing no differentiation between all route options. In terms of watercourse crossings, all of the options cross the one unnamed ditch and a NRW Main River, and Option C3 crosses an extra unnamed ditch. Various trenchless options have been considered for the NRW Main River crossing with the proposed cables as noted in Appendix A that would need to be reinstated after works are complete. Any residual adverse effects during construction would likely be very minor using standard pollution control and other mitigation measures.
Socio-Economic Assessment Considerations • Economic Activity	Most of the lands that the route options crosses are mainly agricultural land, hence construction for the proposed options in Section C have the potential to disrupt agricultural and economical activities and the livelihood of landowners. Options C2, C3, and C4 each cross 9 different plots, while Option C1 crosses 10 in total. The primary disruption lies in agricultural activity, which is

Criteria	Commentary
• Traffic Congestion • Transport Corridors • ~~Aviation~~ • ~~Defence~~	the predominant land use here. There are multiple landowners involved in these areas including the heritage railway. Note that none of the options in Section C require permanent land acquisition. Instead, construction requirements involve the temporary acquisition of land for building a cable corridor and installing cables. Subsequently, most of the land will be returned to the landowners for their continued use. During construction, landowners will experience a temporary loss of access, which leads to discussions about fair compensation for this period. All options are required to cross the eastern side of the A487 roundabout, the school playing field right after the roundabout and Snowdon Street. Option C1 and C3 crosses the access road to a local farm after crossing the Heritage Railway, and C3 would have an extra highway crossing near the southern side. Construction activities may disrupt these areas, particularly due to its proximity to an urban and local business area, potentially affecting the school, economic and leisure activities, unless trenchless methods are considered. Careful management of these disruptions will be essential to minimize inconvenience to residents and businesses. It is worth noting that Option C3, which follows the existing 400kV route, would likely be the least disruptive to landowner operations, as it is maintained along the field boundaries for the entire length. Additionally, trenchless construction methods are proposed for the highway crossing, assuming negligible traffic congestion and impact on highway operations. Options C2 and C4, while crossing the heritage railway at the preferred location by external stakeholders, would have the least impact on this transport corridor. The crossing of the local road into Section D was considered to be equal for the two proposed crossing locations and of negligible effect on this scoring.
Cost Assessment Considerations • Capital Cost • ~~Lifetime Cost~~	High level review of capital costs indicates that Option C2 and C4 are preferable due to it being two of the shortest routes and causing the least disruption to landscape/ecology. Whilst Option C3 has the longest cable route length, Option C1 is most costly among all the options due to having higher number of service crossings along the route. The capital cost rate for service crossing was suggest being higher than standard agricultural trenching.
Health & Safety Assessment Considerations • Design Risk • Construction Risk • Operation & Maintenance • Demolition & Decommissioning	Option C3 is considered to be slightly less preferable from a health and safety perspective due to the proximity to the live 400kV cables at the proposed heritage railway and highway crossing. Of the rest of the options, Option C4 is ranked highest as it provides the most room for crossing the highway and crosses the gas main perpendicularly. Option C1 provides additional room before crossing the highway and improves the angle of the highway crossing and is therefore ranked higher than Option C2.

6.3 Comparative Ranking & Conclusion

Assessment Criteria	Technical	Environmental	Socio-Economic	Cost	Health & Safety	Overall
Option C1	Rank 3	Rank 3	Rank 3	Rank 3	Rank 2	Rank 3
Option C2	Rank 2	Rank 2	Rank 2	Rank 1	Rank 3	Rank 2
Option C3	Option discarded.					
Option C4	Rank 1	Rank 1	Rank 1	Rank 2	Rank 1	Rank 1

Option C4 is the preferred route within Section C4. However, upon review of the typical construction swathe and space constraints between the highway and 400kV live cables, it is decided to use the western portion of Option C1 (where the alignment meanders south) to achieve an improved alignment of cables in the approach to the trenchless crossing under the highway. It is also noted that while Option C4 only appears to connect with Options D9, D4, and D8, the route can deviate within the final land parcel to connect with the other options to the north if they are found to be preferable. Option C3 was discarded from the available options primarily due to the heritage rail crossing location and constraints associated with completing works

adjacent to the existing 400kV line. Options C1 and C2 ranked lower primarily due to the less advantageous crossing location of the highway.

