Steelstown to Carrickmines: Technology Options Report

EirGrid PLC

May 2026

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Kildare-Dublin Grid Reinforcement

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Contents

Tables

Figures

Abbreviation	
AC	Alternating current
ACSR	Aluminium conductor steel reinforced
CENELEC	European Committee for Electrotechnical Standardisation
EBPO	Emerging Best Performing Option
EMF	Electromagnetic field
ESBN	ESB Networks
EU	European Union
FRA	Flood Risk Assessment
GIS	Gas-insulated switchgear
GPR	Ground penetrating radar
GSI	Geological Survey Ireland
GZTACSR	Gap-type ZT-aluminium conductor steel reinforced
ha	Hectare
HDD	Horizontal directional drilling
HDPE	High-density polyethylene
HTLS	High temperature low sag
HV	High voltage
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
KCC	Kildare County Council
kV	Kilovolt
LCIM	Line cable interface mast
m	Metres
MCA	Multi-criteria analysis
MHz	Megahertz
MTTR	Mean time to repair
OHL	Overhead line
OHL-PU	Overhead line with partial undergrounding
OPEX	Operating expenditure
pNHA	proposed Natural Heritage Area
RFI	Radio frequency interference
RPS	Record of Protected Structures
SAC	Special Area of Conservation
SDCC	South Dublin County Council

Abbreviation	
SEM	Single electricity market
SPA	Special Protection Area
TUoS	Transmission use of system
UGC	Underground cable
XLPE	Cross-linked polyethylene

Glossary of Terms	
Capital Project Number	Each project has a Capital Project Number to help coordination between EirGrid and the Transmission Asset Owner (TAO), and for reporting purposes.
Circuit	A line or cable, including associated switchgear, which carries electrical power.
Corridor	A designated study area (often 1 km wide) within which a proposed overheal line or underground cable route is evaluated.
Distribution System Operator (DSO)	In the electrical power business, a distribution system operator is the licensed entity responsible for: ▪ Operating and ensuring the maintenance and development of the distribution system in a given area (and its interconnections), if necessary and where applicable; and ▪ Ensuring the long-term ability of the system to meet reasonable demands for electrical power.
EirGrid	The independent statutory electricity Transmission System Operator in Ireland.
Flood Zone A	High probability of flooding - Where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
Grid	A network of high voltage lines and cables (400 kV, 275 kV, 220 kV and 110 kV) used to transmit bulk electricity supplies around Ireland. The terms grid, electricity transmission network, and transmission system are used interchangeably.
Loop-In Circuits	Loop-In Circuits are circuits used to connect a new substation by connecting or looping into an existing circuit.
Outage	Times when transmission infrastructure (i.e., lines, cables and transformers, etc.) will be out of service for maintenance or capital works.
Study Area	A geographic boundary defined such that it is appropriate to the scale of the proposed development, thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
Substations	Contains the specialist equipment that allows the voltage of electricity to be transformed.
Transmission circuit	An overhead line, underground cable, or combination of both, used for the bulk movement of electrical energy from one node to another node within the electrical grid.
Transmission interface substation	A Transmission Interface Substation is a specific substation that serves as the critical point of connection between a Transmission System Operator (TSO) and

Glossary of Terms	
	a Distribution System Operator (DSO). This substation plays a vital role in managing the transfer of electrical power from the high-voltage transmission grid (operated by EirGrid as its role as the TSO) to the lower-voltage distribution network (operated by ESB as its role as the DSO). A Transmission Interface Substation is responsible for stepping down the voltage from transmission levels to distribution levels.
Transmission substation	A Transmission Substation is a substation within the high-voltage transmission network where electrical power is transformed, switched, and routed. It typically steps up or steps down voltage levels to facilitate efficient power transmission over long distances. Transmission substations are integral to the operation of the transmission grid, helping to control and protect the network, manage power flows, and ensure the reliable delivery of electricity across regions where it is needed.
Transmission System Operator (TSO)	In the electrical power business, a transmission system operator is the licensed entity responsible for the management of the flow of power on the electricity grid, moving high-voltage electricity around the country, from where it is produced to where it is used, supplying large energy users and the distribution network that powers homes and businesses.

1. Introduction

1.1 Who is EirGrid?

EirGrid PLC (hereafter referred to as EirGrid) operates and develops and enhances the electricity transmission system and the wholesale electricity market in Ireland and, more recently, has been mandated to operate, develop and own Ireland's offshore transmission grid. EirGrid also develops and operate interconnections with neighbouring grids and enables third-party interconnectors. EirGrid sends power from where it is generated to where it is needed.

EirGrid uses the grid to supply power to industry and businesses that use large amounts of electricity. The grid also powers the distribution network. This supplies the electricity used every day in homes, businesses, schools, hospitals, and farms.

1.2 What is the Kildare-Dublin Grid Reinforcement (Capital Project 1226)?

The current electricity network in the east of Ireland does not have the required capacity to accommodate anticipated future electrical generation and maintain compliance with the Transmission System Security and Planning Standards (TSSPS). New infrastructure is also needed to accommodate the continued growth in electricity demand in the East Kildare and South West Dublin area, which is being driven by several sectors including:

- The transfer of power in the East Kildare and South West Dublin area is encountering capacity problems on the existing 220 kV circuits during various generation and demand scenarios. This includes scenarios when the network is intact and in the case of the unplanned loss of a single circuit or piece of transmission equipment.
- The transmission system in the area needs additional capacity to facilitate the integration of renewable energy generation both from onshore and offshore, integration of new interconnectors and connection demand in counties Dublin, Meath, and Kildare. This need was identified in Shaping Our Electricity Future roadmap published in 2021.
- Additionally, new interface points or Bulk Supply Points (BSPs) that connect the Transmission System and Distribution System are needed to supply the projected demand growth in this area, including increasing demand related to new residential housing, commercial loads, as well as electrification of the heat and transport sectors with the latter as a result of the Governments Climate Action Plan 2021.

The Kildare-Dublin Grid Reinforcement (CP1226) is the Capital Project identified under the Infrastructure Agreement to address these significant additional capacity needs in East Kildare and South West Dublin while also contributing to the Government's Climate Action Plan target of 80% of electricity supplied from renewable sources. As such, it is a part of EirGrid's statutory objective to plan and develop the grid infrastructure needed to support Ireland's economy in accordance with Regulation 8(6) of SI No 445/2000 - European Communities (Internal Market in Electricity) Regulations, 2000 (SI 445/2000).

The specific new substations and circuits requirements, identified for delivery through the Kildare-Dublin Grid Reinforcement programme of works, include:

- New Hynestown 220/110 kV transmission interface substation, situated near West County Dublin;
- New Steelstown 220/110 kV transmission interface substation, situated near the South Dublin / East Kildare boundary, with new loop-in circuits from the proposed substation to the Dunstown-Carrickmines 220 kV circuit, the Dunstown-Maynooth 220 kV circuit, and the Kilteel-Maynooth 110 kV circuit;
- New transmission circuit between the proposed Hynestown Substation and the existing Maynooth 220 kV Substation;
- New transmission circuit between the proposed Hynestown Substation and the proposed Steelstown Substation;
- New transmission circuit between the proposed Hynestown Substation and either the existing Castlebagot 220 kV Substation or the existing Inchicore 220 kV Substation; and
- New transmission circuit between the proposed Steelstown Substation and the existing Carrickmines 220 kV Substation.

The Kildare-Dublin Grid Reinforcement contains several individual and autonomous projects, which can each be considered standalone projects in their own right and which can be progressed through separate planning consents (albeit together they will meet the objective of the Capital Project identified in the Transmission Development Plan).

In the interests of future-proofing, all new substations and circuits are now to be designed for 400 kV (but to be operated at 220 kV initially, where relevant).

There are four projects currently identified to deliver the new substations and circuits requirements, identified by the Kildare-Dublin Grid Reinforcement. This reflects a snapshot in time, and should be viewed as a flexible, evolving tool that will require adaptation and refinement as those projects develop and new information emerges. EirGrid has determined that this approach is correct, appropriate and the most efficient way to deliver this programme of work at this time.

1. New transmission interface substation, situated near West Dublin ('Hynestown Substation', abbreviated as HTN) and new transmission circuit connecting to the existing Maynooth 220 kV Substation ('Hynestown-Maynooth Circuit', abbreviated as HTN-MAY).
2. New transmission interface substation, situated near South Dublin / East Kildare boundary ('Steelstown Substation', abbreviated as SLN) with new loop-in circuits from the proposed substation to the Dunstown-Carrickmines 220 kV circuit, the Dunstown-Maynooth 220 kV circuit, and the Kilteel-Maynooth 110 kV circuit; and a new transmission circuit to the proposed Hynestown Substation ('Hynestown-Steelstown Circuit', abbreviated as HTN-SLN).
3. New transmission circuit between the proposed Hynestown Substation and the existing Castlebagot or Inchicore substation ('Hynestown-Castlebagot Circuit' or 'Hynestown-Inchicore Circuit', abbreviated as HTN-CBT or HTN-INC, respectively).
4. New transmission circuit between the proposed Steelstown Substation and the existing Carrickmines 220 kV Substation ('Steelstown-Carrickmines Circuit', abbreviated as SLN-CKM).

1.3 New transmission circuit between the proposed Steelstown Substation and the existing Carrickmines 220 kV Substation.

The new transmission circuit connecting the proposed Steelstown Substation to the existing Carrickmines 220 kV Substation (i.e., the Steelstown-Carrickmines Circuit) is a key project under Kildare-Dublin Grid Reinforcement and critical enabling infrastructure. By connecting the existing Carrickmines Substation to the proposed Steelstown Substation (via a new transmission circuit), the result is an increase in the reliability and resilience of the overall transmission network.

1.4 Purpose of this Report

This Technology Options Report provides an update on the progress of the new Steelstown-Carrickmines Circuit. The report documents the technology options which were considered in the circuit technology assessment process.

Feasibility work on other individual elements / projects forming part of the Kildare-Dublin Grid Reinforcement is ongoing.

2. Project Progression Through Step 3

The objective of Step 3 is to identify a best performing technology solution and associated study area to meet the identified need from Step 2.

2.1 Steelstown-Carrickmines Circuit

2.1.1 Overview

Figure 2-1 shows the process that was followed in Step 3 for the identification of the study area and the assessment of the technology options for the Steelstown-Carrickmines circuit. A high-level summary is outlined below with further detail discussed in this section.

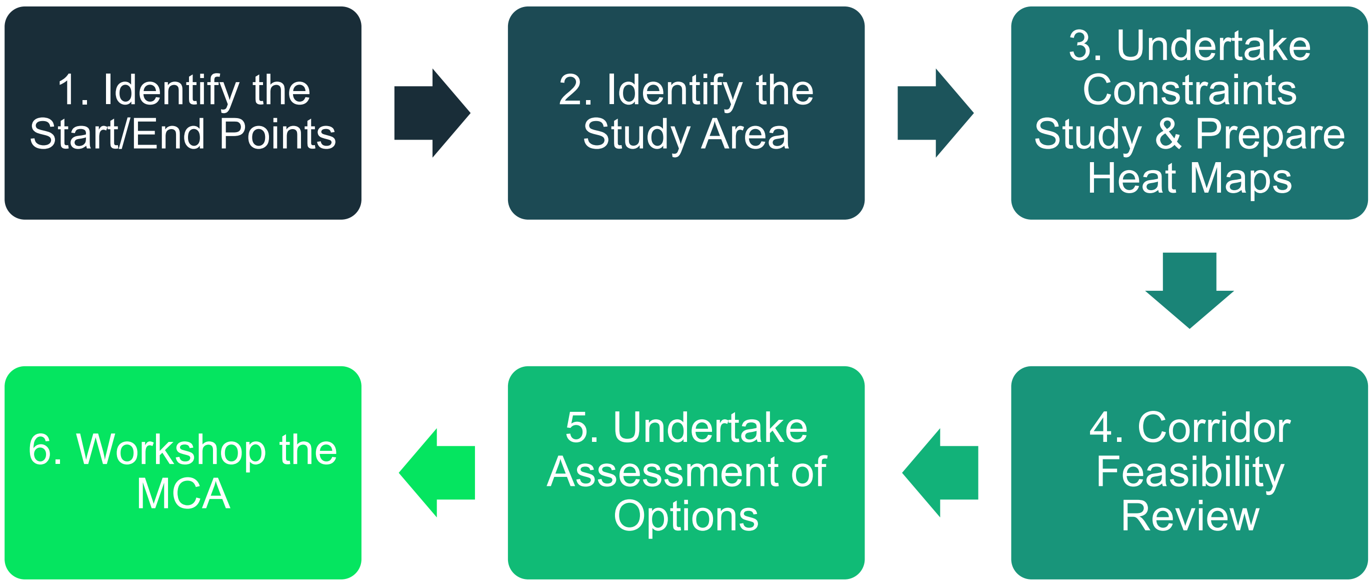

Figure 2-1 - Process Followed for Steelstown-Carrickmines Circuit in Step 3

1. **Identify the Start/End Points:** The circuit will connect into substations on either end of the circuit. The proposed Steelstown Substation does not yet have a site selected, and therefore the Steelstown Substation search area was considered as the ‘start’ of the circuit. The Carrickmines Substation is an existing substation, and therefore that point is fixed and considered the end of the circuit.
2. **Identify the Study Area:** The Study Area was defined such that it is appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
3. **Undertake Constraints Study and Prepare Heat Maps:** Once the Study Area was defined, a constraints assessment was carried out. The identified constraints were then assigned a risk, and heat maps generated to graphically represent the constraints. The heat maps were used as a guide to determine locations where the proposed infrastructure could be best positioned (when considering the constraints).
4. **Corridor Feasibility Review:** A feasibility review for OHL, UGC and OHL-PU (overhead line with partial undergrounding) technologies was undertaken for the proposed Steelstown-Carrickmines circuit. This feasibility

review considered indicative corridors for all three technologies and assessed constraints along each indicative corridor. A description of the three technologies is provided in Section 2.1.5.

5. **Undertake Assessment of Options:** Using the EirGrid Multi-Criteria Analysis Guidelines and the available constraints information, an assessment of all technologies (i.e., OHL, UGC and OHL-PU) was undertaken for the Study Area. The sub-criteria were scored from low to high risk and the overall performance for each option determined.
6. **Workshop the Multi-Criteria Analysis (MCA):** The EirGrid Cross-Functional Team and the AtkinsRéalis team conducted a MCA workshop where the technology options were presented and the MCA scoring of each of the technology options discussed. Following the MCA workshop, the Step 3 Technology Options Report (i.e., this report) was prepared in order to present the findings of the MCA during the Step 3 Public Consultation Campaign for the Steelstown-Carrickmines circuit.

2.1.2 Study Area

The Study Area was defined such that it was appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area. The Study Area is presented in Figure 2-2. The Study Area falls within South Dublin County Council, Kildare County Council, Wicklow County Council and Dún Laoghaire-Rathdown County Council.

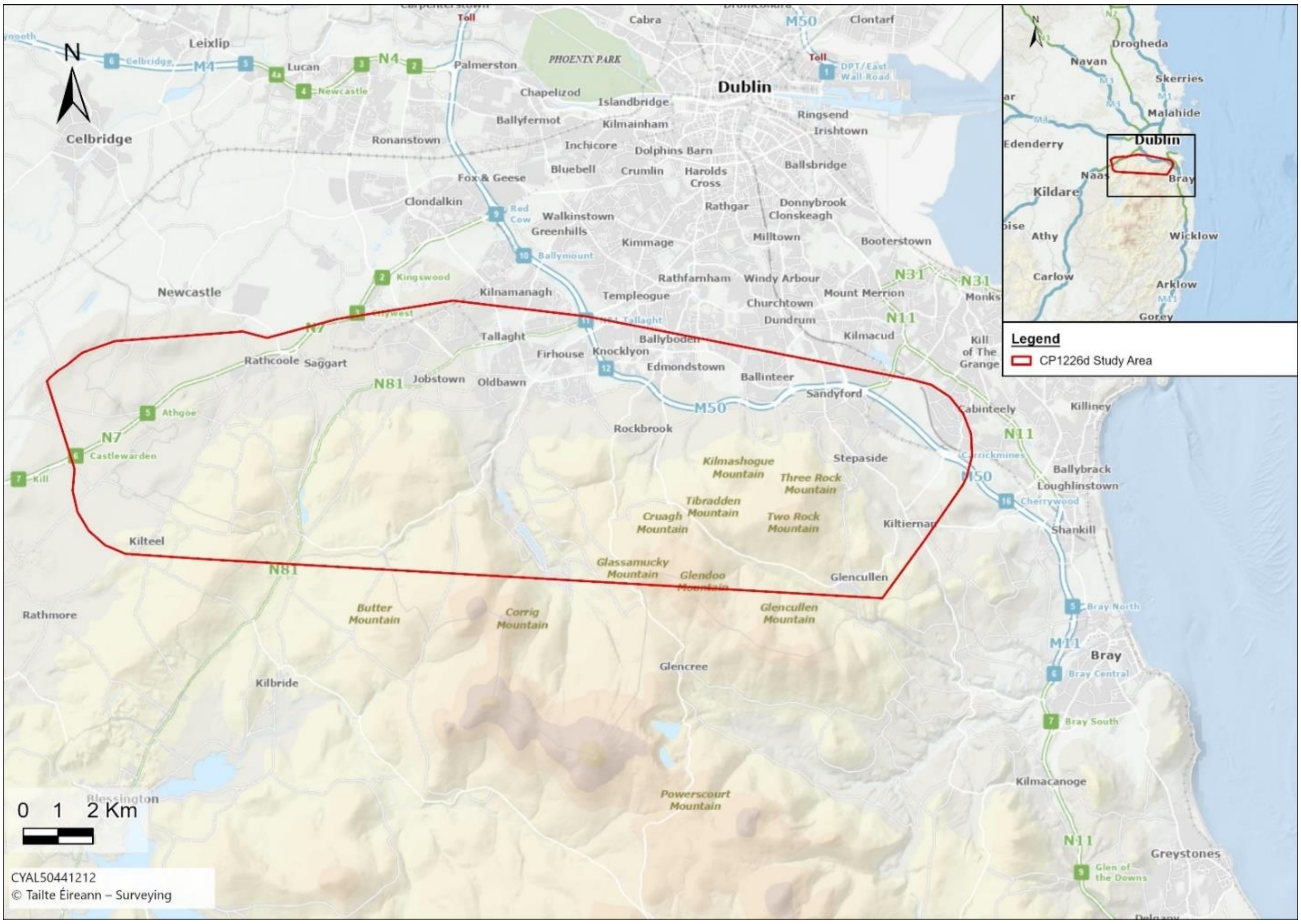

Figure 2-2 - Study Area

The identification of the CP1226d Study Area was based primarily on a high-level assessment of the factors that present a significant constraint to the development of feasible solutions.

A desktop study, which was supplemented by site visits and windshield surveys, identified some key factors which influenced the identification of the Study Area from a technical development aspect:

- The potential locations for the proposed Steelstown Substation (i.e., the substation zones identified in the Step 3 Report; document ref. 0088248DG0098);
- The existing 220 kV network routes for:
  - Dunstown-Carrickmines 220 kV OHL; and
  - Dunstown-Maynooth 220 kV OHL.
- The EirGrid Dublin Cable Replacement Programme;
  - Carrickmines - Poolbeg 220 kV Cable Replacement (CP1146);
  - CP1196 Uprating of Arklow-Ballybeg-Carrickmines 110 kV circuit to 220 kV;
  - CP1398 Dublin Array onshore substation and 2x 220 kV circuits connecting into Carrickmines 220 kV Substation and being developed by RWE;
- The motorway network e.g., N7, M50;
- Casement Aerodrome (Military), Baldonnell;
- Significant towns and settlements such as Rathcoole, Carrickmines;
- Consideration of OHL route options with the shortest and straightest possible routes; and
- Consideration of UGC route options including the use of public roads and potential off-road sections.

