APPENDIX 5.1

The Potential for Partial Undergrounding of the Line to Mitigate Significant Impacts on Landscapes (2015)

North-South 400 kV Interconnection Development

The Potential for Partial Undergrounding of the Line to Mitigate Significant Impacts on Landscapes

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1 INTRODUCTION

1.1 INTRODUCTION

1 In its role as competent authority under PCI, An Bord Pleanála examined the draft application file under Article 10.4(c) of Regulations 347/2013 and requested that certain missing information be submitted. Included in the list of missing information is the following request relating to partial undergrounding:

> *"Where significant impacts on landscapes/demesne landscapes are identified, the EIS should address the potential for partial undergrounding of the line to mitigate those impacts".*

2 The purpose of this report is to address that request made by the Board.

3 It should also be noted that the issue of partial undergrounding of the line has been addressed in Chapter 4 (Section 4.7.3) **Volume 3B of the EIS**, which provides a full consideration of the option of partial undergrounding along the entirety of the alignment of the proposed development. The relevant section of the EIS accordingly sets out the technical, environmental and costing considerations of partial undergrounding. The section also specifically addresses the potential reliability and risk issues which would arise with the insertion of a section of underground cable along part of the alignment of the proposed development.

4 Additionally a consideration of partial undergrounding as a mitigation measure in respect of certain potential impacts of the proposed development is provided in Chapter 5, Section 5.4.2, **Volume 3B of the EIS**. Specifically Table 5.4 therein summarises the consideration of partial undergrounding in order to mitigate potential significant environmental impacts arising from the preferred OHL line design, based on an understanding of the environmental issues associated with the Monaghan, Cavan and Meath study area. As outlined therein, in respect of the majority of environmental topics considered, OHL is identified as having an equal or lesser environmental impact to partial undergrounding and that no particular area(s) have been identified where there is an overriding need for partial undergrounding in order to mitigate significant potential impacts.

5 The works outlined in the above referenced sections of **Volume 3B** of the EIS have been taken into account in the preparation of this report on the potential for partial undergrounding of the line to mitigate significant impacts on landscapes. These works may be significant of themselves and could give rise to significant environmental impacts, particularly in relation to ecology.

1.2 FORMAT OF THE REPORT

6 The format of this report into the potential for partial undergrounding on the North-South 400kV Interconnection Development to mitigate significant impacts on landscapes/demesne landscapes is as follows:

- Section 1 –Outline of Methodology and Key Assumptions for the Methodology
- Section 2 – A description of a Partial Underground Cable (UGC) for the area reviewed
- Section 3 – A description of the Process and Outputs of the Methodology to determine locations for assessment by environmental and technical specialists
- Section 4 to Section 6 – A high level desk study and review by the environmental and technical specialists of the potential for partial undergrounding
- Section 7 – Assessment of Potential for partial UGC to mitigate significant Landscape Impacts
- Section 8 – Comparison of Overhead Line OHL versus UGC

1.3 SUMMARY OF THE METHODOLOGY

7 A methodology has been devised to respond directly to the request by the Board, i.e., significant impacts on landscapes/demesne landscapes, working within the relevant technical parameters (such as length of UGC which is technically feasible within the entire 400 kV circuit between Turleenan, County Tyrone and Woodland, County Meath (the proposed interconnector)) and building on the appraisal carried out to date in the draft EIS and Consolidated Environmental Statement (ES)[1] As is set out in the EIS and as is described later in this document, a key constraint to the use of partial undergrounding, is that the length of UGC which is technically feasible for the entire proposed interconnector, both in Ireland and Northern Ireland, is approximately 10km. The methodology seeks to identify the locations where UGC might have the most effective mitigating effect on identified significant landscape impact. Conceivably, the use of this approximate 10km length might be in one location, or the use of shorter lengths of UGC might be considered in more than one location, while bearing in mind the potential impact of sealing-end compounds required at the OHL/UGC interface.

8 The process starts with a listing of locations where significant landscape and visual impact has been identified. Following this, the impacts that can feasibly be mitigated by partial UGC are identified. Some impacts are so dispersed that partial UGC of 10km can be excluded as having no potential to mitigate by UGC due to the amount of sealing-end compounds required.

[1] Consolidated Environmental Statement published in 2013 which relates to the development being proposed by SONI for that portion of proposed interconnector in Northern Ireland (the SONI proposal).

9 Certain impacts may arise in locations which are in close proximity to each other and where this is the case, these receptors may be considered as a "cluster". A "cluster", can be defined as, "*a group of locations (experiencing significant landscape or visual impact that partial UGC may mitigate) in sufficient proximity to each other, such that they may be considered for the purposes of a single length of UGC*".

10 "*Sealing end compounds*" refer to compounds which link the OHL to the partially undergrounded section of the line and so they are therefore an essential element of any proposed partial UGC. They are described in more detail in Section 2.2.3. However, bearing in mind their potentially significant landscape and visual impact, the number of sealing end compounds should be minimised. Clustering of receptors allows for an area to be considered for UGC rather than an individual receptor.

11 Following these stages of appraisal, it may be the case that a number of areas will emerge where significant landscape impact has been identified, and that effective mitigation of certain landscape and visual impacts may potentially be achievable by UGC.

12 As previously noted UGC is limited to an approximate 10km length over the proposed interconnector. Therefore a process will be undertaken to prioritise those locations experiencing the most significant effects in order to best "*allocate*" this 10km. This process will take into account the minimum amount of UGC required to span the receptor and mitigate the effect of OHL, as well as the variance in significance of particular impacts. At the end of the process, conclusions may be drawn on the potential location and distribution of approximately 10km of partial UGC in order to mitigate identified significant landscape effects.

13 The methodology and process used to assess the potential for partial undergrounding are presented in Section 3 of this report. The principal objective throughout the appraisal, is to identify those receptors or clusters that would benefit the most from the use of partial undergrounding as an effective mitigation measure, so as to "address the potential" for mitigation by UGC in the context of site specific circumstances and potential benefits affecting these particular areas. A summary of the main elements of the methodology, graphically presented in Plate 1, is given here:

1. List those areas where "*significant impacts on landscapes/demesne landscapes are identified*".
2. Exclude areas where the potential to effectively mitigate does not exist and so identify areas in which (subject to further consideration) the potential exists to effectively mitigate landscape and visual impacts by partial undergrounding approximately 10km of UGC over 140km of OHL.
3. Consider the potential of any given length of UGC to address "clusters" of adjacent receptors.
4. Taking clusters into account, list the areas where partial undergrounding has the potential to provide effective mitigation, in order of priority based on the scale of

significance of the landscape/visual impacts set out in the EIS or ES as the case may be.

5. Identify the broad locations for UGC sealing end compounds in respect of each of the identified areas and establish potential routes for partial UGC in respect of each area.

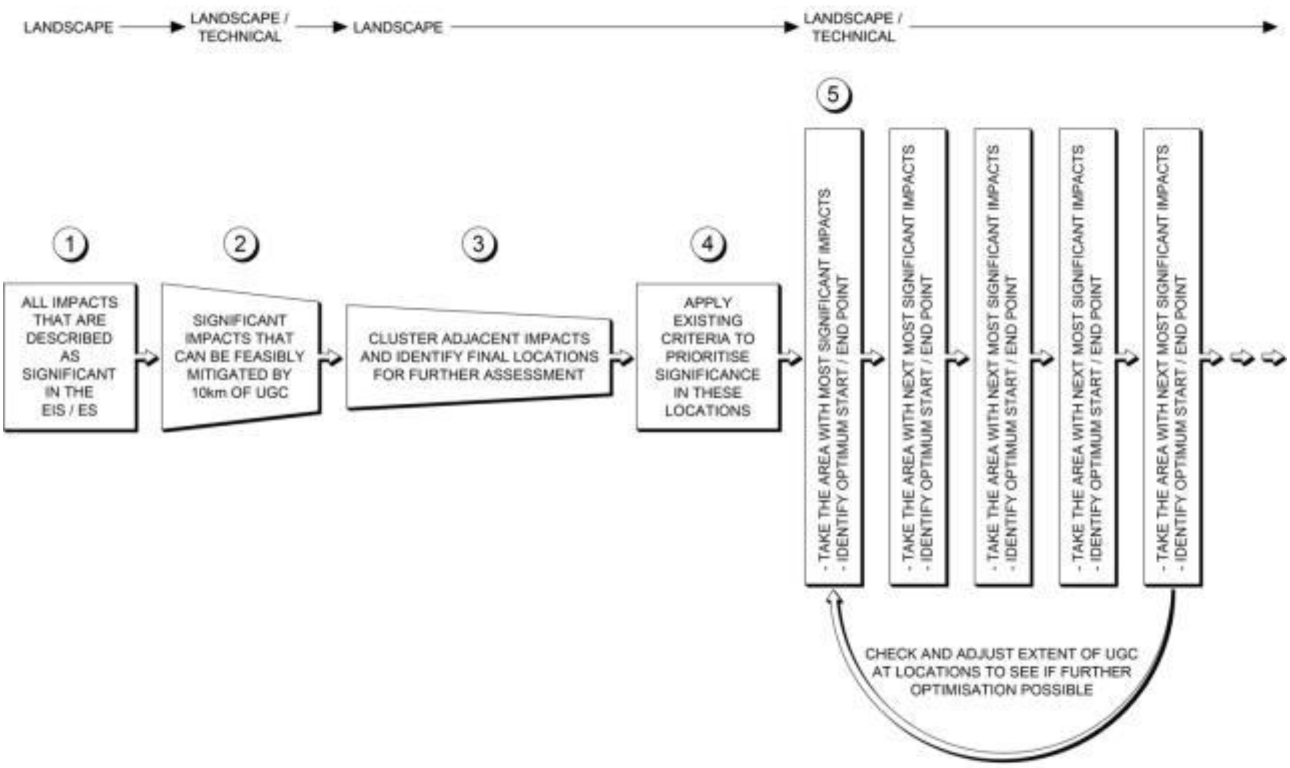


Plate 1 Methodology for addressing the potential for Partial Undergrounding in order to address the An Bord Pleanála request (finding the right places for approximately 10km of UGC)

14 Working within the approximate 10km length of UGC, identify the optimal routes which may potentially mitigate significant impacts on the landscape.

15 Describe and compare environmental impacts of partial UGC across multidisciplinary topics with respect to the optimal identified routes. Further identify potential to mitigate any such environmental impacts.

16 Conclusion from the multidisciplinary assessment considering all environmental impacts (including landscape impacts) on the potential for partial UGC to mitigate significant adverse landscape impacts.

1.4 KEY PARAMETERS FOR METHODOLOGY

17 The key assumptions followed in the above methodology are as follows:

Landscape and Visual Effects

18 For the purposes of this report, significant impacts to landscapes, including demesne landscapes, and significant visual impacts are considered in the response to the request to the request from An Bord Pleanála (ABP). Landscape effects are defined as the result of physical changes to the fabric of the landscape resulting from new development. Visual effects are closely related to landscape effects but concern changes in views. Therefore both landscape and visual effects have been considered when addressing the potential for UGC.

Length of UGC

19 **Volume 3B, Section 4.7.3** of the EIS provides a summary of the consideration of Partial Undergrounding of AC Transmission Circuits for the proposed development. In summary, it is noted that "*based on the present extent and configuration of the Irish network, EirGrid considers that the maximum length of 400 kV UGC that would be technically feasible to install as part of the proposed development (inclusive of that part of the interconnector located in Northern Ireland) is approximately 10km, whether installed in one continuous length or in an accumulation of shorter lengths*". This conclusion has been applied to this study as a technical parameter.

20 Limitation of extra high voltage AC cable lengths on transmission networks is an industry standard mitigation practice that has been applied by many utilities. Limitations may be applied for a number of reasons singularly or in combination. Notably for Ireland one reason is to avoid equipment failure due to stresses being applied beyond equipment voltage limits. In this situation the source of these voltage stresses arise due to impact of the different characteristics of AC cables at high voltage levels compared to overhead lines, creating the operational conditions for a very large amplification of electrical voltages at higher frequencies than the nominal 50Hz used by consumers. The nominal voltage and the higher frequency voltages in combination can create voltages much higher than normal and beyond the designed rating of network and customers equipment. These voltages may last for some time (seconds to minutes) but are generally naturally dissipated and are hence referred to as Temporary Over voltages (TOV). However by reducing the cable length, the risk of this amplification occurring is averted.

21 This concept is known as 'system de-tuning' and it is suggested by International standards. This is the most certain and common technique for TSOs to specifically mitigate TOV issues arising from the insertion of extra high voltage AC Cable lengths into the transmission network. As noted in Volume 3B of the EIS its recommended that the risk of system fault on the Irish

transmission network is mitigated by reducing the length of 400kV AC cable within the overall network to approximately 10km and for the purpose of this study this total length has been applied exclusively against the proposed interconnector circuit.

22 This 10km of partial UGC can be used in the parts of the study area in both Northern Ireland and Ireland.[2] For this reason this report considers the potential for partial undergrounding in Northern Ireland in addition to Ireland, albeit recognising that the report is prepared in response to a request from An Bord Pleanála which is concerned with that part of the proposed interconnector in Ireland only.

23 Based on the technical description of a potential underground cable section as provided by the team of cable engineers to the Landscape consultants, it has been considered by the Landscape consultants, as a general rule, that any undergrounding length of less than approximately 1.5km could potentially result in higher Landscape and Visual impact than OHL due to the potential cumulative effects of closely located sealing end compounds. However, this merely serves as a guide and the context of any particular landscape impact, and the screening potential within the landscape will be taken into account. Section 2 of this report gives a description of a potential underground cable section, including photographs of sealing end compounds.

Further Parameters

24 The partial UGC route will be optimised for a cable route and therefore may stray from the OHL route where constraints relating to UGC are encountered (e.g. established vegetation, archaeology).

25 It is assumed that routeing resulting in movement to other existing towers either side of the sealing end compounds is to be avoided. It is assumed that the inclusion of additional towers into the OHL design is to be minimised; however any additional towers are to be placed in-line with the existing OHL route.

26 It is assumed that the temporary construction haul road would be removed and reinstated post construction and that there would be no upright above ground structures along the length of UGC.

27 It is assumed that 3-5m width of native tree planting would be located around sealing end compounds (except for directly under conductors and with required distances from towers and fences). It is assumed that the sealing end compound area is to allow for an area of approximately 80m x 80m. This includes an approximate buffer of 10m for all screening and security fencing.

[2] Often referred to as 'Republic of Ireland'

28 Existing screening provided by hedgerows and trees would be utilised to provide immediate screening of sealing end compounds where applicable.

29 Permanent vehicle access is required for sealing end compounds. It is assumed that sealing end compounds should not be more than approximately 150m from public roads or tracks.

30 The topography is to be predominantly flat. Ground conditions are critical for the sealing end compound and flood extents are a constraint in the potential site location selection.

31 The maximum span length from the end mast / existing tower into the gantry is 50m. A gantry is the lattice steel support structure onto which the overhead conductor is terminated in the sealing end compound.

32 The Joint Paper on the Feasibility and technical aspects of partial undergrounding of extra high voltage power transmission lines as produced by Entsoe/Europacable (2011) has been considered as a guide in the preparation of this report. It is noted that the parameters taken into account within the Joint Paper are customised on a case-by-case basis for each transmission project. A copy of this paper is included in Annex 6.

2 DESCRIPTION OF A PARTIAL UNDERGROUND CABLE SECTION

2.1 INTRODUCTION

1 This section considers the technical aspects of partial undergrounding and outlines factors influencing the design, construction and location of the infrastructure required. It also provides an indicative construction methodology for the partial undergrounding.

2.2 PARTIAL UNDERGROUNDING – TECHNOLOGY

2.2.1 General

2 Partial undergrounding is the term used to describe the undergrounding of a short section, or short sections, of a long transmission circuit that is comprised predominantly of OHL. A sealing end compound is needed to connect the section of 400 kV underground cable to the overhead line. The sealing end compound contains the equipment required to connect the overhead line to the underground cable.

2.2.2 400 kV Underground Cable

3 The cable technology that would be applied is 400 kV Cross Linked Polyethylene (XLPE). The power transmission requirement for the North South Interconnector is 1500MVA. At 400kV this is equal to a phase current of 2165A. Two cables per phase will be required to achieve this current carrying capacity (i.e. a total of 6 cables plus associated communication cables).

4 A typical underground cable design for this type of application is shown in Figure 2-1. This figure is taken from the February 2009 PB Power report: Cavan-Tyrone and Meath Cavan 400kV Transmission Circuits – Comparison of High Voltage Transmission Options (Appendix 6, Figure 1) – refer to **Volume 3B Reference Material** of this EIS.

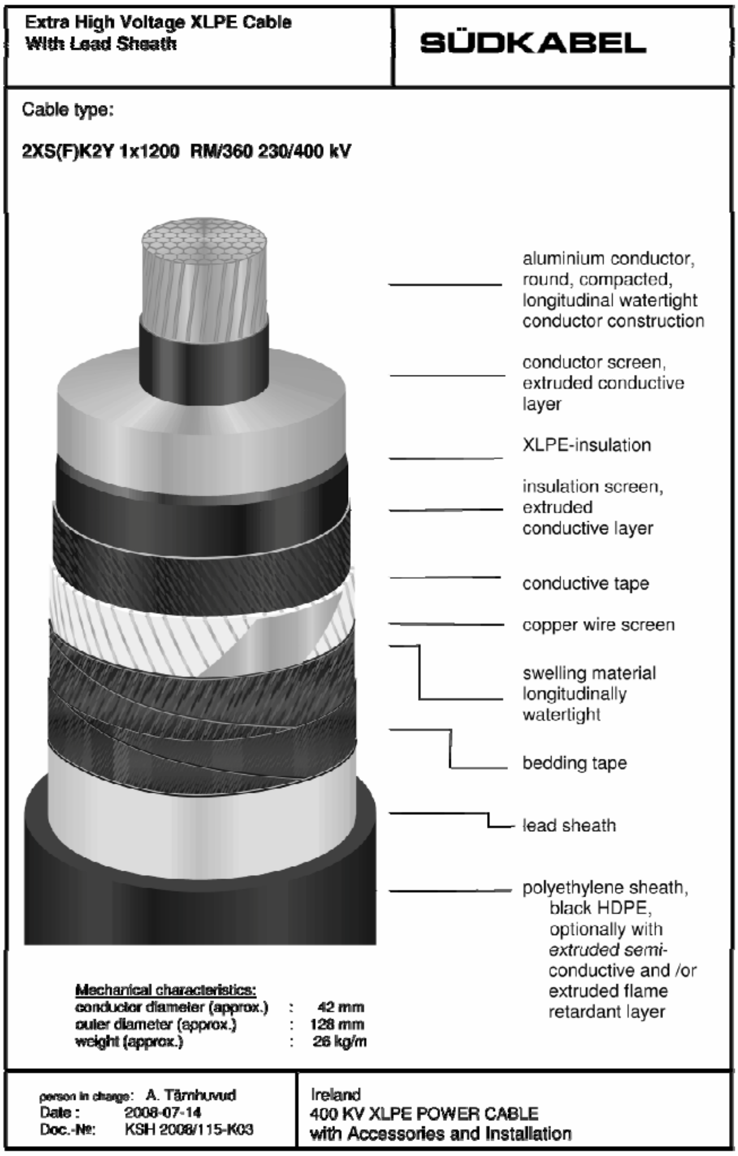


Figure 2-1: Typical 400 kV XLPE Underground Cable

Outer diameter	128 mm approx.
Cable weight (Cu/Al)	26 kg/m approx.
Bending radius during laying	3.00 m min approx.

Table 2-1: Typical Cable Technical Data

5 According to the PB Power report, cables of this type and voltage level would be manufactured and supplied in lengths of about 700 metres, though this can vary from supplier to supplier and can depend on the routing and terrain of the cable. In determining maximum cable lengths, consideration must also be given to transport requirements and in particular to the ability to transport such wide and heavy loads on the local road network.

2.2.3 400 kV Sealing End Compounds

6 Sealing end compounds link the overhead line to the partially undergrounded section. The cables are terminated using outdoor sealing ends (terminations) located in sealing end compounds. The size of the sealing end compound largely depends on the transmission capacity and protective installations that are required for the specific line. These compounds can often be screened to provide some visual mitigation.

7 The sealing end compound is fenced and the compound contains the equipment required to connect the overhead line to underground cable. Permanent vehicle access is required for the compounds. Such compounds should ideally be located near to existing public roads or tracks. A double fence arrangement is required to fully contain the earth grid and to provide space for screening vegetation around the compound.

8 Ideally, the topography of sites selected for a sealing end compound should be predominantly flat. Ground conditions are an important aspect and sites that are prone to flooding would not be suitable. An overhead line terminal tower is located adjacent to the compound. The span length from the end mast / existing tower into the gantry should be approximately 50m maximum.

9 Two types of sealing end compound would be required for the North South Interconnector:

- Type A: 400 kV Compound without compensation
- Type B: 400 kV Compound with compensation

10 The differences between the two compound types are outlined in the following paragraphs.

11 The sealing end compounds would contain cable terminations, surge arresters, disconnects, current transformers and a container building for auxiliary equipment. In the case of the Type B compound, it would also contain a reactor. Each compound would consist of an inner compound enclosing the live high voltage equipment, a small building, with a buffer strip around the compound to accommodate an earth berm and or vegetation for screening.

12 The requirement for a reactor and for the double fence adds to the complexity and size of the Type B compound.

13 Such a compound looks somewhat similar to a small substation. An illustration of a typical interface compound (Type A) is shown in Figure 2-2. A photomontage depicting the setting of a sealing end compound on a typical Irish landscape is shown in Figure 2-3.

14 Indicative layouts of the sealing end compounds are shown in Annex 1A and 1 C.

Figure 2-2: Typical Sealing End Compound

Figure 2-3: Photomontage depicting the setting of a Sealing End Compound on a typical Irish landscape

15 Regarding the length of cable within the compound, the following is estimated:

Compound Type	Description	Dimensions of Double Fence Compound	Cable Length in Compound
A	400 kV compound without reactive compensation	65m x 65m (0.43 ha)	76m
B	400 kV compound with reactive compensation	89m x 85m (0.75 ha)	92m

Table 2-2: Sealing End Compound Dimensions

16 Each potential partially undergrounded section on the North-South 400kV Interconnection Development would require one Type A compound and one Type B compound.

2.2.4 Optimising Underground Cable Route Design

17 The following considerations formed the basis of developing feasible route corridors for the underground circuit:

- It is the preference of EirGrid to use the road network where possible for underground cables. The majority of HV underground cable routes in Ireland, where technically feasible, are installed along existing roadways and public land. However in this case it is not considered feasible to install the circuits within the road network as the roads are too narrow. A standard rural road is approximately 4 to 5 metres wide. The width of the required cable working swathe would be up to 22 metres. Cross country routes are therefore considered unavoidable;
- Route corridors endeavour to avoid unnecessary crossings of major roads and water ways;
- The routes are identified to minimise impact on the community and to minimise traffic disruption during construction where possible;
- The identified route corridors attempt to minimise sudden and frequent changes in direction, both horizontal and vertical;
- The identified cable route corridors provide suitable locations for joint bays;
- Constructability of the cable along the route corridor is a critical factor;
- Maximum cable pulling tensions and sidewall forces must not be exceeded;
- Cable route corridors are selected to avoid lakes, water features and marshy ground where possible;
- Cable route corridors were selected that minimise the overall length and therefore reduce costs;
- Safe design clearances between existing underground high voltage cables and other major infrastructure must be maintained;
- Areas of significant planting or forestry are avoided;
- Access for future maintenance is achieved; and
- Environmental constraints including designated areas such as NHAs, SPAs, SACs and areas of archaeological importance are avoided wherever possible.

18 After the cable goes into service, the cable route would have to be patrolled regularly after installation to ensure it is not being put at risk due to other works taking place nearby. In the event of a fault, a temporary haul road would have to be constructed to bring equipment and materials to the fault site.

2.3 OUTLINE CONSTRUCTION METHODOLOGY

2.3.1 Introduction

19 The construction of each partial underground cable section would involve the following elements:

- 400 kV cable and associated trenching (XLPE, 6 separate cables and separate communications cables).
- 2 no. sealing end compounds
- Joint bays at intervals of approximately 650m
- Civil work including trench excavation, duct laying,
- Cable pulling and jointing.
- Backfilling and reinstatement works.
- Commissioning
- All ancillary temporary construction works, plant, traffic management and health and safety measures associated with the project.

20 The details in this section are indicative and are subject to customisation following contractor selection and detailed design.

2.3.2 Trenching and Ducting

2.3.2.1 Trench Design

21 The trench cross section envisaged for any partially undergrounded sections for the proposed interconnector is shown in Figure 2-4. The six cables are arranged in two sets of three cables arranged in flat formation. A working width of approximately 22 metres would be required during the construction phase. This working width is required to accommodate the cables, a temporary haul road and a temporary top soil storage area. The fences, haul road and top soil storage are removed when the installation is complete. Actual arrangements would need to be confirmed at the time of procurement using the cable design offered by the supplier, but these drawings are likely to be typical for the cable conductor size considered.

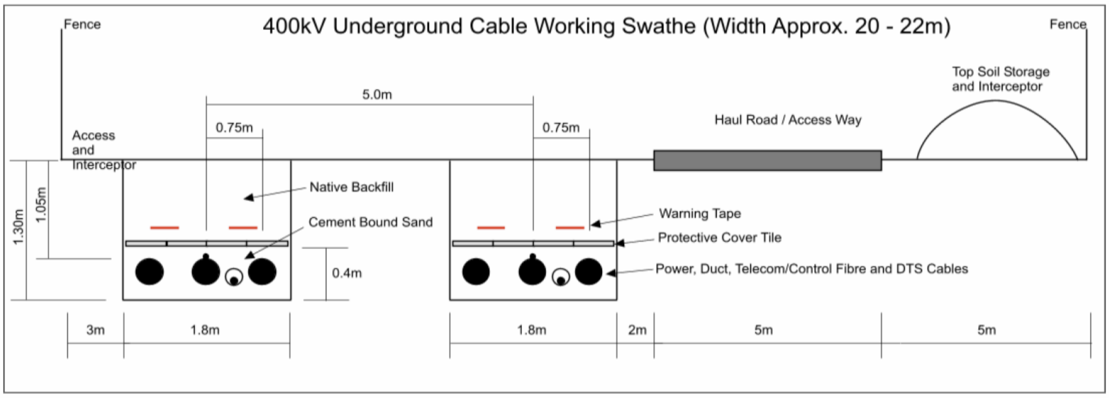


Figure 2-4: Cross Section of 400 kV Underground Cable Trench

22 This design will result in a cable corridor width of approximately 10 metres.

2.3.2.2 Site Investigations

23 Site investigations along the UGC route would have been carried out in advance of the approved designs being finalised and before the contractor commences trenching and ducting civil works. These site investigations would include slit trenches along the route to detail the route and to ensure that there is sufficient space to install the cable trench. Construction drawings which detail the cable alignment and joint bay locations and river crossing proposals are made available to the contractor. Further site investigations may be required to gather additional information.

2.3.2.3 General Methodology

24 Vegetation clearance would be necessary across the entire working swathe. Drainage improvement works may be necessary in certain areas. A fence, temporary haul road or access way would be constructed alongside the trenches for construction vehicles, as shown in Figure 2-5. Where possible, the access way could be constructed using a track-way laid on the surface. In other areas, a stoned access road would have to be provided. Temporary soil storage would be provided at the edge of the swathe. When the trenches are complete, the haul road and stored top soil would be removed.

Figure 2-5: Cable Trench Preparation

Figure 2-6: Cable Working Swathe for Construction

25 For the trenching and ducting works, the following general methodology would apply for the construction of the trench cross section as per Figure 2-4:

I. Grade, smooth and trim trench floor when the required depth and width have been obtained.

II. Place bedding layer of Cement Bound Sand material in accordance with the specification and compact it so that the compacted thickness is as per the design drawings.

III. Lay the bottom row of ducts in flat formation as detailed on the design drawings. Fit a secure cap / bung to the end of each duct run to prevent the ingress of dirt or water.

IV. Carefully surround and cover ducts with Cement Bound Sand in accordance with the design drawings and specifications and thoroughly compacted without damaging ducts.

V. Place cable protective cover tile on compacted Cement Bound Sand directly over the ducts.

VI. Install further Cement Bound Sand over the protective cover tiles in accordance with the drawings and thoroughly compact without damaging ducts.

VII. Place warning tape on top of compacted Cement Bound Sand over each set of ducts.

VIII. Place and thoroughly compact backfill as specified and place warning tape.

IX. For road crossings, carry out immediate permanent reinstatement in accordance with the specification to as good as or better than previous condition.

X. Backfill with suitable excavated material to ground level leaving at least 100mm topsoil or match existing level at the top to allow for seeding or replace turves to as good as or better than previous condition.

XI. Clean and test the ducts in accordance with the specification by pulling through brush and mandrel. Install rope in each duct and seal all ducts using robust duct end seals fitted with rope attachment eyes in preparation for cable installation at a later date.

Figure 2-7: Cable Construction Vehicles

2.3.2.4 Reinstatement

26 Following trench construction, reinstatement of soil above the cable trench and across working area is completed, as illustrated in Figure 2-8. The temporary access tracks and site fencing are removed. Any re-planting above the cables is limited to plant species with non-invasive root systems.

Figure 2-8: Reinstatement

2.3.2.5 Joint bays

27 Joint bays are used to connect individual cable lengths together and are typically installed every 650 metres or so. Joint bay dimensions are typically in the order of 10m long, approx. 3m wide and approx. 2.5m deep and are designed to be covered over. The land above the joint bay is available for agricultural use following reinstatement. Each set of 3 cables in the trench would require a joint bay. There would therefore be two joint bays adjacent to each other at each jointing location. Joint bays would be located where possible close to existing roads and access routes but it is not possible to indicate joint bay positions until the detailed design stage of the project. Joint bays are completely undergrounded. A small pit with a manhole cover (roughly 1m x 1m x 1m) is located adjacent to each joint bay to facilitate maintenance and inspection of the underground cables.

28 The following steps outline the methodology for joint bay construction and reinstatement:

I. The contractor would excavate a pit for joint bay construction, including a sump pit in one corner.

II. Grade and smooth floor; then lay a 75mm depth of blinding concrete (for in situ construction) or 50mm thick sand (for pre-cast concrete construction) on 200mm thick Clause 804 granular material.

III. In situ construction. Construct 200mm thick reinforced concrete floor slab with sump and starter bars placed for walls as detailed on the drawings.

IV. In situ construction. Construct 200mm thick reinforced concrete sidewalls as detailed on the drawings. (See Figure 2-9 and Figure 2-10).

Figure 2-9: Typical joint bay under construction (in-situ)

V. In situ construction. Remove formwork and, once ducting has been placed in the bay, backfill internally with suitable backfill material in grassed areas or Clause 804 material elsewhere. Backfill externally with granular material.

VI. Pre-cast concrete construction. Place pre-cast concrete sections on sand bedding. (See Figure 2-11)

Figure 2-10: Completed joint bay prior to cable installation (in-situ)

Figure 2-11: Typical joint bay under construction (pre-cast)

VII. Carry out temporary reinstatement of surface as specified.

VIII. Temporary joint bay covers may be used as temporary reinstatement. These covers are placed over the constructed joint bay and are then removed at the cable installation stage of the project.

IX. To facilitate cable installation and jointing, secure the area surrounding three consecutive sets of joint bays. Re-excavate the in-fill material and store for reuse.

X. The cable is supplied in pre-ordered lengths on large cable drums (See Figure 2-12). One length of cable from joint bay to joint bay is a section. As this project contains a double circuit cable installing “one section” would involve pulling six individual cables into six separate ducts using a cable pulling winch. The cable would be connected to the winch rope using a cable pulling eye and swivel arrangement (See Figure 2-13). A sponge may also be secured to the winch rope to disperse lubricant through the duct. A water based lubricant is also applied to the cable in the joint bay before it enters the duct to reduce cable pulling tensions.

Figure 2-12: HV cable pulling procedure (Typical drum set-up)

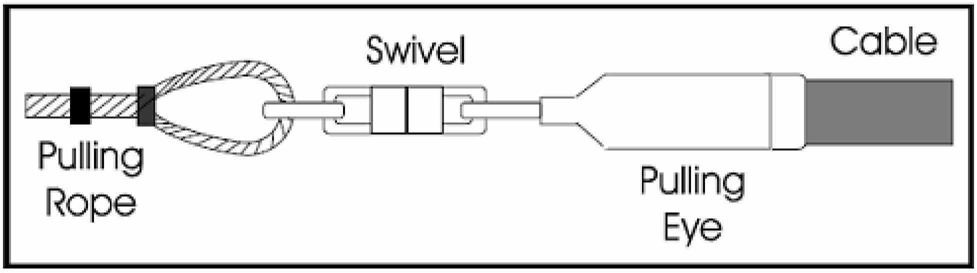


Figure 2-13: Swivel and pulling eye

XI. Once the cables are pulled into the joint bay, a jointing enclosure is positioned over the joint bay and the cable jointing procedure is carried out in this controlled environment.

XII. Following the completion of jointing and duct sealing works in the joint bay, the joint bay is reinstated in accordance with the approved detailed design specification.

2.3.3 Water Crossings

2.3.3.1 Introduction

29 Where the cable route crosses water courses, it would be necessary to pass underneath the water course. Crossings of smaller ditches and drains would generally be carried out by open trench using damming and overhead pumping.

30 The crossing of streams and rivers would be carried out by open trench method or trenchless methods. The open trench method crossing of streams and rivers can be carried out by “damming and fluming” or “damming and pumping” as discussed below. Each location would have to be assessed to determine the most appropriate crossing method.

31 Appropriate measures would need to be put in place by the contractor to prevent ground damage on the access routes to watercourse crossings on both banks, particularly where the ground is soft or slopes steeply toward a crossing. This would prevent solids reaching a watercourse from damaged access tracks.

2.3.3.2 Ditch/Drain Crossing

Open Trench (Damning and pumping)

32 The crossing of ditches and drains along the route would be achieved by damming and over pumping of the water flow. Silt traps, such as geotextile membrane, straw bales etc. would be placed downstream of the trenching location prior to construction to minimise silt loss. A dam would be constructed using sand bags and suitable clay material. Temporary pump sump(s) would be provided to house the pumps used to move the water downstream. The pumping rate would be suitable to cater for the expected flows in the particular location. The cable ducts would then be installed in the ditch / drain bed. Following the installation of the cable ducts, the bed of the ditch / drain would be re-instated with original or similar material. The duration of this process would vary depending on the site location, crossing length, ground/weather conditions etc.; however, it would typically take 5-10 days to complete each crossing.

2.3.3.3 Stream/River Crossing

Option 1 – Open trench (Damning and fluming)

33 The crossing of the stream/river would be achieved by fluming the existing river flow through one or more pipes depending on the size of the flows in the stream/river. The flume pipe(s) would be approx. 10m long and the diameter suitable to accommodate the existing flows.

34 Where applicable, under the supervision of an aquatic ecologist, spawning gravels would be removed at the stream crossing areas where construction would take place. The extent of spawning gravel removal would be agreed for each site with IFI.

I. The flume pipe(s) would be set out on the bed of the existing stream.

II. A dam would be constructed using sand bags and suitable clay material around the flume pipe(s) and across the stream so that all the flows are diverted through the pipe(s).

III. Silt traps, such as geotextile membrane, straw bales etc. would be placed downstream of the in-river trenching location prior to construction, to minimise silt loss.

IV. Excavate the trench in the dry stream bed and under the flume pipe(s). If required, a temporary pump sump can be established upstream of the flume and a pump used to deliver any additional flows to the downstream of the flume.

V. Install the cable ducts in the stream bed as described in section 2 or install a precast concrete slab incorporating the ducts, ensuring the designed cable route alignment is maintained.

VI. Following the installation of the cable ducts, the stream bed would be re-instated with original or similar material and the spawning gravels replaced under the supervision of the aquatic ecologist.

VII. Once the stream bed is appropriately re-instated the dam and the flume pipe(s) would be removed thus restoring the stream to its original condition.

Option 2 - Open Trench (Damning and pumping)

I. The crossing of the stream/river would be achieved by damming the existing river upstream of the crossing area.

I. Where applicable, under the supervision of an aquatic ecologist, spawning gravels would be removed at the stream crossing areas where construction would take place and would be stored appropriately to be used during the reinstatement stage of the crossing. The extent of spawning gravel removal would be agreed for each site with IFI.

II. Silt traps, such as geotextile membrane, straw bales etc. would be placed downstream of the in-river trenching location prior to construction, to minimise silt loss.

III. A dam would be constructed using sand bags and suitable clay material.

IV. Temporary pump sump(s) would be provided to house the pumps used to move the water downstream. The pumping rate would be suitable to move the flow rates of the existing stream.

V. Install the cable ducts in the stream bed as described in section 2 or install a precast concrete slab incorporating the ducts.

VI. Following the installation of the cable ducts the stream bed would be re-instated with original or similar material and the spawning gravels replaced under the supervision of the aquatic ecologist.

VII. Once the stream bed is appropriately re-instated the dam and the pumps would be removed thus restoring the stream to its original condition.

2.3.3.4 Stream/River Crossing Option 3

Trenchless installation

35 It is common practice to use trenchless technology to install cable ducting under wider watercourses where technically feasible. The trenchless technology chosen may depend upon many different factors such as the length of the trenchless section, ground conditions at the specific site, the suitability of staging areas either side of the trenchless section and budget costs. These trenchless installation methods may involve horizontal directional drilling, micro tunnelling, pipe ramming, pipe jacking or auger boring. The most commonly used method of trenchless installation is Horizontal Directional Drilling (HDD).

36 HDD is a well-contained trenchless technology, which can be undertaken in a relatively confined area. Individual entry and exit pits are typically of the order of 1 m x 1 m x 2 m in size.

37 For this project, each of the 6 power cables would be installed in a separate duct. Each duct diameter would have an outer diameter of approximately 200 mm. A total of 7 to 8 bores would therefore be required for the entire trench cross section. Launch and reception pits would be set back from the river. The location of the launch and reception pits would depend on the drill profile. The bores would be arranged in a horizontal formation with a separation distance of 3 to 4 metres being maintained between each bore. This means that a corridor width of approximately 25 metres would be required for each HDD.

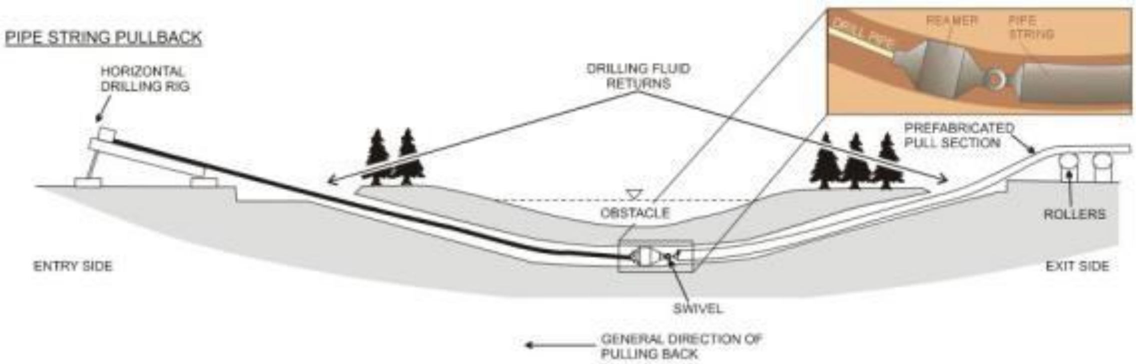


Figure 2-14: Typical HDD section drawing

38 Aspects of this crossing method which could give rise to potential impacts will be addressed by best practice construction methods under the following headings:

- site access and ground preparation
- bentonite preparation, injection and re-cycling
- bentonite blow-out
- site re-instatement.

I. *Site access and ground preparation*: The access track and works area around the HDD launch and reception areas at both sides of the river would be top-soil stripped, laid with terram and surfaced with suitable aggregate material to prevent ground damage and associated wash-out of solids toward the river. The works area would be a minimum of 15m back from the river and within this zone, the natural vegetative cover would not be altered and no construction traffic would use the area so that the natural filtering capacity of the vegetation if required would remain intact. Stripped topsoil would be stored on level ground at least 15m back from the river and ringed by silt fencing to prevent solids washout.

II. *Bentonite preparation, injection and re-cycling*: The area around the bentonite batching, pumping and re-cycling plants would be bunded using terram and sandbags in order to contain any spillages. One or more lines of silt fences would be interposed between the works area and the river on both banks to prevent solids laden runoff from the works areas reaching the watercourse. Spills of bentonite or bentonite contaminated with drill arisings (cuttings) from any aspect of the bentonite handling process would be cleaned up immediately and transported off site for disposal at a licensed facility. As these operations would take place within or adjacent to the road network, any watercourses involved would be roadside ditches or field drains in some cases and not true watercourses, i.e. their connectivity with a watercourse with aquatic life of ecological interest would be limited. Any bentonite spills on the road would be immediately visible and be removed to secure skips on site. In addition, as stated above any bentonite pits would be located a minimum of 15m from streams and rivers to prevent any possibilities of bentonite entering these watercourses. If arisings are being temporarily stored on site they would be held in adequately sized skips with adequate freeboard to accommodate intense rainfall during the storage period without overflowing.

III. *Bentonite blow-out:* A number of geologies are considered unsuitable for HDD because they increase the chances of bentonite being lost and eventually breaking up through the overburden into the watercourse. A typical example is fissured or fractured rock. A thorough geotechnical assessment of all crossings would need to be undertaken to determine the suitability of the site for this installation method. The drilling process would be constantly monitored to detect any possible leaking of bentonite into the surrounding geology and possible breakout. This can be gauged by monitoring pumping rates and pressures as well as observing for a bentonite plume. If any of these signs appear, then drilling and bentonite pumping would be stopped immediately and an attempt made to bypass the affected section by using a higher viscosity bentonite mix. If this fails then an alternative crossing alignment or an alternative crossing method would be considered. This would only arise in cases where the soil through which the HDD was directed is unsuitable for this process. Prior site investigation including detailed geotechnical investigations would ensure that HDD would only be employed where the soil and geological conditions are suitable. The possibility of any bentonite breaking through, into the watercourse above, during the HDD process can be mitigated with careful management. .

IV. *Site reinstatement:* While silt fences remain in place, all the temporary surface dressings on access tracks and working areas would be removed for offsite disposal and stored topsoil replaced and reseeded. The area would be reinstated to as good as or better than previous condition to the satisfaction of the landowner.

2.3.4 Duration of Works

39 A civil contractor carrying out this 400 kV trenching and ducting arrangement will complete between 30 to 50 linear metres of trench per day across open country depending on the site conditions. Cable pulling into the ducts will be done after trench installation, followed by jointing of the cable sections. It is estimated that, for the 10km of underground cable that has been deemed to be feasible for the proposed development, cable pulling will require 2 weeks per section and jointing will take 3 weeks at each jointing position.

2.3.5 Assumptions

40 In the event that, notwithstanding the conclusions reached in this report, it is determined that the partial undergrounding options considered are suitable for being taken forward then site investigations and more detailed design would be required to confirm whether partial undergrounding would indeed provide effective mitigation and in order to identify the route of the partially undergrounded section(s). The cable routes outlined in this report are based on desktop analysis only. Confirmation of underground cable routes requires site investigation. Site investigations would include, for example, ground penetrating radar survey of the cable route, slit trenches at certain road crossings and archaeological investigation at certain locations along the cable route. It must be recognised that, given the different suite of potential impacts arising from undergrounding cable, further appraisal would be required in relation to the potential impacts of partial undergrounding in those specific locations.

41 Indeed, as part of this additional evaluation, the introduction of partial undergrounding would also require the adjacent overhead line sections to be re-designed.

3 SELECTION OF LOCATIONS FOR ASSESSMENT

3.1 INTRODUCTION

1 As outlined in Section 1.3 the main elements of the methodology to identify potential locations where UGC may mitigate significant landscape impact, graphically presented in Plate 2, are as follows:

1 List those areas where "*significant impacts on landscapes/demesne landscapes are identified*".

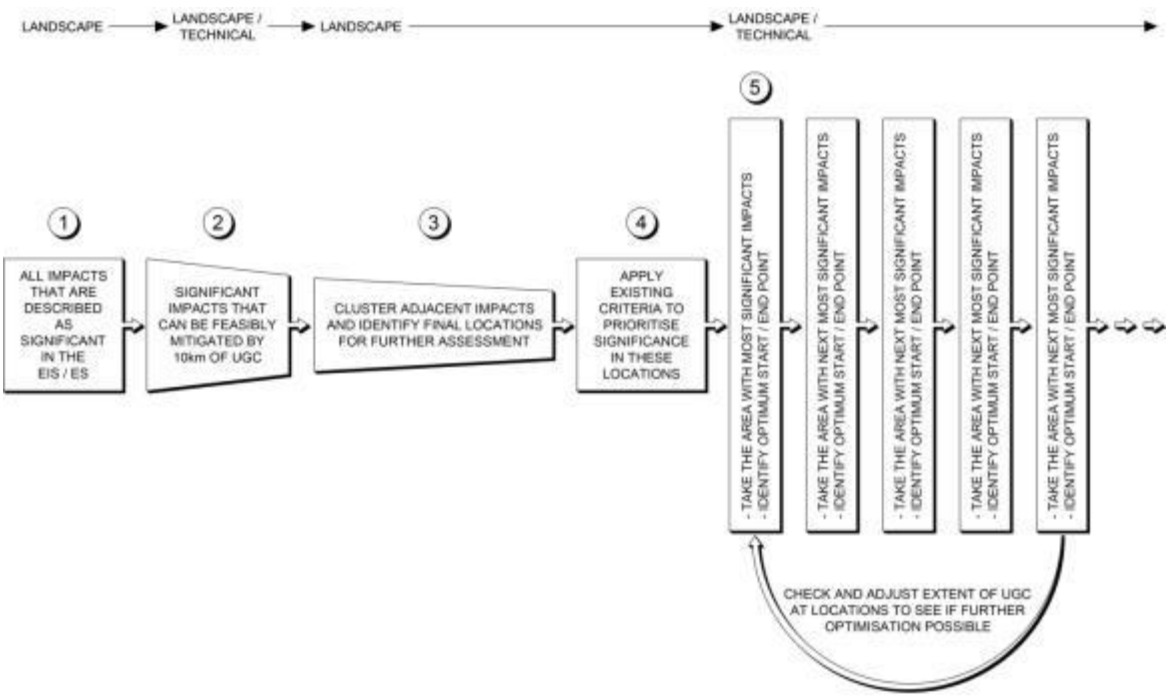
2. Exclude areas where the potential to effectively mitigate does not exist and so identify areas in which (subject to further consideration) the potential does exist to effectively mitigate landscape and visual impacts by partial undergrounding approximately 10km of UGC over 140km of OHL.

3. Consider the potential of any given length of UGC to address "clusters" of adjacent receptors.

4. Taking clusters into account, list the areas where partial undergrounding has the potential to provide effective mitigation, in order of priority based on the scale of significance of the landscape/visual impacts set out in the EIS or ES as the case may be.

5. Identify the broad locations for UGC sealing end compounds in respect of each of the identified areas and establish potential routes for partial UGC in respect of each area.

Plate 2 Methodology for addressing the potential for Partial Undergrounding in order to address the An Bord Pleanála request

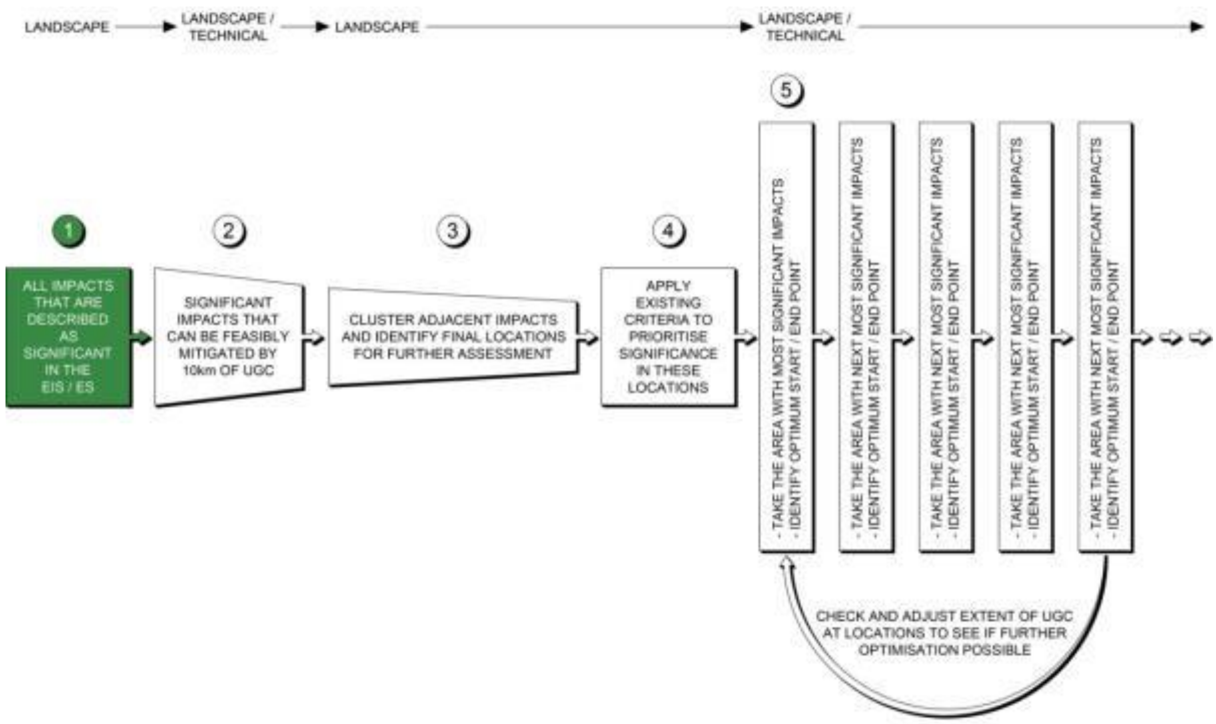


4. Working within the approximate 10km length of UGC parameter, it will then be possible to identify the optimal routes which may potentially mitigate significant impacts on the landscape.

5. This section of the report follows the steps set out in Section 1.3 and Plate 2 in order to identify the locations for consideration for the potential undergrounding of this proposed development.

3.1.1 Methodology - Step 1

6. Step 1 of the methodology is to list those areas where "*significant impacts on landscapes/demesne landscapes are identified"*



7. The first step in the methodology is to establish what is meant by significant impacts and to list the locations where "*significant impacts on landscapes/demesne landscapes are identified*" as well as where potentially significant visual effects have been identified in the Draft EIS and Consolidated Environmental Statement (ES)3 in relation to the overhead line (OHL).

8. The total length of underground cable (UGC) which is technically feasible along the entire length of the proposed Interconnector circuit between Turleenan, County Tyrone and Woodland, County Meath is approximately 10km (Refer to Annex 1, Parameter for potential for partial undergrounding). For this reason it is necessary to include the length of the proposed OHL in Northern Ireland in this evaluation in addition to that in Ireland, when considering the potential for partial undergrounding. The places experiencing potential

[3] SONI Consolidated Environmental Statement published in 2013.

significant landscape impact identified in the EIS and the ES will also therefore be considered in the context of the limited length of underground cable (UGC) which is technically feasible. It is noted here however, that the request from An Bord Pleanála is concerned only with the portion of the proposed Interconnector in Ireland.

9. Extracts from the EIS Appendices (contained in Annex 2 and Annex 3 of this report) define what is meant by "*significant*" – namely an adverse effect deemed "moderate" or above. The appendices also explain how "*significant impacts*" were identified using defined criteria4, and that there are variances in the level of significance from "Moderate to Moderate-Major to Major". The ES addressed the level of significance in accordance with this same process. The EIS methodology also acknowledges a more qualitative sliding scale of significance from "*more significant*" to "*less significant*".

10. The list of locations experiencing both potentially significant landscape effects and potentially significant visual effects is as follows:

Location of significant landscape effects (Ireland, see Annex 2)

- Landscape Character effects in unscreened areas within 600-800m of the development
- River Boyne, County Meath
- River Blackwater, County Meath
- Brittas Estate, County Meath
- Tassan Lough, County Monaghan
- a plateau and valley close to the jurisdictional border with Northern Ireland in County Monaghan
- the setting of the Fair of Muff/Cavan Highlands, County Cavan
- the vicinity of the proposed Emlagh Wind Farm (cumulative), County Meath
- the vicinity of a number of small lakes, and
- the locations where towers need to cross drumlins to avoid other constraints.

Location of significant visual effects (Ireland, see Annex 2)

- Views potentially from unscreened individual properties (significant up to 500m and varying in significance and reducing to not significant beyond approximately 600-800m)
- Scenic View 86 (County Meath)
- Boyne Valley Driving Route, County Meath
- Proposed walking route along the river Blackwater, County Meath
- Outskirts of Dunderry and Robinstown, County Meath
- The Monaghan Way

Registered Historic Parks, Gardens and Demesnes

- The Manor House, Benburb

[4] Note Table numbers in the Appendices are those from the EIS

Locations of potentially significant landscape and visual effects (Northern Ireland)

Landscape Areas

- LCA 47 Loughgall Orchard Belt
- LCA 66 Armagh Drumlins
- LCA 6 Mullyash Uplands

Viewpoints

- 22 no. viewpoints of the 34 evaluated in the Consolidated ES
  - Clonteevy Bridge over River Rhone on Trewmount Road (B106) - View towards substation
  - Derrygally Way to east of Turleenan Substation - View towards substation
  - Derrygally Way to south of Turleenan Substation – View towards substation
  - Trewmount Road (B106) near site access road
  - Moy Road (A29) crossing
  - Culkeeran Road
  - Gorestown Road
  - Benburb Road
  - Benburb Road south of Ninewell Bridge
  - Benburb Priory
  - Artasooly Road at Tullymore Bridge
  - Battleford Road (B115) crossing
  - Killylea settlement (Fellows Grange Court)
  - Monaghan Road (A3) east of Norton's Cross Roads
  - Monaghan Road (A3) crossing
  - Maddan Road south of Norton's Cross Roads
  - Drumhillery Road crossing
  - Fergort Road (B3) crossing
  - East of Derrynoose
  - Derrynoose Road at Curragh Lane looking north
  - Derrynoose Road at Curragh Lane looking south
  - Crossaghy Road

Visual impacts upon settlements

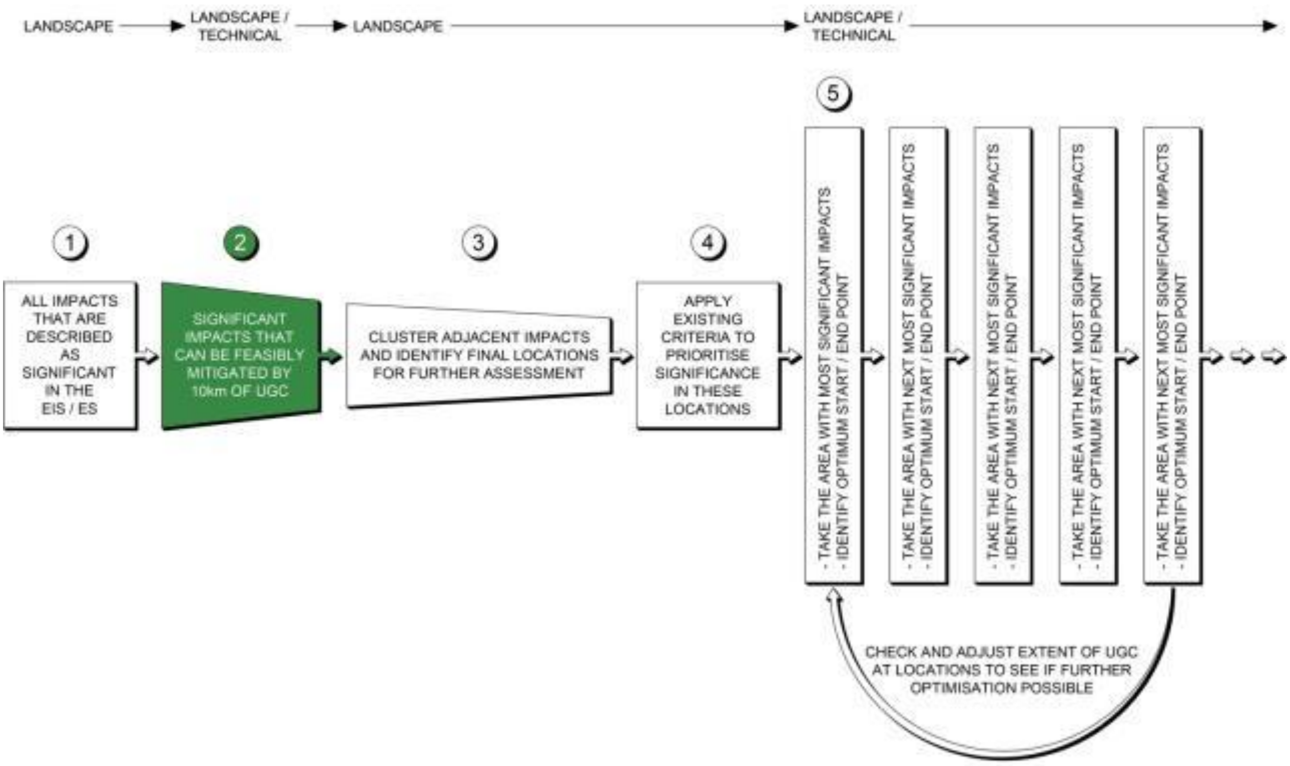
- Moy
- Blackwatertown
- Benburb
- Killylea
- Derrynoose

Properties

- 322 properties that experience a major adverse - moderate adverse impact

3.1.2 Methodology - Step 2

11. The purpose of Step 2 of the methodology is to exclude areas where the potential to effectively mitigate significant impacts on landscapes/demesne landscapes does not exist and so identify areas in which (subject to further consideration) the potential does exist to effectively mitigate landscape and visual impacts by partial undergrounding approximately 10km of UGC over 140km of OHL.



12. As this process is limited by the length of the proposed interconnector which may be undergrounded, it is important to screen out those identified impacts that would not be mitigated by the use of approximately 10km of UGC. Thereafter, Step 2 of the methodology entails the identification of locations experiencing potentially significant impact that can be potentially mitigated by the alteration of the proposed interconnector to include 10km UGC over the 140km of OHL.

13. Due to the limited length of UGC technically feasible (approximately 10km) it is prudent to ensure that this is utilised in the locations where such a mitigation would minimise or eliminate the greatest number of impacts over the 140km length of the proposed interconnector with only approximately 10km of UGC. A number of the receptors listed above in Step 1 are dispersed over the length of the line route and would require a high number of sealing end compounds to change from OHL to UGC at dispersed intervals. These sealing end compounds, and the stop-start OHL would themselves potentially result in significant adverse landscape and visual impacts. Listed below are those types of receptors that experience significant impact, but where 10km of UGC is not likely to effectively mitigate landscape or visual impact. These

receptors are excluded at this step of the assessment as the use of the approximate 10km of UGC would not fully mitigate the impacts experienced (i.e. additional length of UGC would be required) or because there are other receptors where the approximate 10km of UGC would be more effective in minimising or eliminating the impacts:

- Views from unscreened individual properties (significant up to 500m and varying in significance and reducing to not significant beyond approximately 600-800m) in Ireland
- Landscape Character effects in unscreened areas within 600-800m of the development in Ireland
- the vicinity of a number of small lakes
- the locations where towers need to cross drumlins to avoid other constraints
- 22 viewpoints in Northern Ireland as shown in the Consolidated ES
- 322 properties in Northern Ireland as shown in the Consolidated ES

14. Therefore it is assumed, that there is no potential for a limited length of 10km of UGC to mitigate all of the impacts identified in relation to these receptors. However, if there is an opportunity to mitigate the most significant of these impacts due to their proximity to another identified impact more suitable for mitigation by way of partial undergrounding, they will be considered in Step 3.

15. Following the exclusion of the aforementioned locations which are less suitable for partial UGC, the locations remaining as potentially suitable for further consideration in relation to partial UGC as a mitigation measure are listed below:

Significant landscape effects (Ireland)

- River Boyne/Boyne Valley, County Meath
- River Blackwater/Blackwater Valley, County Meath
- Brittas Estate, County Meath
- a plateau and valley close to the jurisdictional border with Northern Ireland, Counties Monaghan & Armagh
- the setting the Fair of Muff/Cavan Highlands, County Cavan
- the vicinity of the proposed Emlagh Wind Farm (cumulative), County Meath

Significant visual effects (Ireland)

- The Monaghan Way
- Scenic View 86 (County Meath)
- Boyne Valley Driving Route, County Meath
- Proposed walking route along the river Blackwater, County Meath

- Outskirts of Dunderry and Robinstown, County Meath

Significant landscape and visual effects (Northern Ireland)

Landscape Areas

- LCA 47 Loughgall Orchard Belt
- LCA 66 Armagh Drumlins
- LCA 6 Mullyash Uplands

Registered Historic Parks, Gardens and Demesnes

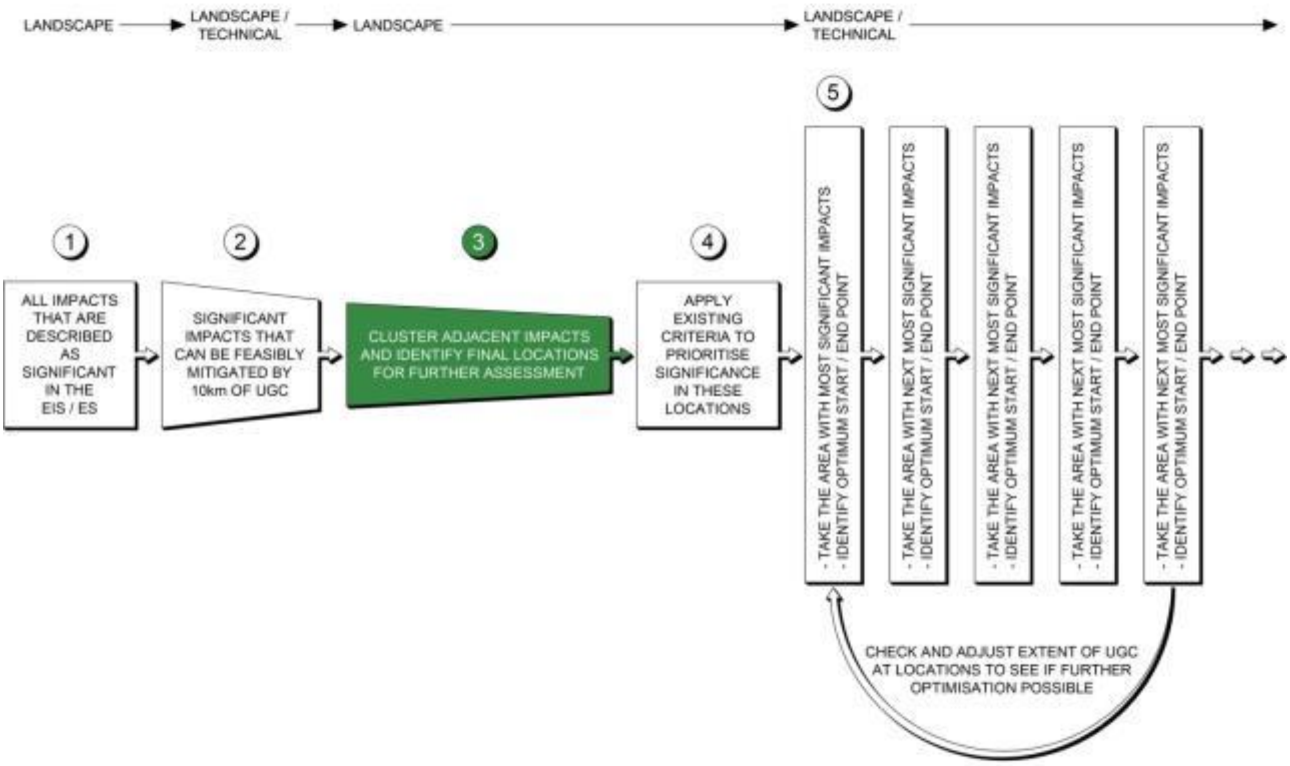
- The Manor House, Benburb

Visual impacts upon settlements

- Moy
- Blackwatertown
- Benburb
- Killylea
- Derrynoose

3.1.3 Methodology - Step 3

16. The purpose of Step 3 of the methodology is to consider the potential of any given length of UGC to address "*clusters*" of adjacent receptors.



17. Step 3 addresses the potential to evaluate adjacent impacts together. A "cluster", for the purposes of this report, can be defined as, "a group of locations (experiencing significant landscape or visual impact that partial UGC may mitigate) in sufficient proximity to each other to be considered for a single length of UGC." For these purposes both landscape and visual effects may form part of the same cluster.

18. Step 3 therefore entails a desktop assessment of the potential of UGC to address adjacent impacts and to "cluster" potentially affected locations (which may be mitigated by partial undergrounding 10km of line), thereby optimising the potential for UGC in a particular location. These clusters can be identified as follows:

Ireland

An area around the Boyne Valley, County Meath including:

- River Boyne/Boyne Valley, County Meath
- Scenic View 86 (County Meath)
- Boyne Valley Driving Route, County Meath
- Outskirts of Dunderry and Robinstown, County Meath

An area around the Blackwater Valley, County Meath including:

- River Blackwater/Blackwater Valley, County Meath
- A proposed walking route along the River Blackwater, County Meath

An area in the Mullyash Uplands Character Area at the jurisdictional border (and extending into Northern Ireland) including

- Tassan Lough, Co. Monaghan
- A plateau and valley close to the jurisdictional border with Northern Ireland
- The Monaghan Way

Other individual locations include:

- Brittas Estate, County Meath
- The setting of the Fair of Muff/Cavan Highlands, County Cavan
- The vicinity of the proposed Emlagh Wind Farm (cumulative impact), County Meath

Northern Ireland

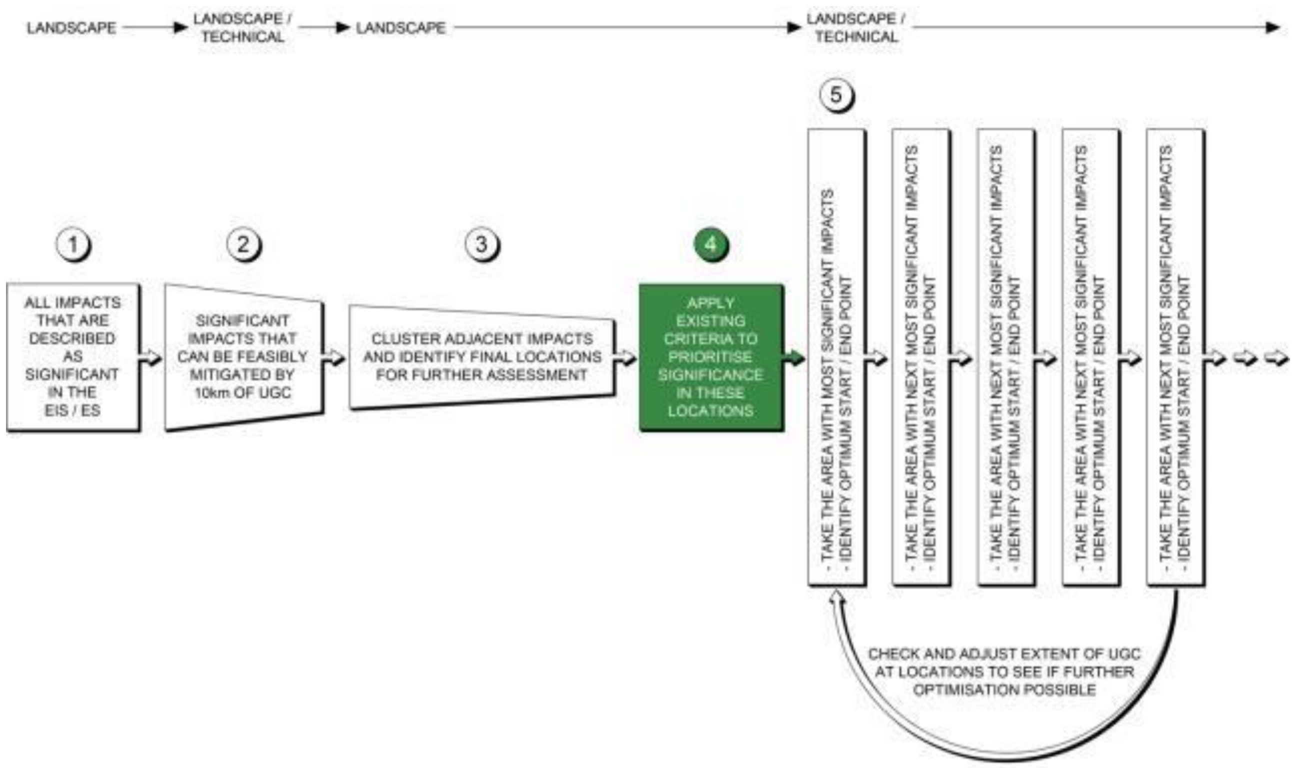
'The Benburb Area', Counties Tyrone and Armagh

- Tullydowey House Gate Lodge
- River Blackwater, Counties Tyrone and Armagh
- Tullydowey House
- National Cycle Route 11 and River Blackwater Canoe Trail
- Benburb as a settlement and constraints within (e.g. Benburb Priory and Benburb Castle)

19. The Benburb Area is located approximately 10km south of the proposed Turleenan substation. Following technical consideration, it was determined that a sealing end compound could be accommodated within the proposed substation. This would mean that an underground cable section from the Turleenan substation to the Benburb Area would in effect require only one additional compound, compared to the other sections of undergrounding, which would require two compounds. Therefore, an expanded cluster from Turleenan would include the above Benburb Area receptors as well as The Argory and Moy village.

