8. LAND SOILS AND GEOLOGY

8.1 Introduction

8.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO to carry out an assessment of the potential likely and significant effects of the Proposed Carrow Wind Farm and Proposed Grid Connection (Proposed Project), Co. Tipperary and Co. Limerick on land, soils and geology aspects of the receiving environment.

The Proposed Project is described in full in Chapter 4 of this EIAR.

The 'Proposed Wind Farm' refers to the 14 no. turbines and supporting infrastructure including the Battery Energy Storage System (BESS) and Biodiversity Enhancement and Management Plan (BEMP) as detailed in Chapter 4 of this EIAR.

The 'Proposed Grid Connection' refers to the 110kV on-site substation, and approximately 37.6km underground 110kV grid connection cabling connecting to the existing Killonan 110kV substation, in the townland of Milltown, southeast of Limerick City, and all ancillary works and apparatus. The Proposed Grid Connection is described in detail in Chapter 4 of this EIAR.

Where 'the Site' is referred to, this relates to the primary study area for the Proposed Project EIAR, as delineated by the EIAR Site Boundary and includes both the Proposed Wind Farm and Proposed Grid Connection.

The 'Proposed Wind Farm site' refers to the portion of the Site surrounding the Proposed Wind Farm but excluding the portion of the Site surrounding the Proposed Grid Connection underground cabling route and 110kV substation.

This chapter provides a baseline assessment of the environmental setting of the Proposed Project, as described in Chapter 4, in terms of land, soils and geology and discusses the potential likely and significant effects (if any) that the construction, operation and decommissioning of the Proposed Project will have. Where required, appropriate mitigation measures to avoid any identified significant effects to land, soils and geology are recommended and the residual effects of the Proposed Project post-mitigation are assessed.

The Proposed Project Study Area with regard Land, Soils and Geology is within a minimum 2km distance of the EIAR Site Boundary as per the Institute of Geologists of Ireland (2013) guidance. However, only direct effects on land, soils and geology within the Site are expected with regard the Proposed Project works (i.e. no off-site indirect effects or cumulative effects are anticipated).

8.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include upland hydrology and windfarm drainage design. We routinely complete impact assessment reports for geological, hydrological and hydrogeological aspects for a variety of project types.

This chapter of the EIAR was prepared by Michael Gill, David Broderick, Adam Keegan and Nitesh Dalal.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer/Hydrologist with over 24 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Glenard Wind Farm, Cahermurphy Wind Farm, and Seven Hills Wind Farm, and over 100 other wind farm related projects across the country.

David Broderick (P. Geo., BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 19 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Borrisbeg Wind Farm, Upperchurch WF Grid Connection and Knockroe Wind Farm, and over 60 other wind farm related projects across the country.

Adam Keegan (B.Sc., M.Sc.) is a Hydrogeologist with 8 years environmental consultancy experience in Ireland. Adam has worked on numerous Environmental Impact Assessments for infrastructure projects, such as wind farms, strategic housing developments and quarries. Adam has experience in intrusive site investigation works within Limestone bedrock aquifers and experience in trial and production well drilling within areas mapped as Regionally Karstified. Adam has worked on several wind farm EIAR projects, including Croagh WF, Lyrenacarriga WF (SID), Cleanrath WF, Carrownagowan WF (SID), and Fossy WF.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management. Nitesh holds a M.Sc. in Environmental Science from University College Dublin (2024), a PG Diploma in Health, Safety and Environment from Annamalai University, India (2021) and B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016).

8.1.3 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU. Regard has also been taken of the requirements of the following legislation:

- Planning and Development Act, 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No. 296/2018 European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018; and,
- The Heritage Act 1995, as amended.

8.1.4 Relevant Guidance

The Land, Soils and Geology chapter of this EIAR is carried out in accordance with the 'EIA Directive' as amended by Directive 2014/52/EU and having regard where relevant to guidance contained in the following documents:

- Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013): Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Commission 2017).

8.2 Assessment Methodology

8.2.1 Desk Study

A desk study of the Site and Study Area was completed in advance of undertaking the walkover survey and site investigations. This involved collecting all relevant geological data for the Site and surrounding area. This included consultation with the following data sources:

- Environmental Protection Agency database (**www.epa.ie**);
- Geological Survey of Ireland - Groundwater and Geology Databases (**www.gsi.ie**);
- Geological Survey of Ireland – Geological Heritage site mapping (**www.gsi.ie**);
- Bedrock Geology 1:100,000 Scale Map Series. Geological Survey of Ireland;
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets;
- General Soil Map of Ireland 2nd edition (**www.epa.ie**); and,
- Aerial Photography, 1:5000 and 6 inch base mapping.

8.2.2 Baseline Monitoring and Site Investigations

A walkover survey, including geological mapping and investigations of the Site, were undertaken by David Broderick and Adam Keegan of HES (refer to Section 8.1.2 above for qualifications and experience) on 4th, 5th & 8th June, 12th December 2024 and on 12th February and 21st October 2025.

Ground investigations in the form of trial pits (28 no. in total) were carried under the supervision of HES out on the following dates:

- 4th and 5th June 2024 (12 no.);
- 12th December 2024 (9 no.); and,
- 12th February 2025 (7 no.).

The trial pits (28 no.) were carried out at various locations across the Site to provide information on the ground conditions, depth to bedrock and to investigate the potential to develop borrow pits within the Site. Soil gouge cores were carried out at areas not accessible for trial pitting.

The objectives of the intrusive site investigations included mapping the distribution and depth of soil and mineral subsoils at the Site along with assessing the mineral subsoil / bedrock conditions at key Proposed Project locations (i.e. proposed turbines, temporary construction compounds, existing and

proposed access roads, spoil repository areas, borrow pits and 110kV substation/BESS). This data was used to inform the impact assessment and final layout design.

In summary, site investigations to address the Land, Soils and Geology chapter of the EIAR included the following:

- Walkover surveys and geological mapping of the Site area were undertaken to assess general ground conditions;
- Trial pitting (28 no.) under the supervision of HES to investigate soil and mineral subsoil lithology as well as depth to bedrock;
- Soils gouge cores (10 no.) were carried out by HES in areas not accessible for trial pitting; and,
- Mineral subsoils were logged according to BS: 5930.

8.2.3 Scope and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process and the list of Consultees is outlined in Section 2.5 of this EIAR.

The Geological Survey of Ireland (GSI) were the only body to respond with regard matters relating to land, soils and geology as summarised in **Table 8-1** below.

The GSI provided a standard response which recommended the use of their publicly available geological data sets in the preparation of the EIAR. These data sets, available to view at www.gsi.ie, have been used in the preparation of this chapter as detailed in Section 8.2.1 above.

Table 8-1: Summary of Scoping Responses with Regards, Land, Soils and Geology

Consultee	Response	Addressed in Section
Geological Survey of Ireland (GSI)	*"Our records show that there are no County Geological Sites in the vicinity of the proposed wind farm".*	Section 8.3.6

8.2.4 Impact Assessment Methodology

Using information from the desk study and data from the site investigations, an assessment of the importance of the land, soil and geological environment within the Site and Study Area is carried out using the criteria set out in **Table 8-2** (NRA, 2008).

Table 8-2 Estimation of Importance of Soil and Geology Criteria (NRA, 2008).

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying the site is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying site is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertility soils. Moderately sized existing quarry or pit Marginally economic extractable mineral resource.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying site is moderate on a local scale.	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed Wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit. Sub-economic extractable mineral Resource.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying site is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral Resource.

EPA, 2022 states that there are 7 no. steps in the preparation of the EIAR. The initial steps relate to screening, scoping, the consideration of alternatives and the description of the project. Step 5 relates to

the description of the baseline environment which is presented in Section 8.3 for the land, soils and geological environment. Step 6 relates to the assessment of impacts and is presented in Section 8.6. The guideline criteria for the assessment of effects states that the purpose of an EIAR is to identify, describe and present an assessment of the likely significant effects. The likely effects are described with respect to their quality (positive, neutral or negative), significance (imperceptible to profound), extent (i.e. size of area or number of sites effected), context (is the effect unique or being increasingly experienced), probability (likely or unlikely), duration (momentary to permanent), frequency and reversibility. The descriptors used in this chapter are those set out in the EPA, 2022 glossary of effects as shown in Chapter 1 of this EIAR. In addition, the two impact characteristics, proximity and probability are described for each impact, and these are defined in **Table 8-3**.