The Study Area (see Figure 3-1) is situated within the boundaries of South Dublin County Council, Kildare County Council, Dun Laoghaire County Council and Wicklow County Council. The western boundary of the Study Area encompasses potential locations for the proposed Steelstown Substation. The areas south of the R114 and R116 regional road are not considered to be feasible for either OHL or UGC for a variety of reasons, including the mountainous nature of the terrain and significant areas of ecological sensitivity. The eastern boundary of the Study Area is defined by the boundary of the Carrickmines 220kV Substation. The northern boundary of the Study Area is defined by the N7, M50 and the northern boundary of the Cookstown Industrial Estate, before running onto the northern boundary of the Sandyford Business Park.

2.1.3 Constraints Study and Heat Mapping

Once the Study Area had been defined, a constraints assessment was carried out. The following topics were included within the constraints assessment of the Study Area:

- Biodiversity, Flora and Fauna;
- Aquatic Environment;
- Land, Soils and Geology;
- Groundwater
- Land Use and Planning Policy;
- Landscape and Visual;
- Cultural Heritage;
- Noise and Vibration;
- Climate;
- Amenity;
- Settlements and Communities;
- Recreation and Tourism; and

- Traffic and Transport.

With the constraints identified, it was necessary to present the information in a manner that would inform the assessment of the circuit technologies. This was done by developing a series of illustrative heat maps which presented the aggregated individual constraints (and their associated risks) into areas of low to high risk. Maps were created for OHL risk and UGC risk as shown in Figure 2-3 and Figure 2-4, respectively. The third technology option (OHL-PU) was assessed using both heat maps as the OHL-PU technology option uses comprises both OHL and UGC.

When assessing the heat maps, it is important to note that the heat maps only show constraints which can be mapped (and where there is available data). The heat maps therefore present mostly environmental data, which is only one of the criteria considered in the MCA.

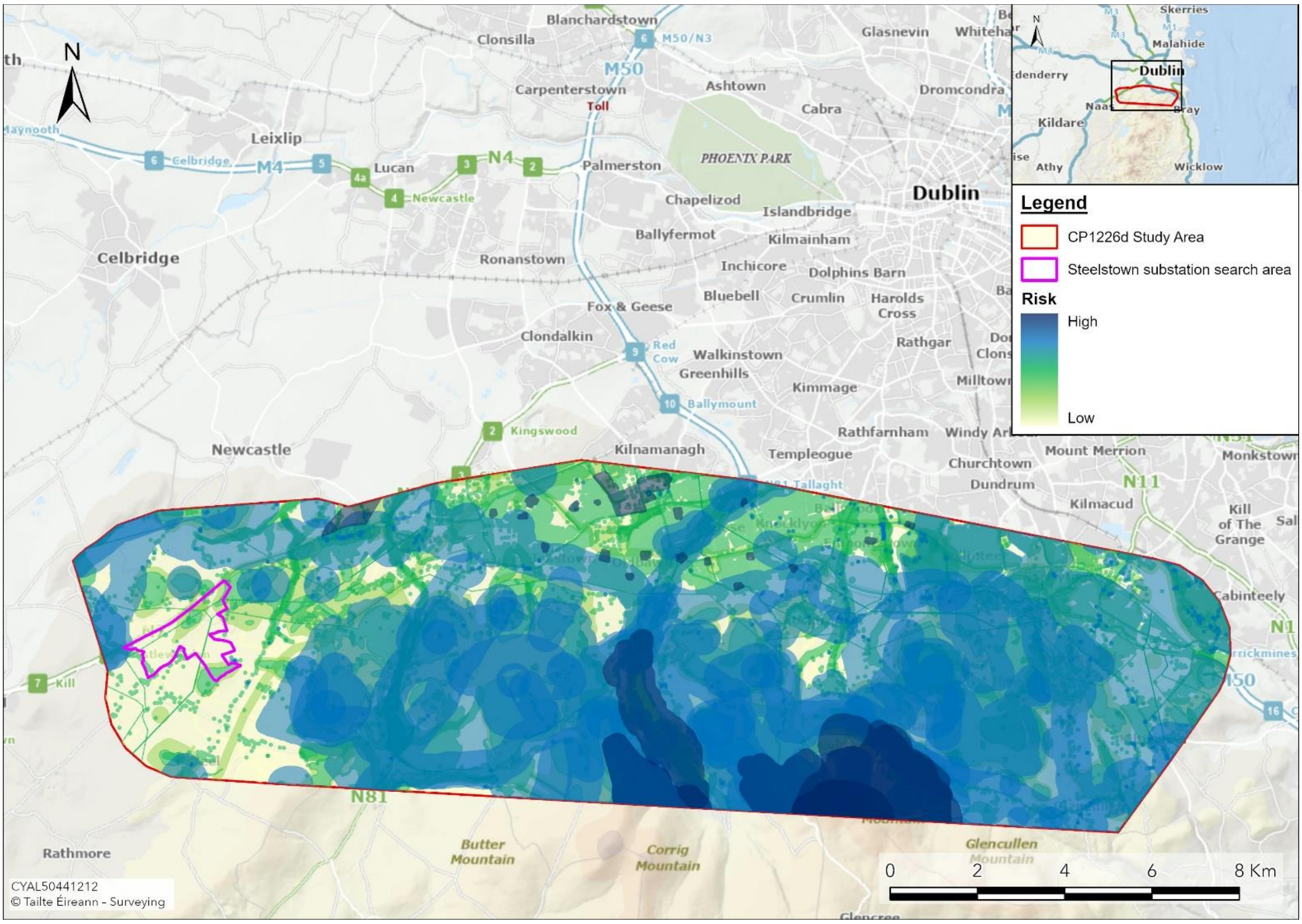

Figure 2-3 - OHL Heat Map

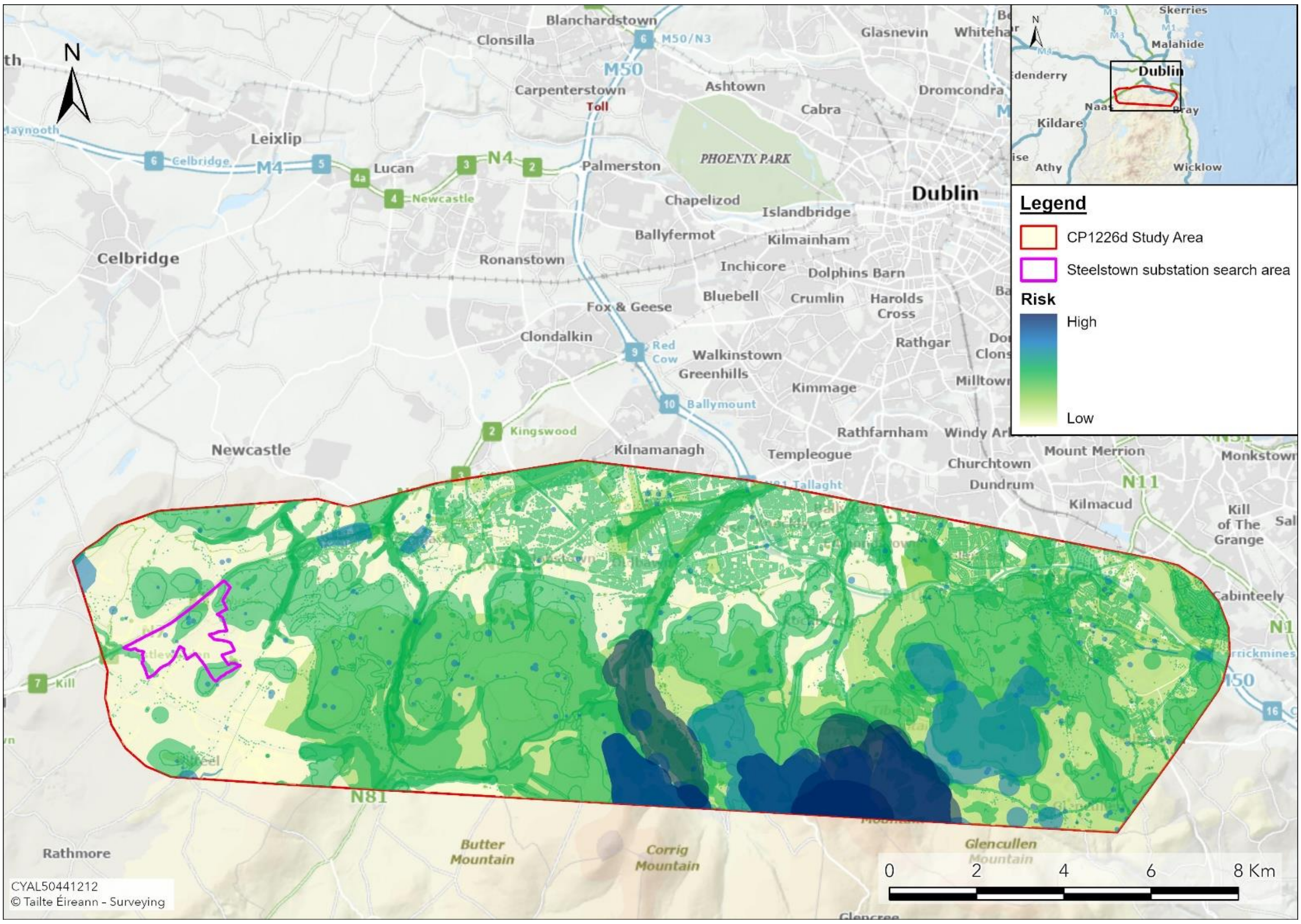

Figure 2-4 - UGC Heat Map

2.1.4 Corridor Feasibility Review

A feasibility review for all technologies (i.e., OHL, UGC and OHL-PU) was undertaken for indicative circuit corridors to ensure that a route can be found between the substation search area for the proposed Steelstown Substation and the existing Carrickmines Substation. For the purposes of the OHL-PU review, it was assumed that the length of the OHL to UGC sections is on the ratio of approximately 3:1.

The review considered the heat maps produced as part of the constraints assessment and considered the viability of OHL, UGC and OHL-PU corridor options between the proposed and existing substations.

2.1.5 Description of Circuit Technologies

Three main technology options are available for developing the required circuit, namely overhead lines (OHL) or underground cables (UGC) or an OHL circuit with partial undergrounding (i.e., sections of UGC).

2.1.5.1 HV AC Overhead Lines (OHL) Technology

- Overhead lines strung on steel lattice towers have traditionally been used in Ireland for high voltage alternating current (HV AC) electrical transmission including 400 kV. A steel lattice tower with one or more conductors per phase, supported on insulator strings to insulate the live conductors from the earthed tower, is commonly used. Figure 2-5 shows a standard hot rolled lattice steel tower that contains bracing. For this circuit application:

- A typical 400 kV single circuit intermediate tower is 26.3-54.3 m high and the maximum width at ground level is 14.4 m.
- A typical 400 kV single circuit angle/strain tower is 28.0-37.0 m high and the maximum width at ground level is 12.0 m.

- When routeing OHLs, EirGrid will seek to maximise the distance of OHLs from buildings and dwellings, and for the purpose of general amenity will seek a minimum separation distance of 50 m wherever possible.
- OHLs will be routed to minimise impacts on all constraints. However, it is not possible to avoid all constraints, and in some circumstances, OHLs will need to be routed through forestry or through developed areas. In these circumstances an easement will be required. The typical easement widths (i.e., corridors) for 400 kV OHLs are:
  - Forestry:
    - 400 kV OHLs – 74 m corridor (i.e., 37 m either side of the line);
    - Within these corridors trees are allowed grow to a maximum height of 3 m. However, a 4 m maintenance access corridor directly under the line must be left clear at all times to allow access.
  - Buildings:
    - 400 kV Lines – 60 m corridor (i.e., 30 m either side of the line).
- Lattice towers can be maintained via climbing which means maintenance of access routes is not as vital because access can be achieved using 4x4 vehicles or quad bikes.

Figure 2-5 - Typical 220 kV OHL Single and Double Circuit Lattice Towers

2.1.5.2 HV AC Underground Cables (UGC) Technology

- Modern HV AC cables are made of either copper or aluminium conductor, sized for high current capacity. Cross-linked polyethylene (XLPE) insulating material is extruded around the conductor for its excellent thermal and electrical insulating properties.
- XLPE cables require little maintenance. The cables are installed (i.e., pulled) through High-density polyethylene (HDPE) ducting buried in trenches, with the ducts buried to a certain depth in set configurations and spacings from each other as per EirGrid specifications.
- Similar to other utility services, UGCs are typically routed along public roads for ease of construction and access for future maintenance and inspection activities. However, sometimes the UGC may have to be routed off-road in order to avoid / bypass particular constraints or pinch-points, site joint bays / passing bays, etc.
- Joint bays (8-10 m x 2.5 m x 2 m) are required to join sections of cable and will be located at intervals of approximately 600-800 m along the route. This is because the cable is supplied in fixed lengths dictated by the cable drum diameter, the diameter of the cable itself, and the maximum weight that can be transported. The joint

bays will be located entirely underground and will be completely backfilled/reinstated. Each joint bay has a link box chamber and C2 chamber (for communication ducts running parallel to the power ducts) which are ancillary inspection chambers adjacent to the joint bay. These chamber covers will be visible at ground level after reinstatement. Access to these chambers is required for maintenance activities and access to the joint bays is only required in the event of cables repairs / fault correction / cable replacement.

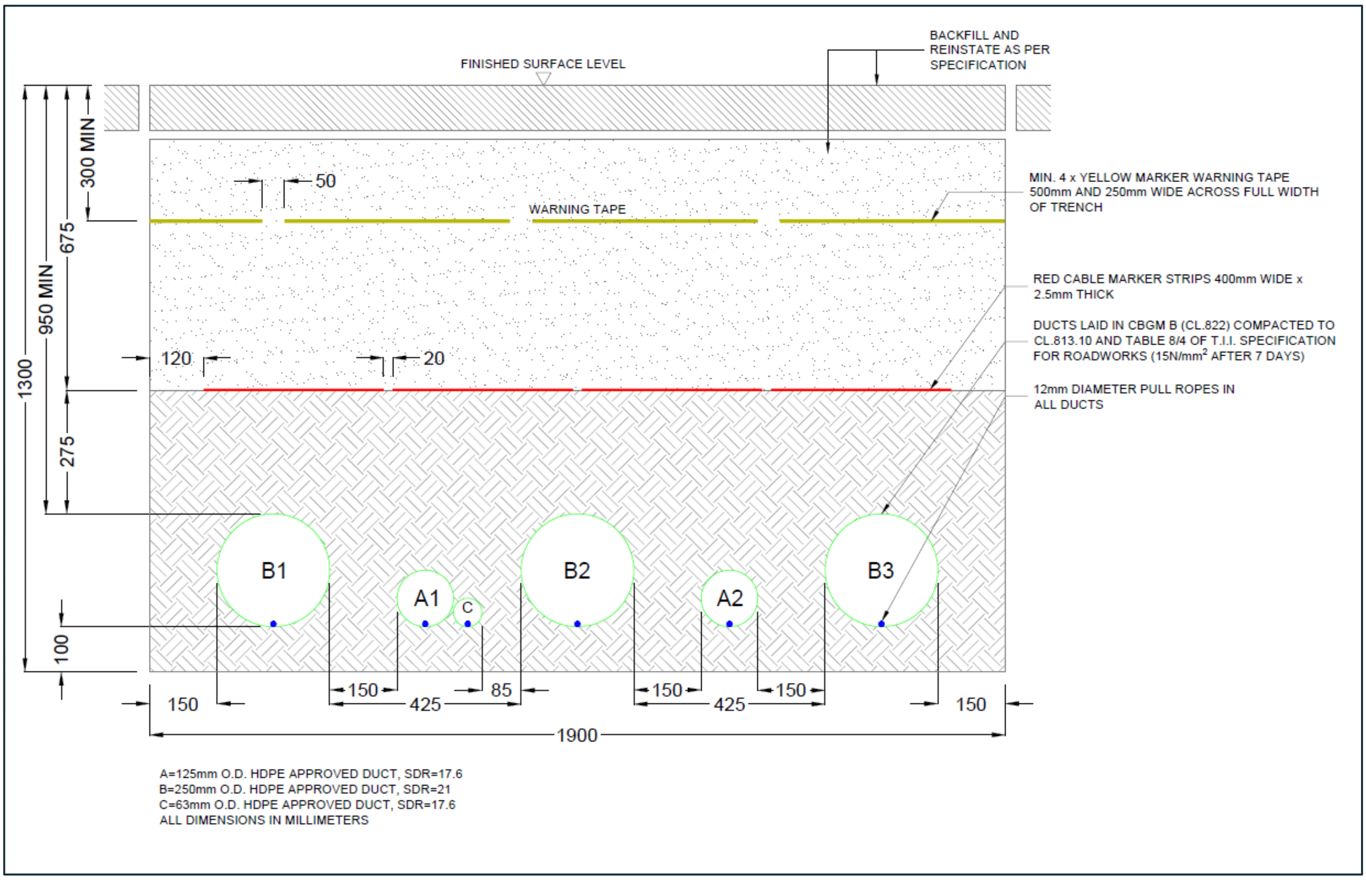

Figure 2-6 - 400 kV Standard Flat Wide Arrangement with ECC (Extract from drawing XDC-CBL-SLND-E-008)

- During construction, a temporary works area (approximately 25 m by 5 m) will be needed either side of the joint bay to allow for excavation equipment, cable pulling and cable joining works. This will be a key requirement for the selection of joint bay locations. The location of all joint bays will be required to be proven by site investigation, including ground proving.
- Where the joint bay position / construction area is significantly impeding or stopping traffic flow (i.e. on a narrow, busy country lane), a localised traffic management plan may have to be put in place and if required, a passing bay (temporary road surface) constructed to widen the existing road such than normal traffic can pass (+3.5 m).