3.1.4 Methodology - Step 4

20. Taking clusters into account, Step 4 of the methodology lists the areas where partial undergrounding has the potential to provide effective mitigation, in order of priority based on the scale of significance of the landscape/visual impacts set out in the EIS or ES as the case may be.



21. The purpose of Step 4 is to apply the significance criteria set out in the EIS and ES to the locations potentially suitable for mitigation by UGC. Where a cluster contains a number of sites experiencing varying degrees of significance of effects (i.e. *Moderate, Moderate-Major or Major*), the cluster will be allocated the highest individual significance see below (also refer to Annex 4).

Table 3-1 Impact Significance Rating for identified clusters

Locations potentially suitable for partial UGC	**Individual locations within clusters of significant landscape or visual effect**	**Significance of effect as described in the EIS**	**Overall rating for cluster**
An area around the Boyne Valley, County Meath	River Boyne/Boyne Valley	Moderate/Moderate-major	**Moderate-major**

	Scenic View 86	Moderate	
	Boyne Valley Driving Route	Moderate	
	Outskirts of Dunderry and Robinstown	Moderate	
An area around the Blackwater Valley, County Meath	River Blackwater/Blackwater Valley	Moderate/Moderate-major	**Moderate-major**
	A proposed walking route along the River Blackwater	Moderate	
An area in the Mullyash Uplands Character Area at the jurisdictional border (and extending into Northern Ireland)	Tassan Lough, Co. Monaghan	Moderate	**Moderate-major**
	A plateau and valley close to the jurisdictional border with Northern Ireland	Moderate-major	
	The Monaghan Way	Moderate	
Brittas Estate, County Meath		Moderate	**Moderate**
The setting the Fair of Muff/Cavan Highlands, County Cavan		Moderate-Major	**Moderate-Major**

The vicinity of the proposed Emlagh Wind Farm (cumulative impact), County Meath	Areas within 500-800m of the line route with open views of towers and turbines	Moderate	**Moderate**
'The Benburb Area', Counties Tyrone and Armagh	Tullydowey House Gate Lodge	Moderate-Major Adverse	**Moderate-major**
	River Blackwater, Counties Tyrone and Armagh	Not assessed as a receptor. The Blackwater Valley is assessed as a whole.	
	Tullydowey House	Moderate-Major Adverse	
	National Cycle Route 11 and River Blackwater Canoe Trail	Negligible	
	River Blackwater, Counties Tyrone and Armagh	Minor Adverse	
	Benburb (as a settlement)	Moderate Adverse	
	Benburb Priory and Castle	Moderate Adverse	
	Cultural Heritage Site 24	N/A	
	Cultural Heritage Site 27	N/A	

22. The application of the ratings of the significance of effects to each cluster is the first element of the prioritisation and is a guide only to act as a starting point to inform professional judgement. The variance in significance of individual impacts also forms part of the evaluation. The

determination of variance in significance also draws from the qualitative scale of significance as set out in Table 11.10[5] *'Scale of Significance'* in Annex 2 of this report.

23. The final prioritisation is arrived at through a combination of these ratings as well as appraisal of other factors such as landscape maturity, aesthetic and perceptual qualities, rarity, distinctiveness of the landscape, whether the landscape is particularly representative of landscape character, and the recognised value of the landscape in documents such as County Landscape Character Assessments. These considerations are set out below.

Table 3-2 Rating of priority

Locations potentially suitable for partial UGC	**Overall rating for cluster**	**Qualitative considerations**	**Rating of priority**
An area around the Boyne Valley, County Meath	**Moderate-major**	The Meath Landscape Character Assessment (MLCA) recognises the Boyne Valley as being of *exceptional value* and *high sensitivity*. This cluster includes the river, which has cultural associations, a scenic driving route, a protected view, as well as, in the wider vicinity, the heritage features of Bective Abbey and Bective Bridge. The cluster includes the villages of Dunderry and Robinstown which are the closest settlements to the line route in County Meath. In some locations the landscape is open and flat with few hedgerows resulting in open visibility of towers.	**1**
An area around the Blackwater Valley, County Meath	**Moderate-major**	The Meath Landscape Character Assessment (MLCA) recognises the Blackwater Valley as being of *very high value* and *high sensitivity* This area contains the heritage features associated with Donaghpatrick and Teltown, as well as the wider Teltown archaeological landscape. This area is also recognised in the MLCA as having potential for Tourism. The area includes a driving route and protected view.	**2**

5 Note: Table numbers in the Appendices are those from the EIS

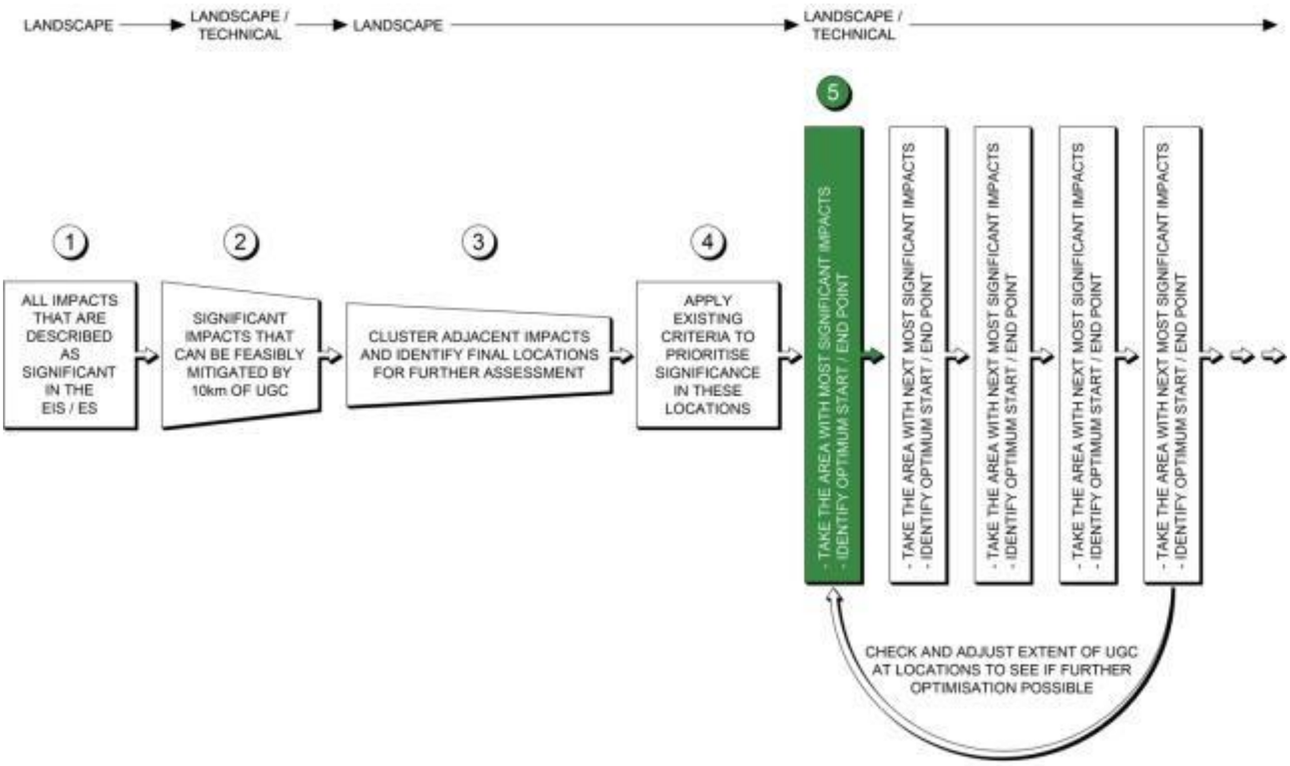
An area in the Mullyash Uplands Character Area at the jurisdictional border	**Moderate-major**	This area is sensitive due its relatively elevated character, open in places, as well as its including an enclosed valley along the jurisdictional border. The Monaghan Way passes through this area and the line route crosses and intermittently parallels the walk. The Mullyash Uplands wider Landscape Character Area is assigned a high sensitivity in the Monaghan Landscape Character Assessment.	**5**
The setting of the Fair of Muff/Cavan Highlands, County Cavan	**Moderate-Major**	This area includes the lower lying parts of the Cavan Highlands area as well as the setting of an annual fair. It is an undulating drumlin landscape, with varying open and enclosed views. The EIS has found that the line route does not have a significant effect on elevated views from Lough an Leagh Mountain to the west.	**6**
Brittas Estate, County Meath	**Moderate**	This historic designed landscape is in private ownership, not publicly accessible and is described in the NIAH (Gardens) as having "*main features substantially present".* The line route avoids the central designed features of the demesne and passes through areas of mature and newly planted woodland on the western edge of the estate. Approximately 1.1ha of mature woodland may be required to be removed to allow for a maximum 74m wide OHL corridor.	**4**
The vicinity of the proposed Emlagh Wind Farm (cumulative impact), County Meath	**Moderate**	The potential for cumulative impact has been identified where the line route passes through the proposed Emlagh wind farm. The cumulative effect would involve a localised increase in the industrialised character of the landscape where both proposed developments are visible in close proximity, particularly when the viewer is close to towers.	**7**
The Benburb Area, Counties Tyrone and Armagh	**Moderate-major**	The potential for cumulative impact has been identified where the line route passes through the Benburb Area.	**3**

24. The list of clusters is therefore prioritised as follows (assuming 1 is the most potentially significant effect):

1. An area around the Boyne Valley, County Meath
2. An area around the Blackwater Valley, County Meath
3. The Benburb Area, Counties Tyrone and Armagh
4. Brittas Estate, County Meath
5. An area in the Mullyash Uplands Character Area, County Monaghan
6. The setting of the fair of Muff/Cavan Highlands, County Cavan
7. The vicinity of the Emlagh wind farm

3.1.5 Methodology - Step 5 - Identify the broad locations for UGC sealing end compounds

25. The purpose of Step 5 is to identify the broad locations for UGC sealing end compounds in respect of each of the identified areas and establish potential routes for partial UGC in respect of each area.



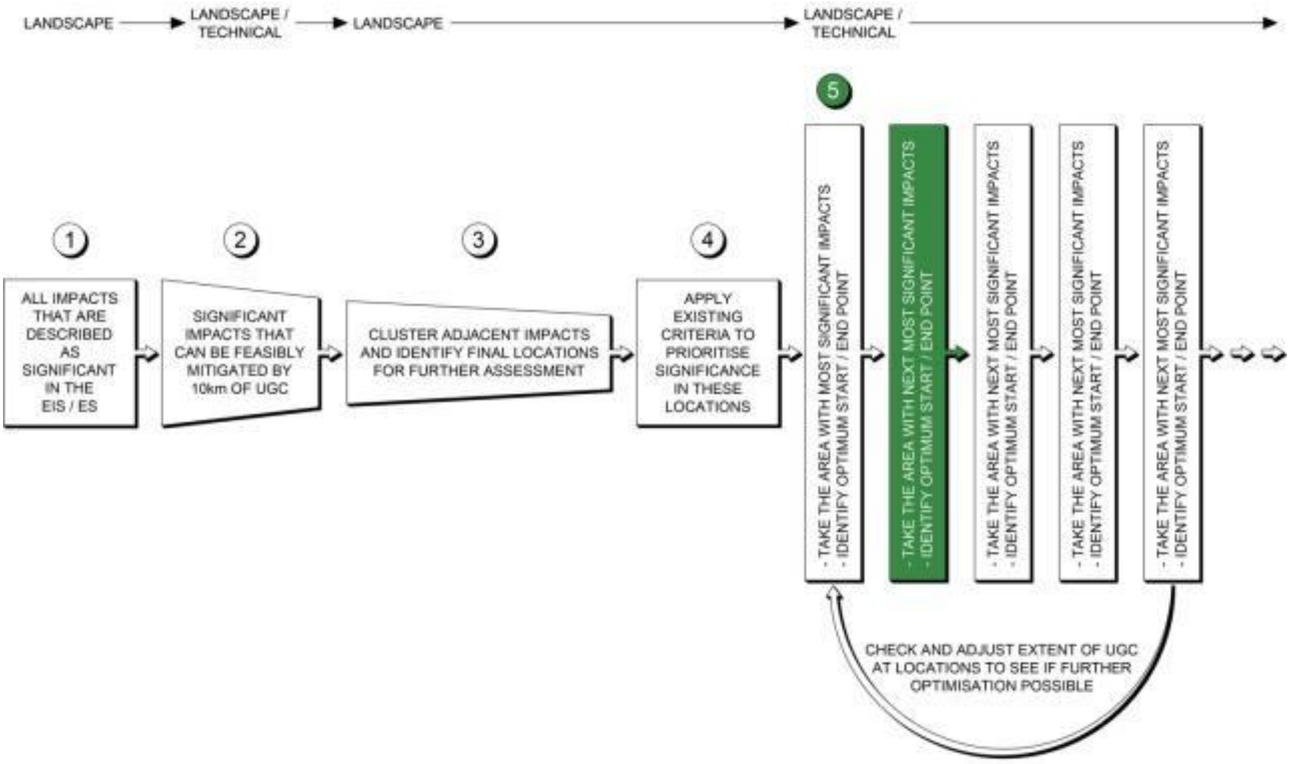
26. Having identified the "locations potentially experiencing the most significant landscape impact, and which are potentially suitable for partial UGC,- the next step is to identify, in a collaboration between the environmental, landscape and electricity transmission planning disciplines, the optimum notional UGC start and end points so as to allow a preliminary investigation of the potential for underground routeing.

27. From the Landscape perspective, using the same approach as undertaken in the EIS and ES and using the tables in Annex 1, the potential impact of the sealing end compounds and a potential partial UGC section as described in Section 2, has been assessed. Examples of considerations include; the existing visual amenity and landscape character sensitivity, whether the potential impacts will be localised or dispersed, whether surface vegetation/drainage are key contributors to landscape character and can be reinstated effectively over and around UGC, the possibility to further cluster together groups of impacts and the possibility for utilising existing screening.

28. This step included the assessment of the technical feasibility of any locations and whether those locations pass the technical criteria, as set out in Section 2.2.3 herein, in order to be

passed to the multi-disciplinary team for consideration, taking account of assumptions and technical considerations noted in Annex 1.

29. Once the first location (Boyne Valley) is assessed for UGC potential the process is re-iterated (as graphically represented below) assessing the next areas (Blackwater Valley, Benburb Area, etc.) in sequence... The same process is repeated in order to optimise the use of the 10km independently at each location.



3.1.5.1 Identification of preliminary feasible locations for the sealing end compounds

30. A work stream was undertaken to provide a starting basis for the engineering team to begin to look at possible broad locations for sealing end compounds (without reference, at this stage to potential UGC routeing). The environmental leads, landscape and archaeological consultants and underground cable engineering team worked through a 'first pass' iteration of Step 5. This provided the output of preliminary feasible locations for the sealing end compounds. The broad locations determined for each of the prioritised areas as listed in Step 4 are shown in the figures below. It should be noted that the red line in the following figures indicates the OHL and no consideration of UGC routeing was undertaken at the initial workshop.

Figure 3-1 Boyne Valley (UGC Route 1A Approximately Tower 339 to Tower 363 - Approx 8km)

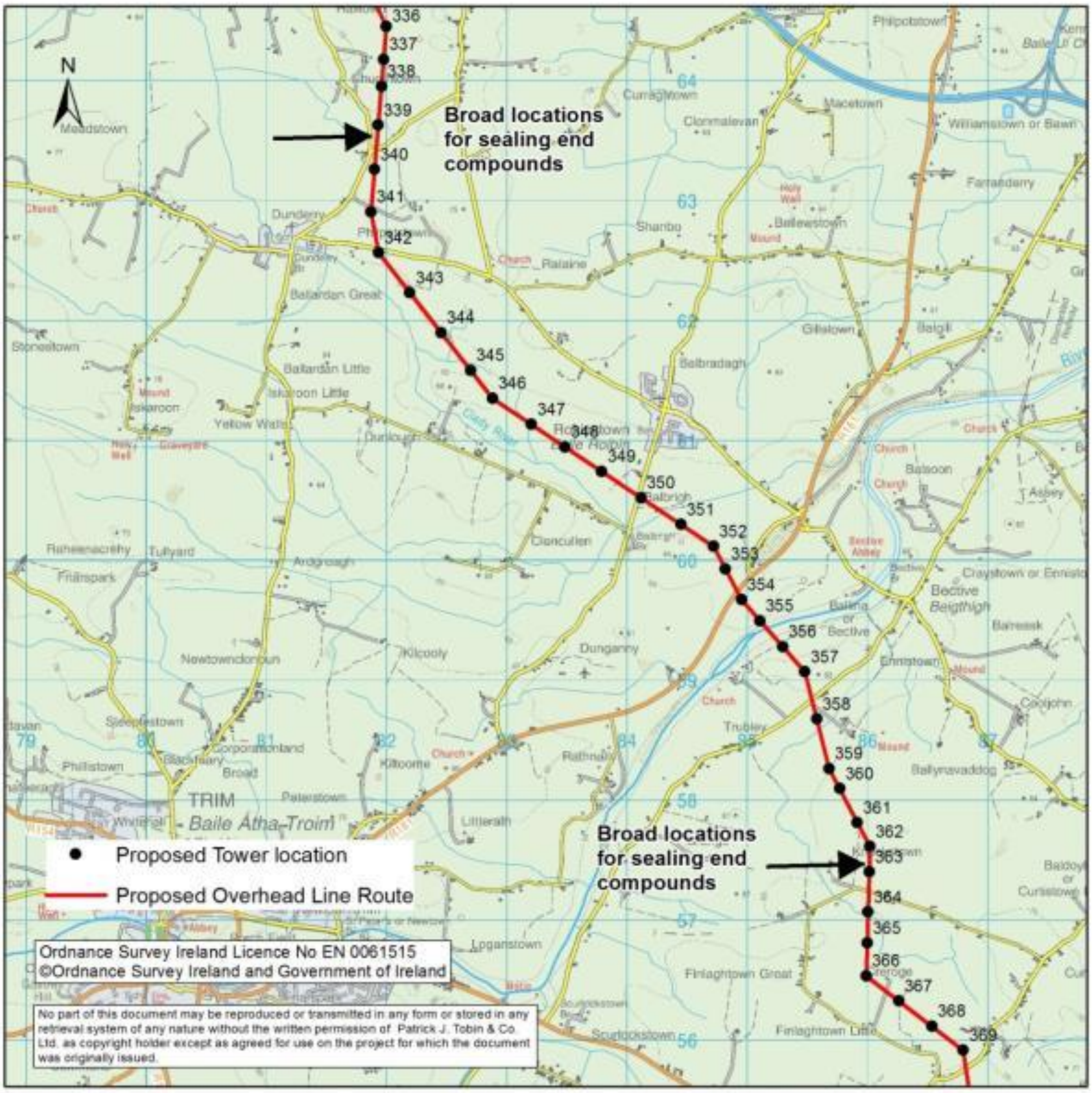


Figure 3-2 Boyne Valley (UGC Route1B Approximately Tower 350 to Tower 363 - Approx 4km)

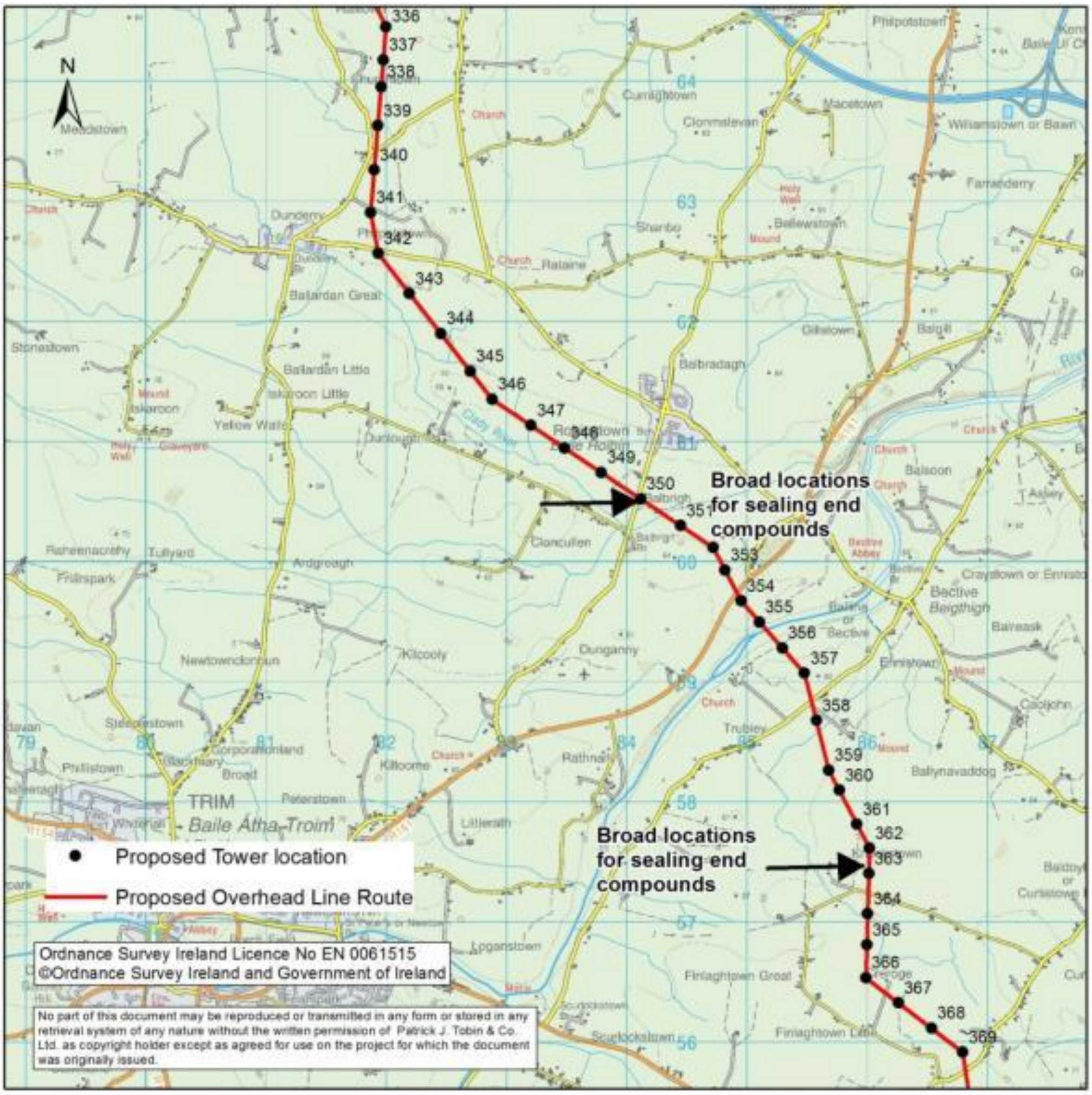


Figure 3-3 Blackwater Valley (UGC Route 2 Approximately Tower 301 to Tower 312 - Approx 4km)

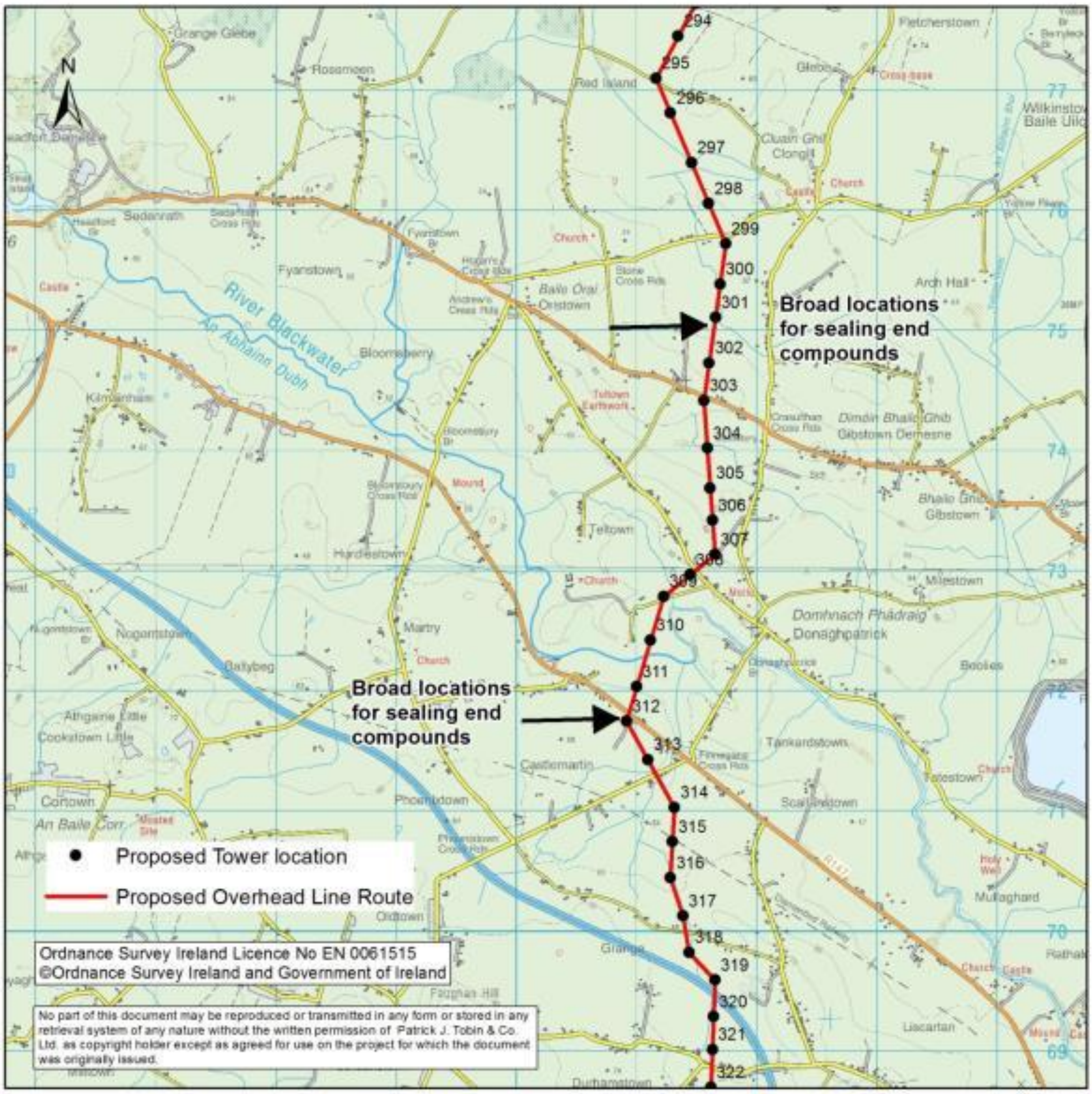


Figure 3-4 Benburb Area (UGC Route 3A Approximately Tower 1 to 33 - Approx 9km)

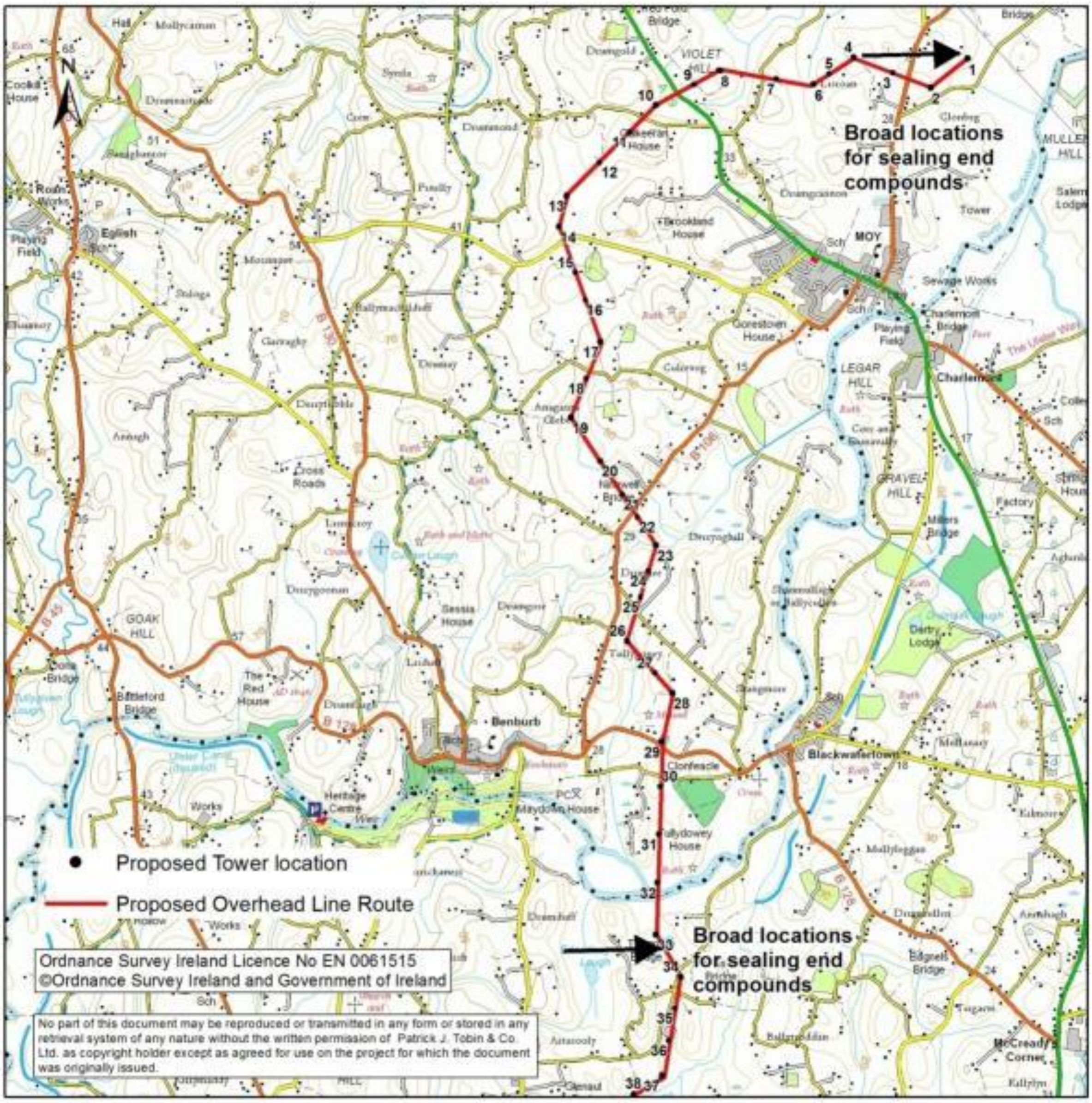


Figure 3-5 Benburb Area (UGC Route 3B Approximately Tower 29 to 36 – Approx 2.6km)

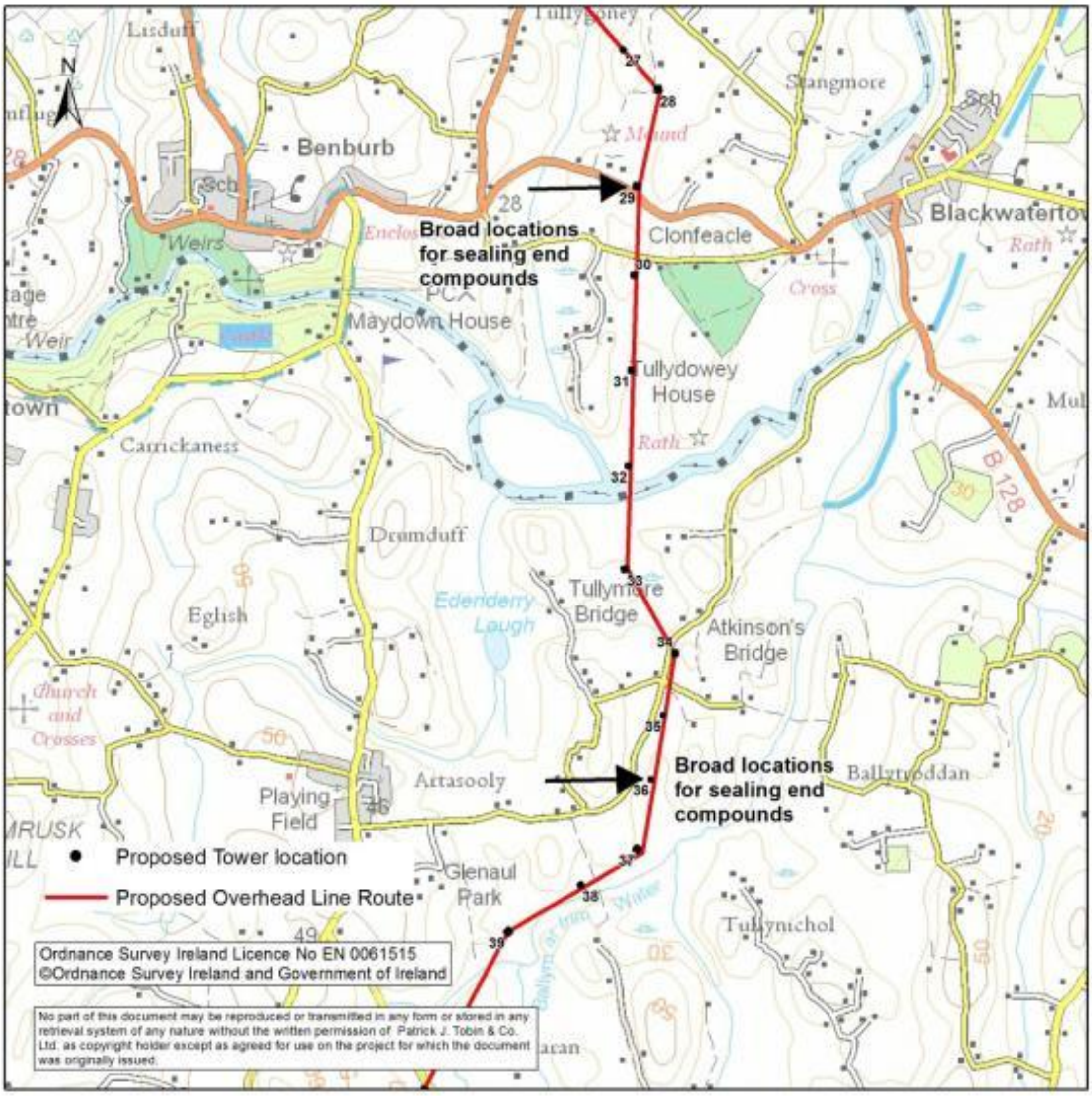


Figure 3-6 Benburb Area (UGC Route 3C Approximately Tower 29 to 33 – Approx 1.8km)

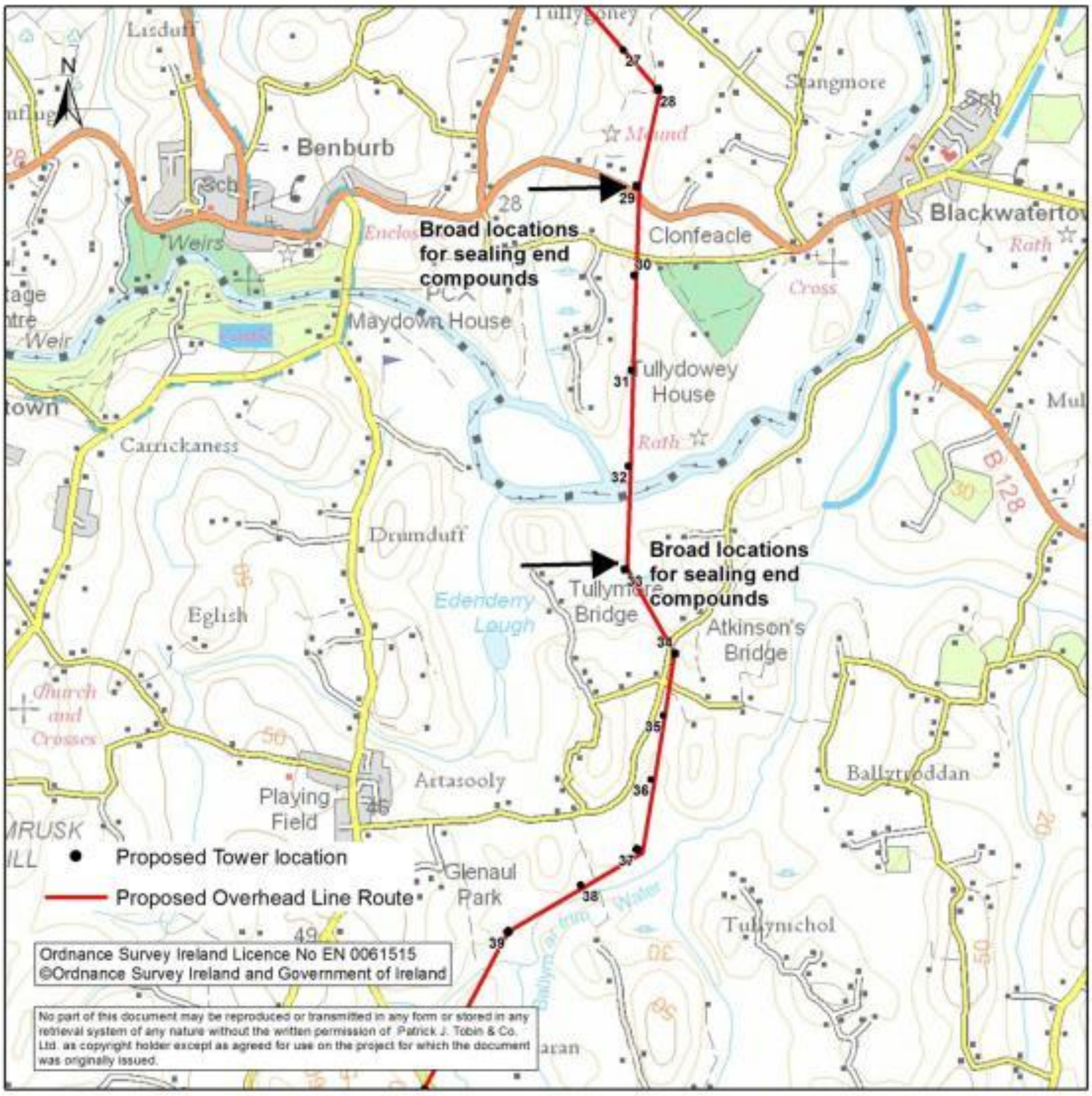


Figure 3-7 Brittas (UGC Route 4A Approximately Tower 251 to Tower 272 - Approx 7km)

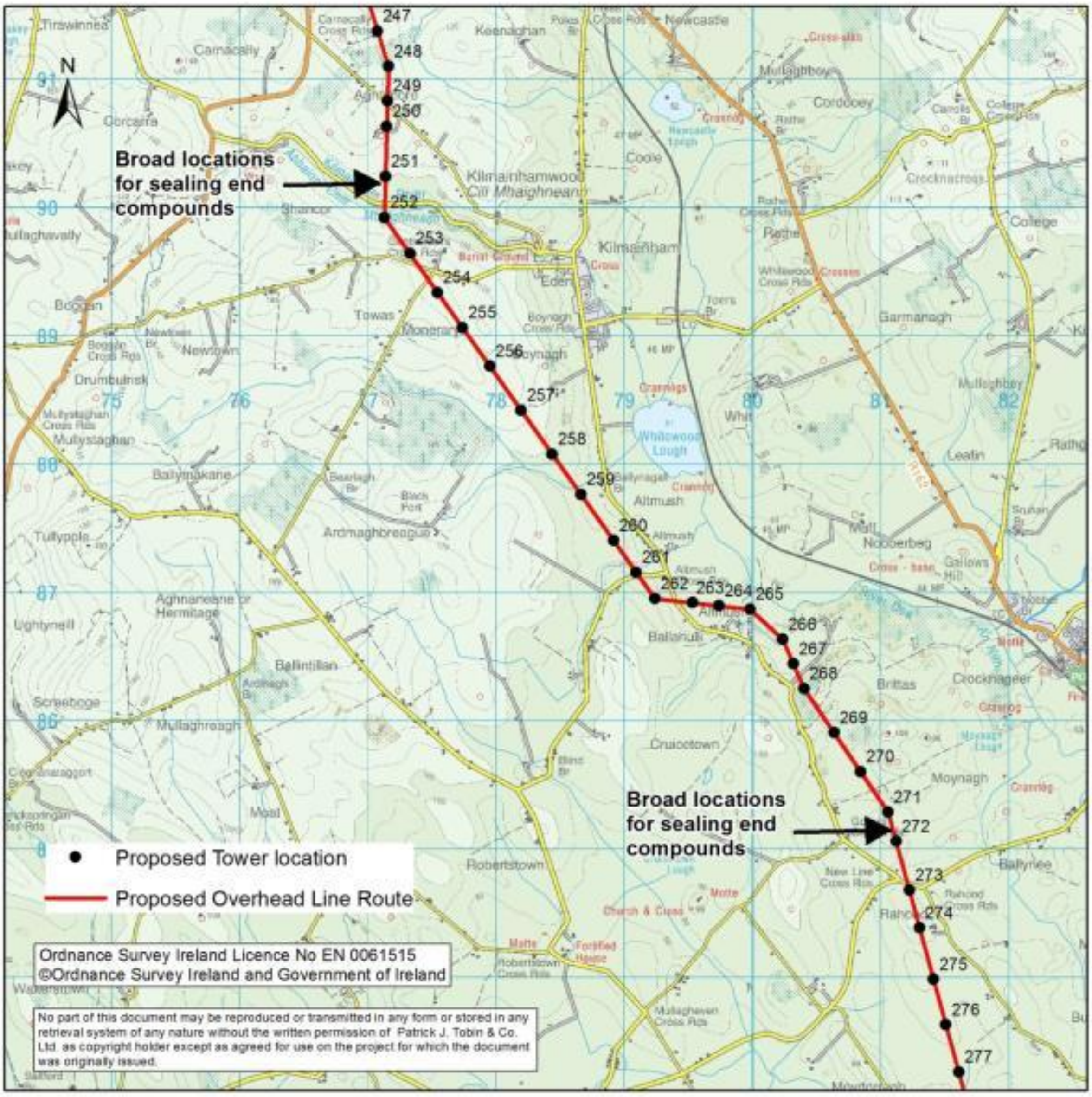


Figure 3-8 Brittas UGC Route 4B Tower 257 to Tower 272 - Approx 5km

Figure 3-9 Brittas UGC Route 4C Tower 263 to Tower 272 - Approx 3km

Figure 3-10 Mullyash Uplands Character Area (UGC Route 5A Approximately Tower 102 to Tower 126 - Approx 5km)

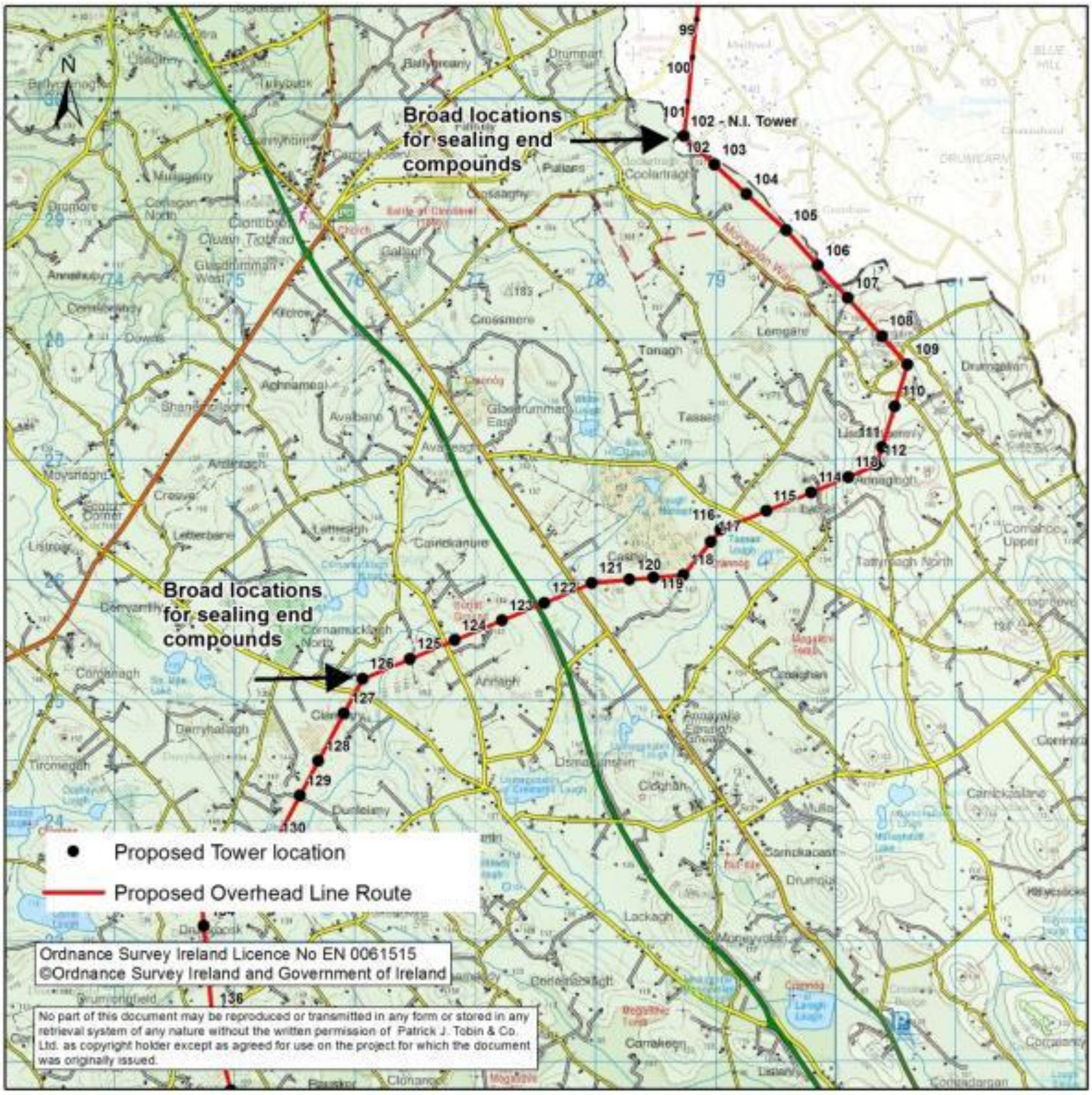


Figure 3-11 Mullyash Uplands Character Area (UGC Route 5B Approximately Tower 101 to Tower 112 - Approx 3km)

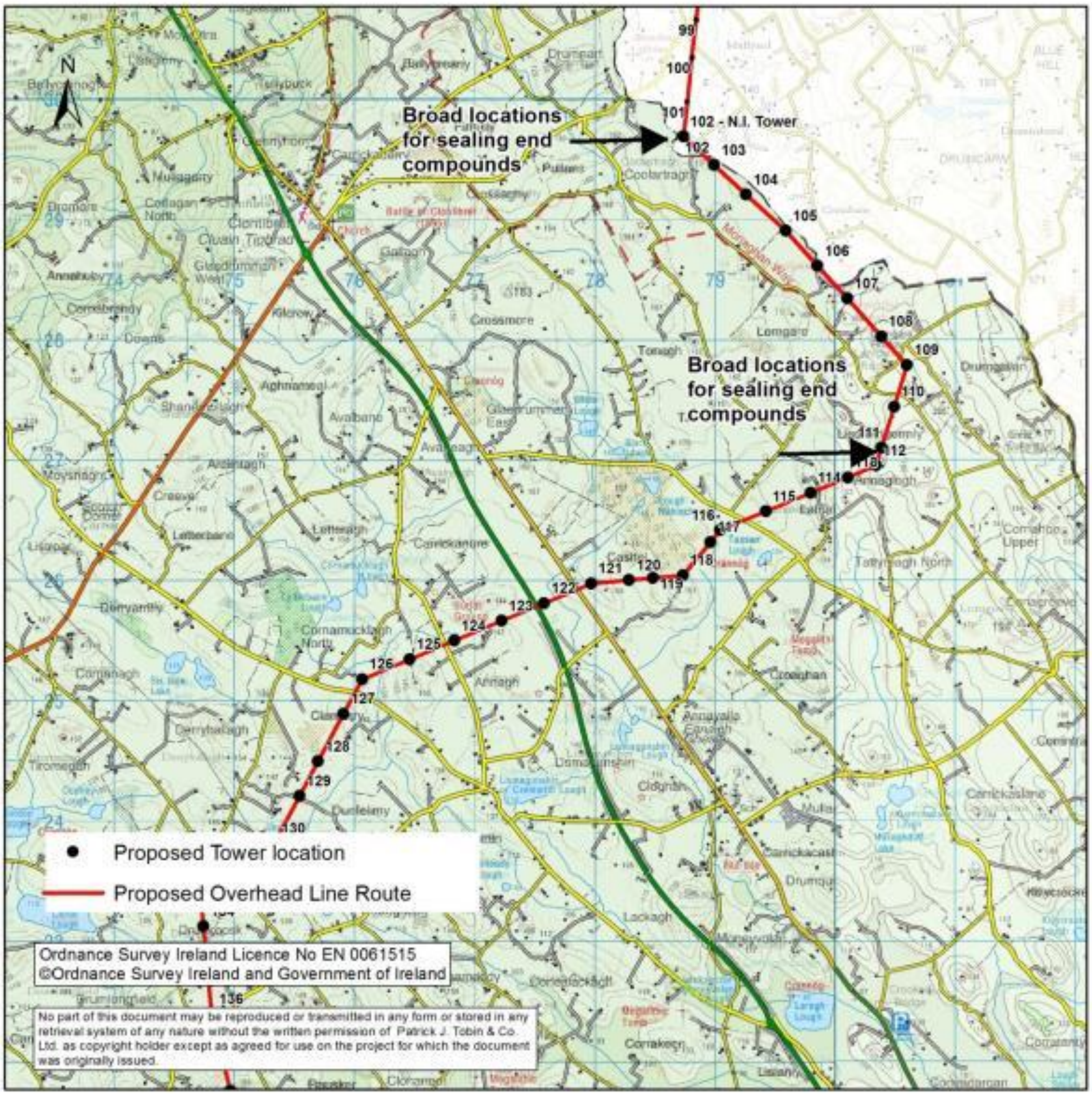


Figure 3-12 Cavan Highlands (UGC Route 6A Approximately Tower 221 to Tower 236 - Approx 5.5km)

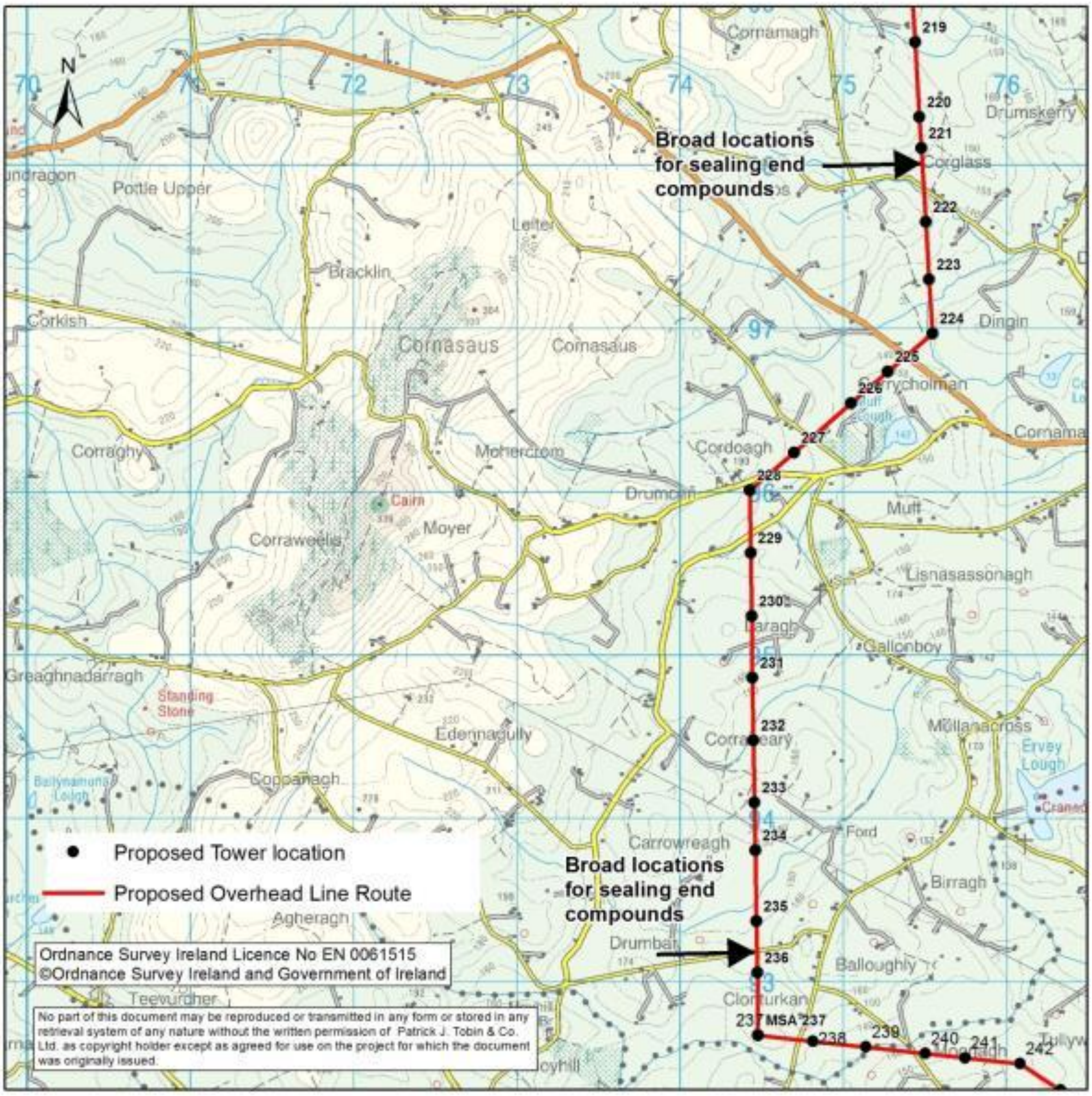


Figure 3-13 Cavan Highlands (UGC Route 6B Approximately Tower 224 to 236 - Approx 4.5km)

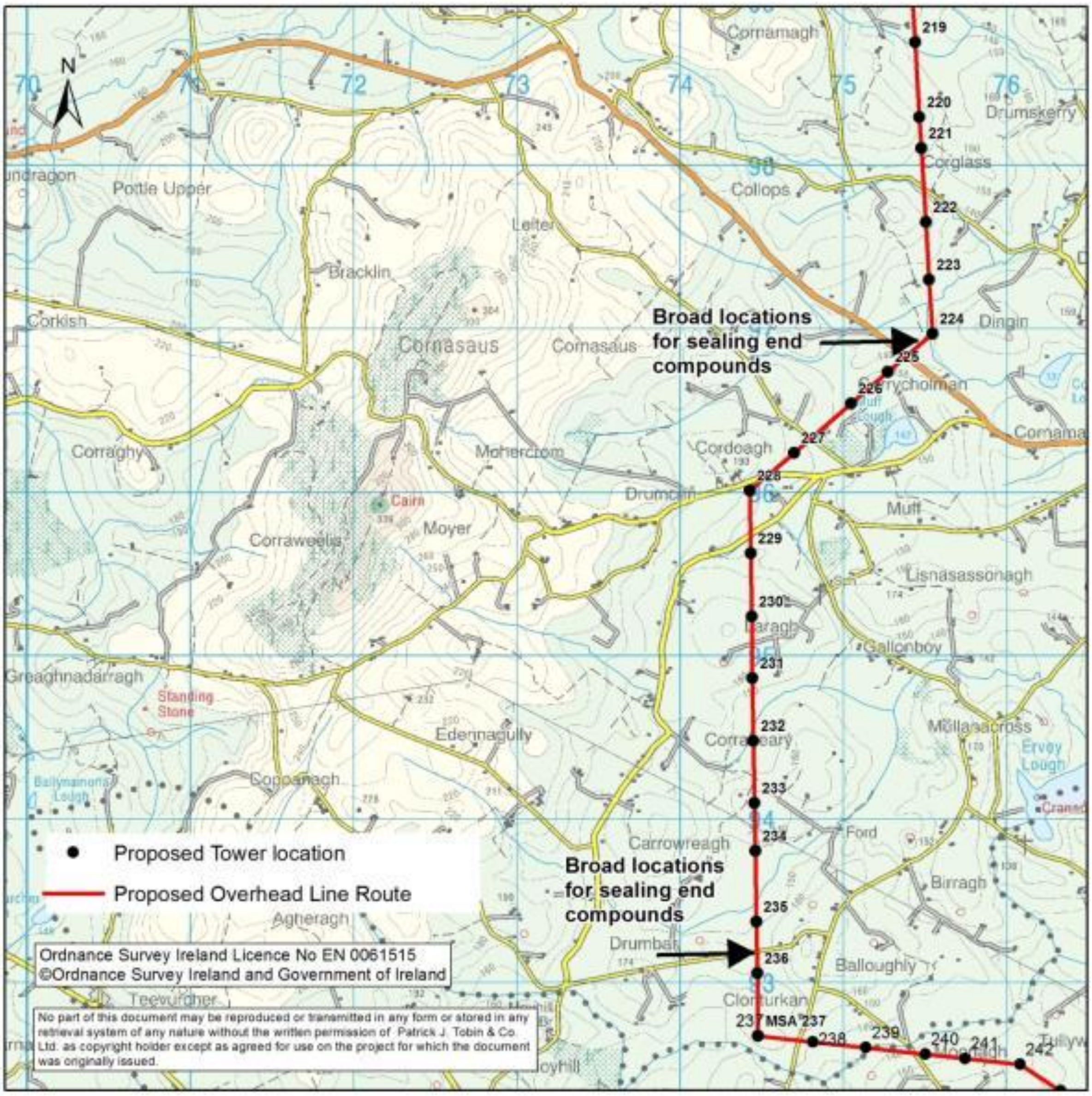
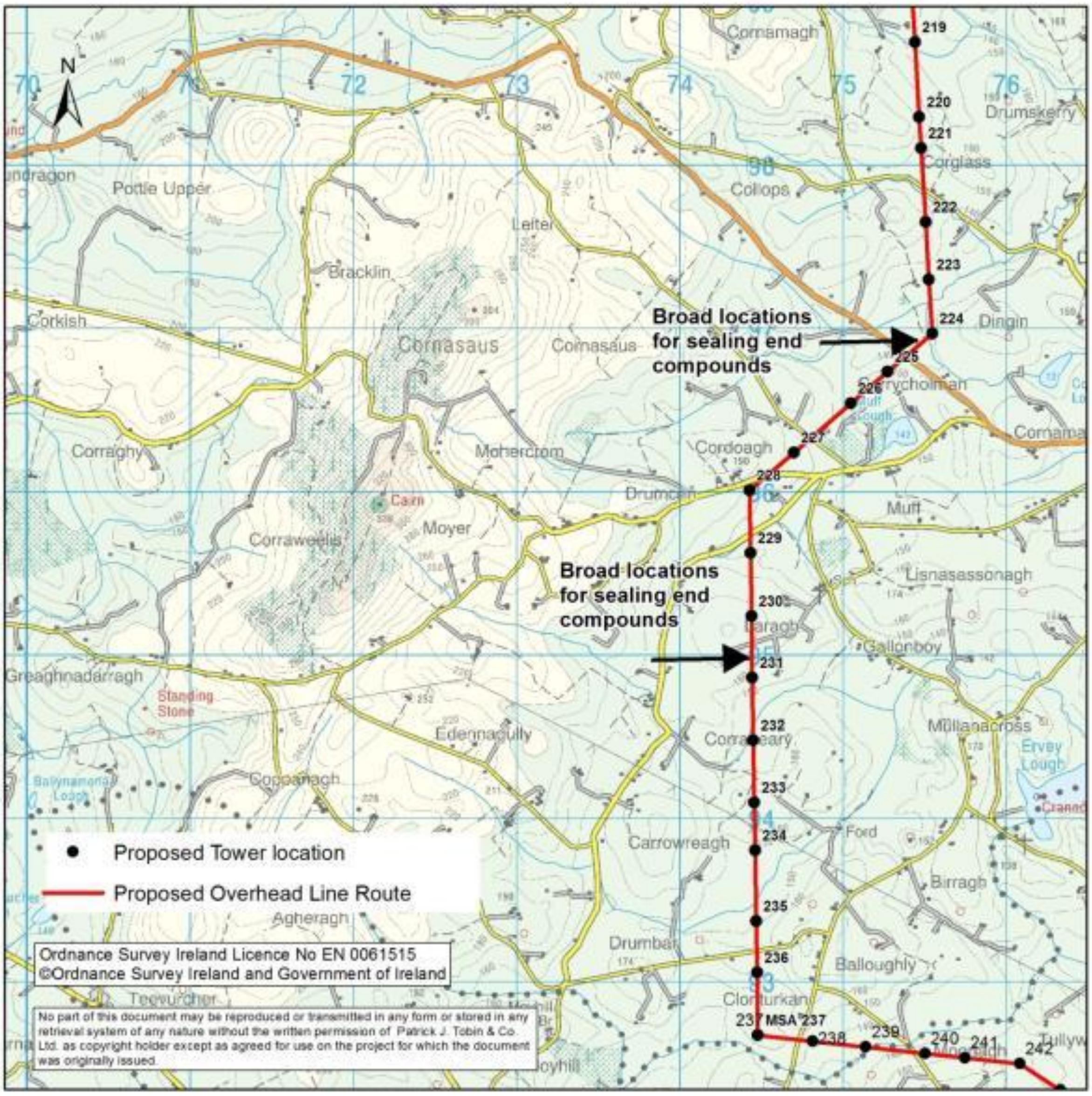


Figure 3-14 Cavan Highlands UGC Route 6C Approximately Tower 224 to 231 - Approx 2.7km



3.1.5.2 Work stream 2: Multidisciplinary work stream to further consider the potential undergrounding cable sections

31. Work stream 2 involved the broader technical and environmental team including specialists for topics including ecology and archaeology as well as landscape and the technical cable team. The purpose of this work stream was to get further feedback on technical feasibility from the engineering team and to further consider the potential undergrounding cable sections.

32. This resulted in the following figures, which show potential sealing end compounds in addition to feasible cable routes.

33. The potential UGC section within the **Boyne Valley** area identified between the sealing end compounds and shown in shown in Figure 3-15 has the potential to mitigate the impacts to a number of receptors clustered in the area:

- Boyne Valley Landscape Character Area
- River Boyne
- Scenic View 86
- Boyne Valley Driving Route
- Outskirts of Robinstown and Dunderry
- Claudy River Valley
- Philpotstown House Demesne

34. In comparison, the potential UGC section identified between the sealing end compounds and shown in Figure 3-16 has the potential to mitigate the impacts only to the Boyne Valley Landscape Character Area, the River Boyne, Scenic View 86 and the Boyne Valley Driving Route.

35. The potential UGC section within the **Blackwater Valley** area shown in Figure 3-17 has the potential to mitigate the impacts to a number of receptors clustered in the area:

The area between the potential sealing end-compound locations includes:

- Boyne Valley Driving Route
- Blackwater River, Co Meath
- Blackwater Valley Landscape Character Area
- Teltown Archaeological Landscape
- Donaghpatrick

2 The **Benburb Area** identified between the sealing end compounds shown in Figures 3-18 to 3-20 has the potential to mitigate the impacts to a number of receptors clustered in the area:

- Tullydowey House Gate Lodge
- River Blackwater, Co. Armagh
- Tullydowey House
- National Cycle Route 11 and River Blackwater Canoe Trail
- Benburb as a settlement and constraints within (e.g. Benburb Priory and Benburb Castle)
- The Argory (with a longer underground section from Turleenan substation to Benburb Area)
- Moy village (with a longer underground section from Turleenan substation to Benburb Area)

36. The potential UGC section within the **Brittas Area** identified between the sealing end compounds shown in Figure 3-21 has the potential to mitigate the impacts to a number of receptors clustered in the area:

- Brittas Demesne
- Whitewood Lough
- Kilmainhamwood
- Kilmainhamwood river

37. In comparison, **route 4b** has the potential to mitigate significant impacts associated with Brittas Demesne and Whitewood Lough, while the shortest UGC route around Brittas identified as shown in Figure 3-22 has the potential to mitigate the impacts to the Brittas Estate alone.

38. The potential UGC section within the **Mullyash Uplands Character Area** identified between the sealing end compounds shown in Figure 3-24 has the potential to mitigate the impacts to a number of receptors clustered in the area:

- Mullyash Uplands Landscape Character Area
- Tassan Lough
- Monaghan Way
- A valley close to the jurisdictional border with Northern Ireland

39. In comparison, looking at the shortest route within the Mullyash Uplands Character Area as shown in Figure 3-25 has the potential to mitigate the impacts to the Monaghan Way and a valley close to the jurisdictional border with Northern Ireland.

- The potential UGC section within the area of **Cavan Highlands Landscape Character Area** shown in Figure 3-26 and identified between the sealing end compounds has the potential to mitigate the impacts to a number of receptors clustered in the area:

- Cavan Highlands Landscape Character Area

- Setting of Muff Fair

40. In comparison, **Route 6b,** shown on Figure 3-27 has the potential to mitigate impacts to a section of the Cavan Highlands and to the Setting of Muff Fair, while the shortest route as identified and shown in Figure 3-28**,** has the potential to mitigate the impacts only to the Setting of Muff Fair.

41. The following figures show in red the line route of the OHL as shown in the EIS and ES, , while the potential UGC sections are shown in blue, with the sealing end compounds identifying the interface with the OHL.