7. Section D – Heritage Railway to East of Afon Glaslyn

7.1 Overview & Baseline Condition

Within Section D the underground circuits are to be routed from Snowdon Street (beginning at either Clwb Chwaraeon Madog or Porthmadog FC grounds) to Section E, east of Afon Glaslyn. This route requires crossing the A487 Highway, the Cambrian Railway Line, and several environmental constraints such as the SSSI, SAC and Priority Habitat. Major assets and infrastructure within this section include a high-pressure gas main, surface water ditches, existing 400kV and 132kV cables.

Crossing the highway, railway, utilities, and SSSI is considered to be the most complex portion of the route. Options that were discarded early in the process and not reviewed as part of this appraisal included:

- Open cut highway and railway crossings: Not permitted by Network Rail and strongly opposed by the highway authority.
- Cable bridge across Afon Glaslyn: Would require extensive works within the SSSI and riverbanks, less financially viable given the size of structure that would be required. The cable bridge should be designed in a way that avoids any adverse effects on flood risk.
- Use of existing bridge structures to cross Afon Glaslyn: Not considered due to the age of existing assets, number of cables being constructed, and complexity of construction.

All route options in Section D therefore considered trenchless construction for crossing these major assets and environmental constraints, with open cut construction being used for the other sections of the route. The trenchless options are summarized in the analysis section below and reviewed in detail in Appendix A. The wide construction swathe of approximately 110m to 150m (as noted in Section 3.4) had an impact on the viability of some of the route options.

Nine options in Section D were considered in this appraisal. Options D1, D2, D3, D5, D6 and D7 align with the end of Options C1 and C3, starting north of Clwb Chwaraeon Madog and continuing around the sports ground. At the approach to the highway and SSSI, these options split into various routes crossing the SSSI, primary habitat, railway, and highway. Option D2 is first to deviate south and cross the highway and railway perpendicularly, taking a longer route through the SSSI. Option D3 follows a similar course to Option D2 but farther to the east. Option D1, D5, D6 and D7 continue furthest east before Options D1 and D7 meander south and cross the SSSI. Option D6 simply maintains a southeast trajectory, crossing the highway and railway at an acute angle before reaching Section E. Finally, Option D5 stays north of the highway and reaches Section E at the quarry, outside of the Primary Work Area.

Options D4, D8 and D9 align with the end of Options C2 and C4, starting from the south of Clwb Chwaraeon Madog and routing around Porthmadog FC ground. Option D4 stays north of the highway running from west to east until it combines with Option D2. Option D8 considers and option where the cable routes would be constructed under the A487 highway, deviating towards northeast right before crossing the Afon Glaslyn river and meeting Section E at the quarry outside of the Primary Area. Option D9 runs towards the south, crosses at the highway and railway as soon as possible, before being constructed in the SSSI for the remainder of the route.