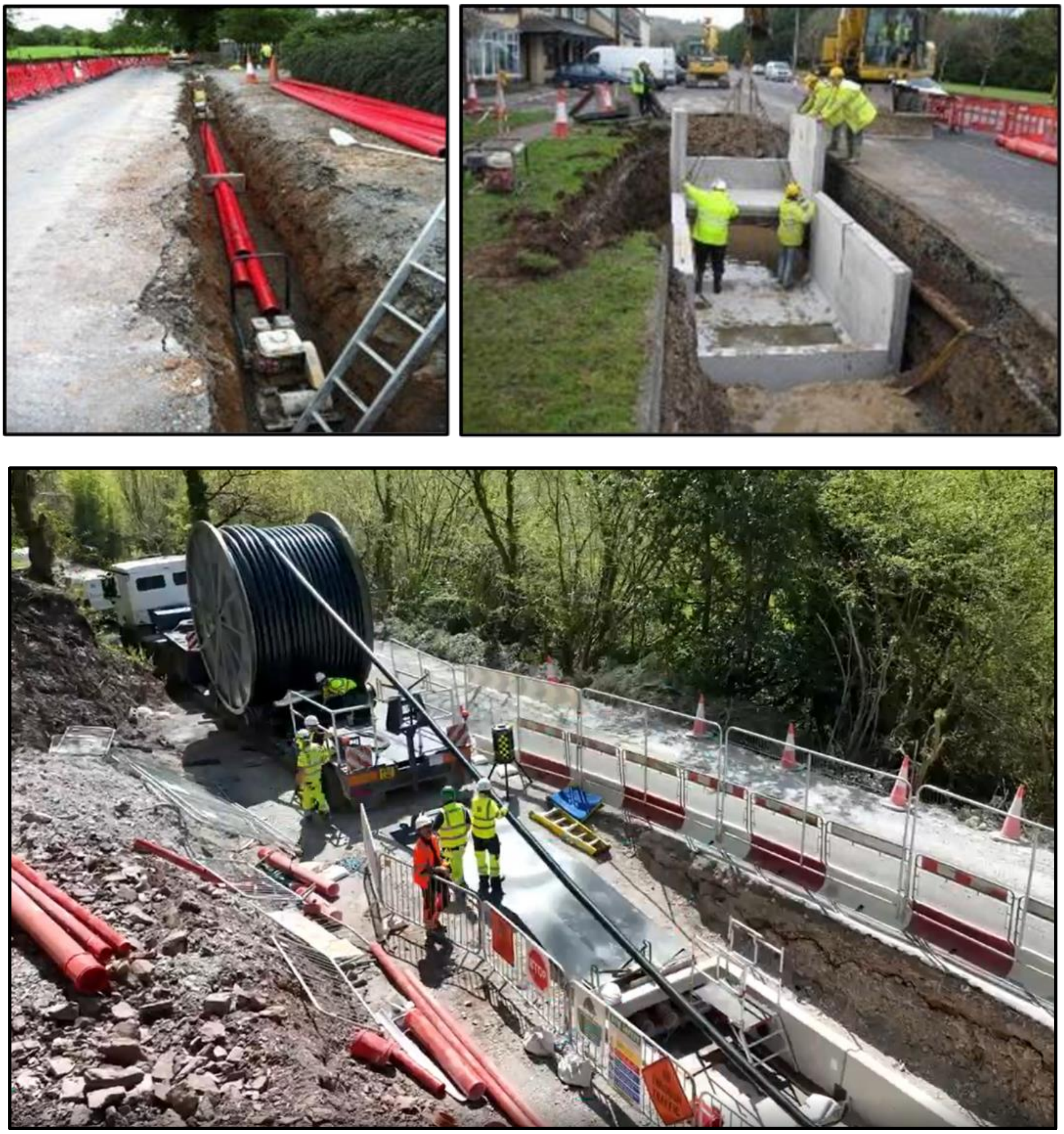

Figure 2-7 - Typical HV UGC laid in ducts / Joint Bay under construction (pre-cast) / Cable pulling (Celtic Interconnector Project)

- At highly constrained locations such as watercourse, motorway, rail crossings, etc., special installation techniques such as horizontal directional drilling (HDD) may be used to install the cable ducts at a sufficient depth to pass under the obstacle. Detailed site investigation works (i.e., boreholes) would be required at each HDD location to confirm ground conditions for detailed design stage.

Figure 2-8 - HDD rig drilling a pilot hole for HV UGCs

- Minimum wayleave widths required for 400 kV UGC is 5 m (centred on centre phase).
- UGCs would have difficulty achieving the same transmission capacity as OHL conductors as burying the cables underground will impact the capacity of a cable due to thermal affects (i.e., heating). Rating studies are carried out to determine the capacity of a circuit, as certain constraints will impact on a cable's performance, e.g., bridge crossings, HDDs, etc.

2.1.5.3 Overhead Line with Partial Undergrounding

An 'overhead line with partial undergrounding' (OHL-PU) option comprises of majority OHL with a small component of UGC sections. This potentially allows for the optimisation of a circuit's use of available road network and off-road lands, whilst also optimising the system's performance and cost characteristics. An overhead line to underground cable interface compound will be required wherever a transition from one technology to the other takes place (an example of which is shown in Figure 2-9). Depending on the extent of UGC deployed, additional circuit compensation and protection/control devices may be required.

For the purposes of the Steelstown-Carrickmines Circuit MCA in Step 3, the ratio of OHL to UGC was assumed to be 3:1 – this was deemed appropriate given the constraints within the Study Area.

Note, where an OHL circuit is used and needs to connect with the appropriate busbar line bay within a Gas-insulated switchgear (GIS) substation, a conversion from OHL to UGC technology is routinely used to facilitate the connection into the substation.

Figure 2-9 - 220 kV OHL to UGC Interface Compound

2.1.6 Circuit Technology MCA Process

To assist in identifying the best performing technology option and associated study area, a Multi-Criteria Analysis (MCA) was carried out in accordance with the EirGrid Multi-Criteria Analysis Guidelines. The five main criteria considered in the MCA are:

- Technical Performance,
- Economic Performance,
- Deliverability Aspects,
- Environmental Aspects, and
- Socio-Economic Aspects.

Each of these criteria were broken down further into sub-criteria and a multi-criteria evaluation matrix was used to identify the best performing option(s) that will be brought forward to Step 4.

2.1.6.1 Technical Performance

The following sub-criteria were scored:

- **Availability Levels:** The predicted availability level rates for the overhead line or underground cable can be calculated using, for example, recorded industry failure rates, average Mean Time To Repair (MTTR) and the length of the line or cable.
- **Circuit Ratings / Headroom:** This is an estimate of the Circuit Rating (Amps) achievable and whether it fulfils the project rating requirements (as set out in EirGrid's Cable Calculation documentation). It will consider possible circuit constraints which may limit the maximum circuit rating. Headroom is the amount of additional capacity that is available for the future without upgrades.
- **Expansion / Extendibility:** This considers the ease with which the option can be expanded.
- **Repeatability:** 'Repeatability' means whether the option can be readily repeated in the EirGrid network.
- **Technology Operational Risk:** 'Technology Operational Risk' aims to capture the risk of operating different technologies on the network.
- **Geotechnical Conditions:** Considers the impact of known ground conditions (from Geological Survey Ireland (GSI) data or other available datasets), and would include depth to bedrock, likely water table depth, known areas of poor ground / marsh etc.
- **Electromagnetic Compatibility:** Impact on wireless services such as radars, radio communications, TV, flight paths, etc.

The following sub-criteria are considered neutral (between OHL, UGC and OHL-PU technologies) and have not been scored in the MCA process.

- **Compliance with Safety Standards:** The project should comply with relevant safety standards such as those from the European Committee for Electrotechnical Standardisation (CENELEC). Materials should comply with International Electrotechnical Commission (IEC) or CENELEC standards.
- **Compliance with System Reliability, Security Standards:** The project should comply with the reliability and security standard defined in the Transmission System Security and Planning Standards and the Operation Security Standards.

2.1.6.2 Economic Assessment

The following sub-criteria were scored:

- **Project Implementation Costs:** Costs associated with the procurement, installation and commissioning of the grid development (including land cost) and therefore includes all the transmission equipment that forms part of the project's scope.
- **Project Life-Cycle Costs:** Costs incurred over the useful life of the reinforcement and include the on-going cost of ensuring that it remains viable for the evaluation period. Includes operating expenditure (OPEX), maintenance, replacement, cost of losses, decommissioning, etc.
- **Cost to SEM:** Cost to Single Energy Market from Development Unavailability (Reliability) i.e., the loss of energy due to unavailability, impact on the Grid, as well as other costs or transmission losses.

The following sub-criteria are considered neutral (between OHL, UGC and OHL-PU technologies) and have not been scored in the MCA process.

- **Project Benefits:** Avoided costs and difference in constraint costs for example due to the lack of capacity to export a forecast volume of generation.

- **Pre-Engineering Costs:** Costs associated with the design and specification, route evaluation and management of the statutory planning application, including contingencies for such activities.

2.1.6.3 Deliverability Aspects

The following sub-criteria were scored:

- **Implementation Timelines:** Relative length of time until energisation (assess significant differences).
- **Permits & Wayleaves:** Various permissions and wayleaves required to proceed to construction (e.g., number or level).
- **Land Availability:** Considers land availability for the construction of the circuit, in addition to working space during construction.
- **Ease of Construction:** Considers elements such as working time constraints, outage impact, utility congestion, etc. and how that may impact the Contractor during construction.

The following sub-criteria are considered neutral (between OHL, UGC and OHL-PU technologies) and have not been scored in the MCA process.

- **Dependence on other Projects:** Does the project depend on the completion of other projects?
- **Risk of Untried Technologies:** Has the technology been used by EirGrid and ESBN in the past?
- **Supply Chain Constraints:** Any constraints (e.g., small number of suppliers in Ireland or internationally) that would affect the procurement of materials or services (e.g., cable laying vessels waiting list lead time) to complete the project.
- **Planning and other statutory requirements:** Considers the requirement for planning, foreshore licenses or other statutory requirements.

2.1.6.4 Environmental Aspects

The following sub-criteria were scored:

- **Biodiversity, Flora & Fauna:** Assessment of the impact on biodiversity, flora and fauna, which could include an ecological desktop study. The following topics were assessed as part of this sub-criterion:
  - Impacts on protected areas: National and European sites (e.g. SAC, SPAs, RAMSAR), National sites (e.g. NHAs) and other Natural Heritage Sites and Conservation Interest Sites e.g. refuge for fauna or flora, wildfowl reserves).
  - Impacts on sensitive bird species and/or their habitats and impacts on protected species (e.g., Annex II and IV of the EU Habitats Directive) and Flora Protection Order and species outside of Natura 2000 sites.
  - Impacts on Annex I Habitats outside of Natura 2000 sites.
  - Impacts on aquatic environment (including watercourses and waterbodies).
- **Soil:** Impact on soil/subsoil geology, Irish geological heritage sites, and bedrock geology, etc.
- **Water:** Impact on river crossings, lakes, and groundwater based on established methodologies.
- **Planning Policy and Land Use:** Considers whether the circuit is consistent with the local authorities Development Plans.
- **Landscape & Visual:** Assessment of landscape constraints and designations and the impact on visual amenity.
- **Cultural Heritage:** The impact of a proposed circuit on recorded cultural heritage resources.
- **Noise & Vibration:** Vibrations and operational noise impact of lines and sub-stations, taking into account sensitive receptors.

The following sub-criterion is considered neutral (between OHL, UGC and OHL-PU technologies) and has not been scored in the MCA process.

- **Climate & Sustainability:** The potential for release of greenhouse gasses or impacts on climatic change on the asset.

2.1.6.5 Socio-Economic Aspects

The below sub-criteria were scored:

- **Amenity:** The potential impact on the overall pleasantness or attractiveness of surroundings. This includes effects on community facilities, and recreation and tourism assets (not already captured).
- **Settlements and Communities:** The expected impact of a grid development on towns, villages and rural housing, and the way of life of their communities, residents, workers and visitors (e.g., severance, settlement patterns, etc.).
- **Recreation and Tourism:** Impact on recreational activities (e.g., fishing, sports) and tourism, during and after construction, that are not included in the other sub-criteria.
- **Traffic and Transport:** This considers potential effects on traffic and transport in the study area during the construction phases of the different solutions. Of concern to communities is the potential of severance, isolation and significant delays during the construction phase.

The following sub-criterion is considered neutral (between OHL, UGC and OHL-PU technologies) and has not been scored in the MCA process.

- **Health:** To determine potential effects on humans, this considers WHO health thresholds. Electromagnetic field (EMF) is considered as set out in EirGrid's 'Your guide to understanding electric and magnetic fields (EMFs)'.

2.1.6.6 MCA Scoring Scale

The effect on each criterion parameter is presented along a range from "more significant / more difficult / more risk" to "less significant / less difficult / less risk". Table 2-1 shows the criteria performance/scoring scale used to illustrate each criteria parameter in a comparative assessment with other options.

Table 2-1 - Criteria Scoring Scale

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

High Risk (Dark Blue)	Moderate-High (Blue)	Moderate (Dark Green)	Moderate-Low (Green)	Low (Cream)

3. Multi-Criteria Analysis – Circuit Technology Selection

3.1 Summary of the Performance of the Technology Options

Table 3-1 shows the overall performance of the 3no. technology options (i.e., OHL, UGC and OHL-PU) for the Steelstown-Carrickmines circuit. All technology options score 'Moderate' risk overall, each with varying risk profiles across the different criteria and sub-criteria. The OHL with partial undergrounding technology option is scored 'Moderate' across all criteria, whereas the OHL and UGC options range from Moderate-Low to Moderate-High across the different criteria.

Table 3-1 - MCA Scoring – Overall Score (Steelstown-Carrickmines Circuit)

Assessment Criteria	OHL	UGC	OHL-PU
Technical Performance			
Economic Assessment			
Deliverability Aspects			
Environmental Aspects			
Socio-Economic Aspects			
Overall Score			

Technical: OHLs can achieve higher circuit ratings and have higher availability levels (fewer failures). Compared to UGC circuits, OHLs are easier to expand (voltage uprate) or extend, and they carry less operational risk. The technical performance of the OHL with partial undergrounding option is between that of the OHL and UGC technology options, as is further elaborated in Section 3.2.

Economic: OHL solutions offer lower construction and lifecycle costs, compared to UGC technology. The improved reliability of OHLs and reduced exposure to constraints also result in lower Single Energy Market (SEM) costs over the project lifetime. The economic performance of the OHL with partial undergrounding option is between that of the OHL and UGC technology options (for the OHL-PU review it was assumed that the ratio of OHL to UGC lengths is approximately 3:1), and is further elaborated in Section 3.3.

Deliverability: UGC technology performs better, as OHL construction is heavily constrained by existing and planned settlement patterns, insufficient wayleave widths, aviation constraints, and multiple high-risk crossing points. Achieving a compliant OHL corridor is significantly more challenging within the Study Area and presents greater landowner, environmental, planning and programme risk. UGC, routed mainly along existing regional roads, offers more straightforward permitting (except for any UGC sections along National roads), reduced land interactions, and fewer visual and amenity concerns, enabling a more deliverable and publicly acceptable solution. The third technology option, OHL with partial undergrounding, is seen to predominantly score in between the two other options. The OHL-PU option is anticipated to have a greater risk of overall programme delay due to difficulties in obtaining public acceptance and the necessary landowner wayleaves for the OHL circuit sections. The 'Land Availability' risks are considered to be less than the OHL option, as UGC technology can be deployed for the final approach into Carrickmines Substation.

Environmental: UGC avoids permanent visual and landscape impacts and removes collision and electrocution risk for birds, which is a significant benefit in areas close to SPAs, wetlands, or known flight paths. Once reinstated, there are no above-ground structures within fields, allowing uninterrupted farming operations across the land surface and a narrower permanent wayleave compared with overhead lines. Day-to-day agricultural use can generally resume over the cable, and the absence of towers or poles is often perceived positively by landowners and communities. However, off-road UGC results in widespread ground disturbance due to continuous trenching, temporary access routes, and passing bays, leading to greater habitat loss during construction than overhead lines. Even after reinstatement, long-term impacts can include permanent breaks in hedgerows or treelines, as deep-rooted vegetation cannot be replanted over the cable, causing habitat fragmentation. Soil structure may take several seasons to recover, with potential localised reductions in productivity, and joint bays introduce small but permanent constraints on land use. Future faults require re-excavation, resulting in repeat disturbance to farmland and biodiversity, and there is an increased risk of invasive species spread along disturbed corridors.

OHL have a very small permanent ground footprint, limited to pole or tower bases, allowing most farmland to remain fully productive with minimal long-term soil disturbance. Construction impacts are localised and short-term, and once installed, farming activities such as grazing and tillage can continue beneath the line. There are no restrictions on soil depth for cultivation or drainage, and faults can be repaired quickly with little additional land disturbance, reducing long-term impacts on land use. OHL introduce permanent above-ground structures that can affect landscape character and visual amenity, often driving community opposition. They pose an ongoing collision risk to birds, even where mitigation such as line markers is used, and may affect bird and bat behaviour along hedgerows and flight routes. In wooded areas, overhead lines require permanent vegetation clearance within the wayleave, resulting in long-term habitat loss and alteration. Towers and poles can also slightly constrain machinery movement and field layouts, particularly where structures are located within productive farmland.

UGC technology can offer lower long-term impacts, greater compatibility with sensitive landscape and community settings, and a lower risk profile in the context of the Study Area. Although UGC carries higher construction-phase risks, these are temporary, manageable, and confined to the construction phase. Conversely, OHL introduces long-term and often irreversible impacts on landscape, amenity, biodiversity, and community receptors. Detailed visual assessments and mitigation measures such as careful tower siting will be required. Traffic and Transport constraints for OHL technology are considered minimal as crossings of motorways, national and regional roads can be achieved without major disruption. However, temporary access tracks for OHL tower construction may affect local traffic and require traffic management plans. For the OHL with partial undergrounding option, the OHL component reduces ground disturbance and the UGC component avoids bird collision risks. OHL-PU can still cause combined impacts, such as trenching, species disturbance, and hydrological disruption. These risks require careful routeing, HDD at sensitive crossings, and precise micro-siting. OHL-PU also poses risks to water bodies and groundwater, including sedimentation and contamination, but these can be mitigated with standard water protection measures and a CEMP.

Socio-Economic: OHL technology presents greater landscape, visual, and amenity impacts than UGC, particularly when routed through urban areas, rural landscapes of medium to high sensitivity, and near scenic routes. These effects necessitate detailed visual assessments and mitigation strategies, such as strategic tower placement and leveraging existing vegetation for screening. While OHL construction typically has a smaller footprint than UGC, it requires permanent wayleaves and clearance zones, potentially limiting future land use and agricultural practices. Temporary access tracks for tower installation may also disrupt local traffic, requiring traffic management plans. However, OHL generally causes minimal disruption to major roads, as crossings can be achieved without significant interference. The Study Area includes numerous urban centres and recreational amenities. In these contexts, OHL may have more pronounced visual and amenity impacts, whereas UGC can reduce such effects. Conversely, UGC construction in urban areas may lead to greater traffic and access disruptions during the construction phase.

Engagement with landowners remains essential to address concerns around visual intrusion and operational safety, particularly for OHL infrastructure. The OHL with partial undergrounding option combines OHL and UGC characteristics and therefore introduces a blended socio-economic risk profile.

3.2 Technical Performance

Table 3-2 shows a summary of the scores for the Technical Performance of each technology option.

Table 3-2 - MCA Scoring – Technical Performance

Sub-Criteria	**OHL**	**UGC**	**OHL-PU**
Average Failure Rates			
Circuit Ratings / Headroom			
Expansion / Extendibility			
Repeatability			
Technology Operational Risk			
Geotechnical Conditions			
Electromagnetic Compatibility			
Overall Technical Score			

Circuit Availability Levels are found to be higher for OHL technology compared to UGC circuits over equivalent circuit lengths.

Compared to UGC technology, the maximum circuit rating of an OHL connection from Steelstown to Carrickmines Substation will not be limited by external constraints. A UGC circuit will be constrained due to the high volume of existing services in the local road network, especially around the South Dublin / Carrickmines urban area and the requirement for HDDs along the route.

OHL options are more flexible in terms of expansion and extendibility in comparison to UGCs. At 400 kV, further uprating of the line rating capacity could be achieved by replacing the 'curlew' conductor line with High Temperature Low Sag (HTLS) conductor (noting that this technology is not currently approved for use by ESBN at 400 kV).

There is a lower risk associated with operating HV OHL circuit compared to UGC (especially at 400 kV). OHL options are deemed to have lower geotechnical impact than UGC options due to their smaller overall footprint.

The third technology option, OHL with partial undergrounding, is seen to predominantly score in between the two other options, but more biased towards the OHL technology risk rating due to its longer lengths (the assumed ratio of OHL to UGC circuit lengths for this option is approximately 3:1). The exception being 'Circuit Ratings' which will be limited overall to the maximum possible UGC rating.

3.2.1 Average Failure Rates

Average failure rates are predicted based on the circuit length and technology. Published and internal EirGrid Asset Reliability survey data indicate that failure rate statistics for 400 kV OHL circuits are less compared to UGC technology.

The mean time to repair (MTTR) is much shorter for OHL circuits (matter of hours to days) as faults / failures are much easier to detect and access. For UGC circuits, significant lead time is required to locate the fault, organise access to joint bays, organise road closures, etc. Even after determining / locating the fault, more time may be required to source new cables, specialist equipment or qualified personnel, such as HV cable jointers, to make the repairs.