Table 8-3: Additional Impact Characteristics.

Impact Characteristic	Degree/ Nature	Description
Proximity	Direct	An impact which occurs within the area of the Proposed Development, as a direct result of the Proposed Development.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Unlikely	The effect can reasonably be expected not to occur.
	Likely	The effect can be reasonably expected to occur.

In order to provide an understanding of this descriptive system in terms of the geological/hydrological environment, elements of this system of description of effects are related to examples of potential likely significant effects on the geology and morphology of the existing environment, as listed in **Table 8-4**.

Table 8-4: Impact descriptors related to the receiving environment.

Impact Characteristics		Potential Hydrological Impacts
Quality	Significance	
Negative only	Profound	Widespread permanent impact on: › The extent or morphology of a cSAC. › Regionally important aquifers. › Extents of floodplains. Mitigation measures are unlikely to remove such impacts.
Positive or Negative	Significant	Local or widespread time-dependent impacts on: › The extent or morphology of a cSAC / ecologically important area. › A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). › Extent of floodplains. Widespread permanent impacts on the extent or morphology of an NHA/ecologically important area. Mitigation measures (to design) will reduce but not completely remove the impact – residual impacts will occur.

Impact Characteristics		Potential Hydrological Impacts
Quality	Significance	
Positive or Negative	Moderate	Local time-dependent impacts on: › The extent or morphology of a cSAC / NHA / ecologically important area. › A minor hydrogeological feature. › Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time-dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

8.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Land, Soils and Geology Chapter of the EIAR. The site investigations and surveys carried out were appropriate for the purpose of assessing effects on Land, Soils and Geology and also for Proposed Project infrastructure design.

8.3 Existing Environment

8.3.1 Site Description and Topography

The Proposed Wind Farm site, which has a total area of approximately 830ha (hectares) is located approximately 2.4km south of the village of Hollyford and 4.7km north of the village of Dundrum, Co. Tipperary.

The Proposed Wind Farm Site is located in an upland setting and is dominated by coniferous forestry plantations along with agricultural pastural land, mixed forest and transitional woodland-shrub. Apart from three turbine locations (T1, T5 and T9), all other proposed turbine locations are situated in coniferous forestry. Proposed turbine location T5 is in scrubland while T1 and T9 are in grassland.

The Proposed Wind Farm Site is accessible via a network of local public roads, forestry tracks and farm tracks. Several site entrances off local roads will be required for the construction and operational phase of the Proposed Project.

The Proposed Wind Farm site setting on the southern foothills of the Mauherslieve Mountains means that topography in the local area is hilly with the Proposed Wind Farm infrastructure spread across several stream valleys that drain southerly within or adjacent to the Proposed Wind Farm site. Ground elevations within the Proposed Wind Farm site range from ~376m OD (metres above Ordnance Datum) on the north to approximately 163m OD on the south. Slopes range from moderate to steep, with the steepest slopes being on the valley sides of the main the streams that drain the Proposed Wind Farm site.

The Proposed Grid Connection route includes for underground cabling from the proposed 110kV substation, located on the south of the Proposed Wind Farm Site to the existing Killonan 110kV substation in the townland of Milltown, Co. Limerick. The proposed 110kV substation setting is poorly drained, rough grassland pastures.

The Proposed Grid Connection underground cable route, measuring approximately 37.6km in length, is primarily located within the public road corridor. Approximately 3.2km is proposed within National Roads, 15.5km proposed within Regional Roads, 16.9km proposed within Local Roads and approximately 2m proposed within agricultural land in Brittas, Co. Limerick.

A Biodiversity Enhancement and Management Plan (BEMP) is proposed for areas of the Proposed Wind Farm site. This includes management of 30.2ha of wet grassland for Marsh Fritillary habitat enhancement, enhancement of approximately 3.3ha of semi-natural woodland habitat and planting of riparian woodland strips either side of mapped watercourses within the Proposed Wind Farm site.

TDR temporary accommodation works will be required at 8 no. locations to facilitate the delivery of turbine components and other abnormal loads to the Proposed Wind Farm during the construction phase. The 8 no. locations are along Regional Road R505 and local road L1283 close to the Proposed Wind Farm.

8.3.2 Land and Land Use

EPA Corine land cover maps (2018) (www.epa.ie) show that the Proposed Wind Farm Site comprises of mainly coniferous forestry surrounded by transitional woodland scrub and agricultural pastures. No significant land use changes have been recorded by historic Corine mapping (1990 - 2018).

The Proposed Grid Connection cable route is located mainly within the carriageway of the existing public road network, within the Proposed Wind farm internal road network and within off-site agricultural land where the route goes briefly off road. The proposed 110kV substation is located within agricultural pastures on the South of the Proposed Wind Farm.

According to Corine land cover mapping (2018), the majority of the lands adjacent to the Proposed Grid Connection cable route comprises of agricultural pastures with some areas of mixed forests, discontinuous urban fabric and transitional woodland scrub.

The proposed TDR works are largely contained within the public road corridor with minor encroachment of adjacent agricultural land.

8.3.3 Soils and Subsoils

8.3.3.1 GSI/EPA Mapping

The published Teagasc soils map (www.gsi.ie) for the area shows that the Proposed Wind Farm site is mostly overlain by poorly drained mineral soils derived from mainly non-calcareous parent materials (AminPD). Smaller areas further on the north of the Proposed Wind Farm site are mapped to comprise deep well drained mineral (Mainly acidic) soils (AminDW) and shallow well drained (mainly acidic) soils (AminSW).

These soils are also sparsely mapped along the boundaries of the Proposed Wind Farm site on the east, west and south. Alluvium soil is mapped along the Lackenacoombe Stream and Glasheenyreagha Stream within the Proposed Wind Farm site and also along the Aughnaglanny River and Multeen River to the east and west of the Proposed Wind Farm respectively.

The GSI subsoils map (www.gsi.ie) shows that the dominant subsoil type within the Proposed Wind Farm site is glacial till derived from Lower Palaeozoic sandstones and shales. Bedrock outcrop or subcrop is mapped to occur predominantly on the more elevated northern and northwestern parts of the Proposed Wind Farm site suggesting shallow depths of glacial till over bedrock.

Bedrock outcrop or subcrop is also mapped along sections of both the Lackenacoombe Stream and Glasheenyreagha Stream which present as bedrock escarpments along the stream valley sides. Glacial till derived from Lower Palaeozoic and Devonian sandstones are mapped on the eastern and southeastern fringes of the Proposed Wind Farm site.

The published Teagasc soils map for the Study Area shows that the majority of the Proposed Grid Connection route passes through areas overlain by deep well drained mineral (Mainly acidic) (AminDW), mineral poorly drained (Mainly acidic) (AminPD) and mineral poorly drained (Mainly basic) (BminPD) with small areas mapped as shallow well drained mineral (Mainly acidic) (AminSW), made ground (Made), shallow poorly drained mineral (Mainly acidic) (AminSP), cutover/cutaway peat (Cut), lacustrine type soils (Lac) and alluvial (mineral) (AlluvMIN).

The GSI subsoil mapping along the Proposed Grid Connection route shows glacial till derived from Devonian Sandstones (TDSs), gravels derived from Lower Palaeozoic and Devonian Sandstones (GLPDSs) and glacial till derived from limestones (TLs) with small areas underlain by glacial till derived from Lower Palaeozoic Sandstones and Shales (TLPSsS), Cut over raised peat (Cut) and Alluvium (A).

Due to the nature of the Proposed Grid Connection cable route being predominately along the carriageway of public roads, the underground cabling earthworks will have little interaction with natural soils and subsoils. There is approximately 2km of off-road section where cabling will be laid in agricultural lands.

Subsoils mapped along the TDR works area is mainly Glacial till derived from Lower Palaeozoic and Devonian sandstones.

A subsoil geology map for the Proposed Wind Farm is shown as **Figure 8-1** below.

8.3.3.2 Site Investigations

The ground investigation comprised 28 no. trial pits across the Site which was supplemented by soil gouge coring (10 no.) in forested areas that were not accessible by the excavator.

A total of 27 no. trial pits were carried out at Proposed Wind Farm infrastructure and 1 no. at the Proposed Grid Connection 110kV substation. No site investigations were carried out along the Proposed Grid Connection cable route or the TDR works areas.