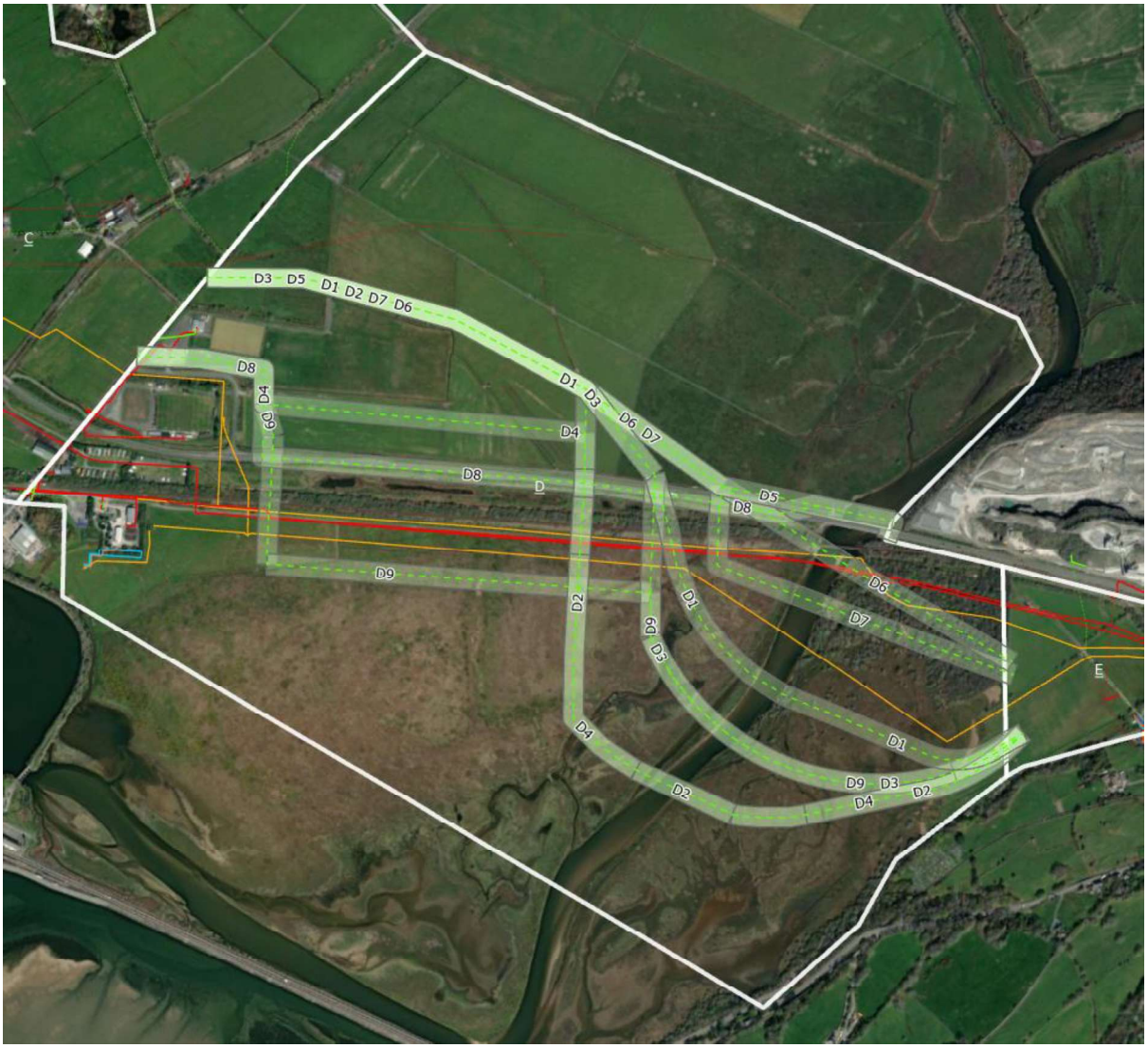


Figure 11: Overview of Section D on GIS model

7.2 Analysis

Criteria	Commentary
Technical Assessment Considerations • Technical complexity • Construction delivery • Project delivery • Carbon ~~• Suitability of Technology~~ ~~• Network Capacity~~ ~~• Network Efficiency / Benefits~~	Option D1 is 2.09km long and Option D1 crosses the highway, railway, gas main, and existing 400kV line at a 75° angle before continuing across the Afon Glaslyn to Section E. This route crosses under the high-pressure gas main and then maintains a 25m offset from the major utility throughout the HDD section. The HDD would need to bend towards Section E after passing under the railway with a radius of 400m or more. This is the preferred alignment noted by the trenchless options report in Appendix A, if this section is completed in a single drive. The HDD length is approximately 1km long, which is achievable with a single cable drum with joint bays on either side. Minimal work is required in the SSSI area, and it would be limited to the eastern perimeter where the HDD would end.