As such, availability levels are proven to be much higher for OHL circuits than equivalent UGC circuits, where:

$$Availability\ (\%) = \frac{\text{Total Time} - (\text{Failure Rate} \times \text{MTTR})}{\text{Total Time}} \times 100$$

Considering the third option of an OHL circuit with partial undergrounding, the failure rates / availability levels of the overall circuit will be between the two technologies but more biased towards the OHL technology risk rating due to its longer lengths and lower failure rates.

However, additional transition and compensation equipment will be required at locations where the technology changes over to UGC which will raise the overall circuit failure rate somewhat.

3.2.2 Circuit Ratings / Headroom

Compared to an UGC circuit, the maximum circuit rating of an OHL connection from Steelstown to Carrickmines Substation will not be limited by external constraints (e.g., thermal cooling / inertia, reactive power / capacitance factors, etc.). At 400 kV, the target ampacity ratings for OHL twin ‘Curlew’ 600mm² aluminium conductor steel reinforced (ACSR) is more than the equivalent UGC circuit rating, refer to Table 3-3. If a higher ampacity rating is required, then the conductor technology can be swapped out to HTLS (pending technology approval by ESBN).

An UGC circuit connection from Steelstown to Carrickmines Substation will be constrained due to the high volume of existing services in the local road network, especially around Rathcoole town, Saggart town and within Dublin city. Compared to OHL technology, an UGC connection between Steelstown and Carrickmines substations may be constrained in meeting the specified ampacity requirements, due to the high density of existing services and major constraints along the route. HDD will likely be required for this cable corridor to cross the numerous rivers and pinch points encountered as the circuit traverses the study area / corridor from west to east. To achieve maximum possible ratings, the HDD bores will need to be spaced adequately apart (e.g., 3no. bores with up to 5 m separation distance for the 400 kV circuit HDDs).

For the OHL with partial undergrounding option, the overall circuit rating achievable will be governed by the maximum UGC rating achieved when accounting for all pinch points encountered along the route. The achievable ampacity for 400 kV UGC technology is lower than the equivalent 400 kV OHL technology. Any UGC circuit section will likely be constrained to meet the required ratings as the circuit will likely route via heavily constrained roads and/or via built up urban areas with an inherent higher volume of existing services and constraints (for example, on the approach into Carrickmines Substation).

Table 3-3 - Circuit ratings summary

Technology	Voltage	Target Rating Summer (A)	Target Rating Winter (A)	Standard Conductor
UGC	220 kV	1,410	1,591	2500 mm^2 ALU
UGC*	400 kV	1,969	2,103	2500 mm^2 CU
OHL – “Curlew”	220 kV	1,139	1,347	600 mm^2 ACSR
OHL – Twin “Curlew”	400 kV	2,278	2,694	2x 600 mm^2 ACSR
OHL – HTLS “Traonach”	220 kV	2,081	2,161	586 mm^2 GZTACSR
OHL – Twin HTLS “Traonach”	400 kV	Not currently available	Not currently available	2x 586 mm^2 GZTACSR

** 400 kV UGC target ratings are currently under review. CP1021 target ratings included.*

3.2.3 Expansion / Extendibility

OHL options are more flexible in terms of expansion and extendibility in comparison to UGCs. Further uprating of the line rating capacity could be achieved by replacing the ‘curlew’ conductor line with HTLS conductor, but this technology is not currently approved / available for use in Ireland at 400 kV.

Further expansion (uprating) of a 400 kV UGC circuit will be very difficult and is constrained by current limitations on cable technology and any rating constraints (i.e., ‘pinch-points’) encountered along a route such as HDDs, circuit crossings, etc. As the circuit will be operated at 220 kV initially, certain circuit components (e.g., sheath voltage limiters, compensation equipment, etc.) will need to be changed when switching to 400 kV operation.

Considering ‘extendibility’, UGC circuits are generally more difficult to loop new circuits into compared to OHLs due to the physical accessibility of the circuit, outage requirements, network issues and the cable sheath bonding arrangements.

Considering the third option of an OHL circuit with partial undergrounding, the expansion / extendibility risk rating of the overall circuit will be between the two technologies but more biased towards the OHL technology risk rating due to its longer lengths (the assumed ratio of OHL to UGC circuit lengths for this option is approximately 3:1).

3.2.4 Repeatability

Both OHL and UGC technology are used in the Irish transmission system however, HV OHL circuits are considered more repeatable than HV UGC circuits as there are fewer potential impact / complications to the network (e.g., need for additional power compensation equipment). The circuits length under consideration for the Steelstown-Carrickmines circuit (up to 30 km) would not be considered unsuitable for HV OHL technology.

However, the possibility of laying 400 kV UGC circuits within the local road network, if it is used, could be restrictive and limit future use of the roads for UGC circuits (but not so much on other services such as telecoms, low pressure water pipes, etc). For a 400 kV circuit, a width of approximately 5 m on either side of the circuit will need to be kept clear of other electrical UGC circuits.

Considering the third option of an OHL circuit with partial undergrounding, the ‘repeatability’ risk rating of the overall circuit is dominated by the higher risk rating associated with UGC.

3.2.5 Technology Operational Risk

Overall, there is a lower risk associated with operating HV OHL circuits compared to UGC (especially at 400 kV).

The most significant risk factors associated with HV OHL circuits are as follows:

- Weather Vulnerability:
  - Storms and Lightning: Susceptible to faults from wind, ice, and lightning strikes.
  - Conductor Galloping: Very rare wind-induced oscillations can cause mechanical damage.
- Maintenance and Access:
  - Easier Fault Detection: Visual inspection and remote sensing are effective.
  - Faster Repairs: Typically resolved in hours to days.
  - Live Line Work: Possible with trained crews and specialised equipment.
- Environmental Impact:
  - HV corona can generate noise and Radio frequency interference (RFI).
  - Electromagnetic Fields (EMFs): Elevated exposure levels as conductor are unshielded however this is mitigated by using minimum mast heights to ensure restriction level are met.
- Flexibility and Uprating:
  - Easier to Uprate: Can replace conductors with new technology (i.e., HTLS) to achieve better ratings.
  - Possibilities for Dynamic Line Rating.
  - Adaptable Routeing: Can span rivers, roads, and uneven terrain.

The most significant risk factors associated with HV UGC circuits are as follows:

- Fault Detection and Repair:
  - Slow Fault Location: Faults are harder to detect and pinpoint due to lack of visual access.
  - Long Repair Times: Repairs can take up to 2–6 weeks, requiring excavation, specialist jointers, and imported components.
  - Third-Party Damage: Risk from construction, excavation, or utility interference.
- Thermal Management:
  - Heat Dissipation: Underground cables dissipate heat during operation; poor thermal conductivity of surrounding material can reduce the current-carrying capacity of the cable / prematurely age or damage the cables due to thermal stress.
- Uprating Limitations:
  - Difficult to Uprate: Increasing capacity will require full excavation and replacement of cable ducts and equipment.
- Limited Flexibility:
  - Cannot easily adapt to changing grid demands.

Considering the third option of an OHL circuit with partial undergrounding, the higher ‘operational’ risk ratings associated with UGCs are considered to outweigh those associated with OHL, even though the proposed OHL sections lengths are longer.

3.2.6 Geotechnical Conditions

OHL options due to their smaller overall footprint, are deemed to have lower geotechnical impact than UGC options

From Steelstown, the Study Area has lower flat ground before heading over hilly / steep terrain and then back down to lower ground near Carrickmines. The land type would be private farmland, although some areas are now built up with housing. The OHL circuit passes over a number of rivers but avoids any major areas of flood risk. Specific site investigation works will be required for assessment and selection of final mast / foundation locations.

UGC options are deemed to have higher geotechnical impact than OHL options, due to long lengths of trenching works and possible HDDs. Any UGC circuit corridor will follow along existing public roads, where geotechnical conditions can be taken as low risk. The general landscape along the route is flat / hilly as the corridor travels from west to east, with a number of moderate inclines encountered, especially on the western / southern approaches into Carrickmines. The UGC corridors encounter a number of rivers and pinch points as the circuit traverses the study area / corridor from west to east, which will need to be cross using Horizontal Directional Drilling. Specific site investigation works will be required for assessment and selection of final circuit routes, joint bay locations and HDD crossing sites.

Considering the third option of an OHL circuit with partial UGC, the ‘geotechnical’ risk rating of the overall circuit will be between the two technologies but biased lower towards the OHL technology risk rating due to its longer lengths (assumed 3:1 ratio between the two technologies).

3.2.7 Electromagnetic Compatibility

Any electrical conductor will generate a magnetic field when electrical current is passed through it. HV circuits are assessed to electromagnetic compatibility standards including IEC 61000 series and International Commission on Non-Ionizing Radiation Protection (ICNIRP) guideline to ensure magnetic field emissions are within allowable limits for the public / equipment, (as per EU 1999/519/EC and ICNIRP (1998) restriction levels).

Regarding OHLs, the standard 400 kV tower design heights ensure that the magnetic and electric field levels at ground height are well within ICNIRP (1998) restriction levels (note, the 1998 levels are more stringent than the more recent 2010 published levels). Likewise, any OHL circuit corridor will need to be carefully routed to ensure it can maintain a 60 m wide clearance corridor (i.e., 30 m each side of the line) from nearby buildings (residential).

The time-varying magnetic fields produced by alternating current circuits may induce voltages in nearby conductive materials therefore consideration needs to be given in the routeing of HV OHLs in proximity to metallic structures such as steel pipelines and telecoms cables (such as railway line signalling communication cables). When routeing a circuit close to such pipelines or signal cabling, care needs to be taken to avoid parallel circuits and ensuring any crossings are as close as possible to 90 degrees.

Any OHL corridor will need to be routed to avoid close proximity to existing telecommunication masts (such as at Saggart Hill). Final siting of the OHL masts needs to be carefully selected and assessed to ensure there is no interference with nearby airport telecommunications, radar or navigation systems at Casement Aerodrome , especially on any final OHL corridor approach into Steelstown Substation (approximately 4 km from the airport).

Corona discharge around HV OHLs can be a source of high-frequency RFI (i.e., generate radio noise) which can affect AM radio (0.15-30 MHz) and nearby telemetry systems. In such circumstances, corona mitigation measures can be employed to reduce the effects.

Compared to OHLs, the electric fields generated by UGCs are effectively blocked by the surrounding soil/bedding material and cable sheath and are of little relevance / insignificant.

The time-varying magnetic fields produced by alternating current UGC circuits may induce voltages in nearby conductive materials therefore consideration needs to be given in the routeing of UGCs in proximity to steel pipelines such as high-pressure gas and water mains including their cathodic protection systems and telecoms cables (such as rail line signalling communication cables). When approaching such pipelines or signal cabling care needs to be taken to ensure the UGC circuits do not interfere by maintaining a set separation distance and ensuring any crossings are as close as possible to 90 degree.

Additional mitigation measures include using trefoil cable arrangements which will minimise magnetic fields (but potentially reduce overall circuit ratings).

Considering the third option of an OHL circuit with partial undergrounding, the ‘Electromagnetic Compatibility’ risk rating of the overall circuit will be between the two technologies but biased lower towards the OHL technology risk rating due to its longer lengths.

3.3 Economic Assessment

Table 3-4 shows a summary of the scores for the Economic Assessment of each technology option.

Table 3-4 - MCA Scoring – Economic Assessment

Sub-Criteria	OHL	UGC	OHL-PU
Project Implementation Costs			
Project Life-Cycle Costs			
Cost to SEM			
Overall Economic Score			

The cost of implementing a new circuit connection depends mainly on the circuit length, chosen technology (OHL vs UGC vs. OHL-PU), and any specialised equipment needed at the substations to facilitate the circuit / connection. In general, OHL circuits are cheaper to construct and operate than UGC circuits of equivalent length. Circuit lengths (and thus procurement and construction costs) are expected to be shorter for an OHL circuit as it can take a more direct route between substation, compared to an UGC circuit which will mostly follow the existing road network.

Life-cycle costs are lower for OHL circuits because they have longer asset lifespans, lower failure rates, cheaper and faster fault repairs, and less frequent maintenance. UGC circuits age faster due to thermal and electrical stresses and require more expensive and time-consuming fault rectification.

In terms of impact on the Single Electricity Market (SEM), OHLs are more economical. UGCs have higher capital and operational costs, leading to increased Transmission Use of System (TUoS) charges. Their lower availability and longer repair times increase constraint and imperfection charges. OHLs, while having higher electrical losses, still offer better overall market efficiency due to flexibility in upgrades, easier integration of renewables, and support for meshed network operation, which reduces redispatch costs.

The third technology option, OHL with partial undergrounding, is found to score in between the two other options. The OHL-PU option is biased towards the more economically advantageous OHL scores as the assumed OHL circuit section length is assumed to be approximately three times the section length of UGC.,.

3.3.1 Project Implementation Costs

Assuming no additional land procurement is required at either substation, the circuit implementation costs will be driven predominantly by the length / technology of the required circuit connection and any bespoke equipment required at the connecting substation (i.e., for OHLs; Line cable interface masts (LCIMs) or conductor gantries).

HV OHL circuit development costs are approximately half those of equivalent UGC circuits. Considering the length of OHL circuit expected there is no need for any additional circuit/network compensation equipment. OHLs by their nature will be able to span over the major constraints encountered along the route such as the River Dodder and the N81 national road, thus avoiding any additional costs associated with UGCs when traversing such constraints (i.e., use of HDD).

HV UGC circuit technology is scored high risk on account of the long circuit length from Steelstown to Carrickmines (up to 35 km). Significant circuit and network compensation equipment (e.g., shunt reactors) will be required (and further new / additional compensation equipment installed when the circuit is operated at 400 kV in future.

. For an UGC circuit option rather complex and large crossing designs / land takes will be required to cross under the River Dodder.

Considering the third option of an OHL circuit with partial undergrounding, the project implementation costs of the overall circuit will be between the two technologies but biased towards the OHL technology costings due to its longer length. There may be additional costs incurred due to transition compounds / compensation equipment required at the points of transitions from OHL to UGC technology

3.3.2 Project Life-Cycle Costs

Life cycle costs are less for HV OHL circuits compared to UGC circuits. This is due to:

- Lower equipment failure rates and replacement costs.
- Longer expected lifespan of the OHLs (40-60 years) compared to UGC (30-40 years). Even though OHL equipment is exposed to the environment / weather, it is not impacted as much as UGC technology which has shorter life spans due to thermal stress / electrical aging effects.
- Fault correction costs are lower for OHL as it is easier to determine fault locations and typically requires less time to gain access to rectify (hours compared to days).
- Longer inspection / maintenance intervals required for OHL due to the longer lifespans of the equipment.

Considering the third option of an OHL circuit with partial undergrounding, the Project Life-Cycle Costs of the overall circuit will be between the two technologies but biased towards the OHL technology due to its longer length.

3.3.3 Cost to SEM

The cost to the Single Energy Market is generally less for OHL circuits compared to equivalent UGC circuits. This is for a number of factors:

- Capital and Operational Costs:
  - UGCs are more expensive to construct than OHLs.
  - Higher capital and operational costs translate into higher TUoS charges.
- Reliability and Outage Costs:

    - Availability Levels are found to be much lower for UGC technology compared to equivalent OHL circuits. This is due to higher failure rates for UGC technology (at 400 kV), coupled with UGCs having longer fault repair times (MTTR) on the order of days to weeks for UGC compared to hours to days for OHL.
    - This increases constraint costs and imperfections charges in the SEM.
- Transmission Losses:
    - OHLs generally have higher electrical losses, which can increase wholesale energy costs. However, this disadvantage is often outweighed by the lower capital and maintenance costs.
- Flexibility and Grid Integration:
    - OHLs are easier to upgrade or reroute, supporting dynamic grid needs and renewable integration (e.g., loop-ins).
    - UGCs are less flexible, which can lead to higher curtailment costs for renewables and reduced market efficiency.
- Impact on Market Dispatch:
    - OHLs support more robust meshed networks, reducing the need for costly redispatch.

Considering the third option of an OHL circuit with partial undergrounding, the 'Cost to SEM' impact of the overall circuit will be between the two technologies but biased towards the OHL technology costings due to its longer length.

3.4 Deliverability Aspects

Table 3-5 shows a summary of the scores for the Deliverability aspects of each technology option.

Table 3-5 - MCA Scoring – Deliverability Aspects

Sub-Criteria	OHL	UGC	OHL-PU
Implementation Timelines			
Permits & Wayleaves			
Land Availability			
Ease of Construction			
Overall Deliverability Score			

The proposed OHL circuits will route predominantly via private, agricultural and hilly land. Any OHL circuit corridor will require easements (74 m wide) to be negotiated and agreed with the relevant landowners. Obtaining the necessary land easements from private landowners will likely be more onerous compared to UGC circuit technology options. Where possible, the proposed circuit will seek to maintain a buffer of at least 50 m from existing dwellings.

Obtaining a land corridor of sufficient clearance direct to Carrickmines Substation will be extremely difficult due to the large density of housing developments and a landfill surrounding the substation. For any OHL circuit to get within close proximity (a few hundred meters) of the substation perimeter it will likely negatively impact on either existing housing or social amenities in the area (e.g., sport pitches and/or golf clubs) in order to establish a new OHL circuit. As such, the OHL technology option is scored High risk for Land Availability.

Routeing a 400 kV UGC circuit from Steelstown to Carrickmines will be constrained by numerous towns and built-up urban areas located along the length of the circuit as it traverses through South Dublin County and City.

Compared to UGC, construction of the proposed HV OHL circuit (masts and conductor stringing) is considered to be more straight forward. Construction of an UGC circuit along the road network will likely cause local disruption and impact on traffic around the South Dublin and Carrickmines areas. A number of off-road sections are likely to be required for an UGC circuit to facilitate getting around unavoidable pinch-point or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc. Any off-road sections will require an easement from the relevant landowners / statutory authority. Obtaining public acceptance and the necessary landowner wayleaves for any off-road UGC sections is considered to be less difficult than compared to OHL technology and pose less risk to the overall development programme.

The third technology option, OHL with partial undergrounding, is seen to predominantly score in between the two other options, The OHL-PU option is anticipated to have a greater risk of overall programme delay due to difficulties in obtaining public acceptance and the necessary landowner wayleaves for the OHL circuit sections.

3.4.1 Implementation Timelines

Construction of an UGC circuit between Steelstown and Carrickmines is expected to be greater length than an OHL option, up to 10 km longer on account that an UGC will need to route via suitable roads within the road network, whereas an OHL circuit can be more direct going off-road / cross country. Construction of an OHL circuit is estimated to take approximately 24no. months (compared to approximately 30no. months for an UGC circuit) depending on the number of construction crews deployed and the number / specification of masts to be constructed.

All materials and components are considered standard and should not represent any risk or delays to the usual procurement timelines, including 400 kV cables (approximately 9+ months).

No major circuit outages will be required except, possibly, for a partial busbar outage when connecting into either of the two substations. If any sections of the new OHL circuit will interact with the existing Dunstown to Carrickmines 220 kV OHL circuit then additional outages may be required, incurring further construction delays.

Regarding the overall development timeframe, obtaining public acceptance and the necessary landowner wayleaves for any off-road UGC sections is considered to be less difficult than compared to OHL technology and pose less risk to the overall development programme.

For the third option, OHL with partial undergrounding, the overall development programme could be delayed due to difficulties in obtaining public acceptance and the necessary landowner easements for the OHL circuit sections, which drives the risk rating higher than the UGC option. Construction of an OHL with partial undergrounding circuit is estimated to take approximately 24no. months as a number of different construction crews will need to be employed (due to different skill set and construction equipment requirements). Additional time may have to be factored in for any LCIM compounds if required.

