Laois - Kilkenny Reinforcement Project

Assessment of 400 kV Connection Methods to Coolnabacky Substation

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1 Introduction

The Stage 1 Report for the Laois – Kilkenny Reinforcement Project was published in May 2011. One of the findings of this report was the identification of an emerging preferred site for the 400/110 kV substation in Laois. During the subsequent four week public consultation phase on this report, no new information came to the project team's attention that would alter its opinion that the location identified is the most suitable.

The location is shown in Figure 1.1 below (red marker) and is approximately 1.4km from the intersection (cross over) of the existing Dunstown-Moneypoint 400 kV line and the Athy-Portlaoise 110 kV line, in the townland of Coolnabacky, 5km South East of Portlaoise.

Figure 1.1: Coolnabacky 400 / 110 kV Substation Location

Both the existing 110 kV and 400 kV overhead lines are to be connected into this new substation. The detailed connection method for the 110 kV diversion of the Athy-Portlaoise line to the new substation is yet to be determined and is not considered in this report. This report considers the connection methods and routes available for the required 400 kV circuit from the existing Dunstown - Moneypoint overhead line to the new Coolnabacky substation. The lead consultants input to this report is to evaluate environmental and cost considerations of the connection methods and make a recommendation - EirGrid, as Transmission System Operator address the technical considerations of the connection methods in the penultimate chapter. This report therefore assesses the connection methods for the 400 kV circuit and makes a recommendation on the preferred option. Two connection technologies are considered, namely:

1. 400 kV AC Overhead Line
2. 400 kV AC Underground Cable

2 Connection Options

Two 400 kV circuits are required to connect into Coolnabacky substation:

1) Coolnabacky - Moneypoint

2) Coolnabacky - Dunstown

This connection can be achieved by way of overhead line or underground cable.

2.1 Overhead line

Two types of overhead design are considered in this report:

- Double Circuit Overhead Line design
- Single Circuit Overhead Line design

2.1.1 Double Circuit Overhead Line

A double circuit overhead line, would carry both circuits (Coolnabacky - Moneypoint and Coolnabacky - Dunstown) on one supporting structure or tower.

Double circuit design comprises of two types of towers, namely Angle Towers (where the line route changes direction) ranging in height from 52m to 62m and Intermediate Towers (where the line route is straight) ranging in height from 50m to 68m. Figure 2.1 shows an existing double circuit 400 kV overhead line in Co. Clare - the towers shown in the photograph are intermediate towers.

Figure 2.1: Photograph of 400 kV Double Circuit Intermediate Towers

2.1.2 Single Circuit Overhead Line

A single circuit overhead line carries one circuit on one set of supporting structures. In this instance, as two circuits (Coolnabacky - Moneypoint and Coolnabacky - Dunstown) are required, two sets of structures would be required.

Single circuit design also comprises of two types of towers, namely Angle Towers ranging in height from 28m to 37m and Intermediate Towers ranging in height from 26m to 55m. Figure 2.2 shows an existing single circuit 400 kV overhead line. The tower shown in the foreground of photograph in figure 2.2 is an intermediate tower, while the tower in the background is an angle tower.

Figure 2.2: Photograph of 400 kV Single Circuit Intermediate Towers

2.2 Underground Cable

As with the overhead lines, two circuits are also required with the underground cable options (Coolnabacky - Moneypoint and Coolnabacky - Dunstown), and like the overhead lines the UGC's can be either double circuit or single circuit. In a double circuit arrangement, both the Moneypoint and Dunstown circuits would be contained within the same trench/corridor and therefore take one route whereas each single circuit would be in a separate trench and may take separate routes. The proposed cable is a 400 kV AC underground cable connection consisting of two single circuits 3 x 1 x 2500mm² Cu/Pb 400 kV XLPE cable i.e. 3 cables per circuit – see Figures 2.3 & 2.4.

Five single circuits (A to F) and one double circuit (G) have been considered in this report. A double circuit cable solution will require an approximate separation of 6 metres between centre phases, with a 10 metre corridor in private property. Figures 2.3 and 2.4 respectively show cross section and cable configurations for both 400 kV double circuit and single circuit underground cables in flat formation.

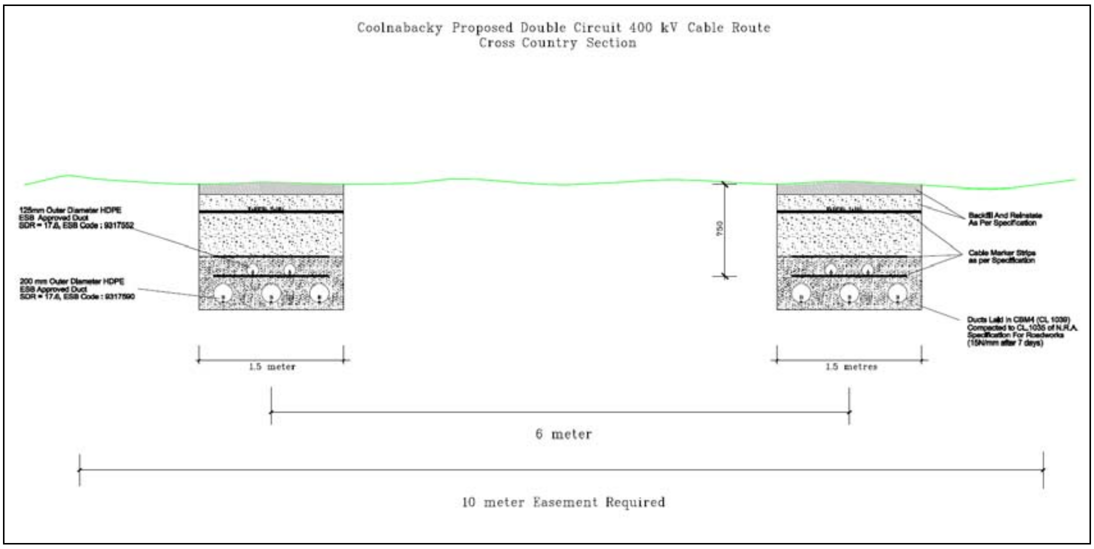

Figure 2.3: Cross Section of 400 kV Double Circuit Underground Cable

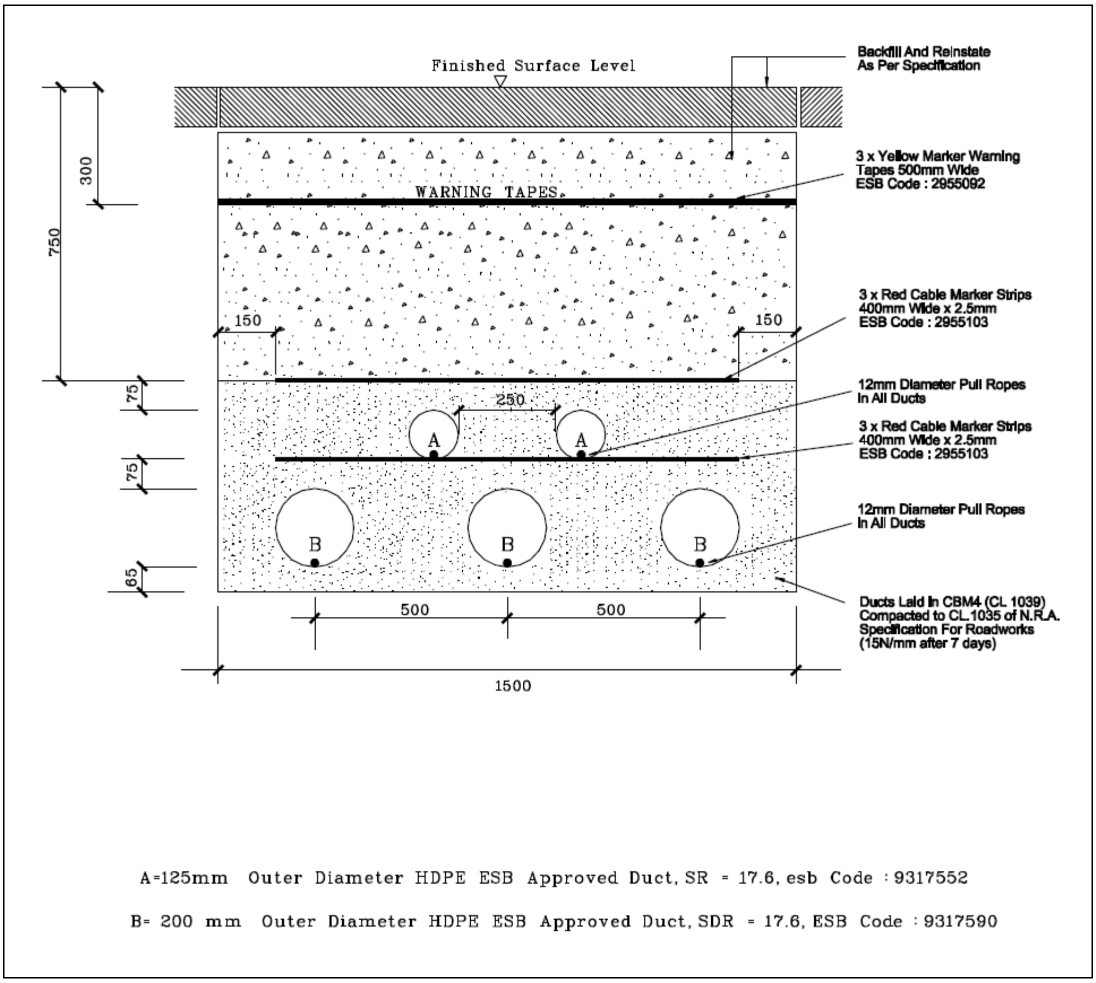

Figure 2.4: Cross Section of 400 kV Single Circuit Underground Cable

3 Connection Route Options

The purpose of this chapter is to identify suitable routes for both overhead line and underground cables (single circuit and double circuit) and to identify the preferred route for each connection method. In order to identify suitable routes, ESBI undertook site visits, as well as relying on previously published reports, (i.e. The Stage 1 Lead Consultant's Report which detailed the study area, constraints, potential corridors and potential substation locations as well as environmental reports on undergrounding of cables).

The emerging preferred 400 kV route corridor was identified in the stage 1 report and reviewed as part of the Stage 2 Report which found it to be the preferred route corridor for the 400 kV overhead line. The following routes are identified within the preferred 400 kV route corridor.

3.1 Double Circuit Overhead Line

One double circuit 400 kV line route paralleling the existing Athy – Portlaoise 110 kV from the Dunstown – Moneypoint 400 kV line to Coolnabacky substation is proposed - see Figure 3.1. The length of this line is approximately 1.4km. This arrangement would require approximately 5 new double circuit towers (ranging in height from 50-68m) and 2 new single circuit towers (ranging in height from 26-55m). It also requires the retirement of approximately 150m of overhead line where the 400 kV line is being diverted.