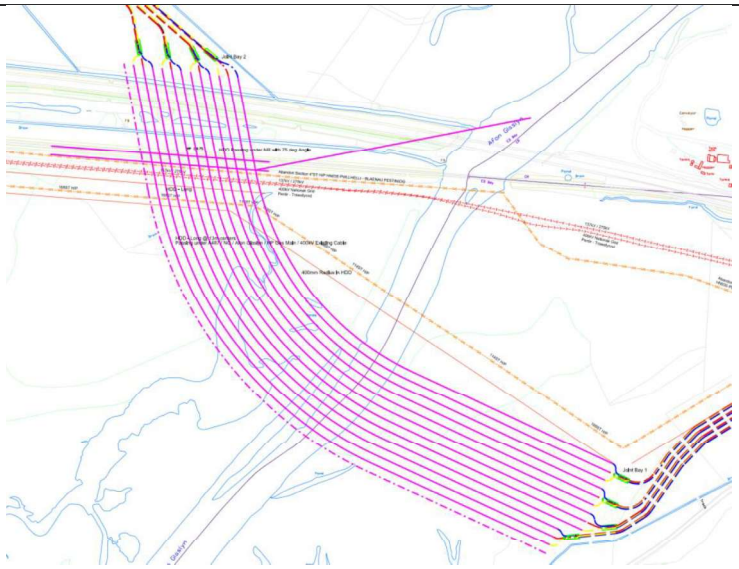


Figure 12: HDD Alignment for Option D1

Options D2 and D4 are the longest route options considered, at 2.45km and 2.53km long, respectively. These routes would cross the highway, railway, gas main, and existing 400kV line at a 90° angle and require some open cut construction in the SSSI before a second HDD is completed across the Afon Glaslyn. This option is feasible but is seen as technically more complex than Option D1 due to the additional construction works required in the SSSI. In terms of the technical assessment, the construction and project delivery would be more complex. Option D4 connects with Option C2 and C4 at a pinchpoint between the football club and the sports club, requiring a reduction in the construction swathe. Since Option D2 is slightly shorter and can maintain the typical cross section, it is preferred above Option D4.

Option D3 is 2.23km long and is very similar Option D1, except that this route would cross the highway, railway, gas main, and existing 400kV line at a 90° angle, instead of at 75°. Crossing the major constraints in a single HDD of approximately 1.4km (as shown by the blue cables in Figure 13 below) was considered to be more complex than options D1, D2, and D4. In addition, the maximum cable length offered by Iljin, the preferred supplier, is 1050m. To make this alignment work with the preferred supplier, this crossing would need to occur in two separate drives, one shorter drive under the highway and railway and then a second drive under the remaining SSSI and Afon Glaslyn. The Figure below demonstrates the requirement for a works area within the SSSI. As mentioned for Option D2, this is considered less preferable from a technical standpoint. Option D9 is similar to Option D3 except that the first HDD alignment occurs farther east, which requires a larger portion of open cut excavation within the SSSI.

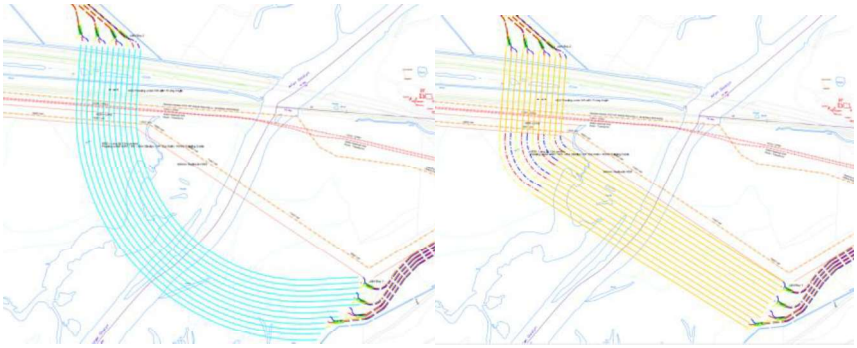


Figure 13: HDD Alignments for Option D3

Option D5 considers an HDD crossing of the river Glaslyn to the north of the highway, meeting Section E outside of the primary work area. Upon review of the spacing requirements for HDD crossings and the proximity of the Quarry, highway, and railway, this option was discarded.