There is no blanket bog present at the Site and therefore no requirement for peat probing. Trial pit logs are attached as **Appendix 8-1**.

Trial pits were carried out at various locations across the Site to provide information on the ground conditions, depth to bedrock, bedrock competency and to investigate the potential to develop borrow pits within the Proposed Wind Farm. A site investigation map is shown as **Figure 8-2** below.

Mineral subsoils most encountered were SILT, CLAY or SILT/CLAY combinations and typically presented as firm to very firm and sometimes stiff, slightly sandy, slightly gravelly with cobbles and occasionally interbedded with SAND and GRAVEL layers. The subsoils are consistent with the underlying parent material (i.e. sandstone/siltstone bedrock).

Refusal on bedrock (presumed) during trial pitting was recorded in 18 of the 28 no. trial pits (64%).

The depth to bedrock at the 18 no. locations ranged between 0m and 3.3m with an average of 1.8m. Trial pits that encountered bedrock were distributed throughout the Proposed Wind Farm site indicating relatively shallow bedrock across the overall Proposed Wind Farm site. At these ground elevations shallow bedrock would be expected and is consistent with GSI mapping (i.e. bedrock outcrop or subcrop). Bedrock was not encountered at the Proposed Grid Connection 110kV substation at a depth of 2.8mbgl.

Trial pits were carried out at the proposed turbine foundation locations at T1, T6 and T9 and within 150m of the proposed turbine base at T3, T4, T8, T10, T11, T12 and T13. Access to the proposed turbine foundation location was not possible at the latter turbine locations due to forestry coverage. Bedrock was confirmed at or within 150m of proposed turbine locations T1, T4, T6, T9 and T11.

A soil gouge core (GC) was carried out as an alternative at proposed turbine foundations (T2, T5, T7 and T14) that were not accessible within a reasonable distance for trial pitting (>150m). Gouge cores typically penetrate to a depth of approximately 300 - 500mm depending on subsoil strength and therefore cannot determine depth to bedrock.

Trial pits were also carried at the proposed 2 no. borrow pits, 110kV substation (Proposed Grid Connection), meteorological mast, 3 no. temporary construction compounds and 3 no. spoil repositories. Overall, shallow bedrock was met at these locations (approximately 1 to 3m in depth).

A summary of investigations carried out at the Proposed Project infrastructure is shown on **Table 8-5** below.

Table 8-5: Site Investigation Summary at Proposed Project locations.

Location ID	Investigation ID	Depth to Bedrock (m)	Summary of Mineral Subsoil Lithology
T1	TP12	2	Firm, slightly gravelly, sandy CLAY
T2	GC-T2	n/d	Firm, sandy CLAY
T3	TP11	>1.8	Firm, silty SAND with cobbles
T4	TP03	3.3	Firm, gravelly CLAY with SAND layer
T5	GC-T5	n/d	Firm, slightly gravelly SILT/CLAY
T6	TP20	2	Soft SILT over firm, sandy gravelly SILT
T7	GC-T7	n/d	Firm, sandy CLAY
T8	TP01	>3	Firm, slightly gravelly SILT/CLAY over firm SILT
T9	TP14	1.2	Firm, very gravelly SILT/CLAY with cobbles
T10	TP19	>3	Firm SILT over firm, gravelly, sandy CLAY
T11	TP28	0.7	Soft grey, gravelly SILT
T12	TP16	>3m	Firm, sandy, gravelly SILT/CLAY
T13	TP18	>2.7	Red, firm, sandy, gravelly SILT
T14	GC-T14	n/d	Firm, sandy CLAY
Substation/BESS	TP07	>2.8	Firm, reddish brown, slightly gravelly SILT
Borrow Pit 1	TP03	3.3	Firm, gravelly CLAY with SAND layer
Borrow Pit 2	TP14	1.2	Firm, very gravelly SILT/CLAY with cobbles
Temp Comp 1	TP07	>2.8	Firm, reddish brown, slightly gravelly SILT
Temp Comp 2	TP02	2.5	Firm, sandy, gravelly SILT/CLAY
Temp Comp 3	TP17	1	Soft, sandy SILT
Spoil Repos 1	TP01	>3	Firm, slightly gravelly SILT/CLAY over firm SILT
Spoil Repos 2	TP12	2	Firm, slightly gravelly, sandy CLAY
Spoil Repos 3	TP15	1.6	Soft to firm, gravelly sandy SILT
Met Mast	TP06	2.4	Firm, gravelly SILT

