Capital Project 966

Feasibility Assessment - Connection into Woodland Substation

321084AE-REP-009 | B

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EirGrid

CP966

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Executive Summary

Capital Project 966 (CP 966) is a proposed development that will help transfer electricity from the west of Ireland and distribute it within the network in Meath, Kildare and Dublin to help meet the growing demand for electricity in that area. This growth is due to increased economic activity and the planned connection of new data centres in the region. CP 966 aims to strengthen the transmission network between Dunstown substation in Kildare and Woodland substation in Meath - and suggests a number of technical solutions to do so.

The connection options being considered by EirGrid:

§ Option 1: Up-voltage existing 220 kV circuits to 400 kV to create new Dunstown – Woodland 400 kV overhead line (OHL),

§ Option 2: A new 400 kV overhead line,

§ Option 3: A new 220 kV underground cable,

§ Option 4: A new 400 kV underground cable.

To facilitate the four options, there will be a number of additional technical requirements at Woodland, Maynooth and Dunstown substations:

i. An extension to Woodland substation,

ii. An extension to Dunstown substation,

iii. A 400kV bay in Woodland substation,

iv. Development within the existing Woodland Substation (ring configuration),

v. A 400kV bay in Dunstown Substation,

vi. Turn in of Gorman - Woodland 220kV circuit into Woodland Substation; and

vii. Linking Woodland - Woodland and Dunstown - Woodland OHL circuits at Maynooth substation.

This report considers the feasibility of item vi and possible solutions to split and turn in the existing Gorman - Woodland 220kV circuit as two separate circuit extensions into Woodland Substation.

Meetings and teleconferences have been held between the Client and Consultants to share information and to determine the scope of the study. The overall study area was jointly identified to the west of Dublin during the month of October 2019 and a team of specialists visited the study area during the month of November 2019 to survey the environment from publicly accessible areas.

This technical report identifies three possible solutions:

A. Two single circuits using OHL between new towers positioned on the line of, or adjacent to, existing OHL alignment and into new 220kV and 400kV bays at Woodland substation,

B. Two single circuits using cable between new towers and cable sealing end compounds positioned on the line of, or adjacent to, existing OHL alignment into new 220kV and 400kV bays at Woodland substation,

C. One double circuit OHL between new a tower positioned on the line of, or adjacent to, existing OHL alignment either north or south of the existing crossing point and into new 220kV and 400kV bays at Woodland substation.

The report considers the technical content, construction sequence and the advantages of each solution and offers the outcome of the feasibility assessment in accordance with EirGrid criteria as presented in table 1 using the following scale to illustrate each criterion parameter:

More significant/difficult/risk | Less significant/difficult/risk

Assessment Criteria	Option A (Two corridors, single circuit towers, one 220kV, one 400kV)	Option B (Two cable swathes, one conductor per phase; one for 220kV and one for 400kV)	Option C (One corridor, double circuit towers with 220kV and 400kV)
Technical Performance			
Economic Performance			
Deliverability			
Environmental			
Socio - economic			
Combined Performance			

Table 1 : Feasibility Assessment for Connections in proximity to Woodland Substation

The outcome of the feasibility assessment is that:

§ The OHL option A is considered technically the most straightforward to construct and subsequently maintain

§ The OHL options A and C are considered economically similar in terms of construction cost and less expensive than the cable option B

§ OHL is quicker to construct than cable from a technical perspective however the impact of planning may delay the OHL construction works

§ The cable option B is likely to offer the least visual impact. The two single circuit OHLs for Option A may have less visual impact than the double circuit OHL option C by virtue of tower height, however the two separate single circuit OHL routes may impact on a greater number of properties and dwellings.

§ The constraints assessment indicates that the double circuit OHL route option is considered more favourable in environmental terms having lowest impact in all categories other than landscape and visual impact where the cable option is favoured.

§ Socio-economically, the OHL options A and C are considered to have marginally lower overall socio-economic effect than the cable route option B.

The final selection will be taken at the next stage should the uprating of the OHLs be taken forward as a preferred option and is dependent upon more information being available in relation to existing tower capacity, clearance availability etc. Therefore, at this stage, the report concludes that while Option C is considered favourable from both environmental and socio-economic perspectives, from the technical, economic and deliverability viewpoint option A would be the preferred option as new sections of single circuit OHL are technically less complex and less expensive than the alternative options considered. The single circuit OHL option will remove the existing oversailing conductor arrangement west of Woodland and could offer a less complex line entry arrangement at Woodland substation. Use of single circuit towers also removes the proximity hazard of working on double circuit OHL towers.

Various assumptions have been made in the study, each of which should be examined further to determine the relevance and impact upon the outcome. The following points are also worthy of note:

- As land use in the study area appears to be largely agricultural, there are no obvious clearance issues associated with the OHL options, however the preferred solution will need to be confirmed in terms of proximity to property and dwellings, vertical clearance to third party features and operations and visual impact.
- Land not presently occupied by the TAO will be required for all options and therefore agreements may be required with landownerships not currently occupied with Transmission Asset Owner (TAO) assets.
- The study area contains a road network which should make delivery of construction materials and plant reasonably straightforward for all options, however temporary roads will be required to each construction site and permanent access is required for the cable sealing end compounds which will influence the location of these sites.
- The outage implications of any planned work need be confirmed in relation to the proposed up-voltage works on the Dunstown – Gorman circuit.
- Areas of groundwater vulnerability (e.g. rock near surface or karst) could impact upon the foundation requirements for structures in certain areas.
- The constructability of cables in the study area requires identification of unrestricted corridors through the study area that will have an impact on the cable rating and construction methodology.

1. Introduction

1.1 What is Capital Project 966?

Capital Project 966 is a proposed development that will help transfer electricity to the east of the country and distribute it within the network in Meath, Kildare and Dublin.

The project will help meet the growing demand for electricity in the east. This growth is due to increased economic activity and the planned connection of new data centers in the region.

A significant number of Ireland's electricity generators are located in the south and south west. This is where many wind farms and some modern, conventional generators are located. This power needs to be transported to where it is needed.

The power is mainly transported cross-country on the two existing 400 kV lines from the Moneypoint station in Clare to the Dunstown substation in Kildare and Woodland substation in Meath. Transporting large amounts of electricity on these 400 kV lines could cause problems that would affect the security of electricity supply throughout Ireland, particularly if one of the lines is lost unexpectedly.

To solve this emerging issue, we need to strengthen the electricity network between Dunstown and Woodland to avoid capacity and voltage problems.

Capital Project 966 aims to strengthen the transmission network between Dunstown and Woodland substations. and suggests a number of technical solutions to do so.

1.2 Framework for Grid Development Explained

EirGrid follow a six-step approach when they develop and implement the best performing solution option to any identified transmission network problem. This six-step approach is described in the document 'Have Your Say' published on EirGrid's website [1]. The six steps are shown on a high-level in Figure 1. Each step has a distinct purpose with defined deliverables and represents a lifecycle of a development from conception through to implementation and energisation.

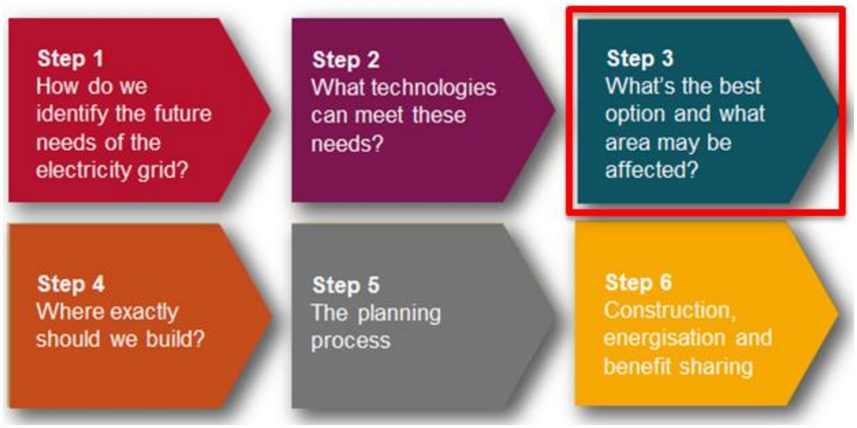


Figure 1.1 : EirGrid's six-Step Framework for Grid Development

Capital Project 966 is in Step 3 of the above process. The aim of Step 3 is to identify a best performing solution option to the need identified. There are four remaining technical viable options to be investigated in Step 3. All

[1] http://www.eirgridgroup.com/the-grid/have-your-say/

options create a connection between Woodland and Dunstown substations and have common reinforcements associated in relation to voltage support devices and 110 kV uprates. The main four options are:

- Up-voltage existing 220 kV circuits to 400 kV to create new Dunstown – Woodland 400 kV overhead line (OHL);
- A new 400 kV overhead line;
- A new 220 kV underground cable,
- A new 400 kV underground cable.

Common reinforcements to all four options (outcome of Step 2, may change in Step 3):

- Uprating of the Bracklone – Portlaoise 110 kV overhead line
- Dynamic reactive support device in greater Dublin area rated at approximately ±250 Mvar

These options will be evaluated against five criteria: technical, economic, environmental, deliverability and socio-economic and each criterion incorporates a number of sub-criteria. It shall be noted that the overall assessment is carried out by EirGrid, but certain aspects are investigated and assessed by various consultants and their assessment will feed into the overall assessment.

1.3 Aims and Contents of the OHL Report

To deliver the up-voltage option noted in section 1.2 above, EirGrid intend to split the existing Gorman – Maynooth 220kV circuit and to turn in the two ends towards Woodland substation; the circuit from Gorman at 220kV and the up-voltaged 400kV circuit from Dunstown. This will be formed by two separate circuits, as indicated in figure 1.2, or possibly by one double circuit arrangement either north or south of where the existing 400kV circuit from Old Street to Woodland crosses the 220kV Gorman – Maynooth circuit. The existing 400kV circuit will be unaffected by the proposed work.

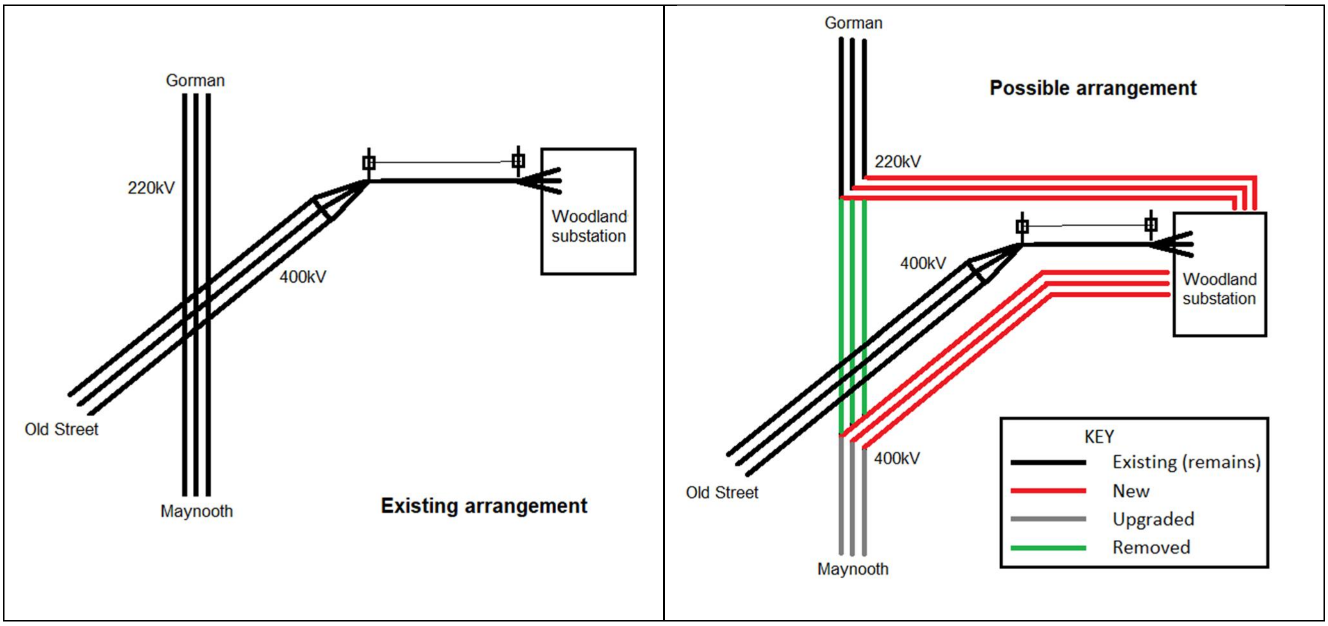


Figure 1.2 : Concept of the proposed arrangement into Woodland substation

EirGrid (the Client) has engaged Jacobs to assess the technical feasibility of options to achieve this connection within the study area. This report considers the factors identified in both the Environmental Constraints Report (reference 321084AE-REP-002) and the Social Impact Assessment Scoping Report (reference 321084AE-REP-003) . These constraints impact on the availability of route corridors, access for construction and both circuit and third-party operations (horizontal and vertical clearances). A preliminary bill of materials has been completed in order to give an insight into the overall economic impact of the different options. The findings will feed into EirGrid's overall evaluation of the four remaining options.

1.4 Description of criteria used to assess the options

This report uses the following criteria to assess each connection option:

- Technical

As part of technical feasibility assessment, connection options were developed in accordance with relevant Eirgrid design standards to indicate a proposed solution. Constructability and health and safety implications for operation and maintenance activities through the achievement of appropriate electrical clearances have been considered.

- Environmental

As part of environmental feasibility, only the impact arising from any new connection infrastructure has been identified and examined. For a broader environmental assessment, please refer to report 321084AE-REP-002 – Environmental Constraints Report.

- Deliverability

As part of deliverability assessment, existing access roadways and operational/maintenance assessments were made to ensure that the solution can be safely constructed, maintained and operated.

- Economic

An approximate bill of quantities (items, units, lengths etc.) has been provided.

- Socio-economic

Socio-economic assessment has been included based upon a summary of findings produced in report 321084AE-REP-003– Social Impact Assessment Scoping Report.

1.5 Scale used to assess each criteria

The effect on each criteria parameter is presented along a range from “more significant”/”more difficult”/“more risk” to “less significant”/”less difficult”/“less risk”. The following scale is used to illustrate each criteria parameter:

More significant/difficult/risk   Less significant/difficult/risk

In the text this scale is quantified by text for example mid-level/moderate (Dark Green), low-moderate (Green), low (Cream), high-moderate (Blue) or high (Dark Blue).

1.6 Relationship to other technical documents

Parallel to this report, Cable Feasibility, Environmental and a Social Impact studies are being prepared to investigate the impact of proposed solutions on the study area.

Please read in conjunction with the following reports:

- 321084AE-REP-001 - CP 966 Cable Route Feasibility Report
- 321084AE-REP-002 - CP966 Environmental Constraints Report
- 321084AE-REP-003 – CP 966 Social Impact Assessment Scoping Report, and

§ 321084AE-REP-004, 006, 007 and 11 – CP 966 Technical Requirements Feasibility Reports

2. The Project

One option that Eirgrid is investigating is to create a new 400kV circuit connecting Woodland and Dunstown which will necessitate splitting and upgrading the existing Gorman – Woodland 220kV circuit in the vicinity of Woodland substation. The southern section of this circuit to Dunstown will be upgraded to operate at 400kV while the northern section to Gorman will be maintained at 220kV with each section being connected into the existing Woodlands substation with a section of new OHL or cable. The study assumes that any modifications required at Woodland substation will be carried out in conjunction with the proposed up-voltage works planned for these circuits.