3.4.2 Permits & Wayleaves

An OHL circuit will predominately route via private, agricultural based land which will require easements (74 m wide) to be negotiated and agreed with the relevant landowners. TII should be consulted regarding the OHLs crossing any major roads such as the N81. If the OHL masts on the final approach into Steelstown Substation are assessed to encroach / impede on the AirNav height restrictions around Casement Aerodrome then further agreements will be required from the relevant aviation authorities / Air Corps. For the construction phase, further liaison and possibly a cranes Special Aeronautical Study may need to be carried out to determine any potential restrictions on allowable crane heights so not to impact on flight operations at Casement Aerodrome.

Compared to UGC technology, it is considered that it will be more difficult to obtain public acceptance and the necessary landowner wayleaves for an OHL circuit within the Study Area and as such is scored at higher risk.

Any UGC circuit will predominately route along public roads. A number of off-road sections are likely to be required to facilitate getting around unavoidable pinch-point or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc. Any off-road sections will require a wayleave from the relevant landowners / statutory authority. Off-road wayleaves for 400 kV UGC circuits will need to be minimum 5 m wide, with the additional requirements for a 3.5 m access track along the off-road routes to ensure subsequent access for maintenance activities, etc. Wayleaves will be required from TII for the UGC circuit to cross under (HDD) the M50 motorway or possibly to travel along the N81 national road. The UGC routes will likely encounter high pressure and medium pressure underground gas pipelines. Consultation with the relevant asset operator, Gas Networks Ireland (GNI), will be required to ensure the HV circuit does not negatively impact or interfere with their assets.

During the construction phase, a road opening licence will be required from the local road authority (South Dublin County Council in the western portion and Dún Laoghaire-Rathdown Council in the eastern portion of the corridor) to construct the UGC circuit trenches and joint bays along any sections of public road. Engagement with the local authorities' road engineers is required to confirm trench designs, reinstatement details and exact joint bay locations. Principal inspection reports and technical assessment reports may also be required for any existing or proposed structures affected by the UGC, for example bridges, culverts or project joint bays.

For the third technology option, OHL with partial undergrounding, the assumed ratio of OHL to UGC circuit lengths is approximately 3:1 so the risks associated with 'Permits & Wayleaves' are considered to be somewhere between the two technologies / biased towards the higher risk rating associated with OHL technology.

3.4.3 Land Availability

The proposed OHL circuits will route predominantly via private, agricultural and hilly based land. The Study Area has a relatively high density of dwellings in areas (especially around Carrickmines Substation) but lower in the west and southern parts of the Study Area. The presence of a SAC in the centre/south of the Study Area will push all potential OHL corridors to the north.

Any OHL circuit corridor will require easements (74 m wide) to be negotiated and agreed with the relevant landowners, including a permanent 4 m access corridor directly under the line which needs to be kept clear at all times. Obtaining the necessary land easements from private landowners will likely be more onerous compared to UGC circuit technology options.

Obtaining a land corridor of sufficient clearance direct to Carrickmines Substation will be extremely difficult due to the large density of housing developments and a landfill surrounding the substation. For any OHL circuit to get within close proximity (a few hundred meters) of the substation perimeter it will likely negatively impact on either existing housing or social amenities in the area (e.g., sport pitches and/or golf clubs) in order to establish a new OHL circuit. As such, the OHL technology option is scored High risk. It is very likely that a final section of UGC will be required (with the necessary wayleaves 5m wide) to connect the circuit the final 1-2 km into Carrickmines Substation.

Routeing a 400 kV UGC circuit from Steelstown to Carrickmines will be constrained by numerous towns and built-up urban areas located along the length of the circuit as it traverses through southern Dublin county and city. The proposed circuit route will predominately route along public roads and within any built-up urban areas the circuit will encounter roads containing a high density of existing services including medium pressure gas pipelines. Several off-road sections may be required to facilitate getting around unavoidable pinch-points or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc.

Any off-road sections of the UGC circuit including joint bays, passing bays, HDDs, etc. will require a permanent wayleave from the relevant landowners. Off-road easements of 5 m are required for 400 kV UGC circuits.

The 'Land Availability' risks associated the OHL with partial undergrounding option are considered to be less than the OHL option as UGC technology can be deployed for the final approach into Carrickmines Substation. However, there is still an elevated level of risk associated with trying to establish a viable 400 kV UGC circuit corridor through the heavily built-up urban environment surrounding Carrickmines Substation.

A terminal overhead line tower and OHL to UGC interface compound (approximately 35 m x 45 m) including an access road may be required wherever the changeover from OHL to UGC technology takes place.

3.4.4 Ease of Construction

An OHL circuit will predominately route via private, agriculturally based land which should have relatively good access and ground conditions for siting and constructing the overhead masts and foundations (up to 70no. masts required in total). However, some sections of hilly terrain will be encountered with more difficult access and ground conditions.

Construction of the proposed HV OHL circuit (masts and conductor stringing) is considered to be straight forward. The only major constraint encountered is where the circuit crosses the N81 and the River Dodder valley as this will be a big span and detailed survey would be needed to assess constructability. Additional protection measures may need to be put in place when stringing the circuit conductors over major roadways such as the N81. Some limitations of construction crane heights may be imposed in the vicinity of Casement Aerodrome.

Any UGC circuit will deliberately make use of wide road corridors (i.e., regional roads), routed predominantly through mostly built-up urban or rural areas. The urban roads will have a high density of existing services within the road network, including water, sewage, medium pressure gas, low voltage power cables, and telecoms. Routeing of an UGC will be difficult and encounter numerous pinch points requiring either service crossing or diversions. Traffic management / work time restrictions will also be a risk in the built-up urban areas / town centres.

HDD will likely be required for the UGC to cross the numerous rivers and any major road / motorways encountered as the circuit traverses the study area / corridor from west to east. Installation complexity associated with UGC circuits include:

- Civil Engineering Demands: Requires trenching, ducting, or tunnelling (e.g. HDD); each with significant planning and environmental considerations.
- Cable Joint Bays: Large, concrete underground structures required approximately every 700 m to facilitate cable installation, jointing and cross-bonding / earthing .
- Cable pulling: Additional land space required for cable reels and pulling equipment. Specialist skill sets required for jointing the HV cables.

The 'Ease of Construction' risks associated with the OHL with partial undergrounding option are considered to be somewhere between the two technologies / biased towards the OHL risk rating on account of its longer section length compared to the UGC section length.. A terminal overhead line tower and OHL to UGC interface compound (approximately 35 m x 45 m) including an access road may be required wherever the changeover from OHL to UGC technology takes place. Additional circuit compensation and protection / control equipment may also be required for the UGC cable sections.

3.5 Environmental Aspects

Table 3-6 shows a summary scores for the Environmental aspects of each technology option.

Table 3-6 - MCA Scoring – Environmental Aspects

Sub-Criteria	OHL	UGC	OHL-PU
Biodiversity, Flora & Fauna			
Soil Impacts			
Water			
Planning Policy and Land Use			
Landscape & Visual			
Cultural Heritage			
Noise & Vibration			
Overall Environmental Score			

While the overall risk rating for OHL, UGC and OHL-PU technologies are the same, the scores for individual sub-criteria differ for each technology, resulting in different risk profiles.

OHL technology generally results in less ground disturbance, but presents a higher overall level of risk to long-term landscape and visual impacts. While careful micro-siting of OHL towers can minimise risk on sensitive landscape, cultural and ecological features, OHL technology introduces additional considerations such as avian collision risk and operational noise (Corona Noise is considered a significant issue for 350-500 kV and above). The presence of designated sites such as the Glenasmole Valley SAC and Lugmore Glen pNHA also constrains viable OHL tower locations, increasing risk.

UGC technology can involve extensive excavation, increasing the potential for disturbance to wetlands, watercourses and hydrological systems, particularly in areas with soft soils, groundwater vulnerability and flood risk. The most pronounced environmental sensitivities in the Study Area relate to ecologically protected sites, wetlands, watercourses, and hydrologically connected habitats, e.g. the Dodder Valley pNHA and Sean Walsh Memorial Park Ponds wetland. UGC interacts more intensively with these receptors during installation and the resulting risks are short-term and can be reduced through avoidance of high-value features during routeing. While UGC introduces more construction-phase disturbance (principally through trenching, excavation, and horizontal directional drilling) these impacts are temporary, predictable, and can be effectively managed through established mitigation measures and careful construction planning. UGC technology offers greater certainty in avoiding direct impacts on above-ground cultural heritage features and allows routeing within existing road corridors.

The OHL with partial undergrounding option provides a balanced environmental risk profile by combining the strengths of both OHL and UGC. The risks associated with the OHL generally apply to OHL with partial undergrounding, given the ratio of OHL vs. UGC, and therefore the scoring for this technology reflects this. The risks associated with soil impacts is a combination of both OHL and UGC, and therefore the risks are considered to be between OHL and UGC risks.

3.5.1 Biodiversity, Flora & Fauna

3.5.1.1 European and National Sites

There are 3no. European sites (Special Area of Conservation [SAC] and Special Protection Area [SPA]) within the Study Area: Glenasmole Valley SAC (site code: 001209), Wicklow Mountains SAC (site code: 002122) and Wicklow Mountains SPA (site code: 004040; Figure 3-1). There are also 8no. proposed Natural Heritage Areas (pNHAs) in the Study Area. Wicklow Mountains National Park overlaps Wicklow Mountains SAC/SPA. Multiple wetlands of international and national importance (Glenasmole Valley SAC [Dublin], Dodder Valley pNHA – River Dodder, Brittas Ponds – Slade of Saggart and Crooksling Glen pNHA) further elevate ecological sensitivity. These habitats are highly sensitive to hydrological changes and physical disturbance, and conflicts between grid infrastructure and high-value habitats typically occur in upland and wetland areas[1].

For OHL technology, potential risks within SACs relate primarily to localised habitat loss or degradation at tower locations due to vegetation clearance and ground disturbance, which may affect Qualifying Interest (QI) habitats. Within SPAs, OHL presents an increased risk of bird collision, particularly for migratory waterfowl and other species moving between feeding and roosting areas. Risks to watercourses and water-dependent habitats arise mainly during tower foundation construction but can generally be avoided or mitigated through careful tower siting, micro-routing and standard construction controls.

While UGC technology removes bird collision risk, works can temporarily disturb sensitive bird species through noise, increased human activity and machinery during construction. Works in or near internationally and nationally important wetlands present additional risks due to the potential for hydrological alteration, groundwater pathway disruption, siltation, and surface-water contamination, all of which may affect wetland functionality if not tightly controlled. The OHL with partial undergrounding option, combining OHL and UGC technologies, allows the route to avoid the highest-value ecological sensitivities by placing each technology where it generates the least risk. UGC technology would be more appropriate in or adjacent to the Wicklow Mountains SPA to remove bird collision while OHL is preferable in SACs or nationally/internationally important wetlands where maintaining hydrological integrity is critical.

OHL poses a low risk of water-quality impacts, and the risk of bird collision can be effectively reduced through the use of bird flight diverters to increase the visibility of overhead lines, with mitigation particularly focused on the thin earth (shield) wires, which present the greatest collision risk to birds[2]. UGC presents a low risk of bird disturbance but a higher potential for impacts on water-dependent habitats during excavation. The OHL with partial undergrounding option enables the route to avoid the most sensitive ecological areas by applying each technology where it results in the least environmental risk.

[1] cms.eirgrid.ie/sites/default/files/publications/EirGrid-Evidence-Based-Environmental-Study-4-Habitats.pdf

[2] EirGrid-Evidence-Based-Environmental-Study-5-Birds.pdf

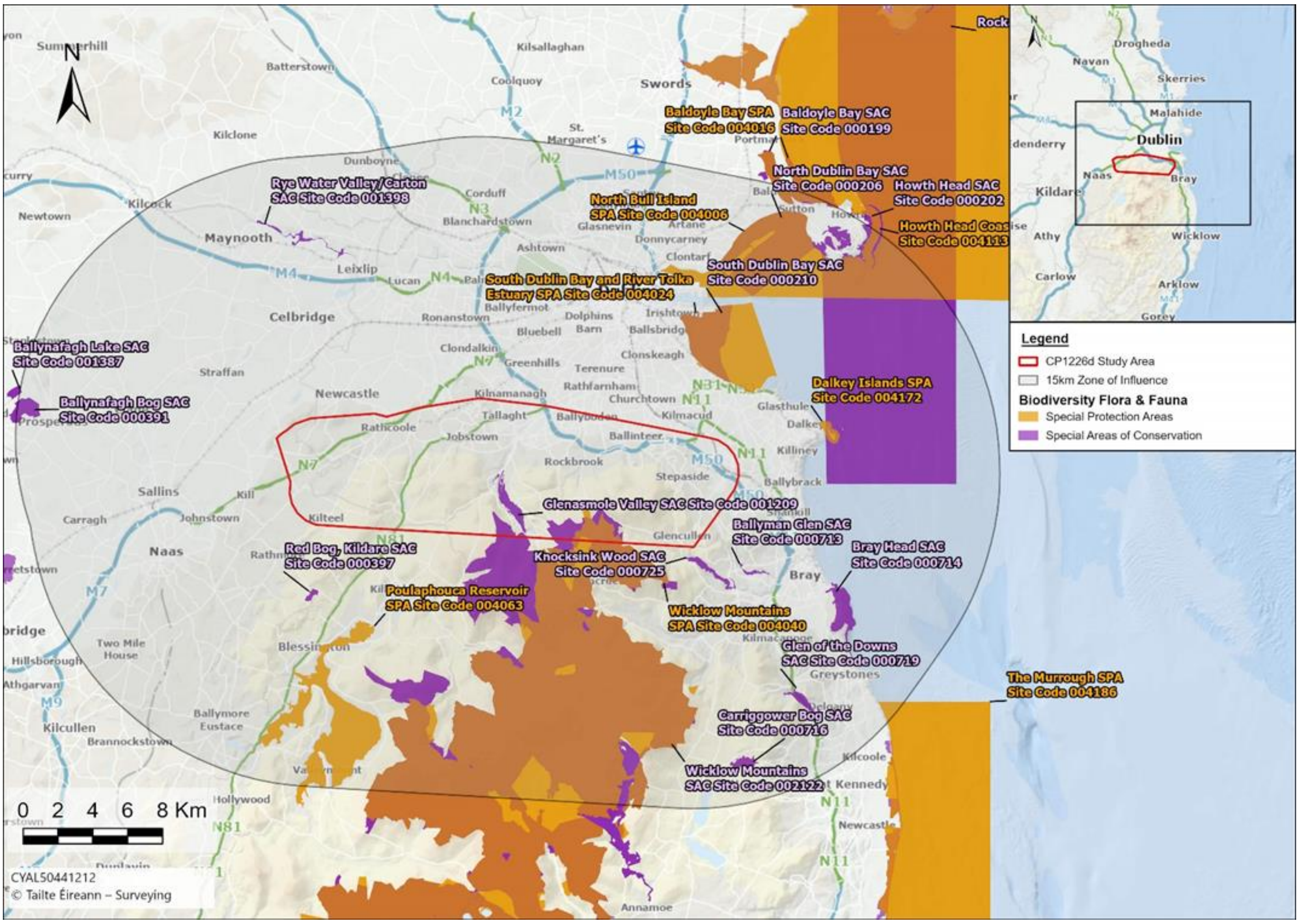

Figure 3-1 - Special Areas of Conservation and Special Protection Areas within the Study Area

3.5.1.2 Protected Species and Habitats

OHL presents a higher risk to sensitive bird species within the Study Area compared to UGC, particularly for large, fast-flying or flocking waterbirds. Raptors, including Merlin and Peregrine (Qualifying Interests of the Wicklow Mountains SPA), as well as waders and migratory species, may be affected where overhead lines intersect established flight paths between feeding, roosting and breeding areas.

UGC technology removes bird collision risk but presents a greater risk of disturbance to ground- and water-dependent fauna. Trenching and excavation may fragment habitats or remove foraging vegetation used by bats, while construction lighting, noise and activity can disrupt commuting routes. Otter and pine marten may be affected where UGC crossings disturb riparian habitats, bank structures or holt locations, particularly within wetlands or along watercourses.

OHL generally results in lower levels of physical disturbance to ground and aquatic habitats, reducing potential risks on Annex II and Annex IV species such as otter, common frog and bats. In contrast, UGC introduces a higher risk of disturbance to water-dependent habitats and protected species through excavation, soil handling and sediment mobilisation, which can affect aquatic systems and riparian corridors, although these effects are temporary and construction-related.

The OHL with partial undergrounding option combines the risk profiles of both approaches, with ecological effects determined by where each technology is applied. Strategic placement of OHL and UGC sections offers the potential to reduce overall ecological risk by avoiding bird collision in sensitive avian areas while minimising ground disturbance and hydrological impacts in habitats supporting protected mammals and amphibians.

3.5.1.3 Annex I Habitats

OHL technology can adversely affect Annex I habitats located outside European sites, primarily through vegetation clearance, tower foundation installation and the creation of temporary access tracks, which may result in localised habitat loss or degradation. Woodland Annex I habitats, including old oak and alluvial woodland, may be affected by canopy fragmentation, edge effects and, where unavoidable, removal of mature trees required to maintain safe operational clearances.

UGC technology can give rise to greater pressure on Annex I habitats due to the extent of ground excavation, trenching and vegetation removal along the working corridor. Wetland Annex I habitats, such as alkaline fens, transition mires and alluvial woodland, are particularly sensitive to hydrological change, including disruption of groundwater flows, localised dewatering and sediment mobilisation, all of which have the potential to compromise habitat structure and function. Woodland habitats may also be affected through root damage, fragmentation and loss of understorey vegetation. As these habitats depend on intact soils and stable hydrological processes, UGC construction can, in some circumstances, result in more substantial and longer-lasting effects than OHL.

The OHL with partial undergrounding option combines the risk pathways associated with both construction types, and its ecological implications are therefore highly dependent on route design and technology placement. Careful routeing is required to ensure that the technology with the lowest ecological risk is applied within each habitat type. Although these Annex I habitats lie outside Natura 2000 designations, their conservation value means that even small-scale impacts may be ecologically significant.

3.5.1.4 Aquatic Environment

OHL technology involves relatively minimal ground disturbance, reducing direct interaction with watercourses, wetlands and associated riparian habitats. The primary residual risk relates to sediment run-off during foundation installation or access creation, which may temporarily affect water quality in nearby rivers and wetlands; however, such risks are usually low and can be effectively managed through standard best-practice mitigation measures such as silt fencing, buffer zones and controlled drainage.

In contrast, UGC technology involves extensive trenching, soil excavation and the creation of working corridors, which introduce substantial risks to aquatic environments. These activities can generate significant sediment run-off, leading to turbidity, siltation and deterioration of water quality in rivers and wetlands. Excavation near riparian corridors can cause bank instability, removal of protective vegetation and increased erosion risk, particularly in Flood Zone A where construction areas may be prone to inundation.

The OHL with partial undergrounding option introduces a combination of risks associated with both OHL and UGC. In areas with wetlands, infrastructure increases the potential for siltation, accidental pollution and disruption of groundwater flows. Within Flood Zone A, both OHL access works and UGC excavation are at heightened risk of wash-out or inundation, which can mobilise sediments or pollutants into nearby rivers and wetlands (Figure 3-2).