Note: n/d – Not determined as only gouge core undertaken

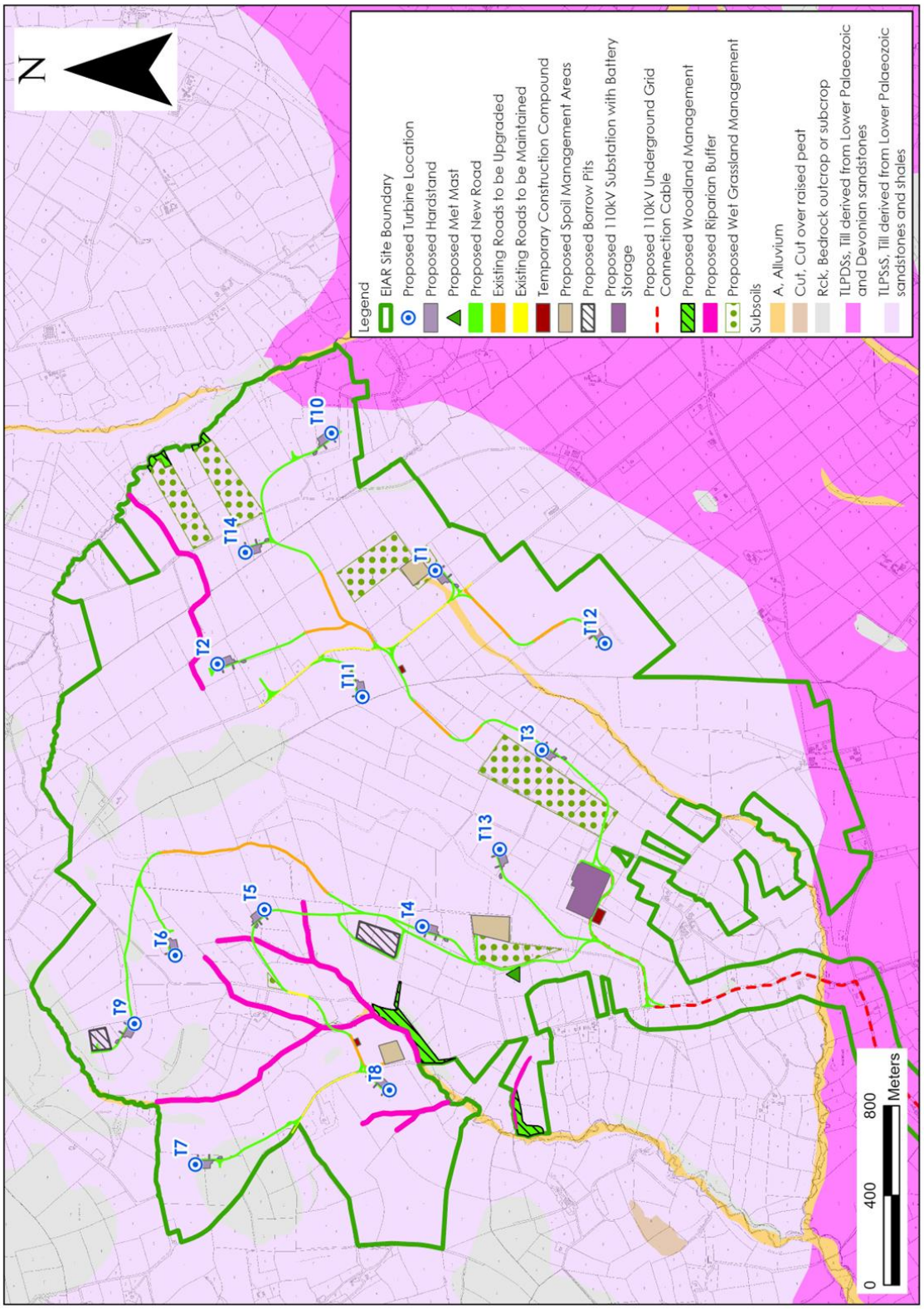

Figure 8-1: GSI Subsoil Mapping

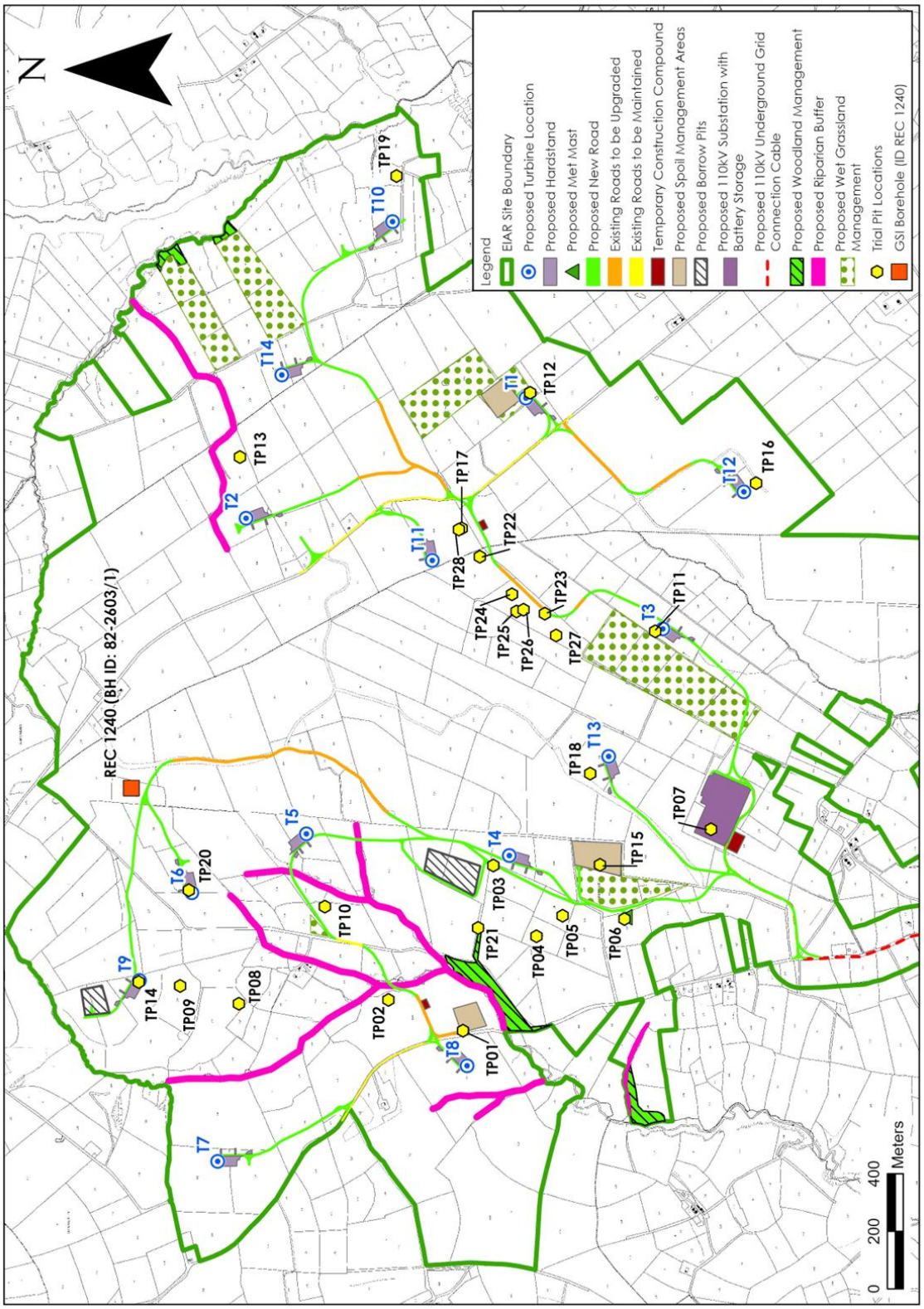

Figure 8-2: Site Investigation Map

8.3.4 Bedrock Geology

8.3.4.1 GSI Mapping

According to GSI mapping (www.gsi.ie) the majority of the Proposed Wind Farm site is underlain by the Cappagh White Sandstone Formation (Old Red Sandstone) which is described as red & white sandstone, conglomerate. Based on the GSI mapping proposed turbine locations T1 to T7 and T10 to T14 and proposed borrow pit no. 1 are underlain by the Cappagh White Sandstone Formation.

The remainder of the Proposed Wind Farm site (northwest and northeast of the Site) is mapped to be underlain by the Hollyford Formation, which is described as greywacke, siltstone & mudstone. Proposed Wind Farm infrastructure mapped to be underlain by the Hollyford Formation include proposed turbine locations T8 and T9 along with proposed borrow pit no. 2.

A bedrock geology map is shown as **Figure 8-3** below.

The Proposed Grid Connection route is underlain by the Cappagh White Sandstone Formation (described above), Lower Limestone Shale described as Sandstone, mudstone & thin limestone, Ballysteen Formation described as dark muddy limestone, shale, Ballynash Member described as wavy-bedded cherty limestone, thin shale, Waulsortian Limestones described as massive unbedded lime-mudstone, Lough Gur Formation described as pale cherty crinoidal limestone and Rathkeale Formation described as dark muddy limestone & shaly mudstone. The Proposed Grid Connection 110kV substation is mapped to be underlain by the Cappagh White Sandstone Formation.

Due to the nature of the Proposed Grid Connection cable route being predominately along the carriageway of public roads as well as the shallow nature cable trenching (1.2m), the underground cable earthworks are not expected to have any interaction with the underlying bedrock.

8.3.4.2 GSI Drilling Records

There are GSI records for 1 no. historical Mineral Exploration Borehole drilled at the Proposed Wind Farm site in the year of 1982. The borehole (GSI Ref: REC_1240 & drill hole ID: 2603/1), which was drilled to final depth of 60.9mbgl (metres below ground level), is located 300m to the northeast of proposed turbine location T6 on the north of the Proposed Wind Farm site. The GSI mapped geology at this location is the Cappagh White Sandstone Formation. Refer to **Figure 8-2** for the borehole location.

Borehole logs record SANDSTONE/SILTSTONE (Old Red Sandstone) from 4.9 to 39.3mbgl, followed by SILTSTONE/MUDSTONE (Silurian) to 60.9mbgl.

No bedrock fracturing or faulting was noted in the drilling log.

The original drilling log is attached as **Appendix 8-2**.

8.3.4.3 Site Investigations

As discussed above, refusal on bedrock (presumed) was recorded in 18 of the 28 no. trial pits (64%) carried out at the Site. Bedrock was confirmed at or within 150m of proposed turbine locations T1, T4, T6, T9 and T11.

The depth to bedrock at the 18 no. locations ranged between 0m and 3.3m with an average of 1.8m. Trial pits that encountered bedrock were distributed throughout the Site indicating relatively shallow bedrock across the overall Proposed Wind Farm site.

Refusal was recorded on broken (blocky/angular) SILTSTONE/SANDSTONE at most of the trial pit locations (14 no. of 18 no.) that encountered bedrock. The upper broken layer was typically thin, (less

than 0.2m in thickness) and was underlain by very strong, competent bedrock that could not be penetrated or broken by the excavator (i.e. refusal). This bedrock lithology is consistent with the Cappagh White Sandstone Formation.

A weak/soft SILTSTONE/SHALE was recorded at the remaining 4 no. trial pit locations with bedrock strength/competency significantly increasing with depth. This bedrock lithology is consistent with the Hollyford Formation.

A summary of observed bedrock conditions during trial pitting at Proposed Project locations is shown in **Table 8-6** below. Refer to **Appendix 8-1** for trial pit logs.