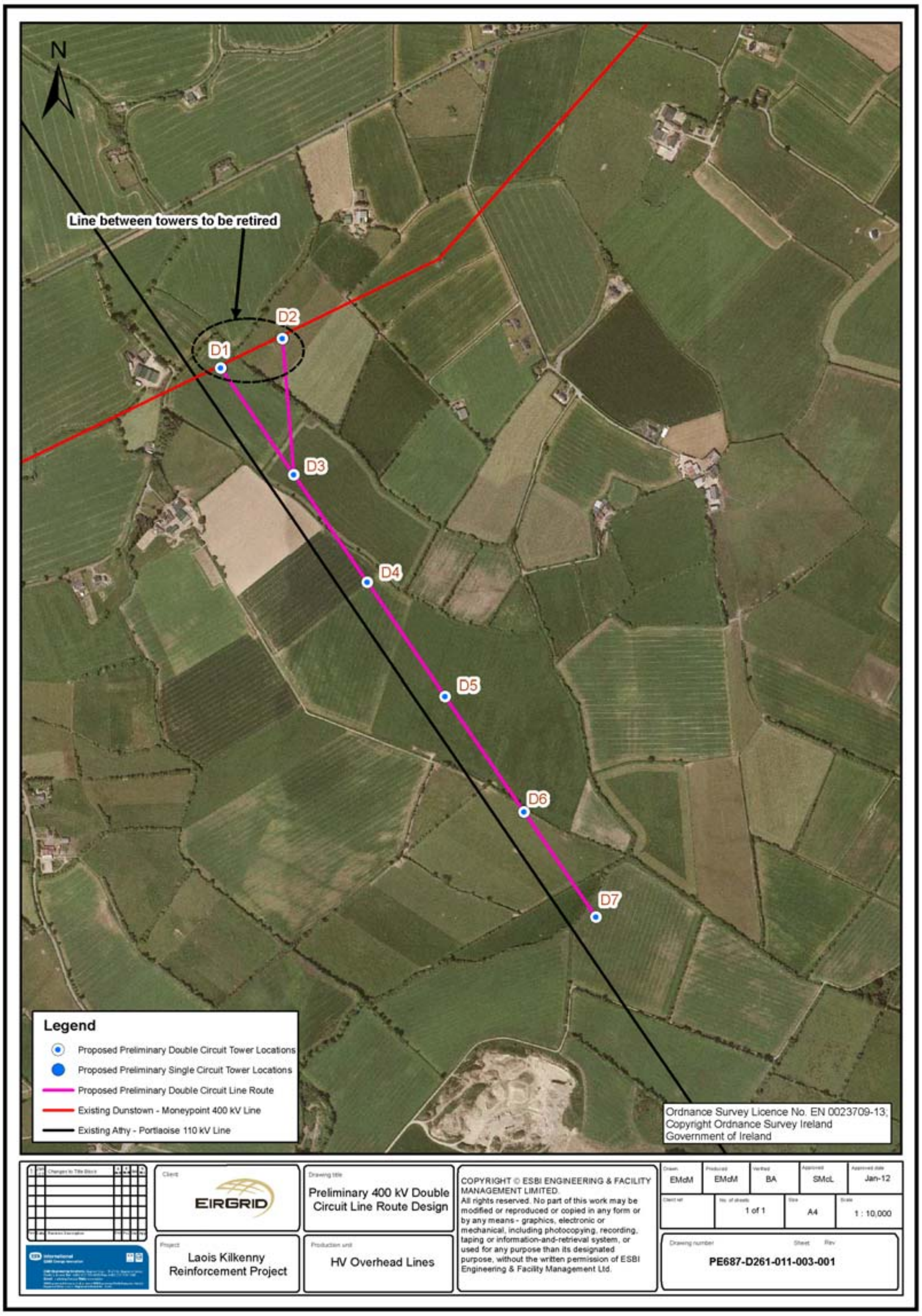

Figure 3.1: Preliminary Indicative 400 kV Double Circuit Overhead Line Route

3.2 Single Circuit Overhead Line

Two single circuit 400 kV line routes paralleling the existing Athy – Portlaoise 110 kV from the Dunstown – Moneypoint 400 kV line to Coolnabacky substation are proposed - see Figure 3.2. The length of each of these lines is approximately 1.4km. Therefore a total of 2.8km of single circuit 400 kV line will be required to connect the substation. This arrangement would require at least 12 new single circuit towers (ranging in height from 26-55m). It also requires the retirement of approximately 190m of overhead line where the 400 kV line is being diverted.

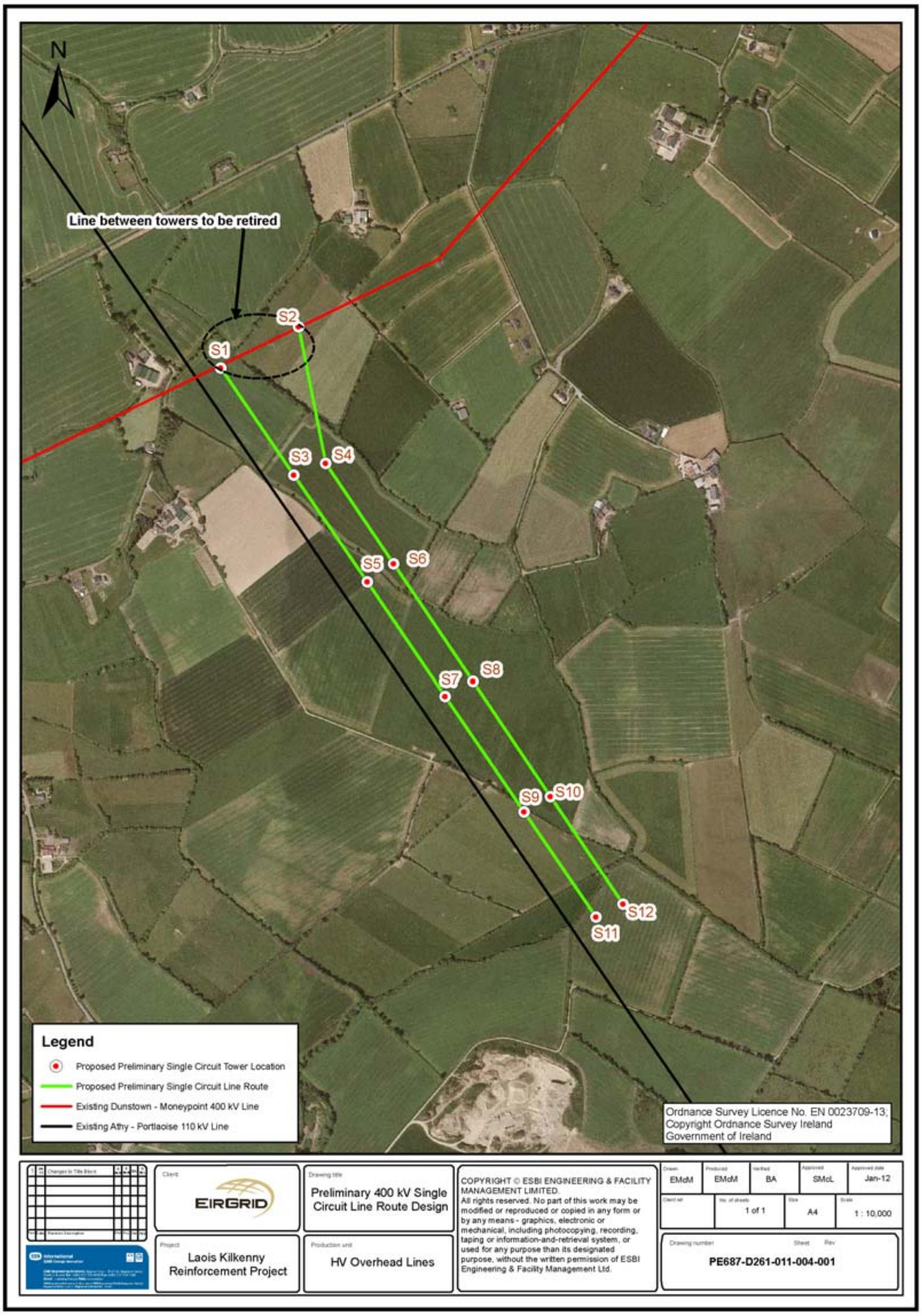

Figure 3.2: Preliminary Indicative 400 kV Single Circuit Overhead Line Route

3.3 Underground Cable

Several feasible cable routes were selected, which were influenced by a number of 'route selection criteria' as follows:

- They minimise the overall length which minimises costs;
- Environmental constraints including designated areas such as NHA's, SPA's, SAC's and areas of archaeological importance are avoided wherever possible;
- They minimise impacts on the residential dwellings;
- They are located on lands within the public domain (e.g. roadways) and on private property;
- They were designed to ensure sufficient clearances from existing features;
- They minimise crossings of major roads and waterways/water features;
- They minimise the need for full road closures and traffic disruption during construction;
- They minimise sharp changes in direction, both in horizontal and vertical;
- They provide suitable locations for joint chambers;
- They minimise potential conflict with future development;
- They avoid areas of significant planting or forestry; and
- Access for future maintenance is achieved.

3.3.1 Cable Installed in Road versus Cross Country

The majority of HV underground cable routes, where technically feasible, are installed along existing roadways and public land rather than across private land. This is in accordance with long established practice of both ESB Networks and EirGrid in Ireland for the following reasons:

- Cables crossing private land may require numerous legal easements with private landowners;
- There are no requirements for private cable easements when an underground cable is installed in public roads;
- The logistics of getting heavy drums (up to 30 tonnes) to joint bay locations may require the construction of haul roads across private land - this requirement does not arise when cables are installed in public roads;
- There is a negative short term disruption to farm practice as a result of the construction activities associated with a cable being installed on private land. There is also the issue of the long term disruption to farm practice due to the restrictions imposed by the cable easement. This issue would be removed by routing the cable in the public road;
- 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. Accessing duct runs for maintenance and repair across private land could also be problematic, especially if haul roads had to be reconstructed to repair any faults;
- Roadworks on public roads are carried out in a controlled manner, with all documentation required under current health and safety legislation and under

licence from the local authority. This is not the case when excavations are undertaken on private land. As a result of this there may be an increased risk of third party damage and associated risks to the public with cross country cable routes.

- The cable route may pass through an area that contains a high density of existing and potential archaeological sites. Archaeology is unlikely to be an issue at the excavation depths proposed under existing roads. It could become an issue crossing private land.

3.3.2 Interface Compound

A line/cable interface compound is needed whenever a circuit changes from overhead line to underground cable. A line/cable interface compound is a fenced compound containing the equipment required to convert a high voltage circuit for overhead lines to underground cables. Such a compound would not look dissimilar to a small substation. An illustration of a typical interface compound is provided in Figure 3.3.

Figure 3.3: Typical Line/Cable Interface Compound

For the purpose of this report it is assumed that a line cable interface compound can be located in the areas shown in Figures 3.4 and 3.5. For a DC UGC it is estimated that this compound would be approximately 35m x 70m in size while for a SC UGC it is estimated that this compound would be approximately 35m x 40m in size. For a DC UGC connection only one compound is required whilst for a SC UGC connection two compounds would be required.

Figure 3.4 illustrates the option where a double circuit underground cable is used. In this option only one compound is required.