Table 3-3 Potential Underground Cable Sections

Crossing	Cable Length (km)	Rivers/streams Open Trench	Rivers/streams HDD	Road Crossings
1 Boyne Valley area				
Boyne 1a (339 to 363)	8.1	5	1 (Boyne)	5
Boyne 1b (350 to 363)	3.9	2	1 (Boyne)	2
2 Blackwater Valley Area				
Blackwater (301 to 312)	3.8	2	1 (Blackwater, Co Meath)	4
3 Benburb Area				
Benburb (01 to 33)	9.0	3	1 (Blackwater, Co Tyrone & Armagh)	11
Benburb (29 to 36)	2.6	0	1 (Blackwater, Co Tyrone & Armagh)	3
Benburb (29 to 33)	1.8	0	1 (Blackwater, Co Tyrone & Armagh)	2
4 Brittas area				
Brittas 4a (251 to 272)	7.3	4	0	5
Brittas 4b (256 to 272)	5.5	3	0	2
Brittas 4c (263 to 272)	3.2	1	0	2
5 Mullyash Uplands Area				
Mullyash 5a (102 to 126)	5.8	5	0	9
Mullyash 5b (102 to 112)	3.8	0	0	3
6 Cavan Highlands Area				
Cavan 6a (221 to 236)	5.5	4	0	7
Cavan 6b (224 to 236)	4.5	3	0	6
Cavan 6c (224 to 231)	2.7	0	0	5

Figure 3-15 Boyne Valley UGC Route 1A South of Tower 339 to North of Tower 363 (Approx 8.1km)

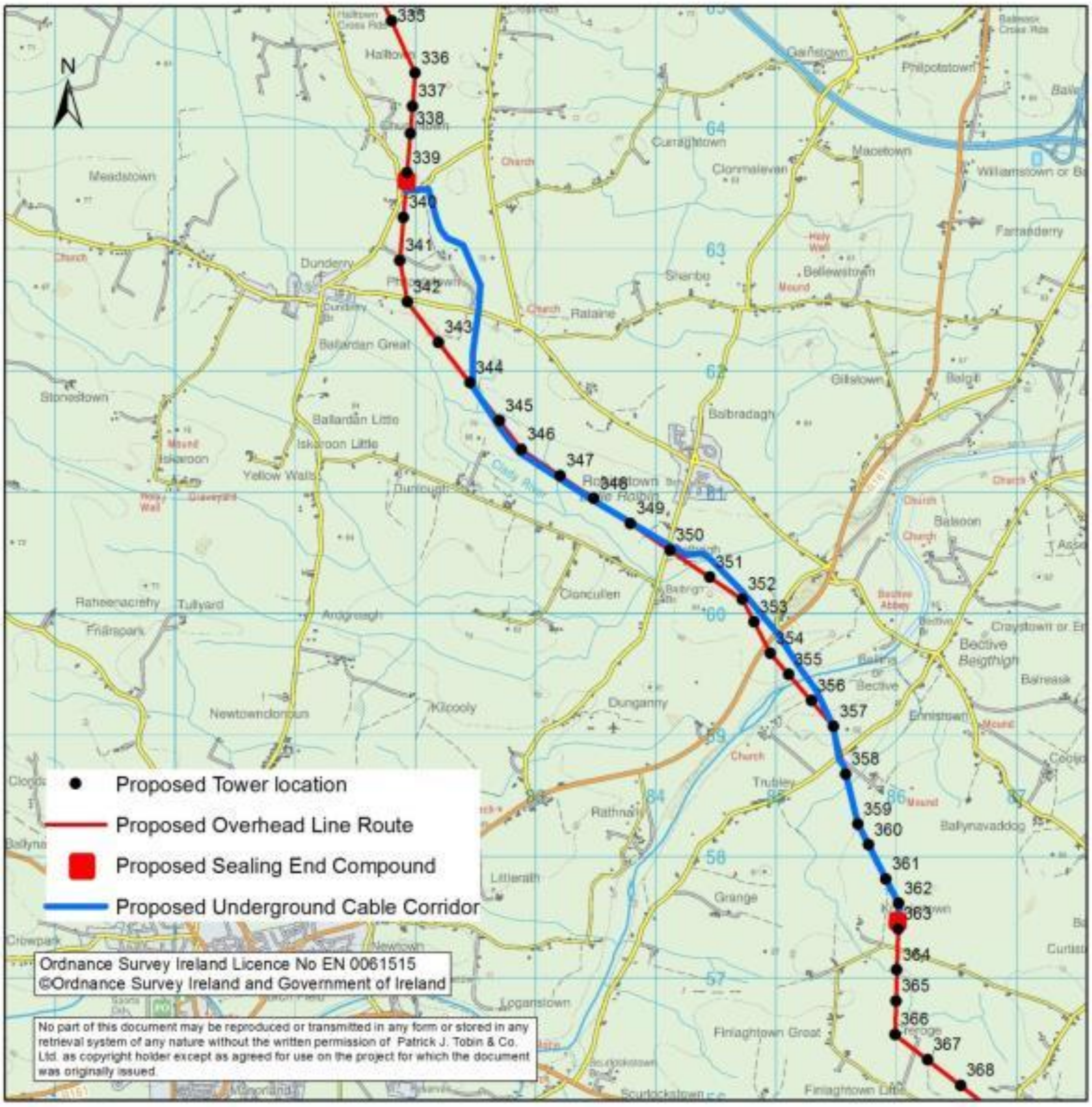


Figure 3-16 Boyne Valley UGC Route1B South of Tower 350 to North of Tower 363 (Approx 3.9km)

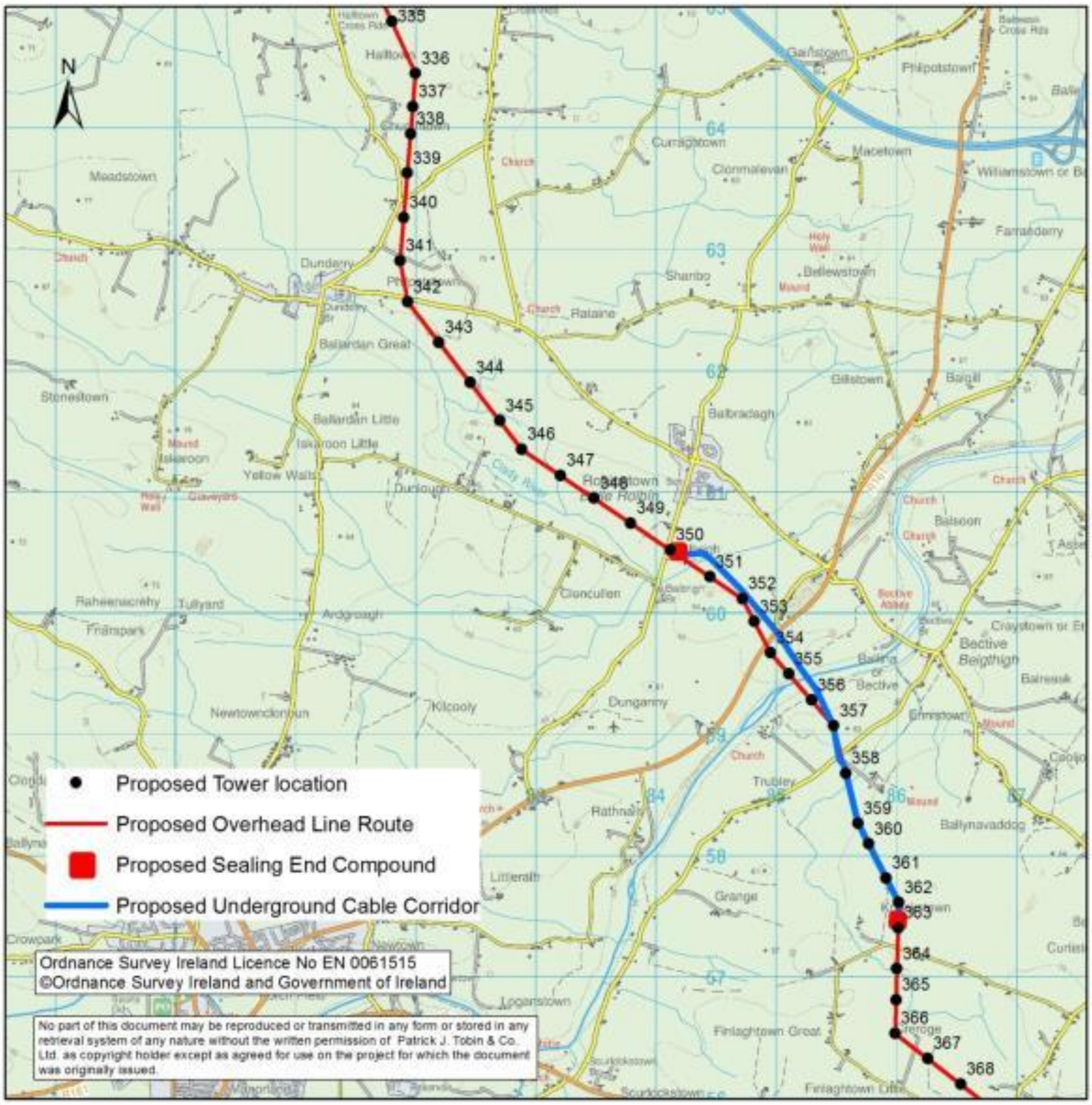


Figure 3-17 Blackwater Valley UGC Route 2 South of Tower 301 to Northwest of Tower 312 (Approx 3.8km)

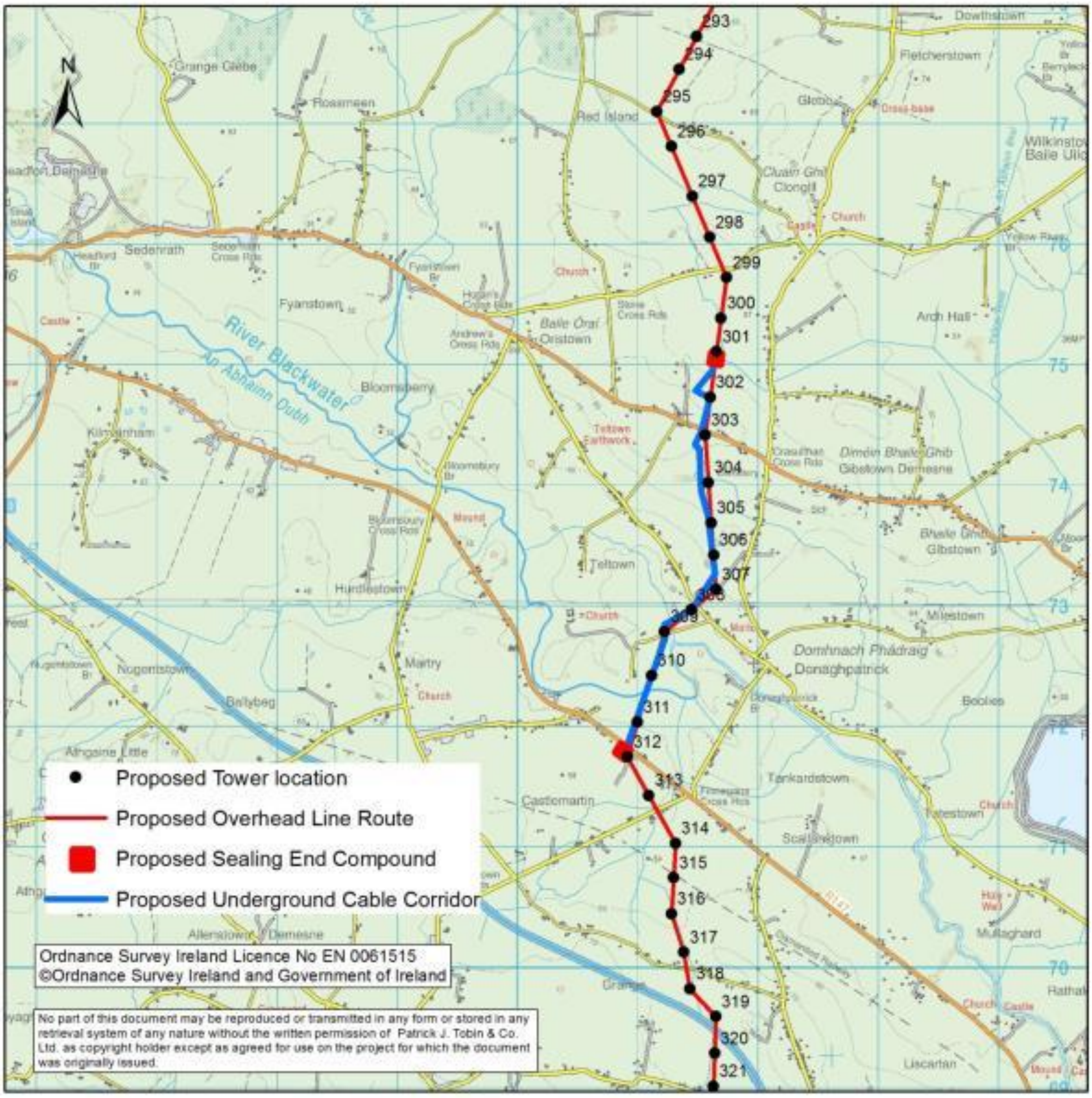


Figure 3-18 Benburb Area UGC Route 3A between Tower 1 and Tower 33 (Approx 9.0 km)

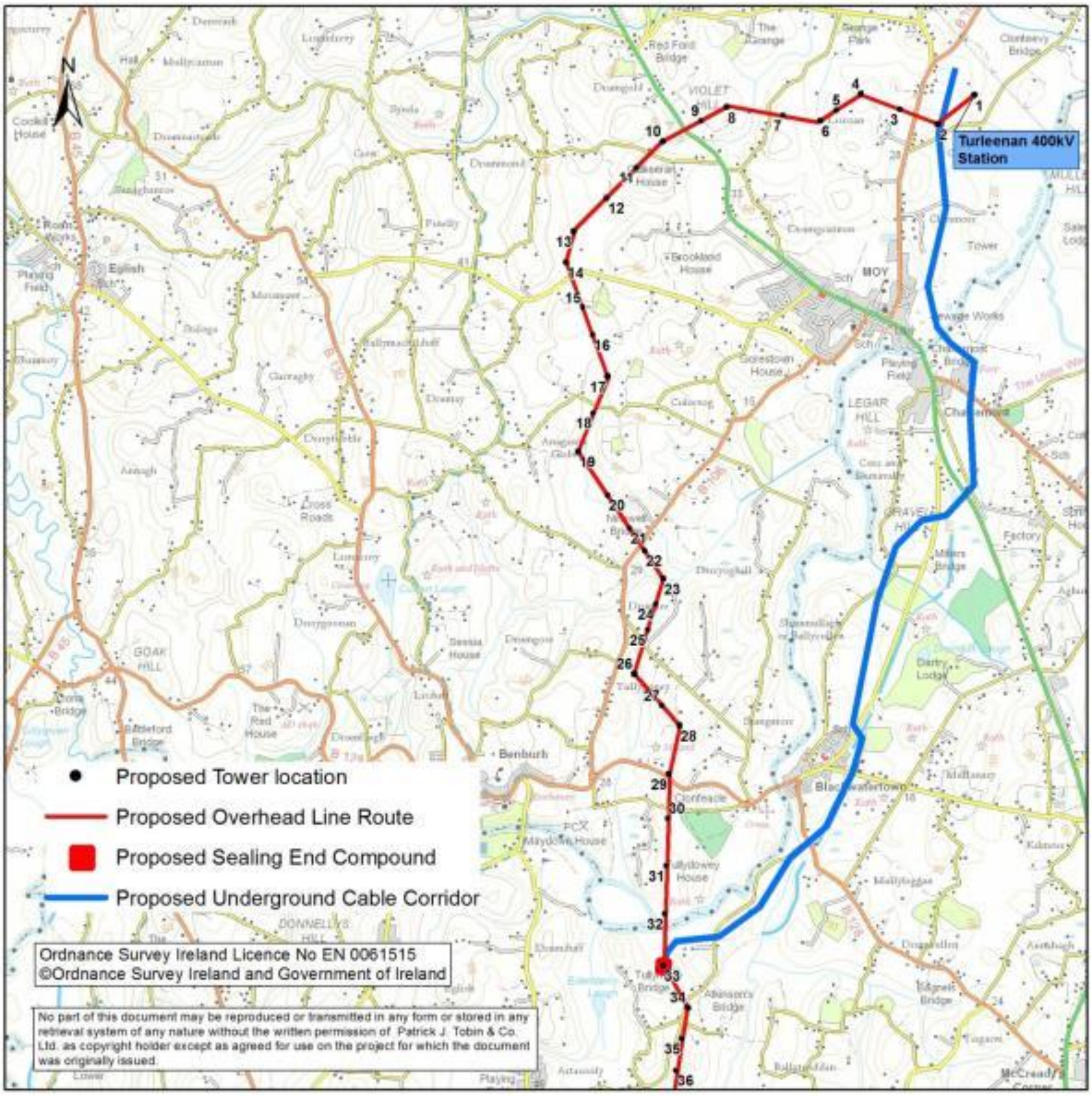


Figure 3-19 Benburb Area UGC Route 3B between Tower 29 and Tower 36 (Approx 2.6 km)

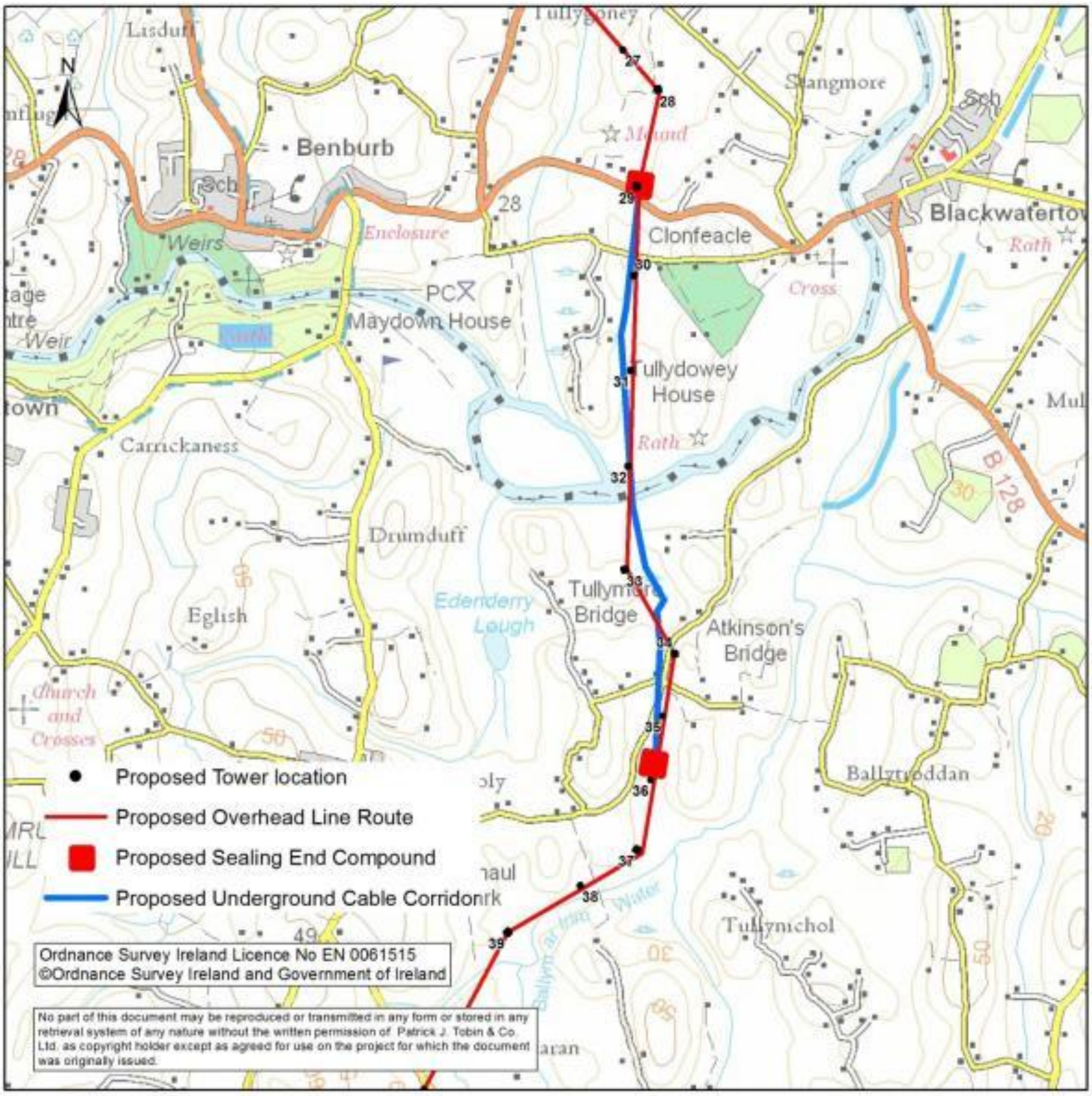


Figure 3-20 Benburb Area UGC Route 3C between Tower 29 and Tower 33 (Approx 1.8 km)

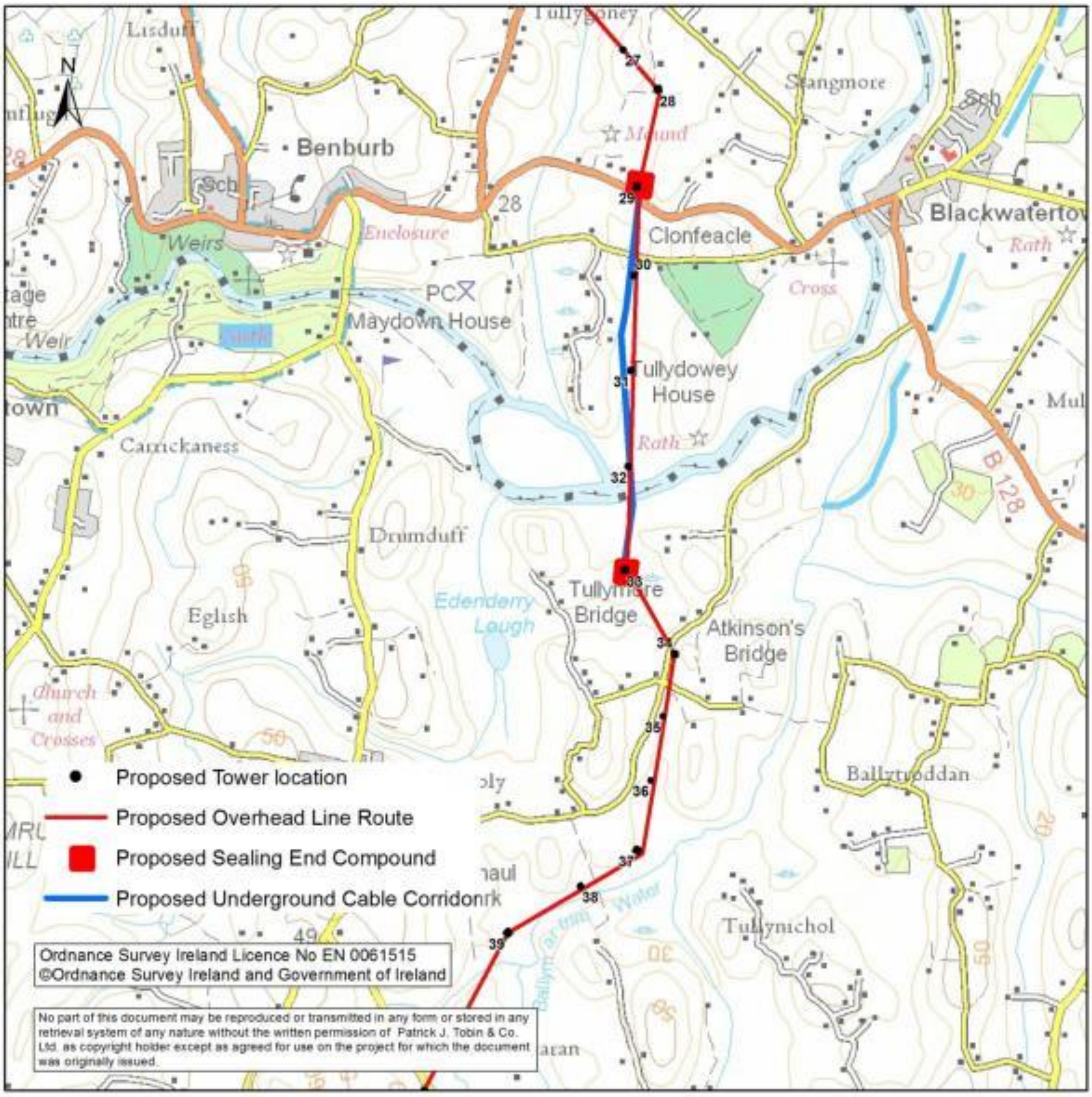


Figure 3-21 Brittas UGC Route 4A South of Tower 251 to North of Tower 272 (Approx 7.3km)

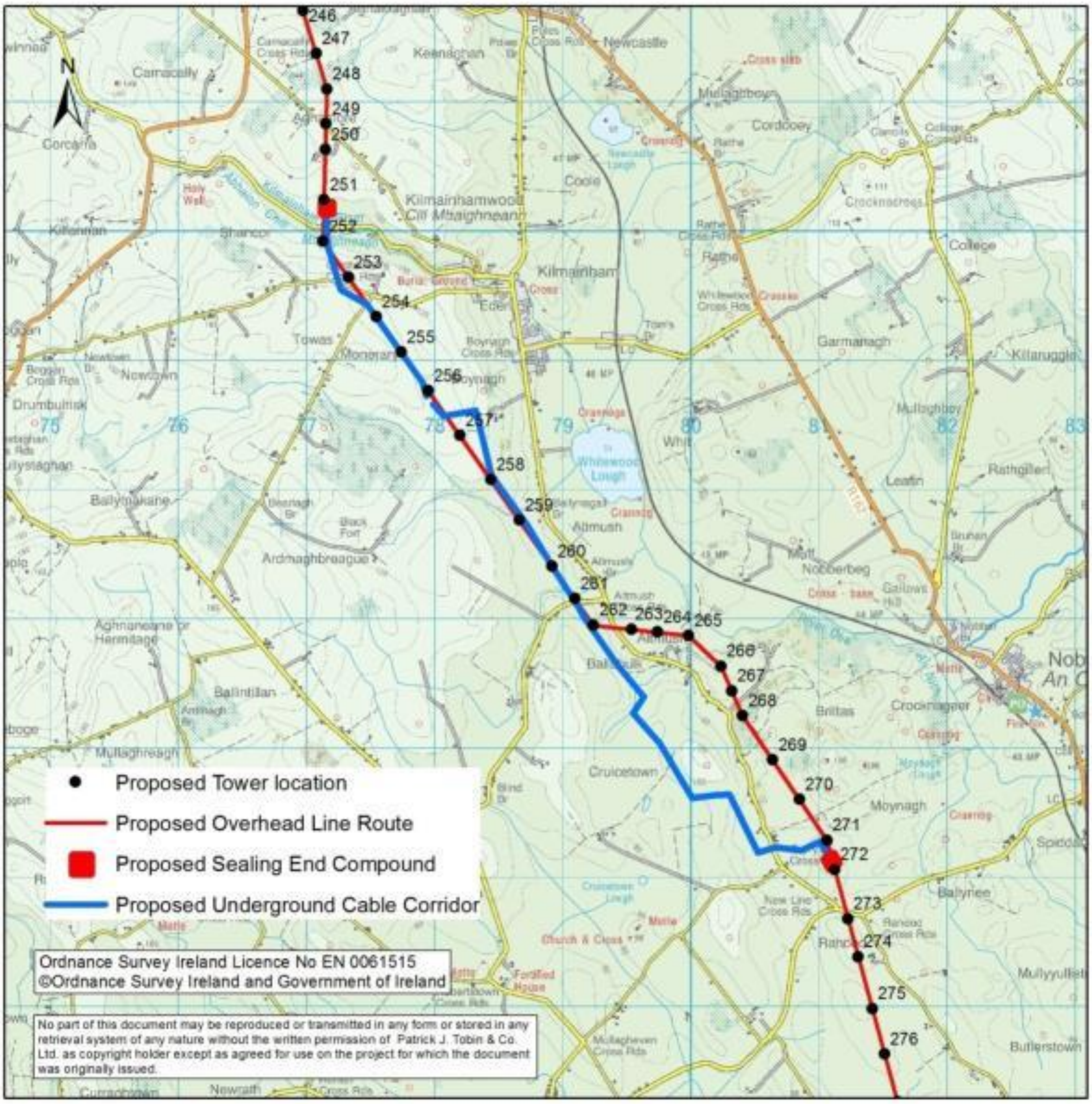


Figure 3-22 Brittas UGC Route 4B South of Tower 256 to North of Tower 272 (Approx 5.5km)

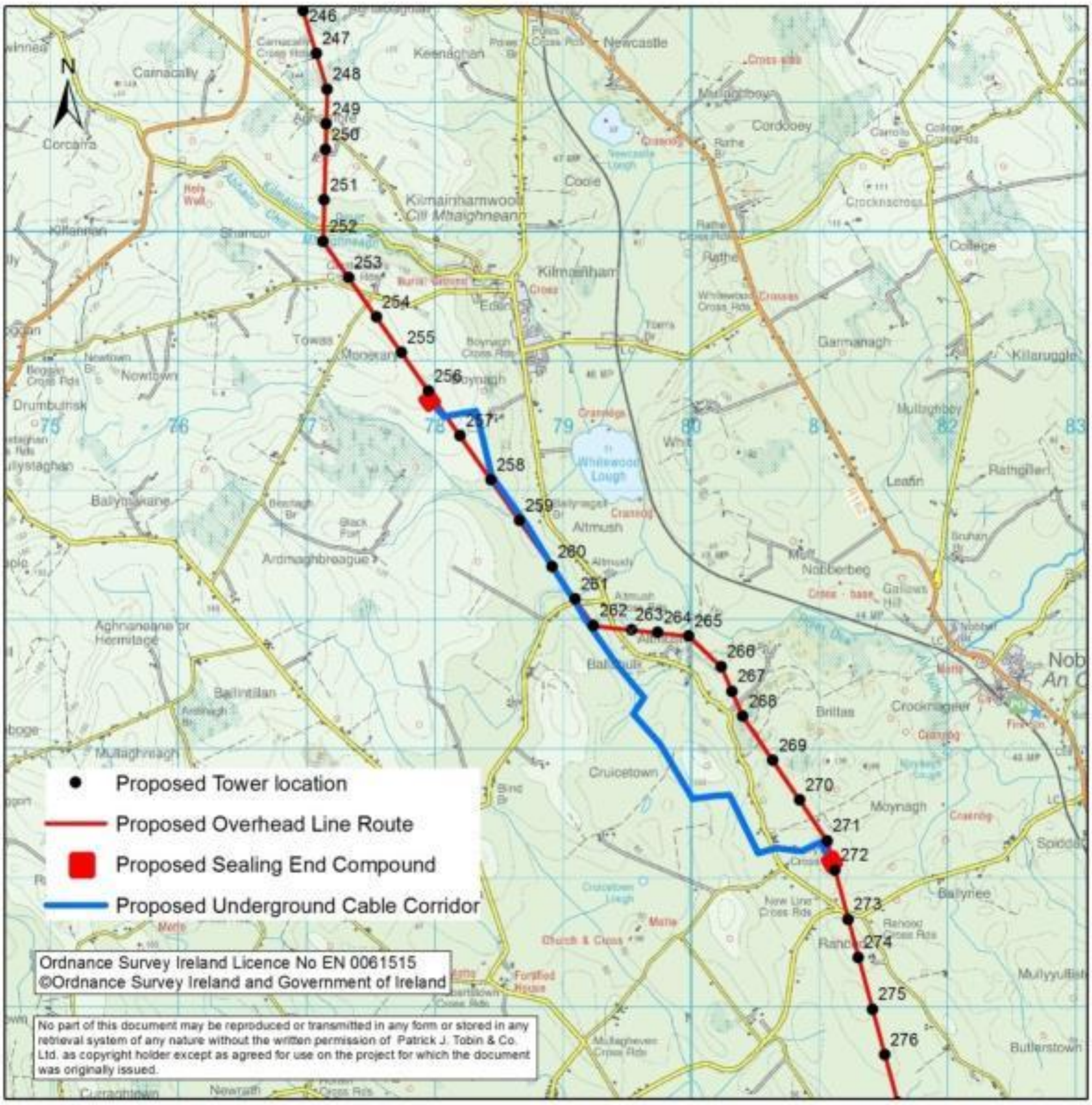


Figure 3-23 Brittas UGC Route 4C Southeast of Tower 263 to North of Tower 272 (Approx 3.2km)

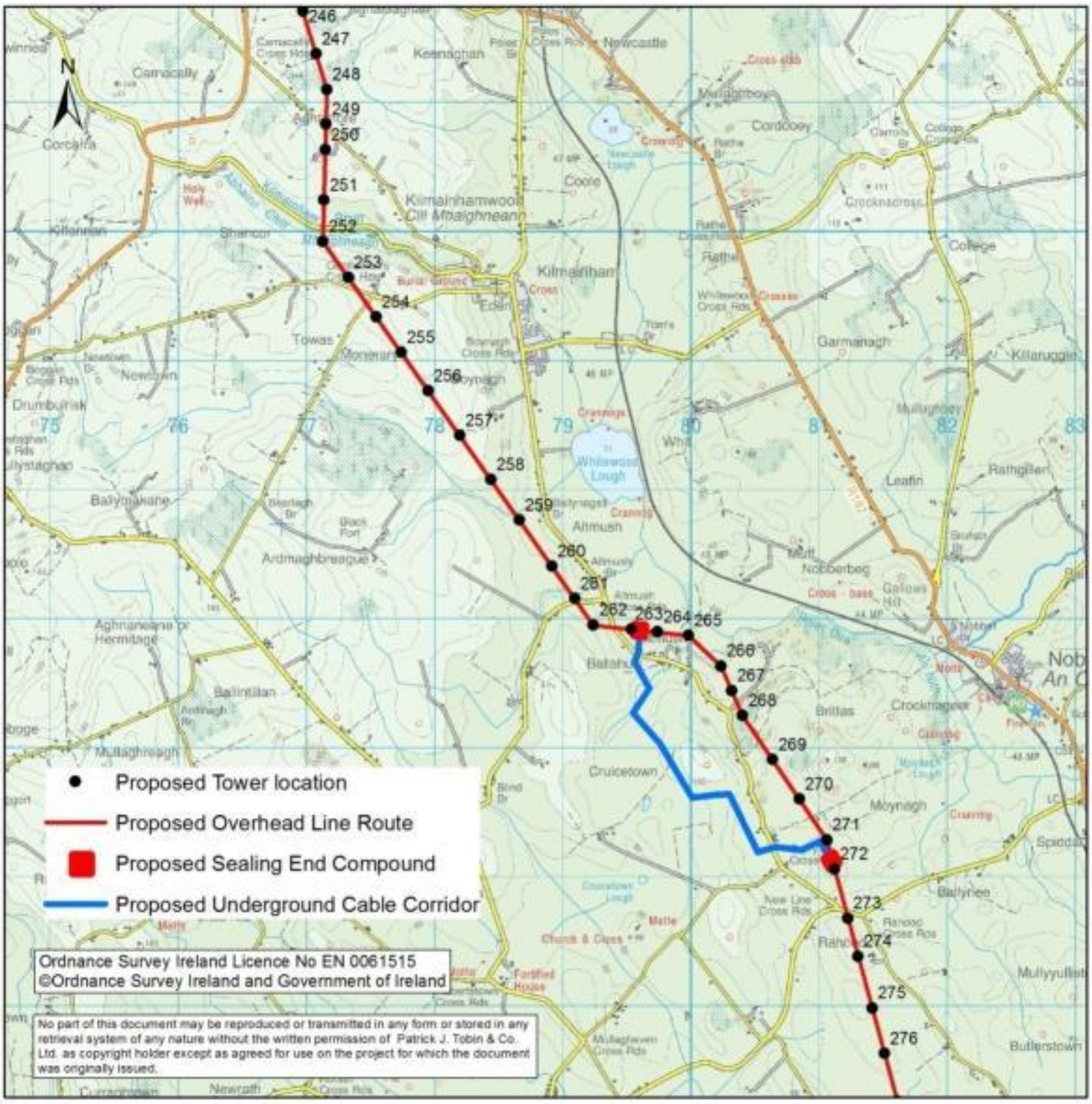


Figure 3-24 Mullyash Uplands Character Area UGC Route 5A South of Tower 102 (offset from OHL) to North of Tower 126 (Approx 5.8km)

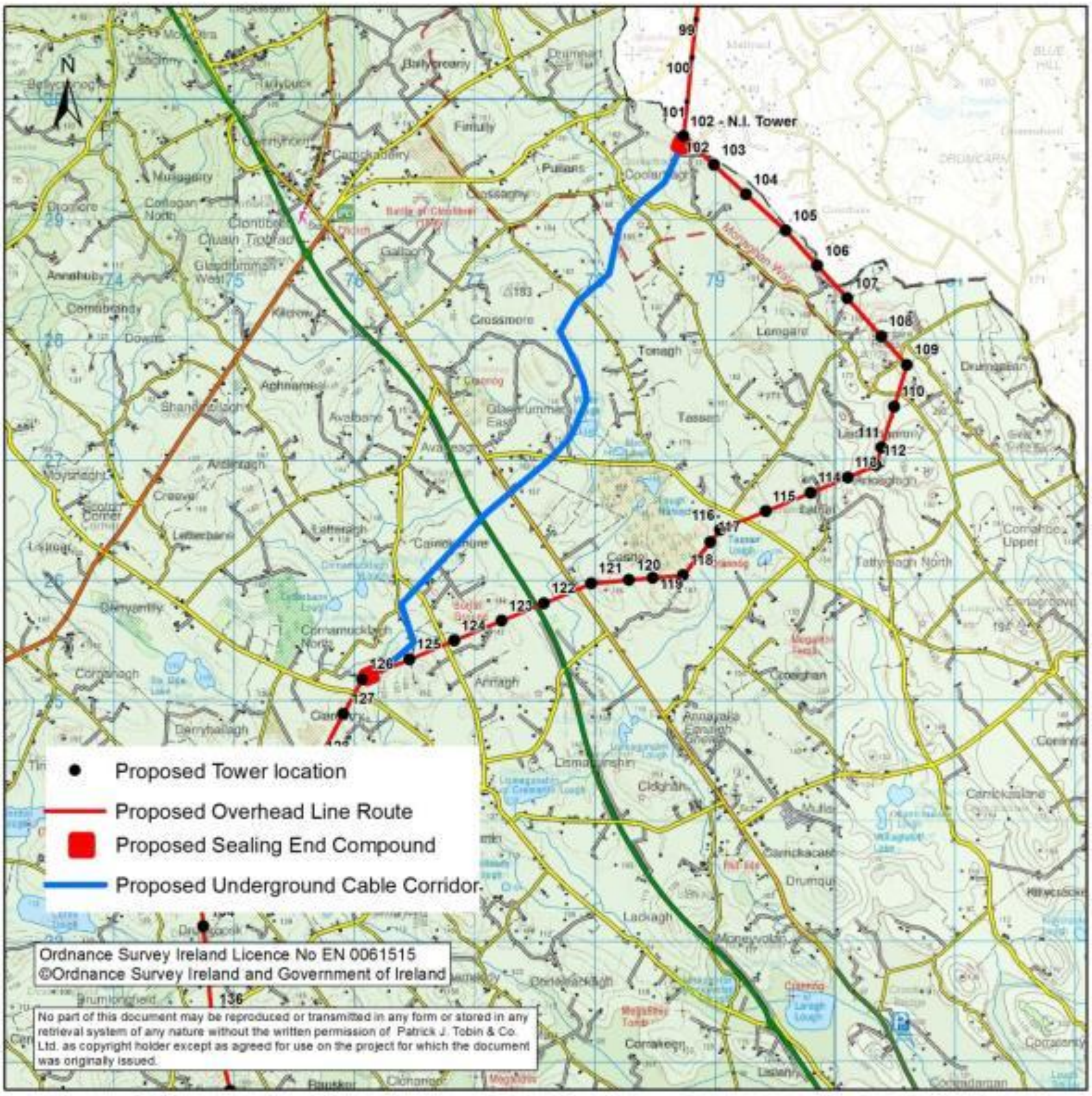


Figure 3-25 Mullyash Uplands Character Area UGC Route 5B South of Tower 102 (offset from OHL) to North of Tower 112 (Approx 3.8km)

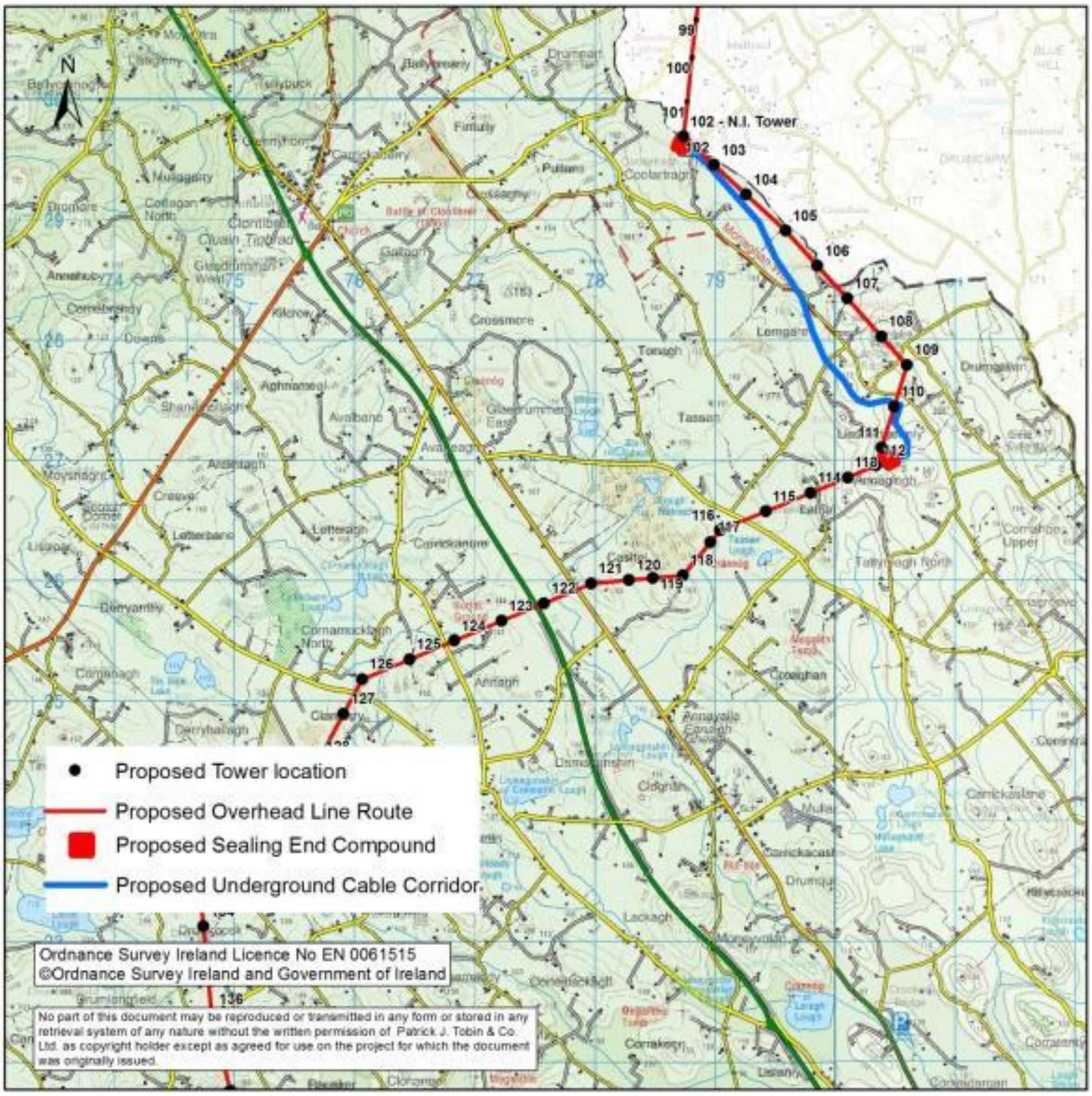


Figure 3-26 Cavan Highlands UGC Route 6A South of Tower 221 to North of Tower 236 (Approx 5.5km)

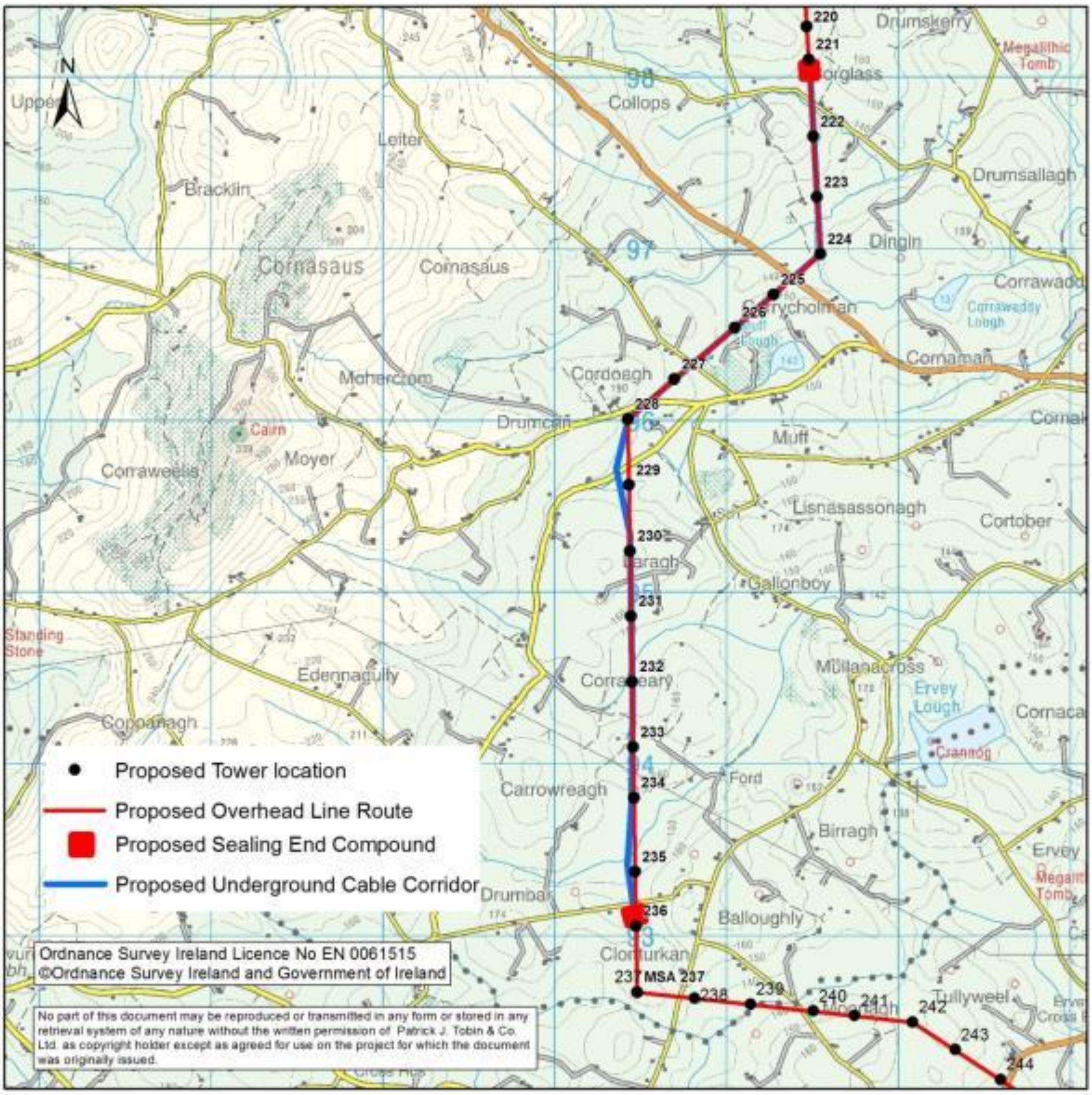


Figure 3-27 Cavan Highlands UGC Route 6B Southeast of Tower 224 to North of Tower 236 (Approx 4.5 km)

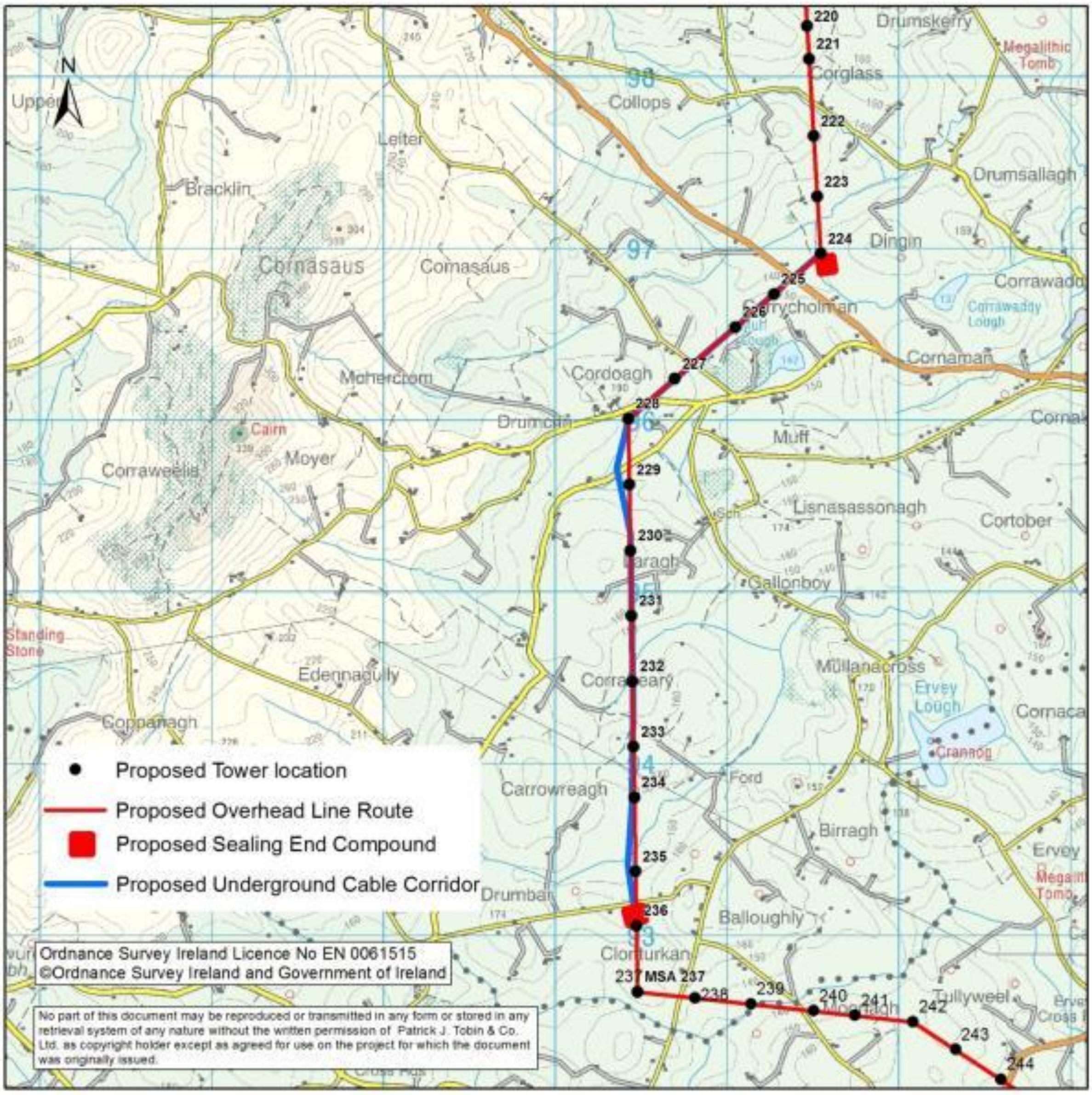
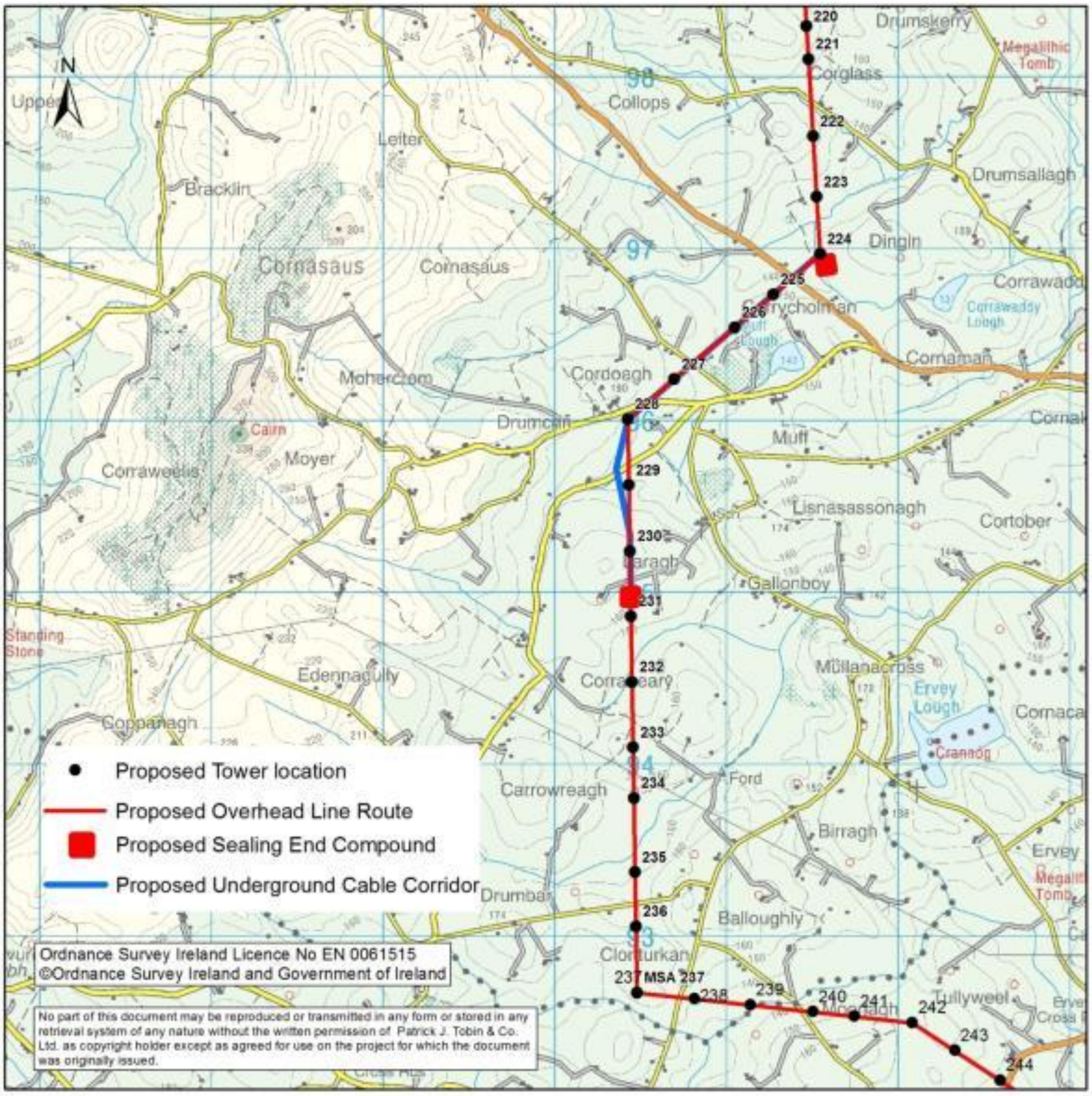


Figure 3-28 Cavan Highlands UGC Route 6C Southeast of Tower 224 to North of Tower 231 (Approx 2.7km)



3.1.6 Step 6: Identification of combinations of UGC Routes to optimise the use of the technical limitation of approximately 10km of UGC

42. The process set out in Table 3-4 below allowed the multi-disciplinary appraisal team to vary length of UGC at locations in order to identify how best to utilise the technical limitation of approximately 10km. The process balances the aim to mitigate impact where identified along the route, with the aim to utilise the limited length of UGC in the areas of highest priority (allocated in Table 3.2). Specifically the table sets out a number of UGC Route Combinations as follows:

- **UGC Route Combination 1:** A combination of the longest routes from each of the selected areas (Total Length 39.5km, therefore ruled out as it is greater than approximately 10km)

- **UGC Route Combination 2:** A combination of the next longest routes from each of the selected areas (Total Length 24.2km, therefore ruled out as it is greater than approximately 10km)

- **UGC Route Combination 3:** A combination of the shortest routes from each of the selected areas (Total Length 19.2km, therefore ruled out as it is greater that approximately 10km)

- **UGC Route Combination 4:** A combination of the shortest routes from the areas, in order of the priority allocated in Table 3.2, which meets the technical limitation of approximately 10km (Total Length 9.4km, therefore brought forward to the next step in the methodology out as it is less than approximately 10km)

43. It is clear from Table 3.4 that it is not possible with the technical limitation of UGC of approximately 10km to include all of the areas identified, even if the shortest UGC route length in each area is chosen. This is UGC Route Combination 3 which has an overall length of 19.2km, almost twice the length of the technical limitation,

44. UGC Route Combination 4 includes the most number of priority areas that meets the approximate 10km technical limitation and can therefore be brought forward for consideration in the next step of the methodology. As outlined in Table 3.4 this combination includes the shortest UGC routes in the three priority areas namely Boyne Valley Area, Blackwater Valley Area (County Meath) and the Benburb Area which give a cumulative length of approximately 9.4km.

45. Given the technical parameter of an approximate 10km limit to partial UGC, this report therefore recommends that the three areas be considered for detailed environmental appraisal. The principal objective throughout the appraisal, is to identify those receptors or clusters that would benefit the most from the use of partial undergrounding as an effective mitigation measure, so

as to "*address the potential*" for mitigation by UGC in the context of site specific circumstances and potential benefits affecting these particular areas.

46. Note that Annex 7 of this report provides a supplementary assessment which applies this methodology to Ireland only.

Table 3-4 Length of the cable routes sections and potential route combinations for UGC sections

Potential UGC Route Combinations	Length (km)	**UGC Route Combination 1**	**UGC Route Combination 2**	**UGC Route Combination 3**	**UGC Route Combination 4**
1. Boyne Valley Area					
UGC Route 1A South of Tower 339 to North of Tower 363 **(Approx 8.1km)**	8.1	8.1			
UGC Route 1B South of Tower 350 to North of Tower 363 **(Approx 3.9km)**	3.9		3.9	3.9	3.9
2. Blackwater Valley Area (County Meath)					
UGC Route 2 South of Tower 301 to Northwest of Tower 312 **(Approx 3.8km)**	3.8	3.8	3.8	3.8	3.8
3. The Benburb Area					
UGC Route 3A Tower 1 to Tower 33 **(Approx 9.0 km)**	9.0	9.0			
UGC Route 3B between Tower 29 and Tower 36 **(Approx 2.6km)**	2.6		2.6		
UGC Route 3C between Tower 29 and Tower 33 **(Approx 1.8km)**	1.8			1.8	1.8
4. Brittas Demesne Area					
UGC Route4A South of Tower 251 to North of Tower 272 **(Approx 7.3km)**	7.3	7.3			
UGC Route 4B South of Tower 256 to North of Tower 272 **(Approx 5.5km)**	5.5		5.5		
UGC Route 4C Southeast of Tower 263 to North of Tower 272 **(Approx 3.2km)**	3.2			3.2	
5. Mullyash Uplands Character Area / Monaghan Way					
UGC Route 5A South of Tower 102 to North of Tower 126 **(Approx 5.8km)**	5.8	5.8			
UGC Route 5B South of Tower 102 to North of Tower 112 **(Approx 3.8km)**	3.8		3.8	3.8	
6. Cavan Highlands/ The setting of the Fair of Muff					
UGC Route 6A South of Tower 221 to North of Tower 236 **(Approx 5.5km)**	5.5	5.5			
UGC Route 6B South of Tower 224 to North of Tower 236 **(Approx 4.5 km)**	4.5		4.5		
UGC Route 6C Southeast of Tower 224 to North of Tower 231 **(Approx 2.7km)**	2.7			2.7	
UGC Option Total Length for Mitigation Assessment of Significant Landscape Impacts		**39.5**	**24.2**	**19.2**	**9.4**
		Longest routes from each Area	Next longest routes from each Area	Shortest routes from each Area	Shortest routes from areas in order of priority which meet the technical limitation of approximately 10 km

3.1.7 Step 7 – Describe and compare environmental impacts of partial UGC across multidisciplinary topics in respect of the identified optimal routes

47. For the identified UGC routes which are routes Boyne Valley route 1B; Blackwater Co. Meath route 2 and Benburb Area, route 3C, a multidisciplinary team has assessed all potential positive and negative environmental impacts (include landscape and visual impacts) associated with the potential UGC option. Specifically whilst the UGC option may be technically feasible it may however result in a more adverse environmental impact when compared to the OHL option. The multidisciplinary team assessed the potential for the mitigation of any negative environmental impacts for the identified routes.

3.1.8 Step 8 – Conclusion from the multidisciplinary assessment considering all environmental impacts (including landscape impacts) on the potential for partial UGC to mitigate significant adverse landscape impacts

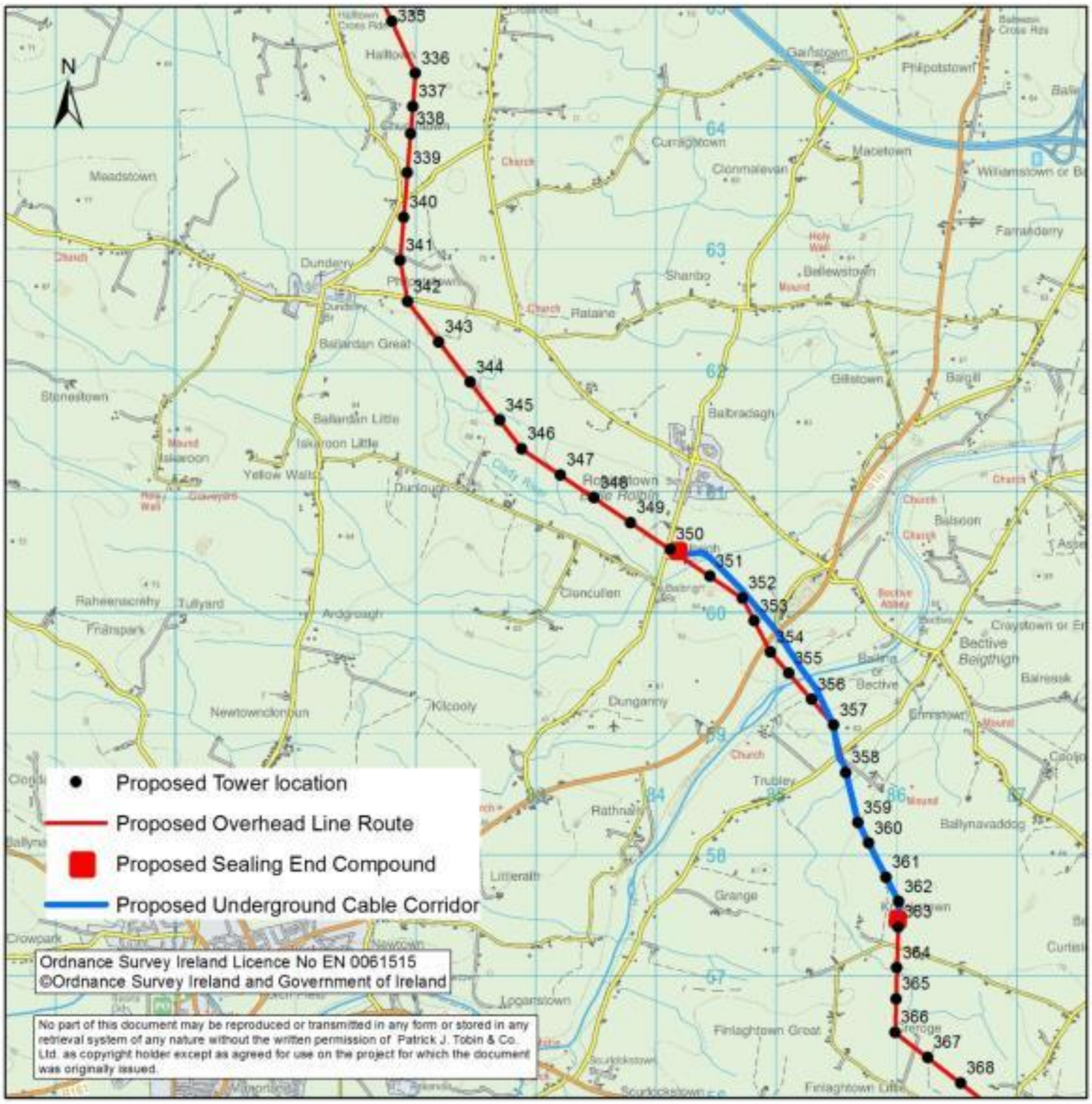
48. Following Step 7 the combined multidisciplinary team, including the engineering team, has set out the conclusions on the potential for partial UGC to mitigate landscape impacts, taking into account other environmental impacts of the partial UGC.

4 UGC SUBSECTION BOYNE VALLEY UGC ROUTE 1B: TOWER 350 - 363

4.1 INTRODUCTION

1 The potential UGC subsection brought forward for consideration at the Boyne Valley is subsection UGC Route 1B, from Tower 350 to Tower 363.

Figure 4-1 Boyne Valley UGC Route 1B Tower 350 to North of Tower 363 (Approx 3.9km)



4.2 TECHNICAL CONSIDERATIONS – UGC SUBSECTION UGC ROUTE 1B TOWER 350 - 363

4.2.1 Alignment Details

2 The potential UGC subsection brought forward for consideration in the area around the Boyne Valley is the shorter of the two potential routes considered. As described in Section 3, this allows for other locations potentially experiencing significant landscape impact to also be considered for a stretch of UGC. A UGC route from Tower 350 to tower 363 has the potential to mitigate significant landscape impact to a part of the Boyne Valley Landscape Character Area, the River Boyne, Scenic View 86 and the Boyne Valley Driving Route. The potential UGC Route 1B follows that of the proposed OHL route from Tower 363 to Tower 357 and the potential UGC route is very marginally off set from the OHL route from Tower 357 to Tower 350.

4.2.2 Road and River Crossings

3 Potential UGC Route 1B includes two roads crossings and a total of three river crossings, including 1 river crossing using horizontal directional drilling, at the River Boyne, and it is approximately 3.87 km in length.

4.3 AGRONOMY – UGC SUBSECTION UGC ROUTE 1B TOWER 350 - 363

4.3.1 Potential Impacts

4 The construction of the underground cable (UGC) would require fencing off a 22m wide swathe of land along the line of the UGC. Within the construction site the top soil would be stripped back, stored and spread over the site at the end of the construction period. The cables would be situated in excavated trenches 1m – 1.5m deep and the soil would be back-filled and levelled.

5 The potential impacts which would arise are;

- Damage to the soil profile. This would occur due to the construction traffic and excavation. The construction site would be re seeded following laying of the cables. Therefore at least one cropping season would be affected and it is possible that reseeded grassland may not come back into production until the following season. The damage to soil would be residual for the short – medium term (2 – 7 years);
- Damage to drainage systems. Where the line of the UGC encounters land drainage systems there is potential for causing damage to these systems;
- General construction disturbance to the farm enterprises. The actual construction site would be unavailable for a period of 2 – 6 months on most farms. The construction activity and land area reduction would disturb livestock and cropping programs and interfere with the day to day running of the farm. Because the construction site is a fenced off linear feature there is the potential to cause temporary severance to the farm;
- There would be residual permanent disturbance to the farm enterprise. The presence of an underground cable is an additional safety risk on the farm. Deep cultivations i.e. below normal plough depth would be restricted and land drainage or excavation above the cables would also be restricted;
- There would be a restriction on building or planting commercial forestry;
- The construction of sealing end compounds at each end of the UGC and joint bays every approximately 650m would increase the permanent land requirement for the construction of UGC.