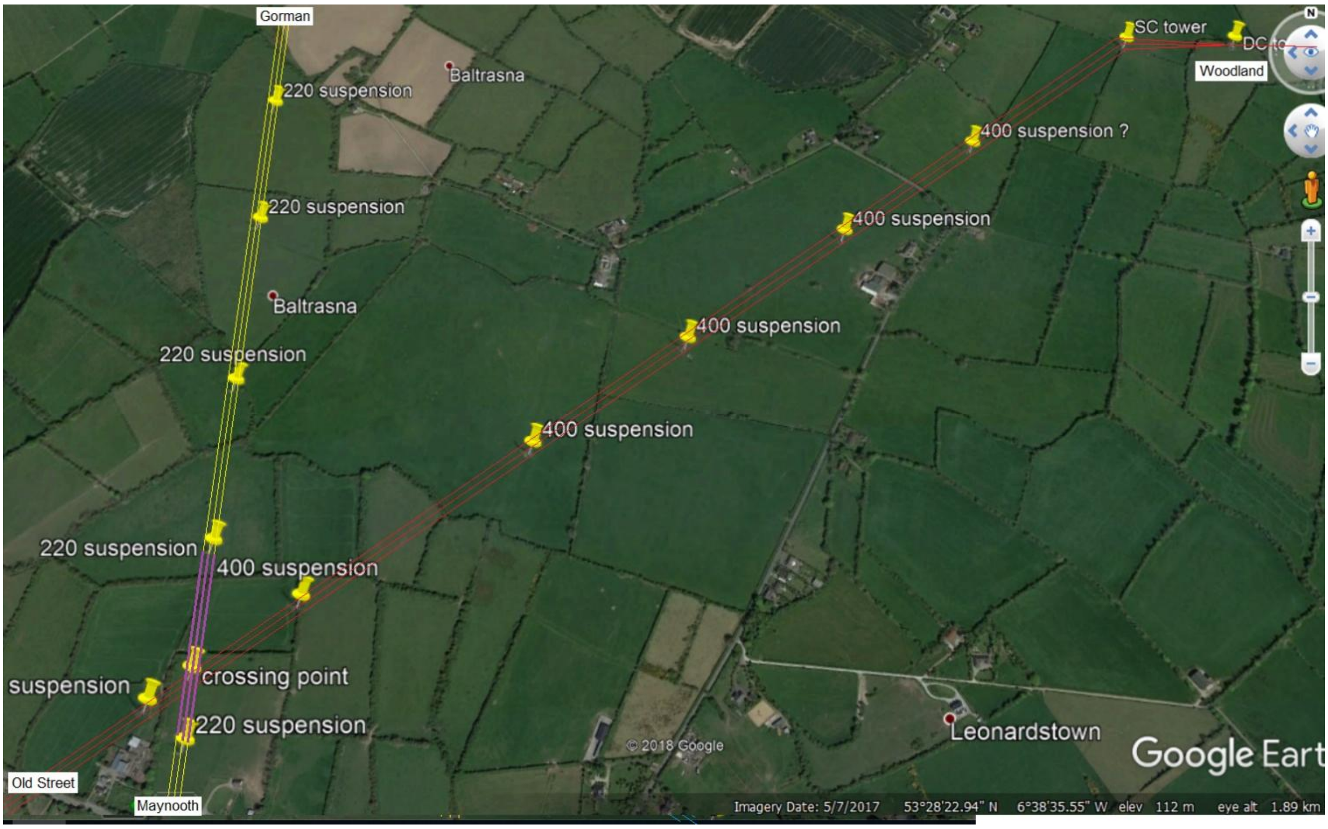
2.1 Existing Arrangements

Woodland substation presently has one 400kV OHL circuit (Old Street – Woodland) approaching the substation from the west as presented in figure 2.1. About 5 km west of Woodland substation the existing Gorman – Maynooth 220kV circuit passes beneath the 400kV OHL as presented in figure 2.2.

Key:

§ 400kV OHL marked in red

Figure 2.1 : Existing 400kV Circuit into Woodland Substation (© Google Earth 2019)



Key:

- 220kV OHL marked in yellow
- 400kV OHL marked in red

Figure 2.2 : Existing 220kV Circuit from Gorman and Dunstown beneath the existing 400kV OHL (© Google Earth 2019)

2.2 Required System Ratings

The study for this option is presented on the basis that the upvoltaging work on existing sections of OHL towards Woodland and Dunstown will utilise a 2 x 600 mm² ACSR (Curlew) conductor system operating at 80°C and therefore the same conductor system will also be used on any new 400kV OHL into Woodland substation.

For any new 220kV OHL into Woodland substation the study assumes that the conductor system will match the conductor on the existing Gorman – Maynooth 200kV circuit (unconfirmed in the study).

2.3 Outline Options Considered

The study has considered that the primary technology for achieving a reconfiguration of existing OHL routes will be by use of new OHL support structures. EirGrid also requested that underground cable was considered to better understand whether there are any opportunities to be gained from the alternative. Therefore, the following options have been considered:

A. Two single circuits using OHL between new towers positioned on the line of, or adjacent to, existing OHL alignment and into new 220kV and 400kV bays at Woodland substation,

B. Two single circuits using underground cable between new towers and cable sealing end compounds positioned on the line of, or adjacent to, existing OHL alignment into new 220kV and 400kV bays at Woodland substation,

C. One double circuit OHL between a new tower positioned adjacent to existing OHL alignment either north or south of the existing crossing point and into new 220kV and 400kV bays at Woodland substation.

The outline options have been developed with reference to proposals for developing Woodland substation as presented in Appendix A (drawing 321084AE-LAY-011) and Appendix B (drawing 321084AE-LAY-015). Appendix C (drawing 321084AE-LAY-016).

2.4 Basis of the Design Approach

2.4.1 Study Area

The study has identified a relatively broad area, as presented in figure 2.3, within which the connection could be made and the merits of this for each option when assessed against the specified EirGrid criteria; the objective being to determine the relative strengths and weaknesses of these options. This has entailed seeking to avoid constraints identified wherever possible and developing the most direct routes where all other factors remain equal.

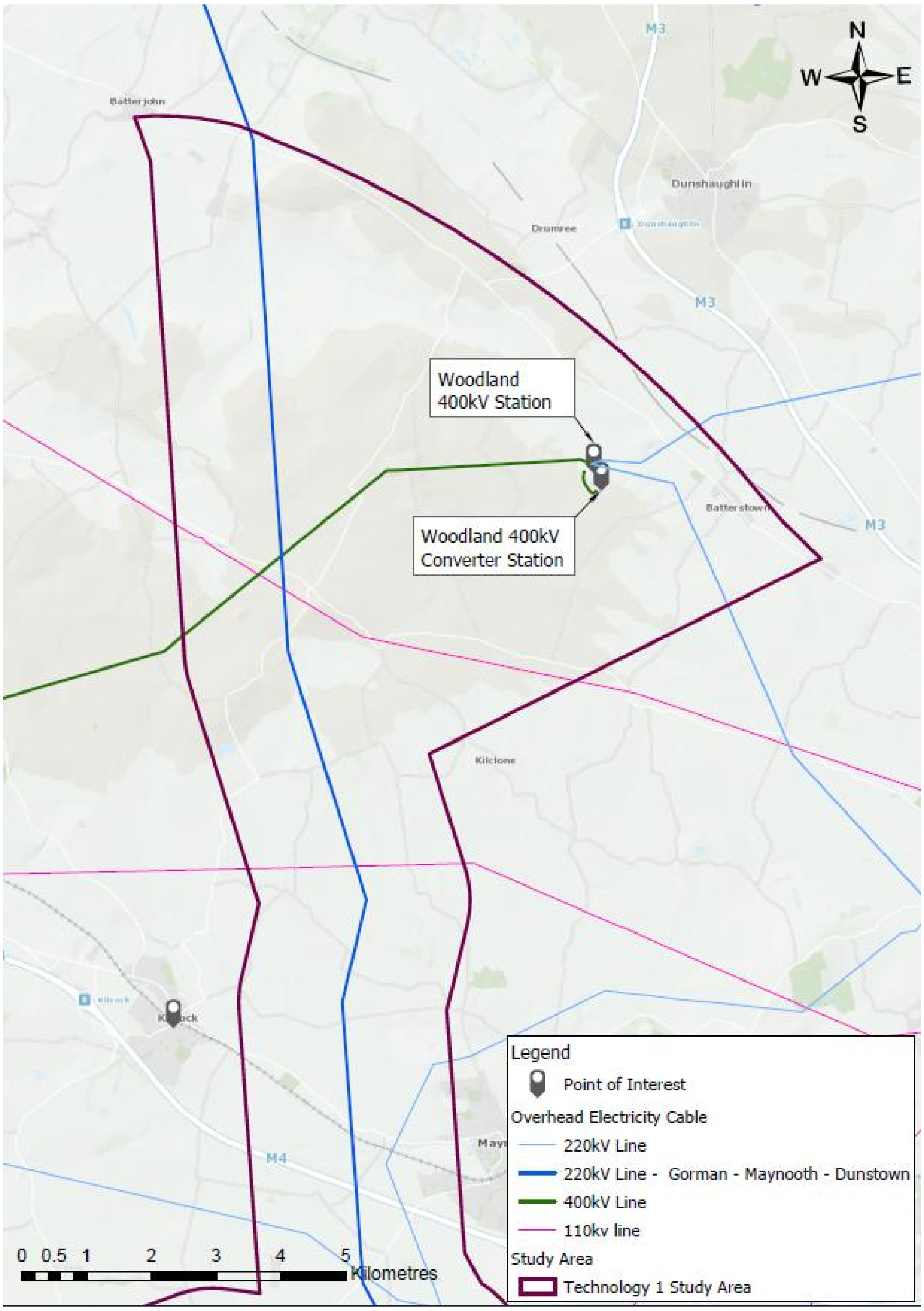


Figure 2.3 : Study Area for Woodland turn-in

2.4.2 Environmental Considerations

Section 5 of the Jacobs Environmental Constraints Report 321084AE-REP-002 considers the various environmental constraints associated with the connection options into Woodland substation, the conclusions of which are summarised below and in table 2.1:

2.4.2.1 Biodiversity

The most significant effects on biodiversity from the Woodland Turn-in would be to cable option B during construction, where two 12m wide swathes would cross 7km of countryside each and require temporary and some permanent loss of habitat; the increased risk of pollution of watercourse from this option during construction is also potentially significant and could lead to permanent effects on aquatic ecosystems. OHL Option A is moderate in terms of risk but there are two corridors of new OHL, each requiring permanent land take under each tower with associated increased magnitude in construction effects. Double circuit OHL option C is lower risk by virtue of fewer tower sites.

2.4.2.2 Soils and Water

The greatest impacts on soils and water from the Woodland Turn-in would be during construction for all options. There would be a relatively low risk from OHL Option C, from a single OHL corridor with no river crossings likely and no karst landforms. OHL option A has a moderate risk, as there are two corridors, with two river crossings and potential to construct in a karst landform area with consequential risk to groundwater. Cable option B has a predicted moderate to high risk to soils and water; this is because of the requirement for two 12m swathes, each 7km long (approximately). This would result in a significant stripping of grassland and soil, increasing the amount of silty water runoff; the cable trenches themselves have the potential to act as a conduit for flood water and silty water from excavations; and two rivers would need to be crossed. In addition, the risk to groundwater in the karst landform area would be high during the installation of cables in this area.

2.4.2.3 Planning Policy and Land Use

From a planning policy perspective, the greatest risk from OHL options A and C would be during operation: Option A would be moderate to high risk as this requires two new OHLs including one within a sensitive landscape; Option C would only require one OHL. Cable option B would have the greatest impacts of all of the options during construction, as a result of significant temporary land take; it would also continue to have effects during operation with restrictions on land use practices likely.

2.4.2.4 Landscape and Views

The greatest risk to landscape and views from OHL options A and C would be during operation: Option A would be moderate to high risk as this requires two new OHLs including one within a sensitive landscape; Option C would also require a new OHL but in a less sensitive landscape with medium compatibility for new electrical infrastructure. Cable option B would have the greatest impacts during construction, but these are unlikely to be significant; it would have some effects during operation as a result of the new sealing end compounds required for each corridor; it would also continue to have effects during operation with restrictions on land use practices being likely.

2.4.2.5 Cultural Heritage

The greatest risk to heritage assets from Options A and C would be during construction: Option A would be low to moderate risk as this requires two new OHLs and associated excavations for the tower foundations. Option C would also require a new OHL but there is only one OHL and associated excavations; however, Option C has also been assessed as low to moderate risk as a worst case, because if it is positioned north of the existing 400kV there are heritage assets in this area; if it is positioned to the south the risk would reduce to low. Option B has the potential for significant impacts on buried heritage assets during construction; it would have none during operation.

2.4.2.6 Assessment of Options Connections into Woodlands

More significant/difficult/risk — Less significant/difficult/risk

Constraint	Option A (Two corridors, single circuit towers, one 220kV, one 400kV)	Option B (Two cable swathes, one conductor per phase; one for 220kV and one for 400kV)	Option C (One corridor, double circuit towers with 220kV and 400kV)
Biodiversity			
Soil & Water			
Land Use			
Landscape & Visual			
Cultural Heritage			
Combined Performance			

Table 2.1 : Environmental assessment for Connections into Woodland Substation

The constraints assessment indicates that:

- Overall, the double circuit OHL route option is considered to be most favourable in environmental terms having lowest impact in all categories other than landscape and visual where the cable option is favoured.
- The effect of constructing two separate single circuit OHL routes is considered to have a greater impact than constructing one double circuit OHL route
- The two cable routes are considered to have the greatest overall impact during the construction phase.

The following specific features have been noted which illustrate some of the constraints within the Study Area.