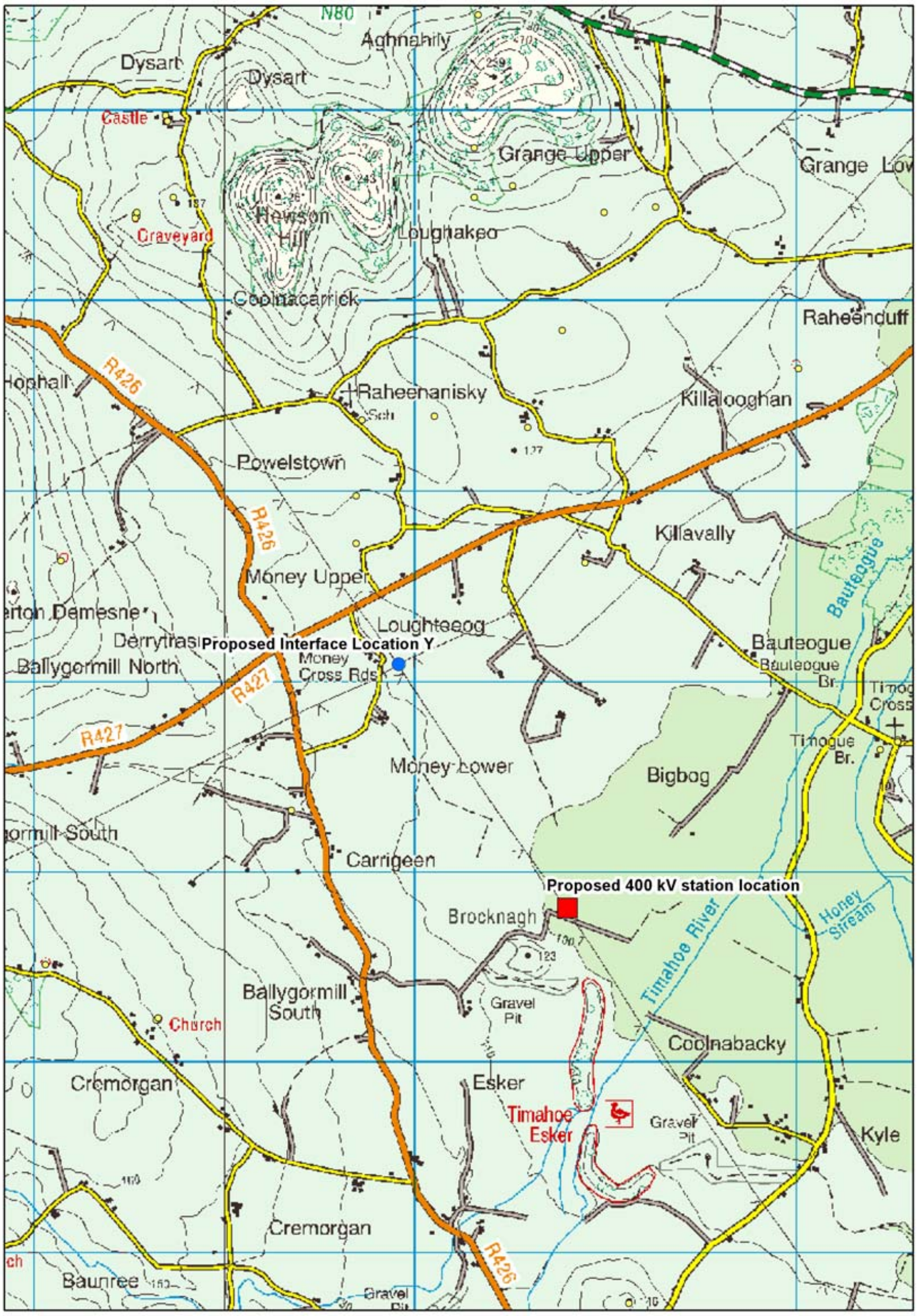

Figure 3.4: Assumed Location of Line Interface Compound (Double Circuit Option)

Figure 3.5 illustrates the option where two single circuit underground cables are used. In this option two compounds are required.

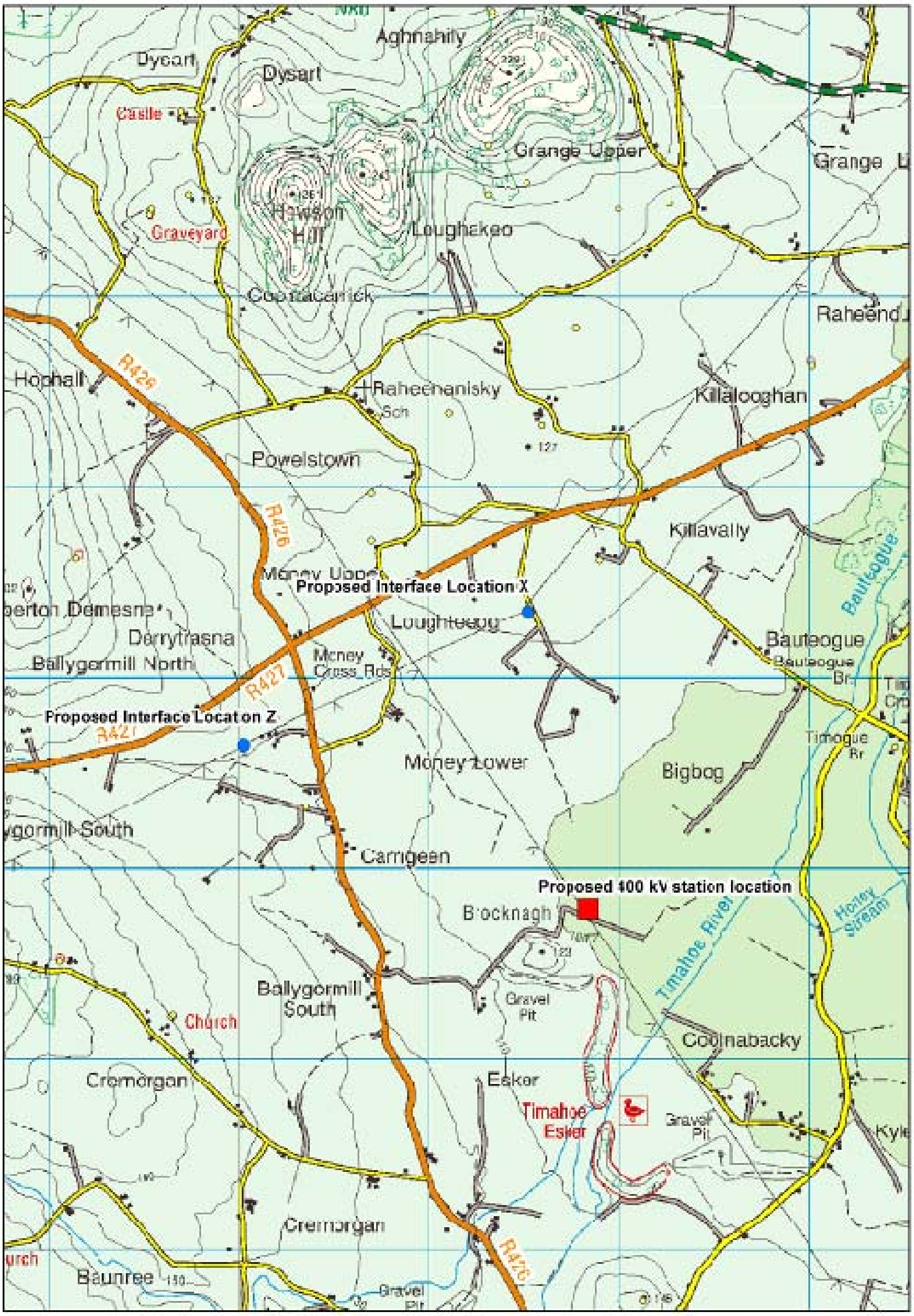

Figure 3.5: Assumed Location of Line Interface Compound (Single Circuit Option)

3.3.3 Cable Route Options

This section identifies a number of feasible cable route options from the existing 400 kV overhead line to the proposed substation in Coolnabacky. As described in section 3.3.2, an interface compound is required wherever the line stops and the cable starts. In total 7 cable routes are identified (A to G). Routes A to F are suitable only for single circuit underground cable and route G is suitable for a double circuit. All of these circuit routes are now described. The single circuit routes are described in isolation and not 'paired' with another single circuit route at this descriptive stage. This is done in section 3.4.2 where the two preferred SC routes are paired. Each option is separately illustrated under the relevant option heading.

3.3.4 Cable Route Option A

This cable route begins at interface location X and its route is illustrated in Figure 3.6 below.

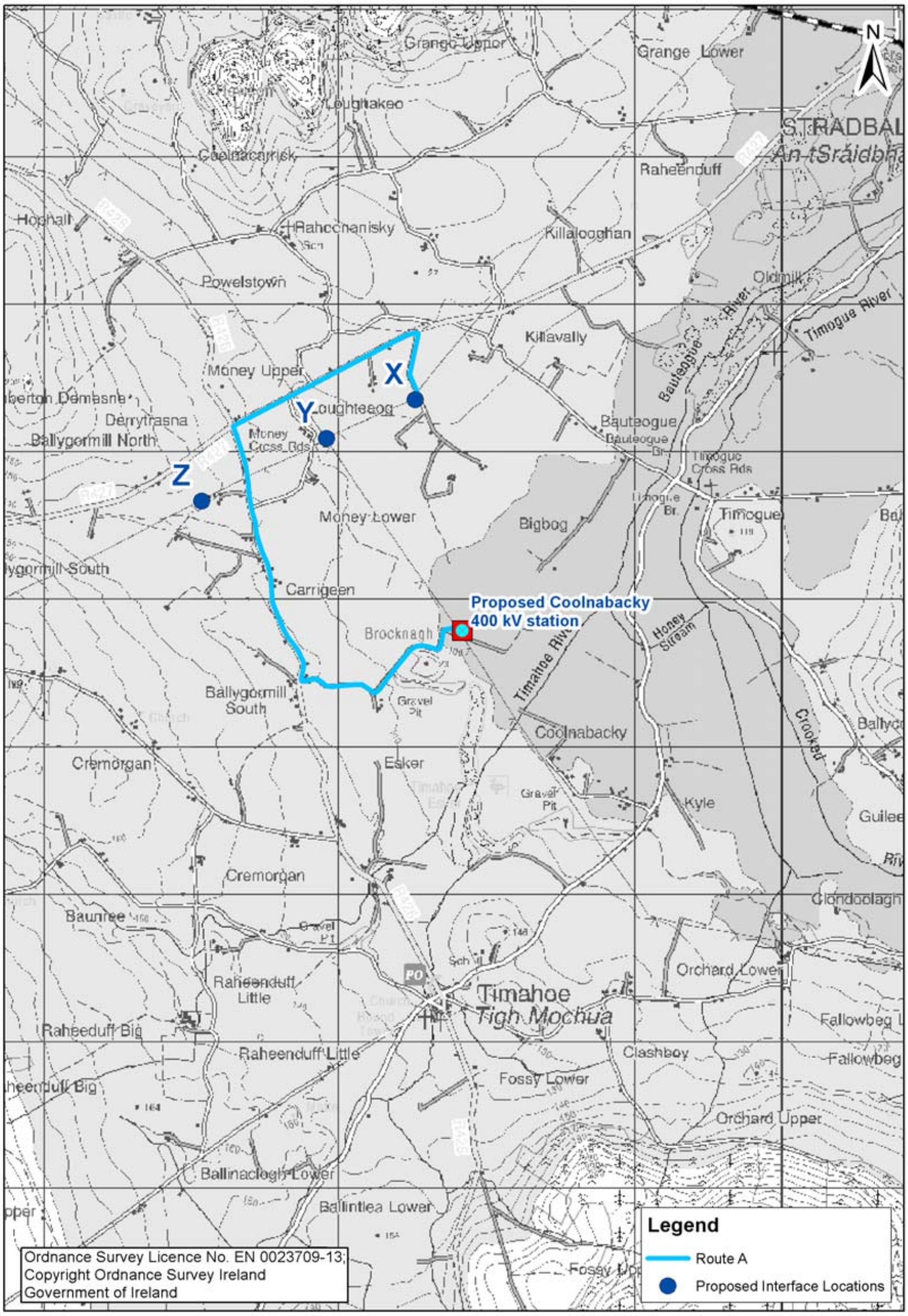

Figure 3.6: Cable Option A

The compound or tower is to be located in the vicinity of an existing angle mast on the Dunstown – Moneypoint 400 kV overhead line, see Figure 3.7.