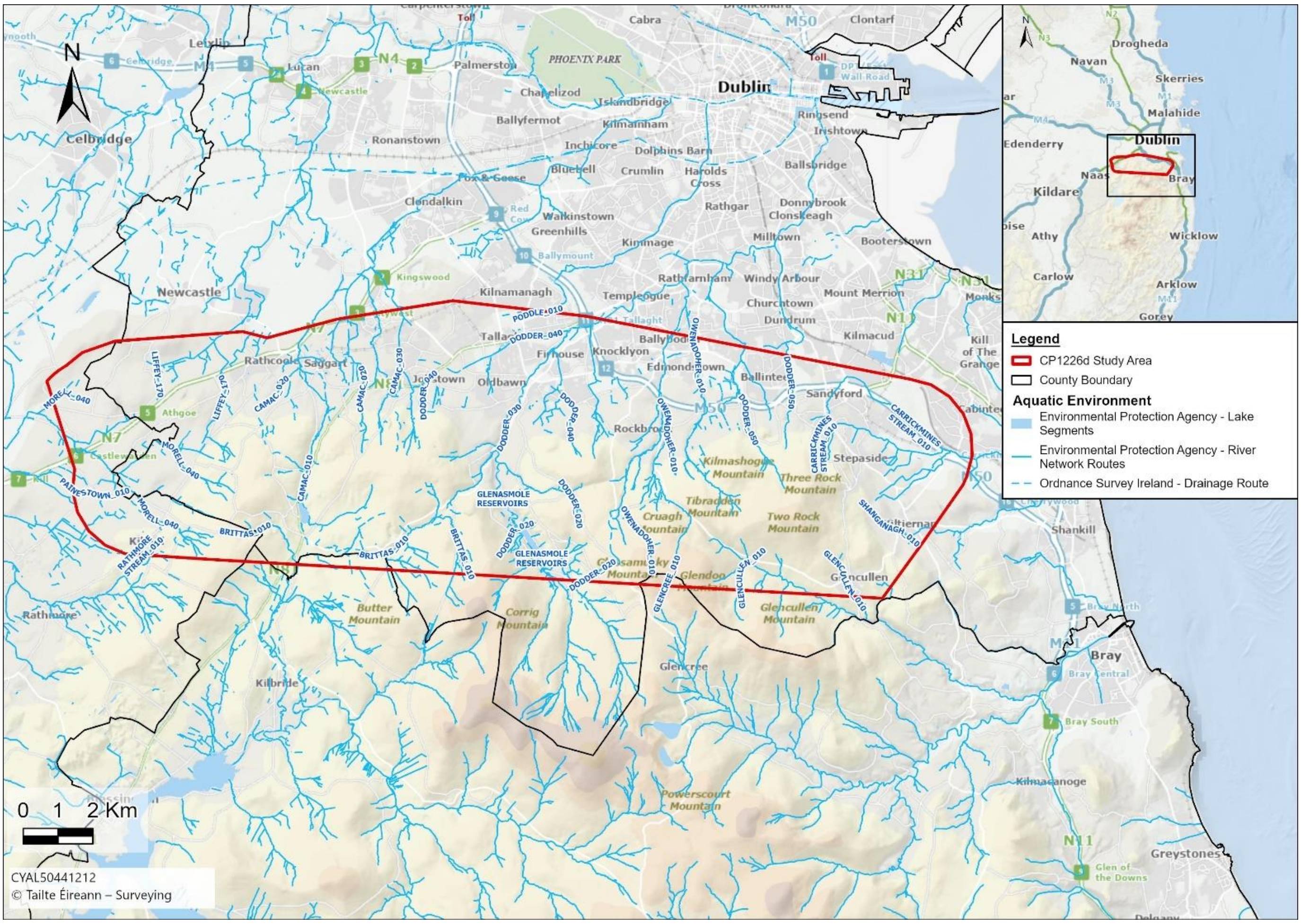

Figure 3-2 - Waterbodies within the Study Area (EPA, 2025; OSI, 2025)

3.5.2 Soil Impacts

The Study Area contains 8no. Geological Heritage Sites: Belgard Quarry, Greenhills Esker, Ballybetagh Bog, Three Rock Mountain, Murphystown Quarry, Dodder Terraces, Ballnascorney Quarry and Brittas Gravel Complex. These sites are of county-level importance and considered sensitive receptors. They should be avoided during route selection and may influence finer-scale access tracks, tower locations, or cable routes alignments.

Landslide susceptibility is predominantly low to the north of the Study Area (Figure 3-3). There are substantial areas classed as 'moderately low', 'moderately high' and 'high' risk, with clusters of past landslide events occurring primarily within the mountainous areas in the southern section of the site. Areas of peatland or, karstified land are especially prone to landslides and past events have been recorded in these areas. Slope stability assessments may be required in these areas, particularly where construction involves significant earthworks. For OHL technology, these areas present a higher risk due to tower foundations and associated access works. UGC installation may also require geotechnical assessments, particularly where trenching intersects susceptible slopes.

Made Ground is identified in urbanised areas, including Rathcoole and Tallaght and may include construction debris, variable soil types, and potential contaminants. This introduces risks of differential settlement and soft spots, complicating foundation design and trench stability. Detailed site-specific investigations, including contamination assessments and geotechnical testing, will be necessary in these areas. While OHL routes are unlikely to traverse major urban areas, UGC routes often follow road networks and may encounter Made Ground, increasing the need for mitigation measures.

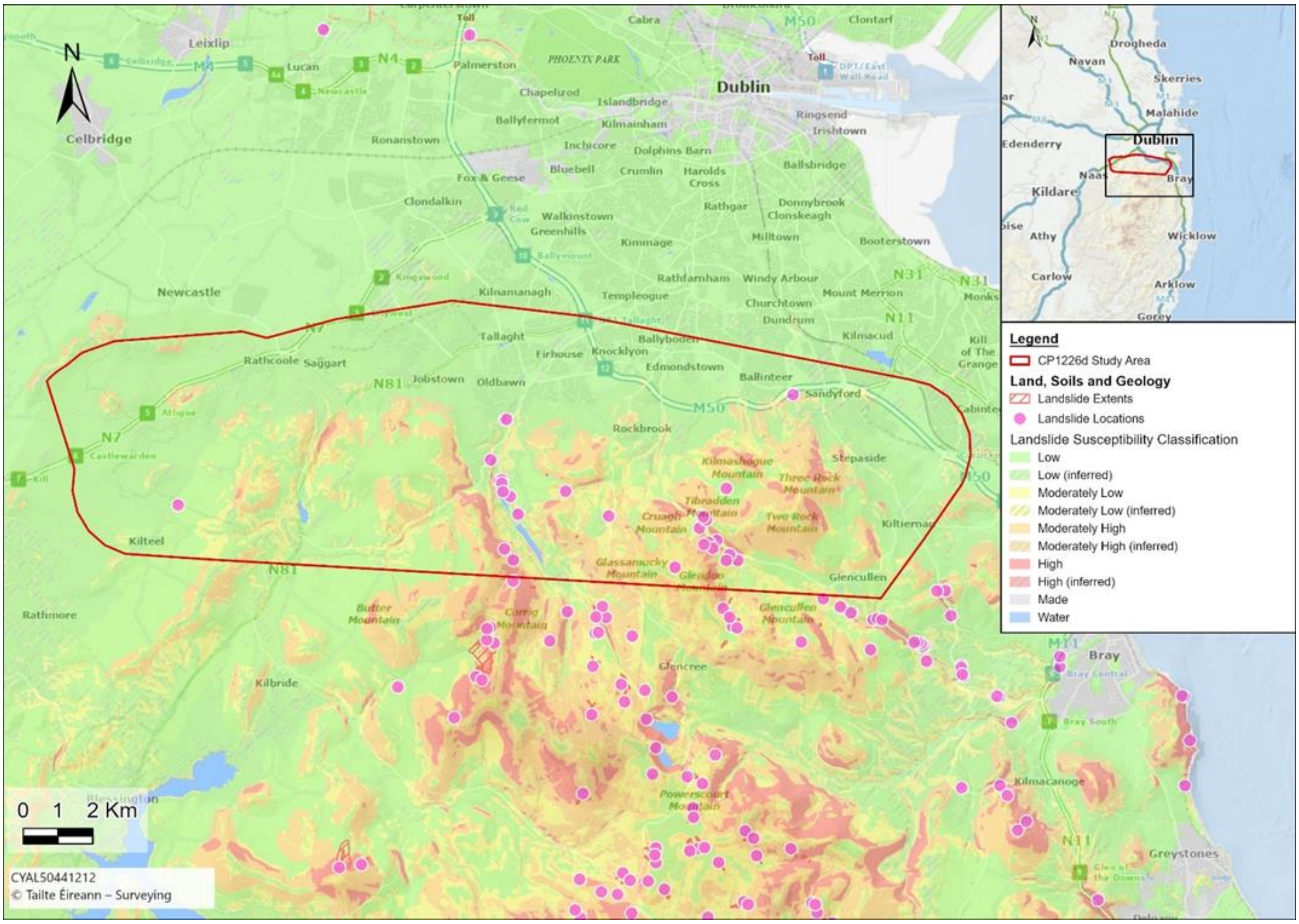

Figure 3-3 - Landslide Susceptibility and Past Landslide Events within the Study Area (GSI, 2025)

3.5.3 Water

There are 6no. river waterbodies in the Study Area situated within Flood Zone A, indicating a high likelihood of flooding. Although OHL structures do not require in-channel works, tower installation, construction of temporary access routes, and stringing activities can generate pathways for sedimentation, increased turbidity, and accidental pollutants to enter adjacent watercourses, particularly in areas with flood risk (Figure 3-4).

UGC technology involves trench excavation, duct installation, and construction of joint bays which can increase the risk of sediment runoff and contaminated surface-water discharge, particularly in areas underlain with alluvium or shallow bedrock where infiltration pathways are more direct. In areas where existing hydrocarbon contamination has been recorded (e.g., Industrial Facility [P0325-01]; Figure 3-5), ground disturbance could mobilise pollutants and facilitate migration within the groundwater system.

The OHL with partial undergrounding option considers both OHL and UGC. Works associated with OHL structures may generate localised risks of sedimentation, soil disturbance and accidental spillages near river crossings and lakes, particularly in areas of shallow bedrock or alluvium where pathways to groundwater are more permeable. UGC trenching introduces additional risks, including increased sediment runoff, alteration of shallow groundwater flow, and potential mobilisation of existing hydrocarbon contamination.

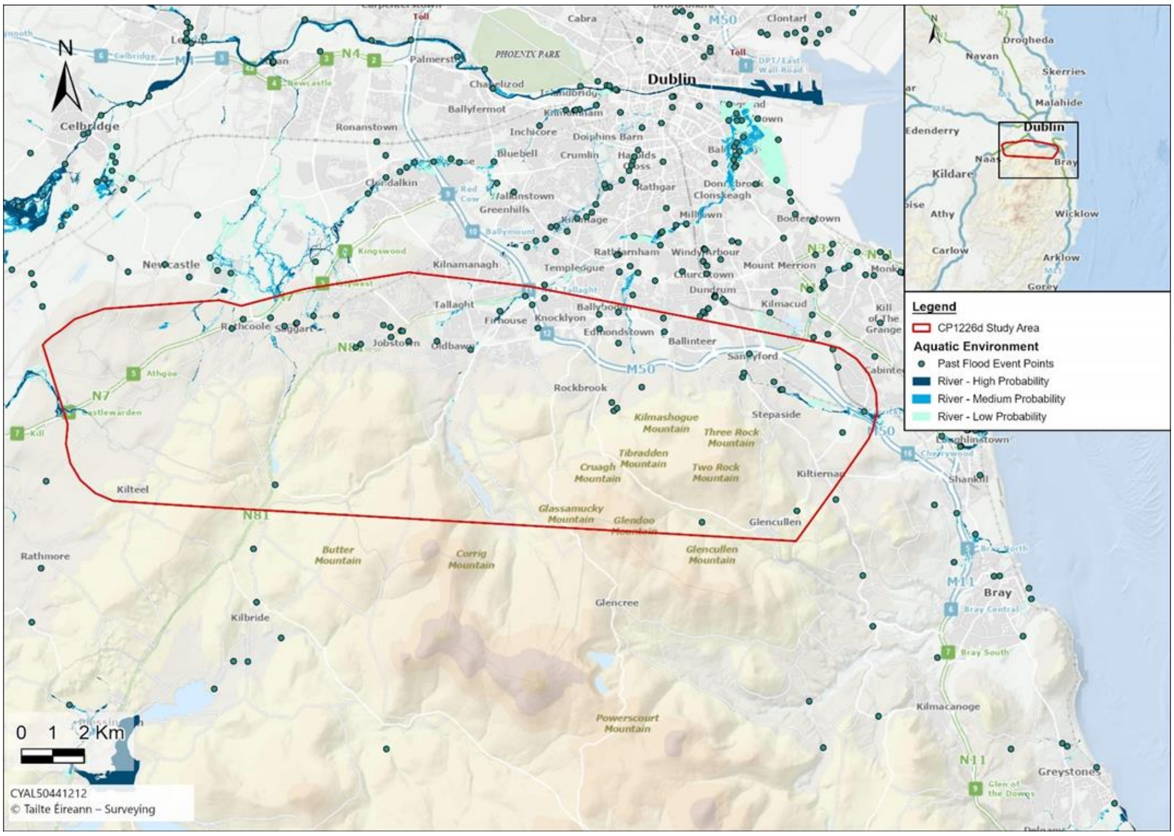

Figure 3-4 - Known Flood Risk and Past flood events within the Study Area (OPW, 2025)

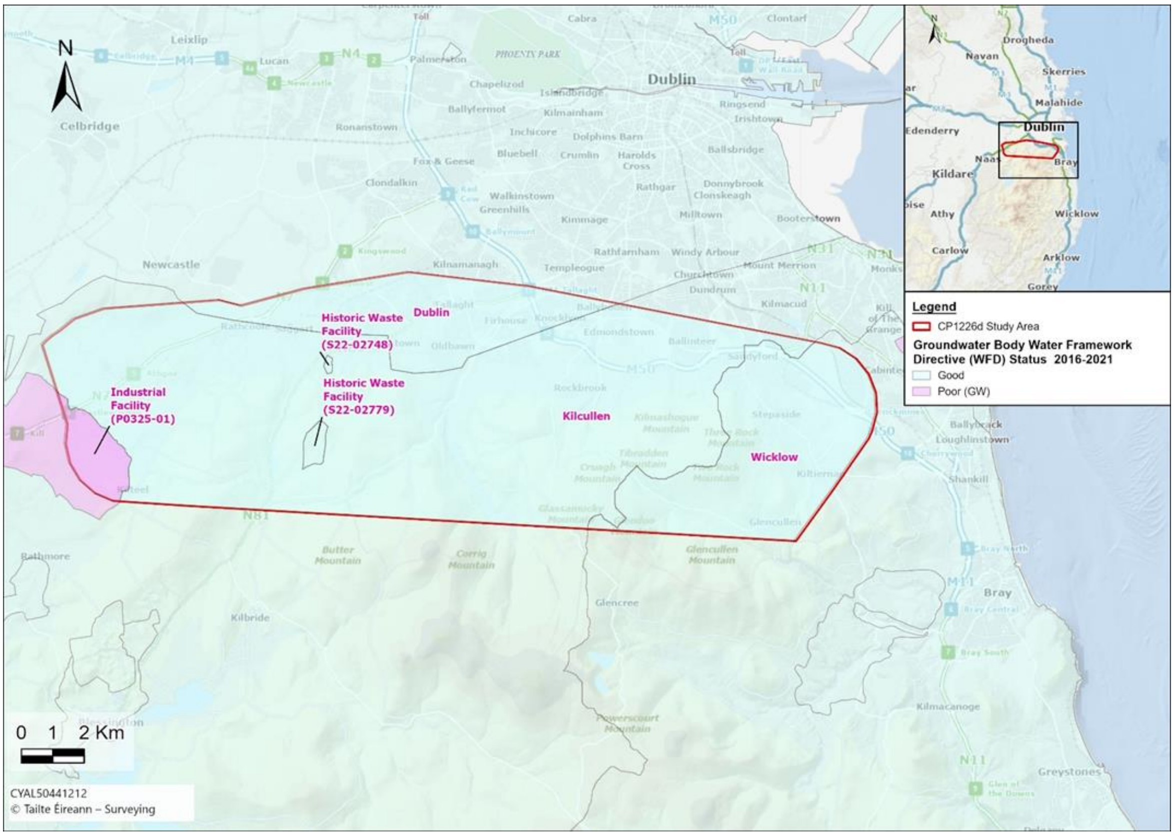

Figure 3-5 - Groundwater Body Status WFD within Study Area (EPA, 2025)

3.5.4 Planning Policy & Land Use

OHL technology results in greater landscape and visual risks. It is less suitable in areas zoned for residential or village/town centre uses, in open space and high-amenity zones such as the mountainous landscapes of the Wicklow Mountains (Figure 3-6).

UGC technology reduces visual risk and can integrate more sensitively in residential areas, including future development lands in Kildare and South Dublin. However it does involve more intensive construction activity that may temporarily disrupt agricultural lands and may affect farming operations.

The OHL with partial undergrounding option offers flexibility to avoid constraints such as EPA-licensed facilities, Seveso sites and active waste facilities, particularly in areas of enterprise and employment zoning while still minimising construction footprints where required (Figure 3-7).

All technology options should consider cumulative development pressures from ongoing housing and infrastructure proposals within the Study Area, coordinating with local authorities to manage short-term impacts such as traffic, noise and soil disturbance, while ensuring long-term compatibility with zoning objectives and land-use priorities.

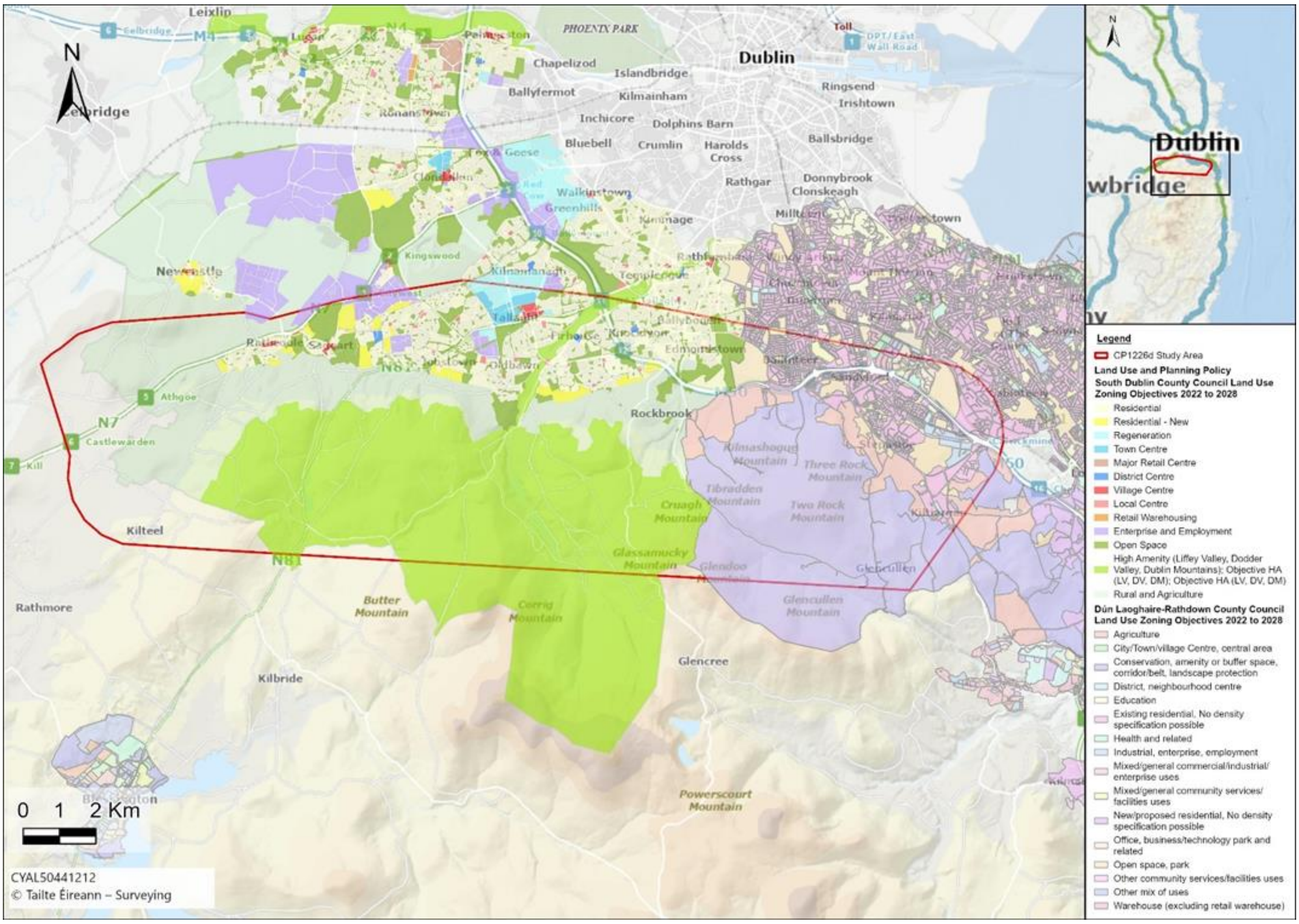

Figure 3-6 - Land Zoning Uses within Dún Laoghaire–Rathdown County Council and South Dublin County Council

Note: no data was available for Kildare County Council or Wicklow County Council here.