- Numerous properties and individual dwellings
- Monuments and sites of architectural heritage
- Rivers and fluvial deposits or landforms
- Areas of groundwater vulnerability (e.g. rock near surface or karst)

An extract of this data is presented in Figure 2.4:

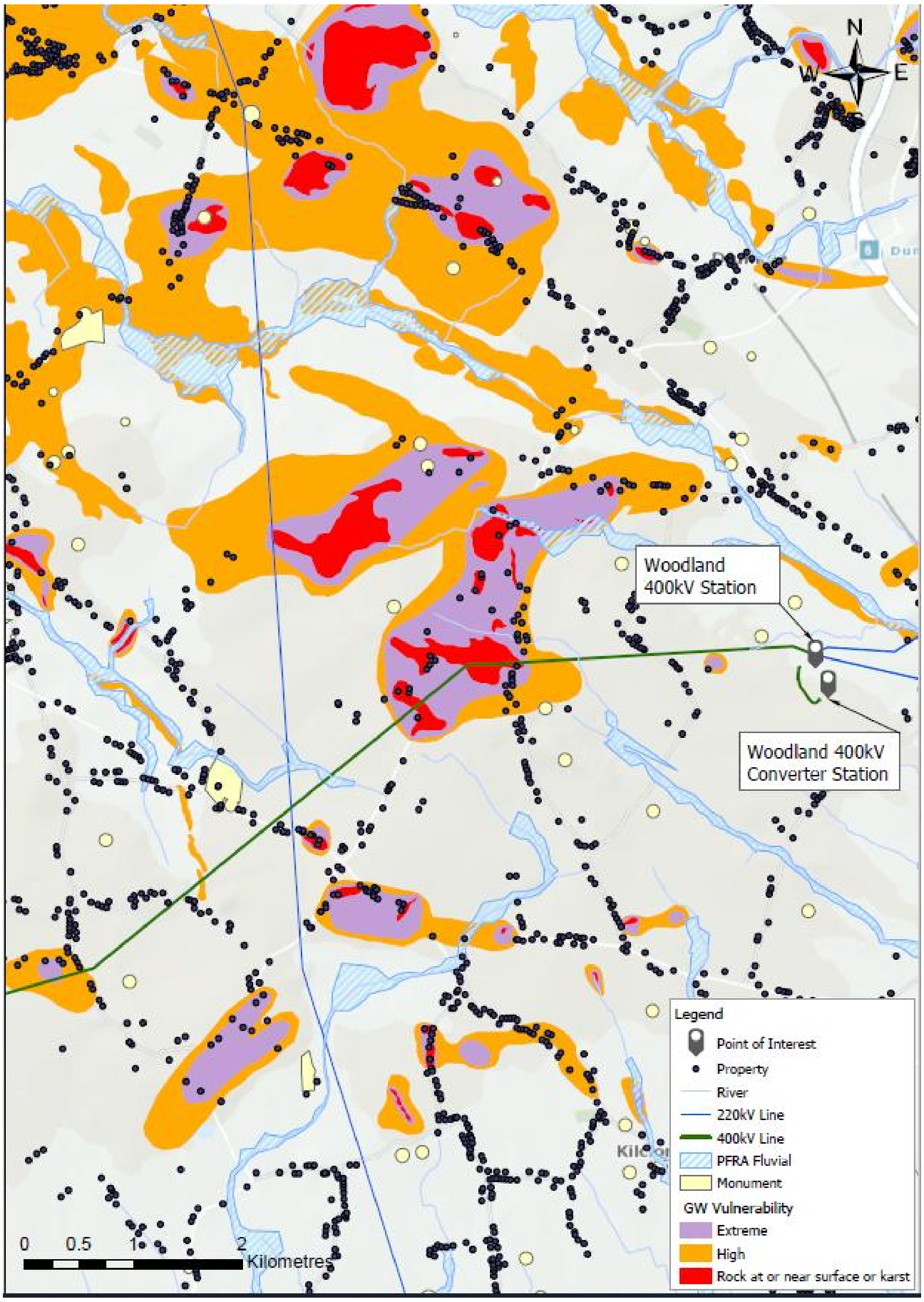


Figure 2.4 : Constraints in proximity to Woodland Substation

The site visit concluded that land use in the study area appears to be largely agricultural which indicates that clearance from ground to any new OHL conductor should not be a major concern, however clearances to any new OHL still needs to be confirmed in accordance with EirGrid functional specification LDS-EFS-00-001-R0 section 6.4 and account for any third-party activity.

2.4.3 Socio-economic considerations

Jacobs strategic Social Impact Assessment Scoping Report 32108AE-REP-003 considers the socio-economic impact of the various connection options into Woodland substation, the conclusions of which are summarised below and in table 2.2.

2.4.3.1 Amenity and Health

The greatest potential impact from Option A is during operation as it proposes two new OHLs and could result in visual and noise effects leading to amenity effects; in addition, there could be increased anxiety regarding the OHL in operation as a result of people's concerns regarding EMFs and high voltage OHLs. Option B would have the most significant effects on amenity during construction, although would have very little affect during operation. OHL Options A and B would both require two new corridors and be constructed across third party lands. Whilst also an OHL option, Option C has a lower impact than Option A during construction and operation as it requires only one corridor.

2.4.3.2 Economy

The economic effects on the local economy during construction for OHL Options A and B are considered to be a low to neutral effect. There is some potential for adverse and beneficial effects during construction as result of possible traffic and access disruption but also an influx of workers. Cable Option C has a lower overall impact as it requires only one corridor. However, none is considered to have a significant impact on the economy during construction. During operation, OHL Option B may have a slightly higher adverse impact as a result of restrictions on agricultural practices.

2.4.3.3 Traffic & Transport

The greatest effects on Traffic and Transport would be during construction for all options. Whilst all would be constructed on third party lands, they would all require access from local roads. OHL Option A and cable Option B are likely to be similar as both would require two new corridors with associated equipment and potential for local disruption for access. OHL Option C has a lower potential for an effect on local roads as it requires only one corridor.

2.4.3.4 Utilities

The effects on utilities during construction for OHL Options A and C are considered to be low risk. There is a low to moderate risk from the construction and operation of cable Option B as it is crossing third party lands where the likelihood of underground utilities is relatively low. Potential issue where roads are crossed.

2.4.3.5 Assessment of Socio-economic criteria

More significant/difficult/risk — Less significant/difficult/risk

Constraint	Option A (Two corridors, single circuit towers, one 220kV, one 400kV)	Option B (Two cable swathes, one conductor per phase; one for 220kV and one for 400kV)	Option C (One corridor, double circuit towers with 220kV and 400kV)
Amenity & Health			
Economy			
Traffic & Transport			

Utilities			
Combined Performance			

Table 2.2 : Socio-economic assessment for Connections into Woodland Substation

2.4.4 Structural Design

For each option identified an assessment of the technical feasibility has been undertaken. This has been limited to:

- use of available standard designs for any new OHL support structures
- modification or replacement of existing OHL support structures on the same site that will satisfy the project's system design requirements i.e. uprated from 220kV to 400kV
- A cable connection requiring a cable sealing end compound with downleads from a terminal tower onto either a line termination structure or anchor blocks.

The support structures used on any proposed OHL route will be standard EirGrid structure designs in accordance with EirGrid Functional Specification LDS-EFS-00-001-R0. Existing 220kV towers upgraded to operate at 400kV will be replaced on existing (or upgraded) foundations and the conductor system uprated accordingly.

2.4.5 Constructability and Outage Implications

Each option has been developed on the basis that it can be constructed using a single circuit outage or series of single circuit outages, but recognising that as a network reconfiguration, new circuits will be created that could result in the need for simultaneous outages being required at some stage.

The basis for construction of towers off-line, but in proximity to existing network assets, has been that while there may potentially be sufficient space available for the construction of new OHL infrastructure without the need for a proximity outage, this cannot be guaranteed at this stage and proximity outages may therefore be required.

Options for any reconfiguration will need to account for the related outage implications associated with the route up-voltage works on the basis that these will be carried out simultaneously and may require the use of temporary OHL diversions.

A sequence of work has been suggested for each option. The study assumes that any modifications required to achieve the connection near Woodland will be carried out in conjunction with the proposed up-voltage works planned for these circuits, however at this stage the EirGrid strategy for delivering the up-voltage works has not been confirmed. On the basis that a single circuit outage will be required to construct the up-voltage option and that this is continuous, then there would be opportunities to integrate any one of the connection options presented during that outage. However, in order to maintain overall system security, EirGrid may look at sequential outages to facilitate the up-voltage works which may affect how the connections are integrated into Woodlands substation and existing OHL assets. Therefore, the outages associated with each option are presented in isolation (i.e. independently of the up-voltage works) in order that EirGrid can understand the potential implications in determining the best performing option.

2.4.6 Maintenance

The basis for the maintenance assessment has been that any existing OHL towers that are proposed to be reused in a revised configuration should still be maintainable using standard EirGrid working practices, however any such tower will be noted as 'non-standard' to recognise that an alteration has been made from the original installation and additional maintenance considerations may be required.

2.5 Other assumptions made in the study

No detailed design work is involved in Step 3 of the framework development process therefore various other assumptions are noted in relation to the feasibility assessment:

- No assets records have been provided by the Transmission Asset Owner (TAO) for the existing OHL routes therefore the type of foundation at existing tower sites is unknown.
- Existing profiles have not been confirmed or any site-specific clearance requirements noted.
- The condition of existing assets is presently unknown therefore the study has assumed that condition will not influence the construction methodology.
- No third-party data other than that derived from the various studies by Jacobs or from publicly available aerial imagery has been used in the study.
- No structural analysis has been undertaken.
- Only outline sequences of work and outages have been considered.
- No indicative tower locations or profile drawings have been produced.
- The study has only considered the technical feasibility of options; no consent or planning factors have been considered.
- The presence of fibre optic services on existing TAO assets has not been confirmed or the potential implications of separate fibre outages on the options under consideration.

3. Option development

3.1 Site Visit Observation

A site visit was undertaken prior to the evaluation of options but was limited to observation from public roads and viewpoints from within Woodland substation. No asset records were available for the site visit.

3.1.1 Existing 400kV OHL and associated line entry at Woodland

The following observations were made during the site visit:

- Existing 400kV circuit OHL entry arrangement into Woodland is via double circuit tower as presented in figure 3.1
- The spare capacity evident on the existing 400kV OHL is noted by EirGrid to be reserved for a future project and is therefore unavailable for use on CP966
- Existing 400kV Old Street circuit is supported on double circuit towers for approximately 2 km before transitioning onto single circuit towers thereafter to the crossing point with the 220kV Maynooth – Gorman circuit

Figure 3.1 : Existing Old Street 400kV circuit into Woodland

- Land to the west of Woodland substation presented in figure 3.2

Figure 3.2 : Land to the west of Woodland 400kV substation

§ Existing 220kV bays at Woodland substation as presented in figure 3.3

Figure 3.3 : Existing 220kV bays at Woodland substation

3.1.2 Existing 220kV and 400kV OHL crossing point

§ The existing Old Street - Woodland 400kV circuit over sails the existing Maynooth – Gorman 220kV circuit as indicated in figure 3.4.

Figure 3.4 : Existing Maynooth - Gorman 220kV circuit passing beneath Old Street – Woodland 400kV circuit

3.1.3 Study area

- Topography typically rural with evidence of pastural agricultural activity as indicated in Figure 3.5
- The topography of the study area is reasonably level or gently undulating.
- Field boundaries generally comprise fencing and / or hedgerow.

Figure 3.5 : Existing 400kV OHL within the Study Area

3.2 Line Diagram

A diagrammatic representation of the circuit arrangements near to Woodland is presented in Figure 3.6 (not to scale) which has subsequently been used as the basis for presentation of the various options considered. The diagram notes the apparent spare capacity in the double circuit tower section, however this is not available to this project.

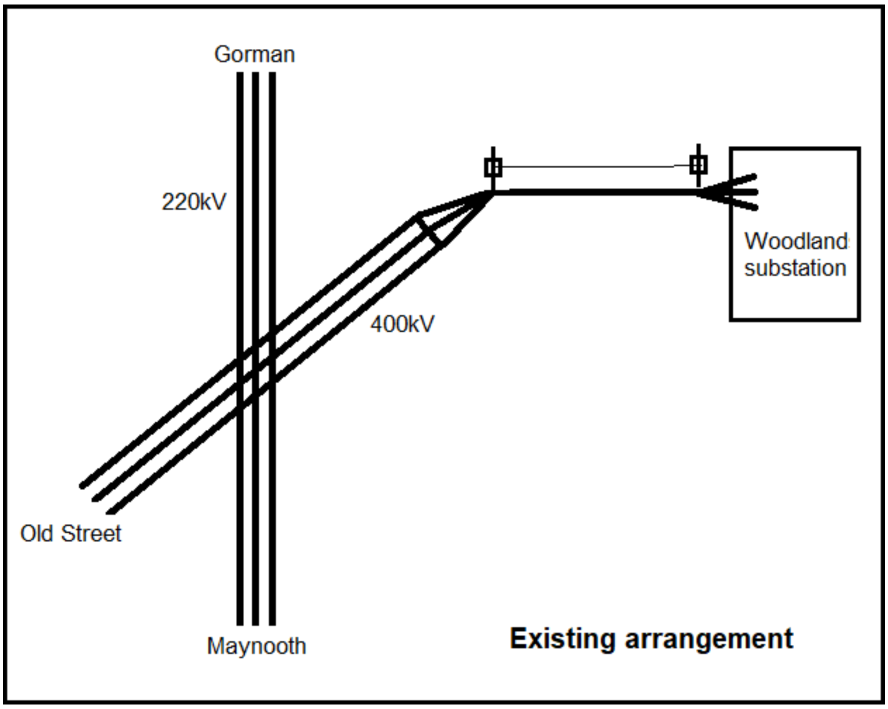


Figure 3.6 : Line Diagram of existing arrangement

3.3 Woodland substation line entry arrangements

3.3.1 Proposed substation layouts

At Woodland substation, the line entry design considerations have been made with reference to Jacobs drawings 321084AE-LAY-011 (Appendix A - Woodland CP966 400kV OHL & 220kV Gorman OHL), 321084AE-LAY-015 (Appendix B - Woodland 400kV OHL & 220kV Gorman cable) and 321084AE-LAY-016 (Appendix C - Woodland 220kV C-type extension).

3.3.2 Proposed 400kV OHL entry

The proposed 400kV OHL entry is presented in figure 3.7; extract of Jacobs drawing 321084AE-LAY-011. Proximity to the Portan Interconnector bay is noted and the construction sequence in this area will need to be confirmed; the study assumes a minimum 10m between respective bay assets will be sufficient to facilitate the construction of the CP966 bay.