Figure 3.7: Location of Interface Option X

(All photos were taken from public property or with the land owners consent)

The cable route enters a third class road and turns left. The proposed compound and cable route would be installed close to an existing archaeological field system, as identified on the desktop study of the area. Appropriate archaeological monitoring will need to be carried out during cable installation. The cable route runs north along this road for approximately 0.5km until reaching the R427, see Figure 3.8.

Figure 3.8: R427 Regional Road Looking East

Upon reaching this junction the cable route would turn left heading west along the R427. The cable route travels west for approximately 1.3km, where it reaches the ‘Money Cross Road’. This section of road is home to several dwellings, and consultations will be required with the relevant local authority in order to minimise disruption and set up an appropriate traffic management plan during cable installation. The cable route turns left at the crossroads entering the R426 regional road as illustrated in the Figure 3.9 below. This area is a busy agricultural region which needs to be considered when determining an appropriate traffic management system along this section of road. The cable route runs south for approximately 1.8km until reaching a junction with a private road in the townland of Ballygormill South. The road is approximately 5.5 metres wide which will allow a single circuit cable to be installed.

Figure 3.9: R426 Regional Road

Once the cable route reaches this junction it turns left in an easterly direction entering a private road. A cable easement would need to be sought in order to allow this cable route be installed along this section of private road. The private road serves a dwelling, gravel pit and farmland located further east. The road appears to be of solid construction and is approximately 4 metres wide, see photo below.

Figure 3.10: Private Road Heading Towards the Proposed 400 kV Station

The cable will travel approximately 1.3 km along this private road (see Figure 3.10), past an existing gravel quarry until reaching the proposed 400 kV station site located in the townland of Coolnabacky. The private road deteriorates as it reaches the proposed 400 kV station, see Figure 3.11 below.

Figure 3.11: Existing Access to Proposed 400 kV Substation Site

It would be necessary to construct a better quality road over this existing track in order to ensure cable security and provide access for heavy machinery required for cable maintenance.

3.3.5 Cable Route Option B

This cable route contains a mixture of public and private property. The route originates at the interface location X and its route is illustrated in Figure 3.12.

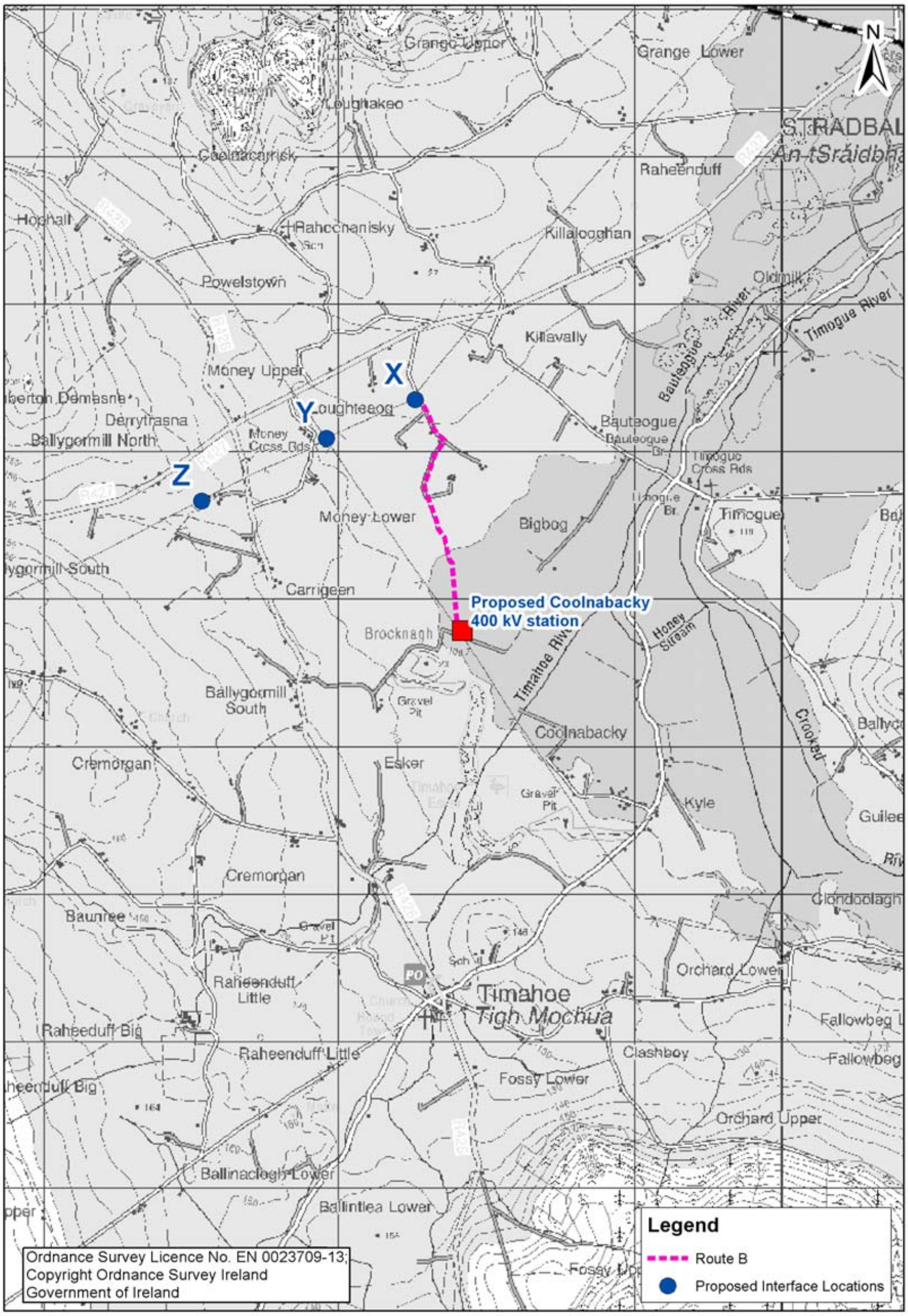

Figure 3.12: Cable Option B

As the cable route leaves location X it enters the adjacent third class road turning right. From this location the cable route travels south along this road. After 0.2 km this road becomes a private road serving several dwellings and farm buildings, see Figure 3.13 below. Agreement would need to be sought with the relevant landowners in order to secure an easement on this length of road.

Figure 3.13: Road Serving Houses South of Proposed Interface Location X

The cable route travels approximately 0.3 km where it reaches a junction. The route turns right at this junction and continues south along this residential access road. The cable route travels for approximately 0.5 km until reaching a right hand turn on the road. At this location the cable route enters private property. Agreement with the landowner(s) will need to be sought in order to obtain a cable easement in this area. This property consists of agricultural ground. It is general practice when cabling in private property to install the cable along the property boundary.

There appears to be an existing farm track running along the existing field boundary that would appear to be a natural location for the proposed cable route. The cable route would run along the existing field boundaries for approximately 0.9km. Whilst no obvious constraints exist, ecological and archaeological monitoring during construction may be required to ensure potential adverse impacts are avoided. There appears to be several water courses in this agricultural land that the cable route may need to cross, further investigation at the detailed design phase will be necessary in order to find a suitable method of crossing these water courses.

3.3.6 Cable Route Option C

This cable route is also a mixture of road and cross country and its route is illustrated in Figure 3.14.

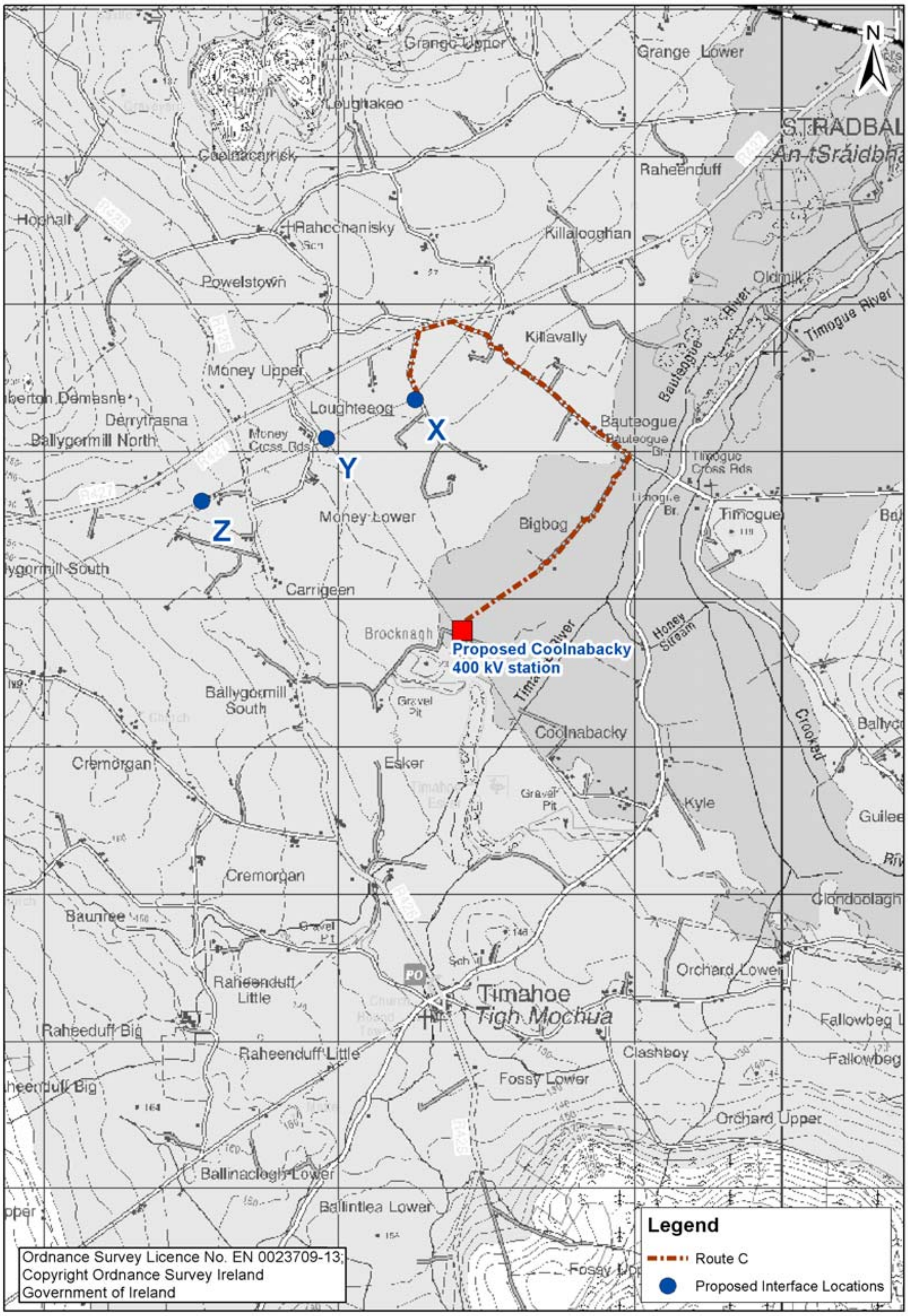

Figure 3.14: Cable Option C

This route follows cable route A until reaching the regional road R427. Route C turns right when reaching this point, and travels east along this road. After approximately 0.3 km the cable route turns right leaving the R427 and enters a third class road, see Figure 3.15.