Table 8-6: Encountered Bedrock Conditions at Proposed Wind Farm Infrastructure

Location ID	Investigation ID	Depth to Bedrock (m)	Bedrock Description
T1	TP12	2	Broken, blocky/angular SILTSTONE/SANDSTONE getting very strong with depth
T4	TP03	3.3	Broken, blocky/angular SILTSTONE/SANDSTONE getting very strong with depth
T6	TP20	2	Broken, blocky/angular SILTSTONE/SANDSTONE getting very strong with depth
T9	TP14	1.2	Weak SILTSTONE/SHALE getting strong with depth
T11	TP28	0.7	Weak, thinly bedded SILTSTONE/SANDSTONE getting strong with depth
Borrow Pit 1	TP03	3.3	Broken, blocky/angular SILTSTONE/SANDSTONE getting very strong with depth
Borrow Pit 2	TP14	1.2	Weak SILTSTONE/SHALE getting strong with depth
Temp Comp 2	TP02	2.5	Broken, blocky/angular SILTSTONE/SANDSTONE getting very strong with depth
Temp Comp 3	TP17	1	Weathered, flaggy SILTSTONE/SANDSTONE getting strong with depth
Spoil Repos 1	TP12	2	Broken, blocky/angular SILTSTONE/SANDSTONE getting very strong with depth
Spoil Repos 3	TP15	1.6	Weathered blocky SILTSTONE/SANDSTONE getting very strong with depth
Met Mast	TP06	2.4	Broken, blocky/angular SILTSTONE/SANDSTONE getting very strong with depth

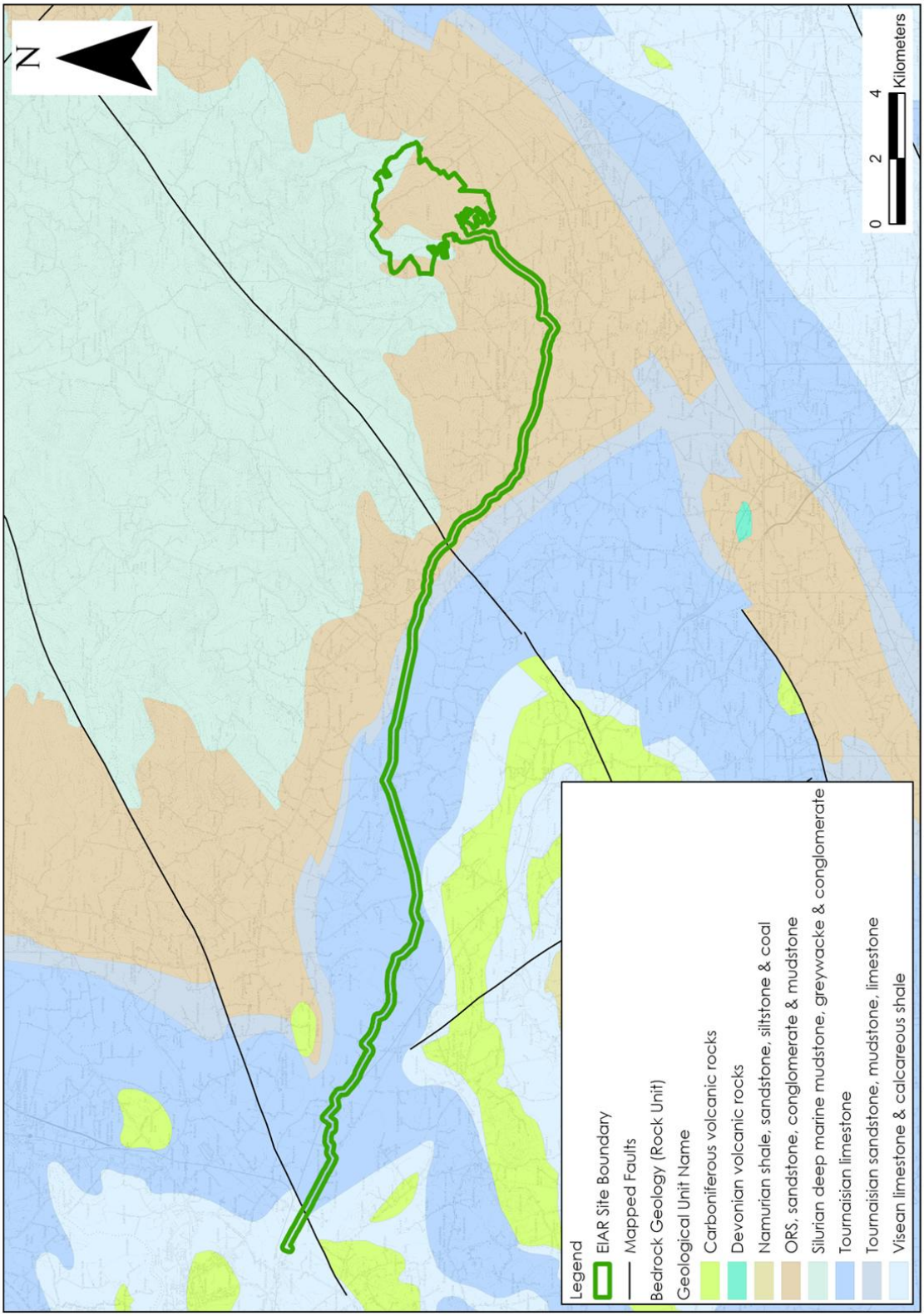

Figure 8-3: GSI Bedrock Geology Mapping

8.3.5 Geological Resource Importance

The GSI online database accessed via the Public Data Viewer (www.gsi.ie) does not record the presence of any active quarries or sand and gravel pits within the Site.

Furthermore, the GSI do not record the presence of any historic quarries or pits within the Site. The closest mapped historic quarry/pit is the Hollyford Mines situated ~1.5km north of the Proposed Wind Farm site and is noted to have been active in the 19th Century.

The GSI online Aggregate Potential Mapping Database (www.gsi.ie) shows that the crushed rock aggregate potential for the majority of the Proposed Wind Farm site ranges from Moderate to High with small pockets of low and very high crushed rock aggregate potential in the northern section of the Proposed Wind Farm site.

The Wind Farm site is not located within an area mapped for granular aggregate potential (i.e., potential for gravel reserves). The soil and subsoil deposits at the Proposed Wind Farm site can be considered to be of "Low to Medium" importance due to their poorly draining nature.

8.3.6 Designated Sites and Geological Heritage Sites

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs).

Aughnaglanny Valley pNHA (Site Code: 000948) is located immediately to the east of the Proposed Wind Farm site where the Aughnaglanny River flows close to the eastern Site boundary. The eastern fringes of the Proposed Wind Farm site are within the mapped pNHA boundary but there are no Proposed Wind Farm infrastructure or associated works within the pNHA. Some of the BEMP areas (woodland management) are located within the pNHA.

The Multeen River located immediately downstream of the Proposed Project site forms part of the Lower River Suir SAC (002137).

Many of the sub-catchments that the Proposed Grid Connection cable pass through form part of the Lower River Shannon SAC (Site Code: 002165). These include the Cahernahallia River, Bilboa River and Mulkear River.

The Proposed Grid Connection cable route intercepts the Lower River Shannon SAC at three locations where its crosses the Cahernahallia River, Bilboa River and Mulkear River via existing road and bridge structures.

There are a number of pNHA designated marshes/wetlands to the south of the Proposed Grid Connection route near Cappawhite; namely Kilbeg Marsh, Philipston Marsh, Ballyneil Marsh and Annacarty Wetlands pNHA. The Proposed Grid Connection follows a local public road at this location.

The Proposed Project has therefore no potential to directly affect these designated sites with regard land, soils and geology due to lack of direct pathways/interaction.

Hydrologically connected designated sites downstream of the Site (indirect effects) are assessed in Chapter 9 (Hydrology/hydrogeology).

There are no recorded geological heritage sites within the Site (www.gsi.ie).

The closest geological heritage site to the Proposed Wind Farm site is Hollyford Mines County Geological Site (CGS) (Site Code: TY035) located ~1.5km to the north of the Proposed Wind Farm site. This

geological heritage site is described as a historical, now abandoned copper mine site with shafts, ruined buildings and mine chimneys. The copper deposits worked at Hollyford were veins within Silurian greywackes (Tipperary – County Geological site Report). There are no recorded or mining at the Proposed Wind Farm site.

Owenbeg Moraines CGS (Site Code: TY054) is situated ~4km to the north of the Proposed Wind Farm site. This geological heritage site is described as "A series of cross-valley moraines, in the Owenbeg Valley between Milestone and Upperchurch" (Tipperary – County Geological site Report).

Eyon Cross Quarry CGS (Site Code: LK011) is located immediately to the south of the Proposed Grid Connection cable route near Brittas, Co. Limerick is described as "representative site exhibiting fresh and extensive exposures of Waulsortian Limestones, as well as the overlying Lough Gur Formation limestones". There are no other geological heritage sites within 5km of the Proposed Wind Farm site.

