4.3.B A487 Highway Crossing Options Appraisal

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Technical Note

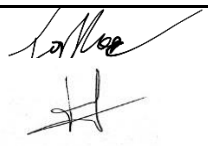
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1. Introduction

This technical note aims to summarise how the A487 highway crossing options have been selected as part of the Glaslyn Cable Uprating project.

2. Glaslyn Cable Uprating

National Grid are undertaking upgrades to the Pentir – Trawsfynydd 4ZC route to allow for future offshore wind power generation connection to the National Grid. The works have been split into the following 5 projects:

- Uprate existing National Grid 400kV Glaslyn Cables
- Replace 132kV SPEN Glaslyn Cables with 400kV
- 4ZC Pentir – Traws OHL Uprating
- New Bryncir Grid Supply Point
- Pentir & Trawsfynydd Cross Site Cables & Minor Substation works

In the vicinity of Porthmadog, the Glaslyn Cables Uprating and replacement of the 132kV SPEN (Scottish Power Energy Network) Cables will interface with the Welsh Government Strategic Highway Network, in the form of the A487 Porthmadog Bypass.

The works comprise of the installation of a new 400kV circuit to replace the existing National Grid 400kV cable installed in the 1960s, and the installation of a new 400kV circuit to replace the existing SPEN 132kV cables running from Trawsfynydd to Four Cross. Four Cross will be served from a new Substation to be built at Bryncir. These works also interface with the Eryri Visual Impact Provision (EVIP) project at Garth / Minffordd where a new tunnel and headhouse are being constructed.

Both existing cable systems run from Garth Cable Sealing End Compound (CSEC) to Wern CSEC as buried cables. Both circuits pass through a SSSI flood plain area adjacent to the Afon Glaslyn and then run alongside the Network Rail Cambrian Railway towards Porthmadog. The cables then split with the 400kV cable running to the north of Porthmadog crossing the High Street just north of the North Wales Fire and Rescue Station and SPEN substation.

The requirements for the new circuits were assessed by National Grid in 2012 and buried cables were selected as the preferred solution to replace the existing cable system.

Murphy Power Networks Limited (MPNL) have been appointed by National Grid to develop a new cable solution to replace the existing circuits whilst the existing circuits remain operational until switchover. MPNL appointed Arup to support the development of the cable design solution.

Part of that scope was to develop a new cable route corridor, optimising the route whilst minimising the impact on the environment and ecology, third party assets and the existing cable corridors.

An option appraisal report (GLAS-ARUP-DS-ZZ-RP-X-0004) was produced to show the various cable route options considered and assess the impact of the scheme to make a recommendation for a preferred route.

Figure 1 below shows the recommended cable corridor along with some of the environmental constraints and utility constraints shown.

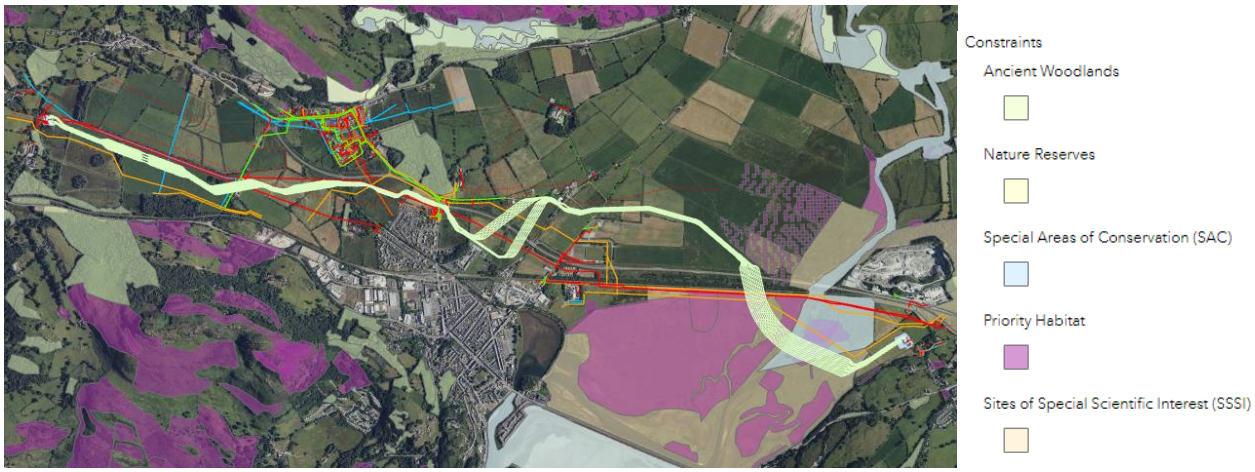


Figure 1 - Glaslyn Cable corridor.

The proposed cable corridor crosses the A487 in two locations, in horizontal directional drills (HDDs) to minimise the impact on the highway. There is also a pinch point where the cables cross the A487 / High Street roundabout which is proposed to be an open cut solution. More details for each of these crossings are provided in this report.

It is highlighted that, as part of the option selection process, consideration was given to routing the cable corridor to the south of the A487, following the line of the existing 400kV cable and thus avoiding the two crossings of the highway. This option was evaluated and determined to be unsuitable due to the number of constraints.

In this scenario the corridor would follow the line of the existing 400kV cable. Given that the existing cables are operational, the new cables have to be constructed offline from the existing live cable. The new cable corridor width in an open cut arrangement is approx. 25-30m and, given the space constraints at certain locations, this would constrain the amount of works that could be undertaken while the cables are live.

As the route progresses east, the existing corridor routes between the A487 Porthmadog Bypass and the Network Rail Cambrian Railway, through a caravan park before the cable turns south, to pass under the railway into the Afon Glaslyn flood plain marshes which are a SSSI. Routing the new cable corridor along this alignment would require the demolition of a farm building and the closure of the caravan park as the new corridor would take up the entire width and length of the park. The cable would then either have to route between the A487 Porthmadog Bypass and the railway, thus clashing with the SUDs drainage and ponds adjacent to the bypass or pass under the railway into the SSSI flood plain marshes. Crossing under the railway would require an undertrack crossing compliant with Network Rail standards. With the limited space afforded between the A487 and the railway, drilling under the railway was deemed not achievable due to the lack of space needed for the HDD worksite on the north side of the railway and the need to construct a further worksite within the SSSI site, south of the railway. An open cut crossing of the railway was also considered but the same issue applies to the worksites and the additional need for a blockade of the railway to construct the open cut crossing.

Given these constraints, this option was not taken forward and alternative options crossing the A487 were developed as described in the following sections.

3. A487 Highway Crossing Locations

The project area has been split into a total of 5 sections in line with the Options Appraisal Report (GLAS-ARUP-DS-ZZ-RP-X-0004), from Section A in the vicinity of the Wern CSEC through to Section E in the vicinity of the proposed Minffordd CSEC. Figure 2 below shows the location of these sections:

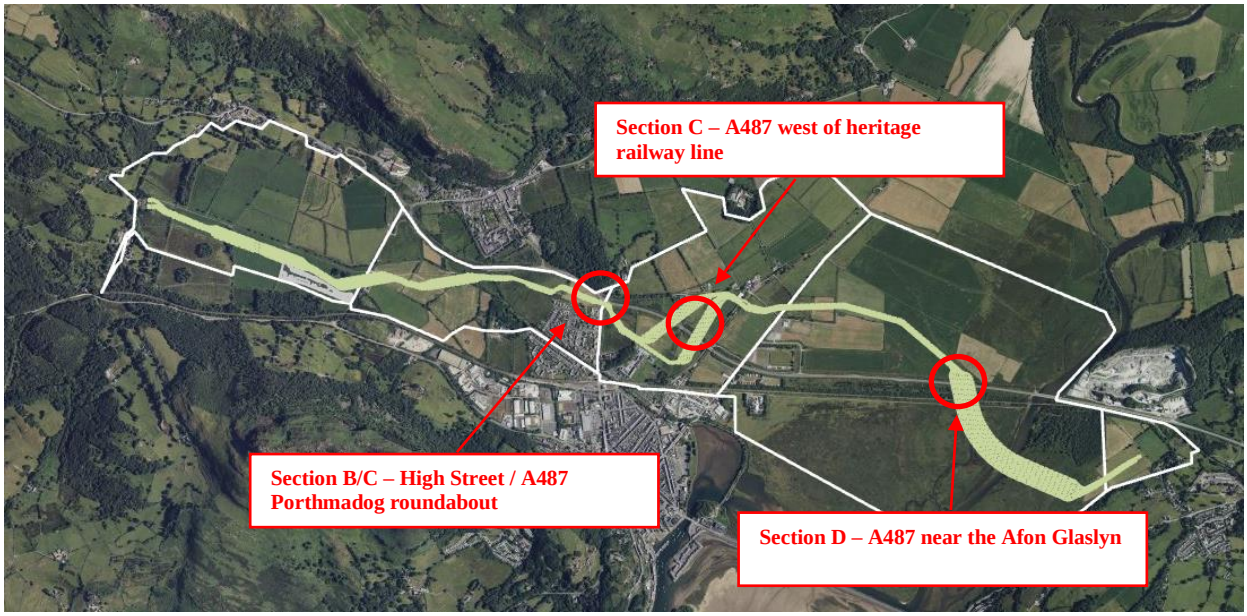


Figure 2: Overview of Glaslyn Cable Uprating project including sections

The new cable corridor intersects the A487 highway at 3 locations:

- Section B / C – High Street / A487 Porthmadog roundabout.
- Section C – A487 west of the heritage railway line.
- Section D – A487 near the Afon Glaslyn.

4. Appraisal Methodology

Multiple options have been appraised in a qualitative manner for each crossing as described below. It should be noted that, while the options largely align with the options described in the Options Appraisal Report, options in the vicinity of the A487 roundabout have been expanded in this note for completeness.

Where multiple route options cross the A487 highway in an identical manner, these have been grouped together for the purposes of this technical note. Please refer to the Options Appraisal Report for a more detailed assessment of the distinction between these routes and the corresponding benefits and drawbacks.

This note does not detail the relative benefits and drawbacks of HDDs with respect to other trenchless techniques. For a detailed assessment of these, please refer to the Trenchless Optioneering Report (GLAS-ARUP-DS-ZZ-RP-X-0005). Where trenchless techniques are referenced, these are assumed to be HDD throughout this note.

5. Route Options Description and High-level Appraisal

5.1 Section B / C – A487 near the Porthmadog roundabout

Routing of the new 400kV cables requires the cable corridor to pass Porthmadog. Options to take the cables through the centre of the town, or to the south, were discounted on the grounds of no clear corridor options without significant interface with existing buildings / properties. National Grid will not accept tunnel solutions under buildings unless no other options are available. Options to the north of the town were considered feasible due to the open land and possibility of routing around the built-up areas. Several options were assessed to route the corridor across the High Street / A487 roundabout, and the key options are detailed below.

5.1.1 Description of Options

The following options have been considered to achieve a crossing from the west of Porthmadog through to the east:

- **Option 1A A487 Roundabout - Open Cut Trench:** the cable route approaches Porthmadog towards the north and crosses the Porthmadog roundabout with an open cut trench, turning southeast to run almost parallel to the A487 highway.
- **Option 1B A487 Roundabout – HDD**: the cable route approaches Porthmadog in a similar manner to Option 1A, but the crossing of the Porthmadog roundabout is achieved by use of HDD. The HDD would end southeast of the roundabout, on the south side of the A487 highway.
- **Option 2 Woodland Route**: approaches Porthmadog towards the north and avoids crossing the Porthmadog roundabout by crossing the A487 highway at a high skew angle to the west of the roundabout, by use of HDD. The HDD would then pass under an environmentally sensitive ancient woodland and a residential building. The crossing would end to the east of the ancient woodland.
- **Option 3 Porthmadog Town Route – HDD**: crosses the town of Porthmadog from east to west by use of HDD with an alignment which is south of the Porthmadog roundabout, thereby avoiding crossing the A487 highway. This HDD alignment would require the drill to pass under a large residential area on the outskirts of Porthmadog.

Indicative figures for each option have been included in the following sections to aid appraisal of these.

5.1.2 Option 1A – A487 Roundabout - Open Cut Trench

This option takes the cable corridor route over the High Street / A 487 roundabout junction in an open cut trench solution. It is located between the existing 400kV cables immediately to the south, with the SPEN substation beyond that, and the high-pressure gas main to the north, with the river and ancient woodland beyond that. These constraints create a narrow pinch point to pass the new cables through. The cable design has been adapted to allow the cables to be built into the central island of the roundabout, so that the construction can be phased to both sides of the roundabout and a suitable traffic management scheme can be developed, thus keeping a traffic managed solution for all arms of the roundabout at all times.

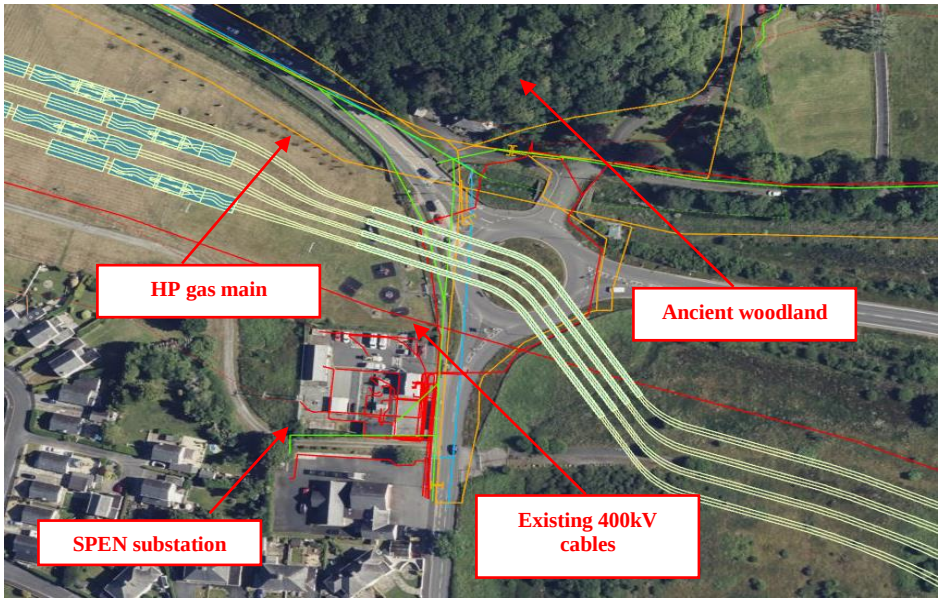


Figure 3: Indicative layout of cables for Option 1A

Benefits	Challenges
Uses an established and safe construction technique to achieve the crossing. Does not impact the high-pressure gas main to the north of the roundabout; works can be progressed beyond its exclusion zone. Minimises risk in terms of impacting the structural integrity of nearby properties and infrastructure. In particular, it does not impact the local substation which is immediately to the south of the roundabout. Does not impact the environmentally sensitive ancient woodland immediately to the north of A487. Can be constructed whilst the existing 400kV cable remains operational. Overall permanent environmental impact likely to be negligible. Offers more flexibility with respect to other options in terms of	Requires open excavation of the A487 roundabout and subsequent reinstatement. Requires works in the vicinity of numerous services. Requirement to carefully protect these assets. In particular requires near crossing of SPEN assets. Requires temporary diversion of ditch southeast of the roundabout during construction. Requires traffic management during open cut excavation and install operation, which will be disruptive to the local area. Will result in temporary disruption to local community in terms of noise. This solution will require the temporary removal of the adjacent playground whilst the works are progressing. Requirement for a supported trench solution and likely requirement for dewatering scheme to control groundwater

Benefits	Challenges
reducing impacts to the nearby stone circle and options for relocating the playground have been proposed. Expected to be less costly solution. Allows for a suitable traffic management regime to be instigated to keep all traffic movements between A487 and High Street during the construction phase. Health and safety aspects can be managed by a competent contractor.	entering excavation.