Figure 3.15: Looking West along the R427 at Junction with Timahoe Road

This road serves the town of Timahoe and is home to several roadside dwellings. The road is relatively narrow in places and consultations will be required with the relevant local authority in order to minimise disruption and set up an appropriate traffic management plan during cable installation. The cable route runs along this section of third class road for approximately 1.5 km where it reaches a junction with a private farm track.

Agreement with the land owner will need to be sought in order to achieve this section of the cable route. This farm track extends for approximately 1 km, running along agricultural land. It is assumed that a cable route can be achieved along the field boundaries beyond the farm track and reach the proposed 400 kV station which is 0.6 km further south. It is general cable practice to install the cable along the existing field boundaries in these areas, thus minimizing the disturbance to the agricultural activities in the area. Whilst no obvious constraints exist, ecological and archaeological monitoring during construction may be required to ensure potential adverse impacts are avoided.

3.3.7 Cable Route Option D

Route D is a slight variation of cable route A and its route is illustrated in Figure 3.16 below.

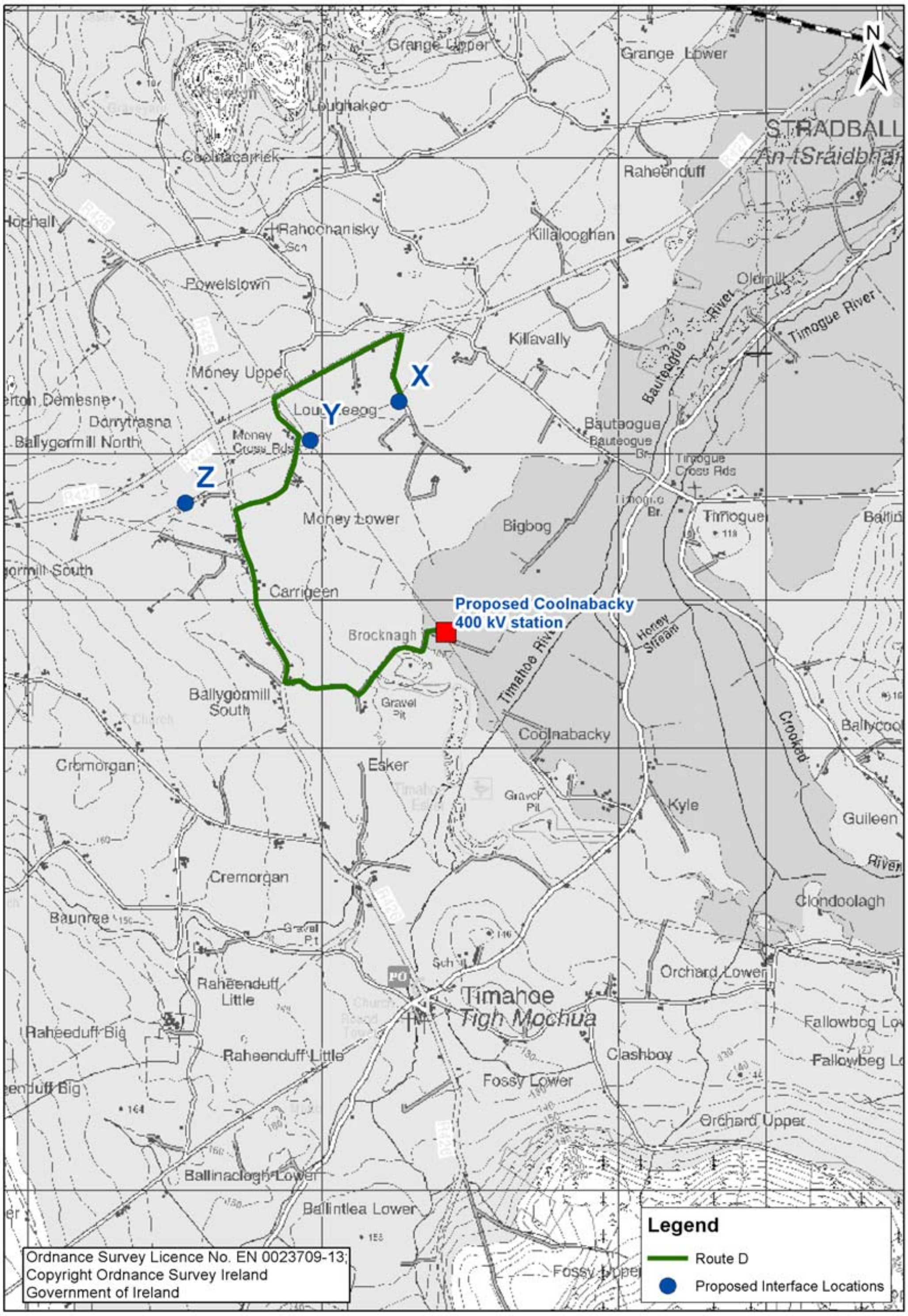

Figure 3.16: Cable Option D

It follows the same cable route as route A however prior to reaching the 'Money Crossroads' the cable route takes the first left entering a third class road, see Figure 3.17 below.

Figure 3.17: Route D, Third Class Road

This section of road is home to several residential and agricultural buildings. The road is relatively narrow in places and consultations will be required with the relevant local authority in order to minimise disruption and set up an appropriate traffic management plan during cable installation. This section of road appears wide enough to allow for a single circuit cable solution. The cable route runs along this road for approximately 1 km before rejoining cable route A along the R426.

3.3.8 Cable Route Option E

This route is a variation of route C and its route is illustrated in Figure 3.18.

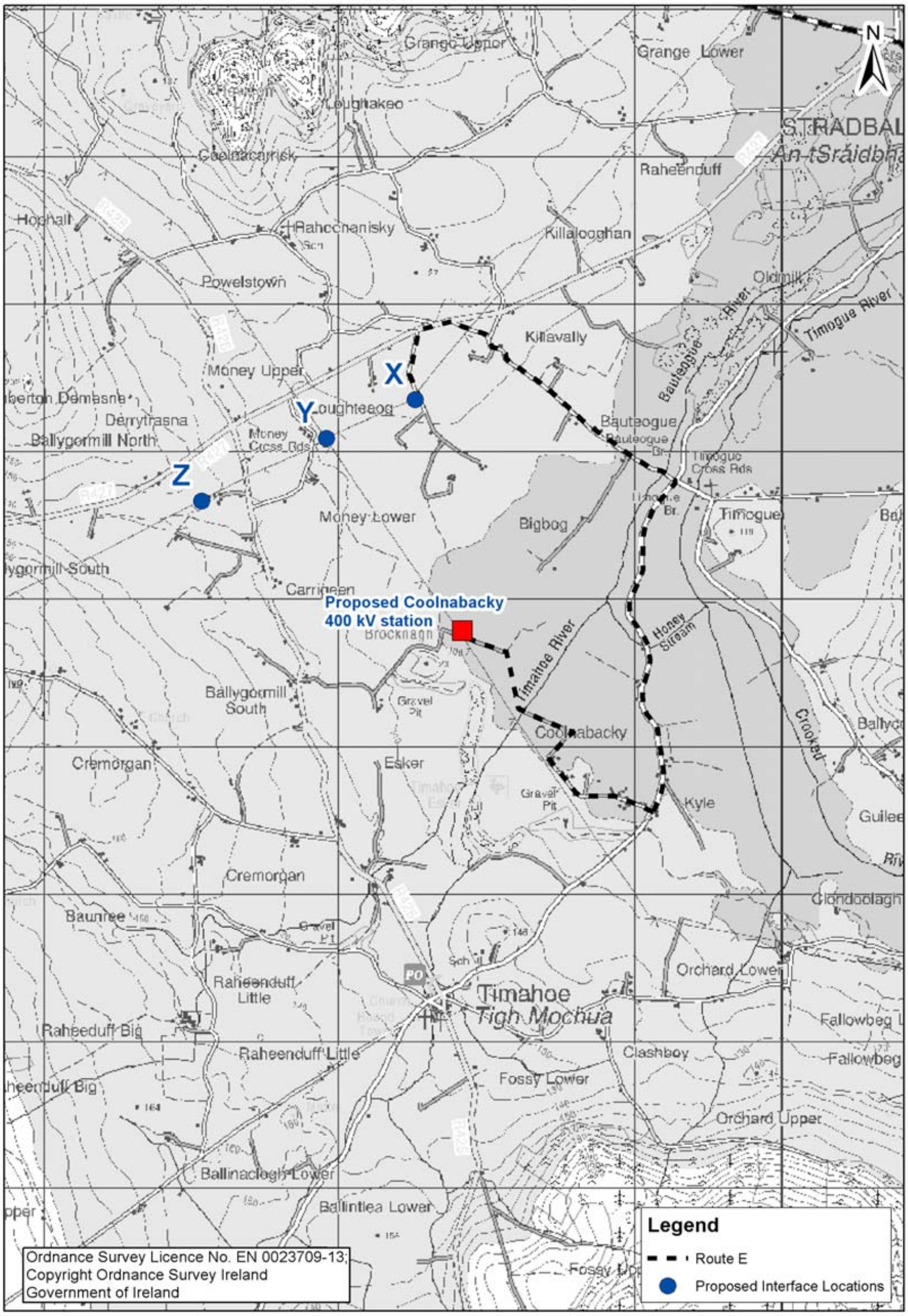

Figure 3.18: Cable Option E

Leaving the proposed interface location X, route E follows the same path as route C until reaching the Bauteogue Bridge, unlike route C this cable route continues along the third class road crossing the bridge, see Figure 3.19 below.

Figure 3.19: Bauteogue Bridge

The cable route continues for approximately 0.3 km before reaching the bridge structure. The structure itself does not appear to have enough cover available to allow cable installation. A trenchless method of crossing the Bauteogue River may be required. The cable route continues east until reaching the 'Timogue Crossroads', where the cable route turns right. The cable route runs south along this road for 1.3 km, which is home to several residential and farm buildings, before reaching the 'Honey Stream'. This stream appears to be culverted. The road is narrow in some places, which may make the installation of a single cable more difficult.