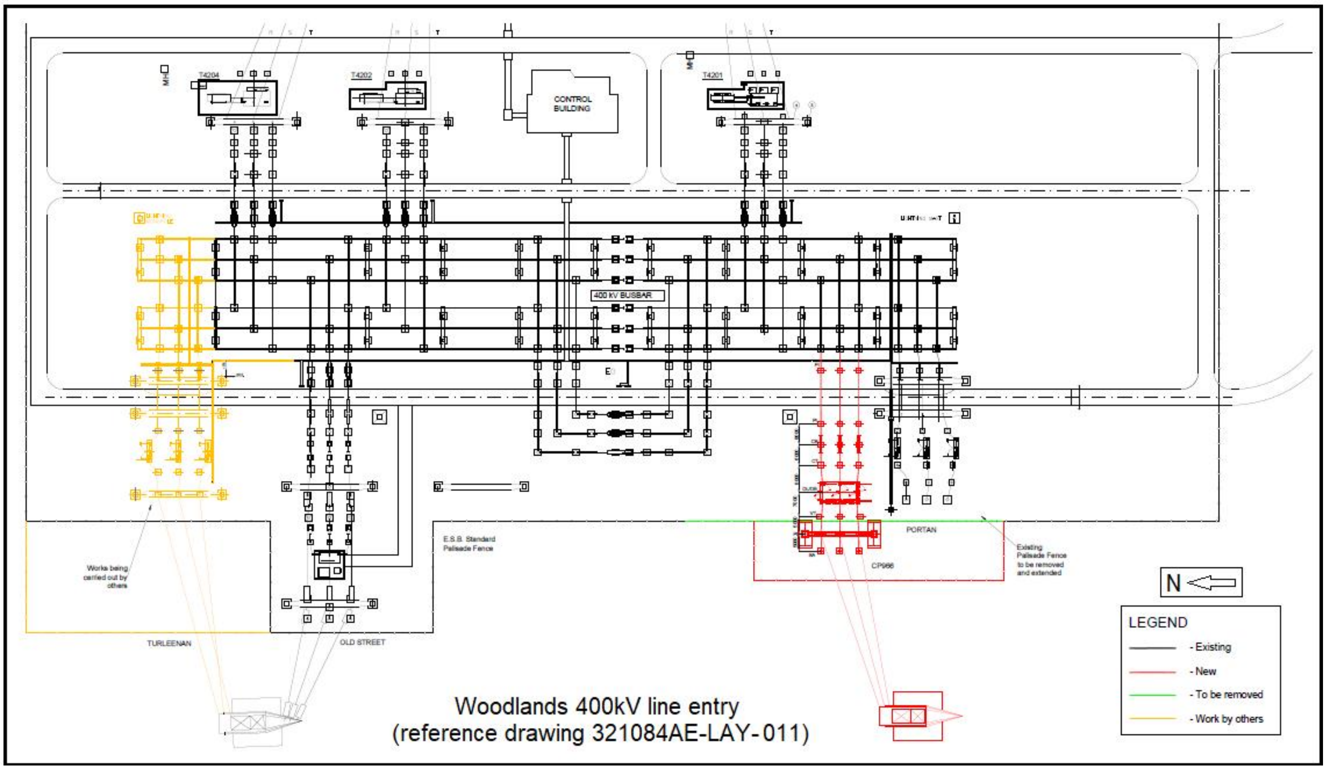


Figure 3.7 : Woodland substation – proposed 400kV line entry

A new 400kV tower is indicated outside of the substation boundary as identified by the palisade fence line in figure 3.7 (drawing 321084AE-LAY-011) but within the Transmission Asset Owner's property boundary (presented in figure 3.8), however the position of this tower will need to be confirmed in due course.

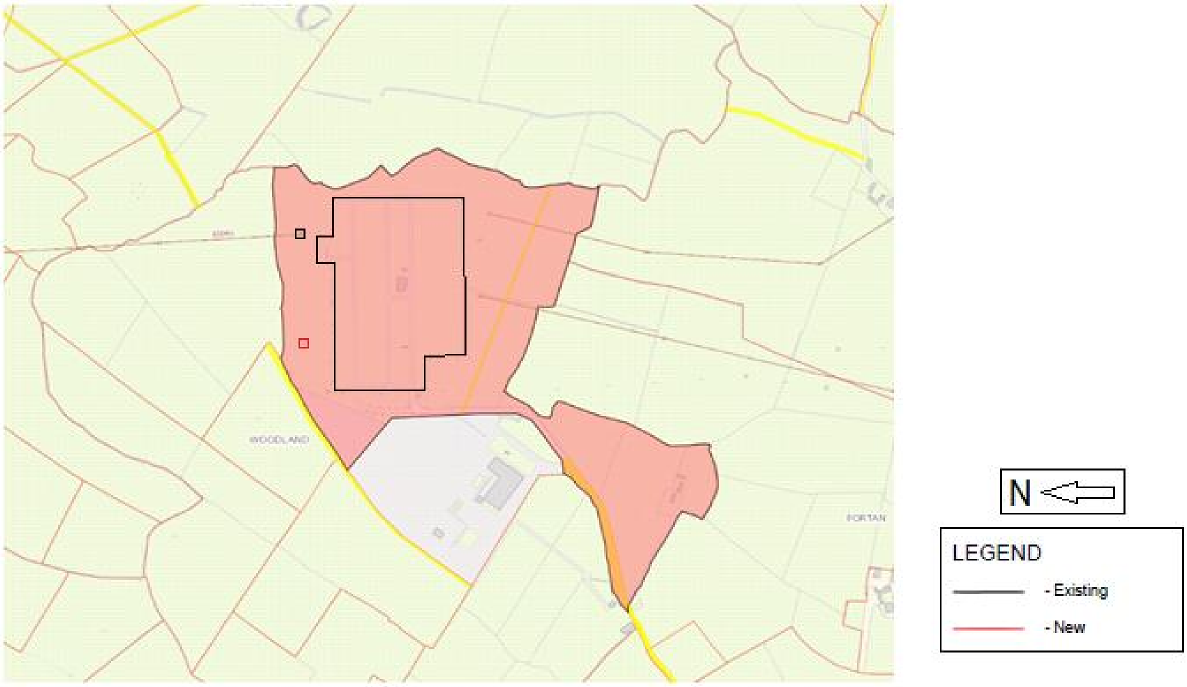


Figure 3.8 : Woodland substation – property boundary

The geometry of an OHL terminal tower and associated line termination structure is a relationship determined by the respective capability of each; permissible angles of entry to achieve the required electrical clearance (horizontally and vertically) and structural capacity. No data has been provided for existing structures therefore the geometry is assumed based on observation of existing Eirgrid line entry arrangements and previous experience of similar UK designs.

The proposed 400kV bay at Woodland substation will be positioned to the south of the existing Old Street 400kV circuit line entry, however at this stage of the project development, the OHL route corridors have yet to be confirmed. As such the location of the associated terminal towers will be constrained to a large degree by the proposed substation design and the 400kV OHL route corridor will need to be aligned with this position. There is however some flexibility in respect of the position of the terminal tower therefore for any given circuit, this location should generally be within 50 metres of the line termination structure and in an area approximately 25m either side of the circuit centre line. This will need to be confirmed at a later stage.

3.3.3 Proposed 220kV OHL entry options

The proposed 220kV OHL circuit from Gorman is likely to approach the existing substation compound from a northerly or north westerly direction into Woodlands substation. To terminate the circuit the simplest solution would be to use OHL downleads into a new bay at the northern end of the substation and the substation design implications of this would be extended development of the substation fence line to the north to facilitate a C-type extension, albeit within the substation property boundary. This option has been developed with reference to Jacobs drawing 321084AE-LAY-016 - Woodland 220kV Gorman OHL Connection Revision A.

The alternative would be to use a bay entry at the southern eastern end of the site where available space would allow development within the existing substation fence line, however this would need to be a cabled circuit entry because the Gorman OHL would need to pass beneath other 220kV OHL circuits as it enters Woodlands 220kV substation. This option has also been developed with reference to Jacobs drawing 321084AE-LAY-015 - Woodland 220kV Gorman Cable Connection Revision A.

3.3.3.1 Proposed 220kV OHL entry

Figure 3.9 illustrates the OHL entry arrangement into the north east corner of Woodlands 220kV substation which is an extract of drawing 321084AE-LAY-016 - Woodland 220kV Gorman OHL Connection Revision A marked up with indicative line termination tower and downleads into Gorman 220kV bay.

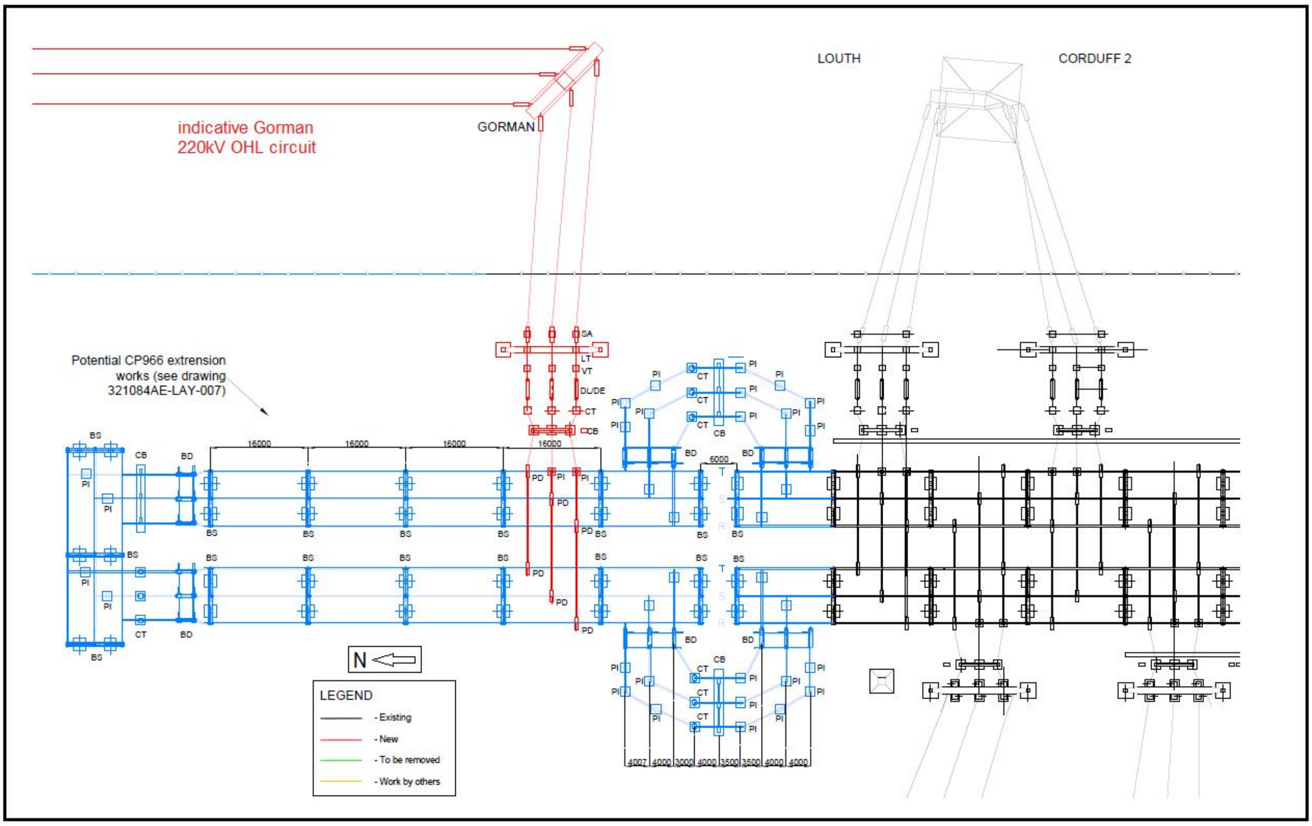


Figure 3.9 : Woodland substation – proposed Gorman 220kV circuit OHL entry option

A conventional single circuit terminal tower has been indicated directly in front of the Gorman bay entry. The downleads would then be orientated onto the line termination structure. The study assumes a single circuit line termination structure would be used rather than an extension of the adjacent structure.

3.3.3.2 Proposed 220kV cable entry

Figure 3.10 illustrates the cable entry option with OHL from the north and indicative line termination tower, cable sealing end compound and cable route into the south east corner of Woodlands 220kV substation (extract of drawing 321084AE-LAY-015 - Woodland 220kV Gorman Cable Connection Revision A marked up with the OHL connection into Gorman 220kV bay).

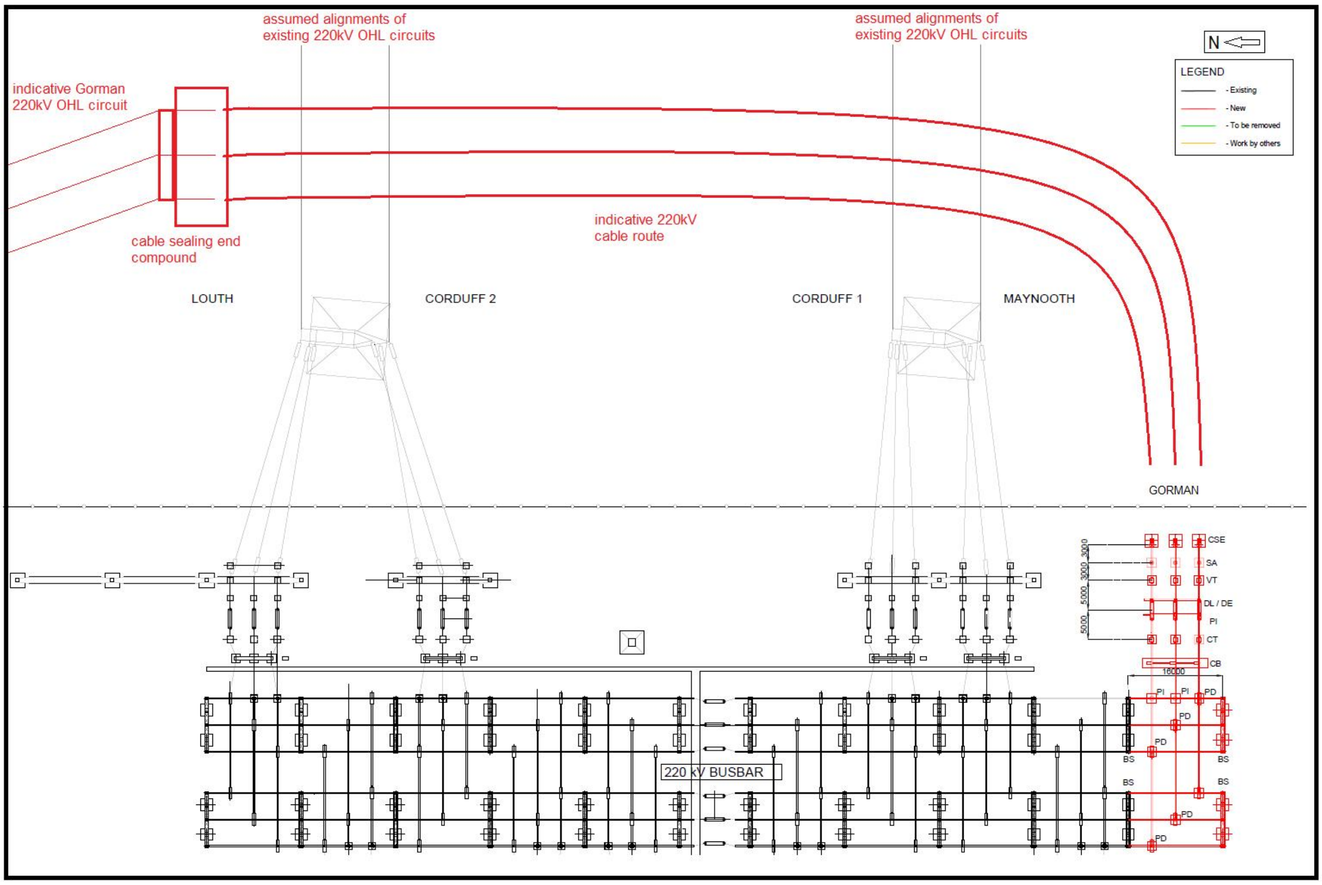


Figure 3.10 : Woodland substation – proposed Gorman 220kV circuit cable entry option

A conventional single circuit terminal tower has been indicated to the north of the existing Louth / Corduff 2 220kV OHL route with downleads into a cable sealing end compound. The cable would then be routed into the Gorman bay in the south east corner of the 220kV substation.