5.1.3 Option 1B – A487 Roundabout – HDD

The alignment of the cable corridor is the same as option 1A but a HDD solution is considered to pass the cables under the roundabout, thus minimising the traffic disruption during the construction phase. To ensure the HDDs can be constructed, the cable spacing has to be increased to allow each drill to be built without clashing with the adjacent drill. The additional depth of each cable also generates additional heat in the cables when operating so this also requires the cables to be spaced apart to keep the cables within the normal operating temperature range. The additional space required to construct the HDD for each cable makes this solution very challenging in terms of clashes with the existing 400kV cables and the high-pressure gas main.

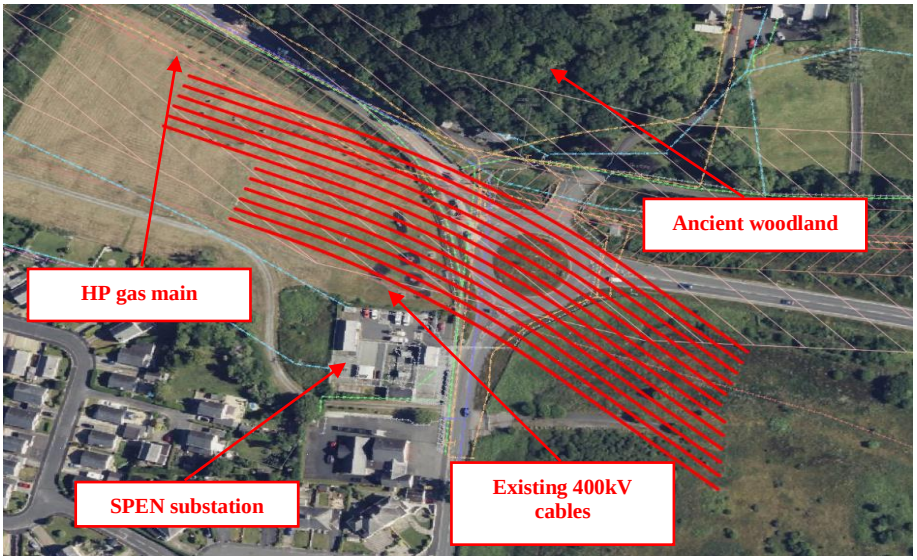


Figure 4: Indicative layout of cables for Option 1B

Benefits	Challenges
Crosses existing services at depth thus simplifying the protection of these. Does not require temporary traffic management hence avoiding the risk of disruption to the local community and associated congestion. Avoids temporary diversion of the ditch to the southeast of the	Clashes with existing 400kV operational cable at launch / exit areas. Require significant temporary works / possible diversion of existing cable to be feasible. Complex curve likely to be required to achieve this HDD alignment which may be a construction challenge.

Benefits	Challenges
roundabout during construction. Overall permanent environmental impact likely to be negligible. Crosses the under existing playground minimising disruption in this area.	Launch/exit areas significantly constrained due to the presence of overhead lines and the high-pressure gas main to the north of the roundabout. Alignment of northern HDD's would pass under the existing high-pressure gas main, requiring mitigation measures to protect the asset. Requires long HDD drive (~240m) which could in turn result in greater spacing, thus increasing the construction corridor and requiring going under nearby properties and/or infrastructure such as the substation, with the associated structural risk. Requires settlement monitoring of roundabout. Introduces risk of frac-out and settlement. May require the removal of the stone circle. Will result in temporary disruption to local community in terms of noise. Costly solution, but less than other HDD alternatives.

5.1.4 Option 2 – Woodland Route

This option considered an HDD solution to the north of the A487 roundabout. The long HDD solution would start to the east of the recreation ground and pass under the environmentally sensitive ancient woodland areas to the north of the A487. The HDD would also have to pass under the Bodawen nursing home building. Whilst this solution is technically viable, National Grid will not accept tunnel solutions that pass below third-party buildings or solutions under / through environmentally sensitive sites if alternative options are available.

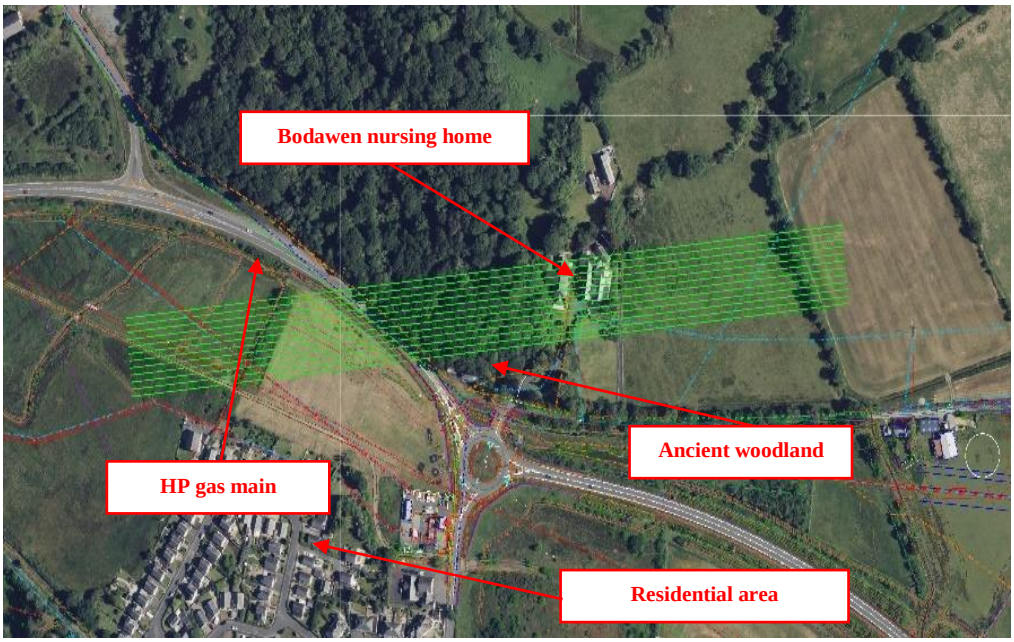


Figure 5: Indicative layout of cables installed for Option 2

Benefits	Challenges
Avoids construction in the roundabout area entirely. Avoids the requirement of an additional highway crossing in Section C. May cross existing services at depth thus simplifying the protection of these. Does not require temporary traffic management hence avoiding the risk of disruption to the local community and associated congestion. Avoids temporary diversion of the ditch to the southeast of the roundabout during construction. No direct impact to stone circle and playground.	Is likely to require going under the care home, with the associated structural risk. Routing under a third-party property is not acceptable to National Grid. Goes under the ancient woodland which is an environmentally sensitive area. Could result in overall increase in cable route length, with implications on the electrical design. Launch/exit areas significantly constrained due to the presence of overhead lines and the high-pressure gas main to the north of the roundabout, as well as the existing 400kV line. Crosses gas mains on five occasions at an acute angle, which is not likely to be acceptable to the gas service provider. Requires long HDD drive (~650m) which could in turn result in greater spacing, thus increasing the construction corridor. Introduces risk of frac-out and settlement. Will result in temporary disruption to local community in terms of noise. Requires settlement monitoring of A487.

5.1.5 Option 3 – Porthmadog Town Route - HDD

This option considers a HDD solution to the south of the A487 roundabout. The HDD would have to pass under the residential areas of Maes Gerddi / Meadow Drive. Whilst technically this would be possible, National Grid will not accept a route under third-party properties when alternative options are available.