A map of local geological heritage sites and designated sites is shown below as **Figure 8-4.**

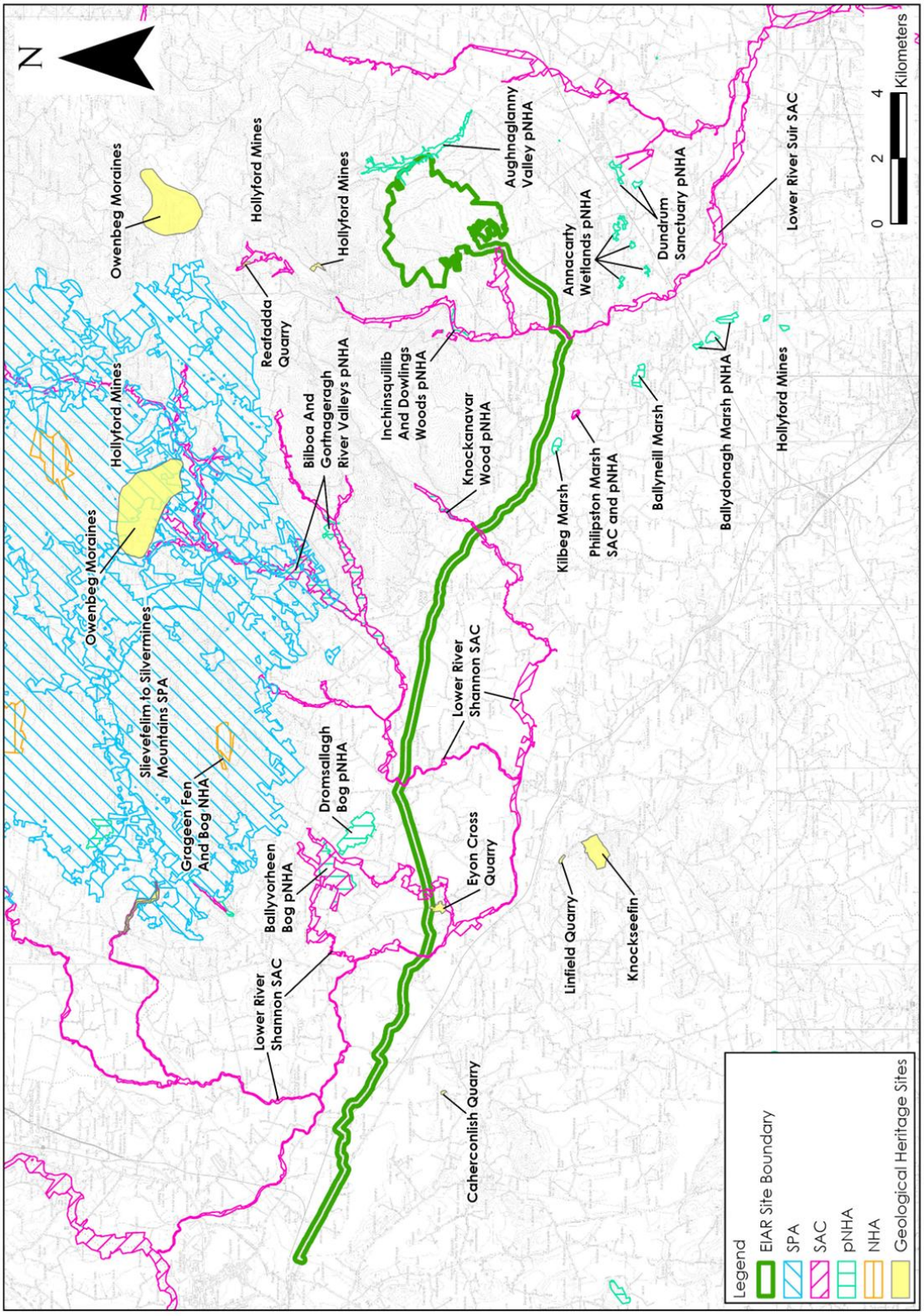

Figure 8-4 Geological Heritage and Designated Sites

8.3.7 Soil Contamination

There are no known areas of soil contamination on the Site. During the site walkovers and extensive site investigations, no areas of contamination concern were identified.

According to the EPA online mapping (http://gis.epa.ie/Envision), there are no licensed waste facilities on or adjacent to the Site.

There are no records historic mines within the Proposed Wind Farm that could potentially have contaminated tailings.

8.3.8 Geohazards

The GSI Landslide database (www.gsi.ie) does not record any historic landslides in the vicinity of the Site or in the surrounding lands.

The GSI Landslide Susceptibility Map (www.gsi.ie) classifies the probability of a landslide occurring at a given location. The Proposed Wind Farm site is mapped mainly as having Low Susceptibility with localised areas mapped as Moderately Low and Moderately High to High Susceptibility.

There is no Proposed Project infrastructure located in areas mapped as High Susceptibility.

There is no possibility of karstified bedrock (i.e. caves, caverns or ground subsidence risk) being present due to the non-calcareous bedrock geology underlying the Proposed Wind Farm site.

8.4 Receptor Sensitivity and Importance

Based on the criteria set out in **Table 8-2** above, the soils and subsoils at the Proposed Wind Farm site can be classed as being of low to medium importance as the overburden deposits are not designated and are commonplace in this area. Lands are typically poorly draining.

The soils and subsoils along the Proposed Grid Connection route can also be considered as being of low to medium importance as the underground electrical cabling route is located predominantly along existing public roads, private access tracks and grassland, and no overburden deposits are designated along the Proposed Grid Connection. The bedrock geology underlying the Site can be classed as being of medium importance where the bedrock could be used on a sub-economic scale.

The land, soils and bedrock geological formations underlying the Proposed Project will be included in the impact assessment due to their proximal location to the Proposed Project and the potential effects that the Proposed Project may have on these receptors.

No geological heritage site or designated site will be included in the impact assessment due to their distant location from the Proposed Project infrastructure (i.e. no potential for direct effects due to setback distances).

There is very low potential for the Proposed Project to affect the land, soils and geological environment outside of the Proposed Project infrastructure footprint. Therefore, there is no potential for effects to occur on any geological heritage site or designated site.

8.5 Characteristics of the Proposed Project

The Proposed Project will involve the removal of soils, subsoils and bedrock for access roads, internal cabling network, hardstanding emplacement, turbine foundations, substation, spoil management areas, underground cabling, crane hardstands, temporary construction compounds, borrow pits, drainage works and met mast installation.

It is proposed that bedrock won from the proposed 2 no. on-site borrow pits (i.e. siltstone/sandstone) will be used to construct the sub-base layer of proposed upgraded and new access roads, hardstand areas and turbine base areas. Once installed the subbase layer will be overlain by a clean capping layer of high-grade limestone which will be sourced from local registered quarries. Please note that limestone is a sedimentary rock and is used country wide for public road construction. Limestone typically has a high strength/weight bearing capacity and is not prone to erosion.

The estimated quantity of available rock within the 2 no. borrow pits is 247,720m3. Conservative assumptions were made in estimating the quantity of rock available in the borrow pits. Actual extraction volumes will be confirmed at the time of construction and following detailed pre-construction site investigation works.

Generally, the construction methodology for constructing any structure or platform foundation, such as a turbine base, hardstand or substation, involves removing all soft material is required to a depth where a suitable bearing material is encountered. Based on the site-investigation findings (shallow depth to bedrock) it is expected gravity foundations may be constructed at all turbine locations. The maximum excavation depth at turbine locations is expected to be approximately 3m.

1.6km of existing access tracks will be utilised for the Proposed Project. These access roads have been in operation for a significant number of years and are regularly used by large lorries transporting timber. Existing access tracks account for ~11% of the overall proposed length of Proposed Wind Farm access roads (14.5km).

12.9km of new access track will be constructed at the Site using the excavate and replace technique. Crane hardstands, the substation platform, the met mast and the temporary construction compounds will all be constructed using the founded technique. The material excavated is required to be properly managed and stored and should be re-used in other elements of the Proposed Project infrastructure.

The quantities of spoil requiring management at the Site have been calculated and are presented in **Table 8-7** below. The total estimated volume of spoil to be managed following excavations during the construction phase of the Proposed Project is approximately 399,565m^3 (this includes a contingency factor of 10% to allow for increase in volume upon excavation).