4.3.2 Mitigation Measures

6 General mitigation measures for UGC construction are as follows;

- Landowners would be notified in advance of the commencement of construction;
- Fencing would be erected to exclude livestock from construction sites but the contractor would ensure that landowners have reasonable access to all parts of their farm during the construction phase;

- Disease protocols would be adhered to. As referenced in the ESB / IFA agreement the contractor would comply with any DAFM regulation pertaining to crops and livestock diseases;
- If rock breaking or pilling are required owners of livestock in fields adjoining the work site would be notified in advance;
- Temporary aluminium or timber plank or panel tracks would be used in certain situations to prevent damage to soil;
- Locally excavated material would be reinstated across the site following construction. All unused excavated fill would be removed from the site and disposed of at a licensed waste facility;
- Affected land drains would be redirected in a manner that maintains existing land drainage;
- Where top soil is stripped back it would be replaced. All disturbed field surfaces would be re-instated;
- Any losses or additional costs incurred by the landowner which are directly attributed to the potential development, during the construction phase or the operational phase, including additional necessary remedial works and including losses and or additional costs arising from Basic Payment Scheme, implementation of Nitrates Regulations and Agri Environmental Schemes would be paid to the landowner;
- Mitigation measures relating to potential effects on water quality and soil contamination due to fuel or concrete spillages are detailed in the outline Construction Environmental Management Plan for the proposed development i.e. the OHL.

4.3.3 Potential for this UGC section and Conclusion on Impact Significance

Construction phase impacts generally do not give rise to significant residual impacts because land use would not be affected after 1 – 2 cropping seasons. While the construction phase impact would be higher with UGC, the residual impact is generally low[6] except where there is additional land take due to the construction of sealing end compounds. The impacts along the Boyne Valley sub section are summarised in Table 4.2.

Table 4-1 Comparison of Overhead Line and Underground Cable Impacts on Land Use in the Boyne Valley Section

Impacts	Overhead	Underground
Number of land parcels affected[7]	6	8[8]
Area of land disturbance / damage (Ha)	5.1	13.3

[6] The evidence from Gas pipelines throughout Ireland is that residual impacts are low.

[7] Six of the affected land parcels were assessed in Chapter 3 **Volume 3D** of the EIS. Two additional land parcels are affected by the UGC route – these were not assessed in Chapter 3 **Volume 3D** of the EIS and are assessed here using aerial photography.

[8] Including one small non agricultural land parcel.

Area of land permanently restricted under OHL and UGC infrastructure (Ha)	0.62	1.5
Impacts on farm yards	1 high magnitude impact	No significant impacts
Impacts on forestry	No significant impacts	No significant impacts

7 The sealing end compounds are located in large land parcels otherwise the residual impacts could have increased from slight adverse to moderate adverse in these two land parcels. The residual impact reduced to imperceptible on one high sensitivity land parcel due to undergrounding the cable and moving it closer to the edge of the affected land parcel. Moving the UGC further from a farm yard reduced the impact on the farm yard, but the overall impact on this land parcel remained slight adverse. The decommissioning phase for the UGC would likely have as significant an impact as that of the construction of the UGC and again would be higher than that for the decommissioning of the OHL.

Table 4-2 Comparison of the Significance of Impacts on Land Use in the Boyne Valley Section

Impact Significance	**Residual Impacts**	
	OHL	**UGC**
	(Number of Land parcels)	
Imperceptible	0	2
Slight Adverse	6	6

8 Although there is an additional impact due to the sealing end compounds, the impact would not result in a significant change in the overall impact on these land parcels. This is because the compounds would be located in relatively large land parcels. There would be a reduction in impact on one high sensitivity land parcel. Therefore, overall, there is no preference in the Boyne Valley for either OHL or UGC from an Agronomy perspective.

4.4 ECOLOGY – UGC SUBSECTION UGC ROUTE 1B TOWER 350 - 363

4.4.1 Description of Ecological Receptors

9 The potential UGC section within the Boyne Valley area would be situated within two European sites (River Boyne and Blackwater cSAC, and the River Boyne and Blackwater SPA) which occupy a relatively similar area - the River Boyne riparian corridor.

10 The River Boyne and Blackwater cSAC qualifying interests include; River Lamprey *Lampetra fluviatilis,* [1106] Salmon *Salmo salar* (only in fresh water)*,* [1355] Otter *Lutra lutra,* [7230] Alkaline fens, [91E0] Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*).

11 The River Boyne and Blackwater SPA qualifying interest is [A229] Kingfisher *Alcedo* (breeding).

12 Each of these two sites are internationally important European sites.

Terrestrial Habitats

13 Terrestrial habitats within this UGC subsection include linear woodland habitats, deciduous woodland, riparian woodland and grassland verges.

14 The terrestrial habitats within this UGC section (outside designated lands) are considered to include habitats of high (local) value.

Aquatic Habitats/Species

15 Aquatic habitats at this location include the River Boyne and Blackwater cSAC, associated riparian habitat and local streams. Aquatic species within these habitats include in-stream aquatic fish (Salmonids, Lamprey and Brown Trout) and other in-stream fauna including Crayfish.

16 Local streams are likely to be of county value in terms of evaluation of aquatic habitat/ species or of high local value. The River Boyne forms part of the River Boyne and Blackwater SAC/SPA an internationally important European site.

Protected Fauna/Birds

17 The key target mammals potentially occurring within habitats which may be potentially affected by the UGC section are badger, otter and, to a lesser extent, bat species.

18 The River Boyne and Blackwater are designated as an SPA for breeding Kingfisher. Other scarcer bird species of conservation significance that may occur within the area of the potential UGC section

include Yellowhammer, Tree sparrow, Grey wagtail and Sand Marten. This is not a significant location for Whooper Swan hence the use of UGC to remove collision risk is not warranted.

4.4.2 Potential Impact

Terrestrial Habitats

19 Potential moderate/ high value habitats would be impacted including woodland, treelines and hedgerow. These habitats would require surveys such as field surveys, vantage point surveys, LiDAR surveys, review of aerial photography etc to inform evaluation and assessment of potential impacts.

20 The vast majority of the route is in arable and improved grassland of low conservation value.

21 A total of 19 identifiable hedgerows and treelines (including those associated with streams) would be crossed and 1 area of wider deciduous woodland. A minimum estimate of 418m of linear woodland would be permanently removed and 880m^2 of deciduous woodland.

Aquatic Habitats/ Species

22 The route crosses six identifiable water courses; three drains/ streams north of the River Boyne, The River Boyne and two drains/ streams south of the River Boyne.

23 There is an option to directionally drill these water courses; however all except the River Boyne would be culverted. Trenching or other construction approaches would lead to direct permanent impacts to water courses and riparian habitats.

24 A temporary significant pollution risk would arise during construction to protected aquatic species. This risk is related to the potential for increased suspended solids and fuel/ chemical spillages arising from construction works and storage/ removal/ reinstatement of disturbed soil and/ or the release of construction related pollutants.

25 The use of directional drilling would pose a low risk of potential impact from bentonite escaping during the process of directional drilling at the River Boyne crossing. This potential impact could result in adverse effects to qualifying Annex II species such as salmon and lamprey species which use the SAC.

26 A temporary significant disturbance risk would arise to Otter and Kingfisher (qualifying species) including the potential loss of resting or breeding sites (if present) in particular at non designated streams linked to the River Boyne.

27 There is ongoing operational risk of pollution and wildlife disturbance during operation if faults arise and further excavation works are required.

Protected Fauna/ Birds

28 The potential loss of habitats detailed would lead to potential loss of breeding and foraging sites and to loss of connectivity and fragmentation of linear woodland and stream habitats used by fauna. A potential barrier effect may occur due to permanent habitat clearway being in place.

Summary of Potential Impacts

29 Internationally important habitats would potentially be impacted. An Appropriate Assessment would therefore be required of the implications for the European site concerned with respect to a partial UGC option prior to its approval. The SAC and rivers linked to here require surveys such as field surveys, vantage point surveys, LiDAR surveys, review of aerial photography etc. to inform the evaluation and assessment of potential impacts. Detailed carefully considered mitigation, informed by best practise for reducing risk is therefore required.

30 The SAC and rivers linked within the area of the potential UGC section would require survey to inform detailed evaluation and assessment of potential impacts.

31 The only option available for installing the cable at the River Boyne is directional drilling under the river. The procedure to use this method of drilling could be undertaken in such a way so as to avoid the requirement for drilling launch and exit points occurring directly within the SAC/SPA lands.

32 It is likely that potential direct impacts to Annex I habitats can be avoided within the SAC based on a desk assessment. This would require confirmation with surveys. If potential direct impacts are unavoidable, they are likely to be permanent to allow for provision of a clearway to facilitate maintenance and fault repair.

33 A significant temporary pollution risk would arise during construction to protected aquatic species. This risk is related to the potential for increased suspended solids arising from construction works and storage/ removal/ reinstatement of disturbed soil and/ or the release of construction related pollutants.

34 There would be a low risk of bentonite escaping during the process of directional drilling at river crossings. This potential impact could result in adverse effects to qualifying Annex II species such as salmon species and lamprey species which use the SAC.

35 A moderate disturbance risk would arise to Otter and Kingfisher (qualifying species) including the potential loss of resting or breeding sites (if present) in particular at non designated streams linked to the River Boyne.

36 There would be ongoing operational risks of pollution and wildlife disturbance during operation if faults arise and further excavation works are required.

37 In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

4.4.3 Risk of Significant Adverse Impact

Terrestrial Habitats

38 Permanent habitat loss within the route of the UGC cannot be mitigated. Habitat connectivity would be permanently affected as hedgerows would be bisected by works area. The potential option for exploring compensatory habitat replacement would be advised in addition to mitigation (reduction of impact) measures.

Aquatic Habitats/ Species

39 There is a moderate/ possibly high risk of significant adverse impact and associated effects on aquatic species and habitats prior to mitigation as culverts would modify sections of stream habitat. This could affect available spawning habitat and culverts would require careful design to ensure they do not affect fish dispersal/ migration. Detailed carefully considered mitigation informed by best practise for reducing risk is required.

Protected Fauna/ Birds

40 There would be a potential moderate risk of significant adverse impacts and associated effects to protected mammals (Otter) and possibly Kingfisher (bird) breeding sites. The potential for habitat fragmentation and for a barrier effect cannot be avoided as permanent works area would bisect hedgerows.

41 Habitat fragmentation and barrier effects mean that species dispersal may be effected with a permanent track way across former hedgerows etc.

42 Mitigation measures are available to reduce impacts on fauna. Compensatory approaches, including for example habitat creation or artificial breeding sites, could be required dependent on the actual impacts.

4.4.4 Mitigation

Terrestrial Habitats

43 It would not be possible to avoid permanent impacts to terrestrial habitats. Compensatory mitigation outside designated sites. Habitats within European sites can be avoided. The main habitats of

ecological value impacted are hedgerows (approximately 418m) and deciduous woodland (approximately 880m^2). Compensatory mitigation approaches, including for example alternative habitat would be the only means to reduce this permanent loss of hedgerow/ woodland habitat in particular.

Aquatic Habitats/ Species

44 It would not be possible to avoid permanent impacts to stream crossings as culverts are likely to be required across streams crossed. There would be the potential for mitigation measures to minimise pollution risks and habitat loss to aquatic species.

Protected Fauna & Protected Birds

45 A survey would be required to confirm breeding sites of protected species. There would be potential scope to avoid protected mammal breeding sites. Mitigation would be available to minimise disturbance risk.

Summary of Mitigation

46 Mitigation of potential impacts would involve the avoidance of works within the River Boyne and Blackwater cSAC and the River Boyne and Blackwater SPA. Directional drilling and carefully managed pollution control measures with monitoring would reduce the potential risk of significant adverse effects. Route modifications would potentially be advised based on surveys such as field surveys, vantage point surveys, LiDAR surveys, review of aerial photography etc. that would be undertaken to assess the reduction of potential risks.

4.4.5 Risk of Significant Residual Adverse Impacts Post Mitigation

Terrestrial Habitats

47 The potential risk of significant residual adverse impacts to terrestrial habitats, post mitigation is Moderate and is dependent on mitigation and compensatory habitats.

Aquatic Habitats/ Species

48 The potential risk of significant residual adverse impacts to aquatic habitats is low. This assessment is based on reinstatement of river/stream habitats post works and some permanent loss of riparian vegetation along a relatively short length of stream at the crossing point.

Protected Fauna/ Birds

49 The potential risk of significant residual adverse impacts to protected fauna and protected birds, post mitigation is Low and would be dependent of confirmatory surveys.

50 Habitat fragmentation means there is a potential adverse effect to species dispersal and the potential for barrier effects associated with a permanent track way across former hedgerows.

51 **Summary of Residual Impacts**

52 In summary the risk of significant residual adverse impacts is Low to Moderate depending on the ecological receptor detailed. In summary the risk of significant residual adverse impacts is Low to Moderate depending on ecological receptor detailed. Residual risk to the River Boyne and Blackwater SAC/ SPA is low as mitigation for works of this nature are typically conducted in a successful manner.

4.4.6 Potential for this UGC section and Conclusion on Impact Significance

53 From an ecology context the partial UGC option, including the sites of the sealing end compounds, would present greater risks overall than OHL, during both the construction and operational phases, along the section under consideration in the Boyne Valley including the River Boyne crossing. Specifically when compared to OHL there is higher likelihood that the UGC option would have greater potential for significant adverse ecological effects including permanent habitat loss (outside European sites), and greater pollution risks (aquatic species – European sites) and disturbance (Otter and Kingfisher – European sites). There is no justification for partial UGC at this location from an ecological perspective.

4.5 SOILS, GEOLOGY & HYDROGEOLOGY – UGC ROUTE 1B TOWER 350 - 363

4.5.1 Potential Impacts

54 The main consideration is dealing with groundwater and excavation stability. 1B UGC Route is located adjacent to the Boyne groundwater dependant terrestrial ecosystem (GWDTE), cSAC and SPA. The construction of sealing end compounds, joint bays, trenching, and directional drilling would require additional excavations and dewatering adjacent to the cSAC.

55 Confirmation of soils and rockhead level is required to provide a robust design for the directional drilling element, in particular the identification of rockhead and/or identification of soft/loose materials. Tunnel boring can encounter difficulties with unexpected ground conditions and mixed face boring. The UGC route does not pass under any permanent buildings or structures therefore the potential impacts are reduced.

56 Additional soil excavation and disposal would be required in the event of undergrounding in these locations. The construction of the UGC would require fencing off a 22m wide swathe of land along the line of the UGC. Within the construction site the top soil would be stripped back, stored and spread over the site at the end of the construction period. The cables would be situated in excavated trenches 1m – 1.5m deep and the soil would be back-filled and levelled. Joint bays are typically 10m long, approx. 3m wide and approx. 2.5m deep. This risk is related to the potential for increased suspended solids arising from construction works and storage/removal/reinstatement of disturbed soil and/or the release of construction related pollutants. There are no known contaminated land issues in the area of the underground cable route.

57 It is anticipated that at certain locations, especially in the lower-lying areas, the groundwater table is shallow. Accordingly, groundwater controls may be necessary to manage shallow groundwater. In these areas it would be necessary to depress by pumping the groundwater level to maintain a dry operational area for installation of the underground cable. Dewatering of the excavation would depress the groundwater level in the vicinity of the excavation. Any impacts would be restricted to the short period of pumping. The extent of the impact of the dewatering depends on the hydraulic characteristics of the strata and the amount of drawdown of the groundwater level necessary to achieve the required dewatering. Any impact on the surrounding groundwater level reduces significantly with increasing distance from the point of abstraction. Due to the shallow excavations and the short term pumping, no significant impacts on the groundwater level would occur.

58 It is considered that the construction works would have minor effects on the geomorphology of the area, as the UGC would not materially change the local slopes and topography.

59 Potential impacts include groundwater impact adjacent to Boyne and Blackwater cSAC. There is also a low risk of drilling fluid escaping during the process of directional drilling at river crossings. Any impact could result in temporary adverse effects to qualifying interests to the Boyne/Blackwater cSAC. These impacts are further considered in the aquatic ecology and water sections.

60 The UGC route is located 30m from the Boyne County Geological Site (CGS). The directional drilling would be undertaken near the Boyne CGS, however the potential impacts are considered low and mitigation measures can ameliorate the potential impacts.

61 Operational impacts on geology and groundwater would be negligible. In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

Table 4-1 Excavation volumes -Boyne

Location	UGC – volume m^3	OHL – volume m^3
Boyne crossing	31,400	1,400

4.5.2 Mitigation Measures

62 Mitigation measures are similar to those for the OHL however the excavation volumes are increased, as shown above in Table 4.1. Measures to minimise the impact on local geology would include reuse of in situ material. However given the extra excavation works approximately 10,000 m^3 would be removed from the UGC route. All construction waste would be stored, managed, moved, reused or disposed of in an appropriate manner by appropriate contractors in accordance with *Waste Management Acts 1996-2013* (refer to Chapter 7, **Volume 3B** of the EIS). Excess soils/subsoils would require disposal at licensed /permitted waste management facilities. It is proposed to mitigate the potential impacts on the Boyne CGS. Soils and bedrock would be encountered during the site investigation works/construction of the UGC. The mitigation measures would be as per GSI agreed mitigation.

63 All excavated materials would be visually evaluated for signs of possible contamination such as staining or strong odours. In *the* event that any unusual staining or odour is noticed, samples of this soil would be analysed for the presence of possible contaminants in order to ensure that historical pollution of the soil has not occurred. Should it be determined that any of the soil excavated is contaminated, this would be dealt with appropriately as per the *Waste Management Act (as amended)* and associated regulations.

64 To minimise any potential impact on the underlying subsurface strata from any material spillages, all oils and fuels used during construction would be stored on temporary proprietary bunded surface (i.e. contained bunded plastic surface). Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles would take place away from surface *water* gullies or drains. No refuelling would be allowed within 50m of a stream/river. Spill kits and hydrocarbon absorbent packs would be stored in this area and operators would be fully trained in the use of this equipment.

65 Additional investigation works are required to design the directional drilling element of the works. In particular rock head needs to be determined. Tunnel boring can be complicated when unexpected ground conditions and *mixed* face boring are encountered. The potential bore route does not pass under any permanent buildings or structures; therefore, the potential impacts are reduced.

66 If groundwater is encountered, the water pumped would need to be discharged off-site, following treatment. The most likely destination for the discharge would be to the nearest watercourse or to a soakaway within the working area, subject to the ground conditions and approval by the relevant authorities. Accordingly, any groundwater intercepted in the excavation, which would have discharged naturally as baseflow to the watercourse would still discharge to the watercourse. As a result, it is concluded that there would be no significant adverse impact on the flow in watercourses as a result of any dewatering.

4.5.3 Potential for this UGC section and Conclusion on Impact Significance

67 Additional mitigation measures would be required to deal with the groundwater encountered during excavation work and directional drilling. In conclusion UGC would present a greater potential risk to soils and hydrogeology than OHL, however the overall potential impact is considered localised and minor.

4.6 WATER – UGC ROUTE 1B TOWER 350 - 363

4.6.1 Potential Impacts

68 The UGC route is located within the River Boyne catchment. The River Boyne cSAC (site code 002299) is a designated site for conservation which may potentially be impacted by the UGC Route 1B. A full description of the River Boyne and Blackwater cSAC (site code 002299) is detailed in the Natura Impact Statement (NIS). The Boyne cSAC is selected for species listed on Annex II of the European– Atlantic Salmon, Otter and River Lamprey. Within the study area, the River Boyne flows in an easterly direction. The River Bective and River Clady discharge to the river Boyne downgradient of the study area.

69 Atlantic Salmon and Trout use the tributaries of the Boyne/Blackwater as spawning grounds. Parts of the river system have been arterially dredged including the River Clady. Ongoing maintenance dredging is carried out along stretches of the river system where the gradient is low. The River Boyne and Clady is classified as currently being at Moderate Ecological Status, with the River Bective classified at Poor Ecological Status. Based on the available information, the majority of the Boyne catchment is 'at Risk of not achieving Good Status' in relation to Surface Water (1a status). It is proposed to restore the river to good status by 2021. Measures to address and alleviate these pressures are to be included in a formal programme of measures to be submitted to the European Commission. Agriculture, Wastewater Treatment Plants (WWTP) and septic tanks are thought to contribute over 90% of the total polluting matter to the Boyne catchment.

70 The construction activities associated with undergrounding would result in a corridor approximately 22m wide and 1.3m deep. The undergrounding corridor would include two 1.8m wide trenches placed approximately 3.2m apart and being serviced by an access track which is able to accommodate vehicles to transport cable drums weighing 45 tonnes or more, along with large cranes for offloading and equipment handling. In addition to the equipment used to dig the trench to facilitate cable laying, directional drilling under the River Boyne would be required.

71 Sealing end compounds link the overhead line to the partially undergrounded section. The cables are terminated using outdoor sealing ends (terminations) located in sealing end compounds. The size of the sealing end compound largely depends on the transmission capacity and protective installations that are required for the specific line. These compounds can often be screened to provide some visual mitigation. Each compound is approximately 1 hectare and would consist of an inner compound enclosing the live high voltage equipment, a small building, with a buffer strip around the compound to accommodate an earth berm and or vegetation for screening. The northern compound would be located within 100m of the River Clady while the southern compound is located 400m from the Bective River.

72 The OPW 'Flood Hazard Database' was used in order to obtain information on historical flooding events in the corridor. This information was used to establish the current baseline conditions in

terms of what sections of the area are liable to flood. Additional sources of information including internet searches, historical maps, data from Catchment Flood Risk Assessment and Management Studies (CFRAMs) and flood risk assessments were also consulted. No incidents of flooding were noted at compounds. The compounds are not located in flood prone areas and the preliminary flood risk assessment (PFRA) maps.

73 Suspended solids can potentially impact on surface water quality by clogging the gills of fish, covering spawning sites, leading to loss of habitats on the riverbed and stunt aquatic plant growth by limiting oxygen supplies, shelter and food sources. During the construction of the potential UGC Route 1B there is a risk of accidental fuel pollution incidences.

74 Due to the proximity of the minor ditch at the identified sealing end compound, moderate adverse impacts from silt laden runoff and the risk of chemical spillages are predicted with mitigation taken into account. Providing the mitigation measures as set out later in this Chapter are adopted, the potential effects on the River Boyne from silt laden runoff and spillage risk are slight adverse only.

75 Construction activities generally associated with the underground cable would be short term and transient in nature, occurring along the entire length of the UGC route. The UGC Route 1B would pass under the River Boyne, River Clady and River Bective, as well as a number of drains. Additional potential impacts arise from UGC particularly at the River Boyne / River Blackwater cSAC. Potential impacts include the diversion of numerous land drains and small streams connected to salmonid streams.

76 Additional soil excavation and disposal would be required in the event of undergrounding in these locations. This risk is related to the potential for increased suspended solids arising from construction works and storage/removal/reinstatement of disturbed soil and/or the release of construction related pollutants to the surface water environment. It may be necessary to divert sections of dry drains/drainage ditches where encountered thereby increasing potential sediment runoff. If excavations encounter groundwater, such inflows may need to be pumped, resulting in short term localised drawdown of the water table and discharges to the surface water channels.

77 Potential impacts include groundwater impact adjacent to Boyne and Blackwater cSAC. There is also a low risk of drilling fluid escaping during the process of directional drilling at river crossings. Any impact could result in temporary adverse effects to qualifying interests to the Boyne/Blackwater cSAC.

78 It would not be proposed to discharge wastewater from compounds.

79 Operational impacts on surface water and groundwater water would be negligible. In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts on surface water and groundwater would be expected to be as

significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

4.6.2 Mitigation Measures

80 Additional mitigation measures would be required to deal with the longer construction periods and the larger excavation volumes involved.

81 The use of directional drilling for the crossing of major water courses would be required. Diversion of watercourses should be avoided where possible to minimise disruption to aquatic ecosystems. In relation to stream crossings, and directional drilling, IFI approval would be required regarding the specification and timing of installation. Short sections of drainage ditches may need to be culverted with the potential for sediment discharge. It is not necessary to ford any streams or rivers as part of this development. All in-stream works should be carried out during the period May to September and in accordance with the Eastern Fisheries Board (2004) Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites.

82 Water quality monitoring would be undertaken prior to the commencement of construction to confirm baseline data and ensure there is no deterioration in water quality. This would be targeted on watercourses considered to be at a higher risk of pollution (i.e. towers where there are watercourses within 20m of the construction works). Water quality monitoring would include daily inspection of adjacent watercourses.

83 Disturbance of bankside soils and in-stream sediments would be kept to the minimum required for the cable laying process. Banks and stream beds would be reinstated in a manner that would minimise the potential for erosion and return the river/stream to as close to its original condition as possible.

84 Implementing the design standards of the GDSDS, the surface water drainage system at the compounds would take into account the recommendations of the GDSDS and utilises SuDs (sustainable urban drainage) devices where appropriate. Runoff from the hardstand areas at the sealing end compounds would be limited to greenfield runoff rates.

4.6.3 Potential for this UGC section and Conclusion on Impact Significance

In conclusion, notwithstanding mitigation measures, UGC would present a minor adverse impact on the River Boyne compared to a negligible impact from the OHL.

4.7 TRAFFIC – UGC ROUTE 1B TOWER 350 - 363

4.7.1 Potential Impacts

85 In order to assess the potential traffic impacts and effects, it is first necessary to consider the construction methodology envisaged and secondly to assess the locations along the cable route where the potential exists for traffic disruption. The likelihood of full or partial road closure is assessed followed by the determination of feasible diversion routes required due to the construction works. Possible mitigation measures along national, regional and/or local roads are also considered.

86 For a project of this size, some disruption to traffic would occur during construction. However, the Construction Phase Traffic Management Plan would minimise and reduce any possible construction impacts associated with traffic diversions and road closures.

87 The UGC route covers approximately 3.87km running between Tower 350 (L40071) and Tower 363 (L22051). For the purpose of the assessment the study area relates to the roads where the permanent accesses are to be located. The study area consists of a one regional road crossing, one local road crossing and one unclassified road crossing, specifically:-

- R161;
- L2203; and
- Unclassified Road adjoining L2203.

88 The section of UGC also includes crossings totalling six streams and rivers.

89 The construction of the UGC results in a corridor width of between 20-22m along the length of the UGC route. This corridor would contain two number trenches for cable ducts and sufficient working width for plant and machinery.

4.7.1.1 Cable Construction Methodology General Comments

90 Minor temporary disruption to traffic is envisaged during construction and installation of the cable. Where the cable crosses an existing carriageway on the R161 Regional Road, the construction of the UGC route would utilise temporary lane closures (the closure of one traffic lane) with the implementation of a Stop/Go traffic management system. This method facilitates the flow of traffic past the works on the existing road network. Once one half of the carriageway crossing has been constructed, works would commence on the remaining portion of the carriageway while allowing traffic to pass on the section of carriageway previously completed.

91 In the instance of the L2003 and the unclassified road adjoining the L2203, the width of the road is such that lane closures would not be possible at the location of the UGC crossing. Therefore these

sections of the road would be closed for the duration of the carriageway crossing construction with diversions in operation. From traffic survey data obtained in 2013 the L2203 has an average daily traffic flow of 757 vehicles, (refer to Table 13.3, **Volume 3B** of the EIS) hence the impact would be minimal.

92 The majority of construction generated traffic associated with the UGC route would result from additional material deliveries, such as additional concrete truck deliveries, and the removal of surplus material from the proposed routes, resulting from excavation of the UGC route.

93 Similar to the overhead line construction it is expected that construction traffic volumes would have a maximum daily flow of 340 vehicles (refer to Appendix 13.1, **Volume 3D** of the EIS), and peak hour calculation on the basis of a 12 hour working day relating to 46 vehicles per hour. i.e. 13 in and 13 out (refer to Table 13.5, **Volume 3D** of the EIS and Appendix 13.1, **Volume 3D** of the EIS). However, it should be noted that this is a maximum daily flow expected to occur with deliveries of materials/ equipment and does not represent a sustained daily flow throughout the construction period.

4.7.1.2 Spoil

94 In terms of spoil material to be removed from site there are three possible sources:

- Cable trench;
- Joint bays; and
- Sealing End Compounds.

95 Similar projects carried out by National Grid have indicated that the volume of spoil excavated for an underground cable where two cables per phase are installed is some 14 times more than for an equivalent above ground route.

96 For comparative purposes the above ground construction methodology generated:

- Tower 350 – 300 tonnes of spoil equating to 17 trips off site (18 tonne loads); and,
- Tower 363 – 300 tonnes of spoil equating to 17 trips off site (18 tonne loads).

97 Therefore on this basis the volume of spoil for the underground cable would see an increase to 238 trips off site from the access to Towers. It should be stressed however that these are worst case maximum trips off site and where possible spoil would be backfilled and compressed. Furthermore the increase of spoil output would be offset by the reduction in concrete, stone and steel deliveries that would be required for the above ground construction. Therefore daily volumes of heavy goods

vehicles are likely to remain at a similar level to that of the above ground construction at both access points. Again as noted above construction traffic volumes would be limited to a maximum daily flow of 200 vehicles.

98 As per the above ground methodology, licensed landfill sites would be used to dispose of waste spoil from the construction.

99 Due to volume of spoil to be removed off site, wheel cleaning facilities would be provided for relevant vehicles.

4.7.1.3 Typical Construction Vehicles

100 As per the above ground tower construction it is expected that the same vehicles would be employed for the UGC construction, specifically:-

- Fastrac with low loader trailer: - This vehicle would represent the majority of the construction vehicles and would be responsible for delivery construction apparatus e.g. dumper/ excavator/ rock breaker, delivery of cable drums, delivery of precast concrete components/ Cement sand materials, delivery of any steel materials.

- Tipper Lorry (22 tonnes):- This vehicle would be used to deliver stone material if required and may be used to transfer excess spoil from the site.

- Concrete Lorry (8m^3):- In the instance of the joint bay construction and the Sealing End Compounds these vehicles would be employed to deliver the concrete. Where conditions on the associated access track adjacent to the UGC trench are not suitable for the concrete lorry, they would off load onto a dumper which would then ferry the concrete to the required location.

- Transit type van: - staff would be transferred to the construction works from the temporary construction material storage yard, Carrickmacross, County Monaghan.

4.7.1.4 Sealing End Compounds

101 The UGC route would require a Sealing End Compound at either end of the UGC section, with one located adjacent to the L40071 and one adjacent to the L22051. These compounds are required to carry the cables from the underground duct to the adjacent tower. Such compounds would be accessed via a permanent access road for routine inspection and maintenance. During the construction of the sealing compounds, an increase in traffic to and from the site at these locations would be on the local road network. During operation of the cable development, traffic impacts associated with routine inspection and maintenance are envisaged to be negligible.

4.7.1.5 Rivers

102 The UGC route crosses a total of six streams and rivers. The river crossings would be by means of directional drilling. This technique may result in extended construction times associated with the procedure, which may increase traffic to and from both sides of the stream / river crossings. It is envisaged that as a result of the operations, local area traffic would experience an increase in site traffic for the duration of the river crossing process.

4.7.1.6 Operational/Decommissioning Phase Impacts

103 Operational impacts on traffic would be negligible for a partial underground route with the exception should there be a need to repair a fault and in such cases the impact would be temporary, albeit if the repair needs to be affected underneath a road crossing road closures may be required. In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential traffic impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

4.7.2 Mitigation measures

104 During construction, the main impacts along the route of the UGC would be temporary lane closures on the R161, temporary traffic diversion along a combination of the existing local road and regional road network can be facilitated. This approach should keep impact on traffic to a minimum without significant affect to local journey times with short-term access restrictions.

105 The limitation of daily traffic to a maximum of 200 vehicles per day (or average of 17 vehicles per hour based on a 12 hour day), associated with the construction of the towers, equates to a 2.2% impact in the peak flows along the L2202 and a 0.2% impact in the peak flows along the R161. Therefore while it is expected that the UGC construction would employ similar levels of construction traffic and that traffic impacts are still considered negligible, the duration of traffic impact would be considerably extended in the case of UGC construction.

106 A Construction Traffic Management Plan (TMP) would be employed by the main works contractor, prior to construction, in consultation with the Local Authority. The plan would outline minimum working practices on public roads, details on traffic management arrangements, temporary road/ lane closures and arrangements for communicating details of diversion routes, vehicular movements and restrictions to members of the public and affected landowners. The construction TMP would also include details related to working hours, parking and access arrangements onto the existing road network.

107 The implementation of the Construction TMP would ensure that local traffic flows as freely as possible with Two-way traffic being maintained wherever possible on wider roads.

108 With regards to the crossing of the access road (Adjoining L2203), a temporary road closure of this road would result in loss of local access in order to facilitate construction along the existing *cul de sac* road. However, this road is limited to low traffic volumes (one number farmyard operation on access road adjoining L2203). Construction of the UGC route at this location could be facilitated by consultation with local road users. This method would result in a significant temporary impact to local traffic.

109 The duration of partial/temporary or full road closures would be kept to a minimum in order to reduce impacts on local road traffic. All closures would be discussed and agreed with the Local Authority in the development of the Construction TMP. Where temporary road closure is required, a temporary diversion route would be agreed and provision at such locations for access by residents and deliveries would be maintained as far as reasonably possible.

110 Traffic Management would be undertaken at the site access, e.g. large construction vehicles such as the Fastrac with low loader trailer would be limited to left in and left out manoeuvres.

111 Shuttle running traffic management on the adjoining road, i.e. to facilitate materials being transferred from the site access to the construction area, would also be employed where necessary.

4.7.3 Potential for this UGC section and Conclusion on Impact Significance

112 The above assessment demonstrates that the construction of a section of UGC can be facilitated in the Boyne Valley area. However, the traffic impacts associated with the UGC route are more significant on a local level when compared to an overhead line route in terms of increased traffic volumes associated with the construction of the UGC route in both the immediate locality and further afield towards neighbouring towns and villages.

113 In conclusion, the construction of this underground section of the proposed transmission line would employ similar levels of construction traffic; however the duration of traffic impact would be considerably extended in the case of UGC construction and also for any potential decommissioning phase. Therefore, from a traffic impact perspective, there is no reason to consider the undergrounding of sections of the proposed development.

4.8 CULTURAL HERITAGE – UGC ROUTE 1B TOWER 350 - 363

4.8.1 Potential Impacts

114 Over the course of the project detailed GIS mapping has been compiled and forms the basis of this evaluation. The GIS mapping to date includes designated archaeological and architectural sites, historic mapping, aerial photography and LIDAR surveys. Undesignated sites, such as demesne landscapes, aerial and cartographic anomalies, and sites noted during fieldwork have also been added to the mapping. This data has been augmented with detailed documentary research, toponym analysis, a review of the topographical files held by the National Museum of Ireland (NMI) and the results of previous excavations as contained on databases hosted by *excavations.ie* and the National Roads Authority.

115 In summary, this option includes two sealing end compounds areas and a UGC route all to be constructed in greenfield areas. The potential UGC route and sealing end compounds would not physically impact on any designated archaeological or architectural sites. In the north, the UGC route passes within approximately 200m of an enclosure (SMR No. ME031-017). There could be associated archaeological deposits in the vicinity that could be negatively impacted on by the development. Further analysis of aerial photography indicates that the enclosure could be associated with a concentration of possible archaeological sites located to the east of the monument (Boyne04). This possible archaeological complex, along with a number of other sites of archaeological potential, were noted in the vicinity of the UGC route following a review of aerial photographs. The potential impact of the UGC route on these sites is discussed in Table 4-6. Where sites have been noted in the EIS for the Overhead Line (OHL) development their MSA_CHS reference numbers have been included.

116 The nearest designated architectural site is Balbrigh Bridge (RPS No. MH031-101), which is located approximately 230m to the south of the sealing end compound at the northern end of the UGC route. During this appraisal it was noted that there is an apparent disparity in the extent of Rathnally demesne landscape as indicated on the first edition OS maps. The colour version of the map indicates that the demesne landscape does not extend as far as the proposed OHL development, stopping approximately 1.25km to the west. The colour map is the source that has been used to complete the OHL EIS. However the black and white map appears to indicate that the demesne extends much further and that both the OHL and UGC routes cross its eastern extent. The core of the demesne is located approximately 1.75km to the west of the OHL development. The impact of the UGC route would consist of the removal of a section of hedgerow which may be the demesne boundary. There are no demesne features noted in the vicinity of the UGC route and the significance of this impact would be slight to imperceptible. It is assumed that the rivers would be crossed using directional drilling. Although this mitigates potential impacts relating to archaeology within the river and in its immediate environs, there is still the potential of encountering archaeological deposits at the work sites on either side of the river. It is noted that the Outline Construction Methodology says that these areas would be stripped and that interceptor trenches would be excavated between these areas and the river.

Table 4-6 Potential Impacts of UGC on previously unrecorded sites of archaeological potential

CHS Ref.	Description	Impacts
Boyne01	River Crossing Clady River	Riparian zones can be areas of high archaeological potential. It is noted that there is an enclosure (SMR No. ME031-017) approximately 300m to the south and a potential archaeological complex (Boyne04) visible on aerial photography approximately 300m to the south east of the river crossing. There is a moderate to high potential that construction of the UGC could have a negative impact on associated archaeological deposits or stray finds.
Boyne02	Field Boundaries	The first edition (OS) mapping indicates the presence of relict field system on the southern side of the Clady River. The remnant mounds, indicative of the location of these old field boundaries, can be seen in Bing aerial photography. Given their location adjacent to a river and between the river and an enclosure to the south (SMR No. ME031-017), with a potential archaeological complex to the south east (Boyne04) there is a moderate to high potential of negatively impacting on associated archaeological deposits.
Boyne03	Trackway	Historic mapping and aerial photography indicate the presence of a trackway to the south of the Clady River. Aerial photography appears to indicate that this trackway continues to the east across adjacent fields, where a field boundary is indicated on the first edition OS map. It is possible that this is a relict trackway that linked to Bective Abbey. It is noted that the trackway also follows a curvilinear route 80 to 100m to the south of the potential archaeological complex noted at Boyne04. The UGC route could have a negative impact on associated archaeological deposits.
Boyne04	Archaeological Complex	Recent aerial photography made available by Bing and Google indicates the presence of a potential archaeological complex to the east of the UGC route. The closest visible element of the complex consists of three circular features approximately 10m in diameter located approximately 150m to the east of the UGC route. Further to the east is an oval area approximately 135m east west by 75m north south which contains a series of similar circular shapes as well as larger enclosing elements. Further east again, approximately 500m from the UGC route, is a site which is approximately 35m in diameter and consists of three concentric circles of equally diminishing diameter. These sites are evidence of a potentially extensive archaeological complex extending over

		an area of at least 440m east west. The complex is located on elevated, flat ground above the Boyne River and adjacent to the Clady River, which is a tributary to the Boyne. It is noted that at this point the potential UGC Route 1B passes between the potential archaeological complex and an enclosure (SMR No. 031-017), which is located approximately 200m to the west. Although there are no features visible along the UGC route at this point, this is an area of very high archaeological potential and construction of the UGC Route 1Bhas a high potential of having a negative impact on associated archaeological deposits.
Boyne05 (MSA_CHS115)	Depression	Approximately 60m to the east of the UGC Route 1B there is what appears to be a depression that is subject to waterlogging. This site was not thought to be archaeological in nature, however given the frequency of anomalies and features in the surrounding area there is the potential that there could be archaeological deposits associated with the site which may be negatively impacted on by the 1B UGC route.
Boyne06	Aerial Anomalies	Approximately 60m to the west of the potential UGC Route 1B are anomalously shaded features which are evident in recent aerial photography made available by Bing and Google. There is the potential that these could be archaeological features. Although the 1B UGC route would not impact on the features they are testament to the high archaeological potential of the area.
Boyne07	Aerial Anomaly	Approximately 100m to the west of the UGC Route 1B is an anomalous shaded feature which is evident in recent aerial photography made available by Bing and Google. There is the potential that this could be an archaeological feature. Although the UGC Route 1B would not impact on the feature it is testament to the high archaeological potential of the area.
Boyne08 (MSA_CHS117)	Tree Copse	A copse of trees is located on the north side of the Boyne River approximately 130m to the west of the 1B UGC route. The site has been noted as a circular tree copse since the time of the first edition OS survey. It is possibly a demesne feature, given its location within the eastern extent of the

		Rathnally Demesne, but it may also have an archaeological provenance. The UGC route 1B would not impact on the feature.
Boyne09	River Crossing Boyne River	At this point the UGC Route 1B crosses the Boyne River. Rivers can be areas of high archaeological potential and the Boyne River valley, in particular, has played a prominent role in Ireland's history and has a rich history of settlement. It is noted that this UGC route involves tunnelling under the river with directional drilling. Nonetheless, given the proximity of trenching and tunnelling works to the river and the requirement for topsoil stripping an extended area to facilitate these works, there is still a moderate to high potential that archaeological deposits could be negatively impacted.
Boyne10	Weir	A weir is noted approximately 10m upstream from the crossing point of the Boyne River. The UGC route 1B would not impact on the weir.
Boyne11	Enclosure	Recent aerial photography made available by Bing and Google indicates the presence of a potential enclosure approximately 150m to the west of the UGC route 1B. The UGC would not impact on the potential archaeological sites however it is testament to the archaeological potential of the area. There is a moderate potential the cable route could negatively impact on associated archaeological remains.

117 The potential UGC Route 1B would impact on a number of Townland Boundaries. Townlands are the smallest administrative land divisions used in Ireland and are in fact the only surviving administrative structure with a continuous history of development going back to medieval times if not earlier. Irish townlands generally relate not to settlements, but land units and as such they acquired legal title at an early date. They are the basic divisions of the countryside and were carefully recorded in the maps and books that accompanied the great land transfers of the 17th Century. The UGC Route 1B would have a negative impact on the following townland boundaries:

- Knockstown / Trubley
- Rathnally / Dunganny
- Dunganny / Ballbrigh

118 There would be no significant impacts on archaeology and cultural heritage during maintenance. In the event that a cable route section is to be decommissioned, potential impacts on cultural heritage

would likely be less, than for the construction phase, as any cultural heritage features previously directly affected would already have been removed or preserved in-situ during the initial construction phase. Any impacts to setting during maintenance or decommissioning would be temporary and not significant.

4.8.2 Mitigation Measures

119 A review of recently available aerial photography along the 1B UGC route indicates the presence of a number of anomalies in the form of circular crop marks in close proximity to the 1B UGC route. In particular there is an area of high archaeological potential in the north of the 1B UGC route that is testament to the archaeological sensitivity of the Boyne River valley. Given the sensitivity of the Boyne River valley, should the 1B cable route proceed as designed, a survey such as a geophysical survey, should be undertaken of all greenfield areas which would be impacted on to feed into a regime of predevelopment archaeological testing. Any such geophysical survey should include the entire extent of the corridor for the UGC as well as the sealing end compounds. The results of this survey should inform a targeted regime of archaeological testing to be conducted under licence to the National Monuments Service of the Department of the Arts Heritage and the Gaeltacht and the National Museum of Ireland. The regime of archaeological testing would include the entire cable corridor as well as targeted testing in areas highlighted in the geophysical survey. The purpose of the regime of archaeological testing is to ascertain the nature and extent of archaeological deposits within the cable corridor. Having accomplished this, in consultation with the National Monuments Service and other relevant stakeholders, the routing of the cable trenches within the wayleave would be adjusted to ensure that impacts on the archaeological heritage are kept to a minimum. Where deemed necessary by the archaeological consultant, in consultation with the relevant authorities, portable trackway mats would be used during the construction phase to minimise ground disturbance.

120 A record would be made of each of the areas where the potential UGC Route 1B impacts on townland boundaries. The record in each instance would consist of a written description of the setting, profile and fabric of the townland boundary, accompanied by photographs, and plans and sections where necessary.

4.8.3 Potential for this UGC section and Conclusion on Impact Significance

121 The Boyne River valley has a long history of settlement and activity and is Leinster’s main waterway. Among the most notable heritage sites associated with the Boyne is the World Heritage Site of Brú na Bóinne, an area within the bend of the Boyne which contains one of the world’s most important prehistoric landscapes. It is also notable that the UGC Route 1B is located between the major historic urban centres of Trim and Navan, with the Boyne River providing a convenient transport link between the two. As such the river valley itself must be seen as an area of archaeological potential. Its sensitivity has been borne out by this appraisal, where recent aerial photography has highlighted a previously unrecorded potential archaeological complex.

122 It should be noted that, when considering the two proposed construction methodologies, there are competing interests within the disciplines of archaeological and architectural heritage.

123 Architectural heritage is almost exclusively comprised of upstanding structures that are sensitive to impacts on setting. UGC construction, with its considerably reduced visual influence, significantly reduces the potential for impacts on setting. For large scale electricity infrastructure in rural areas, such as that being proposed, avoidance of direct physical impacts on designated architectural sites is usually feasible, as architectural heritage sites tend to be clustered in and around urban centres while being sparsely distributed in rural areas. Where direct physical impacts are unavoidable there is a potential that these impacts can be mitigated. For example, a section of demesne wall may be dismantled and reconstructed on a floating foundation following construction of the UGC.

124 The evaluation of the proposed OHL noted three architectural sites that would experience impacts on their setting from the proposed development in the vicinity of the UGC Route 1B, including Bective Abbey (RPS No. MH031-107), Bective Bridge (RPS No. MH031-108) and Bective Bridge Saw Mill (RPS No. MH031-105). It was found that Bective Abbey would experience an impact of moderate significance on its setting, while Bective Bridge and Bective Bridge Saw Mill would experience impacts on their setting that would be of slight to moderate significance. Were the UGC Route 1B is to be constructed then there would be no impacts on the settings of these sites. There would be an impact on the demesne boundary of Rathnally demesne landscape of slight to imperceptible significance. From an architectural perspective the preferred project solution would be UGC.

125 Public perception of archaeological heritage often relates to the prominent upstanding archaeological monuments, which are predisposed to impacts on setting, such as Bective Abbey. Where these are the only archaeological sites, then UGC may be the preferred construction technique. However, there can be dense areas of previously recorded archaeological sites along with other environmental or physical constraints along a route, making it difficult to avoid all known archaeological monuments when designing an UGC. OHL construction, with its flexibility of tower placement and greatly reduced physical footprint, can often avoid known archaeological monuments without difficulty. The potential to impact on previously unrecorded archaeological monuments is greatly increased when constructing an UGC. When archaeological monuments, be they previously recorded or not, fall within the route of a UGC, then the worst case scenario impact would result in the destruction of part or all of the associated archaeological deposits; this impact is permanent and irreversible.

126 The evaluation of the OHL in the vicinity of the UGC Route 1B found that there would be negative impacts of moderate significance on Bective Abbey (National Monument No. 187) and an enclosure (SMR No. ME031-017). There were also negative impacts of slight to moderate significance on a ringfort (SMR No. ME031-025), Bective Bridge (SMR No. ME31-042) and a barrow (SMR No. ME037-30). Were the UGC Route 1B to proceed, there would be no long term impacts on the settings of these sites, except for the enclosure (SMR No. ME031-017), which would likely still experience an impact of slight to imperceptible significance on its setting following construction of the sealing end compound. In general terms, impacts on the setting of the cultural heritage resource

could be significant during the UGC construction phase and immediately thereafter, reducing to imperceptible with time during the operational phase as vegetation is re-established. There would be no direct physical impact on any designated archaeological monuments.

127 Given the presence of known cultural heritage sites in the surrounding area and the location of the UGC Route 1B in the Boyne River Valley, along with the presence of the newly identified cropmarks and anomalies, this UGC Route 1B should be considered sensitive from a cultural heritage point of view. Predicting the level and extent of the buried and unknown cultural heritage resource is difficult by virtue of the fact that these sites are not easily detectable in the absence of additional surveys such as field surveys, vantage point surveys, LiDAR surveys, geophysical surveys, review of aerial photography etc and without further investigations. Therefore there remains the potential for the discovery of additional cultural heritage sites.

128 While it is not possible to ascertain for certain the potential for impacting directly on previously unknown archaeological remains, it is nonetheless considered that there is a greater risk of impacting on these remains during construction of an UGC than the proposed OHL. Any direct impact would also be permanent and irreversible. Although the OHL option would have a greater impact on the setting of cultural heritage sites, it would be preferable to an UGC option at this location as it is likely to generate fewer direct, physical, irreversible impacts on the non-renewable cultural heritage resource.

4.9 LANDSCAPE – UGC ROUTE 1B TOWER 350 – 363

4.9.1 Potential Impacts

129 The UGC Route 1B corridor crosses through the Boyne Valley Landscape Character Area which is described as being of high sensitivity in the Meath Landscape Character Assessment. However, as the valley is relatively flat, the river is only visible in its immediate vicinity and at bridge crossings. The corridor crosses a local road at Trubley and the R161 south of Robinstown. The local road at Trubley forms part of the Fáilte Ireland promoted Boyne Valley Driving Route. Scenic View 86, as listed in the Meath County Development Plan, looks south from Bective Bridge. Wide views over the landscape to the south are available from parts of Bective Abbey. A large GAA training facility has been constructed adjacent to the R161. Fields are generally medium sized and bound by hedgerows of varying height and condition. However, closer to the river Boyne and particularly in the townland of Trubley, the landscape consists of large open fields with few hedgerows. There is a narrow strip of woodland along the northern banks of the river Boyne. The landscape also contains dispersed houses and farm buildings along with the small settlement of Bective and the larger village of Robinstown.

Table 4-7 Summary of effects of elements of Partial UGC.

Note: Unless otherwise stated, effects are considered adverse. Ratings of significance have not been given as this is a high level appraisal.

Element	Landscape effects	Visual effects	Period of impact
Sealing end compound	*	*	Construction / Operation
Sealing end compound screening	* (positive)	* (positive)	Operation
Soil excavation and storage	*	*	Construction /decommissioning
Haul road	*	*	Construction /decommissioning
Vegetation removal	*	*	Construction /decommissioning
Reinstatement of shallow-rooting vegetation	* (positive)	* (positive)	Operation
Permanent removal of trees and hedgerows	*	*	Operation
Construction machinery		*	Construction /decommissioning
Maintenance machinery		*	Operation
Fencing		*	Construction
Changes to drainage pattern	*	*	Operation
Manholes at 600-900m intervals		*	Operation
Vegetation changes arising from drainage changes	*	*	Operation
Cross-directional drilling	*	*	Construction

130 The northern sealing end compound is located in relatively flat agricultural lands with a strong hedgerow pattern. There would be views of the sealing end compound from the adjacent local road in the immediate vicinity. There may be longer distance views from the houses on the southern side of Robinstown which look south. However there are a number of hedgerows between the settlement and the potential sealing end compound sites. Screen planting could be successfully established in this area.

131 The southern sealing end compound is located to the north of a local road at Knockstown. A track runs from the local road to approximately 100m to the west of the sealing end compound site. There are relatively few roads in this area between Kilmessan and the Boyne and the most open public views of the sealing end compound site would be from the looped local road at Knockstown.

4.9.2 Mitigation Measures

132 Mitigation measures include (following the construction period) removal of all soil storage mounds, fencing and reinstatement of vegetation within the parameters of the rooting restrictions over the trench. Screen planting of up to 5m would be provided around each sealing end compound which within 10-15 years would have reached a height where the structure starts to become visually absorbed into the wider hedgerow pattern.

4.9.3 Potential for this UGC section and Conclusion on Impact Significance

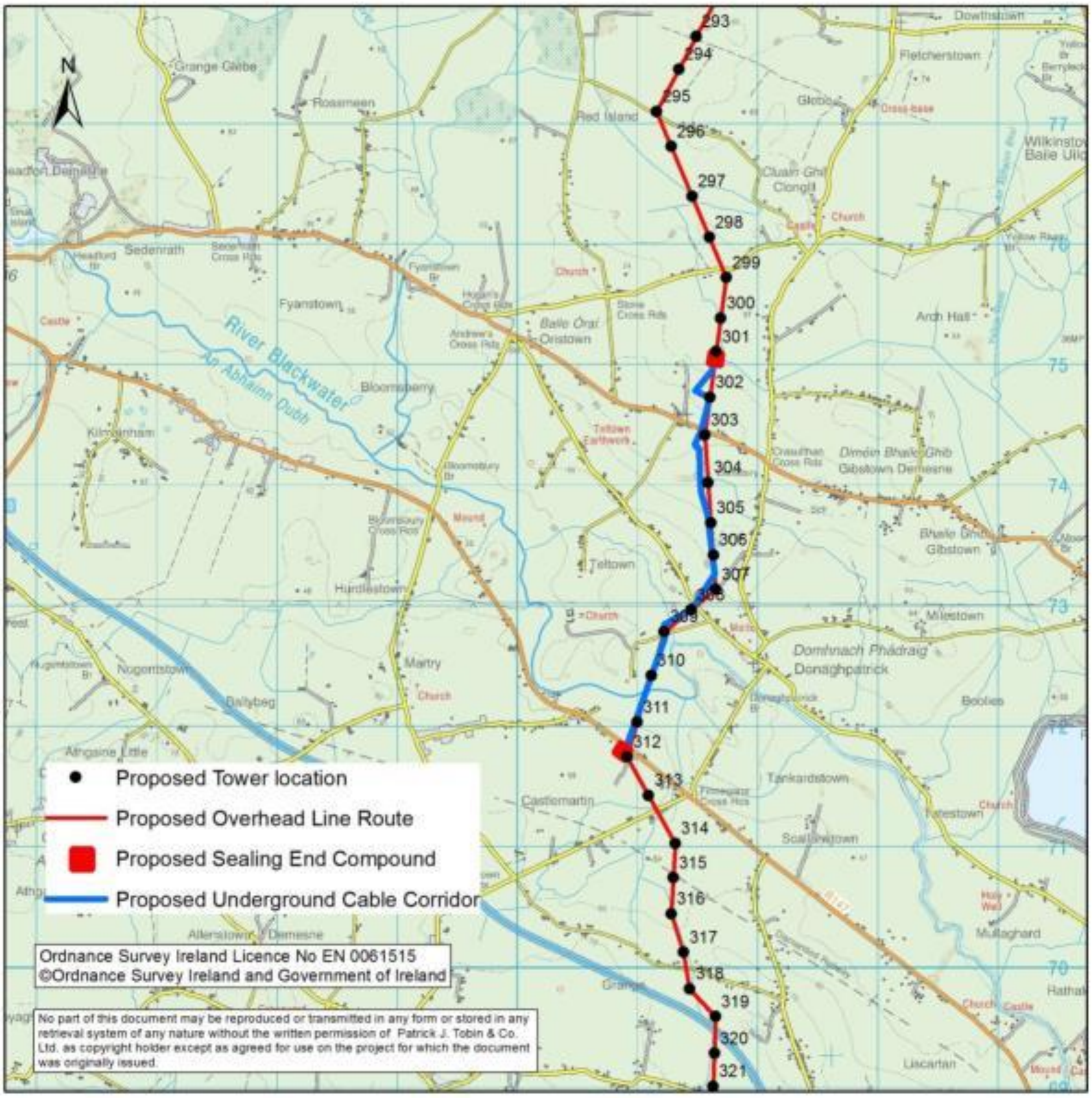
133 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along the lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. An approximate 10m width of trees on the northern side of the Boyne River would be permanently removed, along with 10m wide strips of hedgerows along the entire length. Up to 22m widths of vegetation would be removed for the construction period and reinstated vegetation would take a number of years to establish. Hedgerow removal would be most readily experienced by viewers where the UGC corridor crosses a road. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC Route 1B, the overall landscape and visual impact of UGC Route 1B is less than that of the OHL in this location.

5 BLACKWATER VALLEY (UGC ROUTE 2: TOWER 301 - 312)

5.1 INTRODUCTION

1 The potential UGC route brought forward for consideration in the area around the Blackwater Valley is from Tower 301 to Tower 312 (UGC Route 2).

Figure 5-1– Blackwater Valley UGC Route 2 Tower 301 to Tower 312 (Approx 3.8 km)



5.2 TECHNICAL CONSIDERATIONS – UGC ROUTE 2 TOWER 301 - 312

5.2.1 Alignment Details

2 There is only one potential UGC subsection considered in the area at the Blackwater Valley, Co Meath. UGC Route 2 has the potential to mitigate the impacts to a number of receptors clustered in the area including the Boyne Valley Driving Route, Blackwater River, the Blackwater Valley Landscape Character Area, the Teltown Archaeological Landscape and Donaghpatrick. The potential UGC Route 2 closely follows the route of the OHL in the vicinity with some minor off sets from the route of the proposed OHL route.

5.2.2 Road and River Crossings

3 Potential UGC Route 2 includes four roads crossings and a total of three river crossings, including 1 river crossing using horizontal directional drilling, at the River Blackwater and it is approximately 3.81km in length.

5.3 AGRONOMY – UGC ROUTE 2 TOWER 301 – 312

5.3.1 Potential Impacts

4 The construction of the underground cable (UGC) would require fencing off a 22m wide swathe of land along the line of the UGC. Within the construction site the top soil would be stripped back, stored and spread over the site at the end of the construction period. The cables would be situated in excavated trenches 1m – 1.5m deep and the soil would be back-filled and levelled.

5 The impacts which would arise are;

- Damage to the soil profile. This would occur due to the construction traffic and excavation. The construction site would be re seeded following laying of the cables. Therefore at least one cropping season would be affected and it is possible that reseeded grassland may not come back into production until the following season. The damage to soil would be residual for the short – medium term (2 – 7 years);

- Damage to drainage systems. Where 2A UGC route encounters land drainage systems there is potential for causing damage to these systems;

- General construction disturbance to the farm enterprises. The actual construction site would be unavailable for a period of 2 – 6 months on most farms. The construction activity and land area reduction would disturb livestock and cropping programs and interfere with the day to day running of the farm. Because the construction site is a fenced off linear feature there is the potential to cause temporary severance to the farm;

- There would be residual permanent disturbance to the farm enterprise. The presence of an underground cable is an additional safety risk on the farm. Deep cultivations i.e. below normal plough depth would be restricted and land drainage or excavation above the cables would also be restricted;

- There would be a restriction on building or planting commercial forestry;

- The construction of sealing end compounds at each end of the UGC, inspection kiosks every 2 km and joint bays every approximately 650m would increase the permanent land requirement for the construction of UGC.

5.3.2 Mitigation measures

6 General mitigation measures for UGC construction are as follows;

- Landowners would be notified in advance of the commencement of construction;
- Fencing would be erected to exclude livestock from construction sites but the contractor would ensure that landowners have reasonable access to all parts of their farm during the construction phase;
- Disease protocols would be adhered to. As referenced in the ESB / IFA agreement the contractor would comply with any DAFM regulation pertaining to crops and livestock diseases;
- If rock breaking or pilling are required owners of livestock in fields adjoining the work site would be notified in advance;
- Temporary aluminium or timber plank or panel tracks would be used in certain situations to prevent damage to soil;
- Locally excavated material would be reinstated across the site following construction. All unused excavated fill would be removed from the site and disposed of at a licensed waste facility;
- Affected land drains would be redirected in a manner that maintains existing land drainage;
- Where top soil is stripped back it would be replaced. All disturbed field surfaces would be re-instated. ;
- Any losses or additional costs incurred by the landowner which are directly attributed to the potential UGC option, during the construction phase or the operational phase, including additional necessary remedial works and including losses and or additional costs arising from Basic Payment Scheme, implementation of Nitrates Regulations and Agri Environmental Schemes would be paid to the landowner;
- Mitigation relating to potential effects on water quality and soil contamination due to fuel or concrete spillages are similar to those detailed in the outline Construction Environmental Management Plan for the proposed development.

7 In addition to the general mitigation measures adopted above it is possible to move the UGC to the edge of the land parcel in three land parcels.

5.3.3 Potential for this UGC section and Conclusion on Impact Significance

Table 5-1 Comparison of Overhead Line and Underground Cable Impacts on Land Use in the Blackwater Valley Section

Impacts	Overhead	Underground
Number of land parcels affected[9]	12	12
Area of land disturbance / damage (Ha)	3.7	8.1
Area of land permanently restricted under OHL and UGC infrastructure (Ha)	0.3	1.6
Impacts on farm yards	No significant impacts	No significant impacts
Impacts on forestry	No significant impacts	No significant impacts

8 Construction phase impacts generally do not give rise to significant residual impacts because land use would not be affected after 1 – 2 cropping seasons. While the construction phase impact would be higher with UGC, the residual impact is low[10] except where there is additional land take due to the construction of sealing end compounds. The impacts along the Blackwater Valley sub section are summarised in Table 5.2. The construction of a sealing end compound results in a major adverse impact on a southern land parcel and a moderate adverse impact on the other land parcel. The residual impact reduced from slight adverse to imperceptible on four land parcels due to the underground cable aligning with the edge of the affected land parcel. The decommissioning phase for the UGC would likely have as significant an impact as that of the construction of the UGC and again would be higher than that for the decommissioning of the OHL.

Table 5-2 Comparison of the Significance of Impacts on Land Use in the Blackwater Valley Section

Impact Significance	Residual Impacts	
	OHL	UGC
	(Number of Land parcels)	
Imperceptible	4	7
Slight Adverse	8	3
Moderate Adverse	0	1
Major Adverse	0	1

9 Within the Blackwater valley subsection there is a preference for the OHL option due to the increase in the number of Moderate and Major Adverse impacts associated with UGC Route 2.

[9] All of the affected land parcels were assessed in Chapter 3 **Volume 3D** of the EIS.
[10] The evidence from Gas pipelines throughout Ireland is that residual impacts are low.

5.4 ECOLOGY – UGC ROUTE 2 TOWER 301 – 312

5.4.1 Description of Ecological Receptors

10 The potential UGC Route 2 within the River Blackwater Valley area would be situated within two European sites (River Boyne and Blackwater cSAC, and the River Boyne and Blackwater SPA) which occupy a relatively similar area - the River Blackwater riparian corridor.

11 The River Boyne and Blackwater cSAC qualifying interests include; River Lamprey *Lampetra fluviatilis,* [1106] Salmon *Salmo salar* (only in fresh water), [1355] Otter *Lutra lutra,* [7230] Alkaline fens, [91E0] Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*).

12 The River Boyne and Blackwater SPA qualifying interest is [A229] Kingfisher *Alcedo* (breeding).

13 Each of these two sites are internationally important European sites.

14 The potential impacts to these sites and other ecological receptors detailed, from the potential UGC route 2, have been assessed based on currently available desk studies and survey information. Where available, for those co-linear OHL and UGC line sections, survey information within the study area from assessment of the overhead line route has been used. However the UGC Route 2 does not completely follow the route of the OHL.

Terrestrial Habitats

15 Terrestrial habitats within this UGC route include linear woodland habitats, wet grassland and grass verge.

16 The non designated terrestrial habitats within this UGC section are considered to include habitats of high (local) value.

Aquatic Habitats/ Species

17 Aquatic habitats at this location include the River Blackwater cSAC, associated riparian habitat and local streams. Aquatic species within these habitats include in-stream aquatic fish (Salmonids, Lamprey and Brown Trout) and other in-stream fauna including Crayfish.

18 Local streams are likely to be of county value in terms of evaluation of the aquatic habitat or of high local value. The River Blackwater forms part of the River Boyne and Blackwater SAC/SPA an internationally important European site.

Protected Fauna/ Birds

19 The key target mammals potentially occurring within habitats which may be potentially affected by the UGC Route 2 are badger, otter and to a lesser extent bat species.

20 The River Boyne and Blackwater are designated as an SPA for breeding Kingfisher. Other scarcer bird species of conservation significance that may occur within the area of the UGC Route 2 include Yellowhammer, Tree sparrow, Grey wagtail and Sand Marten.

21 Whooper Swan regularly fly across this location in numbers which reach national importance. The location of the UGC includes fields beside the River Blackwater used irregularly by flocks of foraging Whooper Swan.

5.4.2 Potential Impact

Terrestrial Habitats

22 Potential moderate/ high value habitats would be impacted including; treelines, hedgerows and unimproved wet grassland.

23 The vast majority of the UGC Route 2 is in arable and improved grassland of low conservation value.

24 A total of 17 identifiable hedgerows and treelines (including those associated with streams) would be crossed. A minimum estimate of 374m of linear woodland would be permanently removed.

Aquatic Habitats/ Species

25 The potential UGC Route 2 crosses 3 identifiable water courses; 2 drains/ streams north of the River Blackwater and the River Blackwater.

26 There is an option to directionally drill these water courses however all streams except the River Blackwater would be culverted. Trenching or other construction approaches would lead to direct permanent impacts to water courses and riparian habitats.

27 A temporary significant pollution risk would arise during construction to protected aquatic species in the SAC. This risk is related to the potential for increased suspended solids arising from construction works and storage/ removal/ reinstatement of disturbed soil and/ or the release of construction related pollutants.

28 If directional drilling is used then there is also a low risk of bentonite escaping during the process of directional drilling at the River Blackwater crossing. This potential impact could result in adverse effects to qualifying Annex II species such as salmon and lamprey species which use the SAC.

29 A moderate disturbance risk would arise to Otter and Kingfisher (qualifying species) including the potential loss of resting or breeding sites (if present) in particular at non designated streams linked to the River Boyne and Blackwater cSAC.

30 There is ongoing operational risk of pollution and wildlife disturbance during operation if faults arise and further excavation works are required.

Protected Fauna/ Birds

31 The potential loss of habitats detailed would lead to potential loss of breeding and foraging sites for fauna and loss of connectivity and fragmentation of linear woodland and stream habitats. A potential barrier effect may occur due to permanent habitat clearway being in place though this is not likely to be significant.

Summary of Potential Impacts

32 Internationally important habitats would potentially be significantly impacted. An Appropriate Assessment would therefore be required of the implications for the European site concerned with respect to a partial UGC option prior to its approval. The SAC and rivers linked to here require survey such as field surveys, vantage point surveys, LiDAR surveys, review of aerial photography etc to further inform the evaluation and assessment of potential impacts. Detailed carefully considered mitigation, informed by best practise for reducing risk would therefore be required.

33 The only option available for installing the cable is directional drilling under the River Blackwater. The procedure to use this method of drilling could be undertaken in such a way so as to avoid the requirement for drilling launch and exit points occurring directly within the SAC/SPA lands or launching and exiting within the River Blackwater.

34 Direct impacts to Annex I habitats identified can likely be avoided in the SAC at this location. This can be determined from existing desktop and visual surveys.

35 A significant temporary pollution risk would arise during construction to protected aquatic species. This risk is related to the potential for increased suspended solids arising from construction works and storage/ removal/ reinstatement of disturbed soil and/ or the release of construction related pollutants.

36 There is also a low risk of bentonite escaping during the process of directional drilling at river crossings. This potential impact could result in adverse effects to qualifying Annex II species such as salmon species and lamprey species which use the SAC. .

37 A moderate disturbance risk would arise to Otter and Kingfisher (qualifying species) including the potential loss of resting or breeding sites (if present) in particular at non designated streams linked to the River Boyne and Blackwater cSAC.

38 There is ongoing operational risk of pollution and wildlife disturbance during operation if faults arise and further excavation works are required.

39 In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned will would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

5.4.3 Risk of Significant Adverse Impact

Terrestrial Habitats

40 Permanent habitat loss within the route of the UGC Route 2 cannot be mitigated. Habitat connectivity would be permanently affected as hedgerows would be bisected by the works area. The potential option for exploring compensatory habitat replacement would be advised in addition to mitigation (reduction of impact) measures.