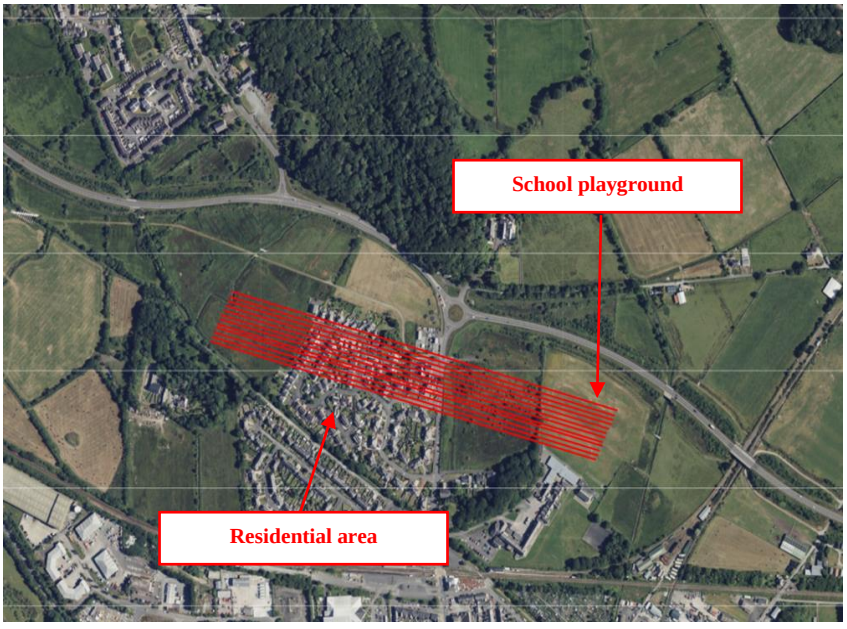


Figure 6: Indicative layout of cables for Option 3

Benefits	Challenges
Avoids construction in the roundabout area entirely. May cross existing services at depth thus simplifying the protection of these. Does not require temporary traffic management hence avoiding the risk of disruption to the local community and associated congestion. Avoids temporary diversion of the ditch to the southeast of the roundabout during construction. No direct impact to stone circle and playground.	Will require going under a significant number of properties, with the associated structural risk. Routing under third-party properties is not acceptable to National Grid, if alternative options are available. Launch/exit areas significantly constrained due to the presence of overhead lines, high-pressure gas main and combined sewer to the east of Porthmadog. Requires long HDD drive (> 700m) which could in turn result in greater spacing, thus increasing the construction corridor. Introduces risk of frac-out and settlement. Impacts the playground of the local school at the eastern end. Will result in temporary disruption to local community in terms of noise. Expected to be most costly solution. Health and safety risks for general public.

5.2 Section C - A487 west of heritage railway

5.2.1 Description of the Options

The following options have been considered with respect to the crossing of the A487 highway west of the heritage railway line, as informed by the preferred option for A487 roundabout crossing, which results in the cable route approaching the area towards the southeast of the Porthmadog roundabout.

All of the proposed options require crossing the A487 highway towards the north. Alternatives which do not cross the highway in this area are not considered feasible due to the reasons outlined in Section 2.

All of the options considered below make use of HDD to achieve the highway crossing towards the north.

- **Option C1** routes south of the existing 400kV cables before heading north by crossing the A487 highway, immediately north of the school building. It then crosses fields and a ditch and crosses the Heritage Railway further 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, slightly further to the west than Option C1. It then crosses fields and the ditch at approximately the same location as Option C1; however, it crosses the Heritage Rail further south than Option C1 (south of the station building) before entering the Clwb Chwaraeon Madog grounds. For the purposes of the highway crossing, C1 and C2 are considered comparable.
- **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 D.
- **Option C4** is similar to Option C2 but crosses the A487 highway at a point further to the east, just west of the existing bridge structure.

Indicative figures for each option have been included in the following sections to aid appraisal of these.

5.2.2 Options C1/ C2

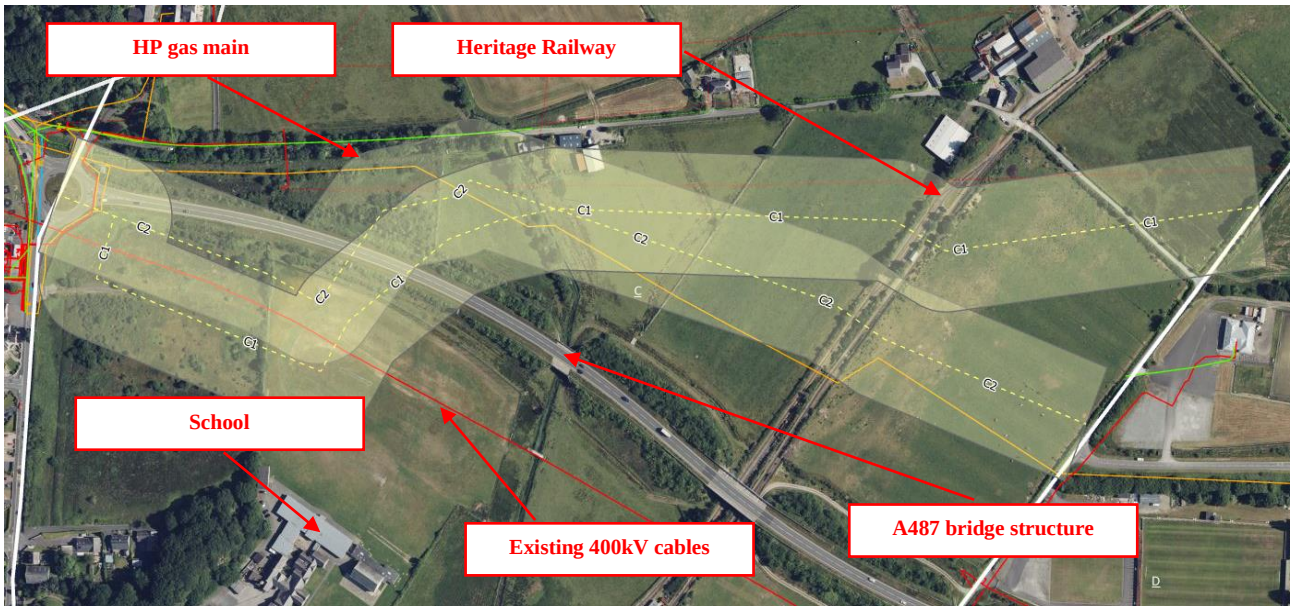


Figure 7: Indicative layout of cables for Options C1 and C2

Benefits	Challenges
Shortest route options. Acceptable highway crossing angle (closer to perpendicular). Does not cross any conservation areas, listed buildings, or ancient woodlands. No construction is required in SSSI, SAC, or Priority Habitat areas. HDD avoids direct impact on A487 highway and the need for temporary traffic management measures and potential congestion. C2 is expected to be the least costly solution of all options.	C1 a challenging solution due to the large number of service crossings. C2 is comparable. Requires HDD drive to achieve the A487 highway crossing and introduces the risk of frac-out and settlement. Requires settlement monitoring of live carriageway pre, during and post HDD installation. Proximity to gas main and overhead power lines; however, risks can be managed. Proximity to existing 400kV underground cables which will introduce constraints to the HDD profiles and/or HDD compounds. C1 expected to be the costliest option of all options due to number of service crossings. Disruption to agricultural activity, C1 affects a large number of landowners of all options, but C2 is comparable. C2 crosses an existing woodland just north of the A487 highway. Both Options C1 and C2 cross the high-pressure gas main at an angle.