3.3.4 Line Termination Structure design

The OHL conductor system could be terminated on a structure designed specifically for this task. Observation from the site visit at Woodland indicates that Eirgrid uses a standard structure for each of the 220kV and 400kV line entries; a typical 400kV structure is presented in figure 3.11. Therefore, the study assumes that available or similar equivalent new structures will be used for any new bays.

Figure 3.11 : Woodland substation – Single circuit 400kV line termination structure

3.4 Option A – Single circuit OHL connections

3.4.1 Objective

The objective of Option A is to provide two separate circuits from the existing 220kV OHL towards Woodland substation using new single circuit towers. The interface between existing and new OHL being provided by towers positioned on the line of, or adjacent to, existing OHL alignment. Whether new or existing, towers should be maintainable using existing procedures. Alignments presented in figure 3.12 are only an indication of the route principle. The connection could be made from various points along the existing OHL alignment although this will affect the length of the new section. The existing structures that would be removed are single circuit 220kV type towers.

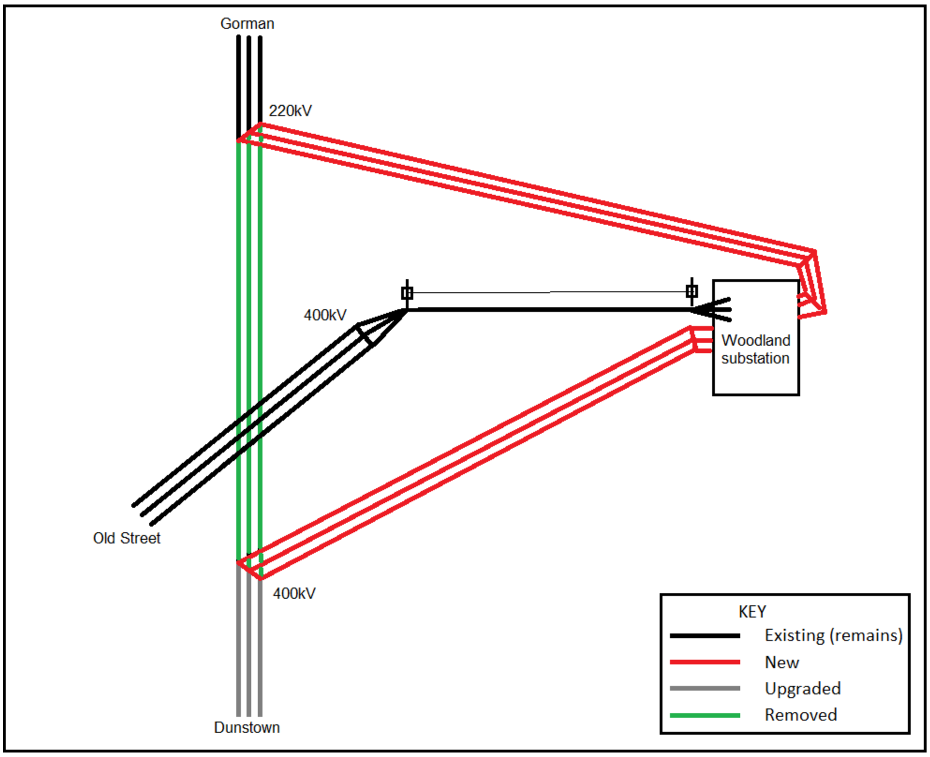


Figure 3.12 : Option A

3.4.2 Observations:

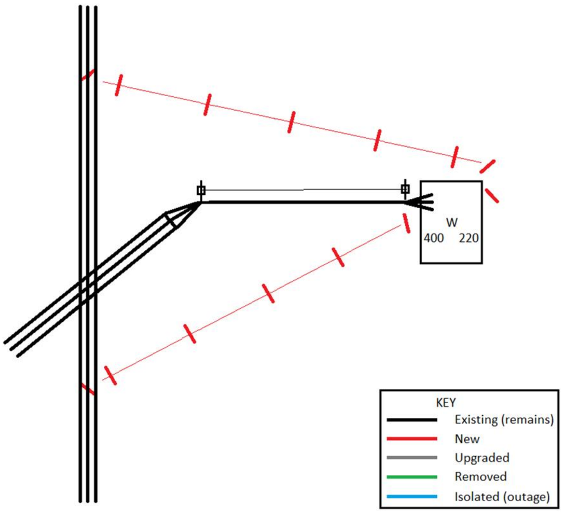
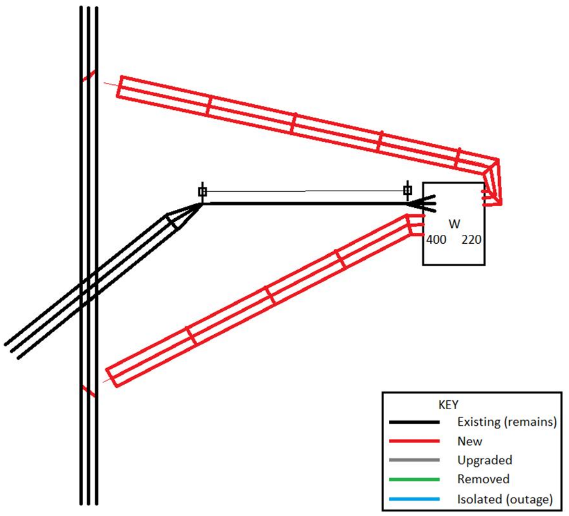
The following observations are noted in relation to option A:

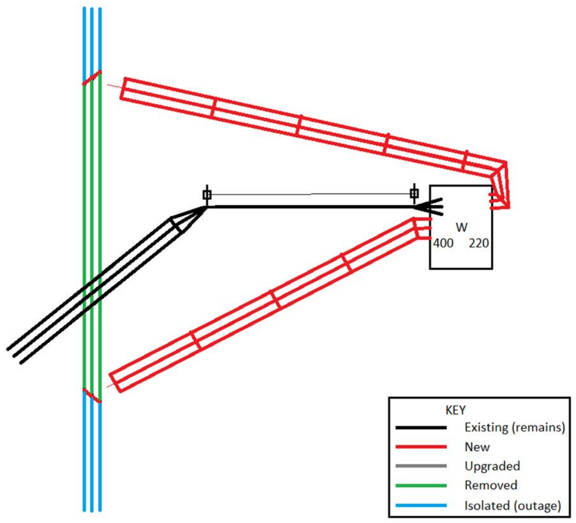
- Additional single circuit towers will be required in the 'new route' corridors in accordance with the EirGrid functional specification LDS-EFS-00-001-R0 for both 220kV and 400kV OHL towers
- Re-use of existing towers may require the upgrade design to account for additional site-specific requirements needed to facilitate the connection of a new section of OHL
- Existing angle towers affected by the modification may be no longer set on the bisector of the angle of deviation; arrangements should be maintainable using currently available procedures. Non-standard configurations may affect future maintenance requirements or require site-specific procedures
- The length of the 'new route' section would be determined by positions of existing structures and availability of route corridors through the study area

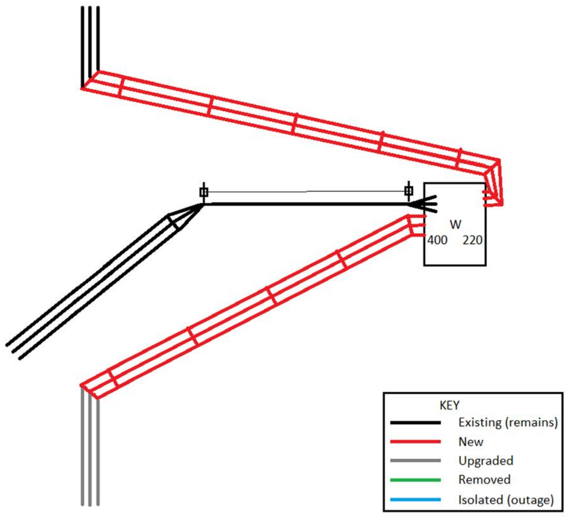
- A detailed assessment of the route corridor will be required to confirm availability of tower positions and the effect of the resulting conductor catenaries on clearances available for existing agricultural activity and other third-party activity
- A section of existing OHL will be removed however as additional towers are required the reconfiguration will have a visual impact in this area.

3.4.3 Outline Sequence of Work (Stage Diagrams)

The following sequence of work is suggested for construction of option A:

<table>
<tr>
<td>
</td>
<td>Stage 1. Pre-Outage
1) Construct foundations for new 400kV towers, including beneath existing conductor systems (assumes sufficient working height permitting is available for foundation construction without an outage).</td>
</tr>
<tr>
<td>
</td>
<td>Stage 2. Pre-outage
1) Construct new 400kV towers
2) Construct line entry arrangement at Woodland substation (without installation of final jumper connections)</td>
</tr>
</table>

<table>
<tr>
<td>


</td>
<td>
Stage 3. Dunstown – Gorman 220kV outage (allow 3 weeks but likely to be an up-voltage project related duration)
1) Dismantle existing section beneath 400kV circuit (backstay as necessary)
2) Remove any redundant assets that may be in proximity.
</td>
</tr>
<tr>
<td>


</td>
<td>
Stage 4. Dunstown – Gorman 220kV outage (up-voltage project related duration)
1) Connect upgraded 400kV conductor system from south (Dunstown circuit).
2) Connect existing 220kV conductor system from north (Gorman circuit)
3) Commission new circuits (assumes coordinated with works elsewhere)
4) Remove any remaining redundant assets
</td>
</tr>
</table>

3.5 Option B – Single circuit cable connections

3.5.1 Objective

The objective of Option B is to provide two separate circuits from the existing 220kV OHL towards Woodland substation in a similar configuration to Option A but using underground cables. The interface between existing and new cable being provided by cable sealing end compounds positioned adjacent to the existing OHL alignment. Alignments presented in figure 3.13 are only an indication of the route principle. The connection could be made from various points along each alignment although this will affect the length of the new section. The cable route would be determined in accordance with the principles and details presented in Jacobs report 321084AE-REP-0001, Cable Feasibility Report.

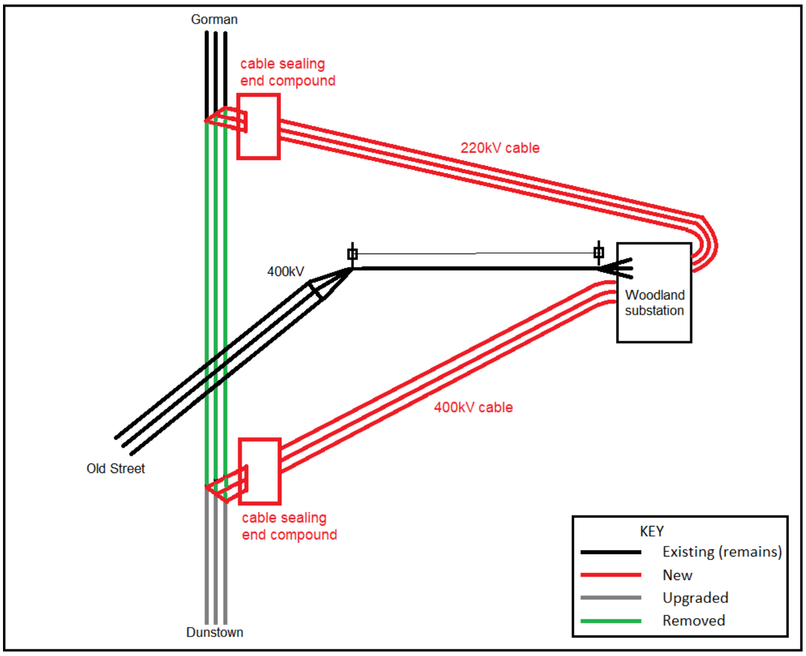


Figure 3.13 : Option B

3.5.2 Observations:

The following observations are noted in relation to option B:

- Additional single circuit towers will be required in accordance with the EirGrid functional specification LDS-EFS-00-001-R0 to facilitate an interface with the cable sealing end compounds
- New OHL towers may be positioned off-line to interface with upgraded OHL therefore re-use of existing towers may require the upgrade design to account for additional site-specific requirements
- Existing angle towers affected by the modification may be no longer set on the bisector of the angle of deviation; arrangements should be maintainable using currently available procedures. Non-standard configurations may affect future maintenance requirements or require site-specific procedures
- A detailed assessment of the route corridor will be required to confirm availability of CSEC associated tower positions and the effect of the resulting infrastructure on existing agricultural activity and other third-party activity
- A cable solution is considered technically feasible but economically expensive; the cable will need to match the rating of the OHL conductor (one or two cables per phase) plus cable sealing ends, surge arresters and earth switches will be required within a cable sealing end compound.
- The length of the cable section would be subject to the availability of a suitable route corridor within the study area
- As sections of existing OHL will be removed the visual impact of OHLs in this area may be improved
- Cable ratings and any constraints within the cable route would need to be confirmed from a route survey. For example, vegetation can result in a de-rating of cables. Furthermore, the required construction process i.e. trenched, direct buried, ducted etc. or the need for larger cable separations or specialised backfill will need to be confirmed, each of which would have construction implications.
- Third party land usage will need to be investigated to confirm the required corridor including sufficient working area for deliveries (cable and construction equipment, materials), storage, trench excavation, soil removal, etc.
- Installation of cable could be required beneath existing OHL therefore safe working clearance will need to be confirmed in these areas

- EirGrid will need to consider whether the proposed cable routes will affect any other existing or planned EHV cable routes around the substation
- Cable sealing end compounds will be required in locations assumed to be in proximity to the existing Maynooth – Gorman 220kV OHL and with suitable access from local roads, however alternative locations for the cable sealing end compounds may be considered by EirGrid, such that the option design represents a combination of Option A (a section of new OHL) and Option B (a section of underground cable) as illustrated in figure 3.14.