Aquatic Habitats/ Species

41 There is a Moderate/ possibly high risk of significant adverse impact and associated effects on aquatic species and habitats prior to mitigation as culverts would remove sections of stream habitat. This could affect available spawning habitat and culverts would require careful design to ensure they do not affect fish dispersal/ migration. Detailed carefully considered mitigation informed by best practise for reducing risk is required.

Protected Fauna/ Birds

42 There would be a potential moderate risk of significant adverse impacts and associated effects to protected mammals and possibly Kingfisher breeding sites. The potential for habitat fragmentation and for a barrier effect cannot be avoided as permanent works area would bisect hedgerows.

43 Habitat fragmentation and barrier effects mean that species dispersal may be effected with a permanent trackway across former hedgerows etc.

44 Mitigation measures are available to reduce impacts on fauna. Compensatory approaches, including for example habitat creation or artificial breeding sites, could be required dependent on the actual impacts.

5.4.4 Mitigation

Terrestrial Habitats

45 It would not be possible to avoid permanent impacts to terrestrial habitats. The main habitat of ecological value impacted is hedgerows (approximately 374m). Compensatory mitigation approaches, including for example alternative habitat would be the only means to reduce this permanent loss of hedgerow/ woodland habitat in particular.

Aquatic Habitats/ Species

46 It would not be possible to avoid permanent impacts to stream crossings as culverts are likely to be required across streams crossed. There would be the potential for mitigation measures to minimise pollution risks to aquatic species.

Protected Fauna/ Birds

47 A survey is required to confirm breeding sites of protected species. There is good scope to avoid protected mammal breeding sites. Mitigation is available to minimise disturbance risk.

Summary of Mitigation

48 Mitigation of potential impacts would involve the avoidance of works within the River Boyne and Blackwater cSAC and the River Boyne and Blackwater SPA. Directional drilling and carefully managed pollution control measures with monitoring would reduce the potential risk of significant adverse effects. Route modifications would potentially be advised based on any surveys such as field surveys (should access be granted), vantage point surveys, LiDAR surveys, review of aerial photography etc. that would be undertaken to assess the reduction of potential risks.

5.4.5 Risk of Significant Residual Adverse Impacts Post Mitigation

Terrestrial Habitats

49 The potential risk of significant residual adverse impacts to terrestrial habitats, post mitigation is Moderate and is dependent on the potential for mitigation through replacement compensatory habitats.

Aquatic Habitats/ Species

50 The potential risk of significant residual adverse impacts to aquatic habitats is low. This assessment is based on reinstatement of river/ stream habitats post works and some permanent loss of riparian vegetation along a relatively short length of stream at the crossing point.

Protected Fauna/ Birds

51 The potential risk of significant residual adverse impacts to protected fauna and protected birds, post mitigation is Low and would be dependent on site specific surveys (LIDAR, aerial photography, ground, vantage point etc.).

52 Habitat fragmentation means there is a potential adverse effect to species dispersal and the potential for barrier effects associated with a permanent trackway across former hedgerows.

53 Whooper Swan regularly fly across this location in numbers which reach national importance. The use of UGC at this location would reduce collision risk to Whooper Swan compared to OHL.

Summary of Residual Impacts

54 Residual risk to the River Boyne and Blackwater SAC/ SPA is low as mitigation for works of this nature are typically conducted in a successful manner.

5.4.6 Potential for this UGC section and Conclusion on Impact Significance

55 When compared to OHL there is likelihood that the UGC option would have greater risk of significant adverse ecological effects to habitats, aquatic species, Otter and Kingfisher. There is some justification for UGC at this location in that UGC would remove the collisions risk identified to a regular Whooper Swan flightline between Tara Mines Tailings Ponds and the Blackwater valley area at this location. UGC would reduce risks to Whooper Swans during the operational phase in the absence of OHL mitigation (though it should be noted that mitigation is being proposed for the OHL proposed development). However overall UGC is less favourable as it would lead to greater risks to European sites, higher habitat loss, and greater disturbance risks to protected fauna.

5.5 SOILS, GEOLOGY & HYDROGEOLOGY – UGC ROUTE 2 TOWER 301 – 312

5.5.1 Potential Impacts

56 The main consideration is dealing with groundwater and excavation stability. The UGC Route 2 is located adjacent to the Blackwater GWDTE, cSAC and SPA. The construction of sealing end compounds, joint bays, trenching, and directional drilling would require additional excavations and dewatering adjacent to the cSAC.

57 Confirmation of soils and rockhead level is required to provide a robust reference design for the directional drilling element. Additional soil excavation and disposal would be required in the event of undergrounding in these locations. This risk is related to the potential for increased suspended solids arising from construction works and storage/removal/reinstatement of disturbed soil and/or the release of construction related pollutants.

58 Potential impacts include groundwater impact adjacent to Blackwater cSAC. There is also a low risk of drilling fluid escaping during the process of directional drilling at river crossings. Any impact could result in temporary adverse effects to qualifying interests to the Boyne/Blackwater cSAC. These impacts are further considered in the aquatic ecology and water sections.

59 Additional soil excavation and disposal would be required in the event of undergrounding in these locations. This risk is related to the potential for increased suspended solids arising from construction works and storage/removal/reinstatement of disturbed soil and/or the release of construction related pollutants. There are no known contaminated land issues in the area of the underground cable route. It is anticipated that at certain locations, especially in the lower-lying areas, the groundwater table is shallow. Accordingly, groundwater controls may be necessary to manage shallow groundwater. In these areas it would be necessary to depress by pumping the groundwater level to maintain a dry operational area for installation of the underground cable.

60 Dewatering of the excavation would depress the groundwater level in the vicinity of the excavation. Any impacts would be restricted to the short period of pumping. The extent of the impact of the dewatering depends on the hydraulic characteristics of the strata and the amount of drawdown of the groundwater level necessary to achieve the required dewatering. Any impact on the surrounding groundwater level reduces significantly with increasing distance from the point of abstraction. Due to the shallow excavations and the short term pumping, no significant impacts on the groundwater level would occur.

61 It is considered that the construction works would have minor effects on the geomorphology of the area, as the UGC would not materially change the local slopes and topography.

62 Potential impacts include groundwater impact adjacent to Boyne and Blackwater cSAC. There is also a low risk of drilling fluid escaping during the process of directional drilling at river crossings.

Any impact could result in temporary adverse effects to qualifying interests to the Boyne/Blackwater cSAC. These impacts are further considered in the aquatic ecology and water sections.

63 The UGC Route 2 is located 30m from the Boyne County Geological Site (CGS). Directional drilling would be undertaken near the Boyne CGS, however the potential impacts are considered low and mitigation measures can ameliorate the potential impacts.

134 Operational impacts on geology and groundwater would be negligible. In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

Table 5-1 Excavation volumes

Location	UGC – excavation volume	OHL – excavation volume
Blackwater crossing	30,500	1,150

5.5.2 Mitigation measures

64 Mitigation measures are similar to those proposed for the OHL however the excavation volumes and length of works is increased, as shown above in Table 5.1. Measures to minimise the impact of the potential UGC option on local geology include reuse of in situ material. However given the extra excavation works approximately 10,000 m^3 would be removed from the potential UGC Route 2. All construction waste would be stored, managed, moved, reused or disposed of in an appropriate manner by appropriate contractors in accordance with *Waste Management Acts 1996-2013*. Excess soils/subsoils would be disposed of at licensed /permitted waste management facilities.

65 All excavated materials would be visually evaluated for signs of possible contamination such as staining or strong odours. In *the* event that any unusual staining or odour is noticed, samples of this soil would be analysed for the presence of possible contaminants in order to ensure that historical pollution of the soil has not occurred. Should it be determined that any of the soil excavated is contaminated, this would be dealt with appropriately as per the *Waste Management Act (as amended)* and associated regulations.

66 To minimise any potential impact on the underlying subsurface strata from any material spillages, all oils and fuels used during construction would be stored on temporary proprietary bunded surface (i.e. contained bunded plastic surface). Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles would take place away from surface *water* gullies or drains.

No refuelling would be allowed within 50m of a stream/river. Spill kits and hydrocarbon absorbent packs would be stored in this area and operators would be fully trained in the use of this equipment.

67 Additional investigation works are required to design the directional drilling element of the works. In particular rock head needs to be determined. Tunnel boring can be complicated when unexpected ground conditions and mixed face boring are encountered. The identified bore route does not pass under any permanent buildings or structures therefore the potential impacts are reduced.

68 If groundwater is encountered, the water pumped would need to be discharged off-site, following treatment. The most likely destination for the discharge would be to the nearest watercourse or to a soakaway within the working area, subject to the ground conditions and approval by the relevant authorities. Accordingly, any groundwater intercepted in the excavation, which would have discharged naturally as baseflow to the watercourse would still discharge to the watercourse. As a result, it is concluded that there would be no significant adverse impact on the flow in watercourses as a result of any dewatering.

5.5.3 Potential for this UGC section and Conclusion on Impact Significance

69 In conclusion the UGC would present a greater potential risk to soils and hydrogeology than OHL, however the overall residual impact is considered localised and minor.

5.6 WATER – UGC ROUTE 2 TOWER 301 - 312

5.6.1 Potential Impacts

70 The potential UGC Route 2 is located within the River Blackwater catchment. The River Blackwater cSAC (site code 002299) is a designated site for conservation which may potentially be impacted by the UGC Route 2. A full description of the River Boyne and Blackwater cSAC (site code 002299) is detailed in the Natura Impact Statement (NIS). The Boyne cSAC is selected for species listed on Annex II of the European– Atlantic Salmon, Otter and River Lamprey. Within the study area, the River Blackwater meanders southeast to the confluence with the River Boyne at Navan.

71 Atlantic Salmon and Trout use the tributaries of the Boyne/Blackwater as spawning grounds. The River Blackwater is classified as currently being at Moderate Ecological Status while the Yellow river/Gibstown river is classified as Poor Status. Based on the available information, the majority of the Blackwater catchment is 'at Risk of not achieving Good Status' in relation to Surface Water (1a status). It is proposed to restore the Blackwater river to good status by 2021 and the Yellow River to good status by 2027. Measures to address and alleviate these pressures are to be included in a formal programme of measures to be submitted to the European Commission. Agriculture, Wastewater Treatment Plants (WWTP) and septic tanks are thought to contribute over 90% of the total polluting matter to the catchment.

72 The construction activities associated with the UGC Route 2 would result in a corridor approximately 22m wide and 1.3m deep. The undergrounding corridor would include two 1.8m wide trenches placed approximately 3.2m apart and being serviced by an access track which is able to accommodate vehicles to transport cable drums weighing 45 tonnes or more, along with large cranes for offloading and equipment handling. In addition to the equipment used to dig the trench to facilitate cable laying, directional drilling under the River Blackwater is would be required.

73 Sealing end compounds link the overhead line to the partially undergrounded section. The cables are terminated using outdoor sealing ends (terminations) located in sealing end compounds. The size of the sealing end compound largely depends on the transmission capacity and protective installations that are required for the specific line. These compounds can often be screened to provide some visual mitigation. Each compound is approximately 1 hectare and would consist of an inner compound enclosing the live high voltage equipment, a small building, with a buffer strip around the compound to accommodate an earth berm and or vegetation for screening. The northern compound would be located within 100m of the Yellow River while the southern compound is located 400m from the Blackwater River.

74 The OPW 'Flood Hazard Database' was used in order to obtain information on historical flooding events in the corridor of the UGC Route 2. This information was used to establish the current baseline conditions in terms of what sections of the area are liable to flood. Additional sources of information including internet searches, historical maps, data from Catchment Flood Risk Assessment and Management Studies (CFRAMs) and flood risk assessments were also consulted.

No incidents of flooding were noted at the identified sealing end compound locations. The compounds are not located in flood prone areas based and the preliminary flood risk assessment (PFRA) maps.

75 Suspended solids can potentially impact on surface water quality by clogging the gills of fish, covering spawning sites, leading to loss of habitats on the riverbed and stunt aquatic plant growth by limiting oxygen supplies, shelter and food sources. During the construction of the potential UGC Route 2, there is a risk of accidental fuel pollution incidences.

76 Due to the proximity of the stream to the northern sealing end compound, minor adverse impacts from silt laden runoff and the risk of chemical spillages are predicted with mitigation taken into account. Providing the mitigation measures as set out later in this Chapter are adopted, the potential effects on the River Blackwater from silt laden runoff and spillage risk are slight adverse only.

77 Construction activities associated with the underground cable would be short term and transient in nature, occurring along the entire length of the UGC Route 2. The UGC route would pass under the River Blackwater and Yellow River, as well as a number of drains. Additional potential impacts arise from UGC particularly at the River Boyne / River Blackwater cSAC. Potential impacts include the diversion of numerous land drains and small streams connected to salmonid streams.

78 Additional soil excavation and disposal would be required in the event of undergrounding in these locations. This risk is related to the potential for increased suspended solids arising from construction works and storage/removal/reinstatement of disturbed soil and/or the release of construction related pollutants to the surface water environment. It may be necessary to divert sections of dry drains/drainage ditches where encountered thereby increasing potential sediment runoff. If excavations encounter groundwater, such inflows may need to be pumped, resulting in short term localised drawdown of the water table and discharges to the surface water channels.

79 Potential impacts include groundwater impact adjacent to Boyne and Blackwater cSAC. There is also a low risk of drilling fluid escaping during the process of directional drilling at river crossings. Any impact could result in temporary adverse effects to qualifying interests to the Boyne/Blackwater cSAC.

80 It would not be proposed to discharge wastewater from compounds.

81 Operational impacts on surface water and groundwater water would be negligible. In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts on surface water and groundwater would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

5.6.2 Mitigation measures

82 Additional mitigation measures would be required to deal with the longer construction periods and the larger excavation volumes involved.

83 The use of directional drilling for the crossing of major water courses would be required. Diversion of watercourses should be avoided where possible to minimise disruption to aquatic ecosystems. In relation to stream crossings, and directional drilling, IFI approval would be required regarding the specification and timing of installation. Short sections of drainage ditches may need to be culverted with the potential for sediment discharge. It is not required to ford any streams or rivers. All in-stream works should be carried out during the period May to September and in accordance with the Eastern Fisheries Board (*2004) Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites.*

84 Water quality monitoring would be undertaken prior to the commencement of construction to confirm baseline data and ensure there is no deterioration in water quality. This would be targeted on watercourses considered to be at a higher risk of pollution (i.e. towers where there are watercourses within 20m of the construction works). Water quality monitoring would include daily inspection of adjacent watercourses.

85 Disturbance of bankside soils and in-stream sediments would be kept to the minimum required for the cable laying process. Banks and stream beds would be reinstated in a manner that would minimise the potential for erosion and return the river/stream to as close to its original condition as possible.

86 Implementing the design standards of the GDSDS, the surface water drainage system at the compounds would take into account the recommendations of the GDSDS and utilises SuDs (sustainable urban drainage) devices where appropriate. Runoff from the hardstand areas at the sealing end compounds would be limited to Greenfield runoff rates.

5.6.3 Potential for this UGC section and Conclusion on Impact Significance

87 In conclusion, notwithstanding mitigation measures, UGC would present a minor adverse impact on the River Blackwater compared to a negligible impact from the OHL.

5.7 TRAFFIC – UGC ROUTE 2 (TOWER 301 – 312)

5.7.1 Potential Impacts

88 In order to assess the potential traffic impacts and effects, it is first necessary to consider the construction methodology envisaged and secondly to assess the locations along the UGC Route 2 where the potential exists for traffic disruption. The likelihood of full or partial road closure is assessed followed by the determination of feasible diversion routes required due to the construction works. Possible mitigation measures along national, regional and/or local roads are also considered.

89 For a project of this size, some disruption to traffic would occur during construction. However, the requirement for a detailed Construction Phase Traffic Management Plan would minimise and reduce any possible construction impacts associated with traffic diversions and road closures.

90 The UGC Route 2 covers approximately 3.81km running between Tower 301 (R163) and Tower 312 (R147). For the purpose of the assessment the study area relates to the roads where the permanent accesses are to be located. The study area consists of two regional road crossings and two local road crossings, specifically:-

- R163;
- R147;
- L3409; and
- L34091.

91 The UGC Route 2 also includes crossings totalling three streams and rivers.

92 The construction of the UGC results in a corridor width of between 20-22m along the length of the 2A UGC route. This corridor would contain two number trenches for cable ducts and sufficient working width for plant and machinery.

5.7.1.1 Cable Construction Methodology General Comments

93 Minor temporary disruption to traffic is envisaged during construction and installation of the cable. Where the cable crosses an existing carriageway on the R1163 and R147 Regional Roads, the construction of the UGC Route 2 would utilise temporary lane closures (the closure of one traffic lane) with the implementation of a Stop/Go traffic management system. This method facilitates the flow of traffic past the works on the existing road network. Once one half of the carriageway crossing has been constructed, works would commence on the remaining portion of the carriageway while allowing traffic to pass on the section of carriageway previously completed.

94 In the instance of the L3409 and unclassified road adjoining the L34091, the width of the road is such that lane closures would not be possible at the location of the UGC crossing. Therefore these sections of the road would be closed for the duration of the carriageway crossing construction with diversions in operation. From traffic survey data obtained in 2013 the L3409 has an average daily traffic flow of 714 vehicles, hence the impact would be minimal.

95 The majority of construction generated traffic associated with the UGC Route 2 would result from additional material deliveries, such as additional concrete truck deliveries, and the removal of surplus material, resulting from excavation of the UGC route.

96 Similar to the overhead line construction it is expected that construction traffic volumes would have a maximum daily flow of 340 vehicles, and peak hour calculation on the basis of a 12 hour working day relating to 46 vehicles per hour. i.e. 13 in and 13 out. However, it should be noted that this is a maximum daily flow expected to occur with deliveries of materials/ equipment and does not represent a sustained daily flow throughout the construction period.

5.7.1.2 Spoil

97 In terms of spoil material to be removed from site there are three possible sources:

- Cable trench;
- Joint bays; and
- Sealing End Compounds.

98 Similar projects carried out by National Grid have indicated that the volume of spoil excavated for an underground cable where two cables per phase are installed is some 14 times more than for an equivalent above ground route.

99 For comparative purposes the above ground construction methodology generated:

- Tower 301 – 300 tonnes of spoil equating to 17 trips off site (18 tonne loads); and,
- Tower 312 – 300 tonnes of spoil equating to 17 trips off site (18 tonne loads).

100 Therefore on this basis the volume of spoil for the underground cable would see an increase to 238 trips off site from the access to Towers. It should be stressed however that these are worst case maximum trips off site and where possible spoil would be backfilled and compressed. Furthermore the increase of spoil output would be offset by the reduction in concrete, stone and steel deliveries that would be required for the OHL construction. Therefore daily volumes of heavy goods vehicles

are likely to remain at a similar level to that of the OHL construction at both access points. Again as noted above construction traffic volumes would be limited to a maximum daily flow of 200 vehicles.

101 As per the OHL methodology, licensed landfill sites would be used to dispose of waste spoil from the construction.

102 Due to volume of spoil to be removed off site, wheel cleaning facilities would be provided for relevant vehicles.

5.7.1.3 Typical Construction Vehicles

103 As per the OHL tower construction it is expected that the same vehicles would be employed for the UGC construction, specifically:-

- Fastrac with low loader trailer: - This vehicle would represent the majority of the construction vehicles and would be responsible for delivery of construction apparatus e.g. dumper/ excavator/ rock breaker, delivery of cable drums, delivery of precast concrete components/ Cement sand materials, delivery of any steel materials.

- Tipper Lorry (22 tonnes):- This vehicle would be used to deliver stone material if required and may be used to transfer excess spoil from the site.

- Concrete Lorry (8m^3):- In the instance of the joint bay construction and the Sealing End Compounds these vehicles would be employed to deliver the concrete. Where conditions on the associated access track adjacent to the UGC trench are not suitable for the concrete lorry, they would off loaded onto a dumper which would then ferry the concrete to the required location.

- Transit type van: - staff would be transferred to the construction works from the temporary construction material storage yard, Carrickmacross, County Monaghan.

5.7.1.4 Sealing End Compounds

104 UGC route 2 would require a Sealing End Compound at either end of the UGC section, with one located adjacent to the R163 and one adjacent to the R147. These compounds are required to carry the cables from the underground duct to the adjacent tower. Such compounds would be accessed via a permanent access road for routine inspection and maintenance. During the construction of the sealing compounds, an increase in traffic to and from the site at these locations would be on the local road network. During operation of the UGC Option, traffic impacts associated with routine inspection and maintenance are envisaged to be negligible.

5.7.1.5 Rivers

105 The UGC Route 2 crosses a total of three streams and rivers. The identified river crossings would be directional drilling. This technique may result in extended construction times associated with the procedure, which may increase traffic to and from both sides of the stream / river crossings. It is envisaged that as a result of the operations, local area traffic would experience an increase in site traffic for the duration of the river crossing process.

5.7.2 Mitigation measures

106 During construction, the main impacts along the UGC Route 2 would be temporary lane closures on the R163 and R147, temporary traffic diversions along a combination of the existing local road and regional road network can be facilitated. This approach should keep impact on traffic to a minimum without significant affect to local journey times with short-term access restrictions.

107 The limitation of daily traffic to a maximum of 200 vehicles per day (or average of 17 vehicles per hour based on a 12 hour day), associated with the construction of the towers, equates to a 2.2% impact in the peak flows along the L2202 and a 0.2% impact in the peak flows along the R161. Therefore while it is expected that the UGC construction would employ similar levels of construction traffic and that traffic impacts are still considered negligible, the duration of traffic impact would be considerably extended in the case of UGC construction.

108 A Construction Traffic Management Plan (TMP) would be employed by the main works contractor, prior to construction, in consultation with the Local Authority. The plan would outline minimum working practices on public roads, details on traffic management arrangements, temporary road/ lane closures and arrangements for communicating details of any diversion routes, vehicular movements and restrictions to members of the public and affected landowners. The construction TMP would also include details related to working hours, parking and access arrangements onto the existing road network.

109 The implementation of the Construction TMP would ensure that local traffic flows as freely as possible with Two-way traffic being maintained wherever possible on wider roads.

110 With regards to the crossing of the L34091 (south of L3409), a temporary road closure of this road would result in loss of local access in order to facilitate construction along the existing *cul de sac* road. However, as the existing road is limited to low traffic volumes (three number domestic properties including two number farmyard operations on L34091). Construction of the UGC Route 2 at this location could be facilitated by consultation with local road users. This method would result in a significant impact to local traffic.

111 The duration of partial/temporary or full road closures would be kept to a minimum in order to reduce impacts on local road traffic. All closures would be discussed and agreed with the Local Authority in the development of the Construction TMP. Where temporary road closure is required, a temporary

diversion route would be agreed and provision at such locations for access by residents and deliveries would be maintained as far as reasonably possible.

112 Traffic Management would be undertaken at the site access, e.g. large construction vehicles such as the Fastrac with low loader trailer would be limited to left in and left out manoeuvres.

113 Shuttle running traffic management on the adjoining road, i.e. to facilitate materials being transferred from the site access to the construction area, would also be employed where necessary.

5.7.3 Potential for this UGC section and Conclusion on Impact Significance

114 The above assessment demonstrates that the construction of a section of UGC can be facilitated in the Blackwater Valley area. However, the traffic impacts associated with the UGC route are more significant on a local level when compared to the provision of an overhead line route in terms of increased traffic volumes associated with the construction of the UGC Route 2 in both the immediate locality and further afield towards neighbouring towns and villages.

115 In conclusion, the construction of the potential UGC Route 2 would employ similar levels of construction traffic to the construction of an OHL; however the duration of traffic impact would be considerably extended in the case of UGC construction. Therefore, from a traffic impact perspective, there is no reason to consider the undergrounding of sections of the proposed development.

5.8 CULTURAL HERITAGE– UGC ROUTE 2 TOWER 301 – 312

5.8.1 Potential Impacts

116 Over the course of the project detailed GIS mapping has been compiled and forms the basis of this evaluation. The GIS mapping to date includes designated archaeological and architectural sites, historic mapping, aerial photography and LIDAR surveys. Undesignated sites, such as demesne landscapes, aerial and cartographic anomalies, and sites noted during fieldwork have also been added to the mapping. This data has been augmented with detailed documentary research, toponym analysis, a review of the topographical files held by the National Museum of Ireland (NMI) and the results of previous excavations as contained on databases hosted by *excavations.ie* and National Roads Authority.

117 The UGC Route 2 and sealing end compounds would not physically impact on any designated archaeological or architectural sites. There are no designated architectural sites in the vicinity of the 2A UGC route nor were there any structures of potential architectural importance that would be impacted on by the UGC Route 2. Demesne boundaries crossed by the UGC Route 2 appear to consist of hedge rows and ditches.

118 The UGC Route 2 roughly follows that of the proposed OHL, commencing within the Baile Ghib Gaeltacht at the sealing end compound in the north. The compound is greenfield adjacent to a stream which is the townland Boundary between Baile Órthaí (Oristown) and Cluain an Ghaill (Clongill). The townland boundary would not be impacted on by the UGC Route 2 but it is noted that both the sealing end compound and UGC route are in greenfield areas and could encounter previously unrecorded archaeological deposits. To the south the UGC route crosses the R163 between Kells and Baile Ghib.

119 At this point the UGC Route 2 enters an area highlighted by the National Monuments Service of DAHG as the Teltown Zone of Archaeological Amenity (ZAA). This area has been identified as the core of the historic region of Tailtiú, a ritual landscape with a unique wealth of folklore, literary references and associated archaeological monuments. A detailed study of the area has been undertaken as part of the evaluation that will accompany the EIS for the proposed development. The study reviewed original sources, historic mapping and included a detailed LIDAR survey of the entire ZAA. The closest previously recorded archaeological monument to the proposed route as it passes through the ZAA is an embanked enclosure (SMR No. ME017-050) located approximately 300m to the west of the OHL proposed development. Two sites of archaeological potential were noted in the vicinity of the UGC Route 2 from the LIDAR survey; these are discussed below. Despite the paucity of archaeological monuments this region is seen as an area of high archaeological potential and the construction of a UGC in the area has a high potential of negatively impacting upon previous unrecorded archaeological deposits.

120 Approximately 375m to the south of the R163, the UGC Route 2 passes approximately 40m to the east of a small area of woodland. This area is noted in the EIS as an area of archaeological potential

(MSA_CHS070) based on the Digital Terrain Model (DTM) produced from the LIDAR survey, which appears to indicate that there is a bank surrounding the site. The bank passes roughly through the middle of the woodland, enclosing the northern half in a rough oval. Given the proximity of this site there is the potential that the UGC Route 2 could have a negative impact on associated archaeological deposits.

121 At this point the UGC Route 2 also crosses the townland boundary between Baile Órthaí (Oristown) and Diméin Bhaile Ghib (Gibstown Demesne). From this point the route passes through the western extent of Diméin Bhaile Ghib (Gibstown Demesne). Approximately 500m south of the townland boundary the UGC Route 2 passes to the west of a circular tree copse which appears between the first and second edition OS surveys (MSA_CHS071). It is likely that this is a demesne feature associated Diméin Bhaile Ghib (Gibstown Demesne) which underwent extensive changes between the two surveys.

122 The UGC Route 2 continues south crossing the Baile Órthaí (Oristown) / Domhnagh Phádraig (Donaghpatrick) road, leaving Diméin Bhaile Ghib (Gibstown Demesne) and passing into the townland of Tailtin (Teltown). Approximately 250m to the south west of the road / townland boundary the UGC Route 2 passes into Teltown demesne. Soon after a change in direction to a more southerly orientation, the route crosses a local assess road. To the west, approximately 275m from the potential UGC route are some anomalous depressions noted from the DTM (MSA_CHS073), which may be associated with man-made loughs mentioned in historic accounts of Teltown.

123 Continuing south the UGC Route 2 crosses the Blackwater River, leaving Teltown demesne landscape, the Teltown ZAA and Baile Ghib Gaeltacht and passing into the townland of Castlemartin. Given the historic significance of the region, the Blackwater River and its immediate environs should be considered as an area of high archaeological potential. It is assumed that the river will be crossed using directional drilling. Although this mitigates potential impacts relating to archaeology within the river and in its immediate environs, there is still the potential of encountering archaeological deposits at the work sites on either side of the river. It is noted that the Outline Construction Methodology says that these areas will be stripped and that interceptor trenches will be excavated between these areas and the river.

124 Approximately 460m south of the point where the UGC Route 2A crosses the Blackwater River the route crosses the R147. The southern sealing end compound is located just to the south of the R147.

125 In summary, the potential UGC Route 2 includes two sealing end compounds and a UGC route all to be constructed in greenfield areas. It is noted that here is a general paucity of archaeology in close proximity to the UGC Route 2, however there is still potential that construction of the UGC and sealing end compounds could encounter previously unrecorded archaeological deposits. This is particularly the case in the Teltown ZAA which is a region of high archaeological potential. Such impacts, if unmitigated, could lead to the destruction of archaeological deposits.

126 There would be no significant impacts on archaeology and cultural heritage during maintenance. In the event that a cable route section is to be decommissioned, potential impacts on cultural heritage would likely be less, than for the construction phase, as any cultural heritage features previously directly affected would already have been removed or preserved in-situ during the initial construction phase. Any impacts to setting during maintenance or decommissioning would be temporary and not significant.

5.8.2 Mitigation measures

127 The 2A UGC route passes through the Teltown ZAA, the core of the historic region of Tailtiú a ritual landscape and area of high archaeological potential. The 2A UGC route also crosses the historic Blackwater River valley, including crossing the river itself. Given the sensitivity of the area, should the development proceed as designed, a survey such as a geophysical survey, should be undertaken of all greenfield areas which would be impacted on, to feed into a regime of predevelopment archaeological testing. Any such geophysical survey should include the entire extent of the corridor for the UGC as well as the sealing end compounds. The results of this survey should inform a targeted regime of archaeological testing to be conducted under licence to the National Monuments Service of the Department of the Arts Heritage and the Gaeltacht and the National Museum of Ireland. The regime of archaeological testing would include the entire cable corridor as well as targeted testing in areas highlighted in the geophysical survey. The purpose of the regime of archaeological testing is to ascertain the nature and extent of archaeological deposits within the wayleave. Having accomplished this, in consultation with the National Monuments Service and other relevant stakeholders, the routing of the cable trenches within the cable corridor would be adjusted to ensure that impacts on the archaeological heritage are kept to a minimum. Where deemed necessary by the archaeological consultant, in consultation with the relevant authorities, portable trackway mats would be used during the construction phase to minimise ground disturbance.

128 A record would be made of each of the areas where the UGC Route 2 impacts on townland boundaries. The record in each instance would consist of a written description of the setting, profile and fabric of the townland boundary, accompanied by photographs, and plans and sections where necessary.

5.8.3 Potential for this UGC section and Conclusion on Impact Significance

129 The Blackwater River Valley and Teltown ZAA have an extensive mythological and folkloric history with links to extant archaeological monuments within the ZAA, including Rath Dhu (SMR No. ME017-027), the Knockauns (SMR No. ME017-049), Donaghpatrick Church (RPS No. MH017-131), Teltown Church (SMR No ME017-031) and Rath Aithtir (SMR No. ME017-033). The picturesque town of Donaghpatrick, with several Protected Structures, is located to the north of the Blackwater River on the eastern edge of the ZAA.

130 It is noted when considering the two proposed construction methodologies, that there are competing interests within the disciplines of archaeological and architectural heritage.

131 Architectural heritage is almost exclusively comprised of upstanding structures that are sensitive to impacts on setting. UGC construction, with its considerably reduced visual influence, significantly reduces the potential for impacts on setting. For large scale electricity infrastructure in rural areas, such as that of the UGC Route 2, avoidance of direct physical impacts on designated architectural sites is usually feasible, as architectural heritage sites tend to clustered in and around urban centres while being sparsely distributed in rural areas. Where direct physical impacts are unavoidable there is a potential that these impacts can be mitigated. For example, a section of demesne wall may be dismantled and reconstructed on a floating foundation following construction of the UGC.

132 The evaluation of the proposed OHL noted several architectural sites that would experience impacts on their setting from the proposed development in the vicinity of the potential UGC Route 2 but all impacts were evaluated as being less than moderate in significance and have not been noted in the EIS text. The sites include Gibstown Demesne Cottages (RPS No.s MH017-136, MH017-136, MH017-140 and MH017-141) which would experience a slight to moderate negative impact, Gibstown Demesne Gate Feature (RPS No. MH017-138) which would experience a slight impact, Teltown House (RPS No. MH017-129) which would experience a slight to moderate impact and Donaghpatrick Bridge (RPS No. MH017-130) which would experience a slight to moderate impact.

133 Construction of the 2A UGC route alternative would reduce impacts on the setting of the Gibstown Demesne Cottages as two to three towers would be removed from their viewshed and the sealing end compound appears to be predominantly screened from the cottages. Gibstown gate would likely experience no impact on its setting and Donaghpatrick Bridge would experience no impact on its setting. Teltown house would experience a slight to imperceptible impact on its setting resulting from construction of the sealing end compound. The preferred project solution from an architectural perspective would be UGC.

134 Public perception of archaeological heritage often relates to the prominent upstanding archaeological monuments, which are predisposed to impacts on setting, such as Rath Dhu and Rath Airthir. Where these are the only archaeological sites, then UGC may be the preferred construction technique. However there can be dense areas of previously recorded archaeological monuments sites along with other environmental or physical constraints along a route, making it difficult to avoid all known archaeological monuments when designing an UGC. OHL construction, with its flexibility of tower placement and greatly reduced physical footprint, can often avoid known archaeological monuments without difficulty. Also the potential to impact on previously unrecorded archaeological monuments is vastly increased when constructing an UGC. When archaeological monuments, be they previously recorded or not, fall within the route of an UGC, then the impact would likely lead to the destruction of part or all of the associated archaeological deposits; this impact is permanent and irreversible.

135 The evaluation of the OHL in the vicinity of the UGC Route 2 found that there would be negative impacts of moderate significance on Teltown Church and Graveyard (SMR No. ME017-031). Impacts on setting were noted for other archaeological monuments in the area but as the significance of these impacts is less than moderate they have not been included in the EIS text. Of note is Rath Dhu which would experience an imperceptible impact, Rath Airthir which would experience a slight to imperceptible impact, the Knockauns which would experience a slight to moderate impact and Donaghpatrick Graveyard would experience a slight to moderate impact. An evaluation of the Teltown ZAA found that there would be a moderate negative impact on the region as a whole.

136 Were an UGC option chosen as a preferred option the impact on Rath Dhu would remain imperceptible, there would be no impact on the setting of Rath Airthir, the impact on the Knockauns would be reduce to slight to imperceptible and the impact on Donaghpatrick Graveyard would be reduced to slight to imperceptible. The impact on the ZAA as a whole would also be reduced to slight to imperceptible. In general terms, impacts on the setting of the cultural heritage resource could be significant during the UGC construction phase and immediately thereafter, reducing to imperceptible with time during the operational phase as vegetation is re-established. There would be no direct physical impact on any designated archaeological monuments.

137 Given the presence of known cultural heritage sites in the surrounding area and the location of this UGC route in the Blackwater Valley and the Teltown ZAA this UGC route should be considered sensitive from a cultural heritage point of view. Predicting the level and extent of the buried and unknown cultural heritage resource is difficult by virtue of the fact that these sites are not easily detectable in the absence of a further investigation. Therefore there remains the potential for the discovery of additional cultural heritage sites.

138 While it is not possible to ascertain for certain the potential for impacting directly on previously unknown archaeological remains, it is nonetheless considered that there is a greater risk of impacting on these remains during construction of an UGC than the proposed OHL. Any direct impact would also be permanent and irreversible. Although the OHL option would have a greater impact on the setting of cultural heritage sites, it would be preferable to an UGC option at this location as it is likely to generate fewer direct, physical, irreversible impacts on the non-renewable cultural heritage resource.

5.9 LANDSCAPE – UGC ROUTE 2 TOWER 301 – 312

5.9.1 Potential Impacts

139 The UGC Route 2 corridor crosses through the Blackwater Valley Landscape Character Area which is described as being of high sensitivity in the Meath Landscape Character Assessment. However, as the valley is relatively flat, the river is only visible in its immediate vicinity and at bridge crossings. The corridor crosses the R147 and the R163 and local roads at Donaghpatrick. The R147 forms part of the Fáilte Ireland promoted Boyne Valley Driving Route. Scenic View 53A, as listed in the Meath County Development Plan, looks east from Bloomsbury Cross Roads. The Teltown landscape is recognised for its archaeological significance, but individual features are not particularly accessible or promoted. This area is recognised for its tourism potential in the Meath Landscape Character Assessment. A walking route is proposed in the Meath County Development Plan for along the river Blackwater. Fields are generally medium sized and bound by hedgerows of varying height and condition. However, closer to the river Blackwater and particularly in the townland of Teltown, the landscape consists of large open fields with few hedgerows. The landscape also contains dispersed houses and farm buildings along with the small settlements of Donaghpatrick and Gibstown.

Table 5-6 Summary of effects of elements of Partial UGC

Note: Unless otherwise stated, effects are considered adverse. Ratings of significance have not been given as this is a high level appraisal.

Element	Landscape effects	Visual effects	Period of impact
Sealing end compound	*	*	Construction /Operation
Sealing end compound screening	* (positive)	* (positive)	Operation
Soil excavation and storage	*	*	Construction /decommissioning
Haul road	*	*	Construction /decommissioning
Vegetation removal	*	*	Construction /decommissioning
Reinstatement of shallow-rooting vegetation	* (positive)	* (positive)	Operation
Permanent removal of trees and hedgerows	*	*	Operation
Construction machinery		*	Construction /decommissioning
Maintenance machinery		*	Operation
Fencing		*	Construction
Changes to drainage pattern	*	*	Operation
Manholes at 600-900m intervals		*	Operation
Vegetation changes arising from drainage changes	*	*	Operation
Cross-directional drilling	*	*	Construction

140 The northern sealing end compound is located in relatively flat agricultural lands with a strong hedgerow pattern which provides good screening. There would be views of the sealing end compound from some parts of the local road to the east. Screen planting could be successfully established in this area.

141 The southern sealing end compound is located to the south of the R147 close to a cluster of houses and a garage.

5.9.2 Mitigation Measures

142 Potential mitigation measures include (following the construction period) removal of all soil storage mounds, fencing and reinstatement of vegetation within the parameters of the rooting restrictions over the trench. Screen planting of up to 5m is around each sealing end compound which within 10-15 years would have reached a height where the structure starts to become visually absorbed into the wider hedgerow pattern.

5.9.3 Potential for this UGC section and Conclusion on Impact Significance

143 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along the lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. Strips of hedgerows (of 10m width) along the entire length would be permanently removed and this change would be most readily experienced by viewers at road crossings. Up to 22m widths of vegetation would be removed for the construction period and reinstated vegetation would take a number of years to establish. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals of 600-900m along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual impact of UGC is less than that of the OHL in this location.

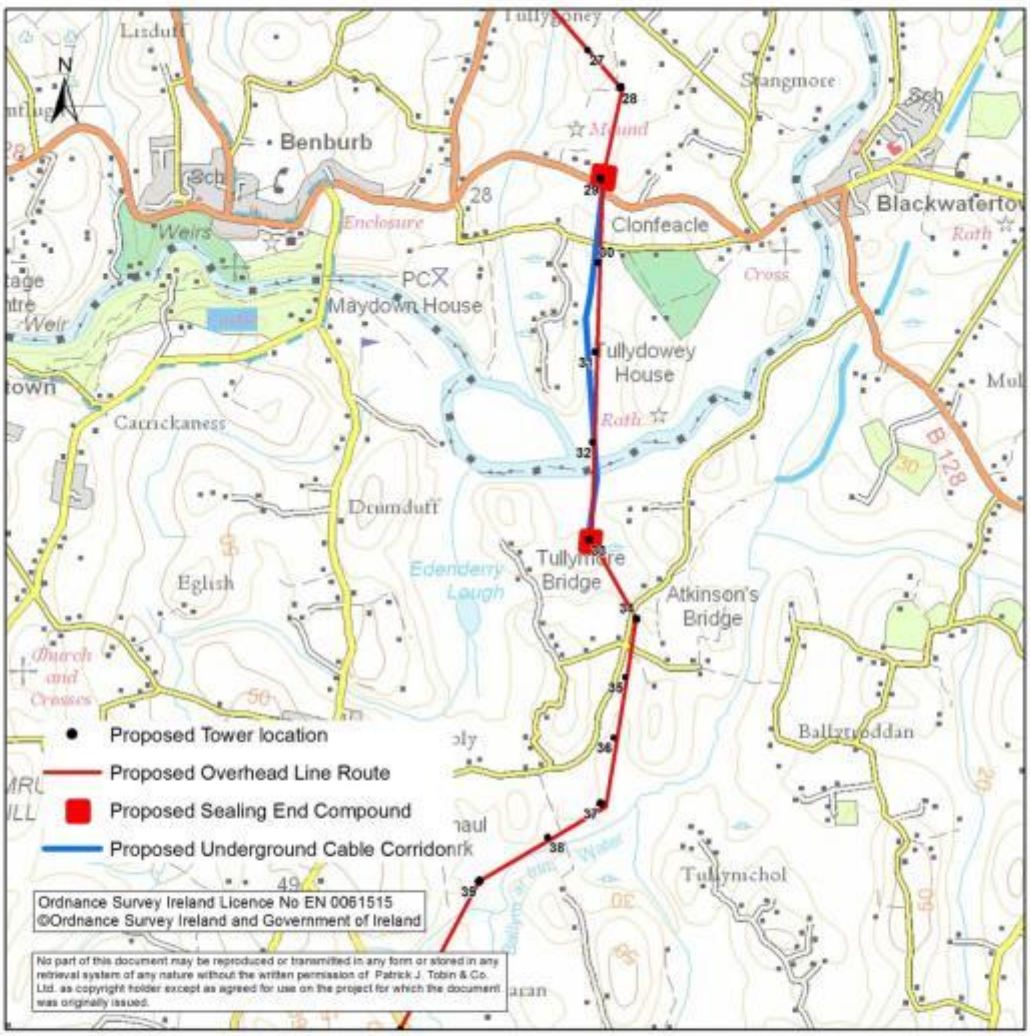
6 BENBURB AREA UGC ROUTE 3C: TOWER 29 - 33

6.1 INTRODUCTION

1 As outlined in Section 1.4 this 10km of partial UGC can be used in the parts of the study area in both Northern Ireland and Ireland. For this reason this report considers the potential for partial undergrounding in Northern Ireland in addition to Ireland, albeit recognising that the report is prepared in response to a request from An Bord Pleanála which is concerned with that part of the proposed development in Ireland only.

2 The potential UGC subsection brought forward for consideration in the area around the Benburb Area is subsection 3C, from Tower 29 to Tower 33.

Figure 6-1 Benburb Area UGC Route 3C between Tower 29 and Tower 33 (Approx 1.8 km)



6.2 TECHNICAL CONSIDERATIONS – UGC ROUTE 3C TOWER 29 – 33

6.2.1 Alignment Details

3 The underground section would commence from a sealing end compound at Tower 29. This compound would be the Type A compound location (i.e. the smaller of the two). This is because of the proximity of the compound to residential properties and to public roads. The underground route would travel from the T29 to the south under the Clonfeacle Road and largely follow the overhead line route. The underground cable route would divert to the west of the OHL route between the Tower 30 and Tower 31 location. This diversion would take the route closer to a number of properties. The underground cable route would continue past the Tower 32 location, crossing the River Blackwater (Armagh) slightly to the east of the OHL crossing point. The underground cable route could terminate at the Type B compound at Tower 33, south of the river. Tower 33 would be located slightly to the south east of its location to accommodate the compound. At this location the line would convert back to an OHL route and continue to Tower 34 following the proposed OHL route.

4 Access to the Tower 29 compound would from the Clonfeacle Road and the Tower 33 compound would be from the Artasooly Road. Neither of the locations has been assessed as a permanent access location and their suitability would require consultation with Transport NI (formerly Roads Service).

5 Construction access to the underground trench would be provided at Tower 29, where the route bisects the Clonfeacle Road and the Tullydowey Road and the access tracks proposed to Tower 33. A construction haul road would be provided alongside the underground trench. No bridging of the River Blackwater (Armagh) would be required as access can be provided from either side of the river.

6 The alignment details for the UGC subsection at the Benburb Area are shown in Figure 6.1.

6.2.2 Road and River Crossings

7 Potential UGC Route 3C includes two roads crossings and one river crossing for which the potential method of construction would be crossing of the river using horizontal directional drilling. The potential route is approximately 1.77 km in length.

6.3 AGRONOMY – UGC ROUTE 3C TOWER 29 – 33

6.3.1 Potential Impacts

8 The construction of the underground cable (UGC) would require fencing off a 22m wide swathe of land along the line of the UGC. Within the construction site the top soil would be stripped back, stored and spread over the site at the end of the construction period. The cables would be situated in excavated trenches 1m – 1.5m deep and the soil would be back-filled and levelled.

9 The impacts which would arise are;

- Damage to the soil profile. This would occur due to the construction traffic and excavation. The construction site would be re-seeded following laying of the cables. Therefore at least one cropping season would be affected and it is possible that reseeded grassland may not come back into production until the following season. The damage to soil would be residual for the short – medium term (2 – 7 years);

- Damage to drainage systems. Where the line of the UGC encounters land drainage systems there is potential for causing damage to these systems;

- General construction disturbance to the farm enterprises. The actual construction site would be unavailable for a period of 2 – 6 months on most farms. The construction activity and land area reduction would disturb livestock and cropping programs and interfere with the day to day running of the farm. Because the construction site is a fenced off linear feature there is the potential to cause temporary severance to the farm;

- There would be residual permanent disturbance to the farm enterprise. The presence of an underground cable is an additional safety risk on the farm. Deep cultivations i.e. below normal plough depth would be restricted and land drainage or excavation above the cables would also be restricted;

- There would be a restriction on building or planting commercial forestry;

- The construction of Sealing Stations at each end of the UGC, inspection Kiosks every 2 km and Joining Bays every 0.6km – 0.8km would increase the permanent land requirement for the construction of UGC.

6.3.2 Mitigation measures

10 General mitigation measures for UGC construction are as follows;

- Landowners would be notified in advance of the commencement of construction;
- Fencing would be erected to exclude livestock from construction sites but the contractor would ensure that landowners have reasonable access to all parts of their farm during the construction phase;
- Disease protocols would be adhered to. The contractor would comply with any DARDNI regulation pertaining to crops and livestock diseases;
- If rock breaking or pilling are required owners of livestock in fields adjoining the work site would be notified in advance;
- Locally excavated material would be reinstated across the site following construction. All unused excavated fill would be removed from the site and disposed of at a licensed waste facility;
- Affected land drains would be redirected in a manner that maintains existing land drainage;
- Where top soil is stripped back it would be replaced. All disturbed field surfaces would be re-instated. All soil disturbance works and remedies would be agreed with land owner;
- Any losses or additional costs incurred by the landowner which are directly attributed to the potential UGC route, during the construction phase or the operational phase, including additional necessary remedial works and including losses and or additional costs arising from Farm Support Payments;
- Mitigation relating to potential effects on water quality and soil contamination due to fuel or concrete spillages are similar to those detailed in the outline Construction Environmental Management Plan for the proposed development.

6.3.3 Potential for this UGC section and Conclusion on Impact Significance

Table 6-1 Comparison of Overhead Line and Underground Cable Impacts on Land Use in the Benburb Section

Impacts	Overhead	Underground
Number of land parcels affected[11]	7	7
Area of land disturbance / damage (Ha)	1.7	4.2
Area of land permanently restricted under OHL and UGC infrastructure (Ha)	0.2	1.5
Impacts on farm yards	No significant impacts	No significant impacts
Impacts on forestry	No significant impacts	No significant impacts

11 Construction phase impacts generally do not give rise to significant residual impacts because land use would be unaffected after 1 – 2 cropping seasons. While the construction phase impact would be higher with UGC, the residual impact is low[12] except where there is additional land take due to the construction of sealing end compounds. The impacts along the Benburb section are summarised in Table 6.2. The construction of a sealing end compound result in moderate adverse impacts on two land parcels (increased from slight adverse). The decommissioning phase for the UGC would likely have as significant an impact as that of the construction of the UGC and again would be higher than that for the decommissioning of the OHL.

Table 6-2 Comparison of the Significance of Impacts on Land Use in the Benburb Section

Impact Significance	Residual Impacts	
	OHL	UGC
	(Number of Land parcels)	
Imperceptible	6	4
Slight Adverse	1	1
Moderate Adverse	0	2

12 Within the Benburb subsection there is a preference for the OHL option due to the increase in the number of moderate impacts (i.e. two additional moderate impacts) associated with UGC. The OHL and UGC route would affect the same number of land parcels; however the UGC route would increase the impact from imperceptible to moderate on two of the seven land parcels that it affects. This is as a result of the land take impact of the sealing end compounds. In total the UGC route would temporarily affect 4.2 ha of land and permanently affect 1.5 ha, compared to 1.7 ha temporarily affected and 0.2 ha permanently affected by the OHL.

[11] All of the affected land parcels were assessed in the Consolidated ES.
[12] The evidence from Gas pipelines throughout Ireland is that residual impacts are low.

6.4 ECOLOGY – UGC ROUTE 3C TOWER 29 - 33

6.4.1 Potential Impacts

13 There are no European protected sites within 10km of the underground cable route. However the River Blackwater (Armagh) does ultimately flow into the Lough Neagh and Lough Beg Special Protection Area (SPA). The site is also an Area of Special Scientific Interest (ASSI) and Ramsar. The site has been designated because of the internationally important numbers of wintering Bewick's and whooper swans, nationally important numbers of breeding common tern and it qualifies as a wetland of international importance by regularly supporting over 20,000 of a variety of species of waterfowl in winter.

14 There are two sites which have been identified as Areas of Special Scientific Interest (ASSI) within 2km of the UGC route. However they have been designated for their geological importance and not their ecological importance. The Milltown Benburb SLNCI is 1.6km from the UGC Route 3C and it consists of a disused canal and broad-leaved woodland habitats.

15 The habitats along the undergrounding route are largely improved grassland with some arable fields. The field boundaries were dominated by species poor intact hedges, with occasional species poor intact hedges with trees and fences. The River Blackwater (Armagh) bisects the UGC route and is lined with species poor hedges with trees. Both sealing end compounds are in locations of improved grassland.

16 The UGC route would result in the permanent removal of species poor hedges and species poor hedges with trees. The habitats lost due to land take would be permanently removed from the site during the construction phase. Hedges and trees are of low ecological value. The underground cable route would be constructed through approximately 16 hedgerows/treelines. The construction area would be approximately 20m wide, affecting a habitat area far greater than that of the same length of overhead line, which would oversail the habitat (with trimming of tall vegetation where required).

17 Breeding birds were identified along the UGC route. They were concentrated around the areas of the sealing end compounds and along the River Blackwater (Armagh); however neither of these areas were considered "hot spots" for breeding birds. As part of the greater Blackwater River Valley (Armagh), whooper swans were recorded in low numbers around the study area.

18 The UGC route would not significantly impact breeding birds, unless construction takes place in breeding bird season, without appropriate mitigation. It is not anticipated the UGC route would impact wintering birds.

19 A bat flight line was recorded along the River Blackwater (Armagh) part of the study area. Two badger setts were recorded approximately 220m west of the UGC route. There was no evidence of

otters recorded in the area of UGC route. The UGC route would directly affect a flight line along the River Blackwater (Armagh). It is not anticipated that the UGC would adversely affect badgers.

20 Salmon, brown trout, White-clawed crayfish and European eel (protected species) occur in the River Blackwater (Armagh). There is potential for contamination of nearby watercourses from run-off of pollutants and sediments during the construction phase.

6.4.2 Mitigation measures

21 Mitigation during construction would minimise impacts to the River Blackwater (Armagh) and associated watercourses as a result of the UGC. Measures would be required to ensure that the earthworks required for the trench construction would not affect the water environment and aquatic habitats. The directional drilling under the River Blackwater (Armagh) would require mitigation to ensure no discharges to the River during construction.

22 It would not be possible to restore the hedgerows and treelines lost during construction. Any planting in the vicinity of the underground cable would need to be of shallow roots to ensure that there is no interference. Off-site planting or compensatory planting would be required to compensate for the loss of the affected habitats.

6.4.3 Potential for this UGC section and Conclusion on Impact Significance

23 The installation and potential decommissioning of the UGC would result in the permanent loss of habitats. This land is common in the wider area and this loss would be negligible; however the loss would be greater than the equivalent length of overhead line route. There would be no significant impacts to protected species as a result of undergrounding. The overhead line section would have an increased impact to wintering birds; however with the proposed bird diverter mitigation there would be no significant impact. It is considered that the undergrounding section would have a minor adverse impact.

6.5 SOILS, GEOLOGY & HYDROGEOLOGY – UGC ROUTE 3C TOWER 29 - 33

6.5.1 Potential Impacts

24 Two Areas of Special Scientific Interest (ASSI) have been designated for their geological interest within 2km of the UGC route. Both sites are located in the area of Benburb. However, because of their distance, there would be no impacts to the sites.

25 Land use throughout the study area reflects the characteristics of local soils, and is dominated by agriculture, with the emphasis on improved pasture. Grassland fields are of variable agricultural quality, but most are improved, although there are occasional fields dominated by rushes. Arable farming is localised and where it occurs is generally devoted to the production of cereals.

26 There are no known contaminated land issues in the area of the underground cable route.

27 The construction phase would impact on the ground and geological conditions through the excavations required for the UGC and the sealing end compounds. The extent of the excavations required for the UGC would have a working depth of 1m, for a distance of approximately 1.8km. A more extensive disturbance of the ground would result from the construction of the sealing end compounds.

28 Despite the excavations required, it is considered that the construction works only would have minor effects on the geomorphology of the construction area would not materially change the local slopes and topography. Landform modification would be most marked at the sealing end compound locations, where existing slopes would be regraded to create a suitable platform for the sealing end compound and to provide perimeter screening.

29 The surplus material has been roughly estimated at this stage as set out in Table 6.1 below.

Table 6-1 Excavation volumes

Location	UGC – excavation volume	OHL – excavation volume
Benburb Area	14,170	535

30 The underground cable installation would require the construction of a 1m deep trench and a launch pad for directional drilling under the River Blackwater (Armagh).

31 It is anticipated that at certain locations, especially in the lower-lying areas, the groundwater table is shallow. There also is potential for perched water within the variable superficial deposits. Accordingly, groundwater controls may be necessary to manage shallow groundwater. In these

areas it would be necessary to depress by pumping the groundwater level to maintain a dry operational area for installation of the underground cable.

32 Dewatering of the excavation would depress the groundwater level in the vicinity of the excavation. Any impacts would be restricted to the short period of pumping. The extent of the impact of the dewatering depends on the hydraulic characteristics of the strata and the amount of drawdown of the groundwater level necessary to achieve the required dewatering. Any impact on the surrounding groundwater level reduces significantly with increasing distance from the point of abstraction. Under normal conditions, it is unlikely that significant effects would be recorded more than 50m from the point of abstraction, although effects may be recorded more than 100m from the excavation. As the maximum depth of the excavation approximately 1m, the maximum drawdown required to provide a dry working area would be less than 1m. Due to the limited drawdown and the short period of pumping required, it is considered that any significant impacts on the groundwater level would be realised only in close proximity to the point of abstraction.

33 Pumping from the excavations would locally modify the direction of groundwater flow. This could result in intercepting groundwater which normally would flow to nearby watercourses or could result in derogation of existing springs, wells and boreholes in the vicinity. The water pumped from the excavation would need to be discharged off-site, following treatment. The most likely destination for the discharge would be to the nearest watercourse or to a soakaway within the working area, subject to the ground conditions. Accordingly, any groundwater intercepted in the excavation, which would have discharged naturally as baseflow to the watercourse would still discharge to the watercourse. As a result, it is concluded that there would be no significant adverse impact on the flow in watercourses as a result of any dewatering.

34 The installation of the underground cable has the potential to cause a temporary modification in the local groundwater level and flow and to impact on water quality through dewatering and the discharge of the pumped water to the surface and/or groundwater systems.

35 Operational impacts on geology and groundwater would be negligible. In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

6.5.2 Mitigation measures

36 Any impacts of the construction of the UGC on geology and soils would be restricted to the locations of the underground cable, sealing end compounds and access route.

37 Measures to minimise the effects of the construction activities on local geology include re-use of in-situ materials, wherever possible, and the importation of additional materials, where necessary, from local sources

38 Measures to reduce any impacts on soils would include:

- Controlling working practices, for example, by minimising land take to that required for the construction process; avoiding repetitive handling of soils; minimising vehicle movements off-road; and minimising the size of stockpiles to reduce compaction of soils: and,

- Re-instatement of soils to their original location, wherever practical.

6.5.3 Potential for this UGC section and Conclusion on Impact Significance

39 The underground section would have an increased impact to soil, geology and hydrogeology in comparison to the overhead line, resulting from significantly more earthworks. The underground cable route is likely to have a temporary minor adverse impact.

6.6 WATER – UGC ROUTE 3C TOWER 29 - 33

6.6.1 Potential Impacts

40 The most significant surface water feature is the River Blackwater (Armagh) and the study area for the UGC route lies within its catchment. East of Benburb, the River Blackwater crosses the study area from west to east, before flowing northwards and eventually draining into Lough Neagh.

41 The River Blackwater (Armagh) is designated under the Water Framework Directive (WFD) as a heavily modified water body that is classified as currently being at Poor Ecological Status, with the exception of the stretch of River Blackwater from Benburb to Ballymartrim Water which is at Moderate Ecological Status (Table 8.5 of the Consolidated ES (2013) provide details of the classification as of 2012). Atlantic Salmon and Trout use the tributaries of the Blackwater as spawning grounds, and the River Blackwater was formerly considered a salmonid fishery under the Fish (Consolidated) Directive before it was subsumed by the WFD. The previous Environmental Statement recorded the importance of this watercourse as Very High.

42 There are two other known watercourses in the study area, both small tributaries of the River Blackwater (Armagh), with one to the north and one to the south. To the north a minor watercourse flows southwards towards the River Blackwater a short distance to the east of the potential UGC route. To the south, a watercourse drains northwards just to the east of tower 33 towards the River Blackwater. No readily available water quality data was available for these watercourses and the Consolidated ES recorded their importance as low.

43 Sealing end compounds link the overhead line to the partially undergrounded section. The size of these Sealing end compounds would be less than 1 hectare and would consist of an inner compound enclosing the live high voltage equipment, a small building, with a buffer strip around the compound to accommodate an earth berm and or vegetation for screening.

44 The construction activities associated with the UGC route would result in a corridor approximately 22m wide and 1.3m deep. The undergrounding corridor would include two 1.8m wide trenches placed approximately 3.2m apart and being serviced by an access track which would be able to accommodate vehicles to transport cable drums weighing 45 tonnes or more, along with large cranes for offloading and equipment handling. In addition to the equipment used to dig the trench to facilitate cable laying, directional drilling under the River Blackwater (Armagh) would be proposed. Construction activities associated with the UGC would be short term and transient in nature, occurring along the entire length of the UGC route.

45 During construction there would be the potential for certain activities (e.g. earthworks) to lead to the creation of sediment rich runoff from the working areas and access roads where mud may be deposited by construction vehicles. The excavation of earth for foundations and the movement of plant and vehicles would increase the potential for runoff to contain fine particulates, and potentially oils and other substances (concrete). High sediment load in runoff may also arise where dewatering

activities are required during excavations or the management of arisings from directional drilling. In watercourses, suspended solids can potentially impact on surface water quality, have direct physical impacts by clogging the gills of fish and covering spawning sites leading to loss of habitats on the riverbed and stunting aquatic plant growth by limiting oxygen supplies, shelter and food sources. Since many of the watercourses that may be impacted are small with limited dilution and dispersion potential, and as works may be required in close proximity to them they would be sensitive to changes in water quality.

46 There would be the potential for accidental spillage or release of potentially contaminative construction materials (such as cement, concrete, diesel or hydraulic fluid) directly into field drains in the vicinity of construction activities.

47 Due to the proximity of the minor watercourse to the sealing end compound at tower 33, moderate adverse impacts from silt laden runoff and the risk of chemical spillages are predicted without mitigation taken into account. The sealing end compound at Tower 29 is remote from any known watercourses and should not give rise to any adverse impacts on the water environment, although best practice mitigation measures to manage site runoff would still be implemented.

48 The UGC route would run close to and parallel to a minor watercourse slightly to the east, with at least two possible flow pathways connecting them, although there may be others. There would be a risk that construction works could result in silt-laden runoff (e.g. from bare ground, earthworks and dewatering of excavations) and chemical spillages that might impact this watercourse. Runoff contaminated with high concentrations of silt or oils might eventually discharge into the River Blackwater (Armagh), although some natural attenuation would be provided by the drainage ditch and the dilution and dispersion potential of the River Blackwater (Armagh) would help to reduce any potential adverse effects. Overall, construction activities associated with the underground cable would be short term and transient in nature, occurring along the entire length of the underground cable route. With the implementation of mitigation measures as discussed below a negligible impact would be predicted.

49 South of the River Blackwater (Armagh), the UGC would cross a minor watercourse using an open-cut technique either involving damming and over pumping or damming and fluming. Straw bales, sand bags or clay (on a geotextile) would be used to dam the watercourse with the flow either pumped around the excavation or flumed through a 10 m pipe. The bed material would be excavated and substrate stored in homogenous layers so that it can be reinstated. Measures to prevent erosion of the bed and banks at the downstream end of the flume or pipes would be provided (e.g. baffles). During construction there would be short term and temporary moderate adverse impacts from physical impacts, the mobilisation of sediments, and the risk of chemical spillages. However, physical impacts would be restricted to a short section of the ditch, which would be fully reinstated after completion of the works, although a minor adverse impact may persist in the short to medium term until bank side vegetation re-establishes.

50 The cable would be conveyed beneath the River Blackwater (Armagh) by HDD at a depth below the bed to be agreed with NIEA as part of the Flood Defence Consent application process. There would therefore be no direct impacts on the watercourse. Arising from the drilling exercise and any sludge would be stored in temporary lagoons or pumped out for removal off site and disposal and a suitable licensed waste management site. Providing the mitigation measures as set out later in this Chapter are adopted, the potential effects on the River Blackwater from silt laden runoff and spillage risk are slight adverse only.

51 Operational impacts on surface water and groundwater water would be negligible. In the event that the cable route section is to be decommissioned, all underground cables, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts on surface water and groundwater would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

6.6.2 Mitigation measures

52 Section 8.5.1 of the Consolidated ES provides information on mitigation measures to manage and control construction works and all measures referred to therein would be adopted during the installation of the UGC. Silt-laden dewaters or runoff from the site would not be discharged to any watercourse untreated and measures to prevent, contain and remediate any chemical spillage would be implemented. However, due to the different nature of construction activities for the installation of this cable additional mitigation measures would be required.

53 Water quality data for the River Blackwater (Armagh) would be obtained from NIEA and used as a baseline against which construction works would be monitored. Works and watercourses would be inspected daily during construction works that might affect watercourses. This would focus on open crossings and the proper operation of mitigation measures, including adherence to any specific consent requirements.

54 Disturbance of bankside soils and in-stream sediments would be kept to the minimum required for the cable laying process. Banks and stream beds would be stored in homogenous layers and reinstated in a manner that would minimise the potential for erosion and return the river/stream to as close to its original condition as possible.

55 The permanent surface water drainage system at the sealing end compounds would utilise SuDS (Sustainable Drainage Systems) where appropriate, or if not possible bypass oil interceptors. Runoff from the hardstand areas would be limited to Greenfield runoff rates.

6.6.3 Potential for this UGC section and Conclusion on Impact Significance

56 As a linear development, the UGC route would cross a number of surface watercourses that vary in size, importance and sensitivity. The majority of the watercourses are small unnamed streams or drains that are tributaries of the larger River Blackwater (Armagh).

57 There would be the potential during construction of the underground cable and sealing end compounds for temporary adverse impacts on the surface water environment leading to short term reductions in water quality and degradation of the water environment, with the physical impact of open-cut crossings persisting in the short to medium term.

58 In assessing the significance of impacts careful attention has been made to the importance of the water receptors and the magnitude of any effect, taking into account the relatively small scale and duration of the works. Regardless, it is an offence to knowingly pollute a Controlled Water and therefore irrespective of the impact assessment, adequate mitigation measures have been set out to prevent pollution occurring in all locations.

59 As part of the preconstruction works, thorough landowner consultation would be undertaken to further develop a construction methodology that avoids an impact on farming in the area.

60 During operation it is predicted that there would be no significant permanent or long term adverse impacts from the underground cable or sealing end compounds providing the drainage system would be well maintained and a Pollution Prevention Plan would be operated.

61 In conclusion, notwithstanding mitigation measures, UGC would present a greater potential risk to water than OHL. This would be because of the more extensive construction works that increase the risk from silt-laden runoff and spillages, and the greater complexity of works to cross the River Blackwater (Armagh).

6.7 TRAFFIC – UGC ROUTE 3C TOWER 29 - 33

6.7.1 Potential Impacts

62 In order to assess the potential traffic impacts and effects, it is first necessary to consider the construction methodology envisaged and secondly to assess the locations along the UGC route where the potential exists for traffic disruption. The likelihood of full or partial road closure is assessed followed by the determination of feasible diversion routes required due to the construction works. Possible mitigation measures along national, regional and/or local roads are also considered.

63 For a project of this size, some disruption to traffic would occur during construction. However, the requirement for a detailed Construction Phase Traffic Management Plan would minimise and reduce any possible construction impacts associated with traffic diversions and road closures.

64 The UGC covers approximately 1.8km running between Tower 29 (Clonfeacle Road) and Tower 33 (Artasooly Road). For the purpose of the assessment the study area relates to the roads where the permanent accesses are to be located. The study area consists of a B class road and two rural unclassified roads, specifically:-

- B103 Clonfeacle Road;
- Unclassified Artasooly Road (generally greater than 4m in width); and
- Unclassified Tullydowey Road (generally less than 4m in width).

65 The section of UGC also includes crossing the River Blackwater (Armagh).

66 The construction of the UGC results in a corridor width of between 20-22m along the length of the UGC route. This corridor would contain two number trenches for cable ducts and sufficient working width for plant and machinery.

6.7.1.1 Cable Construction Methodology General Comments

67 Minor temporary disruption to traffic is envisaged during construction and installation of the cable. Where the cable crosses an existing carriageway on the B103 Clonfeacle Road, the construction of the UGC would utilise temporary lane closures (the closure of one traffic lane) with the implementation of a Stop/Go traffic management system. This method facilitates the flow of traffic past the works on the existing road network. Once one half of the carriageway crossing has been constructed, works would commence on the remaining portion of the carriageway while allowing traffic to pass on the section of carriageway previously completed.

68 In the instance of the Tullydowey Road, the width of the road is such that lane closures would not be possible at the location of the UGC crossing. Therefore this section of the Tullydowey Road would

be closed for the duration of the carriageway crossing construction with diversions in operation. From traffic survey data obtained in 2013 the Tullydowey Road has an average daily traffic flow of 54 vehicles, hence the impact would be minimal.

69 The majority of construction generated traffic associated with the UGC route would result from additional material deliveries, such as additional concrete truck deliveries, and the removal of surplus material, resulting from excavation of the UGC route.

70 Similar to the overhead line construction it is expected that construction traffic volumes would have a maximum daily flow of 200 vehicles, and peak hour calculation on the basis of a 12 hour working day relating to 16 vehicles per hour. i.e. 8 in and 8 out. However, it should be noted that this is a maximum daily flow expected to occur with deliveries of materials/ equipment and does not represent a sustained daily flow throughout the construction period.