Option D6 is considered the shortest route that meets Section E. While this is advantageous in terms of cable length, this option was discarded due to feedback from Network Rail that crossings at an acute angle are not acceptable.

Option D7 considers crossing the railway at a 90° angle with and HDD, having a small section of open cut to realign the cables, and then using another HDD to cross under the Afon Glaslyn. This option is similar to option D3 except that the alignment stays north of the high pressure gas

Criteria	Commentary
	main. This option is complex and high risk as the cables would need to re-surface between the live 400kV cables and high-pressure gas main. It was therefore discarded from the analysis. Option D8 considered a potential route of following the highway. This option was discarded due to multiple technical issues including cable installation swathe, stakeholder feedback, and inadequate space for the river and railway crossings.
Environmental Assessment Considerations • Landscape / Visual Amenity • Ecology • Historic Environment • ~~Local Air Quality~~ • ~~Noise & Vibration~~ • ~~Soils & Geology~~ • Water	Although all the routes cross the SSSI, SAC, and Priority Habitat areas. All routes require a combination of both open-cut and trenchless construction in these restricted areas. Option D1 offers the preferred option with the least amount of construction work within the SSSI, and that work would be restricted to the eastern edge, where the long HDD would terminate. To the north of the highway, it is anticipated that all options can be adjusted slightly during the design to avoid Priority Habitat area to the north of A487 highway. Options D4, D8 and D9 have no impact on hedgerow boundaries along the route whilst Options D1, D2, D3, D5, D6 and D7 all require two hedgerows to be removed and replaced. Any tree or hedgerow removals within the construction swathe highlight potential impacts on wildlife habitat. Noise & Vibration, Local Air Quality, and Soils & Geology criteria are also considered to be negligible for this Section as the differences between each option are minimal. All Options within Section D do not cross any conservation areas, listed buildings, or ancient woodlands, and any adverse effect during construction assets or their setting would be very minor. The entire Work Area is within the extents of the historic landscape area, showing no differentiation between all route options. There are no scheduled monuments within the project area as well. In terms of watercourse crossings (apart from the Afon Glaslyn), all routes appear to cross at least 7 unnamed watercourses/ditches that would need to be reinstated after works are complete. The entire Work Area is within the extents of the Flood Zone 3, showing no differentiation between all route options.
Socio-Economic Assessment Considerations • Economic Activity • Traffic Congestion • Transport Corridors • ~~Aviation~~ • ~~Defence~~	In Section D, the predominant land use is agricultural, with most of the land falling into this category. All options cross between 4 to 7 different plots. It is essential to underline that none of the options in Section D necessitate the permanent acquisition of land. Instead, construction requirements involve the temporary acquisition of land for constructing a cable corridor and installing cables. Afterward, the land will mostly be returned to the landowners for their continued use. During the construction phase, landowners may experience a temporary disruption in access, prompting discussions on fair compensation for this interim period. It is important to note that Options D8, D4, and D9 could be more disruptive to the sports club and football club due to the connection point with Section C, potentially affecting their leisure or economic activity. Among these options, D8 is the most disruptive as it requires extensive open-cut work along the A487 highway, leading to heavy traffic congestion and affecting the transport corridor. Consequently, this option was discarded. Trenchless construction methods are proposed for the highway and railway crossing in all other options, which is expected to result in negligible traffic congestion and minimal impact on highway operations. Option D1 is the most preferred because it involves no major temporary works and construction access requirements within the SSSI area to the south of the railway and west of the Afon Glaslyn.
Cost Assessment Considerations • Capital Cost • ~~Lifetime Cost~~	High level review of capital costs indicates that of all the options, Option D3, D4 and D9 are the least favourable as they are significantly costly due to the longest HDD lengths crossing the SSSI Area. Similarly, Option D6 and D7 have slightly reduced capital cost due to fewer crossings and relatively shorter HDD length. Whilst Option D5 and D8 both have the shortest cable route length and the lowest estimated capital cost, both options were discarded due to multiple technical issues. As a result, Option D1 and D2 are preferable due to them being the only possible options with least HDD lengths and crossings. Option D1 is considered to be the most preferable as it has the lowest estimated capital cost in this analysis.
Health & Safety Assessment Considerations • Design Risk • Construction Risk • Operation & Maintenance • Demolition & Decommissioning	Option D1 is considered to be the most preferable as it would require the least amount of temporary works within the SSSI area. In addition, it stays north of the pinch point between the sports club and football club and therefore the typical cross section can be maintained. The other options are ranked according to the amount of work required within the SSSI.