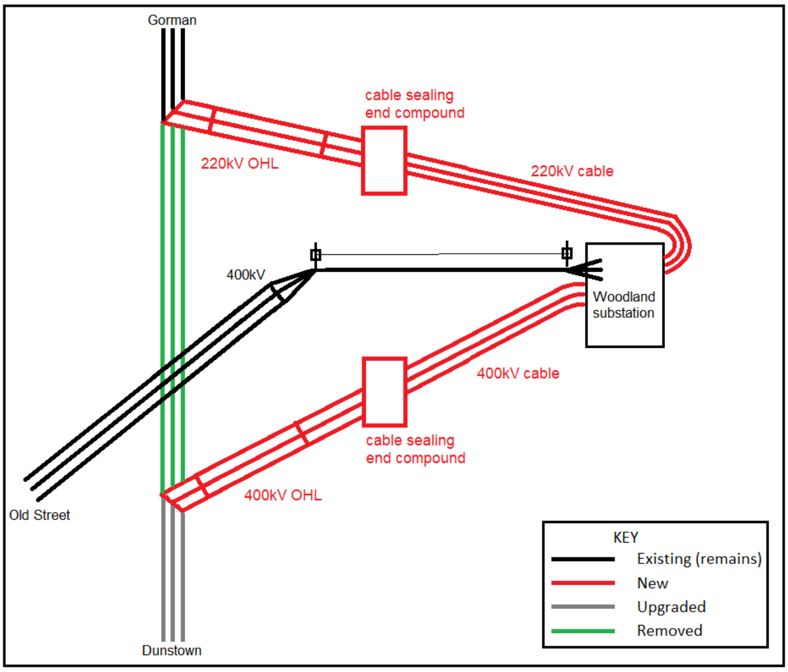
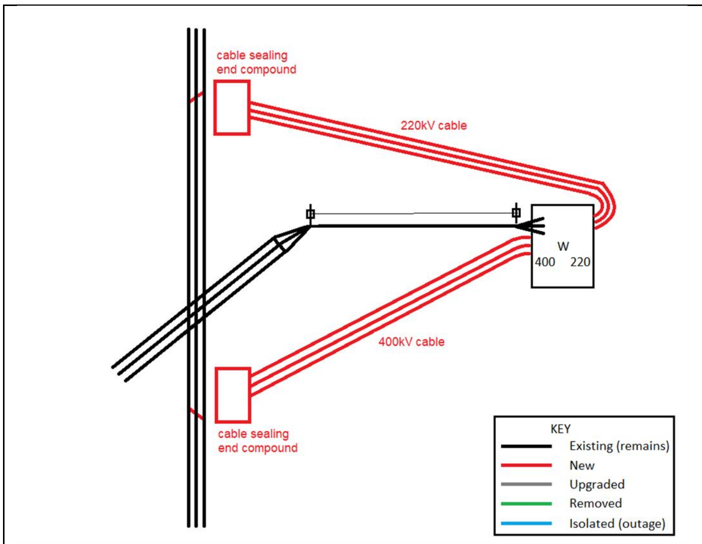


Figure 3.14 : Combined OHL / Cable solution

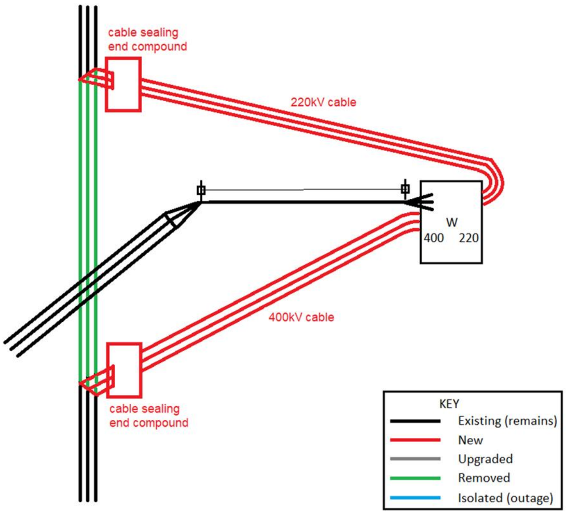
3.5.3 Outline Sequence of Work (Stage Diagrams)

The following sequence of work is suggested for construction of option B using the underground cable option as illustrated in figure 3.15 above (section 3.5.1).



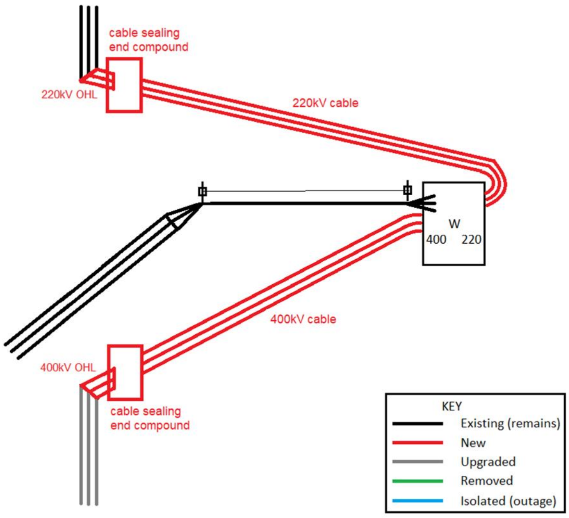
Stage 1. Pre-Outage

1) Construct cable sealing end compounds adjacent to OHL
2) Install cables between cable sealing end compounds and Woodland substation
3) Construct foundations for new 400kV towers (assumes sufficient horizontal clearance is available for foundation construction without an outage)



Stage 2. Dunstown – Gorman 220kV outage (allow 3 weeks but likely to be an up-voltage project related duration)

1) Outage and decommissioning of Maynooth - Gorman 220kV circuit
2) Backstay existing conductors in section to be dismantled
3) Erect new towers
4) Construct span of conductor between new towers and cable sealing end compounds



Stage 3. Dunstown – Gorman 220kV outage (up-voltage project related duration)

1) Connect upgraded conductor system from southern direction and commission new 400kV Dunstown – Woodland circuit (assumes coordinated with works elsewhere).

2) Connect existing conductor system from northern direction and commission new 220kV Gorman – Woodland circuit.

3) Remove any remaining redundant assets

3.6 Option C – Double circuit OHL connections

3.6.1 Objective

The objective of Option C is to achieve the required connection using one double circuit OHL between new towers positioned on the line of, or adjacent to, existing OHL alignment and Woodland substation, either north or south of the existing crossing point. Conceptually, there are two possible ways of achieving this; with alignments north or south of the existing crossing point as presented in Figure 3.15, which is only an indication of the route principle. The connection could be made from various point along each alignment although this will affect the lengths of new OHL and cable sections.

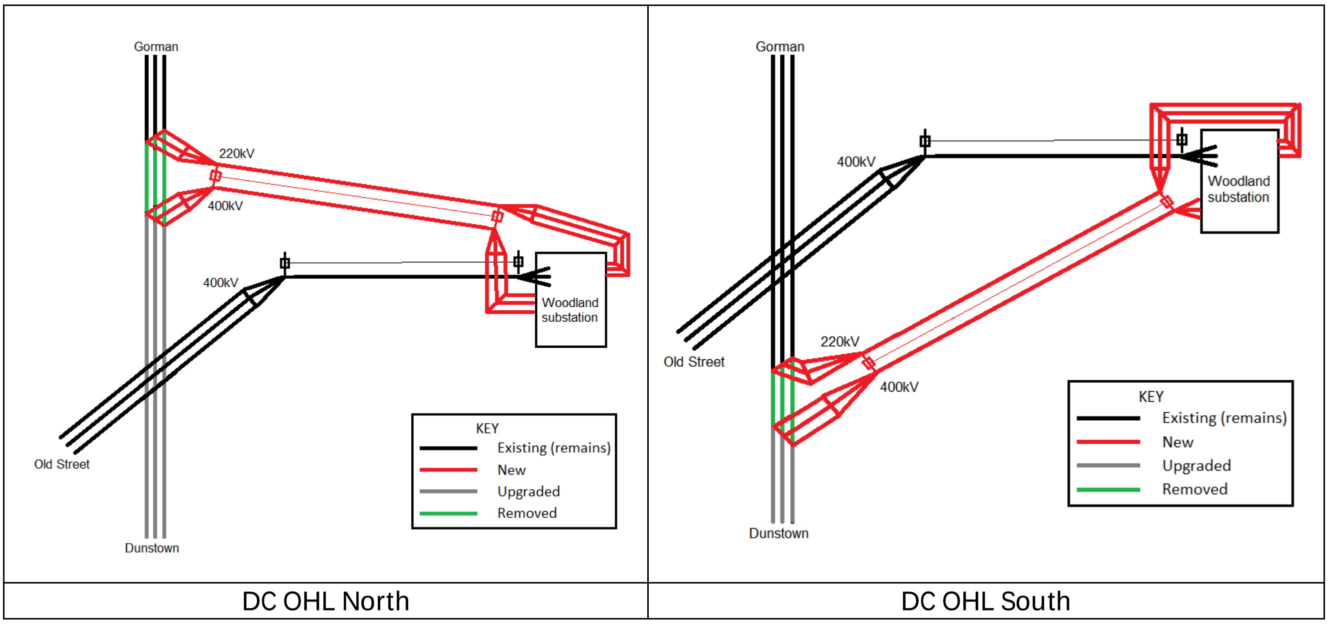


Figure 3.15 : Option C

3.6.2 Observations:

The following observations are noted in relation to option C:

- A double circuit OHL ‘North’ would require the up-voltaged section of the existing 220kV circuit to pass beneath the existing 400kV Old Street circuit twice (at the existing crossing point and also outside of Woodland substation) for which 400kV circuit clearance would be required. Modifications to the existing 400kV arrangements may therefore be required
- A double circuit OHL ‘South’ would allow the above circuit clearances to be managed at 220kV i.e. no change at the existing crossing point and therefore a reduced clearance requirement at the crossing point close to Woodland substation
- By maintaining the crossing point in some form, EirGrid will have to consider whether future maintenance of the upper circuit will require an outage on the lower circuit and thereby compromise the network operation in this area
- The circuit crossing close to Woodland substation could be provided by underground cable rather than OHL; this would eliminate any potential under-sailing clearance issues but be more expensive as cable and cable sealing end arrangements would be required (quantities not provided).
- Additional double circuit towers would be required in the ‘new route’ corridor in accordance with the EirGrid functional specification LDS-EFS-00-001-R0. New double circuit towers will be 400kV design despite one of the circuits operating at a lower voltage. This will however give EirGrid the opportunity to ‘up-voltage’ the 220kV circuit in the future if required.
- Re-use of existing towers may require the upgrade design to account for additional site-specific requirements of transitioning from single to double circuit tower configuration
- Existing angle towers affected by the modification may be no longer set on the bisector of the angle of deviation; arrangements should be maintainable using currently available procedures. Non-standard configurations may affect future maintenance requirements or require site-specific procedures
- The length of the ‘new route’ section would be determined by positions of existing structures and availability of route corridors through the study area, noting that a double circuit configuration may require a wider swathe than a single circuit configuration
- Profile of conductor to ground will affect both agricultural activity and any other third-party activity in the ‘new route’ corridor

- A detailed assessment of the route corridor will be required to confirm availability of tower positions and the effect of the resulting conductor catenaries on clearances available for existing agricultural activity and other third-party activity
- A section of existing OHL will be removed and only one route corridor would be required however new towers will be taller than those removed. The route corridors may or may not use those required for Option A; the visual impact of the taller double circuit towers being a significant factor in this outcome.
- The transition point from two single circuit OHL routes to one double circuit route could be made at various points along the route corridor as illustrated in figure 3.16 (quantities not provided)

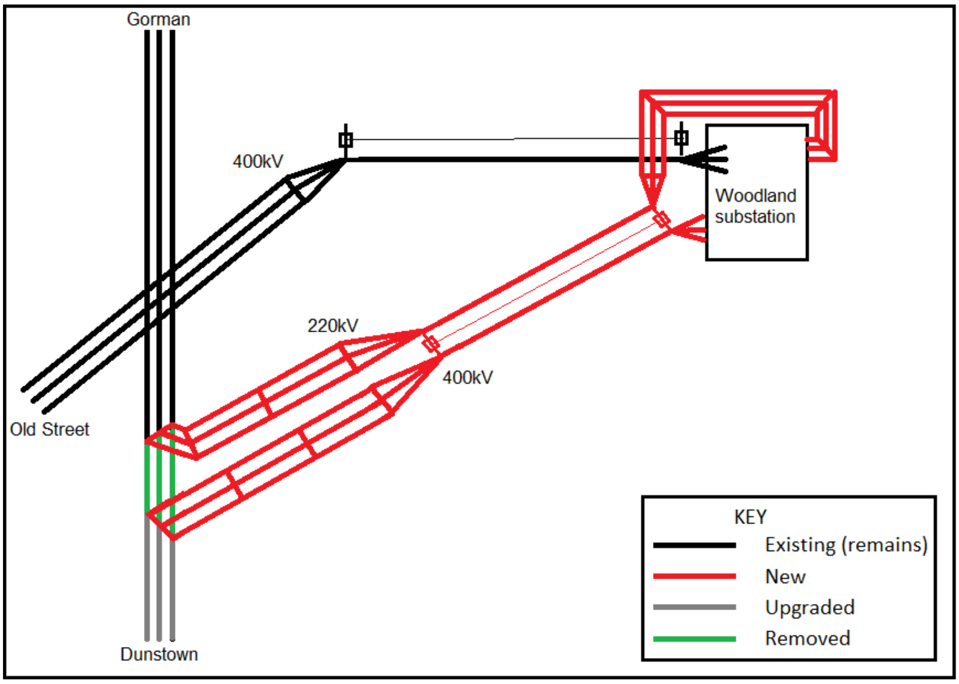
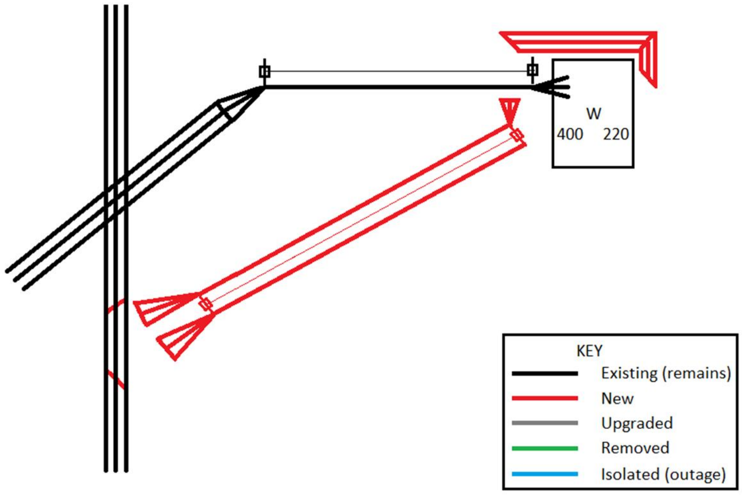
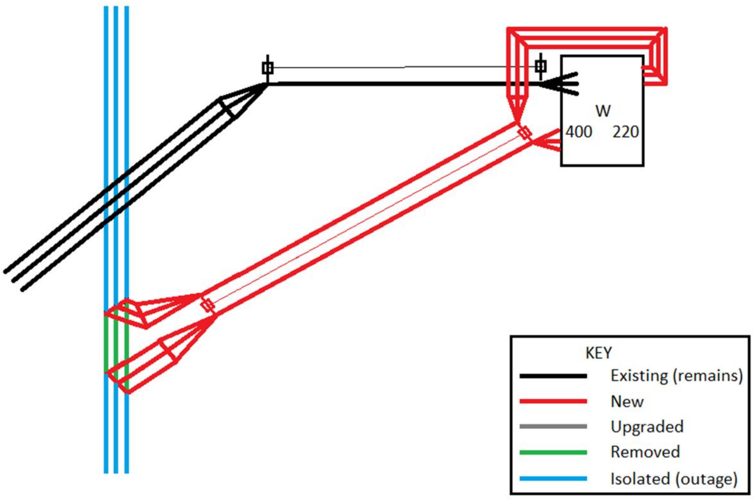
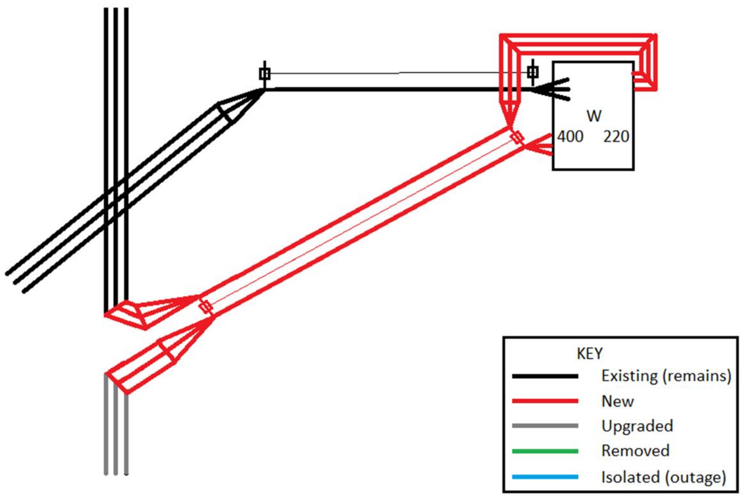


Figure 3.16 : Combined single / double circuit OHL solution

3.6.3 Outline Sequence of Work (Stage Diagrams)

The following sequence of work is suggested for construction of option C assuming the construction of a route corridor south of the existing crossing point.