6.7.1.2 Spoil

71 In terms of spoil material to be removed from site there are three possible sources:

- Cable trench;
- Joint bays; and
- Sealing End Compounds.

72 Similar projects carried out by National Grid have indicated that the volume of spoil excavated for an underground cable where two cables per phase are installed is some 14 times more than for an equivalent above ground route.

73 For comparative purposes the above ground construction methodology generated:

- Tower 29 – 158 tonnes of spoil equating to 9 trips off site (18 tonne loads); and,
- Tower 33 – 293 tonnes of spoil equating to 16 trips off site (18 tonne loads).

74 Therefore on this basis the volume of spoil for the underground cable would see an increase to 123 trips off site from the access to Tower 29 and 227 trips off site from the access to Tower 33. It should be stressed however that these are worst case maximum trips off site and where possible spoil would be backfilled and compressed. Furthermore the increase of spoil output would be offset by the reduction in concrete, stone and steel deliveries that would be required for the above ground construction. Therefore daily volumes of heavy goods vehicles are likely to remain at a similar level to that of the above ground construction at both access points. Again as note above construction traffic volumes would be limited to a maximum daily flow of 200 vehicles.

75 As per the above ground methodology, licensed landfill sites would be used to dispose of waste spoil from the construction. There are a number of landfill sites in the area that can be used to dispose of the waste and spoil material. These include for example Tullyvar Landfill Site, near Aughnacloy the Aughnagun Landfill Site near Mayobridge and the Lisbane Landfill Site near Tandragee.

76 Due to volume of spoil to be removed off site, wheel cleaning facilities would be provided for relevant vehicles.

6.7.1.3 Typical Construction Vehicles

77 As per the above ground tower construction it is expected that the same vehicles would be employed for the UGC construction, specifically:-

- Fastrac with low loader trailer: - This vehicle would represent the majority of the construction vehicles and would be responsible for delivery construction apparatus e.g. dumper/ excavator/ rock breaker, delivery of cable drums, delivery of precast concrete components/ Cement sand materials, delivery of any steel materials.

- Tipper Lorry (22 tonnes):- This vehicle would be used to deliver stone material if required and may be used to transfer excess spoil from the site.

- Concrete Lorry ($8m^3$):- In the instance of the joint bay construction and the Sealing End Compounds these vehicles would be employed to deliver the concrete. Where conditions on the associated access track adjacent to the UGC trench are not suitable for the concrete lorry, they would off load onto a dumper which would then ferry the concrete to the required location.

- Transit type van: - staff would be transferred to the construction works from the NIE Depot in Cairn via transit vans.

6.7.1.4 Sealing End Compounds

78 The UGC section would require a Sealing End Compound at either end of the UGC section, with one located adjacent to the Artasooly Road and one adjacent to the Clonfeacle Road. These compounds are required to carry the cables from the underground duct to the adjacent tower. Such compounds would be accessed via a permanent access road for routine inspection and maintenance. During the construction of the sealing compounds, an increase in traffic to and from the site at these locations would be on the local road network. During the operational phase, traffic impacts associated with routine inspection and maintenance are envisaged to be negligible.

79 As part of the previous above ground tower section, construction access points where created to facilitate towers 29 and 33. It is expected that the construction access points would become permanent accesses to facilitate routine maintenance and inspection. The traffic volumes

associated with the maintenance/ inspection are negligible and limited to either cars or Light Goods Vehicles (LGVs) such as transit vans.

80 The accesses have been designed in accordance with Development Control Advice Note (DCAN) 15 and achieve the required visibility requirements at their specific location. Furthermore the accesses have been designed to accommodate the largest vehicles expected during the construction phase.

6.7.1.5 Rivers

81 The UGC route crosses one river and the crossings would be directional drilling. This technique may result in extended construction times associated with the procedure, which may increase traffic to and from both sides of the River Blackwater (Armagh). It is envisaged that as a result of the operations, local area traffic would experience an increase in site traffic for the duration of the river crossing process.

6.7.2 Mitigation Measures

82 During construction, the main impacts along the route of the UGC would be temporary lane closures on the Clonfeacle and Artasooly Roads, temporary traffic diversion on the Tullydowey Road, temporary road closure on the Tullydowey Road and short-term access restrictions.

83 As per the previous above ground tower section analysis, the impacts on the Clonfeacle Road were considered negligible. The traffic associated with the construction of the towers equated to a 1.6% impact in the AM peak and a 2.7% impact in the PM peak. Therefore as it is expected that the UGC construction would employ similar levels of construction traffic, the traffic impacts are still considered negligible.

84 Impacts on the Artasooly Road were noted to be higher with a traffic impact of 9.0% in the AM peak and 10.7% in the PM peak associated with the above ground tower sections. It is expected that the UGC would display similar traffic impact levels. However, due to the Blackwater River (Armagh) crossing, which would be accessed through this point, the impacts may extend over a longer period of time. The impacts in the Artasooly Road are taken in the context of the existing traffic flow and potential road capacity. The calculation of Congestion Reference Flows (CRF) of a link is an estimate of the Annual Average Daily Traffic (AADT) flow at which the carriageway is likely to be congested in the peak periods on an average day (DMRB Volume 5 Section 1 TA 46/97 'Traffic Flow Ranges for use in the Assessment of New Rural Roads). The CRF for the Artasooly Road is noted to have a value of 2,293 vehicles (per day); a traffic survey of the Artasooly Road indicated a daily flow of 460 vehicles. Hence with a spare capacity of 1833 it is considered that the impact of the UGC construction traffic would be nominal.

85 A Construction Traffic Management Plan (TMP) would be employed by the main works contractor, prior to construction, in consultation with Transport NI. The plan would outline minimum working

practices on public roads, details on traffic management arrangements, temporary road/ lane closures and arrangements for communicating details of diversion routes, vehicular movements and restrictions to members of the public and affected landowners. The construction TMP would also include details related to working hours, parking and access arrangements onto the existing road network.

86 The implementation of the Construction TMP would ensure that local traffic flows as freely as possible with Two-way traffic being maintained wherever possible on wider roads.

87 The duration of partial/temporary of full road closures would be kept to a minimum in order to reduce impacts on local road traffic. All closures would be discussed and agreed with the Transport NI in the development of the Construction TMP. Where temporary road closure is required such as the Tullydowey Road, a temporary diversion route would be agreed and provision at such locations for access by residents and deliveries would be maintained as far as reasonably possible.

88 As identified in the previous above ground work the access onto the Clonfeacle Road would require two specific mitigation measures as part of the Construction TMP:

89 Traffic Management at the Site Access, i.e. large construction vehicles such as the Fastrac with low loader trailer would be limited to left in and left out manoeuvres

90 Shuttle running traffic management on the adjoining road would be employed, i.e. to facilitate materials being transferred from the site access to the construction area. Similarly, the access onto the Artasooly Road would employ shuttle running traffic management.

6.7.3 Potential for this UGC section and Conclusion on Impact Significance

91 The above assessment demonstrates that the construction of a section of UGC can be facilitated between Clonfeacle Road and Artasooly Road. The construction traffic levels are expected to be in the same order as the previous above ground construction analysis but may extend over slightly longer periods of time.

92 The traffic impacts would only be during the construction phase and therefore are a temporary effect of the development. Artasooly Road which would experience a temporary increase of greater than 10% has shown to have the operational capacity to accommodate the additional temporary traffic associated with the construction of the towers. Mitigation measures would be put in place to ensure the impacts of the access points are minimal and do not impede the local road network.

6.8 CULTURAL HERITAGE – UGC ROUTE 3C TOWER 29 - 33

6.8.1 Potential Impacts

93 The cultural heritage sites recorded within the immediate study area have the potential to be impacted by the partial undergrounding.

94 There is the potential that previously unrecorded archaeological sites may be discovered during the partial undergrounding construction work.

95 No topsoil removal is required for the construction of access tracks. Where possible, existing tracks have been incorporated into the proposals and would be used. Any new tracks would be constructed on the surface. Therefore access track construction would not impact upon any archaeological sites.

96 Tullydowey House Gate Lodge is a Grade B1 listed building to the south of tower 29. It is of architectural significance due to the style of architecture it represents with features including a slate roof and decorative edging around the gables. It also has historical significance associated with its place in the history of settlement in the area as well as the associated with the development of the house and estate which it served. The setting of the Tullydowey Gate Lodge comprises its roadside location as well as the landscape surrounding the estate it serves. Although the lodge was not designed to have long ranging views, it was designed to be visible to people approaching it as a secondary entry point for the main house. The gate lodge is primarily of significance for its architectural and historic important although its setting also contributes to its significance. However, the contribution the setting makes to its significance is considered to only be to a minor extent. The gate lodge is considered to be of high value due to its designation as a listed building.

97 It is likely that Tower 29 and the sealing end compound would be visible from the House. While there would be a visual impact upon the setting of the associated Gate Lodge, the building would still be preserved and its architectural and historical significance would still be possible to be understood. Therefore the significance of effect to the Gate Lodge from the UGC route would be slight adverse.

98 Tullydowey House is also a Grade B1 listed building and has gardens and outbuildings associated with it. It is of architectural significance as the asset represents an example of a relatively large formal house with associated outbuildings. It also has historical significance linked to its role in the development of settlement in the area. The setting of the asset comprises the grounds which surrounds it, although these grounds were designed to have some views across the surrounding landscape. Tullydowey House is best understood within its associated gardens and lands. While it is primarily of significance for its architectural and historic importance, its setting also contributes to its significance, although this is considered to only be to a minor extent. It is considered to be of high value due to its designation as a listed building.

99 The Grade B1 Tullydowey House is located to the south east of tower 29 and it is likely that the tower and aspects of sealing end compound would be visible from the House. There would be a

visual intrusion upon the setting of the house including any wider views of the surrounding landscape to the north. However, the mature nature of the woodland that now surrounds the House provides some screening and would limit some views of the tower and compound. The House would still be preserved and it would still be possible to understand its architectural and historical significance. Therefore the magnitude of change to the significance of the asset is considered to be negligible. This is because the House will be preserved, and the contribution the setting makes to its significance is only slightly altered. This equates to a slight adverse significance of impact to Tullydowey House.

100 There would be no significant impacts on archaeology and cultural heritage during maintenance. In the event that a cable route section is to be decommissioned, potential impacts on cultural heritage would likely be less, than for the construction phase, as any cultural heritage features previously directly affected would already have been removed or preserved in-situ during the initial construction phase. Any impacts to setting during maintenance or decommissioning would be temporary and not significant.

6.8.2 Mitigation Measures

101 An archaeological strip, map, record would be undertaken during the excavation of the partial undergrounding of the route. Although no recorded sites would be directly affected, there is the potential for previously unrecorded sites to be located during construction. Any mechanical excavation would be undertaken under archaeological supervision. If archaeological remains or artefacts are discovered, sufficient time would be allowed for an archaeological team to appropriate excavate, clean and record the remains.

102 Access tracks would be constructed without the removal of topsoil. Therefore no archaeological mitigation is required.

103 The mitigation planting and bunding at the sealing compounds would help to limit the impacts. Off-site screen planting at the properties could be provided, however, this is not appropriate as the planting itself would adversely affect the setting of the House and Gate Lodge.

6.8.3 Potential for this UGC section and Conclusion on Impact Significance

104 In terms of Cultural Heritage effects, a programme of archaeological strip, map, and record should be undertaken prior to the excavation for the partial undergrounding of the proposed development between Towers 29 and 33. Effects upon recorded archaeological assets are not anticipated. The partial undergrounding would have an effect upon the setting of two Grade B1 listed buildings Tullydowey House and its associated gate lodge.

105 As part of the Consolidated ES, a detailed assessment of the impact on the Gate Lodge as a result of the OHL was undertaken (Appendix 12F):

"No. 39 Tullydowey Road [the Gate Lodge] *is a listed building which has been significantly altered by large extensions and alterations, diminishing its architectural character and importance. It was the 'back' gate lodge for Tullydowey House but has only a tenuous visual connection with it now, rather than an ownership or functional connection.*

The 'primary' or 'immediate' setting of No. 39 is the entrance, back lane and lands framing the visual connection between the lodge and house. The 'secondary' or 'extended' setting is the wider lands and landscape around the house.

I [the author of Appendix 12F] *do not believe the proposed Inter-connector has an adverse effect on the 'immediate'' setting of No. 39, but it clearly has an adverse impact on the extended setting of the house. I would agree that the overall impact, as defined in Chapter 12 of the Environmental Statement, could be considered as 'moderate adverse'.*

There are no obvious significant mitigation measures possible within this general alignment of an overhead line and so the impact on the extended setting of No. 39 is unlikely to be reduced.

Ultimately, it is for the Department or PAC to make a judgement on whether the extent of impact on the extended setting of one listed building, already compromised in heritage terms by its own extensions, is so significant as to be a reason for refusal of such a major piece of national infrastructure."

106 Further to this detailed assessment, an assessment of plans and policies relevant to the Gate Lodge were outlined (Volume 2, Chapter 3):

"Policy BH11 is again considered in Chapter 12 Cultural Heritage where the impact of the Proposed Development on all listed buildings in the area is assessed. The impact on the former back gate lodge to Tullydowey House (No 39 Tullydowey Road, a grade B1 listed building) is the only building identified as having a moderate adverse impact, which is on its setting only. Notably it is also the only remaining consideration raised by NIEA Protecting Historic Buildings in respect of the Proposed Development. The Proposed Development's impact is addressed in Chapter 12. This advises that the Proposed Development does not have an adverse effect on the primary (or 'immediate') setting

of No 39 Tullydowey Road, but that it has an adverse impact on the secondary (or 'extended') setting of the house. In terms of policy BH 11 the Proposed Development would have an adverse effect however the Proposed Development would be a permissible exception. The word 'normally' (as explained in page 5 of PPS 6) is included in policy because the Department consider it "necessary …to ensure that there is no public misunderstanding of its planning policies. It is generally recognised that on occasion there will be circumstances where other material considerations outweigh these policies".

The impacts of the Proposed Development upon the setting of No.39 Tullydowey Road and other sites of archaeological interest are therefore matters that must be balanced by the decision maker but in terms of Policies BH 1, BH 2 and BH 11 the overriding national/regional need for the Proposed Development clearly outweighs these adverse impacts."

107 These assessments acknowledge that the Gate Lodge would experience a moderate adverse impact to its setting, however the policy relating to its nature as a listed building and the protection of its setting allows for exception for projects of overriding national/regional need. It was concluded that the OHL was not in conflict with the built heritage policy BH11.

6.9 LANDSCAPE – UGC ROUTE 3C TOWER 29 - 33

6.9.1 Potential Impacts

108 The study area lies within County Armagh, the linear corridor runs south from Tower 29 to Tower 33. A portion of the study area includes the River Blackwater (Armagh).

109 The area is predominantly rural in character, with the village of Blackwatertown located to the east and Benburb to the west. It lies within the rural hinterland close to the main settlement of Armagh area and is populated with many scattered farms, dwellings and small commercial buildings. Small villages are located along secondary and minor roads and around local educational or commercial centres.

110 The land within the study area is primarily agricultural, consisting of low rolling hills, shallow valleys and structured fields, which often have overgrown hedgerows and many mature trees.

111 The community is well served by a network of B and C class roads, three of which bisect the site:

- Clonfeacle Road;
- Tullydowey Road;
- Artasooly Road;

112 The River Blackwater, which includes part of the disused Ulster Canal, flows through part of the study area.

113 There landscape is traversed by are small-scale telephone and electrical distribution lines that connect to the many scattered dwellings and settlements. This evidence of human settlement is typical of rural locations in Northern Ireland.

6.9.1.1 Landscape Designations

114 There are no national or international landscape designations within the study area.

6.9.1.2 Register Historic Parks, Gardens and Demesnes

115 The Manor House, Benburb is within the study area and is listed in The Register of Parks, Gardens and Demesnes of Special Historic Interest, Northern Ireland.

116 This section of the study area falls within Landscape Character Area 47: Loughgall Orchard Belt. It's key characteristics are:

- Varied rural landscape pattern, with mixed farmland and horticulture; extensive orchards on sheltered drumlin slopes.

- Wooded designed estate landscapes, parklands and attractive loughs, hilltop copses, mature trees and neat clipped hedges.

- Two types of woodlands: demesnes woodland and wet woodland.

- Numerous scattered dwellings connected by hedge lined winding roads.

6.9.1.3 Landscape Description

117 The Loughgall Orchard Belt extends from Portadown to the M1 motorway, the River Blackwater and Armagh. The area is characterized by low drumlins, which fall towards Lough Neagh to the north and to the slopes of the Blackwater valley to the west. It is crossed by numerous small river valleys and streams; tributaries of the Rivers Blackwater and Bann. The underlying geology is a mix of sedimentary and contemporaneous igneous rocks and gives rise to rich brown soils.

118 The upper slopes of the Loughgall Orchard belt are a mixture of pasture and arable fields, enclosed by hedgerows and some hedgerow trees. Roadside hedgerows are mostly well maintained and there are some short avenues of mature beech and ash trees. Blocks of attractive, well kept orchards are located on the steeper sheltered drumlin slopes with a favourable aspect. Regenerating alder, birch and willow are found on the moss and previous peat extraction has left a typical pattern of rectangular working sites linked by access tracks. There are numerous wooded estate landscapes, parklands, woodland and attractive loughs. Villages, farms and other dwellings are scattered along the sides of lanes and at the end of access tracks. Many cottages are of simple, traditional styles, with a narrow layout and whitewashed exterior.

119 Numerous large houses and churches are a feature of the area. Stone buildings and traditional gate posts are also quite common. Dwellings are connected by winding minor roads lined with hedges and roller coaster like ‘A’ roads. Two lines of existing towers cross the landscape.

120 This is a varied landscape, with a mix of landscape patterns and scales (small to medium). In some areas there are pleasant, long views across mixed farmland to farmsteads, churches and woodlands, but elsewhere, views are restricted by narrow tree and hedge lined roads or intervening areas of regenerating scrub.

6.9.1.4 Landscape Condition & Sensitivity to Change

121 The northern section of this LCA comprises low gently sloping drumlins. It has numerous small streams and the landscape character is generally quite open. The landscape condition is relatively good and the majority of the area has rolling landform with a well-maintained hedgerow structure and good tree cover. The LCA Sensitivity to Change is Medium

122 Two sealing end compound units would be constructed. One to the north of Clonfeacle Road adjacent to the location of a garden centre and Tower 29, and one in the south adjacent to Tower 33. Tullydowey House and Tullydowey Lodge are judged to have high sensitivity and overlook the UGC route as do several properties to the south and west of T30 and 31.

123 Hedgerow removal would be required at road crossings.

124 The UGC route would cross the River Blackwater between T31 and T32 and would require removal of riparian planting.

125 The southern sealing end unit would be visible from Tullymore Bridge and Atkinson's Bridge with partial screening provided by woodland planting to the west.

Table 6-3 Summary of effects of elements of Partial UGC

Note: Unless otherwise stated, effects are considered adverse. Ratings of significance have not been given as this is a high level appraisal.

Element	Landscape effects	Visual effects	Period of impact
Sealing-end compound	*	*	Construction / Operation
Sealing end compound screening	* (positive)	* (positive)	Operation
Soil excavation and storage	*	*	Construction /decommissioning
Haul road	*	*	Construction /decommissioning
Vegetation removal	*	*	Construction /decommissioning
Reinstatement of shallow-rooting vegetation	* (positive)	* (positive)	Operation
Permanent removal of trees and hedgerows	*	*	Operation
Construction machinery		*	Construction /decommissioning
Maintenance machinery		*	Operation
Fencing		*	Construction
Changes to drainage pattern	*	*	Operation
Manholes		*	Operation
Vegetation changes arising from drainage changes	*	*	Operation
Cross-directional drilling	*	*	Construction

126 Mitigation measures include (following the construction period) removal of all soil storage mounds, fencing and reinstatement of vegetation within the parameters of the rooting restrictions over the trench. Screen planting of up to 5m would be provided around each sealing end compound in combination with earth berms, would ensure that within 10-15 years, planting would have reached a

height where the structure starts to become visually absorbed into the wider landscape pattern of fields and hedgerows.

6.9.2 Potential for this UGC section and Conclusion on Impact Significance

127 The northern sealing end compound is located in relatively flat agricultural lands with a strong hedgerow pattern. There would be views of the sealing end compound from the adjacent local road in the immediate vicinity. There would be views from Tullydowey House and Tullydowey Gate Lodge along with longer distance views of the houses to the south and west of Tower 30. However roadside hedgerows and planting within fields between the settlement and the sealing end compounds would filter views. Screen planting and earth berms could be successfully established in the confines of the sealing end unit to help reduce effects.

128 At the river crossing, between T31 and T32, some riparian trees would be lost.

129 Lengths of hedgerow would be lost at the three road crossings.

130 The southern sealing end compound is located to the south of Tower 33. Although there are potential views from Tullymore Bridge and Atkinson’s Bridge, an existing block of woodland located to the west would screen views to the sealing end compound site. Again, mitigation planting and earthworks would serve to provide further screening.

131 Hedgerow removal would be most readily experienced at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual amenity is considered to have the capacity to accommodate the UGC.

132 There are likely to be physical effects arising from localised vegetation removal for the potential underground cable option. The sealing end compounds would introduce new elements into the landscape character, which with mitigation including earth bunds and native planting would have reduced impacts locally and when considered in conjunction with the UGC route between Towers 29 and 33 are assessed as having reduced effects. There would be visual effects experienced by residential receptors arising from the sealing end units. However, after construction and once mitigation planting reaches maturity, providing partially screened views, it is considered that overall the visual amenity would accommodate the UGC route without significant adverse effects.

133 There are no predicted residual significant effects for Benburb as a settlement and constraints within (e.g. Benburb Priory and Benburb Castle) arising from the potential UGC Route.

134 It is concluded that UGC route would be preferred to the OHL.

7 POTENTIAL FOR PARTIAL UGC TO MITIGATE SIGNIFICANT LANDSCAPE IMPACTS

7.1 INTRODUCTION

1 As outlined in Section 1 of this report, An Bord Pleanála examined the draft application file under Article 10.4(c) of Regulations 347/2013 and their request for information to be submitted included the following relating to partial undergrounding: *"Where significant impacts on landscapes/demesne landscapes are identified, the EIS should address the potential for partial undergrounding of the line to mitigate those impacts".*

2 This chapter provides the conclusions from a Landscape perspective as to the potential for partial undergrounding to mitigate significant landscape impacts.

7.1.1 Boyne valley Tower 350 - 363

3 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. An approximate 10m width of trees on the northern side of the Boyne River would be permanently removed, along with 10m strips of hedgerows along the entire length. Up to 22m widths of vegetation would be removed for the construction period and reinstated vegetation would take a number of years to establish. Hedgerow removal would be most readily experienced by viewers at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular 600-800m intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual impact of UGC is less than that of the OHL in this location.

7.1.2 Blackwater Valley Tower 301 - 312

4 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. Strips of hedgerows (10m in width) along the entire length would be permanently removed and this change would be most readily experienced at road crossings. Up to 22m widths of vegetation would be removed for the construction period and reinstated vegetation would take a number of years to establish. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular 600-900m intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual impact of UGC is less than that of the OHL in this location.

7.1.3 Benburb – Tower 29 - 33

5 The highest residual landscape and visual effects would occur in the immediate vicinity of sealing end compounds and at localised points along lengths of UGC which cross hedgerow field boundaries. Riparian trees on both banks of the Blackwater River to be permanently removed. Hedgerow removal would be evident at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals along the route. Increased landscape and visual effects would be limited to receptors adjacent to the sealing end compounds with localised landscape and visual effects arising along the length of the UGC arising from removal of vegetation.

6 Overall, the landscape is reasonably tolerant of the UGC route. With mitigation measures in place, as described in Section 3 of this report, it is anticipated that generally the impacts on landscape and visual amenity arising from the UGC would be less than that of the OHL in this location with potential for increased impacts occurring for residential receptors located in closest proximity to the northern sealing end unit. Overall it is considered that increased physical effects, including removal of portions of hedgerow along the UGC route, would be offset by the reduced landscape and visual impacts arising from the removal between T29 and T33 of both the overhead line and reduction in towers.

8 COMPARISON OF OHL VERSUS UGC ACROSS ALL ENVIRONMENTAL IMPACTS

8.1 INTRODUCTION

1 This chapter provides for a comparison of the potential for a partial underground option versus the overhead option based on the conclusions of the individual specialists for each of the locations considered in Section 4 to Section 6 of this report.

8.2 BOYNE VALLEY TOWER 350 - 363

8.2.1 Agronomy

2 There is no preference in the Boyne Valley for either OHL or UGC from an Agronomy perspective.

8.2.2 Ecology

3 From an ecology perspective UGC presents greater risks than OHL at the Boyne crossing. UGC would have greater potential for significant adverse ecological effects including permanent habitat loss, increased disturbance risk to protected fauna (Otter and Kingfisher) and greater likelihood of pollution to the River Boyne and Blackwater SAC/ SPA. There is no justification for UGC at this location from an ecology standpoint.

8.2.3 Soils, Geology and Hydrogeology

4 The potential UGC option at the Boyne Valley would present a greater potential risk to soils and hydrogeology than OHL, however the overall potential impact is considered localised and minor.

8.2.4 Water

5 Notwithstanding mitigation measures, the UGC option at the Boyne Valley would present a greater potential risk to water than OHL.

8.2.5 Cultural Heritage

6 Although the OHL option would have a greater impact on the setting of cultural heritage sites, it would be preferable to an UGC option at the Boyne Valley location as it is likely to generate fewer direct, physical, irreversible impacts on the non-renewable cultural heritage resource.

8.2.6 Traffic

7 The potential underground option at the Boyne Valley would increase the volumes of construction traffic using the public road network when compared to overhead line construction. Therefore, from a traffic impact perspective, there is no reason to consider the undergrounding of sections of the proposed development at this location.

8.2.7 Landscape

8 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. An approximate 10m width of trees on the northern side of the Boyne River would be permanently removed, along with strips of hedgerows along the entire length. Hedgerow removal would be most readily experienced at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual impact of UGC is less than that of the OHL in this location.

8.2.8 Conclusion

9 In relation to all the potential environmental impacts considered, with the exception of landscape, there is no preference for partial UGC over the OHL option for this Boyne Valley location. Furthermore the UGC option at the Boyne Valley would present greater potential risks (water, soils, hydrogeology) and create greater adverse impacts (traffic, ecology, cultural heritage) than OHL.

10 In terms of visual impact, it is acknowledged that removing towers from views would reduce the extent of visibility of the proposed development in short lengths of sensitive landscape locations such as the crossing of the Boyne.

11 However, as stated in the *Preferred Project Solution Report,* the use of short lengths of UGC would only be considered in the event that an appropriate and acceptable OHL solution could not be found. This is considered to occur if *Profound* impacts, as defined in the EPA Guidelines, were predicted. A profound impact is defined in the Guidelines as one which *"obliterates sensitive characteristics"*. This would be the case if, for example, there are major landscape and visual impacts on highly sensitive landscape features of National or International value The primary mitigation measure in landscape terms is avoidance at route selection stage. The determination of the best route for an OHL resulted in the avoidance of those parts of the landscape in the study area which are most sensitive to the landscape and visual effects of an OHL; including where possible, higher ground and ridgelines, waterbodies, landscape designations and important scenic views. Best practice routing principles (refer to Section 5.4.2.1, Volume 3B of the EIS) also informed the line design process including measures to integrate the line within the landscape where possible. The proposed OHL, derived following the above route selection process, does not result in effects of this magnitude within the Boyne Valley and therefore there is no critical need for partial UGC along the route at this location. It is noted that with respect to Boyne Valley, none of the significant landscape/visual impacts identified in the EIS are classified as "major" on the scale of significance.

12 In summary, there are no impacts of such significance envisaged, including those on landscape that would introduce the need for consideration of partial undergrounding for the proposed development at this location.

8.3 BLACKWATER VALLEY TOWER 301- 312

8.3.1 Agronomy

13 Within the Blackwater valley subsection there is a preference for the OHL option due to the increase in the number of Moderate and Major Adverse impacts associated with UGC.

8.3.2 Ecology

14 From an ecology perspective the partial UGC option presents potential greater risks than the OHL option along the section under consideration in the Blackwater Valley, including the crossing at the River Blackwater. UGC would reduce the collisions risk identified to a regular Whooper Swan flightline between Tara Mines Tailings Ponds and the Blackwater valley area at this location, (albeit with the proposed bird diverter mitigation there would be no significant impact as a result of the OHL). However, overall the partial UGC option would have greater potential for significant adverse ecological effects when compared to OHL including; more permanent habitat loss, greater disturbance risk to protected fauna (Otter and Kingfisher) and greater pollution risk to aquatic ecology in the River Blackwater SAC. It is considered that there is not enough justification for partial UGC at this location from an ecological perspective.

8.3.3 Soils, Geology and Hydrogeology

15 Notwithstanding mitigation measures, the potential UGC option at the Blackwater Valley would present a greater potential risk to soils and hydrogeology than OHL. Whilst the overall residual impact is considered localised and minor, partial undergrounding of the proposed development is not required.

8.3.4 Water

16 Notwithstanding mitigation measures, the UGC option at the Blackwater Valley would present a greater potential risk to water than OHL.

8.3.5 Cultural Heritage

17 Although the OHL option would have a greater impact on the setting of cultural heritage sites, it would be preferable to an UGC option at the Blackwater Valley location as it is likely to generate fewer direct, physical, irreversible impacts on the non-renewable cultural heritage resource.

8.3.6 Traffic

18 The potential underground option at the Blackwater Valley Area would increase the volumes of construction traffic using the public road network when compared to overhead line construction. Therefore, from a traffic impact perspective, there is no reason to consider the undergrounding of sections of the proposed development at this location.

8.3.7 Landscape

19 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. Strips of hedgerows along the entire length would be permanently removed and this change would be most readily experienced at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual impact of UGC is less than that of the OHL in this location at the Blackwater Valley.

8.3.8 Conclusion

20 In relation to all the aspects considered, with the exception of landscape, there is no preference for partial UGC over the OHL option proposed for this Blackwater Valley location. Furthermore the UGC option at the Blackwater Valley would present greater potential risks (ecology, water, soils, hydrogeology) and create greater adverse impacts (agronomy, traffic, ecology, cultural heritage) than OHL.

21 In terms of visual impact, it is acknowledged that removing towers from views would reduce the extent of visibility of the proposed development in short lengths of sensitive landscape locations such as the crossing of the Blackwater.

22 However, as outlined in Section 8.2.8 above and stated in the *Preferred Project Solution Report,* the use of short lengths of UGC would only be considered in the event that an appropriate and acceptable OHL solution could not be found which is considered to occur if *Profound* impacts, as defined in the EPA Guidelines, were predicted. However, as a consequence of the route selection employed at outlined in Section 8.2.8 above, the proposed OHL, does not result in effects of this magnitude within the Blackwater Valley and therefore there is no critical need for partial UGC along the route at this location. It is noted that with respect to Blackwater Valley, none of the significant landscape/visual impacts identified in the EIS are classified as “major” on the scale of significance.

23 In summary, there are no impacts of such significance envisaged, including those on landscape, which would introduce the need for consideration of partial undergrounding for the proposed development at this Blackwater Valley location.

8.4 BENBURB AREA TOWER 29 – 33

8.4.1 Agronomy

24 Within the Benburb subsection there is a preference for the OHL option due to the increase in the number of moderate impacts associated with UGC as a result of the land take impacts from the sealing end compounds.

8.4.2 Ecology

25 In relation to the location at Benburb, the installation of the UGC would result in the permanent loss of habitats that are common in the wider area and this loss would be negligible. However the loss would be greater than the equivalent length of OHL. There would be no significant impacts to protected species as a result of undergrounding. The overhead line section would have an increased impact to wintering birds; however with the proposed bird diverter mitigation there would be no significant impact. It is considered that the undergrounding section would have a minor adverse impact. There is therefore no justification for partial UGC at this location from an ecological perspective.

8.4.3 Soils, Geology and Hydrogeology

26 The underground section at Benburb would have an increased impact to soil, geology and hydrogeology in comparison to the overhead line, resulting from significantly more earthworks. In this case, the OHL would be preferred to UGC.

8.4.4 Water

27 UGC would present a greater potential risk to water than OHL. This is because of the more extensive construction works that increase the risk from silt-laden runoff and spillages, and the greater complexity of works to cross the River Blackwater (Armagh).

8.4.5 Cultural Heritage

28 Significant effects upon recorded archaeological assets are not anticipated as a result of the UGC. Significant pre-construction mitigation measures would be required to ensure underground undiscovered archaeology is not damaged or destroyed during the construction of the UGC. The partial undergrounding would have an effect upon the setting of two Grade B1 listed buildings - Tullydowey House and its associated gate lodge. However the impact would be less than that of the OHL and so UGC is preferred to the OHL in terms of Cultural Heritage impacts. The OHL would have a significant impact on the Gate Lodge, however the built heritage policy does provide for such impacts to listed buildings for projects of overriding national/regional need such as the Interconnector.

8.4.6 Traffic

29 The potential underground cable option at Benburb would likely generate significantly more construction traffic because of the increased earthworks. This would be a minor adverse impact to the local road network and the OHL is preferred to the UGC.

8.4.7 Landscape

30 There are likely to be physical effects arising from localised vegetation removal for the potential underground cable option. The sealing end compounds would introduce new elements into the landscape character, which with mitigation including earth bunds and native planting would have reduced impacts locally and when considered in conjunction with the UGC route between Towers 29 and 33 are assessed as having reduced effects. There would be visual effects experienced by residential receptors arising from the sealing end units. However, after construction and once mitigation planting reaches maturity, providing partially screened views, it is considered that overall the visual amenity would accommodate the UGC route without significant adverse effects.

31 There are no predicted residual significant effects for Benburb as a settlement and constraints within (e.g. Benburb Priory and Benburb Castle) arising from the potential UGC Route.

32 It is concluded that UGC route would be preferred to the OHL.

8.4.8 Conclusion

33 It is acknowledged that the UGC would have reduced impacts in terms of landscape and cultural heritage; however it is concluded that there is no justification for partial UGC at this location over the OHL option proposed for this location at Benburb. The UGC option at Benburb would create greater adverse impacts (agronomy, ecology, soils, geology, hydrogeology and traffic) than the OHL.

34 As outlined in, Section 8.2.8, the use of short lengths of UGC would only be considered in the event that an appropriate and acceptable OHL solution could not be found which is considered to occur if *Profound* impacts, as defined in the EPA Guidelines, were predicted. While the EPA guidelines are not directly applicable to Northern Ireland, the text provides a useful methodology for use in this cross-border assessment. The EPA Guidelines state that a profound impact is one which *"obliterates sensitive characteristics"*. This would be the case if, for example, there are major landscape and visual impacts on highly sensitive landscape features of National or International value. As outlined in the Consolidated ES best practice routing principles informed the line design process including measures to integrate the line within the landscape where possible. Those areas experiencing the most adverse impacts have been identified herein. However, it is considered that the route selection process (as outlined in the Consolidated ES) has avoided such highly sensitive landscape features of National or International value and so the partial undergrounding of Proposed Development would not be justified in the Benburb area.

9 OVERALL CONCLUSION

1 This chapter provides for a comparison of the potential for a partial UGC option versus the OHL option based on the conclusions of the individual specialists for each of the locations considered in Section 4 to Section 6 of this report. For each of the locations identified and evaluated, in accordance with the methodology outlined herein, it has been concluded that there is no overriding justification for the provision of partial UGC when compared to the proposed development i.e. the OHL option, at the respective locations.

2 This report builds on the consideration of the potential for a partial UGC option contained in the EIS for the proposed development, taking into account technical, cost and environmental parameters as included in **Section 4.7.3, Chapter 4 Volume 3B** and the overview of the consideration of partial UGC for the proposed development including a summary appraisal of its use as a mitigation measure as included in **Section 5.4.2.4, Chapter 5 Volume 3B**. That section of Volume 3B provides a full consideration of the option of partial undergrounding along the entirety of the proposed development using technical, environmental and cost parameters. **Chapter 4 of Volume 3B** also specifically addresses the potential reliability and risk issues with the insertion of a section of underground cable in the proposed development. The chapter notes that based on latest industry guidelines:

- AC UGC would cost on average €5.4 million per km more to install than the AC OHL.
- Depending upon the length of an underground section (and therefore the facilities required at each end), transition stations (sealing end compounds) could add an additional €5 - €15 million (approximately) per installation.
- Inserting a section of UGC into an OHL circuit will have a negative effect on the reliability performance of the overall circuit

3 While this Report has specially addressed the potential for partial UGC to mitigate significant impacts on landscape / demesne specifically from an environmental perspective and found that there is no justification for the provision of partial UGC, these cost and technical conclusions are entirely valid and further support the final conclusion of this Report. For example, if all 4 options were to proceed, the resultant additional cost to the project would be between €94 and €174 million euro.

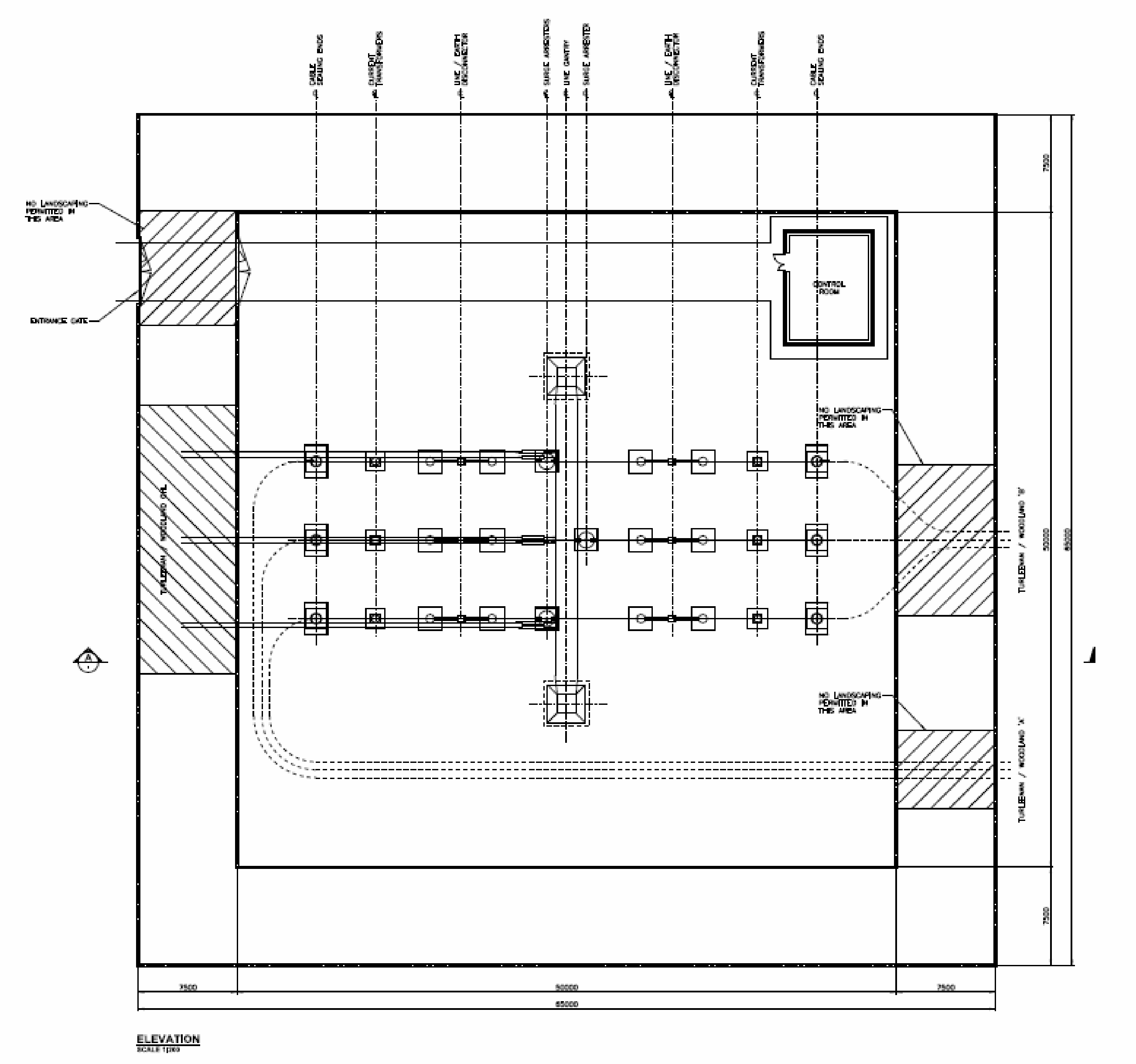
4 Again it is reiterated that, as the 10km of partial UGC can be used along the entirety of the proposed interconnector, this report considers the potential for partial undergrounding in Northern Ireland in addition to Ireland, albeit recognising that the report is prepared in response to a request from An Bord Pleanála which is concerned with that part of the proposed development in Ireland only.

5 As outlined in Section 3.2.1, Annex 7 of this report provides a supplementary appraisal which applies this methodology to Ireland only.

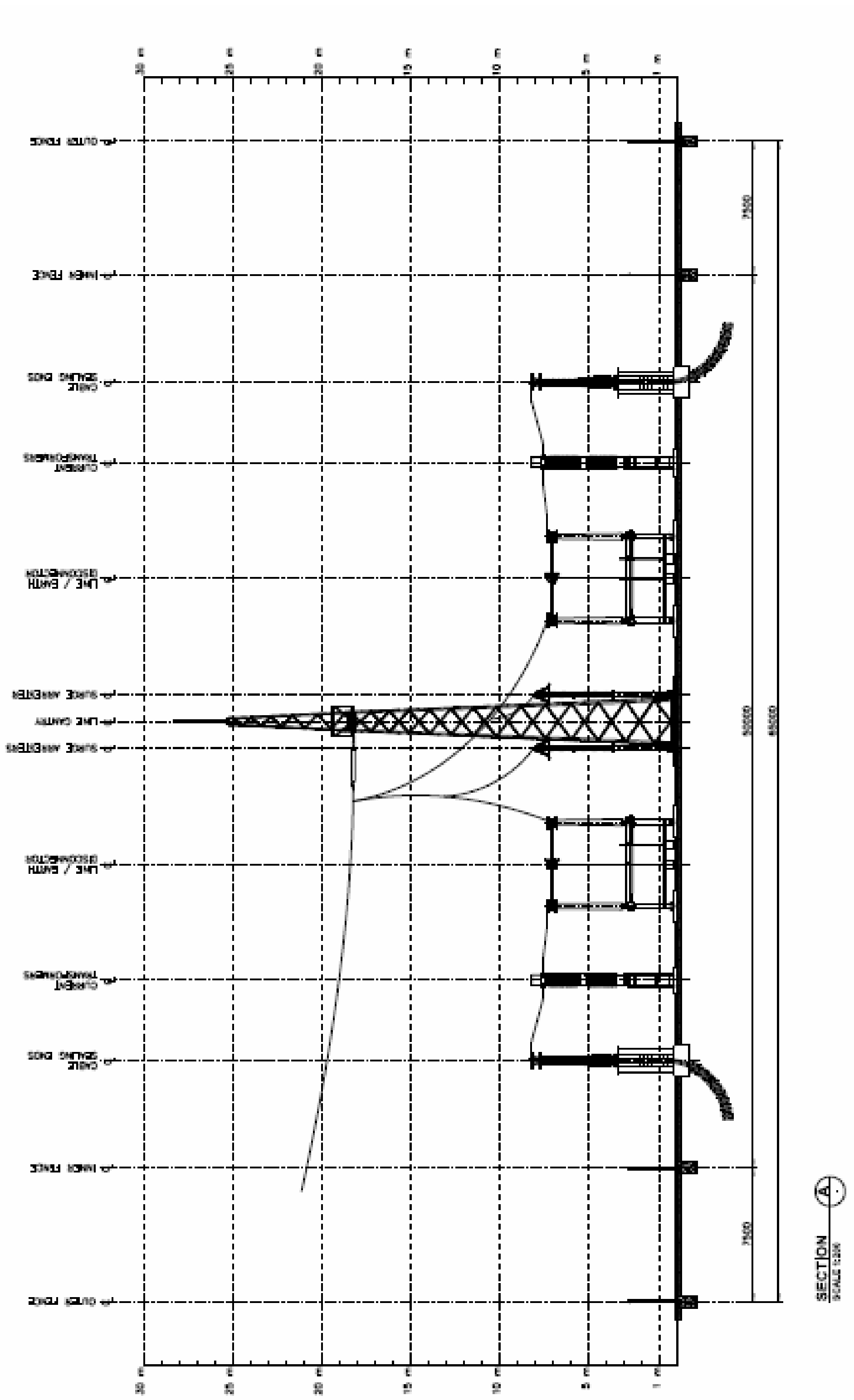
ANNEX 1

A. Sealing End Compound Layout – Type A (plan)
B. Sealing End Compound Layout – Type A (section)
C. Sealing End Compound Layout – Type B (plan)
D. Sealing End Compound Layout – Type B (section)
E. Typical Horizontal Directional Drill Procedure

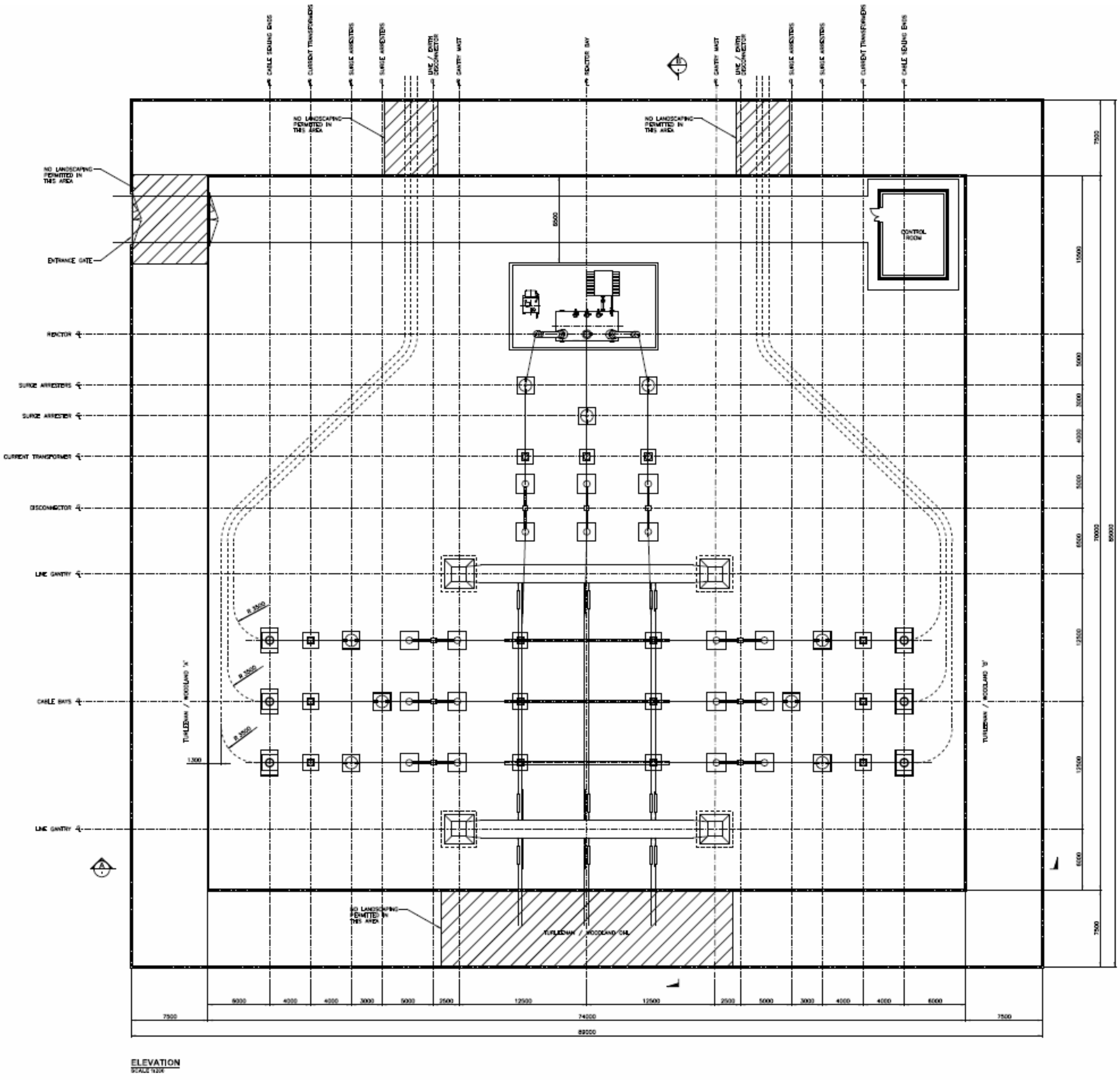
A. Sealing End Compound Layout – Type A (plan)



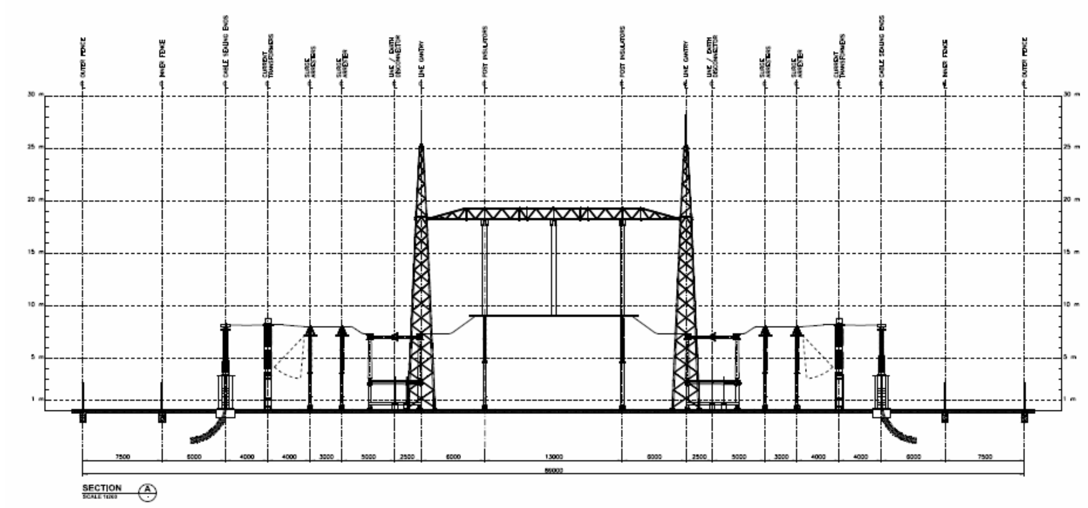
B. Sealing End Compound Layout – Type A (section)

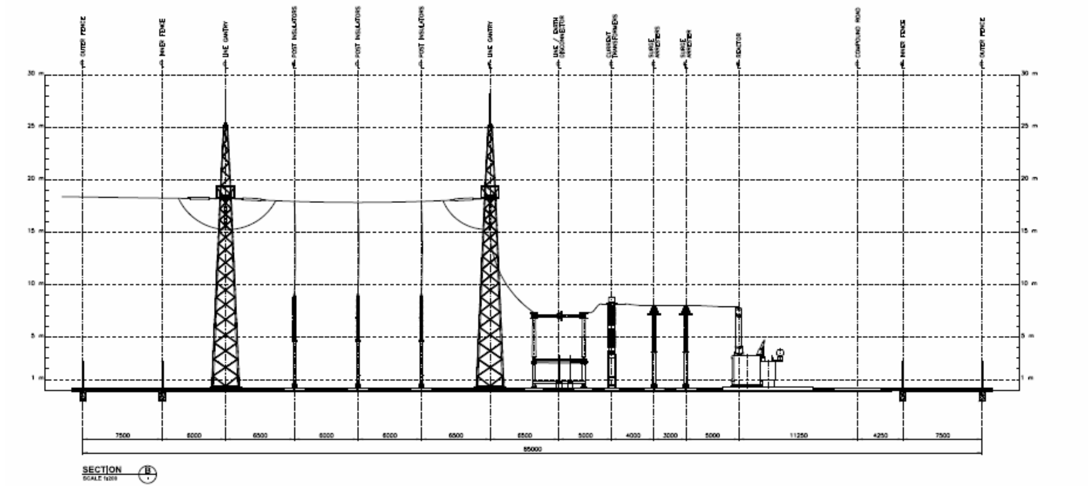


C. Sealing End Compound Layout – Type B (plan)



D. Sealing End Compound Layout – Type B (section)





E. Typical Horizontal Directional Drill Procedure

Setting up the Site

The drilling contractor prepares a site area of approximately 30 m x 25 m, accommodated within the agreed site area. If areas are overgrown with thick vegetation, a section of it would be removed appropriately and disposed of via a licensed waste contractor. The area is then levelled where required by using the front bucket of a 180º excavator; however there may be a requirement for the working area to be stripped of topsoil. Instead it may be overlain with a suitable geotextile material and 200mm of appropriate stone. The boundaries of the rig up area and exit area would both be defined with security fencing positioned to ensure adequate access is maintained.

Entry and exit pits (1m x 1m x 2m) are excavated using a 180° excavator and the resultant spoil bunded in 0.5mm PVC liner within the designated working areas. A steel box (1m x 1m x 2m) is placed in the ground to control drilling fluid returns from the borehole. Drilling fluid is pumped down the drill string and through the down hole motor, which converts the fluids hydraulic power to mechanical power and rotates the drill bit. The drill bit is oriented by the surveyor, and the driller pushes the drill string into the ground maintaining the bore path. The drilled cuttings are flushed back by the drill fluid flowing via nozzles in the bit, up the annulus to surface, where they are separated from the fluid fraction for disposal.

Drilling Fluids Circulation System

The drilling rig and fluid handling units may be placed on bunded 0.5mm PVC to contain any fluid spills and storm water run-off. The major components of the drill rig circulation system are five tanks, two solids separation cycles, a mud pump and a mud-mixing hopper. The solids removal system includes both a high-speed linear shale shaker and a desander/desilter. Centrifugal pumps circulate drilling fluid returns through the mud cleaners before being pumped back downhole. Solids removed from the drilling fluid are diverted into tipping skips. Drilling fluids returning to the surface are diverted through a conductor pipe to a mud pan on the surface. This mud is then lifted to the shale shaker by a hydraulically powered centrifugal pump. The ability to clean and re-circulate drilling fluids keeps the volume of drilling fluids required to a minimum. Constant monitoring of fluid volume, pressure, pH, weight and viscosity is undertaken. Constant attention is given to amount of cuttings produced so that no over cutting takes place and that hole cleaning is maintained. The mud returns are pumped to the circulation system trailer by means of a bunded centrifugal pump.

Bore Construction

A steering system, guided by tri-axial magnetometers and accelerometers that provide real time directional information to the surveyor at the driller's console, is used to navigate the bores. Once the first pilot hole has been completed a hole-opener or back reamer is fitted at the exit side and pulled back through the bore to the entry side. A drill pipe is added at the exit side to ensure that a mechanical presence is always present within the bore. On completion of the hole-opening phase a towing assembly consisting of tow heads, a swivel and a reamer would be used to pull the ducts into the bore. Close attention is paid to modelled drag forces during pullback with constant monitoring of load stress undertaken to ensure that modelled tensile stress, collapse pressures, hoop stress and buckling stress are not exceeded.

Waste Disposal

The drilling fluid used would consist of sodium bentonite which is NSF/ANSI Standard 60 certified for use in drilling water wells etc. During drilling, the control and minimisation of waste fluids are the responsibility of the Fluids Technician and the Drilling Superintendent. Fluids can be minimised by the following procedures:

1. Cleaning and recirculating the drilling fluid.
2. Maintaining excellent fluid properties (pH, density, viscosity, gel strength, shear strength) while drilling to eliminate the need for additional drilling fluid.
3. Monitoring of borehole volumes, flow rates, pressures and drag characteristics to ensure that all cuttings are being circulated out of the borehole and that critical annular fluid velocities are not exceeded maintaining laminar flow to prevent eddying and sloughing of the borehole.

The fluid used is inert clay and can be classified in the European Waste Catalogue under 01-05-04 as freshwater drilling muds and wastes. The cuttings circulated from the bore can be classified under 17-05-04 as soil and stones not containing dangerous substances. The fluid and the cuttings are non-hazardous wastes and therefore suitable for disposal to landfill. MSDS (Material Safety Data Sheets) and COSHH (Control of Substances Hazardous to Health) Sheets for all materials would be kept on site.
Drilled cuttings are stored on site for disposal via a licensed waste contractor. The European Waste Catalogue reference is 17-05-04. Drilling fluid volumes would be minimised. Excess fluid disposal would be via a licensed waste contractor. The European Waste Catalogue reference is 01-05-04.

The Contractor would provide a site office, mess and welfare facilities. These units would be powered by a bunded and silenced generator and water would be stored in on-site tanks. The units would be serviced on a weekly basis which includes removal of all wastewater by a licensed contractor.

Reinstatement of Site

Prior to reinstatement, the ducts are tested and proved and the duct bundles are also gyro-surveyed to provide an accurate as constructed record. On completion of the works, the stone and geo-membrane are carefully removed using a backhoe or 360° excavator and transported to a licensed disposal unit. Topsoil would be imported to sites where necessary and the area reseeded. The site area is then reinstated as per the landowner and statutory requirements.

Typical plant to be utilised on site would comprise the following: -

- 2 No. 4 x 4 Twin cab pick-up truck
- 1 No. Luton Box Van
- JCB 3CX 180° Backhoe Loader
- Terrain 7m Telehandler
- JCB Fastrac and 2000 gallon bowser

A crew of approximately six people operate all of the above equipment.

Annex 2

Table 11.8 Significance of Landscape Effects Matrix[1]

Significance of effects (effects rated Moderate and above are considered significant)		Sensitivity		
		High	Moderate	Low
Magnitude of change	High	Major	Moderate-Major	Moderate
	Medium-High	Moderate-Major	Moderate	Minor-Moderate
	Medium	Moderate	Moderate	Minor
	Low-Medium	Moderate	Minor-Moderate	Minor-Negligible
	Low	Minor-Moderate	Minor	Negligible
	Low-Negligible	Minor-Moderate	Minor-Moderate	Negligible
	Negligible	Negligible	Negligible	Negligible

Effects rated Moderate and above are considered significant.