7.3 Comparative Ranking & Conclusion

Assessment Criteria	Technical	Environmental	Socio-Economic	Cost	Health & Safety	Overall
Option D1	Rank 1	Rank 1	Rank 1	Rank 1	Rank 1	Rank 1
Option D2	Rank 3	Rank 3	Rank 3	Rank 2	Rank 3	Rank 3
Option D3	Rank 2	Rank 2	Rank 2	Rank 3	Rank 2	Rank 2
Option D4	Rank 4	Rank 4	Rank 4	Rank 5	Rank 4	Rank 4
Option D5	Option Discarded					
Option D6	Option Discarded					
Option D7	Option Discarded					
Option D8	Option Discarded					
Option D9	Rank 5	Rank 5	Rank 5	Rank 4	Rank 5	Rank 5

Option D1 ranks first since only 1 HDD is required and work within the SSSI area would be limited. The other available options rank lower due to the requirement for two separate HDDs and open cut construction within the SSSI. Finally, Options D4 and D9 rank lower as they connect with Section C at a pinch point.

8. Section E – East of Afon Glaslyn to Minffordd CSEC

8.1 Overview & Baseline Condition

Within Section E the underground circuits are to be routed from the east of Afon Glaslyn to Minffordd CSEC through a relatively smaller open flat area of arable land that contains a few drainage ditches and hedgerows. Major assets and infrastructure in this section for consideration include the Minffordd CSEC, surface water ditches, existing HV and LV cables and telecoms.

Four options were considered as shown in Figure 14 below. After crossing the woodlands in the SAC and SSSI region, Option E1 aligns with the end of Options D1, D2, D3, D4 and D9 at the southmost of Section E. Similarly, Option E3 aligns with the end of Option D7 and Option E4 aligns with the end of Option D6. In contrast, Option E2 starts from the Afon Glaslyn and aligns with the end of Option D5 and D8, running from west to east between the A487 highway and the quarry. It meanders south after reaching the quarry entrance and crosses perpendicular to the highway and railway until it arrives the Minffordd CSEC.



Figure 14: Overview of Section E on GIS model

8.2 Comparative Ranking & Conclusion

As the previous section of this report discarded Options D5 to D8, the only available option for consideration is Option E1. Due to the size of this area and the connection with Snowdonia VIP tunnel project, no further analysis was conducted.

9. Conclusion

Option A1, Option B3, Option C4, Option D1, and Option E1 have been selected as the preferred option for each section, as shown in Table 3 below.

Table 3: Summary of Options Ranking

Section	Option #								
	1	2	3	4	5	6	7	8	9
A	Rank 1	Rank 3	Rank 2						
B	Rank 3	Rank 2	Rank 1						
C	Rank 3	Rank 2	Discarded	Rank 1					
D	Rank 1	Rank 3	Rank 2	Rank 4	Discarded	Discarded	Discarded	Discarded	Rank 5
E	Rank 1	Discarded	Discarded	Discarded					