The sequence would be very similar for construction of a route corridor north of the existing crossing point, however additional work may be necessary on the existing 400kV circuit (Old Street – Woodland) at the circuit crossing point as a result of the 'up-voltage' work being undertaken on the existing OHL creating a clearance issue.

	Stage 1. Pre-Outage 1) Construct new DC OHL adjacent to existing conductor systems 2) Construct foundations for new 400kV towers beneath existing conductor systems Assumes sufficient working height permitting is available for foundation construction, and sufficient horizontal clearance is available for OHL construction without an outage
	Stage 2. Dunstown – Gorman 220kV outage (allow 3 weeks but likely to be an up-voltage project related duration) 1) Outage and decommissioning Gorman and Dunstown 220kV circuits 2) Backstay existing conductors 3) Erect new towers and connect both circuits to new DC OHL 4) Commission new 220kV circuit
	Stage 3. Dunstown – Gorman 220kV outage (up-voltage project related duration) 1) Connect upgraded conductor system 2) Commission new 400kV circuit 3) Remove remaining redundant assets.

3.7 Design Considerations

3.7.1 Design Capability of Upgraded Towers

As part of the up-voltage works, existing 220kV structures will be replaced above ground level and foundations upgraded as required. EirGrid has specified a standard conductor system for the proposed connection. As such the replacement structures should have the same basic capability as those presented in the EirGrid Functional Specification LDS-EFS-00-001-R0.

Accordingly, the suspension type tower (Figure 3.17) will only be capable of supporting conductor systems purely in suspension and without deviation (any permissible deviation therefore only being because of constructability issues and not by design). By positioning new structures on-line, existing suspension towers should not be adversely affected; subject to ground profiling and tower heights the weight span on existing suspension towers will be altered, however this is likely to be very limited in magnitude.

Figure 3.17 : Single circuit 220kV Suspension Towers (Woodland-Gorman)

Section or Angle type tension towers in the EirGrid Functional Specification LDS-EFS-00-001-R0 are available to suit angles of deviation ranging from 0° to 30° through to 60° and 100°. Conventionally, Section or Angle towers (figure 3.18) are set on the bisector of the angle of deviation, indeed EirGrid functional specification LDS-EFS-00-001-R0 stipulates that angle supports shall be correctly orientated in plan so that the transverse axis of the support is aligned with the bisector of the line angle within a tolerance of ± 2°, however this does not mean that structurally an existing tower cannot be modified to create unequal angles of entry in each side of the tower, thus enabling an existing Section or Angle tower to be used to deviate the existing alignment onto a new section of OHL as suggested for each of the options considered. Any such reuse should however be considered a non-standard configuration as it could have structural or maintenance implications.

Figure 3.18 : Single Circuit 220kV Section / Angle Towers (Dunstown-Woodland)

3.7.2 Design Capability of New Towers

Any proposed new towers should be standard designs in accordance with the EirGrid Functional Specification LDS-EFS-00-001-R0. Accordingly, suspension type towers should be as noted above for existing towers and Section or Angle type tension towers set on the bisector of the angle of deviation.

3.7.3 The Route Up-voltage Technology (220kV to 400kV)

EirGrid has specified an option to consider upgrading existing 220kV towers to be capable of supporting a replacement 400kV conductor system with polymeric insulators and accordingly has proposed an outline replacement structure.

How these are to be replaced is currently being developed by EirGrid with a trial exercise on the redundant section of OHL. The process of upgrading related foundations will presumably be undertaken without outages, however there could be significant outage implications associated with replacing existing structures and conductor systems and EirGrid will therefore need to consider how these outages can be managed. Unless the network can be configured to provide the necessary system security during an extended outage period to replace existing towers, some form of temporary circuit diversion will be necessary.

The study assumes that where towers will be replaced, the equivalent up-voltage design suspension or section type of tower will be used and that where replacement with an alternative tower type is required, then this will be undertaken on an adjacent site.

3.7.4 Temporary Structures

Temporary diversions are used by network operators to provide short-term structural support of an overhead conductor system while either emergency repairs or planned works are undertaken on existing permanent structures. The benefit of these being that the network can continue to operate albeit at a slightly reduced level of security due to the temporary nature of the support system; as such they can represent a risk. Occasionally these systems are used for work on complete sections of OHL, however the duration of work may necessitate increasing the levels of security in the design. Temporary support tends to be guyed structures positioned on simple pad foundations as these are less intrusive.

At this stage the study has not considered the need for temporary diversions as the outage implications of proposed solutions have not been confirmed. Any assessment of the need for a temporary diversion should recognise the following factors:

- That the OHL structures being modified are supporting a horizontal configuration of phase conductors which may require a similar corridor width for the temporary diversion,
- That section towers may well be supporting angles of deviation and differential conductor tensions that will need to be accommodated in the temporary diversion.
- That complete sections of OHL will need to be replaced i.e. the corridor space for the temporary diversion will need to be available alongside any one section for the construction of mast and associated guys in proximity to the existing OHL circuits.

3.8 Cost Considerations

A table of quantities has been produced for each option and is presented in tables 3.1 – 3.3 based on standard equipment configurations and estimated mid-range route lengths such that an economic comparison can be made by EirGrid. As each option has only been developed as a concept, the quantities are based on the stated assumptions.

3.8.1 Option A - Single circuit OHL connections

Option	Item	Route OHL	Route Cable	Cable Accessories	Substation	Land
A) SC OHL Connection	Construction	6km 220kV [1]				OHL corridor
	Construction	6km 400kV				OHL corridor
	Removal	3km 220kV				
Optional: 220kV cable line entry incl CSEC [2]			200m 220kV	Cable sealing ends x3 or x6 depending upon cables per phase Surge arrestors x 3 phases	Compound civil costs	

Table 3.1 : Table of quantities – Option A

Note 1. 220kV line entry as presented in figure 3.9 above i.e. downleads into substation bay.

Note 2. Consideration has also been given to the cost of installing 220kV cable as indicated in figure 3.10 above i.e. a Cable Sealing End Compound adjacent to a terminal tower on the north side of the substation and cabling through to the proposed bay. This is presented as an optional element in table 3.1 with costs associated with the bay arrangements at Woodlands substation accounted for in Jacobs report 321084AE-REP-011.

3.8.2 Option A assumptions

- Approximate route lengths for construction of the new single circuits OHLs are based on a connection point at Woodland substation and undefined locations north and south of the existing crossing point of the existing 220kV OHL (Dunstown – Gorman) and 400kV (Woodland – Old Street). Each section of OHL could vary between 5km and 7km in length.
- Approximate route lengths for removal of existing 220kV OHL could vary between 0.5km and 5km therefore based on a mid-range value of 3km.
- Cable sealing end compound for 220kV line entry at Woodland assumed within the Transmission Asset Owner’s property boundary

3.8.3 Option B - Single circuit cable connections

Option	Item	Route OHL	Route Cable	Cable Accessories	Substation	Land
B) SC Cable connection[1]	Construction	0.5km 220kV				OHL corridor
	Construction	0.5km 400kV				OHL corridor
	Construction		6km 220kV	Cable sealing ends x3 or x6 depending upon cables per phase Surge arrestors x 3 phases	Compound civil costs	Compound
	Construction		6km 400kV	Cable sealing ends x3 or x6 depending upon cables per phase Surge arrestors x 3 phases	Compound civil costs	Compound
	Removal	3km 220kV				

Table 3.2 : Table of quantities – Option B

Note 1. Costs associated with the bay arrangements at Woodlands substation are accounted for in Jacobs report 321084AE-REP-011.

3.8.4 Option B assumptions

- Approximate route lengths for construction of each new single circuit cable is based on a connection point at Woodland substation and undefined locations north and south of the existing crossing point of the existing 220kV OHL (Dunstown – Gorman) and 400kV (Woodland – Old Street) OHLs. Each circuit could vary between 5km and 7km in length.
- Connection point between existing OHL and new cable sealing end compounds could vary in length between a single span and several spans depending upon the availability of land and access for a sealing end compound, therefore 0.5km of new single circuit OHL is assumed required.

- Approximate route lengths for removal of existing 220kV OHL could vary between 0.5km and 5km, therefore cost based on a mid-range value of 3km.
- Cable rating requirements not confirmed; 1600sqmm cable size assumed for each.

3.8.5 Option C - Double circuit OHL connections

Option	Item	Route OHL	Route Cable	Cable Accessories	Substation	Land
C) DC OHL connection	Construction	6km 220/400kV double circuit				OHL corridor
	Construction	1.0km 220kV single circuit [1,2]				
	Construction	0.5km 220kV single circuit [2]				OHL corridor
	Construction	0.5km 400kV single circuit [2]				OHL corridor
	Removal	1km 220kV				
Optional: 220kV cable line entry incl CSEC [3]			500m 220kV	Cable sealing ends x3 or x6 depending upon cables per phase Surge arrestors x 3 phases	Compound civil costs	

Table 3.3 : Table of quantities – Option C

Note 1. 220kV line entry as presented in figure 3.9 above i.e. downleads into substation bay.

Note 2. OHL connection arrangement based on figure 3.15 (south).

Note 3. Consideration has also been given to the cost of installing 220kV cable as indicated in figure 3.10 above i.e. a Cable Sealing End Compound adjacent to a terminal tower on the north side of the substation and cabling through to the proposed bay. This is presented as an optional element in table 3.3 with costs associated with the bay arrangements at Woodlands substation accounted for in Jacobs report 321084AE-REP-011.

3.8.6 Option C assumptions

- Approximate route lengths for construction of new 400kV double circuit OHL is based on a connection point at Woodland substation and an undefined location south of the existing crossing point of the existing 220kV OHL (Dunstown – Gorman) and 400kV (Woodland – Old Street) OHLs. The route length could vary between 5km and 7km in length.

- A 1km section of new 220kV OHL is assumed required at Woodland to pass beneath the existing 400kV Woodland – Old Street circuit and connect directly into the 200kV substation bay as figure 3.9.
- Connection point between up-voltaged 400kV OHL and the new section of double circuit OHL could vary between a single span and several spans depending up upon the configuration therefore 0.5km of new single circuit 400kV OHL assumed required.
- Connection point between existing 220kV OHL and the new section of double circuit OHL could also vary between a single span and several spans depending up upon the configuration therefore 0.5km of new single circuit 220kV OHL assumed required.
- Approximate route lengths for removal of existing 220kV OHL assumed could vary between 0.5km and 1.5km.
- Cable sealing end compound assumed within the Transmission Asset Owner's property boundary.
- 220kV line entry OHL assumed within the Transmission Asset Owner's property boundary

3.8.7 Common assumptions

- No allowance made for Proximity Payments; the largest being €30,000 for a residential building located 50 m from the centre line of a new 400 kV project and the smallest being €2,000 for a residential building located 200 m from the centre line of a new 110 kV pylon.
- Any longer-term implications of maintenance activities have not been accounted for e.g. OHL alone versus combination of cable and OHL technologies.

4. Evaluation of the Options

4.1 Option Review

4.1.1 Technical Performance

EirGrid considers favourable options to be those which extend technical performance beyond minimum acceptable levels, provide operational switching flexibility and which minimise risks to operation during maintenance. The extent to which future reinforcement or modification to the transmission network can be facilitated should also be considered.

Option A proposes new sections of single circuit OHL off-line but integrated with existing circuits and recognises that while the re-use of existing towers may require the upgrade design to account for additional site-specific requirements, this should be limited in extent or impact. The benefit of this is that the towers should be maintainable using current procedures, notwithstanding that the consequences of introducing the up-voltage design is likely to require a review of existing procedures anyway.

Option B requires a similar OHL interface with existing towers to facilitate a connection into a cable sealing end compound as it introduces underground cable technology and therefore increased complexity, with additional maintenance requirements for both switchgear and property.

Option C proposes a sections of double circuit OHL off-line but integrated with existing circuits and recognises that the re-use of existing towers will require the upgrade design to account for additional site-specific requirement of transitioning from single to double circuit arrangements. Furthermore, this option maintains an existing oversailing conductor situation and may introduce another at Woodland Substation.

Options A and C will introduce new spans of conductor and therefore constrain the working clearance available in the route corridor for both agricultural activity and any other third-party activity.

OHL based options are considered technical less complex than a cable option and are also considered economically advantageous in terms of construction costs. The single circuit OHL option is considered technically preferable on the basis that the double circuit option requires an extension of single circuit OHL (or equivalent cable) that will pass beneath the existing 400kV OHL close to Woodlands substation.

The cable option requires cable sealing end interface however this is standard technology and considered potentially less hazardous than the implications of oversailing OHL conductors. Where OHL circuit crossings do occur, there will be the need for a protection system at some stage, such as netted scaffold, in order that the over-sailing conductors can be maintained or replaced.

4.1.2 Economic Performance

The economic performance has been based on the estimated quantities for each technology and suggests that the OHL based options will generally cost less to construct than the cable connection option. Furthermore, experience indicates that the OHL options will subsequently cost less to maintain than the cable option.

The cost of the OHL based options A and C appear quite similar and cheaper than the more expensive cable based option B, however the route length quantities of each item noted will vary according to where the proposed OHL alignments are integrated into the existing OHL and the ratio of OHL / cable route length adopted, should a combination be preferred.

The subsequent maintenance costs of the OHL based options are also likely to be less on the basis that cable technology is more complex and individual components such as underground cable and cable sealing ends are more expensive to repair or replace.

4.1.3 Deliverability

The deliverability considers programme as well as engineering, constructability and planning risks.

Each of options A, B and C are likely to have planning implication for EirGrid as each is in a public area, albeit some of this could be in proximity to existing OHL infrastructure that has been constructed within a planning framework.

Option C is limited to one OHL route corridor rather than the two lower level single circuit routes required for Option A but is likely to have a greater visual impact given the need for taller double circuit towers; Option B eliminates a lot of the visual impact implication by virtue of being underground, however the cable sealing end compounds are likely to increase the visual impact locally where they interface with the existing OHL route. Option B also requires sterilisation of a corridor to install cables which will have a significantly greater short-term environmental impact.

Each of options A, B and C include OHL work that will need around three weeks of outages in total to achieve the connection with existing OHL infrastructure, however this is based on assumptions in relation to proximity, i.e. to allow construction of towers in options A and C and cable sealing end compounds in option B, and also works associated with the up-voltage works and related substation works.