Table 11.9 Categories of Landscape and Visual Significance of Effect

Degree of effect	Description of landscape effect	Description of visual effect
Moderate adverse effect	• The development is out of scale with the landscape • It is visually obtrusive and would have an adverse effect on the landscape • Mitigation would not prevent the development from adversely affecting the landscape in the longer term as some features of interest would be partly destroyed or their setting diminished. • It would have an adverse effect on a landscape of recognised quality	• Where a development would cause a noticeable deterioration in the existing view

The EIS methodology also acknowledges a more **qualitative** sliding scale of significance

Table 11.10: Scale of Significance

- Loss of mature of diverse landscape elements, features, characteristics, aesthetic or perceptual qualities
- Effects on rare, distinctive, particularly representative landscape character
- Loss of lower value elements, features, characteristics, aesthetic or perceptual qualities

- Loss of new, uniform, homogeneous elements, features, characteristics, qualities
- Effects on areas in poorer condition or of degraded character
- Effects on lower-value landscapes

More significant

↓

Less significant

[1] Note that the matrix is a guide - the determination of significance of effects also requires an element of professional judgement

Annex 3

Extracts from Appendix 11.1, Volume 3C, CMSA, Appendix Table 11.18

Extracts from Appendix 11.1, Volume 3D, MSA, Appendix Table 11.22

Extracts from Consolidated ES, Volume 2, Tables 13.8 and 13.9

Table 11.18: CMSA Summary of landscape and visual effects – [significant effects highlighted]

SUMMARY OF RESIDUAL LANDSCAPE EFFECTS						
Physical landscape effects						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	Impact	Magnitude of change	Impact	
LCA 66 Armagh Drumlins (Northern Ireland)	Moderate/High	Low	Minor-moderate	Low	Minor - moderate	Not significant
Landscape Unit A	Moderate/High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Landscape Unit B	Moderate	Low	Minor	Low	Minor	Not significant
Landscape Unit C	Moderate	Low	Minor	Low	Minor	Not significant
Landscape Unit D	Moderate	Low	Minor	Low	Minor	Not significant
Landscape Unit E	Moderate/High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Landscape Character effects in unscreened areas within 600-800m of the development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
LCA 66 Armagh Drumlins (Northern Ireland)	Moderate/High	Medium-high	Moderate-major	Moderate-high	Moderate-major	Significant
Mullyash Uplands	Moderate/High	Medium-high	Moderate-major	Moderate-high	Moderate-major	Significant
Monaghan Drumlin Uplands	Moderate	Medium-high	Moderate	Moderate-high	Moderate	Significant
Ballybay Castleblaney Lakelands	Moderate	Medium-high	Moderate	Moderate-high	Moderate	Significant
Drumlin and Upland Farmland of South Monaghan	Moderate	Medium-high	Moderate	Moderate-high	Moderate	Significant
Highlands of East Cavan	Moderate/High	Medium-high	Moderate-major	Moderate-high	Moderate-major	Significant

Landscape effects on designated landscape features within 5km (up to 10km where elevated)						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Lough Muckno and environs	High	No change	No impact	No change	No impact	Not significant
Billy Fox Memorial Park and environs	High	No change	No impact	No change	No impact	Not significant
Dromore River and lake system including White Lake and Bairds Shore	High	No change	No impact	No change	No impact	Not significant
Lough Major and environs	High	No change	No impact	No change	No impact	Not significant
Lisanisk lake	High	No change	No impact	No change	No impact	Not significant
Lough Naglack	High	No change	No impact	No change	No impact	Not significant
Rahan's lake	High	No change	No impact	No change	No impact	Not significant
Dun na Ri forest park, Co. Cavan	High	No change	No impact	No change	No impact	Not significant
Lough an Leagh Mountain, Co. Cavan	High	Low-negligible	Minor-moderate	Low-negligible	Minor-moderate	Not significant
Landscape effects on areas within 5km designated for ecological reasons that have potential amenity value						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Loughbawn house Loughs, Co. Monaghan	High	No change	No impact	No change	No impact	Not significant
Lough Eglish, Co Monaghan	High	Low-negligible	Minor-moderate	Low-negligible	Minor-moderate	Not significant
Cordoo Lough, Co Monaghan	High	Negligible	Negligible	Negligible	Negligible	Not significant
Tassan Lough, Co. Monaghan	High	Low-medium	Moderate	Low-medium	Moderate	Significant
Lough Smiley, Co. Monaghan	High	No change	No impact	No change	No impact	Not significant
Strahan's Lough	High	No change	No impact	No change	No impact	Not significant
Crossbane Lough	High	No change	No impact	No change	No impact	Not significant
Drumcarn ASSI	High	Negligible	Negligible	Negligible	Negligible	Not significant

Landscape effects on Historic Designed Landscapes with main features substantially present within 5km of development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Lakelands, Co. Monaghan	Moderate	Negligible	Negligible	Negligible	Negligible	Not significant
Shantonagh House, Co. Monaghan	Moderate	Negligible	Negligible	Negligible	Negligible	Not significant

SUMMARY OF RESIDUAL VISUAL EFFECTS						
Settlements within 5km of proposed development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Clontribret	High	Negligible	Negligible	Negligible	Negligible	Not significant
Creaghanroe	High	Negligible	Negligible	Negligible	Negligible	Not significant
Annayalla	High	Negligible	Negligible	Negligible	Negligible	Not significant
Doohamlet	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Ballybay	High	Negligible	Negligible	Negligible	Negligible	Not significant
Castleblayney	High	Negligible	Negligible	Negligible	Negligible	Not significant
Shercock	High	No change	No impact	No change	No impact	Not significant
Kingscourt	High	No change	No impact	No change	No impact	Not significant
Teevurcher	High	No change	No impact	No change	No impact	Not significant
Kilmainhamwood	High	No change	No impact	No change	No impact	Not significant

Transport corridors and paths within 5km of the development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
N2	Low	Medium	Minor	Medium-high	Minor-moderate	Not significant
R183	Low	Medium	Minor	Medium-high	Minor-moderate	Not significant
R180	Low	Medium	Minor	Medium	Minor	Not significant

R181	Low	Medium	Minor	Medium	Minor	Not significant
R178	Low	Medium	Minor	Medium	Minor	Not significant
R162	Low	Medium	Minor	Medium	Minor	Not significant
R165	Low	Medium	Minor	Medium	Minor	Not significant
The Monaghan Way	Moderate	Medium	Moderate	Medium	Moderate	Significant (localised)
Lough an Leagh walk, Co. Cavan	Moderate	Low-negligible	Minor-moderate	Low-negligible	Minor- moderate	Not significant
Dun na Ri Forest park walks, Co. Cavan	Moderate	No change	No impact	No change	No impact	Not significant
Castle walk, Balieboro, Co. Cavan	Moderate	No change	No impact	No change	No impact	Not significant
Views from unscreened individual properties						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	Impact	Magnitude of change	Impact	
Unscreened properties within 500m	High	Between Low and High	Between Minor-moderate and Major	Between Low and High	Between Minor-moderate and Major	Significant
Unscreened properties within 500m-1km	High	Between Negligible and Medium	Between Negligible and Moderate	Between Negligible and Medium	Between Negligible and Moderate	varying in significance and reducing to not significant beyond approximately 600-800m
Unscreened properties within 1km-1.5km	High	Between No impact and Negligible	Between No impact and Minor-moderate	Between No change and Negligible	Between No impact and Minor-moderate	Not significant
Unscreened properties further than 1.5km	High	Negligible	Negligible	Negligible	Negligible	Not significant
Scenic viewpoints within 5km of development (up to 10km for elevated viewpoints)						
Receptor	**Sensitivity**	**Magnitude of change**	**Impact**	**Magnitude of change**	**Impact**	**Significance**
SV11 (Monaghan)	High	No change	No impact	No change	No impact	Not significant
SV12 (Monaghan)	High	Negligible	Negligible	Negligible	Negligible	Not significant
SV13 (Monaghan)	High	No change	No impact	No change	No impact	Not significant
SV14 (Monaghan)	High	Negligible	Negligible	Negligible	Negligible	Not significant
SV15 (Monaghan)	High	No change	No impact	No change	No impact	Not significant
SV16 (Monaghan)	High	No change	No impact	No change	No impact	Not significant

SV17 (Monaghan)	High	No change	No impact	No change	No impact	Not significant
SV18 (Monaghan)	High	No change	No impact	No change	No impact	Not significant
SV19 (Monaghan)	High	No change	No impact	No change	No impact	Not significant
SV21 (Monaghan)	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
SV22 (Monaghan)	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
SV23 (Monaghan)	High	No change	No impact	No change	No impact	Not significant
SV 8 (Cavan)	High	Low	Minor-moderate	Low	Minor-moderate	Not significant

Table 11.22: MSA Summary of landscape and visual effects – [significant effects highlighted]

SUMMARY OF RESIDUAL LANDSCAPE EFFECTS						
Physical landscape effects						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Landscape Unit E	Moderate/High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Landscape Unit F	Moderate	Low/Medium	Minor-moderate	Low/Medium	Minor-moderate	Not significant
Landscape Unit G	Moderate	Low	Minor	Low	Minor	Not significant
Landscape Unit H	Moderate/High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Landscape Unit I	Moderate	Low	Minor	Low	Minor	Not significant
Landscape Unit J	Moderate/High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Landscape Unit K	Moderate	Low	Minor	Low	Minor	Not significant
Landscape Unit L	Moderate	Low	Minor	Low	Minor	Not significant
Landscape Character effects in unscreened areas within 600-800m of the development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Highlands of East Cavan	Moderate/High	Medium-high	Moderate-major	Medium-high	Moderate-major	Significant
North Meath Lakelands	Moderate	Medium-high	Moderate	Medium-high	Moderate	Significant
North Navan Lowlands	Moderate	Medium-high	Moderate	Medium-high	Moderate	Significant
Blackwater Valley	Moderate/High	Medium-high	Moderate-major	Medium-high	Moderate-major	Significant
West Navan Lowlands	Moderate	Medium-high	Moderate	Medium-high	Moderate	Significant
Boyne Valley	Moderate/High	Medium-high	Moderate-major	Medium-high	Moderate-major	Significant
Central Lowlands	Moderate	Medium-high	Moderate	Medium-high	Moderate	Significant
Tara Skryne Hills	Moderate	Medium-high	Moderate	Medium-high	Moderate	Significant

Landscape effects on designated landscape features within 5km (up to 10km where elevated)						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Dun na Ri forest park, Co. Cavan	High	No change	No impact	No change	No impact	Not significant
Lough an Leagh Mountain, Co. Cavan	High	Low-negligible	Minor-moderate	Low-negligible	Minor-moderate	Not significant
Dunsany Castle, Co. Meath	High	No change	No impact	No change	No impact	Not significant
Kilkeen Castle, Co. Meath	High	No change	No impact	No change	No impact	Not significant
Talbot Castle, Co. Meath	High	No change	No impact	No change	No impact	Not significant
Trim Castle, Co. Meath	High	Negligible	Negligible	Negligible	Negligible	Not significant
People's Park Lighthouse, Co. Meath	High	No change	No impact	Negligible	No impact	Not significant
Whitewood Estate House, Co. Meath	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Beech Copse, Co. Meath	High	Negligible	Negligible	Negligible	Negligible	Not significant
Tower, Co. Meath	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Bective Abbey, Co. Meath	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Yellowsteeple, Co. Meath	High	No change	No impact	No change	No impact	Not significant
Skryne Church, Co. Meath	High	No change	No impact	No change	No impact	Not significant

Landscape effects on areas with 5km designated for ecological reasons that have potential amenity value						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
River Boyne and River Blackwater	High	Medium	Moderate	Medium	Moderate	Significant (localised)
Trim	High	No change	No impact	No change	No impact	Not significant
Jamestown Bog	High	No change	No impact	No change	No impact	Not significant
Landscape effects on Historic Designed Landscapes with main features substantially present within 5km of development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Culmullin House, Co. Meath	Moderate	Negligible	Negligible	Negligible	Negligible	Not significant
Galtrim House, Co. Meath	Moderate	Negligible	Negligible	Negligible	Negligible	Not significant
Philpotstown, Co. Meath	Moderate	Low-Medium	Minor-moderate	Low-Medium	Minor-moderate	Not significant
Churchtown House, Co. Meath	Moderate	Negligible	Negligible	Negligible	Negligible	Not significant
Mountainstown House, Co. Meath	Moderate	Low-Medium	Minor-Moderate	Low-Medium	Minor-moderate	Not significant
Brittas, Co. Meath	Moderate	Medium-high	Moderate	Medium-high	Moderate	Significant
Whitewood House, Co. Meath	Moderate	Low	Minor-moderate	Low	Minor-moderate	Not significant
Ardbraccan House, Co. Meath	Moderate	Negligible	Negligible	Negligible	Negligible	Not significant
Dowdstown House, Co. Meath	Moderate	Negligible	Negligible	Negligible	Negligible	Not significant

SUMMARY OF RESIDUAL VISUAL EFFECTS

Settlements within 5km of development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Kingscourt	High	No change	No impact	No change	No impact	Not significant
Teevurcher	High	No change	No impact	No change	No impact	Not significant
Nobber	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Kilmainhamwood	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Carlanstown	High	Negligible	Negligible	Negligible	Negligible	Not significant
Wilkinstown	High	Negligible	Negligible	Negligible	Negligible	Not significant
Donaghpatrick	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Navan	High	No change	No impact	No change	No impact	Not significant
Castletown	High	No change	No impact	No change	No impact	Not significant
Bohermeen	High	Negligible	Negligible	Negligible	Negligible	Not significant
Summerhill	High	No change	No impact	No change	No impact	Not significant
Drumree	High	No change	No impact	No change	No impact	Not significant
Dunsany	High	No change	No impact	No change	No impact	Not significant
Oristown	High	No change	No impact	No change	No impact	Not significant
Trim	High	No change	No impact	No change	No impact	Not significant
Gibstown	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Dunderry	High	Medium	Moderate	Medium	Moderate	Significant (outskirts of settlement)
Robinstown	High	Medium	Moderate	Medium	Moderate	Significant (outskirts of settlement)
Bective	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
Kilmessen	High	Negligible	Negligible	Negligible	Negligible	Not significant

Transport corridors and paths within 5km of the development						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
R164	Low	Medium	Minor	Medium	Minor	Not significant
R162	Low	Low	Minor	Low	Minor	Not significant
R165	Low	No change	No impact	No change	No impact	Not significant
N52	Low	Medium	Minor	Medium	Minor	Not significant
R163	Low	Medium	Minor	Medium	Minor	Not significant
R147	Low	Medium	Minor	Medium	Minor	Not significant
M3	Low	Medium	Minor	Medium	Minor	Not significant
N51	Low	Medium	Minor	Medium	Minor	Not significant
R161	Low	Medium	Minor	Medium	Minor	Not significant
R154	Low	Medium	Minor	Medium	Minor	Not significant
R125	Low	Medium	Minor	Medium	Minor	Not significant
R156	Low	Low	Negligible	Low	Negligible	Not significant
Boyne Valley Driving Route, Co Meath	Moderate	Medium	Moderate	Medium	Moderate	Significant (localised)
Proposed walking route along the river Blackwater, Co. Meath	Moderate	Medium	Moderate	Medium	Moderate	Significant (localised)
Lough an Leagh walk, Co. Cavan	Moderate	Low-negligible	Minor-moderate	Low-negligible	Minor-moderate	Not significant
Dun na Ri Forest park walks, Co. Cavan	Moderate	No change	No impact	No change	No impact	Not significant
Boyne Ramparts Heritage Walks, Co. Meath	Moderate	No change	No impact	No change	No impact	Not significant
Trim Sli na Slainte	Moderate	No change	No impact	No change	No impact	Not significant

Views from unscreened individual properties						
Receptor	Sensitivity	Construction		Operation		Significance
		Magnitude of change	Impact	Magnitude of change	Impact	
Unscreened properties within 500m	High	Between Low and High	Between Minor-moderate and Major	Between Low and High	Between Minor-moderate and Major	Significant
Unscreened properties within 500m-1km	High	Between Negligible and Medium	Between Negligible and moderate	Between Negligible and Medium	Between Negligible and Moderate	varying in significance and reducing to not significant beyond approximately 600-800m
Unscreened properties within 1km-1.5km	High	Between No impact and Negligible	Between No impact and Minor-moderate	Between No change and Negligible	Between No impact and Minor-moderate	Not significant
Unscreened properties further than 1.5km	High	Negligible	Negligible	Negligible	Negligible	Not significant
Scenic viewpoints within 5km of development (up to 10km for elevated viewpoints)						
Receptor	**Sensitivity**	**Magnitude of change**	**Impact**	**Magnitude of change**	**Impact**	**Significance**
SV 8 (Cavan)	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
13 (Meath)	High	Low	Minor-moderate	Low	Minor-moderate	Not significant
15 (Meath)	High	Negligible	Negligible	Negligible	Negligible	Not significant
16 (Meath)	High	No change	No impact	No change	No impact	Not significant
17 (Meath)	High	Low	minor-moderate	Low	minor-moderate	Not significant
18 (Meath)	High	No change	No impact	No change	No impact	Not significant
19 (Meath)	High	No change	No impact	No change	No impact	Not significant
20 (Meath)	High	No change	No impact	No change	No impact	Not significant
21 (Meath)	High	No change	No impact	No change	No impact	Not significant
40 (Meath)	High	No change	No impact	No change	No impact	Not significant
42 (Meath)	High	No change	No impact	No change	No impact	Not significant
44 (Meath)	High	Negligible	Negligible	Negligible	Negligible	Not significant

47 (Meath)	High	No change	No impact	No change	No impact	Not significant
50 (Meath)	High	No change	No impact	No change	No impact	Not significant
52 (Meath)	High	Negligible	Negligible	Negligible	Negligible	Not significant
77 (Meath)	High	No change	No impact	No change	No impact	Not significant
80 (Meath)	High	No change	No impact	No change	No impact	Not significant
85 (Meath)	High	No change	No impact	No change	No impact	Not significant
86 (Meath)	High	Medium	Moderate	Medium	Moderate	Significant

Consolidated ES Table 13.8: Summary of Landscape Residual Impacts **[significant effects highlighted]**

Landscape Type	Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
		Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
Physical Landscape Effects								
Substation and Towers 1-8	Medium	Medium	Moderate Adverse	Medium	Moderate Adverse	Low	Minor Adverse	Not Significant
Towers 9-19	Medium	Low - Medium	Minor – Moderate Adverse	Low - Medium	Minor – Moderate Adverse	Low	Minor Adverse	Not significant
Towers 20-30	Medium	Low - Medium	Minor – Moderate Adverse	Low - Medium	Minor – Moderate Adverse	Low	Minor Adverse	Not significant
Towers 31-40	Medium – High	Low	Minor – Moderate Adverse	Low	Minor – Moderate Adverse	Negligible	Minor Adverse	Not significant
Towers 41-51	High	Low	Moderate Adverse	Low	Moderate Adverse	Negligible	Minor Adverse	Not Significant
Towers 52-61	Medium – High	Low	Minor - Moderate Adverse	Low	Minor - Moderate Adverse	Low - Negligible	Minor Adverse	Not Significant
Towers 62-71	Medium – High	Low	Minor -Moderate Adverse	Low	Minor -Moderate Adverse	Low - Negligible	Minor Adverse	Not Significant
Towers 72-81	Medium – High	Low - Negligible	Minor Adverse	Low - Negligible	Minor Adverse	Negligible	Negligible	Not Significant
Towers 82-92	Medium	Low - Negligible	Minor – Negligible	Low - Negligible	Minor – Negligible Adverse	Negligible	Minor Adverse	Not Significant

Landscape Type	Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
		Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
			Adverse					
Towers 93-102	High	Low	Moderate Adverse	Low	Moderate Adverse	Negligible	Minor Adverse	Not Significant
Designated Landscapes								
Armagh City Former Green Belt	High	Negligible	Minor Adverse	Negligible	Minor Adverse	Negligible	Minor Adverse	Not Significant
Dungannon Green Former Belt	Medium - High	Low - Negligible	Minor Adverse	Low - Negligible	Minor Adverse	Low - Negligible	Minor Adverse	Not Significant
The Argory	Medium	Low - Medium	Minor - Moderate Adverse	Low - Medium	Minor - Moderate Adverse	Low - Medium	Minor - Moderate Adverse	Not Significant
The Manor House, Benburb	High	Low - Medium	Moderate Adverse	Low - Medium	Moderate Adverse	Low - Medium	Moderate Adverse	Significant
Armagh Palace	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Tynan Abbey	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Northern Ireland Landscape Character Areas								
LCA 47 Loughgall Orchard Belt	Medium	High	Moderate - Major Adverse	Medium - High	Moderate Adverse	Medium - High	Moderate Adverse	Significant
LCA 66 Armagh Drumlins	High	Medium - High	Moderate - Major Adverse	Medium - High	Moderate - Major Adverse	Medium - High	Moderate - Major Adverse	Significant

Landscape Type	Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
		Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
LCA 45 Dungannon Drumlins and Hills	Medium	Low	Minor Adverse	Low	Minor Adverse	Low	Minor Adverse	Not Significant
LCA 64 Lough Neagh Peatlands	Medium	Low - Negligible	Negligible - Minor Adverse	Low - Negligible	Negligible - Minor Adverse	Low - Negligible	Negligible - Minor Adverse	Not Significant
LCA 68 Carrigatuke Hills	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
LCA 46 Blackwater Valley	High	Negligible	Minor Adverse	Negligible	Minor Adverse	Negligible	Minor Adverse	Not Significant
Republic of Ireland Landscape Character Areas								
LCA 6 Mullyash Uplands	High	Medium	Moderate Adverse	Medium	Moderate Adverse	Medium	Moderate Adverse	Significant
LCA 2 Blackwater Valley and Drumlin Farmland	High	Negligible	Minor Adverse	Negligible	Minor Adverse	Negligible	Minor Adverse	Not Significant

Table 13.9: Summary of Visual Impacts **[significant effects highlighted]**

Receptor Type	Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
		Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
Settlements								
Armagh City	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Dungannon	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Moy	High	Low-Medium	Moderate	Low-Medium	Moderate	Low-Medium	Moderate	Significant
Blackwatertown	High	Low-Medium	Moderate	Low-Medium	Moderate	Low-Medium	Moderate	Significant
Benburb	High	Medium-High	Moderate – Major	Medium	Moderate	Medium	Moderate	Significant
Killylea	High	Low-Medium	Moderate	Low-Medium	Moderate	Low-Medium	Moderate	Significant
Milford	Medium	Low-Medium	Minor - Moderate	Low-Medium	Minor - Moderate	Low-Medium	Minor - Moderate	Not Significant
Middletown	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Keady	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Derrynoose	High	High	Major	Medium-High	Moderate - Major	Medium-High	Moderate - Major	Significant

Receptor Type	Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
		Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
Individual Properties								
A total of 423 properties were assessed that lie within 500m of the proposed overhead line route. Overall, in summer 15 years after opening, there will be a total of 322 properties will experience a significant impact: • 18 properties that experience a major adverse impact; • 199 properties that experience a moderate - major adverse impact; • 105 properties that experience a moderate adverse impact.								
Transport Corridors and Paths								
M1	Low	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
N2	Low	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
A28	Low	Low	Negligible	Low	Negligible	Low	Negligible	Not Significant
A3	Low	Medium	Minor	Medium	Minor	Medium	Minor	Not Significant
A29	Low	Low	Negligible	Low	Negligible	Low	Negligible	Not Significant
A45	Low	No Change	No Impact	No Change	No Impact	No Change	No Impact	Not Significant
B115	Medium	Low-Medium	Minor - Moderate	Low-Medium	Minor – Moderate	Low-Medium	Minor – Moderate	Not Significant

Receptor Type	Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
		Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
B106	Medium	Medium	Moderate Adverse	Medium	Medium	Moderate Adverse	Minor - Moderate	Not Significant
B3/R214	Medium	Low-Medium	Minor - Moderate	Low-Medium	Minor - Moderate	Low-Medium	Minor - Moderate	Not Significant
B34	Medium	No Change	No Impact	No Change	No Impact	No Change	No Impact	Not Significant
B517	Medium	No Change	No Impact	No Change	No Impact	No Change	No Impact	Not Significant
B45	Medium	No Change	No Impact	No Change	No Impact	No Change	No Impact	Not Significant
B128	Medium	Low	Minor Adverse	Low	Minor Adverse	Low	Minor Adverse	Not Significant
B28	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
B130	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
B210	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
B361	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
B32/R181	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
R184	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
National The Ulster Way/Cycle	Medium	Low-Medium	Minor - Moderate	Low-Medium	Minor - Moderate	Low-Medium	Minor - Moderate	Not Significant

Receptor Type	Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
		Magnitude of Change	**Impact**	**Magnitude of Change**	**Impact**	**Magnitude of Change**	**Impact**	
Route 91								
National Cycle Route 95	Low	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Regional Cycle Route 11	Low	Medium-Low	Negligible - Minor	Low	Negligible	Low-Negligible	Negligible	Not Significant
River Blackwater Canoe Trail	Medium	Medium	Moderate	Medium-Low	Minor - Moderate	Low	Minor	Not Significant
The Monaghan Way	Medium	Medium-Low	Minor - Moderate	Medium-Low	Minor - Moderate	Medium-Low	Minor - Moderate	Not Significant
The Beetlers Trail	Medium	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant
Viewpoints								
01 Clonteevy Bridge over River Rhone on Trewmount Road (B106)	Medium	High	Moderate - Major	High	Moderate - Major	High	Moderate - Major	Significant
02 Derrygally Way to east of Turleenan Substation	Medium	High	Moderate - Major	High	Moderate - Major	High	Moderate - Major	Significant
03 Derrygally Way to south of Turleenan Substation	Medium	High	Moderate - Major	High	Moderate - Major	High	Moderate - Major	Significant

Receptor Type		Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
			Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
04	Trewmount Road (B106) near site access road.	Medium	High	Moderate - Major	Medium - High	Moderate	Medium - High	Moderate	Significant
05	Bonds Bridge over River Blackwater near the Argory	Medium	Low – Medium	Minor - Moderate	Low - Medium	Minor - Moderate	Low - Medium	Minor - Moderate	Not Significant
06	Moy Road (A29) crossing	Medium	Medium - High	Moderate	Medium	Moderate	Medium	Moderate	Significant
07	Culkeeran Road	Medium	Medium - High	Moderate	Medium	Moderate	Medium	Moderate	Significant
08	Gorestown Road	Medium	Medium - High	Moderate	Medium	Moderate	Medium	Moderate	Significant
09	Benburb Road	Medium	High	Moderate - Major	High	Moderate - Major	High	Moderate - Major	Significant
10	Benburb Road south of Ninewell Bridge	Medium	High	Moderate - Major	High	Moderate - Major	High	Moderate - Major	Significant
11	Clonfeacle Road (B128) crossing	Medium	Medium	Moderate	Low - Medium	Minor - Moderate	Low - Medium	Minor - Moderate	Not Significant
12	Benburb Priory	High	Medium	Moderate	Medium	Moderate	Medium	Moderate	Significant
13	Artasooly Road looking towards Blackwater River Crossing	Medium	Medium	Moderate	Low - Medium	Minor - Moderate	Low - Medium	Minor - Moderate	Not Significant

Receptor Type		Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
			Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
14	Artasooly Road at Tullymore Bridge	Medium	Medium	Moderate	Medium	Moderate	Medium	Moderate	Significant
15	Artasooly Road and Maydown Road junction at Artasooly	High	Low	Moderate	Low - Negligible	Minor - Moderate	Low - Negligible	Minor - Moderate	Not Significant
16	Battleford Road (B115) crossing	High	High	Major	High	Major	High	Major	Significant
17	Killylea Road (A28) crossing	Medium	Medium	Moderate	Low - Medium	Minor - Moderate	Low - Medium	Minor - Moderate	Not Significant
18	Killylea settlement (Fellows Grange Court)	High	Low - Medium	Moderate	Low - Medium	Moderate	Low - Medium	Moderate	Significant
19	Navan Fort	High	Negligible	Minor	Negligible	Minor	Negligible	Minor	Not Significant
20	Monaghan Road (A3) east of Norton’s Cross Roads	Medium	High	Moderate - Major	Medium - High	Moderate	Medium - High	Moderate	Significant
21	Monaghan Road (A3) crossing	Medium	High	Moderate - Major	Medium - High	Moderate	Medium - High	Moderate	Significant
22	Maddan Road south of Norton’s Cross Roads	Medium	Medium - High	Moderate	Medium	Moderate	Medium	Moderate	Significant

Receptor Type		Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
			Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
23	Cavanagarvan Road and Sheetrim Road Junction	Medium	Medium	Moderate	Low - Medium	Minor - Moderate	Low - Medium	Minor - Moderate	Not Significant
24	Drumhillery Road crossing	Medium	Medium - High	Moderate	Medium	Moderate	Medium	Moderate	Significant
25	Lagan Road west of Keady	High	Low	Moderate	Low - Negligible	Minor - Moderate	Low - Negligible	Minor - Moderate	Not Significant
26	Fergort (B3) Road crossing	Medium	Medium - High	Moderate	Medium - High	Moderate	Medium - High	Moderate	Significant
27	East of Derrynoose	High	High	Major	Medium - High	Moderate - Major	Medium - High	Moderate - Major	Significant
28	Derrynoose Road at Curragh Lane looking north	Medium	Medium - High	Moderate	Medium - High	Moderate	Medium - High	Moderate	Significant
29	Derrynoose Road at Curragh Lane looking south	Medium	Medium - High	Moderate	Medium - High	Moderate	Medium - High	Moderate	Significant
30	Crossbane Road (NIE)	Medium	Low - Negligible	Negligible - Minor	Low - Negligible	Negligible - Minor	Low - Negligible	Negligible - Minor	Not Significant
31	Crossaghy Road	Medium	Medium - High	Moderate	Medium - High	Moderate	Medium - High	Moderate	Significant
32	Castleshane Brae	Low	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Not Significant

Receptor Type		Sensitivity	CONSTRUCTION		OPERATION (Year 1)		OPERATION (Year 15)		Significance
			Magnitude of Change	Impact	Magnitude of Change	Impact	Magnitude of Change	Impact	
33	Tully buck	High	No change	No Impact	No change	No Impact	No change	No Impact	N/A
34	Mullyash Mountain	High	Negligible	Minor	Negligible	Minor	Negligible	Minor	Not Significant

Annex 4

Initial assessment of significance of landscape effects for clustered areas. See report for sliding scale assessment

An area around the **Boyne Valley i**ncluding:

Significance of effects for individual receptors in the "cluster" of the Boyne Valley						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Boyne Valley (Unscreened areas within 600-800m)	Moderate/High	Medium-high	**Moderate-major**	Medium-high	**Moderate-major**	Significant
River Boyne and River Blackwater	High	Medium	**Moderate**	Medium	**Moderate**	Significant (localised)
Scenic view 86, Co Meath	High	Medium	**Moderate**	Medium	**Moderate**	Significant
Boyne Valley Driving Route, Co Meath	Moderate	Medium	**Moderate**	Medium	**Moderate**	Significant (localised)
Dunderry	High	Medium	**Moderate**	Medium	**Moderate**	Significant (outskirts of settlement)
Robinstown	High	Medium	**Moderate**	Medium	**Moderate**	Significant (outskirts of settlement)
Significance of effects for An area around the **Boyne Valley** as a clustered receptor						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
An area around the **Boyne Valley**	Moderate/High	Medium-high	**Moderate-major**	Medium-high	**Moderate-major**	Significant

An area around the **Blackwater Valley i**ncluding:

Significance of effects for individual receptors in the "cluster" of the **Blackwater Valley (Co Meath)**						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
River Boyne and River Blackwater	High	Medium	**Moderate**	Medium	**Moderate**	Significant (localised)
Blackwater Valley (Unscreened areas within 600-800m)	Moderate/High	Medium-high	**Moderate-major**	Medium-high	**Moderate-major**	Significant
Proposed walking route along the river Blackwater, Co. Meath	Moderate	Medium	**Moderate**	Medium	**Moderate**	Significant (localised)
Significance of effects for An area around the **Blackwater Valley (Co Meath)**as a clustered receptor						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
An area around the **Blackwater Valley (Co Meath)**	Moderate/High	Medium-high	**Moderate-major**	Medium-high	**Moderate-major**	Significant

An area in the Mullyash Uplands Character Area at the jurisdictional border (and extending into Northern Ireland)

Significance of effects for individual receptors in the "cluster" of the **Mullyash Uplands Character Area**						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Tassan Lough	High	Low-medium	**Moderate**	Low-medium	**Moderate**	Significant
Mullyash Uplands (Unscreened areas within 600-800m)	Moderate/High	Medium-high	**Moderate-major**	Medium-high	**Moderate-major**	Significant
The Monaghan Way	Moderate	Medium	**Moderate**	Medium	**Moderate**	Significant (localised)
Significance of effects for An area around the **Mullyash Uplands Character Area** as a clustered receptor						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
An area around the **Mullyash Uplands Character Area**	Moderate/High	Medium-high	**Moderate-major**	Medium-high	**Moderate-major**	Significant

Brittas Estate

Significance of effects for the Brittas Estate, Co Meath						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Brittas, Co. Meath	Moderate	Medium-high	**Moderate**	Medium-high	**Moderate**	Significant

The setting of the **Fair of Muff/ Cavan Highlands**:

Significance of effects for The setting of the **Fair of Muff/ Cavan Highlands**:						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Highlands of East Cavan (Unscreened areas within 600-800m)	Moderate/High	Medium-high	**Moderate-major**	Moderate-high	**Moderate-major**	Significant

The **Benburb Area**:

The **Benburb Area**:						
Receptor	**Sensitivity**	**Construction**		**Operation (Year 15)**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
Benburb (as a settlement)	High	Medium-High	**Moderate Adverse**	Low-Medium	**Moderate**	Significant
Benburb Priory and Castle	High	Low-Medium	**Moderate Adverse**	Low-Medium	**Moderate Adverse**	Significant
Regional Cycle Route 11	Low	Medium-Low	**Negligible**	Low	**Negligible**	Not Significant
River Blackwater Canoe Trail	Medium	Medium	**Minor Adverse**	Medium-Low	**Minor Adverse**	Not Significant
River Blackwater	Not assessed as a receptor. The Blackwater Valley is assessed as a whole.					
Tullydowey House Gate Lodge	High	High	**Moderate-Major Adverse**	High-Medium	**Moderate-Major Adverse**	Significant
Tullydowey House	High	High - Medium	**Moderate-Major Adverse**	High - Medium	**Moderate-Major Adverse**	Significant
The Argory	Medium	Low - Medium	**Minor - Moderate Adverse**	Low - Medium	**Minor - Moderate Adverse**	Not Significant
Moy	High	Low-Medium	**Moderate**	Low-Medium	**Moderate**	Significant
Significance of effects for An area around the **Benburb Area** as a clustered receptor						
Receptor	**Sensitivity**	**Construction**		**Operation**		**Significance**
		Magnitude of change	**Impact**	**Magnitude of change**	**Impact**	
An area around the **Benburb Area**	High	Medium-high	**Moderate-Major Adverse**	Low- Medium-	**Moderate-Major Adverse**	Significant

Annex 5

Ecofys Study on the comparative merits of overhead electricity transmission lines versus underground cables (2008)

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif**[1]	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
LAND USE				
Time and Flexibility of Construction	***	●●	**	●●
Length of Construction	***	●●	**	●●
Disrupt. To Agric. Operations	***	●●●	**	●●●
Land Take	**	●●	*	●●●
Effect on Field Boundaries	***	●●	**	●●●●
Effects on Farm Buildings	**	●	**	●●●
Effects on Drainage Patterns	***	●●	*	●●●●
Catastrophic Event Implications	***	●●	**	●●●
Repair & Maintenance	***	●●	*	●●●●
GEOLOGY and SOILS				
Soil Cover	***	●●●	**	●●●●
Excavated Material	***	●●	**	●●●●
Quarrying and Mining	**	●●●	**	●●●
EFFECTS ON WATER				
Disruption to Groundwater incl. Wetland	***	●●	*	●●●●
Effect on Surface Waters	***	●●●	*	●●●●
GROUND RESTORATION	***	●●●	**	●●●
ECOLOGY and NATURE CONSERVATION				
Bird Strike	N/A	N/A	***	●●●
Risk to Flora (construction)	***	●●	**	●●●
Risk to Flora (operations)	**	●●	*	●●●
Risk to Mammals	**	●●	*	●●●
Risk to Insects	**	●●	*	●●

	Underground Cables		Overhead Lines	
Potential for Effect	**Signif[1]**	**Ease of Mitigation**	**Signif.**	**Ease of Mitigation**
Loss of Habitat (construction)	***	●●●	**	●●●
Loss of Habitat (operations)	**	●	**	●
Risk to Aquatic Ecosystems	***	●●●	*	●●●●
Restoration	***	●●●	*	●●●
LANDSCAPE and VISUAL				
Landscape Character	*	●●●	***	●●
Landscape Features	**	●●	*	●●●
Visual Impact (construction)	***	●●	**	●●
Visual Impact (operations)	*	●●●	***	●●
Access Tracks/Haul Roads	***	●●●	**	●●●●
Communities	**	●●●	***	●●
CULTURAL HERITAGE				
Archaeological Resources	***	●●	*	●●●
Cultural/Historic Resources	**	●●	**	●●●
Language and Culture	*	●●●	***	●●
TRAFFIC AND NOISE				
Traffic	***	●●	**	●●
Noise (construction)	***	●●	**	**
Noise (operations)	*	●●●●	**	●●
AIR QUALITY				
Construction	***	●●	**	●●
Operations	N/A	N/A	**	●
COMMUNITIES				
Quality and Cohesiveness	*	●●●●	***	●●

Note: 1 = Significance of Impact

Significance:

***	Major: a fundamental change to a sensitive environment
**	Moderate: a material but non-fundamental change to the environment
*	Minor: a detectable but non-material change to the environment
N/A	Not applicable

Mitigation:

●	No practicable mitigation possible
●●	Remedial measures only
●●●	Mitigation likely to reduce adverse scale of impact
●●●●	Mitigation likely to avoid adverse discernible impact
N/A	Not applicable

Annex 6

Joint paper:
Feasibility and technical aspects of partial undergrounding of extra high voltage power transmission lines

Following an invitation by the European Commissioner for Energy, Mr. Andris Piebalgs, in December 2009, ENTSO-E and Europacable have jointly produced this paper, outlining the feasibility and technical aspects of partial undergrounding of Extra High Voltage (EHV) power transmission lines (AC 220 kV – 400kV).

The objective of this document is to provide an authoritative source of information for future transmission projects, which shall be made available to any interested party.

Partial undergrounding may, in some cases, be part of a solution of transmission projects of vital interest for the development of the EU transmission network, and for that purpose the availability of agreed authoritative information on this topic is of fundamental importance.

ENTSO-E and Europacable have reviewed the following dimensions of partially undergrounded transmission lines:

1) Technical aspects of extra-high voltage cross linked polyethylene (XLPE) cables
2) Integration of partial undergrounding in transmission networks
3) Environmental aspects of partial undergrounding
4) Cost aspects of partial undergrounding in general.

This paper merges the experience European Transmission System Operators (TSOs) have gained with the inclusion of underground EHV cables into their transmission networks over many years with the technical expertise of the leading XLPE EHV cable systems manufacturers in Europe.

Given the complexity of integrating partial undergrounding into high voltage transmission systems, all projects will require a case-by-case analysis of the technical specifications required for partial undergrounding.

Against this background ENTSO-e and Europacable have agreed to conclude a joint assessment of the fundamental aspects of partial undergrounding.

It is important to stress that this paper only reflects on the technical aspects of partial undergrounding. It is not in the remit of this work to define when and where partial undergrounding could be applied to complement overhead transmission lines. This question remains to be answered by individual Transmission System Operators and, where applicable, by other national planning authorities or regulators.

This paper has been sent to the European Commissioner for Energy, Mr Günther Oettinger, on 11th January 2011 and is now available to the public at the following link: http://ec.europa.eu/energy/studies/index_en.htm

Brussels, 12th January 2011

Jean Verseille
Chairman of ENTSO-E
System Development Committee

Thomas Neesen
Secretary General Europacable

Joint paper:

Feasibility and technical aspects of partial undergrounding of extra high voltage power transmission lines

Brussels, December 2010

1. Introduction

For the purpose of this paper, ENTSO-E and Europacable agree to focus on cross-linked polyethylene XLPE (also called VPE) cables used in partial undergrounding of extra high voltage (EHV) 220 kV – 400 kV alternating current (AC) transmission lines. Direct current (DC) and submarine cables are not considered here and may be subject to a subsequent paper.

We explicitly want to highlight the approach of partial undergrounding with lengths of the order of some kilometres to complement overhead lines.

Technical specifications required for XLPE cable solutions in partially undergrounded sections are highly dependent upon the specific transmission capacity requirements. They will vary considerably from transmission line to transmission line. The case presented in this paper can only be considered as a guide. Therefore it is important to revise the parameters listed in this joint paper on a case-by-case basis for each transmission project.

The objective of this paper is to give an overview of the parameters which need to be taken into account when reviewing a possible partial undergrounding of an EHV transmission project.

Additionally, this paper provides a case study of a typical partial undergrounding requirement involving XLPE cables.

2. Executive Summary

Following an invitation by the European Commissioner for Energy, Mr. Andris Piebalgs, in December 2009, ENTSO-E and Europacable have jointly produced this paper, outlining the feasibility and technical aspects of partial undergrounding of Extra High Voltage (EHV) power transmission lines (AC 220 kV – 400kV).

The objective of this document is to provide an authoritative source of information for future transmission projects, which shall be made available to any interested party.

It provides information on the feasibility and technical aspects of partial undergrounding of EHV transmission lines (AC 220 kV - 400 kV) based on the expertise of cable systems manufacturers and on the experience gained by the European Transmission System Operators with the inclusion of underground EHV cables in their systems.

The document focuses on the use of 400kV XLPE cables, a technology that performs well based on established international standard IEC 62067 and is available for transmission projects.

It is recognised that each transmission project is unique due to its specific features. Given the complexity of integrating partial undergrounding into high voltage transmission systems, all projects require a case by case analysis of the technical specifications.

From a technical perspective, partial undergrounding can be a viable option for transmission projects of vital interest for the development of the EU transmission network.

Reliability and costs are of the highest importance. The use of IEC standards for testing and qualification aims to ensure the reliability of the cable systems. Monitoring systems are available to further increase reliability. Depending on the type and scope of failure, repair times for cables can be longer than for overhead lines. As with any transmission link, also partial undergrounding requires a risk assessment by the TSO of integrating the link into the system.

The Underground Cable (UGC) investment cost is typically 5 to 10 times higher than Overhead Line (OHL) costs. These cost ratios are directly related to the capacity of the link. Factor down to 3 can be reached for links with limited rating and under special favorable conditions for cable laying or in case of expensive OHL. Factors above 10 can be reached for high capacity double circuit links and if specific structures are needed.

Where partial undergrounding is considered, the above multiples apply to the undergrounded part of the link; therefore any decision for partial undergrounding needs to take the whole economical balance of the transmission projects into account. Such a decision must also be carefully analysed with all stakeholders, in particular the regulators whose authorization is in many cases needed by the TSO to ensure an appropriate cost recovery through the transmission tariff.

The case study provides an example of UGC dimensioning in order to comply with the requirements of a typical double circuit 400kV OHL carrying 2*2500MVA which can be considered today as a typical solution used for the development of the European transmission system.

It shows that four cable systems would be generally needed leading to a corridor of 20-25 meters on which no deeply rooted trees may be planted and appropriate access must be managed.

3. Partial undergrounding of Extra High Voltage power transmission lines

3.1. Technical aspects of high voltage cross linked polyethylene (XLPE) cables

3.1.1. History of XLPE cables

- At high voltage levels (110-150kV) TSOs and Europacable member companies have more than 25 years of commercial experience with XLPE cables.
- Extra high voltage cables of 220kV and 275kV XLPE have been applied for over 20 years.
- Extra high voltage cables of 400kV have been in use over the last 14 years, with the oldest 400kV XLPE cable being in operation in Copenhagen since 1996, the majority of the projects have become operational during the recent past years as reported in Annex 6.
- With a length of 40km the longest double circuit EHV XLPE cable (500kV laid in a tunnel) has been in use in Japan since 2000.
- With over 1,100 km of 220kV and around 200 km of 400 kV cable circuit length[1] installed in Europe, it is a technology that performs well based on established international standard IEC 62067 and the technology is available for transmission projects.
- It is recognised that each transmission project is unique due to its specific features.

3.1.2. XLPE cable design

1) Copper conductor (alternative Al)
2) Semiconductor
3) XLPE insulation
4) Semiconductor
5) Waterblocking
6) Metallic screen and water barrier (aluminium laminated foil)
7) Polyethylene outer sheath

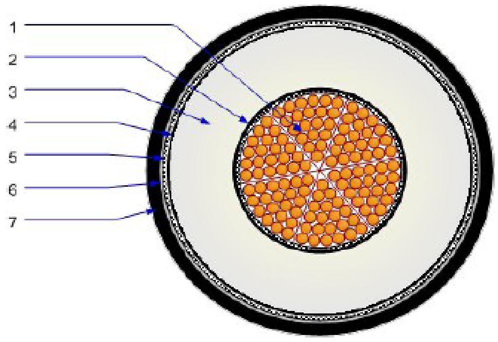


Figure 1 : Example of XLPE cable design; note that there are also other solutions, e.g. lead sheaths or welded smooth aluminium sheaths (Diameter: 140mm; Weight: 40kg per meter).

[1] We herewith define as follows:
1. Cable system = 3x single phase cable
2. Cable circuit = group of n cable systems making one transmission circuit
3. Double cable circuit = two cable circuits making two separate transmission circuits to double the capacity
4. Route length = distance from point A to point B

3.1.3. Cable length / Transport

- XLPE cables can be delivered in lengths of up to 1150 meters of phase conductor. Typically, for most applications at 400kV they are delivered in a length of 700 – 1000 meters.
- Main considerations on length are possible limitations resulting from logistics: Weight and size of the cable drum have to be considered for transport.
- Cable drums are usually transported on road or rail to the actual site.
- Typical drum dimension:
  - o 4.2 m overall diameter
  - o 2.5 - 3 m overall width
  - o 35 - 40 T weight.

Figure 2: 400kV XLPE drums transported by truck

3.1.4. Installation of XLPE cables

- XLPE cables can be directly buried into the ground or installed in tunnels, ducts or pipes to respond to requirements from surroundings, to enhance protection against external damage or to facilitate link to other installations.
- The XLPE cable is surrounded by a sand blending, in some cases a mixture of sand and weak cement (CBS cement bound sand) for better heat dissipation. This has to be delivered to the site and the excavated soil (max 30%) has to be transported away.
- This installation type is mostly applied in rural areas. When installed in ducts or pipes to ensure additional mechanical protection against external damages, access to the cable can be facilitated. In cases where surface routes are not possible the cable can be installed in tunnels (not considered in this paper).

Figure 3: 220 kV cable system pulled in pipes and buried

3.1.5. Joint bays

- Cable sections are linked every 700-1000m by so called joint bays. These three phase joint bays typically are around 10m by 2.5m by 2.1m depth. The location of the joint bays is part of the design to allow access.
- Joint bays can be directly buried into the ground, surrounded only by a sand blending. If required, joint bays may be placed into an underground structure.
- There is no or only little visibility of these installations above ground.
- Developments in prefabricated joints and terminations technology make the erection of joints on site easier, shortening the time needed to complete the joint bay's installation.

Figure 4: Example of a 400 kV joint bay directly buried into the ground; Typical dimension: length 10 m, width 2.5 m, depth 2.1 m

3.1.6. Transition stations or Cable Sealing End Compounds

- Transition stations link the overhead line to the partially undergrounded section.
- The size of the transition station largely depends on the transmission capacity and protective installations that are required for the specific line.
- The size of a transition station will be between 2,000-4,000m², depending on voltage, number of circuits and type of additional apparatus or accessories installed. These compounds can often be screened to provide some visual mitigation.

Figure 5: Overhead line cables transition station (400kV)

- Transition compounds contain terminations, surge arresters, grounding connectors and a dead-end tension tower for the overhead line. Depending on design criteria of the TSO, voltage transformers, current transformers and container building for auxiliary equipment may be included.

3.1.7. Cable termination

- Transmission cable terminations are generally installed inside the transition stations at the extremities of the cable line.
- The cable termination may be of the porcelain or composite type.

Figure 6: 400 kV Termination under construction

3.1.8. Norms and standards, Life expectancy

- The IEC international standards 62067 require specific prequalification protocol for transmission cable systems. This prequalification process applied for each supplier and each system consists of a 12 months test having the scope to demonstrate long term satisfactory performance of the complete cable system (cable and their accessories).
- Several bodies, in particular the IEC and the International Council on Large Electric Systems (CIGRE), facilitate the development of best practices and issue harmonized rules for fundamental principles in EHV cable technology. This ensures that industry meets a minimum level of standardization and quality.
- XLPE cables and accessories have been designed to ensure a technical life of several decades.
- Monitoring systems, both on-line and off-line, allow a continuous 'health check' on the cable temperature and possible partial discharges to take timely measures to ensure its longevity.

3.1.9. Time to manufacture / Production capacity

- By expanding its production capacity, the cable industry is responding to the global increase in demand for EHV XLPE insulated cables.
- Today, based on an annual capacity of 120 – 140 km of phase conductor (220 kV and 400kV) per year per line, there is the capability to produce, test, certify and install some 2,000 – 3,000 phase km of 220 and 400kV EHV cable per year (700 – 1000 km of single circuit length) including the necessary accessories and man power by European manufacturers.

Europacable believes this is sufficient capacity to meet demands in Europe for the foreseeable future. If demand for EHV XLPE cables were to increase beyond expectation, the industry is ready, as it has been in the past, to adapt capacity to meet new demand. Two to three years are necessary to build and qualify a new manufacturing line.

3.1.10. Time to install

- The installation time depends on the characteristics of the cable route, the type of installation and the civil works required.
- In the case of the Turbigo-Rho line in Milano (Italy), the construction of a double cable system 8.4 km 400kV underground section along road sides took 14 months to complete[2]. In this case cables run along both sides of urban roads, crossing many interferences with other infrastructures and with several points in directional drilling. The soil was mainly clay mixed with gravel stones. The minimum depth of laying was 1.2 meters according to the Italian standards.
- The average installation time per km (direct buried in urban area) is 1.5 months/km for opening the trench per circuit, cable laying and closing the trench. For the cable laying alone, 1 – 2 days per km and per phase is required. Installation times indicated here refer to working with one civil work team only. By increasing the number of teams, installation times can be reduced. Also, if there are more systems in the same trench timing will only increase by approximately 10 – 20 %.
- Environmental requirements need to be taken into consideration for the installation phases.

[2] CIGRE B1-302 Turbigo- Rho An example of the use of Underground XLPE cables in a meshed transmission grid, 2006

3.1.11. Time to test / commission

- After the installation the cable system is subjected to the final tests as requested by the relevant applicable standards.
- The tests after installation are composed by the AC high voltage test of the cable system main insulation and the DC test on the cable outer sheath in order to ascertain its integrity. All these tests are carried out on site using a mobile test set working at a resonance frequency between 20 and 300 Hertz. Testing in the order of 20 km is available.
- These tests have a typical duration of one week, including the preparation and the final control of the circuit arrangement, depending on the number of cables and systems to be tested according to IEC 62067.

Figure 7: Test after installation in proximity of an overhead – underground transition compound

Additional tests can be carried out after the installation including the partial discharges on the accessories that may require approximately another week depending on the length of the circuit and the number of accessories to be tested. It should be noted that the scope of the test after installation is that to ascertain that the operations as the cable pulling, the joints and terminations mounting etc. are carried out in the proper manner and not to check the quality of the cable and the accessories that are previously 100% tested in the factory.

3.2. Integration of partial undergrounding in transmission networks

Integration issues are focussed here on the two following aspects. Other considerations like switching sequences, reactive compensation, potential harmonic resonance can also be relevant for some projects.

3.2.1. Transmission capacity

The cable shall be designed to carry the load flows under normal and under emergency conditions corresponding to the grid build up conditions in order to comply with the security rules deriving from the European regulations and with the specific conditions of the local grid.

A typical overhead transmission line consists of two systems, each allowing the transmission of a nominal current of 3600 Amp. In order to meet the (n-1) conditions each of the two cable circuits will be loaded up to 70% (which makes 2520 Amp) in normal conditions. In case of the loss of one system the remaining one must be able transmit 3600 Amp continuously. These values correspond to base case which is studied in the chapter 4.

3.2.2. Transmission losses

- The cable cross section consists mostly of single core copper conductors (sometimes aluminium) and has usually a higher cross section compared to overhead line which uses aluminium conductors normally; however the use of bundle conductors for OHL may equalize the cross sections. However copper (UGC) has a lower resistance than aluminum (OHL); so for the same flow conditions, the level of losses in cables is lower than in overhead lines. Metallic sheath losses have also to be taken into account for underground cables: these depend on cable laying configuration, type of connection of the metallic sheath (cross-bonding or not).

- A comparison of losses for OHL and UGC depends on the dimension and number of conductors and systems per transmission circuit, on needs for cooling, and reactive power compensation. Losses also vary much by the actual load on the line. Therefore the calculation of losses must be made on a case by case basis.
- However regarding partial undergrounding a cable section of few kilometres length in a transmission circuit will only originate a small part of the losses of the whole link and will not reduce the energy losses significantly.

3.3. Reliability of links with partial undergrounding

3.3.1. Reliability of cable section

XLPE cable systems undergo thorough test procedures according to IEC Standards with thermal and electrical stress levels exceeding operational levels before being placed in operation. Qualified cable systems are carefully checked before delivery and commissioning:

- Following production the XLPE cable and all system components undergo a thorough verification procedure, routine tests, to confirm compliance with homogenous quality according to international standards.
- Following installation, the cable system is subject to a commissioning test to confirm proper installation.

Once in the ground, the XLPE cable system is safely in place and well protected against any external weather influences. As any important infrastructure, partial undergrounding solutions shall be carefully designed to be protected against extreme weather conditions (e.g. floods, landslides, avalanches…). Monitoring systems allow close tracking of cable performance to ensure no overheating of the cable system.

Figure 9 illustrates various temperature measurements. The temperature measurement is ideally carried out using an optical fibre inside the cable in the screen area. (See position 2 in Figure 9) Alternatively, the optical fibre can be positioned on the cable sheath. Positioning the fiber too far away from the cable in the surrounding soil may compromise the accuracy and should be avoided. It should only be applied on existing cable systems where no alternative is available.

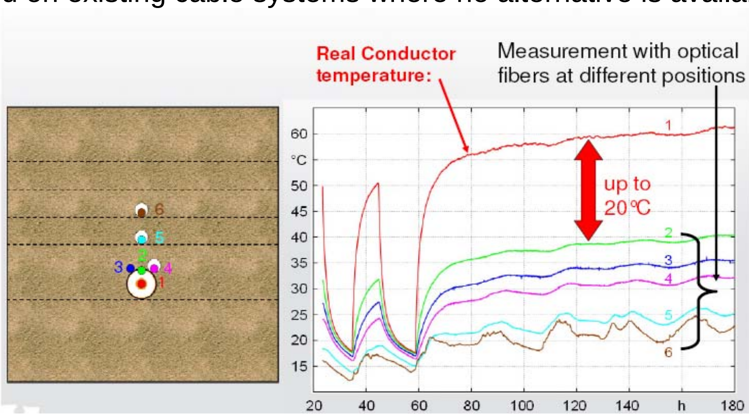


Figure 8: Differences in temperature measurements during load cycles according to the position of the sensor

Online partial discharge monitoring can be used to monitor the status of a cable system.

3.3.2. Failure

The common reference agreed between ENTSO-E and Europacable for this paper is the Cigre Technical brochure 379 "*Update of Service Experience of HV Underground Cable Systems*"[3]. This paper reports the fault on land cables over the period 2000 – 2005 for land cable systems according to voltage classes (60 to 219kV and 220 to 500kV).

In this brochure a failure is defined as "*Any occurrence on a cable system which requires the circuit to be de-energized*", i.e. a failure is counted irrespective of the reason or length of outage time. This has to be taken into account comparing this study with other failure statistics.

The Cigre Study is based on data from the period 2000 – 2005. Since then, a significant number of new 400kV cable systems has been installed in Europe (see Annex 6). The operational experience of these systems is not taken into account in the study. Therefore it is agreed that it would be useful to update the Cigre data in the near future.

Once in operation, the cable is protected by the surrounding soil. However as confirmed by the Cigre Technical brochure, external damages (e.g. other construction works) contribute to 50% of cable system failures. As direct buried cable systems are more exposed to damage by external interventions than cable systems installed in ducts or tunnels, installation in ducts or tunnels as an appropriate mitigation measure may be considered. However it is to be noted that repair time of cable buried in ducts are longer than for cables directly buried.
Concerning workmanship the following statement on internal faults is given in the study: "*Within the data there are examples (approx 50%) of cases where inadequate jointer training gives rise to a significant number of failures".*

Taking into account the failure rates for EHV cables and accessories of the Cigre Technical brochure failure rates for a defined cable system can be estimated. Assuming a partial undergrounding of 10 km with single cable lengths of 1000m and based on the failure rate of a single cable system 0.0307 failures per year, the time between failures can be estimated at 33 years. When the circuit is made of two cable systems the time between failures of the circuit can be estimated at 16 years. Fault location is carried out using a standard procedure for locating cable and accessories failures.

3.3.3. Repair time

According to Cigre Technical brochure 379, more than one third of the cable faults in EHV cable systems were repaired and the cable system was re-energized again within one week and more than 75% within one month. This includes fault location, repair and testing. (Note that outage times less than 1 day and longer than 6 months were not considered in the survey)

"*The 13% of AC-extruded cables which took more than 3 months for repair is probably due to a very low priority given to this repair*" (Cigre Technical brochure 379). Operational constraints may however have contributed sometimes to such a delay between repair and re-commissioning.

Down times are affected by:

- Safe access to site
- Clarification time required for TSOs and, if required, independent experts to undertake a thorough investigation to assess the reasons behind a failure; in exceptional circumstances this can last several months
- Decisions on counter measures to prevent future failures

[3] CIGRE 379 Update of Service Experience of HV Underground and Cable Systems, April 2009

- Availability / ordering / delivering of spare parts (recommended to hold stock)
- Repairs and testing itself can be conducted in less than 3 weeks.

3.3.4. Consequences for TSOs at the planning stage

As any transmission link, also partial undergrounding requires a risk assessment of integrating the link into the system. This includes:

- a check on whether it is acceptable regarding the system operation especially long duration outage,
- identification of mitigating measures which would have to be implemented in an outage situation and
- any measure (from the design phase to the operation and maintenance conditions) to reduce the risk of outages.

3.3.5. Autoreclosure functionality

This functionality is used for overhead transmission lines; it allows to reenergize the line just after a fault and to face the fugitive faults (which represent the majority of faults affecting overhead lines) without any disturbance in the power system.

Since any failure on the cable section is permanent, autoreclosure is not applicable on this section. In order to maintain this functionality specific protection and measurement equipments should be used which will make possible a precise localisation of the fault, to identify which one of the cable or the overhead line section is affected and to initiate the adequate remedial action.

3.4. Environmental aspects of partial undergrounding

3.4.1. Environmental impacts during operation

3.4.1.1. Trench width in directly buried cables

- Width required depends on the number of cables, which in turn depends mainly
  - on the desired transmission capacity
  - on the general geology of the soil
  - on existing surrounding structures (undercrossing roads, highways, rails roads, rivers or waterways)
  - on the thermal resistivity of the refilled soil material in the trench
  - on other cable systems adjacent to the new ones
  - on space available
  - on the thermal mutual influence

Each circuit is installed in a trench approx 1 to 1.5 meters deep and 1 to 2 meters wide. If two systems are to be installed in two separate trenches spaced 5 meters apart, the total space or right of way would be less than 10 meters. If three trenches are required, the total space would be less than 15 meters. If four trenches are required, the total space would be around 20-25 meters. In any case the cable systems must be accessible permanently along the route which may require servitude agreements.

Illustrations below provide an indicative example of a 400kV XLPE cable system, directly buried, with a current rating per circuit of 3.600 A (2500 MVA). As can be seen by the more precise calculations under Chapter 4 ‘Case Study’, the recommended spacing between trenches will depend on the thermal resistivity of the soil, laying configuration, depth, type of metallic sheath connection. In case of 4 cable systems a working area can be managed between circuits in order to facilitate repairing.

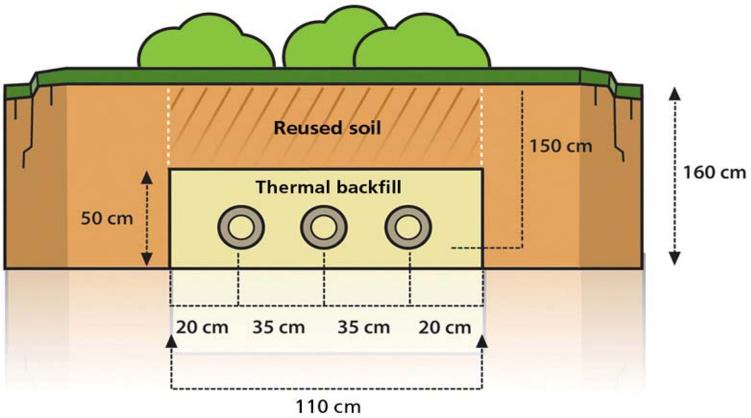


Figure 9: Example of a single AC 400kV system carrying 1250 MVA (space depends on soil resistivity)

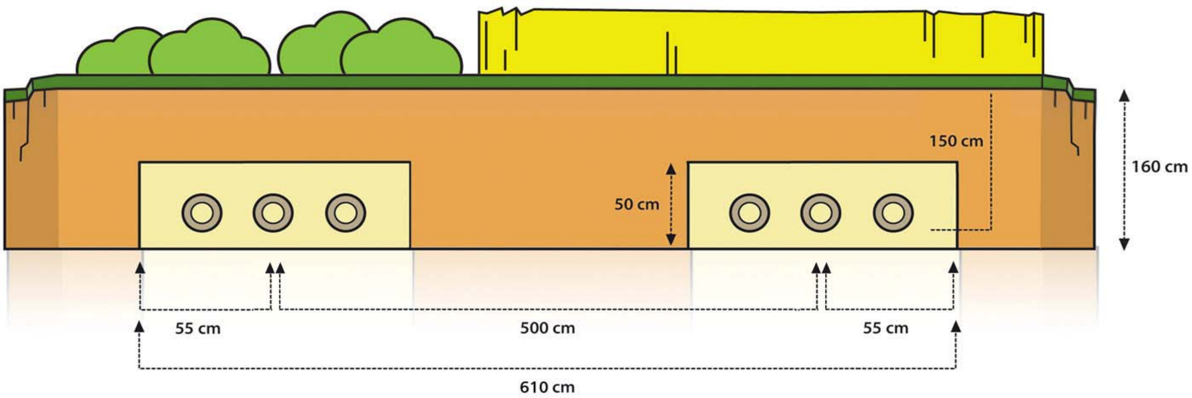


Figure 10: Example of a double AC 400kV circuit carrying 2500 MVA (space depends on soil resistivity)

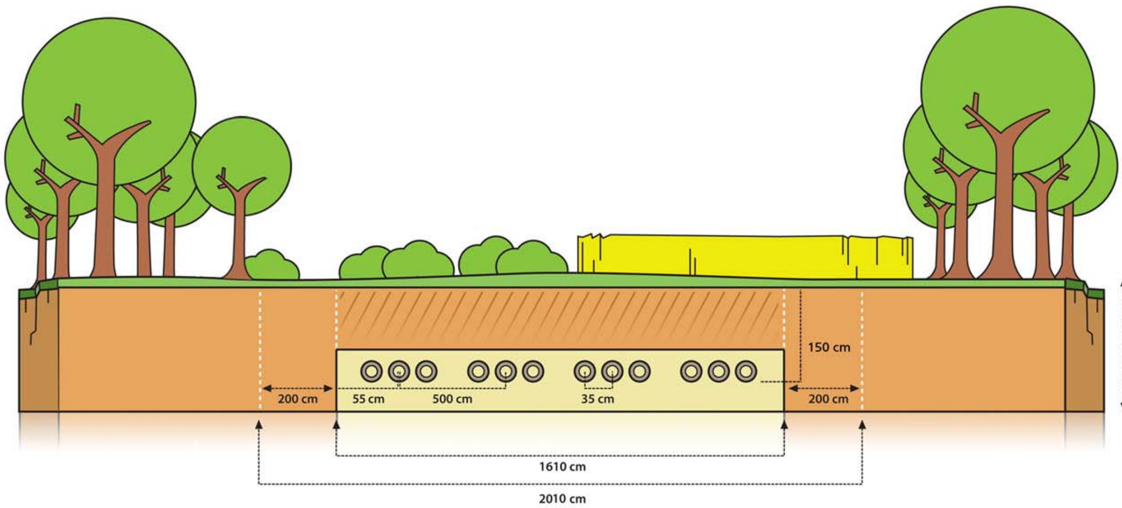


Figure 11: Example of two double AC 400kV circuits carrying 5000 MVA in total

(space depends on soil resistivity)

3.4.1.2. Use of land

- The only restriction on the use of land over a partially undergrounded section is that no deeply rooted trees may be planted within the corridor width plus a margin of about 5 meters to prevent roots encroachment into the cable trench. Apart from that there are no limitations to cultivation, including agricultural farming.
- The laying depth of the cable systems has to be sufficient to avoid any damage to the cable trench and cables themselves by agricultural activities above the cables. The corridor must be kept free from any buildings.

Figure 12 : cable route above ground

3.4.1.3. Electric and Magnetic Field Exposure

Typical specifications:

	OHL	UGC
Voltage (kV):	400	400
Number of electric circuits:	2	2
Kind of conductors per electric circuit:	3 x 4x560/50	2 x 3 x 2500 RMS Cu (parallel)
Maximum power (MVA):	2 x 2500	4 x 1250
Maximum current (A):	7200	7200
Current per electric circuit (A):	3600	3600 (2 x 1800 parallel)
Minimum clearance to ground (m):	8,0	
Calculation height above ground (m):	1,0	0,2
Depth of centre of cable (m):		1,5
Dimensions:	geometry of phases as shown in figure13 and 15	

- Figure 14 and 16 shows that the magnetic field exposure is in the same range of 65 – 70 µT on both cases. These calculations just refer to one specific example of overhead line and underground cable configuration. These values vary with the clearance to ground for OHL and the depth of cables for UGC. Beneath an OHL the magnetic field exposure decreases slower than above ground from an UGC when moving away from the axis of the link.
- In both cases (OHL, UGC) the maximum values do not exceed the given reference levels of the EU Recommendation 1999/519/EC of 100 µT for public exposure based on values established by the International Commission on Non-Ionising Radiation (ICNIRP)..

Electric Field Exposure

Since an underground cable is shielded, there is no exposure above ground. Therefore the electric field of an overhead line is not shown in this case because comparison with underground cable is not applicable.

Overhead Line

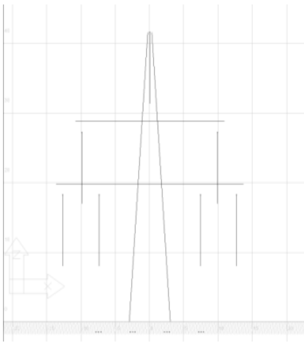


Figure 13: One electric circuit on each side of the tower

Magnetic Field Exposure Overhead Line

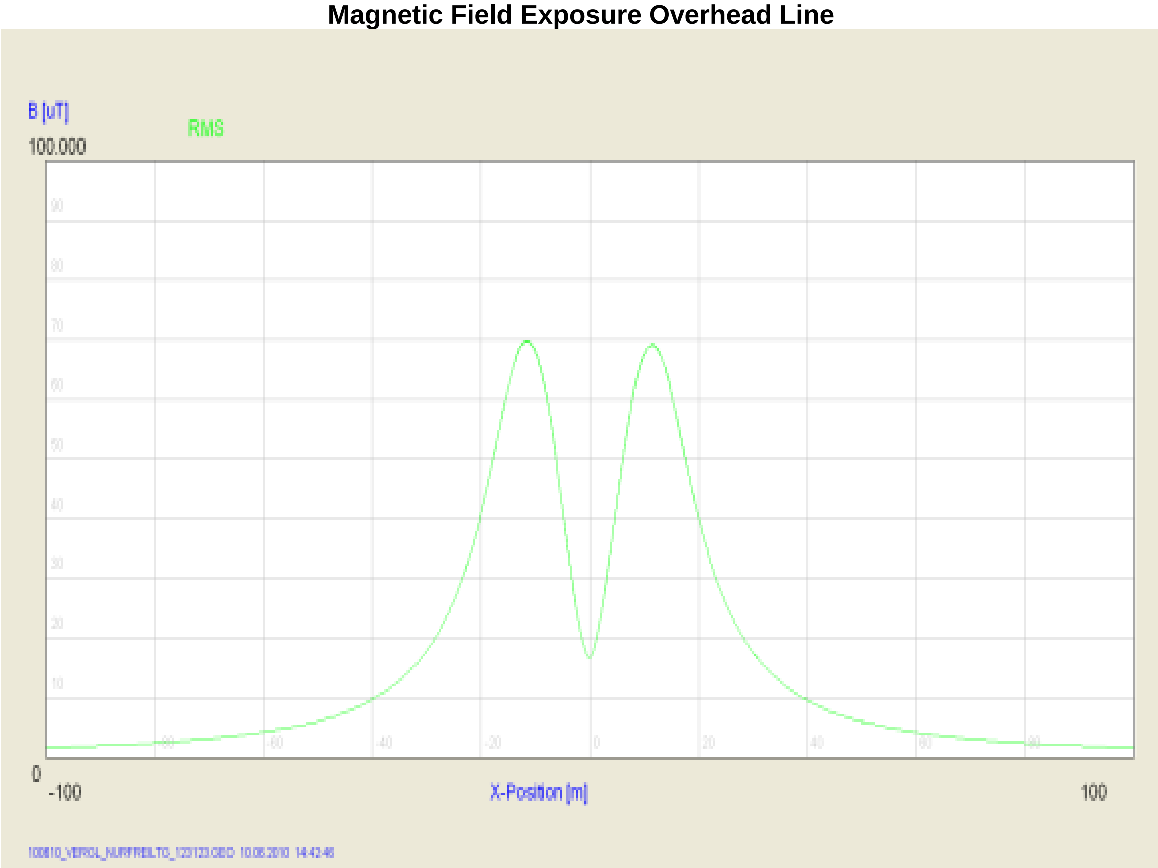


Figure 14: Magnetic Field Exposure OHL calculated at 1 meter above the ground and at X meter from the centre of the line

Underground Cable

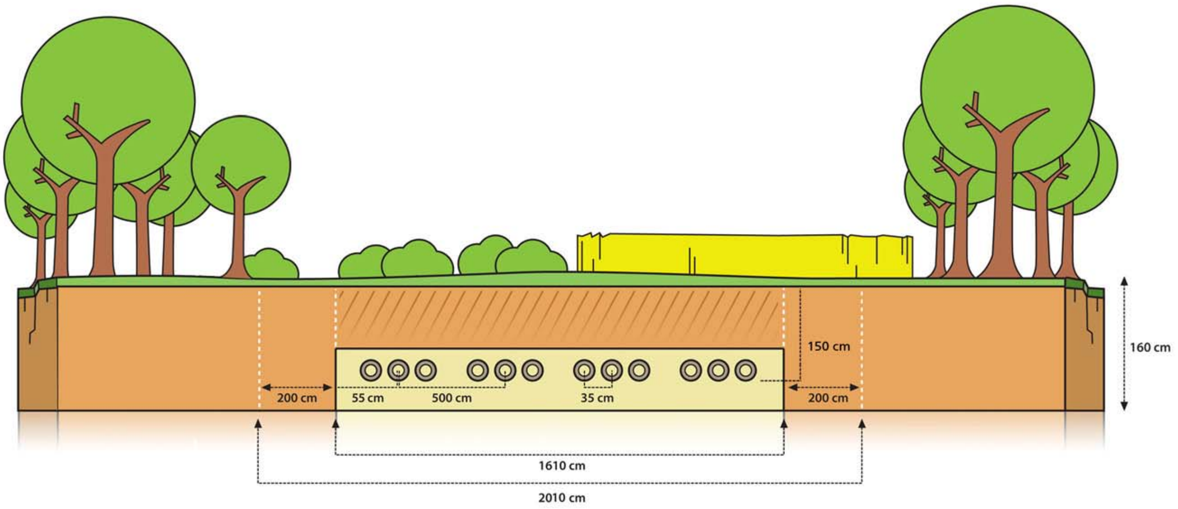


Figure 15: Two double electric systems (2 parallel circuit made of two systems)

Magnetic Field Exposure Underground Cable

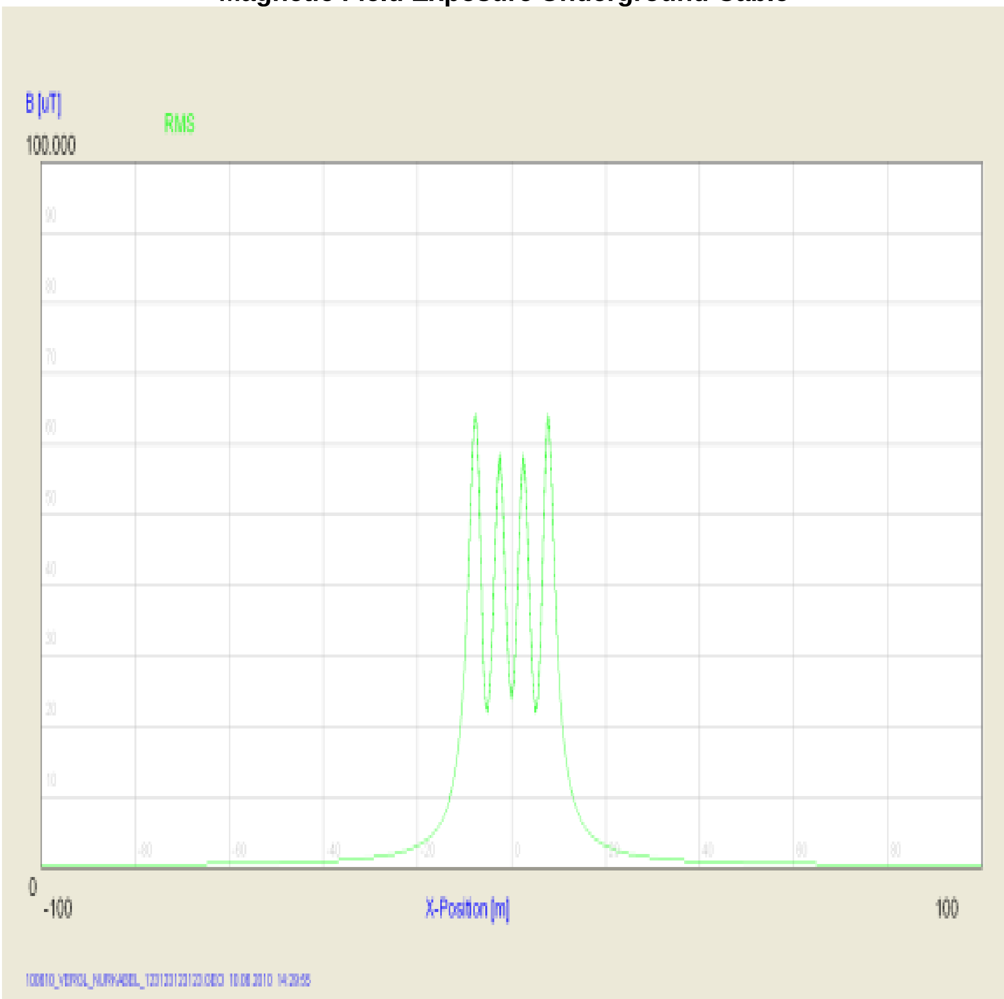


Figure 16: Magnetic Field Exposure UGC calculated at 20 cm above ground and at X meters from the centre of the cable circuit

3.4.1.4. Possible heating of ground

- During operation, the temperature of the cable will rise dependent on the current carried and load factor. Heat distribution to surrounding soil depends on the backfill material.
- The impact of heat release on soil temperature is strictly local and very limited.
- It is only under long term full load conditions that soil directly over the trench may heat up by approximately 2° Celsius – in partial load operations this value is lower.
- If necessary, the thermal impact may be additionally mitigated with the use of a cable with a larger conductor size if possible.

3.4.2. Environmental impacts during installation

- Civil works required to partially underground a high voltage transmission line may have a considerable impact on the environment. Heavy machinery will be required for trenching as well as for delivery of cable drums. During the construction period, access tracks and haul roads are required to the site. These ones are removed following the completion of the works but there will be a need to consider ongoing requirements for operational access.
- Waterways or particularly sensitive areas can be crossed by applying drilling techniques to install the cable. Distances of up to 1km can be crossed. These sections often determines the rating of the line or the size of the cable.
- In most cases, the cable system is directly buried hence 70% - 80% of the soil can be re-filled in the trench. For the period of the construction the soil can be stored alongside the trench. Up to 30% of backfill material has to be transported to the trench and the equivalent soil will be transported away from the site.
- Depending on the type of vegetation, the landscape is usually reinstated within 18 – 24 months. The surface vegetation above the installation is managed to ensure no route encroachment for the life time of the cable system.