The majority of soil and subsoil excavated during the works will be used to backfill the proposed 2 no. borrow pits and placed at 3 no. spoil management areas.

Any additional soil and subsoil will be used for site landscaping or will be placed alongside site access roads and turbine hardstands (avoiding environmentally constrained areas and watercourse buffers). Excess spoil will also be placed around selected turbines bases and hardstands. The areas around 8 no. turbine bases and hardstands (12 no. individual areas proposed) have been assessed as suitable locations for spoil placement due to suitable ground conditions and slope angles.

The majority of material excavated along the Proposed Grid Connection underground cabling trench will be transported back to the Proposed Wind Farm site for storage. However, some excess spoil material generated during the cable route construction will be transported by permitted waste contractors to a suitable permitted/licensed site for disposal/recovery. This is dependent on the road makeup at locations along the Proposed Grid Connection underground cabling route. The main contractor will determine the appropriate location for management of arisings from the route.

The Proposed Wind Farm also includes a Biodiversity Enhancement and Management Plan (BEMP) and TDR works. The BEMP includes woodland management, wet grassland management and riparian buffers along watercourses. No stock piling or management of spoil will be required at the BEMP areas.

Table 8-7: Estimated Spoil Volumes

Development Component	Spoil Volume (m3) (approx.)	Crushed Stone Requirement (m3) (approx.)
Proposed Wind Farm		
14 no. Turbines and Hardstanding Areas (including foundations)	93,175	60,040
Access Roads (including met mast hardstand and security cabin)	108,065	134,150
Temporary Construction Compounds	6,550	2,905
Borrow Pits	64,670	n/a
Total	**272,460**	**197,095**
Proposed Grid Connection		
Onsite Substation	52,135	29,840
Cabling Trench	34,125	15,910
Total	**86,260**	**45,750**
Turbine Delivery Route		
Temporary Accommodation Areas	**4,520**	**4,875**
Total	**363,240**	**247,720**
Total (including 10% contingency)	**399,565**	**n/a**

Note: *A contingency factor of 10% has been applied and is included in the excavated spoil volumes, to allow for expected increase in volume upon excavation and to allow for a variation in ground conditions across the Site.*

8.6 Likely Significant Effects and Associated Mitigation Measures

8.6.1 Do Nothing Scenario

If the Proposed Project was not developed, the Proposed Wind Farm Site will continue to function as it does at present, with no changes made to the current land-use of commercial forestry and agricultural land. The forestry operations would continue at the Proposed Wind Farm Site and may be extended in some areas.

The forestry operations would comprise of felling and replanting of certain areas depending on the productivity of each area. All forestry operations would continue to conform with the current best practice Forest Service regulations, policies and guidance documents as well as Coillte and DAFM guidance documents. The impact of this is considered neutral in the context of the EIAR.

If the Proposed Project were not to proceed, the opportunity to capture an even greater part of County Tipperary's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment and to diversify the local economy would also be lost.

8.6.2 Construction Phase - Likely Significant Effects and Mitigation Measures

The likely effects of the Proposed Project and mitigation measures that will be put in place during the construction phase to eliminate or reduce them are outlined below.

8.6.2.1 Effects on Land / Land-Take (Proposed Project)

Land take will be required for the Proposed Wind Farm and Proposed Grid Connection. The Proposed Project is assessed herein.

The Proposed Project includes the construction of 14 no. turbines, associated hardstand areas, 3 no. temporary construction compounds, an on-site substation and battery energy storage compound, 2 no. borrow pits, new access roads and upgrades to the existing road network. The Proposed Project has a total footprint of 26.1ha which accounts for 3.14% of the overall Site (830ha).

A total of 51.65ha of coniferous forestry will be permanently felled within and around the Proposed Project. In addition, 13.94ha of agricultural land at the Proposed Wind Farm will be replaced by turbine bases, hardstand areas, access roads, substation, BESS and other related infrastructure.

No significant effects on land will occur along the Proposed Grid Connection cable route as all works will mainly occur within the carriageway of the existing public road network apart from 2km of new access track (4m wide) required along the off-road section. The 110kV substation and BESS will require 2.66ha of agricultural land (included in the total of 13.94ha).

All accommodation works along the TDR are temporary and therefore there will be no loss of land or landuse affects.

There will be no effects on the lands adjoining the Proposed Project site.

Pathways: Excavation and infrastructure construction.

Receptors: Land and land use.

Pre-Mitigation Potential Effect: Negative, slight, direct, permanent, likely effect on land (land-take) within the Proposed Wind Farm site. In the absence of mitigation measures, there will be no potential for significant effects on land at the Proposed Wind Farm site.

Negative, imperceptible, direct, permanent, likely effect on land along the Proposed Grid Connection. In the absence of mitigation measures, there will be no potential for significant effects on land along the Proposed Grid Connection.

Mitigation Measures / Impact Assessment: The Proposed Grid Connection is located predominantly along existing public roads. There will be no change in the land environment along the existing roads, whereby the roads will be reinstated with a comparable ground surface. The use of the existing road network reduces the area which will be altered or disturbed as a result of the works associated with the Proposed Grid Connection. The only change to the land environment will occur where the new access tracks are proposed and these works will have a very small footprint.

Following the construction phase areas of the Proposed Wind Farm site will be replaced by hardstand areas with a permanent development footprint of 21.6ha. This represents a change in landcover of 3.14%.

The loss of coniferous forestry (51.6ha) and grassland (13.94ha) will not have a significant effect on land at the Proposed Wind Farm site due to the small development footprint. The loss of this land is minimal on a local and regional scale and therefore, the effects of land loss is negligible. The loss will be offset by the works proposed as part of the Proposed Biodiversity Enhancement and Management Plan.

All felling operations will be completed in line with the Forest Service's published policy and will be subject of a Limited Felling Licence (LFL). The Forest Service policy requires replacement or replanting on a hectare for hectare basis for the footprint of the infrastructure developments. Therefore, while the loss of coniferous forestry will be a permanent change to the land at these locations, all forestry lost will be replaced elsewhere within Ireland as per the Forest Service felling policy.

Given the undulating nature of the local topography resulting from the quaternary deposits, any change in topography is likely to be minimal in the overall landscape.

Post Mitigation Residual Effect: The Proposed Project will result in the loss of 51.6ha of coniferous forestry and 13.94ha of agricultural lands which will be replaced by turbine bases, hardstands and other proposed infrastructure. This will result in a permanent change to land at these locations. However, due to the relatively small footprint of the Proposed Project infrastructure on a site scale and even more so on a local scale the residual effect is negative, direct, slight, permanent, likely effect on land (land-take).

Significance of Effects: For the reasons outlined above (small development footprint), no significant effects on land (land-take) will occur.

8.6.2.2 Soil, Subsoil and Bedrock Excavation (Proposed Project)

Excavation of soil, subsoil and bedrock will be required for the Proposed Wind Farm and Proposed Grid Connection. The Proposed Project is assessed herein.

These construction phase activities will result in the permanent removal and relocation of in-situ soil and subsoil at most excavation locations. Estimated volumes of spoil (soil and subsoil) and bedrock to be relocated are summarised above in **Table 8-7**. It is estimated that the total volume of spoil excavated will be 399,565m^3. We note that earthworks of this type, scale and magnitude have been granted permission and successfully completed at similar sites around the country.

However, there will be no loss of spoil, it will just be relocated within the Proposed Project site. It is proposed to manage any excess overburden generated through construction activities within the Site.

Excavated subsoils along the Proposed Grid Connection will be removed from the underground electrical cabling trench and will be transported to the spoil storage area at the Proposed Wind Farm site or transported to a local licenced facility as appropriate if contaminated by tar.

Pathway: Extraction/excavation.

Receptor: Soil and subsoil.

Pre-Mitigation Potential Effect: Negative, moderate, direct, likely, permanent effect on soil, subsoil and bedrock due to relocation within the Proposed Project site.