The study area contains a road network which should make delivery of construction materials and plant reasonably straightforward for each of the options, however temporary roads will be required to each construction site other than within the Woodland substation. The availability of suitable access for the cable sealing end compounds will influence the location of these sites.

The cable option B is considered technically the most difficult to deliver because of the need for cable sealing end compounds and the need to sterilise a corridor of land for cable construction. Double circuit OHL option is considered slightly easier to deliver than single circuit OHL option A as fewer sites are involved.

4.1.4 Environmental

The planning and environmental implications of the OHL options consider the apparent implications of developing two separate single circuit OHL routes against the increased height implications one double circuit OHL route. This must be balanced with siting twice as many structures required for the two separate single circuit OHL routes and the number of properties / dwellings affected by developing two routes.

The most significant effects on biodiversity would be during construction and particularly in relation to cable route option B where two 12m wide swathes would each cross 7km of countryside and require temporary and some permanent loss of habitat; the increased risk of pollution of watercourse from this option during construction is also potentially significant and could lead to permanent effects on aquatic ecosystems.

The greatest impacts on soils and water would be during construction for each option. Cable related option B has a predicted moderate to high risk to soils and water because of the requirement for two 12m wide swathes. This would result in a significant stripping of grassland and soil, increasing the amount of silty water runoff.

From a planning policy perspective, the greatest risk from the OHL options A and C would be during operation including one within a sensitive landscape. While cable related option B would have the greatest impacts during construction as a result of significant temporary land take, it would also continue to have effects during operation with restrictions on land use practices being likely.

Regarding Landscape and Views the greatest risk would be from OHL Options A and C during operation with Option A being a moderate to high risk as this requires two new OHLs including one within a sensitive landscape.

The greatest risk to heritage assets would be from OHL Options A and C during construction. Option A would be low to moderate risk as this requires two new OHLs and associated excavations for the tower foundations. There are more heritage assets north of the existing 400kV than south. Cable related options have the potential for significant impacts on buried heritage assets during construction.

4.2 Criteria Assessment

The feasibility assessment for these options, in accordance with EirGrid criteria, is presented in table 4.

The effect on each criteria parameter is presented along a range from "more significant"/"more difficult"/"more risk" to "less significant"/"less difficult"/"less risk". The following scale is used to illustrate each criteria parameter:

More significant/difficult/risk — Less significant/difficult/risk

Assessment Criteria	Option A (Two corridors, single circuit towers, one 220kV, one 400kV)	Option B (Two cable swathes, one conductor per phase; one for 220kV and one for 400kV)	Option C (One corridor, double circuit towers with 220kV and 400kV)
Technical Performance			
Economic Performance			
Deliverability			
Environmental			
Socio - economic			
Combined Performance			

Table 4 : Criteria assessment

5. Conclusions

Three options have been considered in relation to achieving the connection of two circuits into Woodland substation.

§ Option A proposes two new sections of single circuit OHL from points on the existing Gorman – Maynooth 220kV OHL towards Woodland substation. The benefit of this is that the towers should be maintainable using current procedures however two separate OHL routes need to be identified.

§ Option B requires a similar OHL interface with existing towers, as option A, but with connections into cable sealing end compounds as the circuits are then cabled to Woodland substation. While this option comprises standard technology, there will be increased complexity and additional maintenance requirements for switchgear and property.

§ Option C proposes a section of double circuit OHL from a point on the existing Gorman – Maynooth 220kV OHL towards Woodland substation and recognises that there may be site-specific requirement of transitioning from single to double circuit arrangements, increased visual impact locally associated with taller towers and potentially additional maintenance requirements as a consequence of introducing an additional circuit crossing or an interface with a cable section to eliminate the circuit crossing.

An assessment of the presented options has been made using the EirGrid colour coding system which ranges from high risk (dark blue) to low risk (cream). The outcome of this being that:

§ The OHL options A and C are considered economically advantageous and technically less complex.

§ From an environmental and socio-economic perspective, the double circuit OHL option C is considered most favourable

§ The two single circuit OHL Option A is likely to have less visual impact locally than the double circuit OHL option C by virtue of tower height, however the two separate single circuit OHL routes may impact on a greater number of properties and dwellings.

§ The cable option B is considered more complex and expensive than either of the alternative OHL options but is likely to offer the least visual impact.

Various assumptions have been made in the study, each of which should be examined further to determine the relevance and impact upon the outcome. As no records of existing Transmission Asset Owner (TAO) assets have been provided for the study, or site investigation data to confirm the geotechnical conditions, the type of tower foundations required in the study area cannot be confirmed but could reasonably be estimated from records of existing tower foundations in the affected area.

All options require replacement or additional towers and conceivably cable sealing end compounds therefore use of third-party land not presently occupied by the TAO. Each option will have planning implications for EirGrid and agreements may also be required with landownerships not currently occupied with TAO assets.

The location of terminal towers at Woodland substation will be constrained by the associated substation design as this will need to align with the OHL route corridors. The implications of proposed circuits crossing existing circuits will need to be reviewed by EirGrid to consider the operational implications of the alternatives presented.

The construction of each option will require the integration of new single or double circuits into existing and up-voltage sections of a single circuit OHL; the outage implications being confirmed in relation to the proposed up-voltage works on the Dunstown – Gorman circuit. Use of standard towers designs is proposed for each of the options although re-use of existing or upgraded towers may require additional assessment to confirm compliance with the EirGrid functional specification.

The study has estimated quantities of different technologies to determine the cost implications and suggests that the OHL based options will generally cost less to construct than the cable connection option. Furthermore, experience indicates that the OHL options will subsequently cost less to maintain than the cable option.

As land use in the study area appears to be largely agricultural, there are no obvious clearance issues, however options A and C will introduce new sections of OHL which may constrain the working clearance available for both agricultural activity and any other third-party activity. Clearances will need to be confirmed in accordance with EirGrid functional specification LDS-EFS-00-001-R0 section 6.4.

The constraints assessment indicates that overall the double circuit OHL route option is considered the most favourable in environmental terms having lowest impact in all categories other than landscape and visual where the cable option is favoured.

Areas of groundwater vulnerability (e.g. rock near surface or karst) could impact upon the foundation requirements for structures in certain areas.

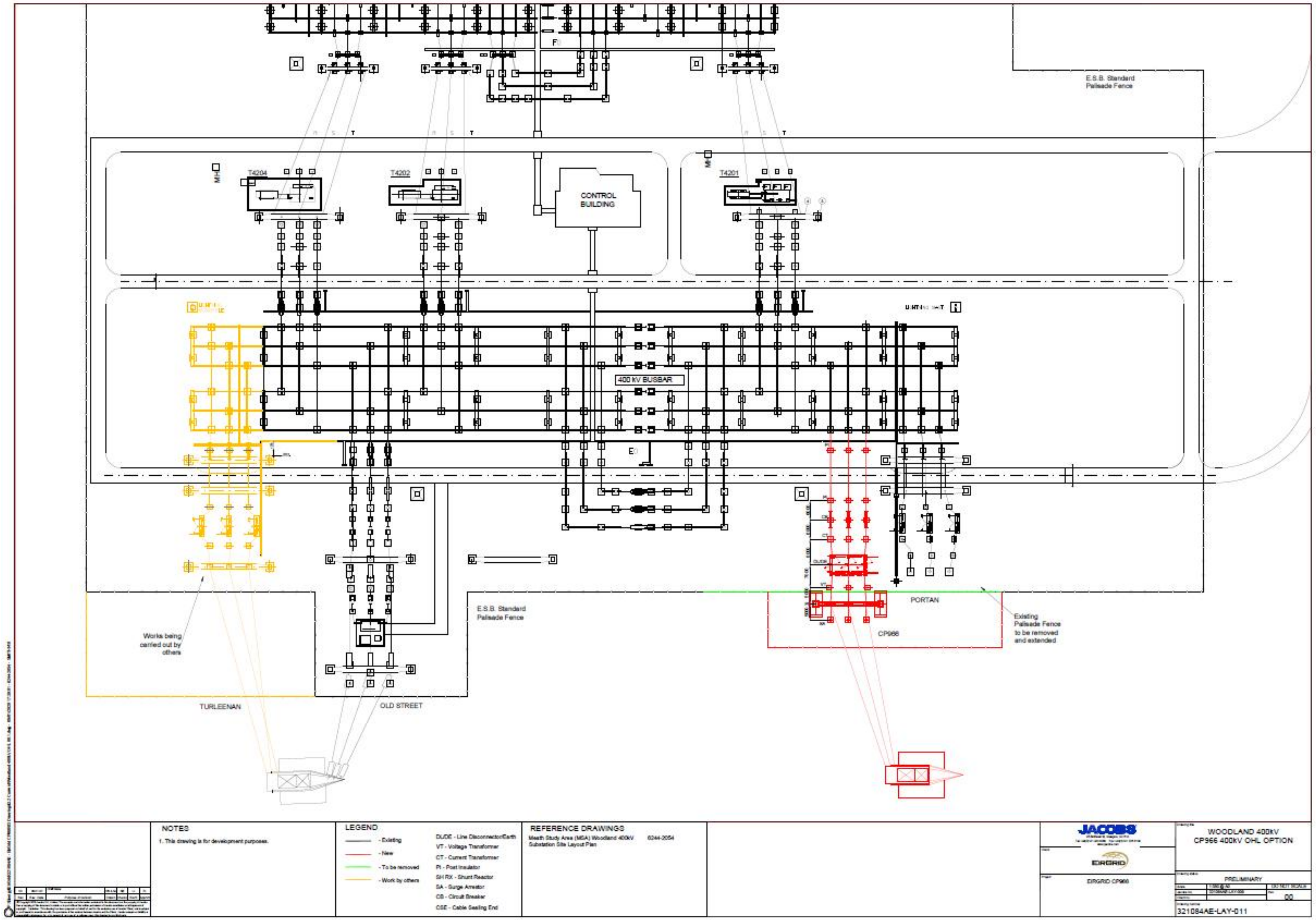
Socio-economically, the double circuit OHL route option is considered to have marginally lower effects in terms of amenity and health and traffic and transport than either single circuit technology option, while the single circuit options are considered to have marginally lower effect than the double circuit OHL route option in relation to effects on economy and utilities. Consequently, the single circuit options A and C are considered to have marginally lower overall socio-economic effects.

The constructability of cables in the study area requires identification of unrestricted corridors through the study area that will have an impact on the cable rating and construction methodology

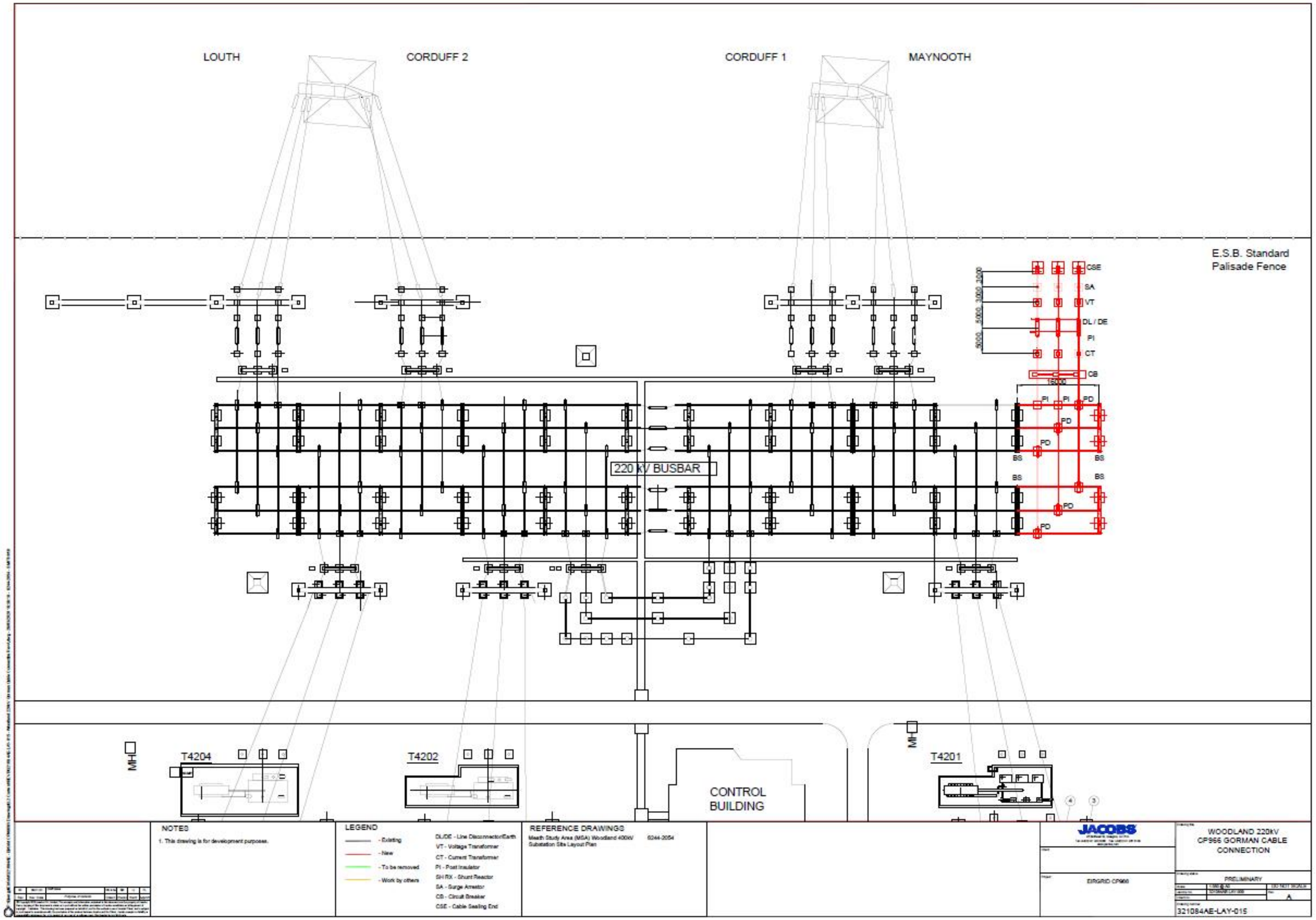
The study area contains a road network which should make delivery of construction materials and plant reasonably straightforward for each of the options, however temporary roads will be required to each construction site other than within Woodland substation. Furthermore, the permanent access required for the cable sealing end compounds will influence the location of these sites.

Overall, the study concludes that while Option C is considered favourable from both environmental and socio-economic perspectives, from the technical, economic and deliverability viewpoint the best overall option is Option A as new sections of single circuit OHL from points on the existing Gorman – Maynooth 220kV OHL towards Woodland substation are technically less complex and less expensive than the alternative options considered. The single circuit OHL option will remove the existing oversailing conductor arrangement west of Woodland and could offer a less complex line entry arrangement at Woodland substation. Use of single circuit towers also removes the proximity hazard of working on double circuit OHL towers.

Appendix A. Woodland layout for 400kV OHL connections - drawing 321084AE-LAY-011



Appendix B. Woodland layout for 220kV cable connection - drawing 321084AE-LAY-015



Appendix C. Woodland layout for 220kV OHL connection - drawing 321084AE-LAY-016