Figure 17 : cable route at site

Figure 18: Installation of 400 kV XLPE cables

3.5. Cost aspects of partial undergrounding

Respecting EU competition requirements, Europacable can only provide general statements regarding cost factors of partial undergrounding.

Also each project is unique and a full macroeconomic assessment of the cable system should be made that takes into consideration installation costs, life costs, maintenance costs, impact on land / property, environmental protection etc.

When lifetime costs and other costs are taken into consideration, cost factor compared to overhead lines (based on self supporting tower structures) can vary between 3 and 10 times for direct burying. Where partial undergrounding is considered, the above multiples apply only to the undergrounded part of the link. This factor needs to be verified against the specific requirements of the project taking also into account the costs of the transition stations and compensation equipments, if required.

From a practical point of view three dimensions should be taken into account:

3.5.1. Cost of installation

- Cost of XLPE cable system depend on the specific requirements defined for the system. In addition to the cable itself, accessories like joint bays, transition station, etc. need to be accounted for. Generally speaking, due to the complexity of the technology, installation costs of an EHV cable solution per km will always be higher than an equivalent distance of an overhead line.

- Up to 60% of the installation costs can result from the civil works required for the installation. These depend on the type of soil that the cable is going to be placed in (sand, rocks etc.) as well as other existing infrastructure the route may cross. Europacable member companies will largely work with local contractors to execute the civil works. The installation of the cable system will be implemented by specifically trained personnel.

- On 400 kV XLPE projects buried in soil and completed in Europe over the past 10 years the range of investment cost has been generally between 5 and 10 times compared to an overhead line. These cost ratios are directly related to the capacity of the link. Factor down to 3 can be reached for links with limited rating and under special favourable conditions for cable laying or in case of expensive OHL. Factors above 10 can be reached for high capacity double circuit links and if specific structures are needed like projects involving the construction of cable tunnels (factors above 15 are expected in these cases) due to the cost for civil works. Higher ratios are also observed when compared to OHL consisting of guyed towers

- Assuming that only one tenth of the length of the project is subject to partial undergrounding and that the investment cost of this section is 5 to 10 times the cost of the current overhead section, as a result partial undergrounding would lead an increase of the investment cost of projects by a factor of 1.5 to 2, not considering costs for transition stations, reactive power compensation etc.

- This example shows how the economical balance of the transmission projects is highly sensitive to the recourse to partial undergrounding and that such a decision must be carefully analysed with all stakeholders and particularly the regulators whose authorization is in many cases needed by the TSO to ensure an appropriate cost recovery through the transmission tariff.

3.5.2. Cost of operation

The health and safety regulation of the TSO requires operational activities which do not differ in costs too much from the operational expenses of the 400 kV overhead lines.

Once in operation, a cable system itself is nearly maintenance free. Monitoring systems allow partial discharge surveillance. As any transmission corridor, the cable route requires regular inspection to prevent any encroachment. In some countries, the corrosion protection test with 5 kV dc voltage for the outer sheath has to be performed at least every second year.

As previously mentioned, as the UGC section represents only a limited part of the total length of the link, it will not significantly affect the volume of operational expenditures generated by the whole link.

The maintenance of the line/cable transition stations is of the same nature as for EHV substations.

4. Case Study

This case study aims at providing more detailed figures concerning the design of an underground section in a typical overhead transmission line.

4.1. Technical specifications

A 400 kV XLPE cable system directly buried in trench connecting 2 substations with the following specifications:

- Sequence: Substation – 35 km OHL – 7.5km UGC – 15km OHL – Substation
- Reference nominal voltage: 360-420 kV, 400 kV for calculations
- Maximum system voltage for one hour: 440 kV
- Minimum voltage for one hour: 350 kV
- Current rating: 3600 A
- Short circuit rating: 63 kA for 1 second
- Soil thermal resistivity: 0.8, 1.0, 1.5 K.m/W
- Operational conditions

Case study:

- In case 1 when two circuits are available each one must transmit up to 70 % (which makes 2 x 2520 A) in order to comply with N-1 conditions (outage of the second circuit of the line); when only one circuit is available it must transmit 3600 A continuously
- In case 2 in addition to the above conditions a emergency load of 3600 A must be transmitted simultaneously in each of the two for a duration of 70 hours. This situation can result from the outage of another link in the grid.

4.2. Transmission Scheme for Case Study

The cable section will be made of 2 cable circuits each of them made of 2 cable systems (in total 4 cable systems).

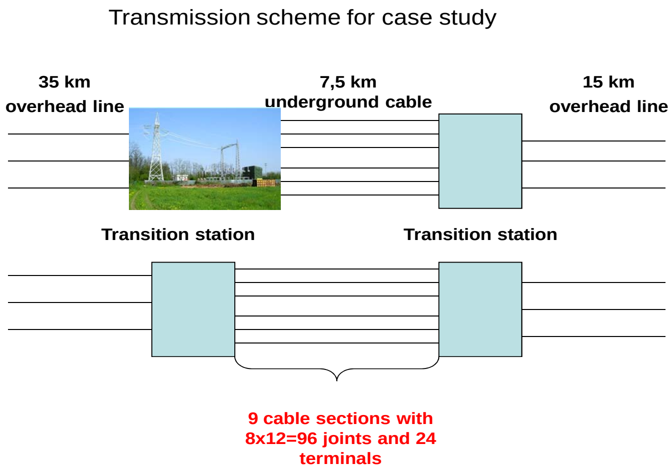


Figure 19: Transmission scheme for the case study

4.3. Type of reference cable and characteristics to be considered for the calculation:

1) Copper conductor (alternative Al)
2) Semiconductor
3) XLPE insulation
4) Semiconductor
5) Waterblocking
6) Metallic screen and water barrier (aluminium laminated foil)
7) Polyethylene outer sheath

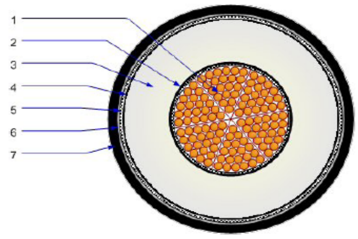


Figure 20: Typical crosssection of XLPE power cable (Diameter: 140mm; Weight: 40kg per meter).

Item	Description	Nominal Thickness [mm]	Details
1	Conductor		Copper 2500 mm^2, Milliken
2	Conductor Screen		Semi-Conducting Polymer
3	Insulation	26.0	XLPE
4	Insulation Screen		Semi-Conducting Polymer
5	S.C. Water Blocking		S.C. Water Swelling Tapes
6	Metallic Screen Wires + AL laminate		Wires + 0.2 Al laminate
7	Outer Sheath	5.0	Black ST7 PE

Note: This is a reference cable design for calculation. Other cable designs i.e. with different conductor, different insulation thickness and different metallic screen or sheath are available as valid alternatives.

4.4. Installation parameters

- Cables directly buried in trenches
- Individual trenches, one group of three cables per trench
- Depth of laying: 1.5 m at the bottom of cables
- Cable spacing: The cable spacing will be function of the soil thermal resistivity and load factor. A maximum phase spacing of 350 mm should not be overpassed in order to maintain the magnetic field in the limit of the requested 100 microT.
- On the base of the maximum phase spacing the width of trench should be at least 1 m

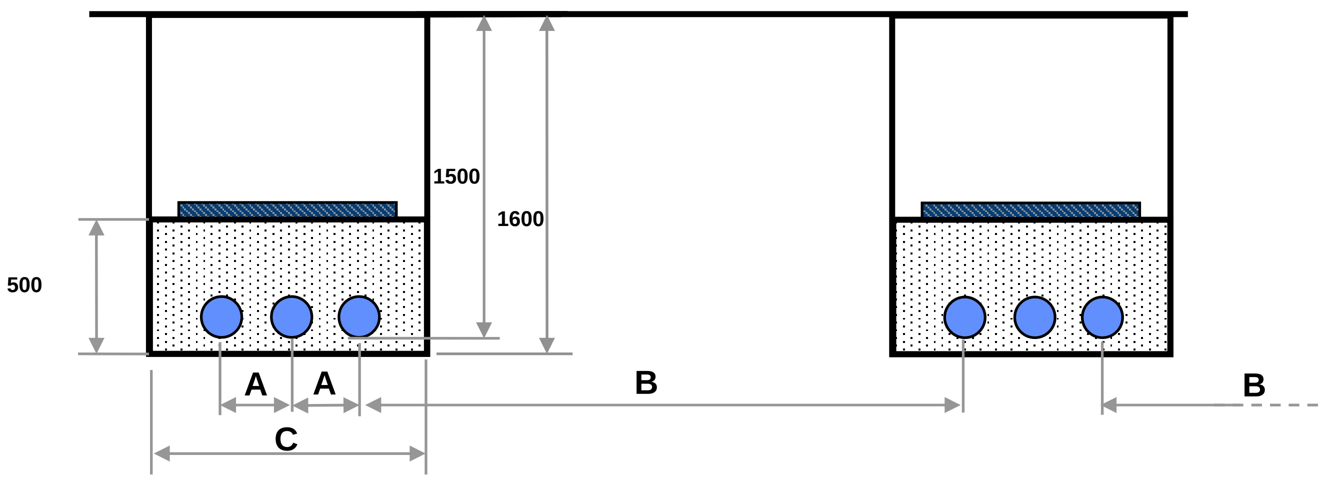


Figure 21: Typical cross-section of cable trench

4.5. Current rating calculation and dimensions

Case 1: The current rating calculations are based on IEC 60287 standard for the 3600 A continuous load when only one circuit is available (2 cable systems each of 1800 A).

In case of two circuits are available the continuous loading will be of 2520 A per circuit (4 cable systems each of 1260 A).

For the purpose of this paper, it is agreed to base the calculations on the only existing international standards. Please note that these assumptions can be considered as conservative since they do not take into account the latest technology (e.g. cross-sections above 1600mm², insulated wires, etc.). The CIGRE working group B1.03, on the basis of more recent data, retains values leading to higher transmission capacity. It is likely that the standard will evolve towards such values in the near future.

The phase cable spacing (Mark A on the figure) in each individual trench and the spacing of the nearest cables of two different trenches (Mark B) is selected in order to assure the requested current of 3600 A per circuit, i.e. 1800 A per cable system. The width of each individual (Mark C) trench is depending on the phase cable spacing.

Table of current rating per cable system and trench dimensions 1st case

	Soil resist. 0.8 K.m/W		Soil resist. 1.0 K.m/W		Soil resist. 1.5 K.m/W (**)	
Operational conditions (***)	One Circuit	Two Circuits	One Circuit	Two Circuits	One Circuit	Two Circuits
Current rating - A	1800	1730	1800	1780	1800	1579
Distance between cable phases (Mark A) (mm)	200		300		1000(*)	
Distance between cable system (Mark B) (mm)	2500		5000		8000	
Width of trench (Mark C indicative) (mm)	1000		1100		2500	

- (*) This cable spacing cause a magnetic field of 220 microT at soil level which is higher than the maximum EU recommended value of 100 microT requiring a specific backfill.
- (**) A thermal soil resistance of 1.5 K.m/W can only be found in very few European locations. Whenever the soil resistance is that high, special stabilization backfill material will be used to reduce the resistance to a lower value. The resulting current ratings and dimensions are therefore only indicative.
- (***) "One Circuit" means that only one circuit is available and must transmit 3600 A continuously (1800 A for each cable system)
  "Two Circuits" means that the two circuit are available and must transmit each 2520 A continuously; as 12 cables are in service the reduced rating is due to the reciprocal thermal influence of the higher number of cables contemporary loaded.

Case 2: same assumptions as above for continuous load conditions with in addition a contemporary emergency load of 3600 A in the two circuits (4 cable systems each of 1800 A) for the duration of 70 hours. In this case the calculation is carried out according to the IEC standard 60287 for the continuous load conditions and IEC 60853-2 for the emergency load conditions

Table of current rating per system 2nd case (trench dimensions as for the 1st case)

	Soil resist. 0.8 K.m/W	Soil resist. 1.0 K.m/W	Soil resist. 1.5 K.m/W (**)
	Two Circuits	Two Circuits	Two Circuits
Current rating during the normal service - A	1260	1260	1260
Current rating during the 70 h emergency - A	2010	2120	2190

As it possible to see once the system has been designed in order to meet the case 1 the admissible rating under temporary emergency conditions is higher than required in case 2. The situation where only one circuit is in service with a continuous load of 3600 A is the limiting factor that is deciding the dimensions of the trenching, All the other conditions allow a higher current rating in respect of the requested value. If only the 2nd case should be considered the cable spacing and trenching dimensions may be significantly reduced.

5. Annex

EHV transmission projects that include 220kV XLPE cables have been installed in Europe since the mid 1990s. Locations include Cote d'Azur, Paris, Lisbon, Barcelona, Dublin, Madrid and Valencia.

Overview of main EHV XLPE Installations in Europe at 400kV:

Location	Project	Type of project	Cable circuits x length (km)	Cables per phase	Power MVA	Time period	Method of laying and cooling
Copenhagen	Elimination of overhead lines in urban area	City feeder	1x22,1x12	1	995	1996 1999	Direct buried
Berlin	Connect West/East system	City feeder	2x6;2x6	1	2x1100	1998 2000	Tunnel ventilated
Madrid	Barajas Airport Expansion	Airport runway crossing	2x13	1	2x1720 winter 2x1390 summer	2002/3	Tunnel ventilated
Jutland	Area of outstanding beauty, waterway & semi urban areas	Partial under-grounding	2x14 in 3 sections	1	2x500 nominal 2x800 temporary overload	2002/3	Direct buried & ducts
London	London St. Johns Wood-Elstree	City feeder	1x20	1	1600	2002/5	Tunnel ventilated
Rotterdam	Rhine waterway crossings	Waterway crossings	2x2.1	1	1470	2004/5	Direct buried & pipes
Vienna	Provide power to centre of city	City feeder	2x5.5	1	2x620 2x1040	2004/5	Buried in concrete block
Milan	Section of Turbigo-Rho line	City feeder	2x8.5	2	2 x1100	2005/6	Direct buried & ducts
London	West Ham – Hackney	City feeder	2x6.3	1	1660 summer 1950 winter	2007/8	Tunnel ventilated
Switzerland/ Italy	Mendrisio – Cagno	Interconnecti on	1x8	1	560	2007/8	Direct buried
Liverpool	Kirkby-Lister Drive	City feeder	1x10	1	750	2007/10	Direct buried & ducts

For further information please contact:

Jean Verseille
Chairman of ENTSO-E
System Development Committee

Email: jean.verseille@rte-france.com
http://www.entsoe.eu

Thomas Neesen
Secretary General Europacable

Email: t.neesen@europacable.com
http://www.europacable.eu

ANNEX 7

THE POTENTIAL FOR PARTIAL UNDERGROUNDING IN IRELAND

TABLE OF CONTENTS

1 INTRODUCTION

Introduction

1 This annex provides a supplemental appraisal using the methodology developed in the main body of the report to consider the potential for partial undergrounding of approximately 10km in Ireland. T**able 1.1** shows the output of the methodology adjusted to consider Ireland separately and sets out a number of underground cable (UGC) Route Combinations as follows:

- **UGC Route Combination 1:** A combination of the longest routes from each of the selected areas (Total Length 30.5km, therefore ruled out as it is greater than approximately 10km).
- **UGC Route Combination 2:** A combination of the next longest routes from each of the selected areas (Total Length 21.5km, therefore ruled out as it is greater than approximately 10km).
- **UGC Route Combination 3:** A combination of the shortest routes from each of the selected areas (Total Length 17.4km, therefore ruled out as it is greater that approximately 10km).
- **UGC Route Combination 4:** A combination of the shortest routes from the areas, in order of the priority allocated in **Table 3.2**, which meets the technical limitation of approximately 10km (Total Length 10.8km, therefore brought forward to the next step in the methodology as it is approximately 10km).

2 UGC Route Combination 4 shows that the shortest route options for the top three areas of priority (Boyne Valley Area, Blackwater Valley Area (County Meath) and Brittas Demesne) are approximate 10km in length (10.8 km) and this option is therefore brought forward for further consideration. As both Boyne and Blackwater are assessed in the main report, this annex therefore exclusively considers an evaluation of the UGC option at Brittas Demesne.

Table 1-1: Length of the cable routes and potential route combinations for UGC sections

Potential UGC Route Combinations	Length (km)	UGC Route Combination 1	UGC Route Combination 2	UGC Route Combination 3	UGC Route Combination 4
1. Boyne Valley Area					
UGC Route 1A South of Tower 339 to North of Tower 363 **(Approx 8.1km)**	8.1	8.1			
UGC Route 1B South of Tower 350 to North of Tower 363 **(Approx 3.9km)**	3.9		3.9	3.9	3.9
2. Blackwater Valley Area (County Meath)					
UGC Route 2A South of Tower 301 to North-west of Tower 312 **(Approx 3.8km)**	3.8	3.8	3.8	3.8	3.8
4. Brittas Demesne Area					
UGC Route4A South of Tower 251 to North of Tower 272 **(Approx 7.3km)**	7.3	7.3			
UGC Route 4B South of Tower 256 to North of Tower 272 **(Approx 5.5km)**	5.5		5.5		
UGC Route 4C Southeast of Tower 263 to North of Tower 272 **(Approx 3.2km)**	3.2			3.2	3.2
5. Mullyash Uplands Character Area / Monaghan Way					
UGC Route 5A South of Tower 102 to North of Tower 126 **(Approx 5.8km)**	5.8	5.8			
UGC Route 5B South of Tower 102 to North of Tower 112 **(Approx 3.8km)**	3.8		3.8	3.8	
6. Cavan Highlands/ The setting of the Fair of Muff					
UGC Route 6A South of Tower 221 to North of Tower 236 **(Approx 5.5km)**	5.5	5.5			
UGC Route 6B South of Tower 224 to North of Tower 236 **(Approx 4.5 km)**	4.5		4.5		
UGC Route 6C South-east of Tower 224 to North of Tower 231 **(Approx 2.7km)**	2.7			2.7	
UGC Option Total Length for Mitigation Assessment of Significant Landscape Impacts		**30.6**	**21.6**	**17.4**	**10.8**
		Longest routes from each Area	Next longest routes from each Area	Shortest routes from each Area	Shortest routes from areas in Ireland in order of priority which meet the technical limitation of approximately 10 km

2 EVALUATION OF UGC OPTION AT BRITTAS DEMESNE

2.1 INTRODUCTION

1 The potential underground (UGC) subsection brought forward for consideration in the area around the Brittas area is subsection 4C, from Tower 263 to Tower 272.

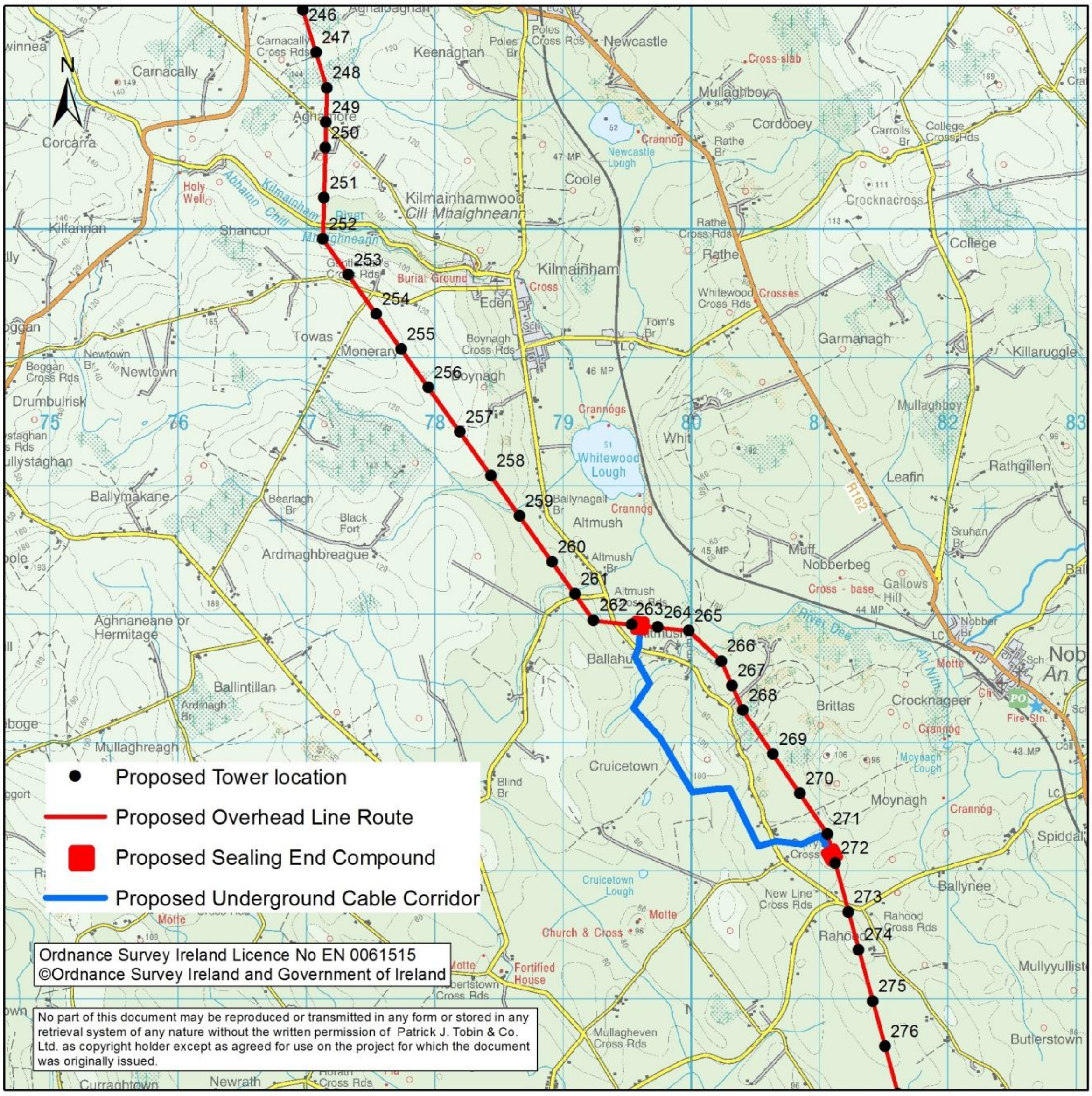


Figure 2.1: Brittas UGC Route 4C Southeast of Tower 263 to North of Tower 272 (Approx 3.2km)

2.2 TECHNICAL CONSIDERATIONS – BRITTAS DEMESNE UGC ROUTE 4C: TOWER 263 – TOWER 272

2.2.1 Alignment Details

2 The potential UGC subsection brought forward for consideration in the area around Brittas is the shorter of the potential routes in that area and the UGC Route 4C has the potential to mitigate the impacts to the Brittas Demesne alone. The potential UGC route departs from the OHL route at Tower 272 and diverts westward away from the local road and around the adjacent hill and reconnects with the overhead line (OHL) at Tower 263.

2.2.2 Road and River Crossings

3 Potential UGC Route 4C includes two roads crossings and one stream crossings and is approximately 3.17km in length.

2.3 AGRONOMY – UGC SUBSECTION TOWER 263 – TOWER 272

2.3.1 Potential Impacts

4 The construction of the UGC would require fencing off a 22m wide swathe of land along the line of the UGC. Within the construction site the top soil would be stripped back, stored and spread over the site at the end of the construction period. The cables would be situated in excavated trenches 1m – 1.5m deep and the soil would be back-filled and levelled.

5 The impacts which would arise are:

- Damage to the soil profile. This would occur due to the construction traffic and excavation. The construction site would be re seeded following laying of the cables. Therefore at least one cropping season would be affected and it is possible that reseeded grassland may not come back into production until the following season. The damage to soil would be residual for the short – medium term (2 – 7 years).

- Damage to drainage systems. Where the line of the UGC encounters land drainage systems there is potential for causing damage to these systems.

- General construction disturbance to the farm enterprises. The actual construction site would be unavailable for a period of 2 – 6 months on most farms. The construction activity and land area reduction would disturb livestock and cropping programs and interfere with the day to day running of the farm. Because the construction site is a fenced off linear feature there is the potential to cause temporary severance to the farm.

- There would be residual permanent disturbance to the farm enterprise. The presence of an UGC is an additional safety risk on the farm. Deep cultivations i.e. below normal plough depth would be restricted and land drainage or excavation above the cables would also be restricted.

- There would be a restriction on building or planting commercial forestry.

- The construction of sealing end compounds at each end of the UGC and joint bays every approximately 650m would increase the permanent land requirement for the construction of UGC.

Table 2-1: Comparison of Overhead Line and Underground Cable Impacts on Land Use in the Brittas Section

Impacts	Overhead	Underground
Number of land parcels affected[1]	7	7
Area of land disturbance / damage (Ha)	3.3	7
Area of land permanently restricted under OHL and UGC infrastructure (Ha)	0.25	1.5
Impacts on farm yards	No significant impacts	No significant impacts
Impacts on forestry	1.4ha of forestry cleared	No significant impacts

2.3.2 Mitigation Measures

6 General mitigation measures for UGC construction are as follows:

- Landowners would be notified in advance of the commencement of construction;

- Fencing would be erected to exclude livestock from construction sites but the contractor would ensure that landowners have reasonable access to all parts of their farm during the construction phase;

- Disease protocols would be adhered to. As referenced in the Electricity Supply Board (ESB) / Irish Farmer's Association (IFA) agreement the contractor would comply with any Department of Agriculture, Food & the Marine (DAFM) regulation pertaining to crops and livestock diseases;

- If rock breaking or pilling are required owners of livestock in fields adjoining the work site would be notified in advance;

- Temporary aluminium or timber plank or panel tracks would be used in certain situations to prevent damage to soil;

[1] Of the 7 affected land parcels along the OHL route, which were assessed in OHL EIS, only 3 are affected by the UGC route. The remaining 4 land parcels along the UCG route were assessed using aerial photography.

- Locally excavated material would be reinstated across the site following construction. All unused excavated fill would be removed from the site and disposed of at a licensed waste facility;
- Affected land drains would be redirected in a manner that maintains existing land drainage;
- Where top soil is stripped back it would be replaced. All disturbed field surfaces would be re-instated;
- Any losses or additional costs incurred by the landowner which are directly attributed to the proposed development, during the construction phase or the operational phase, including additional necessary remedial works and including losses and or additional costs arising from Basic Payment Scheme, implementation of Nitrates Regulations and Agri Environmental Schemes would be paid to the landowner; and
- Mitigation relating to potential effects on water quality and soil contamination due to fuel or concrete spillages are detailed in the outline *Construction Environmental Management Plan* (CEMP) for the proposed development i.e. OHL (refer to Appendix 7.1, **Volume 3B Appendices**, of the EIS).

2.3.3 Potential for this UGC section and Conclusion on Impact Significance

7 Construction phase impacts generally do not give rise to significant residual impacts because land use would not be affected after 1 – 2 cropping seasons. While the construction phase impact would be higher with UGC, the residual impact is low[2] except where there is additional land take due to the construction of sealing end compounds. The impacts along the Brittas subsection are summarised in **Table 2-2**. The construction of a sealing end compound results in a major adverse impact on the northern land parcel, which has a high sensitivity. While the UGC avoids impacting on a large high sensitivity land parcel (with a slight adverse impact), it does affect a new large high sensitivity land parcel (with a slight adverse impact). The UGC avoids forestry plantations. The decommissioning phase for the UGC would likely have as significant an impact as that of the construction of the UGC and again would be higher than that for the decommissioning of the OHL.

Table 2-2: Comparison of the Significance of Impacts on Land Use in the Brittas Section

Impact Significance	**Residual Impacts**	
	OHL	**UGC**
	(Number of Land parcels)	
Imperceptible	2	
Slight Adverse	4	6
Moderate Adverse	1	
Major Adverse	0	1

[2] The evidence from Gas pipelines throughout Ireland is that residual impacts are low.

8 Within the Brittas area there is a preference for the OHL option due to the increase in the number of Major Adverse impacts associated with UGC and sealing end compounds.

2.4 ECOLOGY – BRITTAS DEMESNE UGC ROUTE 4C: TOWER 263 – TOWER 272

2.4.1 Description of Ecological Receptors

9 The potential UGC section does not cross any European site and does not occur within any designated river catchment.

10 The northern sealing end compound is close to the River Dee.

Terrestrial Habitats

11 Noteworthy terrestrial habitats within this UGC subsection include linear woodland habitats and grass verge. The vast majority of habitat crossed in improved agricultural grassland of low ecological value.

12 The terrestrial habitats within this UGC section are considered to include habitats of low and moderate value.

Aquatic Habitats / Species

13 There is limited scope for sensitive in-stream fauna crossed by the UGC. Pollution controls are required for streams downstream of here linked to possible effects of the UGC construction. The northern sealing compound construction works specifically would require diversion / culverting of a drainage ditch linked to the River Dee. The potential impact of the compounds are considered moderate adverse from silt laden runoff and the risk of chemical spillages. With mitigation measures, the potential effects on the River Dee from silt laden runoff and spillage risk are slight adverse. The effects of silt runoff on aquatic receptors in the River Dee are not considered significant provided sufficient pollution controls are implemented during construction of the compound.

Protected Fauna / Birds

14 The key target mammals potentially occurring within habitats which may be potentially affected by the UGC section are badger. Temporary disturbance effects may occur to common breeding birds in hedgerows impacted.

2.4.2 Potential Impact

Terrestrial Habitats

15 Low / moderate value habitats would be impacted including; hedgerows. These habitats would require surveys such as field surveys, vantage point surveys, Light Detecting and Ranging (LiDAR) surveys, review of aerial photography etc to inform evaluation and assessment of potential impacts.

16 The vast majority of the route is in improved grassland of low conservation value.

17 A total of 13 identifiable hedgerows and treelines (including those associated with streams) would be crossed. A minimum estimate of 286m of hedgerow would be permanently removed.

Aquatic Habitats / Species

18 The route crosses 1 identifiable water course.

19 This stream would be culverted. Trenching or other construction approaches would lead to direct permanent impacts to this water course and riparian habitat.

20 A temporary significant pollution risk would arise during construction to aquatic species in particular relating to the sealing compound construction. This risk is related to the potential for increased suspended solids arising from construction works and storage / removal / reinstatement of disturbed soil and / or the release of construction related pollutants.

21 A temporary pollution risk would arise during construction to aquatic species. This risk is related to the potential for increased suspended solids arising from construction works and storage / removal / reinstatement of disturbed soil and / or the release of construction related pollutants.

Protected Fauna / Birds

22 The potential loss of habitats detailed would lead to potential loss of breeding and foraging sites and to loss of connectivity and fragmentation of hedgerows and a stream. A potential barrier effect may occur due to permanent habitat clearway being in place though this is not likely to be significant. A temporary disturbance risk (construction phase) would arise to badger setts. This requires confirmation surveys.

23 There is ongoing operational risk of pollution and wildlife disturbance during operation if faults arise and further excavation works are required.

24 In the event that the cable route section is to be decommissioned, all UGCs, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the

construction phase due the need to excavate the UGCs, import soil to make-up levels and reinstate the land to its previous use.

2.4.3 Risk of Significant Adverse Impact

Terrestrial Habitats

25 Permanent habitat loss within the route of the UGC cannot be mitigated. Habitat connectivity would be permanently affected as hedgerows would be bisected by works area. The potential option for exploring compensatory habitat replacement would be advised in addition to mitigation (reduction of impact) measures.

Aquatic Habitats / Species

26 There is a low risk of significant adverse impact and associated effects on aquatic species and habitats prior to mitigation downstream of the UGC works area. Detailed carefully considered mitigation informed by best practise for reducing risk is required.

Protected Fauna / Birds

27 There would be a potential low risk of significant adverse impacts and associated effects to badger breeding sites. The potential for habitat fragmentation and for a barrier effect cannot be avoided as permanent works area would bisect hedgerows.

28 Habitat fragmentation and barrier effects mean that species dispersal may be effected with a permanent trackway across former hedgerows etc. Mitigation measures are available to reduce impacts on fauna. Compensatory approaches, including for example habitat creation or artificial breeding sites, could be required dependent on the actual impacts.

Summary

29 There is a low risk of significant adverse impacts and associated effects on habitats, badgers and downstream aquatic receptors. Mitigation informed by best practise for reducing risk is therefore required.

2.4.4 Mitigation

Terrestrial Habitats

30 It would not be possible to avoid permanent impacts to terrestrial habitats. Compensatory mitigation approaches, including for example alternative habitat would be the only means to reduce this permanent loss of hedgerow habitat in particular.

Aquatic Habitats / Species

31 There would be the potential for mitigation measures to minimise pollution risks to downstream aquatic species.

Protected Fauna / Birds

32 A survey is required to confirm breeding sites of protected species. There is good scope to avoid protected mammal breeding sites. Mitigation is available to minimise disturbance risk.

Summary of Mitigation

33 Carefully managed pollution control measures with monitoring would reduce the potential risk of significant adverse effects to downstream aquatic receptors. Route modifications would potentially be advised based on based on surveys such as field surveys, vantage point surveys, LiDAR surveys, review of aerial photography etc. that would be undertaken to assess the reduction of potential risks any ground surveys that would be undertaken to assess the reduction of potential risks. Mitigation of potential impacts would involve the avoidance of possible badger setts.

2.4.5 Risk of Significant Residual Adverse Impacts Post Mitigation

Terrestrial Habitats

34 The potential risk of significant residual adverse impacts to terrestrial habitats, post mitigation is low and is dependent on the potential for mitigation through replacement compensatory habitats.

Aquatic Habitats / Species

35 The potential risk of significant residual adverse impacts to aquatic habitats / species, post mitigation is considered Low / Imperceptible.

Protected Fauna / Birds

36 The potential risk of significant residual adverse impacts to protected fauna and protected birds, post mitigation is Low / Imperceptible and would be dependent on surveys.

37 Habitat fragmentation means there is a potential low adverse effect to species dispersal and the potential for barrier effects associated with a permanent trackway across former hedgerows.

Summary of Residual Impacts

38 In summary the risk of significant residual adverse impacts is Imperceptible / Low depending on ecological receptor detailed.

2.4.6 Potential for this UGC section and Conclusion on Impact Significance

39 From an ecology perspective there is some limited justification for partial UGC at this location. UGC would mean identified impacts to Whooper Swan would be reduced slightly and impacts to mature deciduous woodland at Brittas Estate would be avoided. However, UGC would lead to greater hedgerow impacts.

2.5 SOILS, GEOLOGY & HYDROGEOLOGY – BRITTAS DEMESNE UGC ROUTE 4C: TOWER 263- TOWER 272

2.5.1 Potential Impacts

40 The construction of sealing compounds, jointing bays, trenching, and directional drilling would require additional excavations and dewatering. Trenching depths are typically between 1 to 1.5m. The main consideration is dealing with excavated soils. Additional soil excavation and disposal would be required in the event of undergrounding in these locations. This risk is related to the potential for increased suspended solids arising from construction works and storage / removal / reinstatement of disturbed soil and / or the release of construction related pollutants. Part of the northern sealing compound is located in a topographical low point and would require site levelling and importation of suitable construction material to raise formation levels.

41 It is anticipated that at certain locations, especially in the lower-lying areas, the groundwater table is shallow. Accordingly, groundwater controls may be necessary to manage shallow groundwater. In these areas it would be necessary to depress by pumping the groundwater level to maintain a dry operational area for installation of the underground cable. Dewatering of the excavation would depress the groundwater level in the vicinity of the excavation. Any impacts would be restricted to the short period of pumping. The extent of the impact of the dewatering depends on the hydraulic characteristics of the strata and the amount of drawdown of the groundwater level necessary to achieve the required dewatering. Any impact on the surrounding groundwater level reduces significantly with increasing distance from the point of abstraction. Due to the shallow excavations and the short term pumping, no significant impacts on the groundwater level would occur.

42 It is considered that the construction works would have minor effects on the geomorphology of the area, as the UGC would not significantly change the local slopes and topography.

43 Operational impacts on geology and groundwater would be negligible. In the event that the cable route section is to be decommissioned, all UGCs, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the underground cables, import soil to make-up levels and reinstate the land to its previous use.

2.5.2 Mitigation Measures

44 Mitigation measures are similar to the OHL however the excavation volumes and length of works is increased, as shown in **Table 2.3**. Measures to minimise the impact of the cable development on local geology include reuse of in situ material.

Table 2-3: Length of works/excavation volumes

	UGC – volume m^3	OHL – volume m^3
Brittas Underground option	30,100	850

45 However given the extra excavation works approximately 10,000 m^3 would be removed from the UGC route. All construction waste would be stored, managed, moved, reused or disposed of in an appropriate manner by appropriate contractors in accordance with *Waste Management Acts 1996-2013* (refer to Chapter 7, **Volume 3B** of the EIS). Excess soils / subsoils would be disposed of at licensed / permitted waste management facilities.

46 All excavated materials would be visually evaluated for signs of possible contamination such as staining or strong odours. In the event that any unusual staining or odour is noticed, samples of this soil would be analysed for the presence of possible contaminants in order to ensure that historical pollution of the soil has not occurred. Should it be determined that any of the soil excavated is contaminated, this would be dealt with appropriately as per the *Waste Management Act* (as amended) and associated regulations.

47 To minimise any potential impact on the underlying subsurface strata from any material spillages, all oils and fuels used during construction would be stored on temporary proprietary bunded surface (i.e. contained bunded plastic surface). These would be moved to each tower location as construction progresses. Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles would take place away from surface water gullies or drains. No refuelling would be allowed within 50m of a stream / river. Spill kits and hydrocarbon absorbent packs would be stored in this area and operators would be fully trained in the use of this equipment.

2.5.3 Potential for this UGC section and Conclusion on Impact Significance

48 Additional mitigation measures would be required to deal with the groundwater encountered during excavation work. In conclusion UGC would present a greater potential risk to soils and hydrogeology than OHL, however the overall potential impact is considered localised and minor.

2.6 WATER –BRITTAS DEMESNE UGC ROUTE 4C: TOWER 263 - 272

2.6.1 Potential Impacts

49 The UGC Route 4C is located within the River Dee catchment. Within the study area, the River Dee flows in a southeasterly direction. The River Dee and its tributaries are classified as moderate to good quality.

50 The UGC Route 4C would pass under a stream as well as a number of drains. Potential impacts include the diversion of numerous land drains and small streams connected to salmonid streams.

51 Additional soil excavation and disposal would be required in the event of undergrounding in these locations. This risk is related to the potential for increased suspended solids arising from construction works and storage / removal / reinstatement of disturbed soil and / or the release of construction related pollutants to the surface water environment. It may be necessary to divert sections of dry drains / drainage ditches or underground services where encountered thereby increasing potential sediment runoff. If excavations encounter groundwater, such inflows may need to be pumped, resulting in short term localised drawdown of the water table and discharges to the surface water channels.

52 The OPW 'Flood Hazard Database' was used in order to obtain information on historical flooding events in the corridor. This information was used to establish the current baseline conditions in terms of what sections of the area are liable to flood. Additional sources of information including internet searches, historical maps, data from Catchment Flood Risk Assessment and Management Studies (CFRAMs) and flood risk assessments were also consulted. No incidents of fluvial flooding were noted at sealing end compounds. However pluvial flooding of the northern compound is noted based and the preliminary flood risk assessment (PFRA) maps and would require raising of existing levels and the diversion / culverting of a drainage ditch.

53 Suspended solids can potentially impact on surface water quality by clogging the gills of fish, covering spawning sites, leading to loss of habitats on the riverbed and stunt aquatic plant growth by limiting oxygen supplies, shelter and food sources. During the construction of the potential UGC Route 4C development, there is a risk of accidental fuel pollution incidences.

54 Due to the proximity of the northern sealing end compound, diversion/culverting of a drainage ditch is required. The potential impact of the compounds, moderate adverse impacts from silt laden runoff and the risk of chemical spillages are predicted with mitigation taken into account. Providing the mitigation measures as set out later in this chapter are adopted, the potential effects on the River Dee from silt laden runoff and spillage risk are slight adverse only.

55 It would not be proposed to discharge wastewater from compounds.

56 Operational impacts on surface and groundwater water would be negligible. In the event that the cable route section is to be decommissioned, all UGCs, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the UGCs, import soil to make-up levels and reinstate the land to its previous use.

2.6.2 Mitigation Measures

57 Additional mitigation measures would be required to deal with the longer construction periods and the larger excavation volumes involved.

58 The use of directional drilling for the crossing of major water courses would be required. Diversion of watercourses should be avoided where possible to minimise disruption to aquatic ecosystems. In relation to stream crossings, and directional drilling, Inland Fisheries Ireland (IFI) approval would be required regarding the specification and timing of installation. Short sections of drainage ditches may need to be culverted with the potential for sediment discharge. It would not be proposed to ford any streams or rivers as part of this development. All in-stream works should be carried out during the period May to September and in accordance with the Eastern Fisheries Board (*2004) Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites.*

59 Water quality monitoring would be undertaken prior to the commencement of construction to confirm baseline data and ensure there is no deterioration in water quality. This would be targeted on watercourses considered to be at a higher risk of pollution (i.e. towers where there are watercourses within 20m of the construction works). Water quality monitoring would include daily inspection of adjacent watercourses.

60 Disturbance of bankside soils and in-stream sediments would be kept to the minimum required for the cable laying process. Banks and stream beds would be reinstated in a manner that would minimise the potential for erosion and return the river / stream to as close to its original condition as possible.

61 Implementing the design standards of the Greater Dublin Strategic Drainage Strategy (GDSDS), the surface water drainage system at the compounds would take into account the recommendations of the GDSDS and utilises SuDs (sustainable urban drainage) devices where appropriate. Runoff from the hardstand areas at the compounds would be limited to greenfield runoff rates.

2.6.3 Potential for this UGC section and Conclusion on Impact Significance

62 In conclusion, notwithstanding mitigation measures, UGC would present a minor adverse impact on the relevant surface water bodies in particular the River Dee compared to a negligible impact from the OHL.

2.7 TRAFFIC – BRITTAS DEMESNE UGC ROUTE 4C: TOWER 263 – TOWER 272

2.7.1 Potential Impacts

63 In order to assess the potential traffic impacts and effects, it is first necessary to consider the construction methodology envisaged and secondly to assess the locations along the UGC Route 4C where the potential exists for traffic disruption. The likelihood of full or partial road closure is assessed followed by the determination of feasible diversion routes required due to the construction works. Possible mitigation measures along national, regional and / or local roads are also considered.

64 For a project of this size, some disruption to traffic would occur during construction. However, the construction Traffic Management Plan (TMP) would minimise and reduce any possible construction impacts associated with traffic diversions and road closures.

65 The UGC Route 4C covers approximately 3.2km running between Tower 263 (L7404) and Tower 272 (L7404). For the purpose of the assessment the study area relates to the roads where the permanent accesses are to be located. The study area consists of a two crossings on the L7404 local road.

66 The UGC Route 4C also includes one river crossing.

67 The construction of the UGC results in a corridor width of between 20-22m along the length of the UGC Route 4C. This corridor would contain two number trenches for cable ducts and sufficient working width for plant and machinery.

2.7.1.1 Cable Construction Methodology General Comments

68 The width of the L7404 road is such that lane closures would not be possible at the location of the 4C UGC route crossing. Therefore these sections of the road would be closed for the duration of the carriageway crossing construction with diversions in operation. From traffic survey data obtained in 2013 the L7404 has an average daily traffic flow of 312 vehicles, hence the impact would be minimal.

69 The majority of construction generated traffic associated with the UGC Route 4C would result from additional material deliveries, such as additional concrete truck deliveries, and the removal of surplus material from the routes, resulting from excavation of the UGC Route 4C.

70 Similar to the overhead line construction it is expected that construction traffic volumes would have a maximum daily flow of 340 vehicles, and peak hour calculation on the basis of a 12 hour working day relating to 46 vehicles per hour. i.e. 13 in and 13 out. However, it should be noted that this is a maximum daily flow expected to occur with deliveries of materials / equipment and does not represent a sustained daily flow throughout the construction period.

2.7.1.2 Spoil

71 In terms of spoil material to be removed from site there are three possible sources:

- Cable trench;
- Joint bays; and
- Sealing end compounds.

72 Similar projects carried out by National Grid have indicated that the volume of spoil excavated for an underground cable where two cables per phase are installed is some 14 times more than for an equivalent OHL route.

73 For comparative purposes the OHL construction methodology generated:

- Tower 263 – 300 tonnes of spoil equating to 17 trips off site (18 tonne loads); and
- Tower 272 – 300 tonnes of spoil equating to 17 trips off site (18 tonne loads).

74 Therefore on this basis the volume of spoil for the UGC would see an increase to 238 trips off site from the access to towers. It should be stressed however that these are worst case maximum trips off site and where possible spoil would be backfilled and compressed. Furthermore the increase of spoil output would be offset by the reduction in concrete, stone and steel deliveries that would be required for the OHL construction. Therefore daily volumes of heavy goods vehicles are likely to remain at a similar level to that of the OHL construction at both access points. Again as noted above construction traffic volumes would be limited to a maximum daily flow of 200 vehicles.

75 As per the OHL methodology, licensed landfill sites would be used to dispose of waste spoil from the construction.

76 Due to volume of spoil to be removed off site, wheel cleaning facilities would be provided for relevant vehicles.

2.7.1.3 Typical Construction Vehicles

77 As per the OHL tower construction it is expected that the same vehicles would be employed for the UGC construction, specifically:

- Fastrac with low loader trailer: - This vehicle would represent the majority of the construction vehicles and would be responsible for delivery construction apparatus e.g. dumper / excavator / rock breaker, delivery of cable drums, delivery of precast concrete components / cement sand materials, delivery of any steel materials.

- Tipper Lorry (22 tonnes): - This vehicle would be used to deliver stone material if required and may be used to transfer excess spoil from the site.

- Concrete Lorry (8m³): - In the instance of the joint bay construction and the sealing end compounds these vehicles would be employed to deliver the concrete. Where conditions on the associated access track adjacent to the UGC trench are not suitable for the concrete lorry, they would off load onto a dumper which would then ferry the concrete to the required location.

- Transit type van: - Staff would be transferred to the construction works from the temporary construction material storage yard, Carrickmacross, County Monaghan.

2.7.1.4 Sealing End Compounds

78 The UGC Route 4C would require a sealing end compound at either end of the UGC section, both located adjacent to the L7404. These compounds are required to carry the cables from the underground duct to the adjacent tower. Such compounds would be accessed via a permanent access road for routine inspection and maintenance. During the construction of the sealing compounds, an increase in traffic to and from the site at these locations would be on the local road network. During operation of the development, traffic impacts associated with routine inspection and maintenance are envisaged to be negligible.

2.7.1.5 Rivers

79 The UGC Route 4C crosses one river. The identified river crossing would be directional drilling. This technique may result in extended construction times associated with the procedure, which may increase traffic to and from both sides of the river crossing. It is envisaged that as a result of the operations, local area traffic would experience an increase in site traffic for the duration of the river crossing process.

2.7.1.6 Operational / Decommissioning Phase Impacts

80 Operational impacts on traffic would be negligible for a partial underground route with the exception should there be a need to repair a fault and in such cases the impact would be temporary, albeit if the repair needs to be affected underneath a road crossing road closures may be required. In the event that the cable route section is to be decommissioned, all UGCs, equipment including at the sealing end compounds and material to be decommissioned would be removed off site and the land reinstated. Potential traffic impacts would be expected to be as significant, if not more, than for the construction phase due the need to excavate the UGCs, import soil to make-up levels and reinstate the land to its previous use.

2.7.2 Mitigation Measures

81 The limitation of daily traffic to a maximum of 200 vehicles per day (or average of 17 vehicles per hour based on a 12 hour day), associated with the construction of the towers, equates to a 5.4% impact in the peak flows along the L7404. Therefore as it is expected that the UGC construction would employ similar levels of construction traffic, the traffic impacts are still considered negligible, the duration of traffic impact would be considerably extended in the case of UGC construction.

82 A construction Traffic Management Plan (TMP) would be employed by the main works contractor, prior to construction, in consultation with the Local Authority. The plan would outline minimum working practices on public roads, details on traffic management arrangements, temporary road / lane closures and arrangements for communicating details of diversion routes, vehicular movements and restrictions to members of the public and affected landowners. The construction TMP would also include details related to working hours, parking and access arrangements onto the existing road network.

83 The implementation of the construction TMP would ensure that local traffic flows as freely as possible with two-way traffic being maintained wherever possible on wider roads.

84 The duration of partial/temporary / full road closures would be kept to a minimum in order to reduce impacts on local road traffic. All closures would be discussed and agreed with the Local Authority in the development of the construction TMP. Where temporary road closure is required, a temporary diversion route would be agreed and provision at such locations for access by residents and deliveries would be maintained as far as reasonably possible.

85 Traffic management at the site access, i.e. large construction vehicles such as the Fastrac with low loader trailer would be limited to left in and left out manoeuvres.

2.7.3 Potential for this UGC section and Conclusion on Impact Significance

86 The above assessment demonstrates that the construction of the UGC route can be facilitated in the Brittas area. However, the traffic impacts associated with the UGC route are more significant on a local level when compared to an OHL route in terms of increased traffic volumes associated with the construction of the UGC route in both the immediate locality and further afield towards neighbouring towns and villages.

87 In conclusion, the construction of the UGC route would increase the volumes of construction traffic using the public road network when compared to an OHL. Therefore, from a traffic impact perspective, there is no reason to consider the undergrounding of sections of the proposed development.

2.8 CULTURAL HERITAGE – BRITTAS DEMESNE UGC ROUTE 4C: TOWER 263 – 272

2.8.1 Potential Impacts

88 Over the course of the project detailed GIS mapping has been compiled and forms the basis of this evaluation. The GIS mapping to date includes designated archaeological and architectural sites, historic mapping, aerial photography and LIDAR surveys. Undesignated sites, such as demesne landscapes, aerial and cartographic anomalies, and sites noted during fieldwork have also been added to the mapping. This data has been augmented with detailed documentary research, toponym analysis, a review of the topographical files held by the National Museum of Ireland (NMI) and the results of previous excavations as contained on databases hosted by www.*excavations.ie* and the National Roads Authority (NRA).

89 The UGC route and sealing end compounds for the townlands of Altmush, Cruicetown, and Brittas between Towers 263 and 272 are located to the west of the overhead option. The route in its current form, from north to south, would divert around the Brittas Estate, a demesne landscape featured on the NIAH Garden Survey (Ref: ME-35-N-806867) and described as having its main features substantially present. From Altmush the UGC section would pass through greenfield, under a local access road (Kilmainhamwood-Cross Guns Road) and across pasture on rising ground. From this juncture the route continues southwards skirting to the west of a ridge, the summit of which contains an enclosure indicated on historic maps as 'Durran's Fort' (SMR No. ME005-084). Dog legging to the south of the enclosure (circa 200m) the route re-crosses the road at a point north of Gorry's Cross Roads. From a review of available inventories, historic maps and aerial photographs the UGC route would not physically impact on any designated archaeological or architectural sites. Nor would it impact on any previously unrecorded cultural heritage sites identified in this evaluation. The route, however, would impact on two townland boundaries defined by the adjacent road.

90 Regarding potential impact on settings the UGC option would as previously stated reduce the impact on the setting of the nearby Brittas Estate and a number of ringforts located within the demesne (RMP's ME005-085, 087, 089, 090, 091 & 092).

91 There would be no significant impacts on archaeology and cultural heritage during maintenance. In the event that a cable route section is to be decommissioned, potential impacts on cultural heritage would likely be less, than for the construction phase, as any cultural heritage features previously directly affected would already have been removed or preserved in-situ during the initial construction phase. Any impacts to setting during maintenance or decommissioning would be temporary and not significant.

2.8.2 Mitigation Measures

92 Given the nature and scale of the groundwork's for the UGC option and the frequency of monuments in the wider landscape it is recommended that the cable corridor be surveyed in advance of any works. The results of this survey would inform a targeted regime of archaeological testing to ascertain the archaeological potential of the route. In consultation with the National Monuments Service appropriate mitigations would be taken to ensure that impacts on the archaeological heritage are kept to a minimum. In addition, where necessary the archaeological consultant may advise on use of portable trackway mats to minimise ground disturbance.

93 A record would be made of each of the areas where the development impacts on townland boundaries. The record in each instance would consist of a written description of the setting, profile and fabric of the townland boundary, accompanied by photographs, and plans and sections where necessary.

2.8.3 Potential for this UGC section and Conclusion on Impact Significance

94 Based on available data the 4C UGC route would not impact on any designated sites, previously known cultural heritage sites or areas of archaeological potential.

95 The evaluation of the proposed OHL between Towers 263 – 272 noted that the overall impact on the setting of Brittas Demesne would be significant. Were the UGC Route 4C to be constructed this impact would be reduced to between imperceptible to slight.

96 Likewise, regarding the local archaeological resource the OHL evaluation assessed the potential operational phase impacts on the Cross (ME005-089001) the enclosure and the ringforts (ME005-089, 090, 091, 092 & 096) in Brittas and Cruicetown townlands as having between a moderate to significant impact on their setting. These monuments, situated for the most part within Brittas Demesne, are particularly sensitive given their context with the estate. If the UGC option was to be pursued the impacts on the setting of these monuments would be reduced to imperceptible.

97 Public perception of archaeological heritage often relates to the prominent upstanding archaeological monuments and architectural sites of significance such as Brittas, sites which are predisposed to impacts on setting. OHL construction, with its flexibility of tower placement and greatly reduced physical footprint, can often avoid known archaeological monuments without difficulty. The potential to impact on previously unrecorded archaeological monuments is greatly increased when constructing an UGC. When archaeological monuments, be they previously recorded or not, fall within the route of an UGC, then the worst case scenario impact would result in the destruction of part or all of the associated archaeological deposits; this impact is permanent and irreversible. Predicting the level and extent of the buried and unknown cultural heritage resource is difficult by virtue of the fact that these sites are not easily detectable in the absence surveys and without further investigations. Therefore, there remains the potential for the discovery of additional cultural heritage sites.

98 Overall, while it is not possible to ascertain for certain the potential for impacting directly on previously unknown archaeological remains as the extent of these potential remains is unknown, it is nonetheless considered that there is a greater risk of impacting on these remains during construction of an UGC than the proposed OHL. However, it is also clear that there would be a reduction in the level of the impact on the setting of Brittas Demesne and other cultural heritage sites within and in the vicinity of the demesne during the operational phase of the cable development. It should also be noted that the UGC route runs through an area which is deemed of slight to moderate archaeological potential whereas the OHL route passes through an area which is of high archaeological potential.

99 Based on this evaluation the UGC route option would be slightly preferred.

2.9 LANDSCAPE – BRITTAS ESTATE UGC ROUTE 4C: TOWER 263 – TOWER 272

2.9.1 Potential Impacts

100 The UGC Route 4C crosses through an undulating landscape which contains drumlins and pockets of woodland. The higher parts of drumlins allow for views out over the landscape in some locations. The corridor crosses the local road alongside Brittas twice. Brittas Demesne is recorded in the Department of Arts, Tourism and Heritage (National Inventory of Architectural Heritage) as "*having main features substantially present - some loss of integrity",* but is not publicly accessible. Scenic Views 16 and 17, as listed in the *Meath County Development Plan 2013-2019*, are located to the south west and look north-east, fields are generally small or medium sized and bound by hedgerows of varying height and condition. There are significant areas of woodland within Brittas Estate and smaller wooded clusters within the wider landscape. The landscape also contains dispersed houses and farm buildings along with the small settlement of Nobber and Kilmainhamwood and a cluster of features of heritage significance around Cruicetown.

101 The northern sealing end compound is located in the lower part of the landscape with potential views towards it from higher parts of drumlins. There is a strong hedgerow pattern which provides good screening in the wider landscape. There would views of the sealing end compound from some parts of the local roads to the east. Screen planting could be successfully established in this area; however this would not fully screen views from higher locations.

102 The southern sealing end compound is located south of Brittas, with again potential for visibility from higher locations to the west and east.

Table 2-4: Summary of effects of elements of Partial UGC

Note: Unless otherwise stated, effects are considered adverse. Ratings of significance have not been given as this is a high level appraisal.

Element	Landscape effects	Visual effects	Period of impact
Sealing end compound	*	*	Construction / Operation
Sealing end compound screening	* (positive)	* (positive)	Operation
Soil excavation and storage	*	*	Construction / decommissioning
Haul road	*	*	Construction / decommissioning
Vegetation removal	*	*	Construction / decommissioning
Reinstatement of shallow-rooting vegetation	* (positive)	* (positive)	Operation
Permanent removal of trees and hedgerows	*	*	Operation
Construction machinery		*	Construction / decommissioning
Maintenance machinery		*	Operation
Fencing		*	Construction
Changes to drainage pattern	*	*	Operation
Manholes at approximately 650m intervals		*	Operation
Vegetation changes arising from drainage changes	*	*	Operation
Cross-directional drilling	*	*	Construction

2.9.2 Mitigation Measures

103 Mitigation measures include (following the construction period) removal of all soil storage mounds, fencing and reinstatement of vegetation within the parameters of the rooting restrictions over the trench. Screen planting of up to 5km is would be proposed around each sealing end compound which within 10-15 years would have reached a height where the structure starts to become visually absorbed into the wider hedgerow pattern. However, the sealing end compounds may remain partially visible from higher points in the landscape.

2.9.3 Potential for this UGC section and Conclusion on Impact Significance

104 It was not possible to visit the interior of Brittas Demesne, but a desktop assessment of potential visibility of the OHL from within the estate has been carried out by assessing views from the main avenue leading to the main house, from the main house and from the outbuildings. The review of the LiDAR survey data concluded that the line would be most visible from the entrance avenue i.e. from the areas along the road and path leading towards the main house until an area of dense mature vegetation between the entrance and the main house is reached. A number of towers would be fully or partially visible in views from the approximate first kilometre of the entrance road as there is very little mature vegetation. As a swathe of up to 74m of trees would be removed there is little scope for screening in this particular location. Towers 268, 269, 270 would be fully visible from the entrance avenue and Towers 265, 266, 267, 271 and 272 would be partially and more distantly visible.

105 The line would be mainly screened in views from the main house at Brittas but there is potential for visibility of upper parts of Towers 266 and 267 from the upper storeys of the main house. Upper parts of the same towers would be also potentially visible from the areas in vicinity of the out buildings, during winter time.

106 There would be no views of the proposed line from the remnants of the distinctive designed tree pattern in the south east of Brittas due to screening effects of the topography.

107 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. Strips of hedgerows along the entire length would be permanently removed and this would be most apparent at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals along the route. There would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape impact of UGC is less than that of the OHL in this location, due to its removal from the Brittas designed landscape and the avoidance of wooded areas. However, the sealing end compounds would increase the amount of transmission infrastructure visible from public roads. This visual impact would reduce over time with the establishment of screening vegetation.

3 POTENTIAL FOR PARTIAL UGC TO MITIGATE SIGNIFICANT LANDSCAPE IMPACTS

3.1 INTRODUCTION

1 As outlined in **Section** 1 of the report titled, '*The Potential for Partial Undergrounding of the Line to Mitigate Significant Impacts on Landscape*s', to which to this **Annex 7** is appended, An Bord Pleanála (the Board) examined the draft application file under Article 10.4(c) of Regulations 347/2013 and their request for information to be submitted included the following relating to partial undergrounding: *"Where significant impacts on landscapes/demesne landscapes are identified, the EIS should address the potential for partial undergrounding of the line to mitigate those impacts".*

2 This chapter provides the conclusions from a Landscape perspective as to the potential for partial undergrounding to mitigate significant landscape impacts.

3.1.1 Boyne Valley Tower 350 – Tower 363

3 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of underground cable (UGC) that cross through landscape with medium sized hedgerow bound fields or woodland. An approximate 10m width of trees on the northern side of the Boyne River would be permanently removed, along with 10m strips of hedgerows along the entire length. Up to 22m widths of vegetation would be removed for the construction period and reinstated vegetation would take a number of years to establish. Hedgerow removal would be most readily experienced by viewers at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at approximate 650m intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual impact of UGC is less than that of the overhead line (OHL) in this location.

3.1.2 Blackwater Valley Tower 301 – Tower 312

4 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. Strips of hedgerows (10m in width) along the entire length would be permanently removed and this change would be most readily experienced at road crossings. Up to 22m widths of vegetation would be removed for the construction period and reinstated vegetation would take a number of years to establish. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at approximate 650m intervals along the route. While there would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape and visual impact of UGC is less than that of the OHL in this location.

3.1.3 Brittas Demesne Tower 263 – Tower 272

5 It was not possible to visit the interior of Brittas demesne, but a desktop assessment of potential visibility of the OHL from within the estate has been carried out by assessing views from the main avenue leading to the main house, from the main house and from the outbuildings. The review of the Light Detecting and Ranging (LiDAR) survey data concluded that the line would be most visible from the entrance avenue i.e. from the areas along the road and path leading towards the main house until an area of dense mature vegetation between the entrance and the main house is reached. A number of towers would be fully or partially visible in views from the approximate first kilometre of the entrance road as there is very little mature vegetation. As a swathe of up to 74m of trees would be removed there is little scope for screening in this particular location. Towers 268, 269, 270 would be fully visible from the entrance avenue and towers 265, 266, 267, 271 and 272 would be partially and more distantly visible.

6 The line would be mainly screened in views from the main house at Brittas but there is potential for visibility of upper parts of Towers 266 and 267 from the upper storeys of the main house. Upper parts of the same towers would be also potentially visible from the areas in vicinity of the out buildings, during winter time.

7 There would be no views of the proposed line from the remnants of the distinctive designed tree pattern in the south east of Brittas due to screening effects of the topography.

8 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. Strips of hedgerows along the entire length would be permanently removed and this would be most apparent at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular intervals along the route. There would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape impact of UGC is less than that of the OHL in this location, due to its removal from the Brittas designed landscape and the avoidance of wooded areas. However, the sealing end compounds would increase the amount of transmission infrastructure visible from public roads. This visual impact would reduce over time with the establishment of screening vegetation.

4 COMPARISON OF OHL VERSUS UGC ACROSS ALL ENVIRONMENTAL IMPACTS

4.1 INTRODUCTION

1 This chapter provides the conclusions perspective as to potential for partial undergrounding to mitigate significant landscape impacts, while taking account of the conclusions of the individual specialists relating to impacts on other environmental topics.

4.2 BRITTAS AREA TOWER 263 – TOWER 272

4.2.1 Agronomy

2 Within the Brittas subsection there is a preference for the overhead line (OHL) option due to the increase in the number of Major Adverse impacts associated with underground cable (UGC) – although UGC avoids a slight adverse impact on a land parcel with forestry. The major adverse impact is a result of the construction of the sealing end compound in a high sensitivity land parcel.

4.2.2 Ecology

3 From an ecology perspective there is some limited justification for partial UGC at this location. UGC would mean identified impacts to Whooper Swan would be reduced slightly and impacts to mature deciduous woodland at Brittas Estate would be avoided. However, the UGC route would lead to greater hedgerow impacts.

4.2.3 Soils, Geology and Hydrogeology

4 Additional mitigation measures would be required to deal with the groundwater encountered during excavation work. In conclusion UGC would present a greater potential risk to soils and hydrogeology than OHL, however the overall potential impact is considered localised and minor.

4.2.4 Water

5 In conclusion, notwithstanding mitigation measures, UGC would present a minor adverse impact on the relevant surface water bodies in particular the River Dee compared to a negligible impact from the OHL.

4.2.5 Traffic

6 The traffic assessment demonstrates that the construction of a section of UGC can be facilitated in the Brittas area. However, the traffic impacts associated with the UGC route are more significant on a local level when compared to the provision of an OHL route in terms of increased traffic volumes associated with the construction of the UGC route in both the immediate locality and further afield towards neighbouring towns and villages.

7 The construction of this underground section would increase the volumes of construction traffic using the public road network when compared to overhead line construction. Therefore, from a traffic impact perspective, there is no reason to consider the undergrounding of sections of the proposed development.

4.2.6 Cultural Heritage

8 The use of an UGC would result in a reduction in the level of the impact on the setting of Brittas Demesne and other cultural heritage sites within and in the vicinity of the demesne during the operational phase of the cable development. It should also be noted that the UGC route runs through an area which is deemed of slight to moderate archaeological potential whereas the OHL route passes through an area which is of high archaeological potential.

9 Based on this evaluation the UGC route option would be slightly preferred in relation to cultural heritage.

4.2.7 Landscape

10 It was not possible to visit the interior of Brittas Demesne, but a desktop assessment of potential visibility of the OHL from within the estate has been carried out by assessing views from the main avenue leading to the main house, from the main house and from the outbuildings. The review of the Light Detecting and Ranging (LiDAR) survey data concluded that the line would be most visible from the entrance avenue i.e. from the areas along the road and path leading towards the main house until an area of dense mature vegetation between the entrance and the main house is reached. A number of towers would be fully or partially visible in views from the approximate first kilometre of the entrance road as there is very little mature vegetation. As a swathe of up to 74m of trees would be removed there is little scope for screening in this particular location. Towers 268, 269, 270 would be fully visible from the entrance avenue and Towers 265, 266, 267, 271 and 272 would be partially and more distantly visible.

11 The line would be mainly screened in views from the main house at Brittas but there is potential for visibility of upper parts of Towers 266 and 267 from the upper storeys of the main house. Upper parts of the same towers would be also potentially visible from the areas in vicinity of the out buildings, during winter time.

12 There would be no views of the proposed line from the remnants of the distinctive designed tree pattern in the south east of Brittas due to screening effects of the topography.

13 The highest permanent landscape and visual effects would occur in the immediate vicinity of sealing end compounds and along lengths of UGC that cross through landscape with medium sized hedgerow bound fields or woodland. Strips of hedgerows along the entire length would be permanently removed and this would be most apparent at road crossings. Changes to drainage may result in the natural re-establishment of different vegetation. Manholes would be visible at regular

intervals along the route. There would be localised visual effects at the location of the sealing end compounds and landscape and visual effects along the length of the UGC, the overall landscape impact of UGC is less than that of the OHL in this location, due to its removal from the Brittas designed landscape and the avoidance of wooded areas. However, the sealing end compounds would increase the amount of transmission infrastructure visible from public roads. This visual impact would reduce over time with the establishment of screening vegetation.

4.2.8 Conclusion

14 There is a minor preference for partial UGC Route 4C over the OHL option proposed for the Brittas Demesne only in relation to landscape. There is also a limited justification for partial UGC over the OHL in relation to cultural heritage and ecology. The UGC option at Brittas would present greater potential risks (soils, water and hydrogeology) and create greater adverse impacts (agronomy and traffic) than OHL.

15 In terms of visual impact, it is acknowledged that removing towers from views would reduce the extent of visibility of the proposed development in short lengths in the sensitive landscape location at Brittas Demesne.

16 However, as outlined in Section 8.2.8 of the report titled, '*The Potential for Partial Undergrounding of the Line to Mitigate Significant Impacts on Landscape*s', to which to this **Annex 7** is appended, and as stated in the *Preferred Project Solution Report* (July 2013), the use of short lengths of UGC would only be considered in the event that an appropriate and acceptable OHL solution could not be found, which is considered to occur if *Profound* impacts, as defined in the Environmental Protection Agency (EPA) Guidelines, were predicted. However, as a consequence of the route selection employed, as outlined in that section noted above, Section 8.2.8, the proposed OHL, does not result in effects of this magnitude at the location of the Brittas Demesne and therefore there is no critical need for partial UGC along the route at this location.

17 In summary, there are no impacts of such significance envisaged, including those on landscape, which would introduce the need for consideration of partial undergrounding for the proposed development at the location of the Brittas Demesne.