5.2.3 Option C3

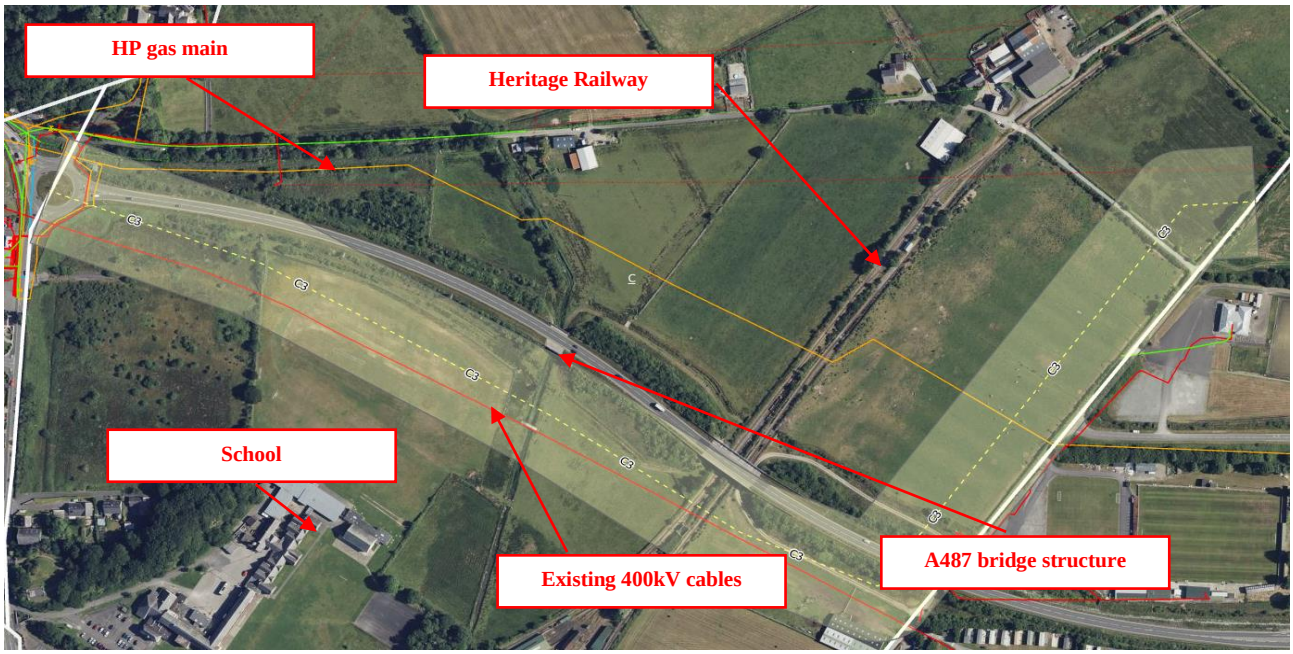


Figure 8: Indicative layout of cables for Option C3

Benefits	Challenges
Does not any cross any conservation areas, listed buildings, or ancient woodlands. No construction is required in SSSI, SAC, or Priority Habitat areas. Likely least disruptive to agricultural activity as it runs along existing boundaries. HDD avoids direct impact on A487 highway and the need for temporary traffic management measures and potential congestion. Offers good crossing angle of high-pressure gas main.	Longest route option. Requires HDD drive to achieve the A487 highway crossing and introducing the risk of frac-out and settlement. Requires settlement monitoring of live carriageway pre, during and post HDD installation. Does not provide sufficient spacing to develop the HDD to achieve the highway crossing. Crosses the heritage railway line at a constrained location south of the A487 highway, between the highway and existing buildings. Requires completion of works adjacent to existing (live) 400kV cable. Most disruptive in terms of requirements for removal of vegetation as it crosses several vegetated boundaries in open cut. Disruption to agricultural activity; however, likely to be less disruptive as it runs adjacent to existing boundaries. Least preferable option in terms of health and safety due to proximity of existing 400kV line.

5.2.4 Option C4

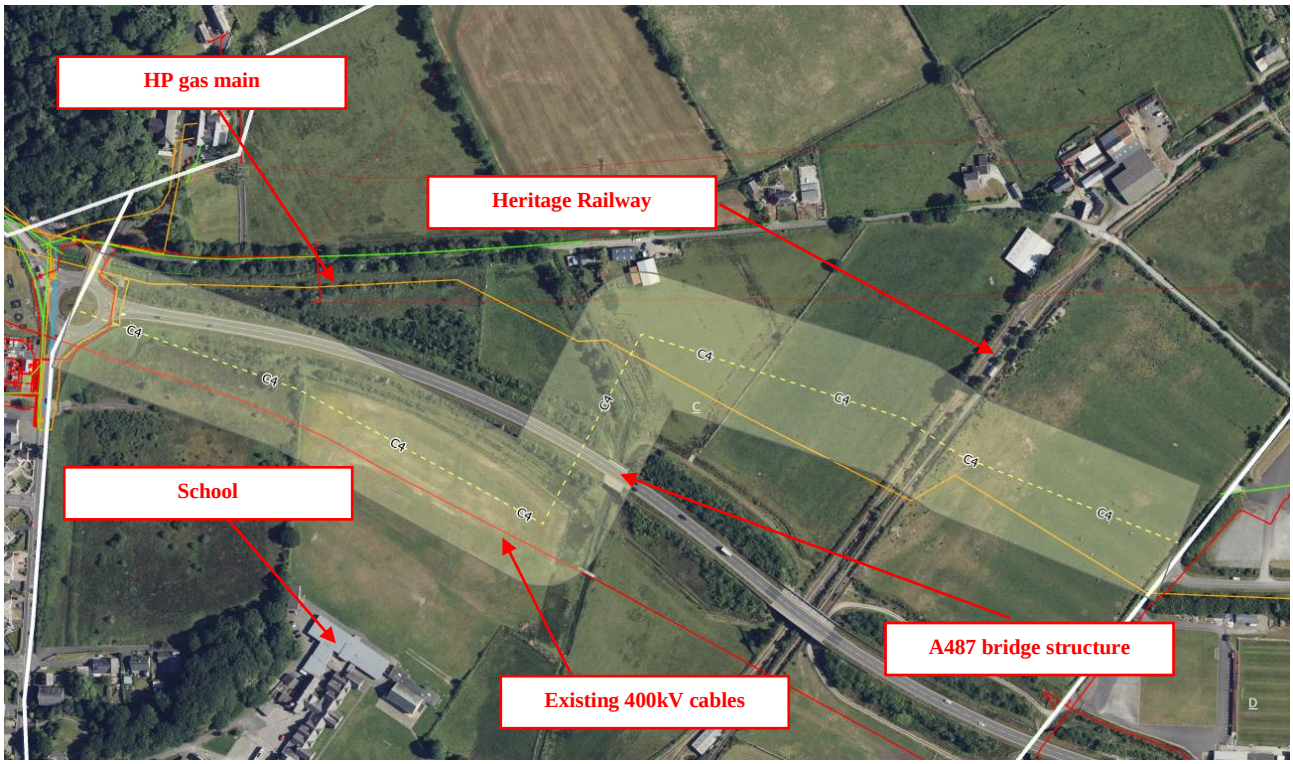


Figure 9: Indicative layout of cables for Option C4

Benefits	Challenges
Second shortest route overall. Crosses the heritage railway at the preferred location by Heritage Railway. Less significant impact on the heritage railway line (avoids impacting the train station). Offers good crossing angle of high-pressure gas main. Provides more space and flexibility in terms of setting up the launch/exit areas of the HDD. Least impact on hedgerow boundaries and trees. Does not cross any conservation areas, listed buildings, or ancient woodlands. No construction is required in SSSI, SAC, or Priority Habitat areas. HDD avoids direct impact on A487 highway and the need for temporary traffic management measures and potential congestion.	Requires HDD drive to achieve the A487 highway crossing and introducing the risk of frac-out and settlement. Requires settlement monitoring of live carriageway pre, during and post HDD installation. Proximity to gas main and overhead power lines; however, risks can be managed. Crosses a ditch to the northern side of the HDD. Northern side is also closer to existing buildings than other options. Disruption to agricultural activity. Preferred solution in terms of health and safety due to greater flexibility to implement the HDD.