Option A1 is the preferred route within Section A1, ranking highest for all criteria. It is the shortest route considered within this section and had the least asset/constraint crossings, and maintains a safe distance from the gas main. Staying to the south of the existing ditch, this route offers an advantage over the other options as it stays away from an OHL route. It is also possible to make adjustment to the route to limit tree removal. From a socio-economic perspective, Option A1 maintains a similar alignment to the existing 400kV line which will be less disruptive to landowners as construction and decommissioning works can occur within the same construction swathe. Option A2 ranked lower primarily due to the proximity with the OHL along the route, which resulted in adverse effects on most of the scoring criteria. Option A3 deviates quite far from the land boundary which started to increase cable length and introduce socio-economic concerns. It is important to note that all options in Section A share common attributes in terms of the environmental assessment, no impact on conservation areas, listed buildings, or ancient woodlands, and expected minor construction effects on assets and their setting. Additionally, construction in SSSI, SAC, or Priority Habitat areas is not required, and criteria related to Noise & Vibration, Local Air Quality, and Soils & Geology are considered neutral, with any residual adverse effects during construction anticipated to be minimal with standard mitigation measures.

Option B3 is the preferred route within Section B. This option would provide more flexibility with the A498 highway crossing location and would allow the construction swathe to avoid an existing golf driving range. Option B3 follows the route of the 400kV cables relatively closely as well as the route of an existing access track. Constructing the cable route on this alignment would likely be less disruptive to the landowners as construction and decommissioning works can occur within the same construction swathe. Option B1 ranks lower primarily due to being in a separate plot to the existing cables, which resulted in adverse effects on most of the scoring criteria. Furthermore, Option B1 crossed the existing 400kV line twice and did not align with the preferred Option from Section A. Finally, while Option B2 is extremely similar to Option B3, it ranked lower due to the impact on the driving range and reduced flexibility at the A498 highway crossing. In Section B, all options share common attributes in terms of the environmental assessment. There is no impact on conservation areas, listed buildings, or ancient woodlands. Minor construction effects are expected on assets and their settings, and no construction is required in SSSI, SAC, or Priority Habitat areas. Noise & Vibration, Local Air Quality, and Soils & Geology criteria are considered neutral, with any residual adverse effects during construction anticipated to be minimal and manageable through standard mitigation measures.

Option C4 is the preferred route within Section C4 primarily due to the highway crossing location being preferable in the technical and environmental assessment. It is also noted that while Option C4 only appears to connect with Options D9, D4, and D8, the route can deviate within the final land parcel to connect with Option D1. Option C3 was discarded from the available options primarily due to the heritage rail crossing location and constraints associated with completing works adjacent to the existing 400kV line. Options C1 and C2 ranked lower primarily due to the less advantageous crossing location of the highway. Whilst Option

C4 has less impact on hedgerow boundaries and trees, and less disruption to landscape/ecology due to reduced length, it is important to note that all options in Section C have no impact on conservation areas, listed buildings, or ancient woodlands. Construction effects on assets are minor, and none require work in SSSI, SAC, or Priority Habitat areas. Criteria related to Noise & Vibration, Local Air Quality, and Soils & Geology are neutral, with expected minimal adverse effects during construction, manageable through standard mitigation measures.

Option D1 ranks first in Section D since only 1 HDD is required and work within the SSSI/SAC/Priority Habitat area would be limited to the eastern perimeter where the HDD terminates and involves no major temporary works and construction access requirements within the SSSI area to the south of the railway and the west of Afon Glaslyn. The other available options rank lower due to the requirement for two separate HDDs and open cut construction within the SSSI. Finally, Options D4 and D9 rank lower as they connect with Section C at a pinch point. Options D5 to D8 have been discarded following further technical review and feedback from stakeholders, which indicated that they were not feasible. In Section D, it is noteworthy again that there is no impact on listed buildings or ancient woodlands. The criteria related to Noise and Vibration, as well as Local Air Quality, are manageable through standard mitigation measures. Additionally, Soils and Geology do not influence the selection of the route, affirming the feasibility of the chosen path. The analysis for Option D resulted in Option E1 being chosen by default within Section E.

It is worth noting that the routes included in this Option Appraisal Report are preliminary to inform options appraisal. It is recommended that minor adjustments will be made to the route during preliminary design to avoid hazards, reduce risk, and limit impact of the proposed works. Following this Options Appraisal Report, engagement will continue with relevant stakeholders and landowners. A proposed design will be put forward for the preferred route that can be taken forward to the consenting stage.

Appendix A

Trenchless Options Report