The cable route continues on from the 'Honey stream' for approximately 1.2 km until making a right hand turn into another third class road, which serves the townland of Coolnabacky. This road also serves a number of existing residential dwellings. The cable route runs for 0.8 km until reaching the end of the third class road and entering what appears to be a private road. This track runs for approximately 0.6 km where it reaches a second river crossing, namely the 'Timahoe River'. This crossing may need to be carried out with trenchless methods. After crossing this river the cable route enters private property, this land appears to be used for agricultural purposes, agreement with the land owner will need to be sought in order to secure a cable easement. The cable route will continue along this private property for approximately 0.5 km until reaching the proposed 400 kV site location in the townland of Coolnabacky. The cable route comes into relatively close proximity to Timahoe Esker NHA (National Heritage Area) in this area, consultation with the relevant authorities may need to be sought prior to cable installation.

3.3.9 Cable Route Option F

This cable route utilizes the proposed interface option Z, which is further west along the existing Dunstown – Moneypoint 400 kV OHL. Its route is illustrated in Figure 3.20.

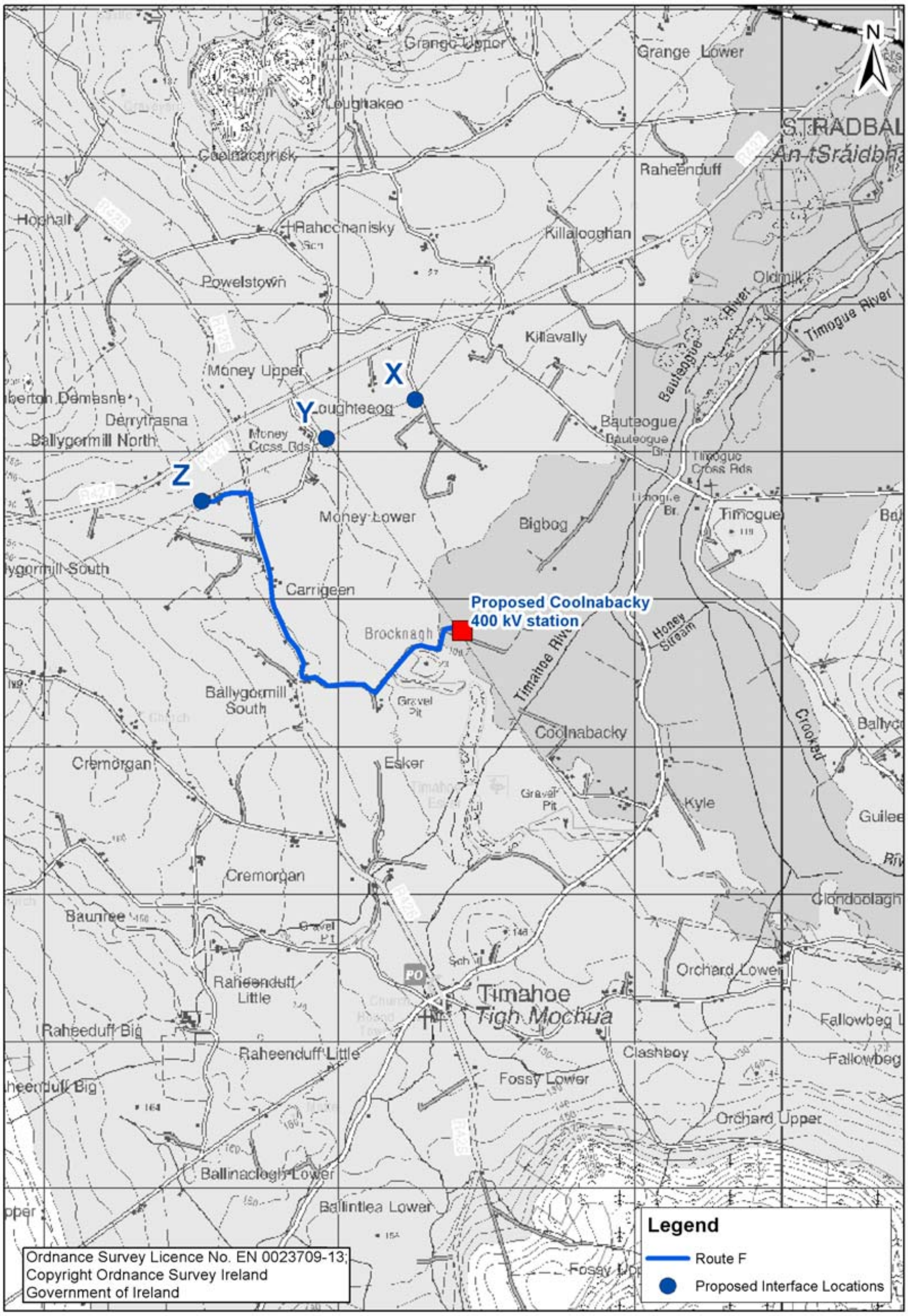

Figure 3.20: Cable Option F

This proposed site location is served by existing farm access tracks and roads. The cable route would leave the proposed site entering the existing farm access roads, running for approximately 0.3 km until reaching the R426, see Figure 3.21.

Figure 3.21: R426 Road Looking North Along Route F

The cable route then turns right at this location and follows the same route as outlined in cable route A until reaching the proposed 400 kV site location at Coolnabacky.

3.3.10 Cable Route Option G

Route option G is a double circuit underground cable. Route G originates at the proposed interface location Y, as shown in Figure 3.4. Its route is illustrated in Figure 3.22 below.

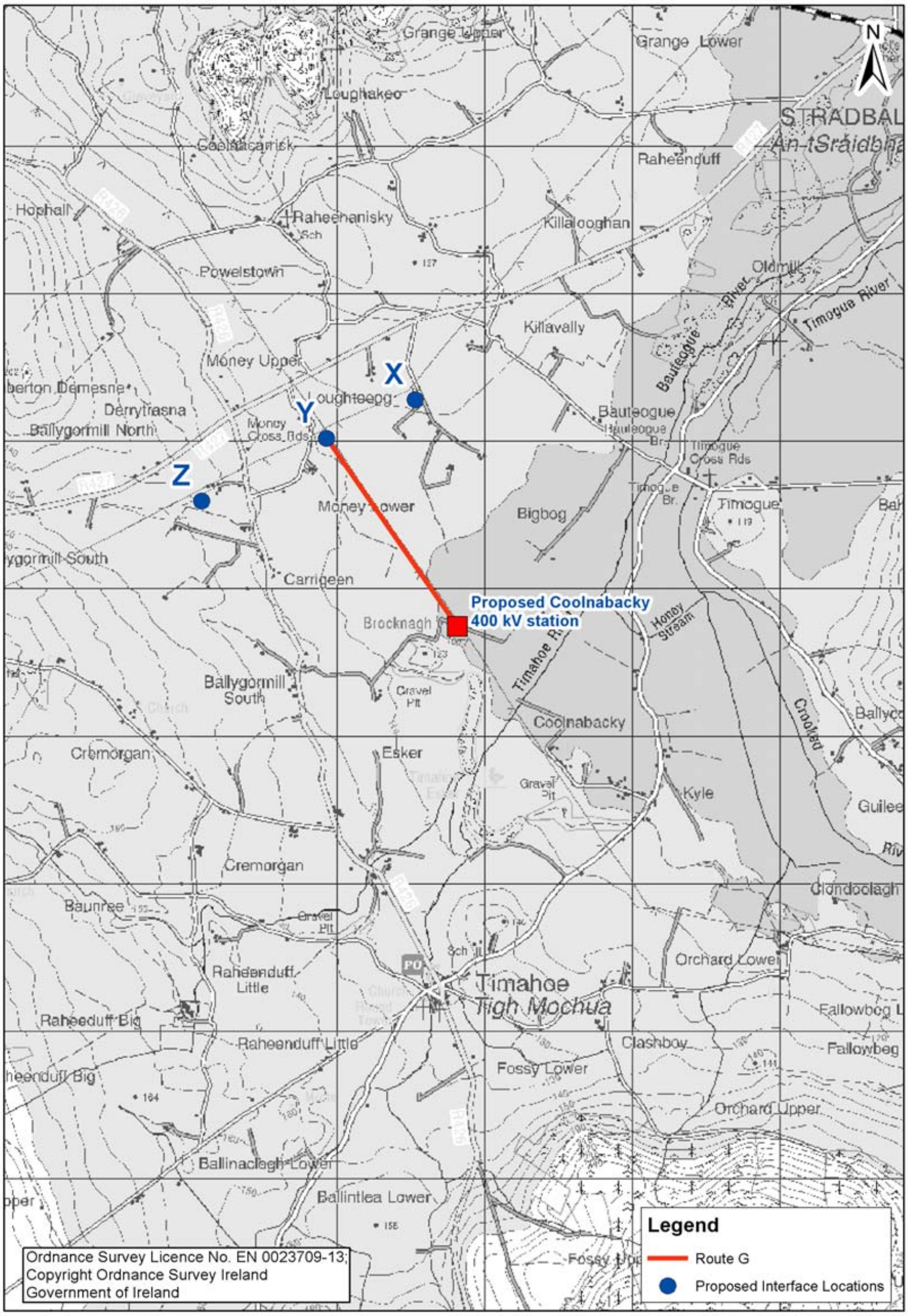

Figure 3.22: Cable Option G

This cable route crosses only private property and so is the shortest cable route available as it takes the most direct route. This cable route is a double circuit, single corridor solution. There would be approximately 6 metres separation required between the circuits and this would result in an overall easement width of approximately 10 metres. It may also be preferable to increase the cable depth in order to improve cable security in certain areas of the cable route.

The distance 'as the crow flies' is approximately 1.4km from the proposed interface location C to the proposed 400 kV station location. This cable route would cut across approximately 8 land parcel boundaries, which are owned by three separate land owners. Agreement with the land owners must be sought in order to acquire a cable easement. It is general underground cable procedure to create a cable corridor along the existing boundaries as opposed to taking the most direct route. This is done to minimize the interference to agricultural practices in the area. In this study ESBI have been asked to examine the most direct route available.

The most direct cable solution will involve several water course crossings, further investigation at the design phase will be required in order to find an appropriate method of crossing these streams. Ecological and archaeological assessments will need to be carried out along this route in order to identify if there is any potential for creating adverse impacts. As well as the actual trench size, a sizable working area would be required during cable installation. A temporary wayleave would be required for this working area. Site investigations will need to be carried out in order to determine the nature of sub soil in the area both during construction and into the future.

Access for cable maintenance or emergencies must be considered. Suitable access roads or tracks must be available to allow access for large machinery and equipment.

3.4 Preferred Cable Routes

Based on site visits, previously published environmental constraints reports and expertise in cable route selection the following matrix has been developed to assist in making an evaluation.