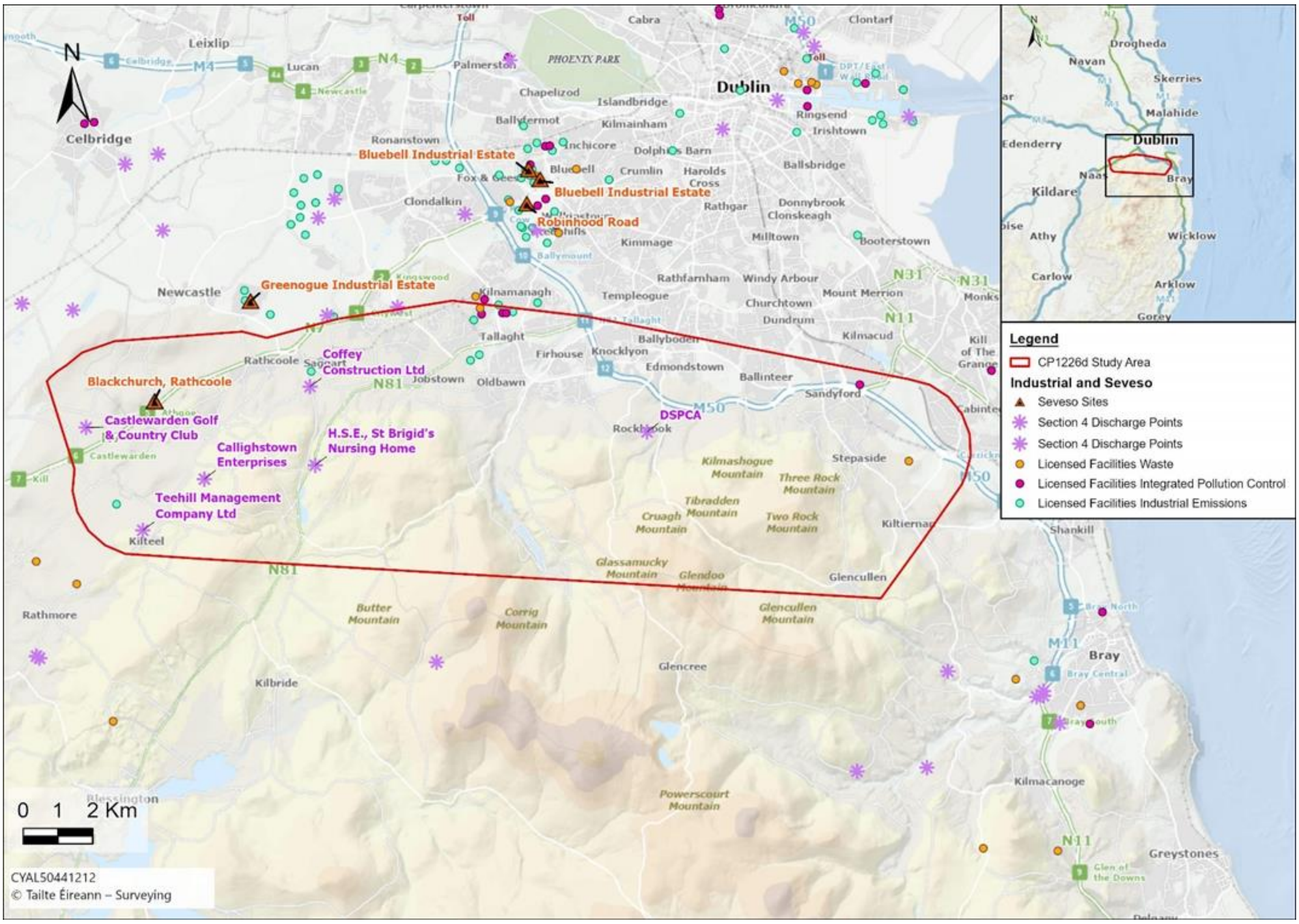

Figure 3-7 - EPA Licensed Industrial Facilities, Waste Facilities, Seveso Sites and Section 4 Discharge Point within the Study Area

3.5.5 Landscape & Visual

The Study Area includes sensitive landscapes such as scenic routes, protected views and prospects and hilltop viewpoints and river valley vistas (Figure 3-8). Landscape sensitivity is classified as 'high' and 'medium to high' in the majority of the Study Area. These areas are highly sensitive to vertical infrastructure, with much of the land recognised as unspoilt rural landscapes where any man-made structures will have a high risk on landscape character. Development within 500 m of scenic routes or Class 4/5 or high sensitivity areas will likely require a Landscape and Visual Impact Assessment.

Potential OHL technology near Lugmore Glen, Dodder Valley, Fitzsimons Wood, Glenasmole Valley pNHAs and the Glenasmole Valley SAC would introduce visual and ecological risks. While physical disturbance is minimal relative to UGC, the presence of tall structures could affect the setting of these features and their associated habitats. UGC technology has minimal long-term visual impact. While construction compounds and access works may temporarily affect heritage sites and natural habitats, these risks are less severe than those associated with OHL. For the OHL with partial undergrounding option, areas with lower landscape and visual sensitivity may offer opportunities for OHL routeing, while medium and high sensitivity zones will require more detailed assessment and potentially favour UGC solutions.

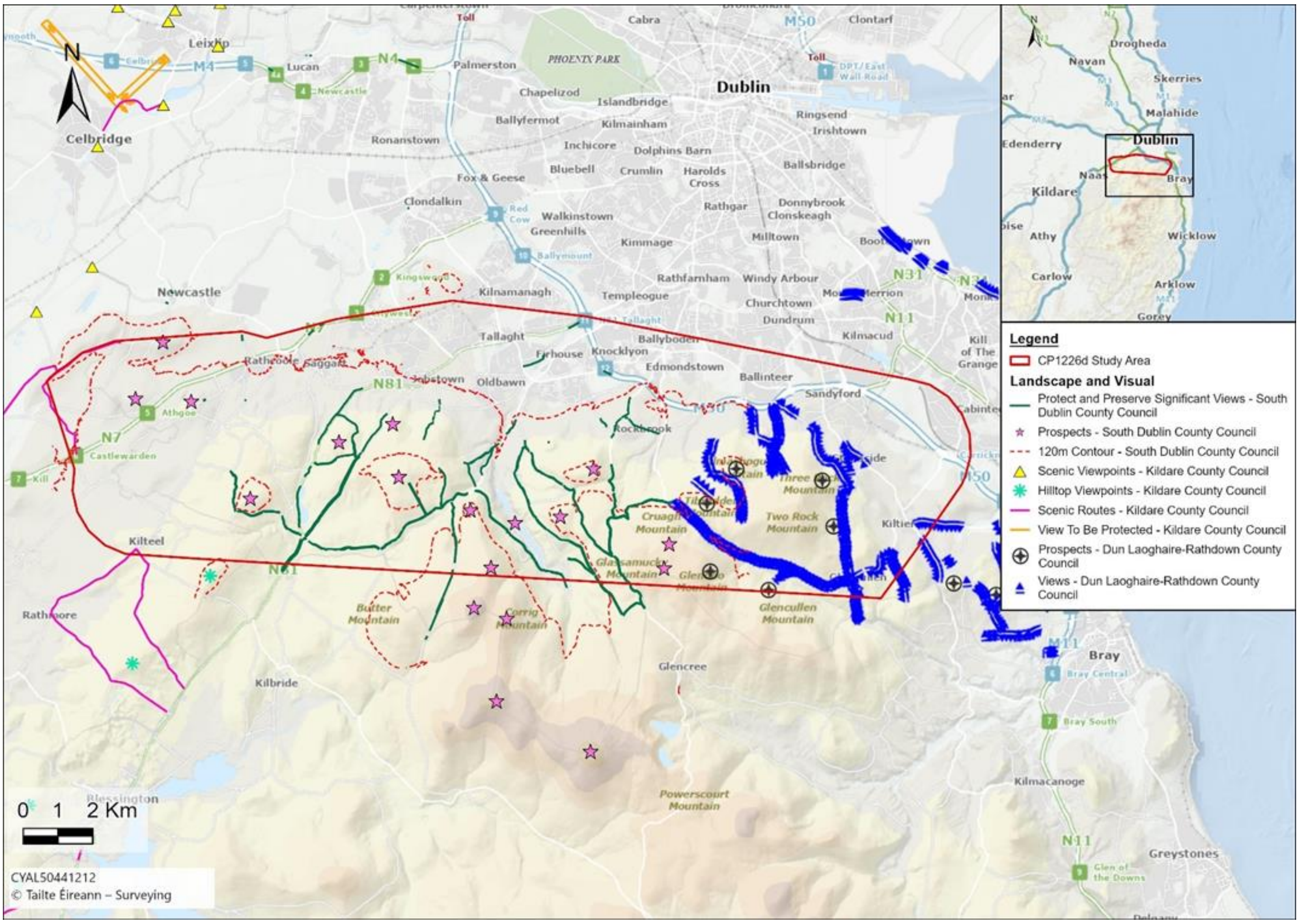

Figure 3-8 - Landscape and Visual Constraints within the Study Area (DLCC, 2022; KCC, 2023; SDCC, 2022)

3.5.6 Cultural Heritage

Recorded cultural heritage presents a low risk for OHL implementation (Figure 3-9) as tower locations can be micro-sited to avoid physical impacts on archaeological remains (i.e., the towers can be positioned to avoid known archaeological features). OHL can be aligned to follow regional roads and bypass settlements (on the outskirts of Saggart and Rathcoole), which reduces interaction with archaeological potential and architectural heritage, and avoids direct overlap with these features.

UGC technology typically follows the road network and local roads. Saggart and Rathcoole are very rich in cultural heritage and many features lie adjacent to the road network (Figure 3-9). South Dublin County Development Plan (2022–2028)[3] further acknowledges that the archaeological record is not limited to documented features, as the cultural heritage resource is dynamic and evolving. As such, there remains a high likelihood of uncovering unrecorded monuments during ground-disturbing works. This proximity increases the likelihood of encountering subsurface remains during trenching and requires careful compound placement to avoid curtilage impacts on protected structures. Assuming these areas are avoided for UGC technology then cultural heritage risks are lower.

The OHL with partial undergrounding option enables OHL sections to be micro-sited to avoid archaeological features and reduce visual effects on architecturally sensitive areas. In more heritage-rich settlements like Saggart and

[3] Adopted Plan - SDCC

Rathcoole, UGC can be used to follow existing road corridors, removing any permanent visual impacts on village character.

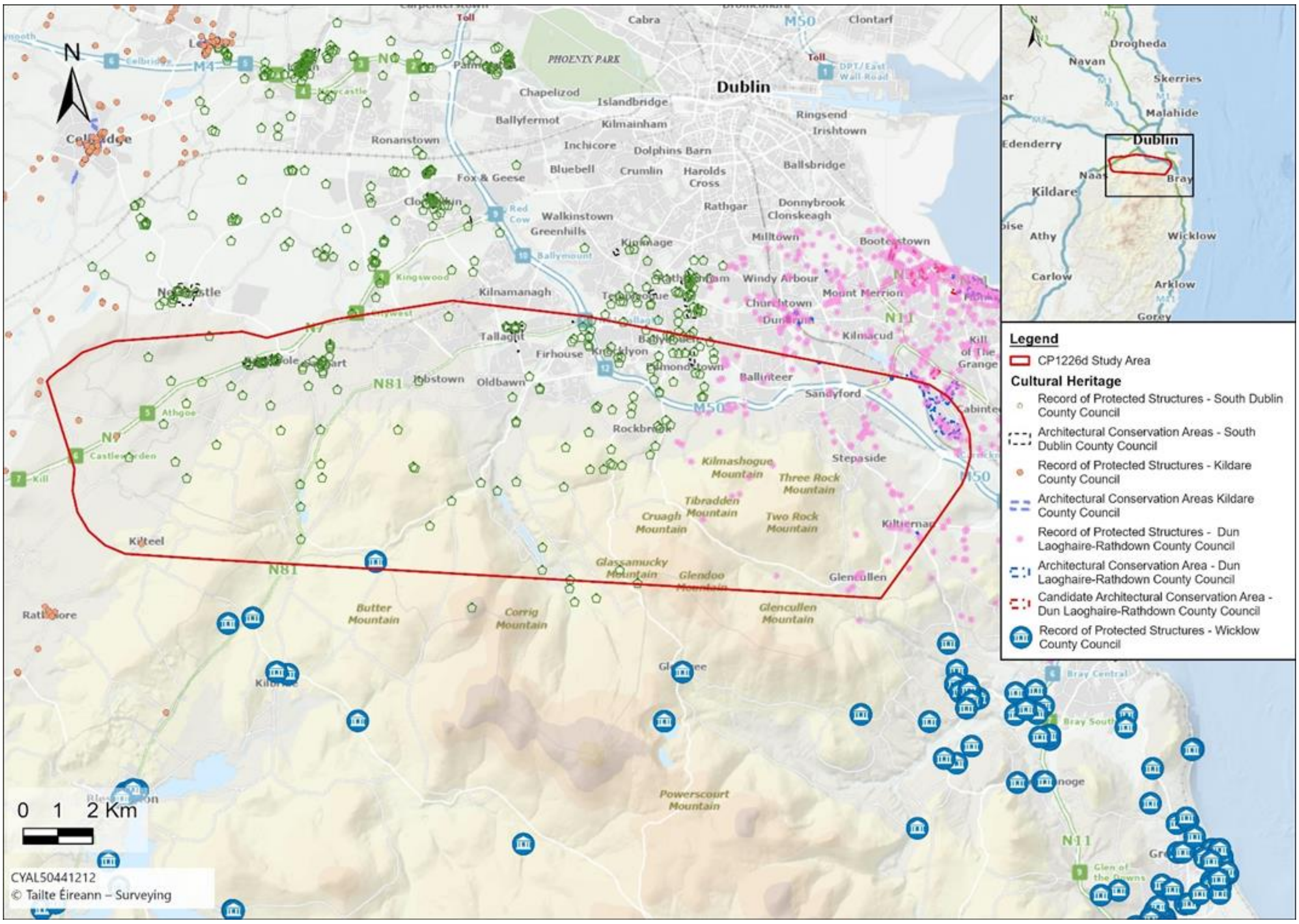

Figure 3-9 - Record of Protected Structures (RPS) and Architectural Conservation Areas (ACA) within the Study Area (DLCC, 2022; KCC, 2023; SDCC, 2022; WCC,2023)

3.5.7 Noise & Vibration

The north and east of the Study Area is located in densely populated regions of County Dublin located in South Dublin and Dún Laoghaire-Rathdown County Councils. Along with these areas, isolated residences in rural areas may experience temporary noise impacts from construction of OHL technology. Operational noise is also expected from OHL (i.e., corona), and according to EirGrid's EBES, Corona Noise is considered a significant issue for 350-500 kV and above.

For UGC technology construction phase noise will occur, however, it is considered low risk as noise impacts will be short term. No noise during operation is expected. The Study Area includes numerous proposed housing and infrastructure developments, increasing the risk of cumulative impacts such as noise from UGC technology construction activity[4].

[4] https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-Evidence-Based-Environmental-Study-8-Noise.pdf

The OHL sections of the OHL-PU technology generates temporary construction noise impacts and potential operational noise from corona effects, particularly on higher-voltage lines. UGC sections generally generate only short-term construction noise and no operational noise.

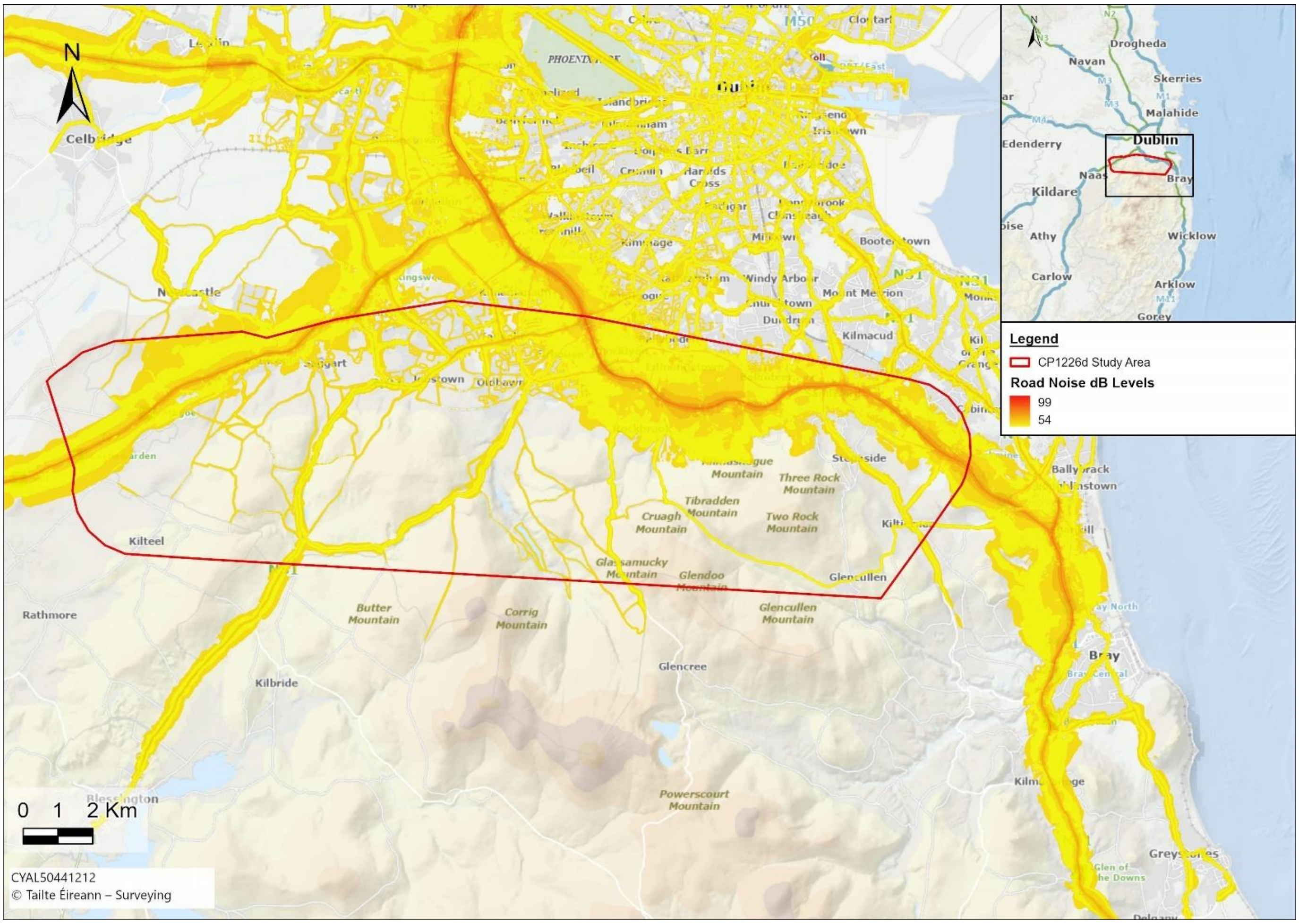

Figure 3-10 - Road Network dB Levels within the Study Area (EPA, 2025)