5.3 Section D – A487 near the Afon Glaslyn

5.3.1 Description of Options

The following options were considered for the crossing of the A487 highway to the west of the Afon Glaslyn, as informed by the preferred option in Section C, which results in the cable route approaching the area from the north. The options are also informed by the requirement to reach the Minffordd area towards the southeast of the Afon Glaslyn, and immediately west of Garth CSEC.

All route options use HDD to cross the highway with open cut construction being used for the other sections of the route.

- **Option D1** starts north of Clwb Chwaraeon Madog and continues around the sports ground. It then continues further east before it turns south to cross the A487 highway, the railway line and the SSSI and the Afon Glaslyn in one long curved HDD drive.
- **Option D2** also starts north of Clwb Chwaraeon Madog and continues around the sports ground; however, it deviates south further west than Option D1 and crosses the highway and railway perpendicularly, taking a longer route through the SSSI. **Option D4** starts south of Clwb Chwaraeon Madog until it combines with Option D2. These options require an additional HDD drive to cross the Afon Glaslyn. For the purposes of the highway crossing, D2 and D4 are considered comparable.
- **Option D3** is similar Option D1 in that it crosses the A487 highway at approximately the same location, but it does this in a perpendicular manner, thus requiring 2 HDD drives and additional construction works within the environmentally sensitive area.
- **Option D9** starts south of Clwb Chwaraeon Madog, crossing the highway and railway further to the west than all other options, before being constructed in the SSSI for the remainder of the route.

The following options were considered as part of the original long list to achieve the A487 highway crossing in Section D and have been discounted due to technical constraints; these are not considered further in this appraisal note:

- Option D5 also starts north of Clwb Chwaraeon Madog and continues around the sports ground; however, it stays north of the highway for the entirety of the section and is not considered further in terms of the crossing of the highway.
- As with Options D1, D2, D3, D5, Option D6 starts north of Clwb Chwaraeon Madog and continues around the sports ground. It then continues further southeast, crossing the highway and the railway line at an acute angle. This option is not considered further due to indication from Network Rail that it would not be approved.
- Option D7 is similar to Option D6 but crosses the highway and the railway line in a perpendicular manner. This option is considered too technically complex due to the need to provide 2 HDD crossings: one for the highway and railway line (in the near vicinity of the high-pressure gas main and existing 132 and 400kV cables) and another one for the Afon Gaslyn. It has not been considered further.
- Option D8 starts south of Clwb Chwaraeon Madog and runs along the A487 highway through Section D. This option is considered too technically complex and likely to impact the A487 highway negatively in terms of works undertaken and associated traffic management and potential congestion and is not considered further.

5.3.2 Options D1

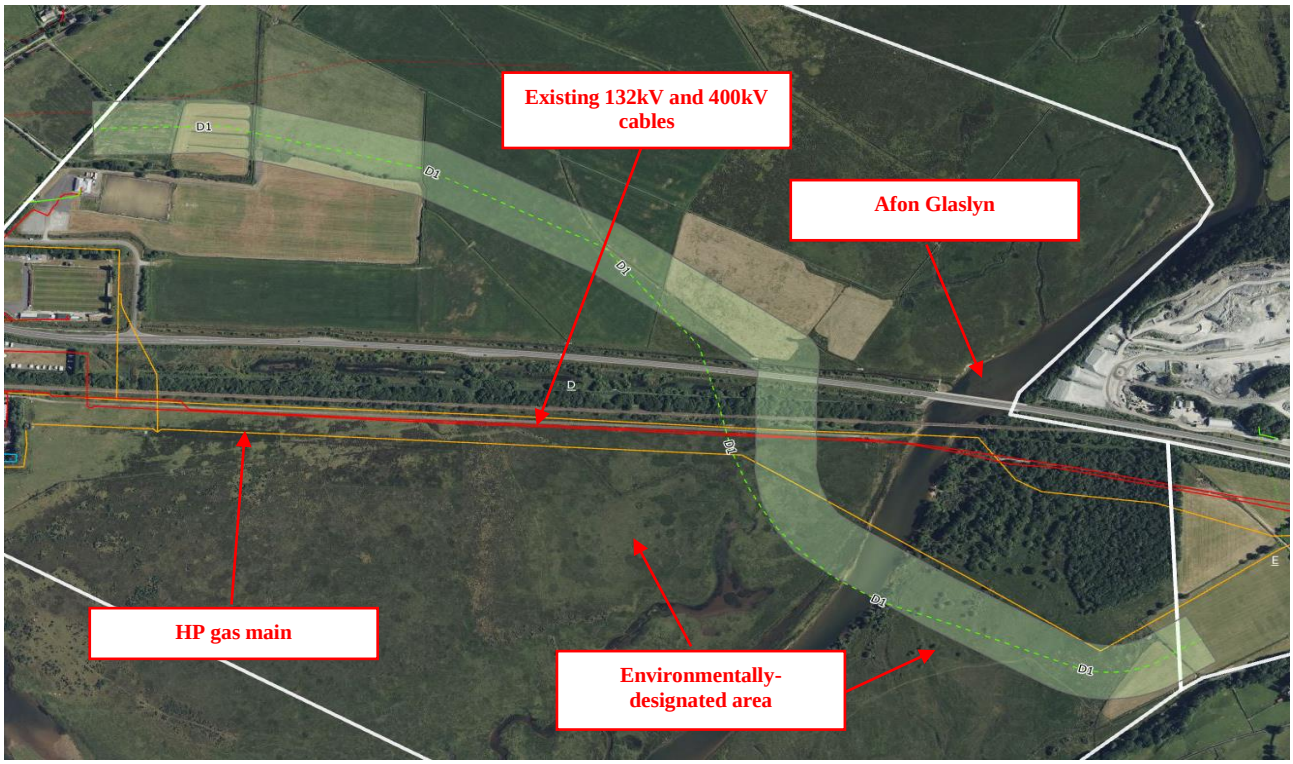


Figure 10: Indicative layout of cables for Option D1

Benefits	Challenges
Technically preferred route in the Trenchless Optioneering Report. Has the potential to be completed with a single cable drum, with joint bays at either side of the crossing. Crosses the highway, railway line and gas main at 75°, but this is considered manageable from a design and construction point of view and is generally acceptable to approving organisations. Does not any cross any conservation areas, listed buildings, or ancient woodlands. HDD avoids direct impact on A487 highway and the need for temporary traffic management measures and potential congestion. Does not require construction works at surface within the SSSI. Expected to have the lowest overall cost. Is the preferred option in terms of health and safety due to the need for less temporary works.	Requires long and curved HDD drive to achieve the A487 highway which is technically challenging. Introduces risk of frac-out under A487 highway and in environmentally sensitive area. Introduces risk of settlement of carriageway and railway line. Requires settlement monitoring of pre, during and post HDD installation. Impacts the SSSI, SAC and Priority Habitat areas, but surface works and associated impacts are minimised by use of a single HDD drive. Disruption to agricultural activity.