	ROUTE OPTION A	ROUTE OPTION B	ROUTE OPTION C	ROUTE OPTION D	ROUTE OPTION E	ROUTE OPTION F	ROUTE OPTION G
OVERALL ROUTE LENGTH (km)	4.9	1.7	3.9	5.1	7.2	2.9	1.5
ALL PUBLIC PROPERTY	NO	NO	NO	NO	NO	NO	NO
PRIVATE WAYLEAVES / EASEMENTS REQUIRED	YES	YES	YES	YES	YES	YES	YES
ENVIRONMENTAL IMPACT	MEDIUM	MEDIUM - HIGH	LOW	LOW	MEDIUM - HIGH	LOW	LOW
CONSTRUCTABILITY	MEDIUM	MEDIUM - HIGH	MEDIUM - HIGH	MEDIUM	MEDIUM - HIGH	MEDIUM	MEDIUM - HIGH
TECHNICAL FEASIBILITY	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM - HIGH	MEDIUM	MEDIUM
CLEARANCE FROM BUILDINGS	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR
TRAFFIC MANAGEMENT IMPACT	LOW - MEDIUM	LOW - MEDIUM	LOW - MEDIUM	LOW - MEDIUM	MEDIUM	LOW - MEDIUM	LOW
PROPOSED ROUTE WITHIN SAC/SPA	NO	NO	NO	NO	NO	NO	NO

TRENCHLESS INSTALLATIONS	LOW	LOW	LOW	LOW	MEDIUM	LOW	LOW
PRIVATE LANDOWNERS	YES	YES	YES	YES	YES	YES	YES

Table 3.1: Evaluation Matrix

RATINGS TABLE
IMPACT
LOW
LOW - MEDIUM
MEDIUM
MEDIUM - HIGH
HIGH

Table 3.2: Matrix Key

It should be re-iterated that Options A to F are single circuit and option G is double circuit. These distinctions have been considered in the evaluation matrix.

In conclusion there are two cable connection options available.

- Double circuit connection (cross country route)
- Single circuit connection using two independent cable routes (public roads and cross country)

3.4.1 Double Circuit Connection

This option consists of a cross country double circuit cable route with a 10 metre wide route corridor, which would require a full legal easement. This option would originate at the proposed interface location Y and would involve the use of **Cable Route Option G**. This cable route is the shortest cable route option available and may reduce overall cost of a proposed connection due to the fact that it requires only one interface location. This would be beneficial in terms of planning, environmental, costs and civil works. However, as outlined in section 3.3 '*Route Selection Criteria*' there are many issues associated with installing cable in private property, such as cable security, access for cable maintenance, easements and the associated costs. Acquiring the necessary cable easements may prove costly in this area as the cable route crosses 8 parcels of land owned by 3 different land owners. Further investigation would need to be carried out on this cable route option at the detailed design phase in order to determine whether this cable route is technically feasible and achievable.

Length of cable = 1.5km x 2, both cables within one 10 metre easement on private property

Total cable length = 3km

3.4.2 Single Circuit Connection Using Two Independent Cable Routes

There are 6 cable routes available within the study area as outlined above. This provides a number of options to achieve a single circuit connection using two independent cable routes. Using a combination of **Cable route F** and **Cable route B** would appear to be the most feasible cable options available based on length of circuit.

Cable Route B Length = 1.7km in a 1.5 metre trench on public roads

Cable Route F Length = 2.9 km in a 1.5 metre trench on public roads

Total cable length = 4.6km

3.5 Connection Options Conclusion

Table 3.3 below summarises the most feasible connection options available both overhead and underground.

Option	Solution	Approx. Total Length (km)
1	Double circuit overhead line	1.4
2	Single circuit overhead line(s)	2.8
3	Double circuit underground cable	3.0
4	Single circuit underground cable	4.6

Table 3.3: Summary of Feasible Options

Chapter 4 will carry out a high level environmental assessment of each of these options, chapter 5 will carry out a cost comparison, and chapter 6 will evaluate the findings with the lead consultant’s recommendations being presented in chapter 7.

4 Environmental Assessment of Connection Options

4.1 Introduction

This section provides an environmental assessment of each of the four options detailed in Table 3.3, having regard to relevant environmental issues, where potential exists for adverse impacts to arise. Environmental assessments have been prepared by the following specialists:

- Soils and Geology and Water – AWN Consulting
- Ecology – Dr. Patrick Crushell
- Cultural Heritage – Tobar Archaeological Services
- Landscape – AOS Planning Limited

In preparing these assessments the consultants have had regard to previous site visits as well as relying on previously published reports, (i.e. The Stage 1 Lead Consultant's Report which detailed the study area, constraints, potential corridors and potential substation locations as well as environmental reports on undergrounding of cables). Information sources are generally similar to those used for the Stage 1 Report. The conclusions of the assessment are based on the definition of impacts as set out in the ***EPA Guidelines: Information to be contained in EISs***, in order to provide a consistent basis for assessment.

4.2 Double Circuit Overhead Line

4.2.1 Soils and Geology

The line passes through agricultural land from the proposed Coolnabacky 400 kV substation to the existing Dunstown - Moneypoint 400 kV Line. This route does not pass through an area of geological heritage importance. The estimation of Magnitude of Impact on Soils & Geology is considered 'Slight Negative'.

4.2.2 Water (Hydrology and Hydrogeology)

The line passes through agricultural land from the proposed Coolnabacky 400 kV substation to the existing Dunstown - Moneypoint 400 kV Line. No distinct surface water features are located along the proposed route. It is underlain by a Regionally Important Karstified (diffuse) aquifer and locally important sand and gravel aquifer. The groundwater vulnerability is moderate/high. The estimation of Magnitude of Impact on Water is 'Slight Negative'.

4.2.3 Ecology

The line crosses over arable crops, improved agricultural grassland and hedgerow habitat from the proposed Coolnabacky 400 kV substation to the existing Dunstown - Moneypoint 400 kV Line. The proposed route does not traverse any mapped natural watercourse. The principal source of ecological impacts is where the proposed overhead line may require the removal of a short section of hedgerow. The line largely avoids areas of semi-natural habitat being confined to areas of intensively managed farmland and ecological impacts associated with both the construction and operation phase are likely to be minor.

4.2.4 Cultural Heritage

No National Monuments, recorded monuments, protected structures or buildings listed in the NIAH are located along or within close proximity the proposed single circuit or double circuit overhead line options. The nearest recorded monuments located to the north of the proposed routes do not have any above ground expression and therefore will not be visually impacted by the construction of either overhead line option. No direct impacts on the recorded archaeological resource or architectural heritage are therefore anticipated.

Both overhead line options are located in an area within which two extensive cropmark landscapes have been identified. Ground works associated with the construction of towers for either overhead line option have the potential to directly impact on unknown sub-surface archaeological features which may exist along the line route. Archaeological monitoring of ground work associated with the construction of the towers is therefore recommended.

4.2.5 Landscape and Visual

The route will closely follow the line of the existing Athy - Portlaoise 110 kV overhead line. The new structures will alter the appearance and character of views from approximately 1 km of the section of the R426 [Portlaoise - Timahoe Rd] where the proposed and existing overhead lines will be seen together.

There will be a pronounced, localised, intensification of this effect in the vicinity of Brocknagh where the new station and associated terminal structures, a section of the new 110 kV line and the new 400 kV lines will all be simultaneously visible from a short [500m] section of the R426 at Carrigeen.

These cumulative changes will significantly change the character of the view at this location which are likely to be perceived as an adverse impact within the area most affected.

There will also be a concentration of new and existing angle masts along south of the R 427 east of Money Cross Roads which will increase the intensity of the established effects in this vicinity.

4.3 Single Circuit Overhead Line

The impacts arising from single circuit overhead line are broadly similar to the double circuit overhead line, however as there will be more structures the effects are intensified.

4.3.1 Soils and Geology

The line passes through agricultural land from the proposed Coolnabacky 400 kV substation to the existing Dunstown - Moneypoint 400 kV Line. This route does not pass through an area of geological heritage importance. The estimation of magnitude of impact on Soils & Geology is ‘Slight Negative’

4.3.2 Water (Hydrology and Hydrogeology)

The line passes through agricultural land from the proposed Coolnabacky 400 kV substation to the existing Dunstown - Moneypoint 400 kV Line. No distinct surface water features are located along the proposed route. It is underlain by a Regionally Important Karstified (diffuse) aquifer and locally important sand and gravel aquifer. The groundwater vulnerability is moderate/high. The estimation of magnitude of impact on water is ‘Slight Negative’.

4.3.3 Ecology

The line crosses over arable crops, improved agricultural grassland and hedgerow habitat from the proposed Coolnabacky 400 kV substation to the existing Dunstown - Moneypoint 400 kV Line. The proposed single circuit line route comprises two separate lines running parallel to one another. The proposed route does not traverse any mapped natural watercourse. The ecological impacts associated with constructing this option are likely to be slightly greater due to the higher potential for disturbance associated with constructing additional towers compared to those associated with the double circuit option. Similarly there is likely to be a greater requirement for trimming of hedgerows during the operation phase of the single circuit option.

4.3.4 Cultural Heritage

The findings for the single circuit line are the same as for the double circuit option outlined above in section 4.2.4.

4.3.5 Landscape and Visual

The findings for the single circuit line are the slightly higher as for the double circuit option outlined above in section 4.2.5. The route of the two single circuit lines will parallel the line of the existing Athy-Portlaoise 110 kV overhead line. The new structures will alter the appearance and character of views from approximately 1 km of the section of the R426 [Portlaoise- Timahoe Rd] where the new and existing power lines will be seen together. The additional structures required for the single circuit option will intensify the visual effects outlined in section 4.2.5.

4.4 Double Circuit Underground Cable (Option G)

4.4.1 Soils and Geology

This route passes through agricultural land from the proposed Coolnabacky 400 kV substation to the proposed Interface Location Y. The estimation of magnitude of impact on Soils & Geology is ‘Slight Negative’.

4.4.2 Water (Hydrology and Hydrogeology)

This route is located at Brocknagh/Money Lower, it passes through agricultural land. It is underlain by a Regionally Important Karstified (diffuse) aquifer and locally important sand and gravel aquifer. The groundwater vulnerability is high/moderate. The estimation of Magnitude of Impact on Water is ‘Slight Negative’.

4.4.3 Ecology

There are no crossings of (mapped) water courses associated with this route, although the absence or presence of drainage ditches feeding into natural watercourses downstream have not been confirmed. This route involves the removal/disturbance of hedgerows (minimal) along agricultural field boundaries from the proposed substation to the Proposed Interface Locations. This option would result in a potential temporary loss of habitat for wildlife particularly nesting birds.

4.4.4 Cultural Heritage

This route is an off-road option and therefore has the potential to directly impact on as yet unknown sub-surface archaeological features or deposits. In this regard it is a less preferred option, although the potential impacts can be mitigated against by pre-development archaeological testing.

4.4.5 Landscape and Visual

Apart from the terminating structures there will be very limited permanent landscape or visual effects arising from the underground option. The interface compounds and inspection chambers will give rise to highly localised effects. There may be temporary effects in areas where it may be necessary to carry the route through hedges, particularly if these contain mature trees.

4.5 Single Circuit Underground Cable (Options B & F)

4.5.1 Soils and Geology

Route B

This route passes through agricultural land from the proposed Coolnabacky 400 kV substation to the proposed Interface Location X. This route does not pass through an area of geological heritage importance. The estimation of magnitude of impact on Soils & Geology is ‘Slight Negative’.