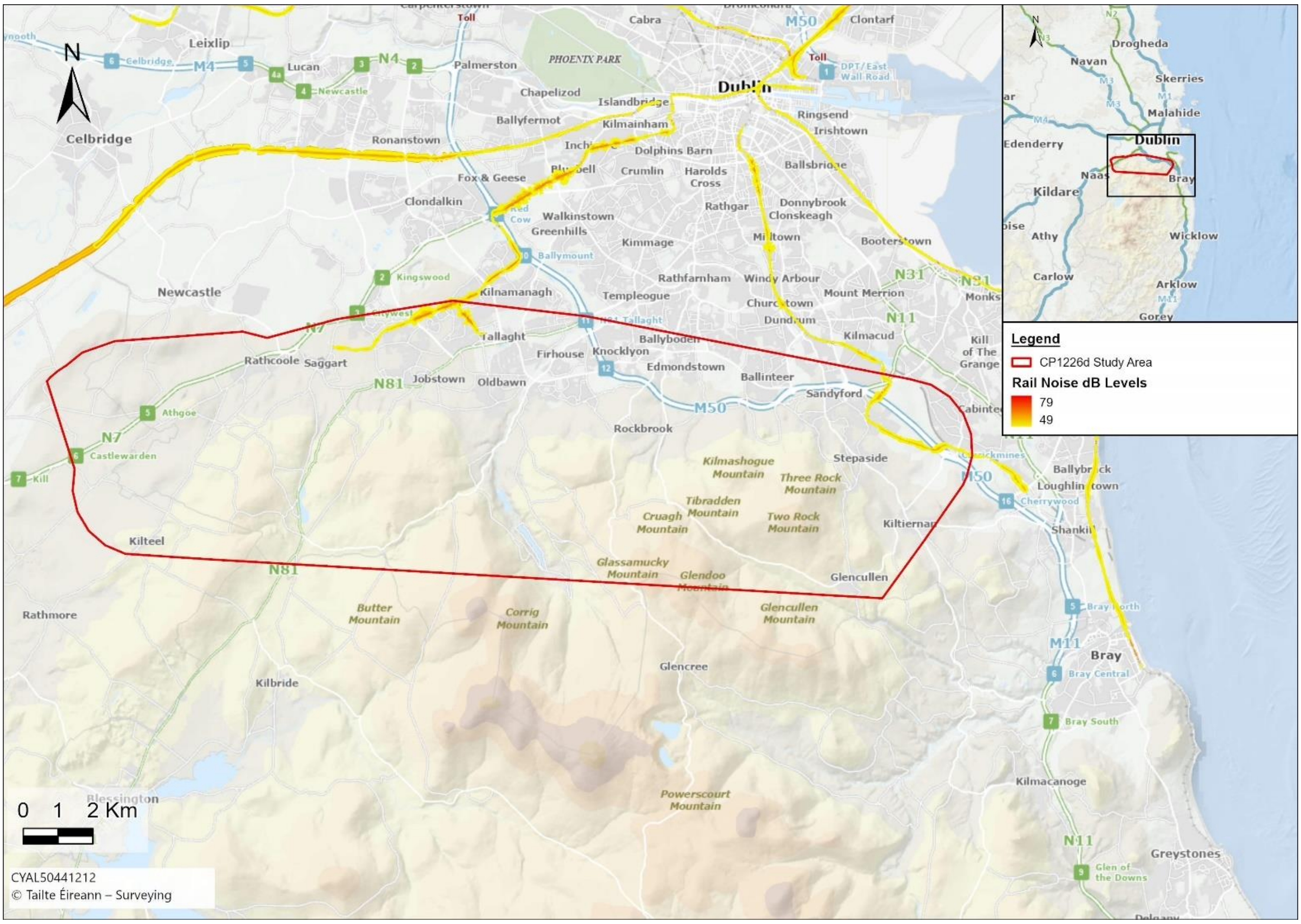

Figure 3-11 - Rail Network dB levels within the Study Area (EPA, 2025)

3.6 Socio-Economic Aspects

Table 3-7 summarises scores for the Socio-Economic aspects of each technology option.

Table 3-7 - MCA Scoring – Socio-Economic Aspects

Sub-Criteria	OHL	UGC	OHL-PU
Amenity			
Settlements and Communities			
Recreation and Tourism			
Traffic and Transport			
Overall Socio-Economic Score			

Both OHL and UGC technologies present community and socio-economic risks within the Study Area, and the OHL with partial undergrounding option introduces a combination of these effects due to its use of both overhead and underground components. While the types of effects overlap, the overall risk profiles differ between the technologies.

OHL presents a greater and more persistent socio-economic risk, primarily associated with long-term and operational effects. These include permanent changes to visual amenity, restrictions on land management and agricultural practices arising from wayleaves, and potential community concerns regarding landscape character and perceived safety. These long-term effects are considered to outweigh the relatively modest, short-term construction impacts associated with OHL installation. OHL development would also require sustained landowner engagement, particularly in relation to visual, land use and safety considerations, and may give rise to ongoing community perception issues during operation. While traffic impacts associated with OHL are generally limited, the construction of temporary access tracks may still necessitate localised traffic management.

UGC is characterised by short-term construction-related socio-economic impacts, including temporary traffic disruption, restricted access along recreational routes , and localised disturbance in rural and peri-urban areas. These effects are temporary in nature and largely confined to the construction phase. Once installed, UGC has a minimal long-term socio-economic footprint, with no operational noise, no visual intrusion, and no ongoing constraints on land use or agricultural activities. Construction-related impacts, including temporary traffic disruption at regional road crossings and potential effects on heritage and tourism receptors, are generally manageable through phased works, traffic management, and reinstatement measures.

The OHL with partial undergrounding option combines OHL and UGC characteristics and therefore introduces a blended socio-economic risk profile. The construction of UGC sections of the OHL-PU option would generate short-term disruption similar to UGC, including temporary access restrictions and traffic management requirements, particularly where works occur near community facilities or within more densely populated areas. The OHL sections of the OHL-PU option would introduce long-term amenity and land-use considerations comparable to standalone OHL, including potential visual impacts and the need for engagement with landowners regarding wayleaves and landscape character. In addition, the OHL with partial undergrounding option may require transition compounds and additional access routes, creating further localised construction activity and short-term disturbance. Overall, the socio-economic implications of the OHL with partial undergrounding option reflect a combination of the temporary construction impacts associated with UGC and the long-term operational presence associated with OHL.

3.6.1 Amenity

Amenity receptors within the Study Area include community facilities, walking and cycling routes, and high-value landscapes such as the Dublin and Wicklow Mountains, the Dodder and Liffey corridors, Marlay Park, and other open-space areas.

OHL can give rise to long-term amenity effects, particularly where routes traverse open space or sensitive rural landscapes (e.g., conservation/amenity landscape protection areas and high-amenity designations). These effects typically relate to changes in visual character and landscape perception and may require detailed visual assessment and mitigation measures, such as tower siting, structure selection, and landscape screening.

UGC has a limited long-term amenity footprint but can result in temporary disruption to amenities during the construction phase. This may include restricted access and reduced amenity value along walking and cycling routes, particularly within the River Liffey and River Dodder corridors, and at locations where trenching or HDD works are required along routes such as the Grand Canal Way.

The OHL with partial undergrounding option incorporate the amenity considerations of both technologies, with overhead sections introducing OHL-type long-term amenity effects and underground sections giving rise to construction-phase amenity disruption similar to UGC. In addition, the OHL with partial undergrounding option may require transition compounds and additional access tracks, which can extend the extent and duration of localised construction-related disturbance to amenities.

3.6.2 Settlements and Communities

The Study Area spans urban parts of Dún Laoghaire-Rathdown and South County Dublin (e.g., Tallaght, Rathcoole, Saggart, Carrickmines) and more rural/agricultural lands with scattered dwellings and holdings. It includes numerous community facilities and sensitive receptors, such as hospitals, care homes (e.g., Marlay Nursing Home, Simpsons Hospital), educational campuses (e.g., TU Dublin Tallaght), retail and business centres, and local schools. OHL routeing must navigate densely populated areas, rural dwellings, and agricultural lands where complete avoidance of sensitive receptors may not be feasible; alignment refinement, setback distances, and focused consultation are key.

UGC can be aligned through agricultural corridors to reduce interaction with dense settlement, yet construction near schools, care homes, and other sensitive receptors requires health and safety controls, access planning, and timing constraints; interactions with business estates and town/district centres also need tailored construction management.

The OHL with partial undergrounding option combines these settlement considerations, with underground sections requiring construction-phase safeguards and overhead sections requiring long-term wayleave and community engagement; siting of transition compounds should consider proximity to residents, access, and visual context.

3.6.3 Recreation & Tourism

The Study Area includes valued Recreational and tourism resources including sports facilities (e.g., Tallaght Stadium, all-weather pitches), golf and equestrian facilities, walking routes (e.g., Fitzsimons Wood, Slievethoul and Lugg Forest trails), and heritage destinations such as Marlay Park. OHL can influence the character and future development potential of recreation and tourism areas where corridors intersect these assets and high-amenity landscapes. However, OHL technologies would not impact tourist numbers and it’s not anticipated that the ability to enjoy the area in the longer term would be impacted.

UGC generally limits permanent effects on recreational use but can affect visitor experience and access during construction, particularly where works coincide with parks, trail networks, and heritage settings; these effects are typically short-term and managed through phasing, diversions, and reinstatement.

The OHL with partial undergrounding option carries both sets of interactions, with underground construction affecting access and overhead sections influencing setting, and with transition compounds and associated access potentially extending the duration and footprint of construction-phase disturbance at specific recreational locations.

3.6.4 Traffic & Transport

Traffic and transport considerations differ by construction method and by proximity to dense urban networks such as Leopardstown, Sandyford, Carrickmines, Tallaght, Ballinteer, Citywest, and Rathcoole.

OHL construction typically cross motorways and regional roads (e.g., M50, N7, N81, N31, R113, R114) with limited disruption, though temporary access tracks and localised works still require traffic management and coordination, particularly given cumulative congestion risks linked to proposed housing and infrastructure.

UGC construction generates more intensive, localised traffic management requirements, including lane restrictions, junction controls, and works programming for road crossings and HDD under water features (e.g., the River Dodder) and at key active travel routes. Mitigation typically focuses on routeing along wider roads where feasible, careful siting of joint bays (in verges or private lands), and comprehensive traffic management plans to maintain safe access for residents, schools, healthcare, businesses and emergency services.

The OHL with partial undergrounding option combines these dynamics with OHL sections generally associated with relatively contained road disruption, while UGC sections require more detailed traffic management. In addition, transition compounds and additional access routes can introduce further temporary transport interactions. Early coordination with local authorities and developers is therefore essential to managing cumulative traffic and transport effects.

4. Conclusion

The objective of Step 3 is to identify a best performing technology solution and associated study area to meet the identified need from Step 2. This report summarises the MCA completed in Step 3 on the three (3no.) options for the Steelstown-Carrickmines circuit technology (i.e., overhead line, underground cable and overhead line with partial undergrounding). This report presents the risks associated with the three (3no.) technology options; a decision on the best performing technology will be made later in Step 3.

4.1 Steelstown-Carrickmines Circuit

A Multi-Criteria Analysis (MCA) was carried out in accordance with the EirGrid Multi-Criteria Analysis Guidelines. The five main criteria considered in the MCA are:

- Technical;
- Economic;
- Deliverability;
- Environmental; and
- Socio-Economic.

Each of these criteria were broken down further into sub-criteria and a multi-criteria evaluation matrix was used to determine the performance of the three (3no.) technology options. The overall scores for each of the five main criteria is shown in Table 4-1.

Table 4-1 - MCA Scoring – Overall Score (Steelstown-Carrickmines Circuit)

Assessment Criteria	**OHL**	**UGC**	**OHL-PU**
Technical Performance			
Economic Assessment			
Deliverability Aspects			
Environmental Aspects			
Socio-Economic Aspects			
Overall Score			

All technology options score ‘Moderate’ risk overall, each with varying risk profiles across the different criteria and sub-criteria. The OHL with partial undergrounding technology option is scored ‘Moderate’ across all criteria, whereas the OHL and UGC options range from Moderate-Low to Moderate-High across the different criteria.

Technical: OHLs can achieve higher circuit ratings and have higher availability levels (fewer failures). Compared to UGC circuits, OHLs are easier to expand (voltage uprate) or extend, and they carry less operational risk. The technical performance of the OHL with partial undergrounding option is between that of the OHL and UGC technology options.

Economic: OHL solutions offer lower construction and lifecycle costs, compared to UGC technology. The improved reliability of OHLs and reduced exposure to constraints also result in lower Single Energy Market (SEM) costs over the project lifetime. The economic performance of the OHL with partial undergrounding option is between that of the OHL and UGC technology options (for the OHL-PU review it was assumed that the ratio of OHL to UGC lengths is approximately 3:1).

Deliverability: UGC technology performs better, as OHL construction is heavily constrained by existing and planned settlement patterns, insufficient wayleave widths, aviation constraints, and multiple high-risk crossing points. Achieving a compliant OHL corridor is significantly more challenging within the Study Area and presents greater landowner, environmental, planning and programme risk. UGC, routed mainly along existing regional roads, offers more straightforward permitting (except for any UGC sections along National roads), reduced land interactions, and fewer visual and amenity concerns, enabling a more deliverable and publicly acceptable solution. The third technology option, OHL with partial undergrounding, is seen to predominantly score in between the two other options. The OHL-PU option is anticipated to have a greater risk of overall programme delay due to difficulties in obtaining public acceptance and the necessary landowner wayleaves for the OHL circuit sections. The 'Land Availability' risks are considered to be less than the OHL option, as UGC technology can be deployed for the final approach into Carrickmines Substation.

Environmental: UGC avoids permanent visual and landscape impacts and removes collision and electrocution risk for birds, which is a significant benefit in areas close to SPAs, wetlands, or known flight paths. Once reinstated, there are no above-ground structures within fields, allowing uninterrupted farming operations across the land surface and a narrower permanent wayleave compared with overhead lines. Day-to-day agricultural use can generally resume over the cable, and the absence of towers or poles is often perceived positively by landowners and communities. However, off-road UGC results in widespread ground disturbance due to continuous trenching, temporary access routes, and passing bays, leading to greater habitat loss during construction than overhead lines. Even after reinstatement, long-term impacts can include permanent breaks in hedgerows or treelines, as deep-rooted vegetation cannot be replanted over the cable, causing habitat fragmentation. Soil structure may take several seasons to recover, with potential localised reductions in productivity, and joint bays introduce small but permanent constraints on land use. Future faults require re-excavation, resulting in repeat disturbance to farmland and biodiversity, and there is an increased risk of invasive species spread along disturbed corridors.

OHL have a very small permanent ground footprint, limited to pole or tower bases, allowing most farmland to remain fully productive with minimal long-term soil disturbance. Construction impacts are localised and short-term, and once installed, farming activities such as grazing and tillage can continue beneath the line. There are no restrictions on soil depth for cultivation or drainage, and faults can be repaired quickly with little additional land disturbance, reducing long-term impacts on land use. OHL introduce permanent above-ground structures that can affect landscape character and visual amenity, often driving community opposition. They pose an ongoing collision risk to birds, even where mitigation such as line markers is used, and may affect bird and bat behaviour along hedgerows and flight routes. In wooded areas, overhead lines require permanent vegetation clearance within the wayleave, resulting in long-term habitat loss and alteration. Towers and poles can also slightly constrain machinery movement and field layouts, particularly where structures are located within productive farmland.

UGC technology can offer lower long-term impacts, greater compatibility with sensitive landscape and community settings, and a lower risk profile in the context of the Study Area. Although UGC carries higher construction-phase risks, these are temporary, manageable, and confined to the construction phase. Conversely, OHL introduces long-term and often irreversible impacts on landscape, amenity, biodiversity, and community receptors. Detailed visual assessments and mitigation measures such as careful tower siting will be required. Traffic and Transport constraints for OHL technology are considered minimal as crossings of motorways, national and regional roads can be achieved without major disruption. However, temporary access tracks for OHL tower construction may affect local traffic and require traffic management plans. For the OHL with partial undergrounding option, the OHL component reduces ground disturbance and the UGC component avoids bird collision risks. OHL-PU can still cause combined impacts, such as trenching, species disturbance, and hydrological disruption. These risks require careful routeing, HDD at sensitive crossings, and precise micro-siting. OHL-PU also poses risks to water bodies and groundwater, including sedimentation and contamination, but these can be mitigated with standard water protection measures and a CEMP.

Socio-Economic: OHL technology presents greater landscape, visual, and amenity impacts than UGC, particularly when routed through urban areas, rural landscapes of medium to high sensitivity, and near scenic routes. These effects necessitate detailed visual assessments and mitigation strategies, such as strategic tower placement and leveraging existing vegetation for screening. While OHL construction typically has a smaller footprint than UGC, it requires permanent wayleaves and clearance zones, potentially limiting future land use and agricultural practices. Temporary access tracks for tower installation may also disrupt local traffic, requiring traffic management plans. However, OHL generally causes minimal disruption to major roads, as crossings can be achieved without significant interference. The Study Area includes numerous urban centres and recreational amenities. In these contexts, OHL may have more pronounced visual and amenity impacts, whereas UGC can reduce such effects. Conversely, UGC construction in urban areas may lead to greater traffic and access disruptions during the construction phase. Engagement with landowners remains essential to address concerns around visual intrusion and operational safety, particularly for OHL infrastructure. The OHL with partial undergrounding option combines OHL and UGC characteristics and therefore introduces a blended socio-economic risk profile.

5. Next Steps

This report, the Technology Options Report, will be published and presented to the public through a consultation campaign, led by EirGrid. Should feedback be given in response to this public information campaign it will be documented by EirGrid and the MCA will be reviewed and may be updated, if required.

EirGrid has commenced engagement with key stakeholders (e.g., public bodies, local authorities, utility providers, etc.) and this process will continue in parallel with the public consultation campaign, and into future steps of the project.

Once a best performing technology option has been selected and potential circuit corridors are identified in Step 4, landowner engagement for any off-road sections of these potential corridors (if required) will also be carried out.

The circuit corridor options will then undergo a detailed MCA assessment in Step 4 to identify an Emerging Best Performing Option (EBPO), which will be subject to further public consultation in Step 4.

The assessments in future steps will be aided by site visits, site walkover surveys, and if applicable, site investigations. EirGrid will continue to engage with communities and landowners about relevant surveys and provide updates before they start. These may include, but are not limited to, the following:

- Topographical surveys;
- Ground investigations, including test pits and boreholes;
- Ground penetrating radar (GPR) surveys;
- Slit trench surveys;
- Ground resistivity measurements;
- Soil contamination testing; and
- Ecological and environmental site investigations e.g., geophysical surveys.

For the next steps i.e., Step 4 and Step 5, the following reports will be prepared:

- Social Impact Assessment;
- Planning and Consent Strategy;
- Screening for Appropriate Assessment and Screening for Environmental Impact Assessment;
- Step 4 Report; and
- All environmental, technical and planning documents associated with the Step 5 planning application submission.

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