5.3.3 Options D2 / D4

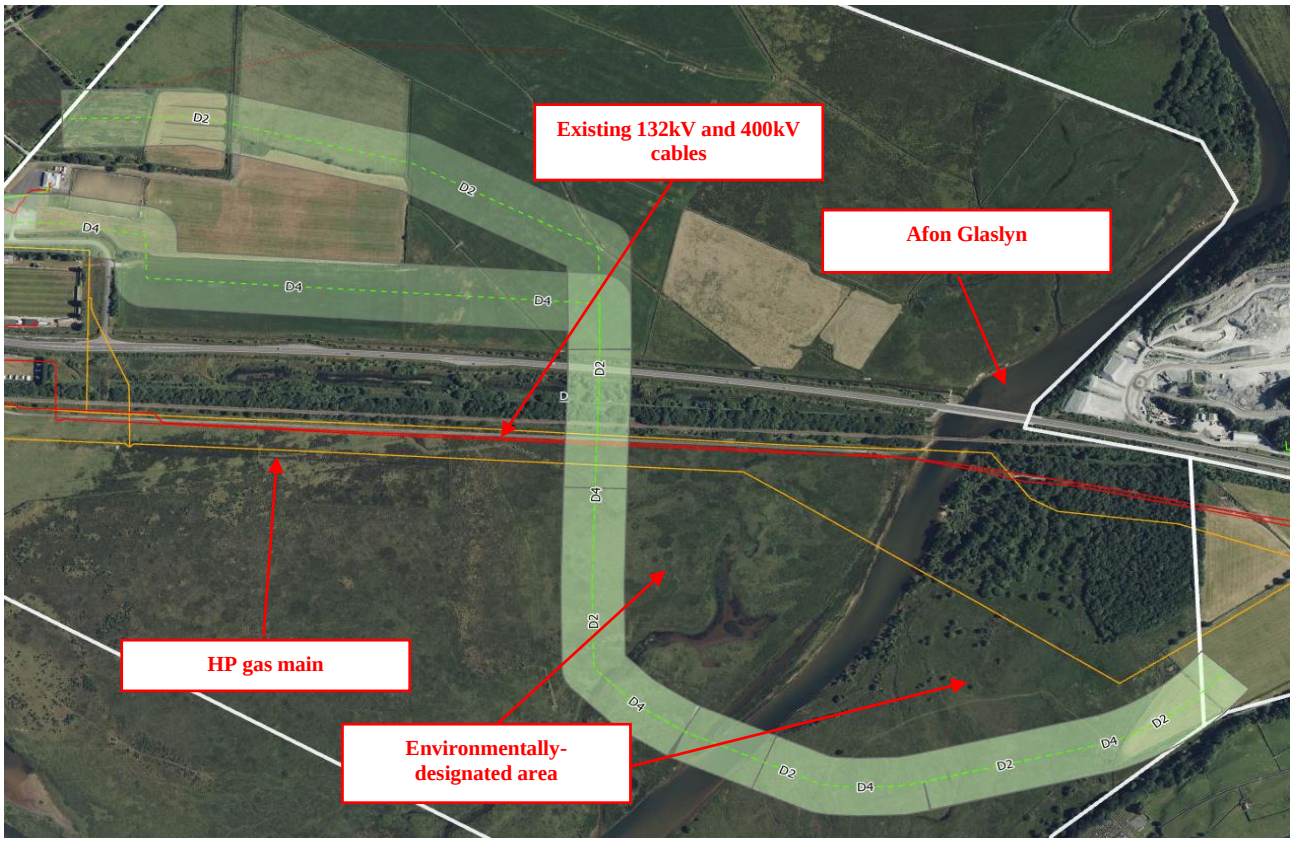


Figure 11: Indicative layout of cables for Options D2 and D4

Benefits	Challenges
These options cross the highway, railway line and gas main in a perpendicular manner, minimising impacts on these. This is considered to be technically advantageous. Does not any cross any conservation areas, listed buildings, or ancient woodlands. HDD avoids direct impact on A487 highway and the need for temporary traffic management measures and potential congestion.	Longest route options considered. Introduces risk of frac-out under A487 highway and in environmentally sensitive area. Introduces risk of settlement of carriageway and railway line. Requires settlement monitoring of pre, during and post HDD installation. Impacts the SSSI, SAC and Priority Habitat areas. Surface works and associated impacts are somewhat minimised by use of HDD, but both options would require additional open cut works within the SSSI as 2 HDD drives are required. Disruption to agricultural activity. Football club acts as a pinch point for the construction of D4.

5.3.4 Option D3

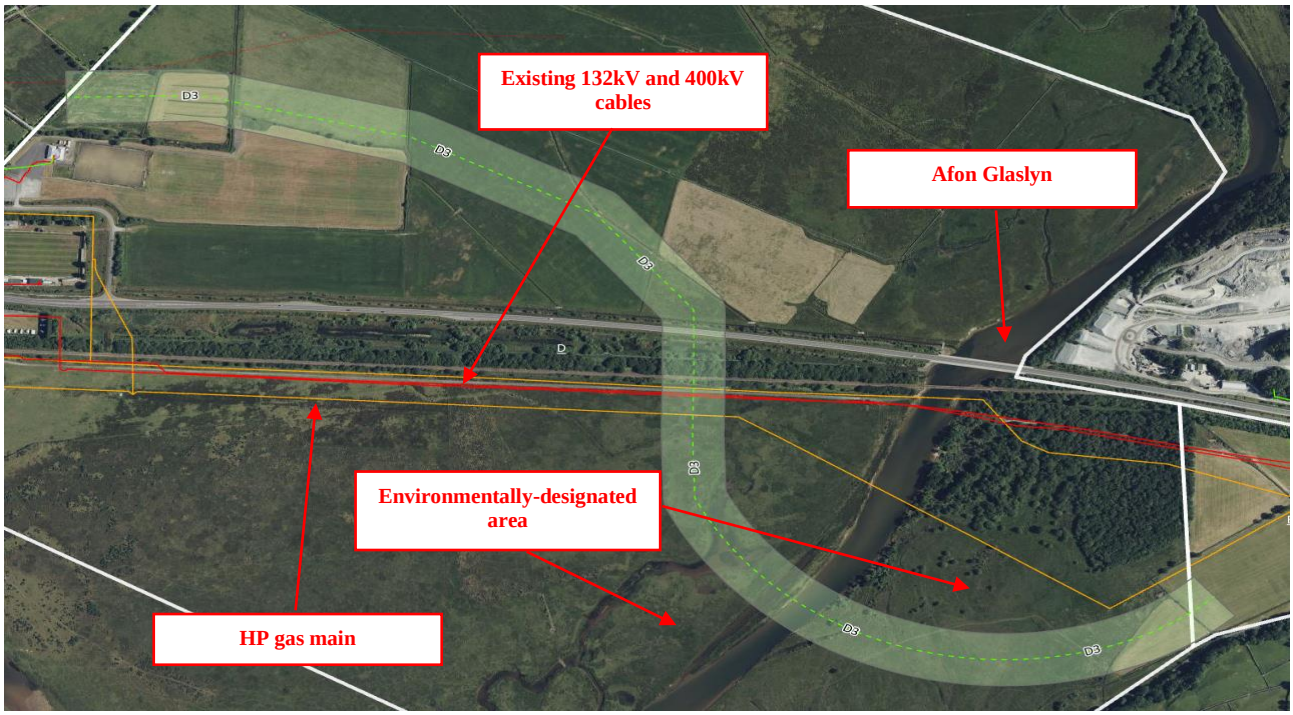


Figure 12: Indicative layout of cables for Option D3

Benefits	Challenges
Somewhat overall reduced route length with respect to Options D2 and D4. Crosses the highway, railway line and gas main in a perpendicular manner, minimising impacts on these. This is considered to be technically advantageous. Does not any cross any conservation areas, listed buildings, or ancient woodlands. HDD avoids direct impact on A487 highway and the need for temporary traffic management measures and potential congestion.	Introduces risk of frac-out under A487 highway and in environmentally sensitive area. Introduces risk of settlement of carriageway and railway line. Requires settlement monitoring of pre, during and post HDD installation. Impacts the SSSI, SAC and Priority Habitat areas. Surface works and associated impacts are somewhat minimised by use of HDD, but it would require additional open cut works within the SSSI as 2 HDD drives are required. Disruption to agricultural activity.