Route F

This route utilises roads and passes through agricultural land from the proposed Coolnabacky 400 kV substation to the proposed Interface Location Z. The estimation of magnitude of impact on Soils & Geology is ‘Slight Negative’.

4.5.2 Water (Hydrology and Hydrogeology)

Route B

This route passes through agricultural land from the proposed Coolnabacky 400 kV substation to the proposed Interface Location X. No distinct surface water features are located along the proposed route. It is underlain by a Regionally Important Karstified (diffuse) aquifer; the groundwater vulnerability is extreme to high. The estimation of magnitude of impact on Water is considered ‘Moderate Negative’ as it has potential to impact on groundwater quality and water supply quality and is also considered ‘Slight Negative’ for other attributes.

Route F

This route passes through agricultural land and utilises existing roads. It is underlain by a Regionally Important Karstified (diffuse) aquifer and locally important sand and gravel aquifer. The groundwater vulnerability is high. The estimation of magnitude of impact on is ‘Slight Negative’.

4.5.3 Ecology

Route B

There are no crossings of major water courses associated with this route, although the absence or presence of drainage ditches feeding into natural watercourses downstream have not been confirmed. This route involves the removal/disturbance of hedgerows (minimal) along agricultural field boundaries from the proposed substation to the proposed Interface Locations. This option would result in a potential temporary loss of habitat for wildlife particularly nesting birds. This option would be preferable as it is the shortest and would cause the least amount of disturbance to hedgerows.

Route F

There are no crossings of major water courses associated with this route, although the absence or presence of drainage ditches feeding into natural watercourses downstream have not been confirmed. This route largely avoid disturbance of semi-natural habitats and is confined to existing road infrastructure and therefore is deemed to be equally preferable above the other route options.

4.5.4 Cultural Heritage

Route B

Route B is regarded as suitable if pre-development archaeological testing of its southern end is undertaken.

Route F

The preferred route is Route F as it extends largely along public roads and existing tracks and no direct or indirect impacts on the archaeological or architectural resource along this route were identified.

4.5.5 Landscape and Visual

Apart from the terminating structures there will be very limited permanent landscape or visual effects arising from the underground option. The interface compounds and inspection chambers will give rise to highly localised effects. There may be temporary effects in areas where it may be necessary to carry the route through hedges, particularly if these contain mature trees.

5 Cost Assessment of Connection Options

The costs for the 400 kV overhead lines were established using the most up-to-date ESB standard transmission costs.

5.1 Overhead Line

5.1.1 Double Circuit Overhead Line

Based on an estimated 1km = €1,650,000 to construct, the total cost of the double circuit 400 kV line proposed (1.4km) in this report is €2,310,000

5.1.2 Single Circuit Overhead Line

Based on an estimated 1km = €1,266,000 to construct, the total cost of the single circuit 400 kV lines proposed (2.8km) in this report is €3,544,800

5.2 Underground Cable

5.2.1 Double Circuit Cable (Route G)

Based on 3km of cable in agricultural land and one interface compound, the total cost of a double circuit cable connection to Coolnabacky 400 kV substation = €8,710,600.

5.2.2 Single Circuit Cable (Routes B & F)

Based on 4.6km of cable predominately in public road and two interface compounds, the total cost of a single circuit cable connection to Coolnabacky 400 kV substation = €14,165,878.

5.3 Overall Costs Comparison

Capital costs for UGC are higher than for an OHL of the same transmission capacity. For the connection to the Dunstown – Moneypoint line considering a DC UGC costs compared to a DC OHL costs over the same route the DC UGC would be of the order of 3.7 times more expensive than the equivalent DC OHL.

The report '*Electricity Transmission Costing Study*'[1] which was published in January 2012 in the UK, has indicated that the cost of UGC for lengths of up to 3km may be in fact up to 7.9 times more expensive than the equivalent OHL. It also acknowledges that there are many factors which influence actual costs including, required transmission capacity, terrain through which the connection runs, world metal prices, labour costs, and the prevailing transmission market itself.

The findings of this report indicate that the above ratio of 3.7 times is therefore at the lower end of the costs between OHL and UGC and that the actual ratio may therefore be significantly greater.

[1] Electricity Transmission Costing Study: An Independent Report Endorsed by the Institution of Engineering and Technology, 31 January 2012, publically available from http://www.theiet.org/factfiles/transmission.cfm'

6 Comparative Evaluation

The chapter provides a comparative breakdown of the different connection methods available for connecting the existing Dunstown – Moneypoint 400 kV line to the proposed Coolnabacky 400/110 kV substation based on the findings of this report.

The comparison basis is similar to that used for the Stage 1 report using similar terminology emerging preferred, less preferred and least preferred and a similar colour scheme.

Emerging Preferred	Less Preferred	Least Preferred

Figure 6.1: Rating Colour Coding

The comparison considers the most feasible solutions that were identified in Table 3.3:

- Option 1 - Double circuit overhead line (DCOHL)
- Option 2 - Single circuit overhead line(s) (SCOHL)
- Option 3 – Double circuit underground cable (DCUGC)
- Option 4 - Single circuit underground cable (SCUGC)

Having regard to the differing potential impacts that arise during the construction and operational stages, separate comparison tables have been prepared for each stage (Tables 6.1 and 6.2). The overall comparison table gives a final conclusion (Table 6.3).

6.1 Construction Stage

	DC UGC	SC UGC	DC OHL	SC OHL	Comments
Ecology					The DCOHL creates the least disturbance and as a result has the least potential impacts.
Landscape & Visual					There is no difference between any option.
Cultural Heritage					The DCUGC creates the most disturbance and as a result has the most potential impacts.
Soils &Geology					The DCOHL creates the least disturbance and as a result has the least potential impacts.
Water (Hydrology & Hydrogeology)					The DCOHL creates the least disturbance and as a result has the least potential impacts.
Cost					The DCOHL is the lowest cost option.

Table 6.1: Comparison at Construction Stage

Table 6.1 concludes that the emerging preferred option is the double circuit overhead line.

6.2 Operational Stage

	DC UGC	SC UGC	DC OHL	SC OHL	Comments
Ecology					The SCUGC creates the least ongoing disturbance and as a result has the least potential impacts.
Landscape & Visual					Underground cables have a significantly lower level of visual impacts than overhead lines.
Cultural Heritage					There is no difference between any option.
Soils &Geology					There is no difference between any option.
Hydrology					There is no difference between any option.

Table 6.2: Comparison at Operational Stage

Table 6.2 concludes that the emerging preferred option is the single circuit underground cable.

6.3 Lead Consultants Overall Comparison

	DC UGC	SC UGC	DC OHL	SC OHL	Comments
Environmental					The overall effect results in the same rating being allocated, ohl have higher visual effects while ugc have higher impacts due to earthworks
Cost	**3.7 (Relative Cost)**	**6.0 (Relative Cost)**	**1.0 (Relative Cost)**	**1.5 (Relative Cost)**	The DCOHL is the lowest cost option and is shown as 1.0, all other costs are given as relative costs to the DC OHL i.e. DC UGC is 3.7 times the cost of DC OHL

Table 6.3: Overall Comparison at Operational Stage

Table 6.3 concludes that whilst OHLs and UGCs have different environmental impacts, having regard to all environmental factors that arise at both construction and operational stage, the UGCs and the DCOHL emerge as being broadly similar with the SC OHL as being the least preferred. The DCOHL is the lowest cost option.

The comparison concludes that the DCOHL is the emerging preferred option as a connection method.

7 Lead Consultants Recommendation on Connection Method

The comparative evaluation detailed in chapter 6 determined that an overhead line (OHL) is preferable to an underground cable (UGC) as the preferred connection method from the existing Dunstown – Moneypoint 400 kV line to the proposed Coolnabacky 400/110 kV substation.

The lead consultants recommend the overhead line should be a 400 kV double circuit overhead line rather than single circuit overhead lines.

This recommendation is based upon an assessment of several underground cable and overhead line route options from an environmental and cost perspective.

EirGrid as TSO provide a technical assessment in the following chapter.

8 Technical Assessment

This section refers to the specific case where technology options are being considered for the loop-in of the existing Dunstown-Moneypoint 400 kV overhead line (OHL) into the new Coolnabacky 400/110 kV substation.

The technology options consider implementing the loop-in using either 400 kV overhead lines (OHLs) or by using 400 kV under-ground cables (UGCs).

The Dunstown-Moneypoint 400 kV line is a strategic circuit in the Irish transmission system that directly connects generation in the west of the country with the primary load centre of Dublin. As a result, any decision that would negatively impact on the reliability of that circuit would effectively impact the reliability of supply to a broad (and strategic) area of the country.

In respect of loop-in of the existing Dunstown-Moneypoint 400 kV overhead line (OHL) into the new Coolnabacky 400/110 kV substation, EirGrid's preference is to implement the loop-in by maintaining the technology of the existing circuit (i.e. OHL) for the following reasons:

1. The technical reliability, measured by forced outage rate, is seen to be significantly better for an OHL than that for an UGC[2]. The reliability of the existing Dunstown-Moneypoint 400 kV OHL would therefore be negatively impacted by the lower level of reliability that is associated with the UGC portions that are to be inserted to complete the looping in of the line into the new station.
2. The mean time to repair a fault on the circuit is considered to be significantly longer for a UGC than for an OHL. The result would be the reliability of a substantial part of the transmission network would be placed at risk for a significantly longer period while repairs were being carried out if UGC was to be used rather than OHL.
3. Long term reliability is also considered to be an issue. The expectation is that as an UGC gets older, it becomes less reliable.

[2] (Cigré. Update of Service Experience of HV Underground and Cable Systems, ISBN 978 -2-85873-066-7 (2009), publically available from Cigré (http://www.cigre.org) on request).

9 Overall Conclusion

This report recommends that the preferred connection option to the proposed Coolnabacky 400/110 kV substation to the existing Dunstown – Moneypoint 400 kV line is by way of a 400 kV double circuit overhead line design based on an environmental, technical and cost assessment of various UGC and OHL connection options. Table 9.1 summarises the technical aspects of the connection methods with the overall comparison by the Lead Consultants.

	DC UGC	SC UGC	DC OHL	SC OHL	Comments
Environmental					The overall effect results in the same rating being allocated, ohl have higher visual effects while ugc have higher impacts due to earthworks
Technical					EirGrid technical preference is for OHL connection for reasons outlined above in section 8. It should be noted however that a DC OHL could be exposed to common cause failures that a SC OHL would not be exposed to (structural).
Cost	**3.7 (Relative Cost)**	**6.0 (Relative Cost)**	**1.0 (Relative Cost)**	**1.5 (Relative Cost)**	The DCOHL is the lowest cost option and is shown as 1.0, all other costs are given as relative costs to the DC OHL i.e. DC UGC is 3.7 times the cost of DC OHL
Total	**Less Preferred**	**Least Preferred**	**Most Preferred**	**Next Preferred**	

Table 9.1 Summary of the technical aspects of the connection methods with the overall comparison by the Lead Consultants

Figure 9.1 shows an example of this type of 400 kV double circuit overhead line design in County Clare. It is envisaged that five of these types of structures will be required for the proposed 1.4km connection with an average spacing between towers of 280 metres.

Figure 9.1: An existing 400 kV double circuit line close to Moneypoint generating station in County Clare