5.3.5 Options D9

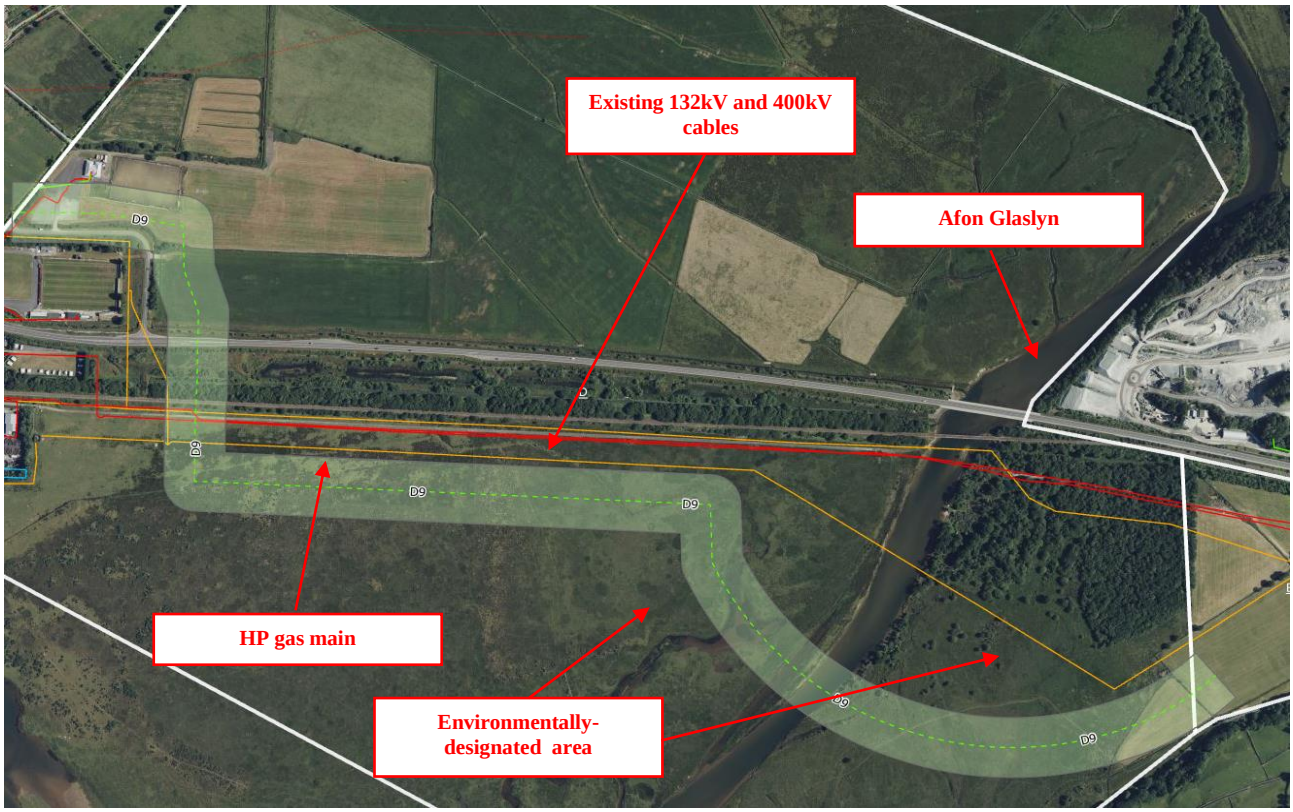


Figure 13: Indicative layout of cables for Options D2 and D4

Benefits	Challenges
Crosses the highway, railway line and gas main in a perpendicular manner, minimising impacts on these. This is considered to be technically advantageous. Does not any cross any conservation areas, listed buildings, or ancient woodlands. Lower impact on boundary hedgerows. HDD avoids direct impact on A487 highway and the need for temporary traffic management measures and potential congestion.	Introduces risk of frac-out under A487 highway and in environmentally sensitive area. Introduces risk of settlement of carriageway and railway line. Requires settlement monitoring of pre, during and post HDD installation. Would require more extensive open cut trench works in the SSSI, SAC and Priority Habitat areas as the route runs parallel to the A487 highway and the railway line. Disruption to agricultural activity. More disruption likely to sports club and football club. Highest cost option. Option D9 is the least preferred option in terms of health and safety due to the need for significant temporary works along the route.

6. Appraisal Summary

6.1 General

Based on the qualitative appraisals included in Section 5, an appraisal for each section and option has been divided into the following 5 categories:

- Technical assessment.
- Environmental assessment.
- Socio-Economic assessment.
- Cost assessment.
- Health and Safety assessment.

Each option has been classified with the following symbols for each category:

- "+" where the assessment of the option shows it has a clear benefit or is relatively advantageous when compared to the other options.
- "≈" where the assessment of the option shows it has a neutral benefit/challenge or is not the most advantageous or the least advantageous when compared to the other options.
- "-" where the assessment of the option shows it has a clear challenge or is the least advantageous when compared to the other options.

6.2 Section B / C – A487 near the Porthmadog roundabout

Table 1: Section B / C – A487 near the Porthmadog roundabout - Appraisal Summary

Criteria	Option 1A	Option 1B	Option 2	Option 3
Technical Assessment	+	-	-	-
Environmental Assessment	≈	≈	-	≈
Socio-Economic Assessment	≈	+	-	-
Cost Assessment	+	≈	-	-
Health & Safety Assessment	+	≈	-	-

Option 1A is the preferred option to cross over the A487 roundabout. Whilst technical challenging with an open cut solution requiring traffic management, it is the only option that can be constructed without significant protective measures to the HP gas main and existing 400kV cable and also does not require drilling under third party properties, thus making it the preferred solution to National Grid.

6.3 Section C – A487 west of the heritage railway line

Table 2: Section C – A487 west of the heritage railway line - Appraisal Summary

Criteria	Option C1 / C2	Option C3	Option C4
Technical Assessment	≈	-	+
Environmental Assessment	≈	-	+
Socio-Economic Assessment	≈	≈	≈
Cost Assessment	≈ (Option C1 likely most costly, Option C2 likely least costly)	≈	≈
Health & Safety Assessment	≈	-	+

Option C4 is the preferred solution, when considering all the criteria. All of the options considered HDD under the A487 Highway embankment, so to a certain extent from a highways perspective, they are all neutral in terms of the highway interface. However, Option C4 provided the best location to minimise the impact on the highway by routeing the HDD so that it can pass under the other constraints, HP gas main, water course in the same drill. It also allows space to allow the HDDs to be located to avoid any highway structures.

6.4 Section D – A487 near the Afon Glaslyn

Table 3: Section D – A487 near the Afon Glaslyn - Appraisal Summary

Criteria	Option D1	Options D2 / D4	Option D3	Option D9
Technical Assessment	+	≈	≈	-
Environmental Assessment	+	≈	≈	-
Socio-Economic Assessment	≈	≈	≈	≈
Cost Assessment	+	≈	≈	-
Health & Safety Assessment	+	≈	≈	-

Option D1 is the preferred solution, combining one HDD to cross under the A487 Porthmadog Bypass, the NR railway, Afon Glaslyn and flood plain in one drive. All other options would require an additional work site in the SSSI flood plain area.

7. Concluding Remarks

The appraisal summarised in this report, and a visual inspection of Table 1, Table 2 and Table 3, indicate the following are the preferred options to achieve each of the crossings of the A487 highway:

- Section B / C – A487 near the Porthmadog roundabout: **Option 1A** – open cut trench through Porthmadog roundabout.
- Section C – A487 west of the heritage railway line: **Option C4 –** HDD crossing of the A487 highway immediately west of the heritage railway line.
- Section D – A487 near the Afon Glaslyn: **Option D1** – HDD crossing of the A487 highway west of the Afon Glaslyn, also crossing the railway line and the Afon Glaslyn in a single drive.

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