Proposed Mitigation Measures by Design:

Proposed Wind Farm:

- Placement of turbines and associated infrastructure in areas with suitable ground conditions where appropriate (based on detailed site investigation data);
- The soils and subsoils which will be removed during the construction of turbine hardstands will be localised to the turbine locations. The soil/subsoil will be placed/spread locally alongside the excavations or stored within the 3 no. designated spoil management areas and 2 no. borrow pits;
- Excavated subsoils shall be excavated and stored separately to topsoil; this will prevent mixing of materials and facilitate reuse afterwards;
- At the identified spoil management areas, the vegetative topsoil layer will be removed to allow for spoil to be placed and upon reaching the recommended height, the vegetative topsoil layer will be reinstated;
- The spoil placed within the spoil management areas will be restricted to a maximum height of 1m and then capped with topsoil;
- The placement of spoil within the spoil management areas will require the use of long reach excavators, low ground pressure machinery and possibly bog mats in particular for drainage works;
- It will be ensured that the surface of the placed spoil will be shaped to allow efficient run-off of surface water. Shaping of the surface of the spoil will be carried out as placement of spoil at management area progresses. This will reduce the likelihood of debris run-off and reduce the risk of instability of the placed spoil;
- Finished/shaped side slopes in the placed spoil will be not greater than 1 (v): 3 (h). This slope inclination will be reviewed during construction, as appropriate;
- Where available, the topsoil will be placed on the finished surface with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the placed spoil within the management areas;
- Supervision by the Project Geotechnical Engineer will be carried out for the works; and,
- An interceptor drain will be installed upslope of the designated spoil management areas to divert any surface water away from these areas. This will help ensure stability of the placed spoil and reduce the likelihood of debris run-off. (interceptor drains will not be required at all areas as the existing drainage network can function as interceptor drains – silt fences will be installed upgradient of the spoil management areas in these locations).

Proposed Grid Connection:

- Any overburden excavated from the cable trench will be transported to the spoil management areas; and,

- Some excess spoil material or pavements materials containing tar generated during the cable route construction will be transported by permitted waste contractors to a suitable permitted/licensed site for disposal/recovery.

Post Mitigation Residual Effect: The granular subsoils and bedrock at the Site can be classified as of "Low to Medium" importance.

The design measures incorporated into the Proposed Project as described above combined with the 'low to medium' importance of the geological baseline means that the residual effect will be negative, slight, direct, likely, permanent effect on soil, subsoils and bedrock due to disturbance and relocation within the Proposed Project site.

Significance of Effects: For the reasons outlined above, no significant effects on soil, subsoils and bedrock will occur.

8.6.2.3 Contamination of Soil/Subsoil by Leakages and Spillages (Proposed Project)

Oils and fuels will be required for the Proposed Wind Farm and Proposed Grid Connection. The Proposed Project is assessed herein.

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk at the Proposed Project site. The accumulation of small spills of fuels and lubricants during routine plant use can also be a significant pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. Large spills or leaks have the potential to result in significant effects (i.e. contamination of soil, subsoils).

Pathway: Soil and subsoil and underlying bedrock pore space.

Receptor: Soil and subsoil, bedrock.

Pre-Mitigation Potential Effect: Negative, slight, direct, short-term, unlikely effect on soil, subsoils and bedrock.

Proposed Mitigation Measures:

- On-site re-fuelling will be undertaken using a refuelling truck with spill kits kept on site for accidental leakages or spillages;
- Only designated trained operatives will be authorised to refuel plant on-site;
- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;
- All fuel storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The electrical control building and BESS (at the substation) will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency response plan for the construction phase to deal with accidental spillages is contained within the Construction and Environmental Management Plan (**Appendix 4-3**).

Post Mitigation Residual Effect: The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all construction sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect will be negative, imperceptible, direct, short-term, low unlikely effect on soil and subsoils and bedrock.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation, no significant effects on soil, subsoils and bedrock will occur.

8.6.2.4 Erosion of Exposed Subsoils During Construction of Infrastructure (Proposed Project)

Potential erosion effects are likely due to the Proposed Wind Farm and Proposed Grid Connection. The Proposed Project is assessed herein.

There is a high likelihood of erosion of soils and subsoils during its excavation and during landscaping works at the Proposed Project site. The main impacts associated with this aspect is to the water environment, and therefore this aspect is further assessed in detail in Chapter 9 Hydrology and Hydrogeology.

Pathway: Vehicle movement, surface water and wind action.

Receptor: Soil and subsoil.

Pre-Mitigation Potential Effect: Negative, slight, direct, short-term, likely effect on soil and subsoils by erosion and wind action.

Proposed Mitigation Measures:

- Soil and subsoils removed from the development locations and access roads will be reinstated within the Proposed Wind Farm site;
- The upper vegetative layer (where still present) of excavated soil will be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the stored spoil within the borrow pits and spoil repository areas;
- Re-seeding and spreading/planting will also be carried out in these areas; and,
- Brash/bog mats will be put in place to support vehicles on soft ground, reducing soil and subsoil erosion and avoiding the formation of rutted areas, in which surface water ponding can occur.

Post Mitigation Residual Effect: Following implementation of these measures the residual effects will be negative, imperceptible, direct, short-term, likely effect on soil and subsoils by erosion and wind action.

Significance of Effects: For the reasons outlined above, no significant effects on soils, subsoils or bedrock will occur.

8.6.2.5 Potential Effects from the Proposed Biodiversity Enhancement and Management Plan (BEMP)

BEMP works are proposed over a total of ~43.47ha at the Proposed Wind Farm site. Approximately 30.22 ha of high-quality wet grassland habitat will be managed to enhance marsh fritillary habitat, enhance approximately 3.3 ha of semi-natural woodland habitat and planting riparian woodland (9.91ha) either side of mapped watercourses.

Some of these proposals will slightly disturb local soil and subsoil deposits and may increase the likelihood of erosion of soils. However, due to the largely non-invasive nature of the works the potential for effects on the soils and geological environment are very limited. The works will have a positive effect on the land environment.

Pathway: Vehicle movement, restoration works, surface water and wind action.

Receptor: Land, soil and subsoil.

Pre-Mitigation Potential Effect: Negative, direct, slight, likely effect on soil and subsoils due to disturbance associated with proposed restoration works. Positive, imperceptible, direct, permanent effect on the land at the Proposed Wind Farm site. In the absence of mitigation measures, there will be no potential for significant effects on land, soils and subsoils at the Proposed Wind Farm site.

Proposed Mitigation Measures:

All proposed habitat management and enhancement works will be in accordance with the best practice Forest Service regulation, policies and strategic guidance documents as well as Coillte, DAFM and NatureScot guidance documents to ensure minimal potential negative effects on the local soil and subsoil environment.

Given the nature of the restoration measures the following mitigation measures are proposed:

- Before any works are completed silt fences will be installed to limit the movement of entrained sediment in surface water runoff;
- Proposed off-road routes will be walked in advance of any machinery;
- All machinery operators will be experienced;
- The Proposed Wind Farm site will be walked before a machine goes off-road;
- Bog mats will be used where the excavator is required to travel over wet ground; and,
- A low ground pressure excavator with wide tracks (1.9m or greater) will be used to reduce compaction of the soil and subsoils.

Post-Mitigation Residual Effect: With the implementation of mitigation measures outlined above there will be residual effect on land, soils and geology with an overall positive effect on biodiversity.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects will occur.

8.6.2.6 Potential Effects from Turbine Delivery Route Works

Minor ground works are required for turbine delivery. These include for temporary widening of existing roads and junctions. These TDR works are described in Section 4.4.3.1 of the EIAR.

Pathway: Extraction/excavation/landscaping.

Receptor: Soil and subsoil

Pre-Mitigation Potential Effect: Negative, imperceptible, direct, likely, temporary effect on land, soil and subsoil. No potential for significant effects.

Proposed Mitigation Measures:

- All works are minor and localised and cover very small areas;
- These works are distributed over a wide area; and,
- All works are temporary in nature.

Post Mitigation Residual Effect: The TDR related earthworks are minor in nature and will be temporary in duration. They are also separated from each other by considerable distances. Residual effects will be negative, imperceptible, direct, likely, temporary effects on soils and subsoil.

Significance of Effects: For the reasons outlined above, no significant effects on soils or subsoils will occur.

8.6.3 Operational Phase - Likely Significant Effects and Mitigation Measures

Very few potential direct impacts are envisaged during the operational phase of the Proposed Project. These may include:

- Some construction vehicles or plant may be necessary for maintenance of turbines which could result in minor accidental leaks or spills of fuel/oil;
- The transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater; and,

- In relation to indirect impacts a small amount of granular material may be required to maintain access tracks during operation which will place intermittent minor demand on local quarries.

8.6.3.1 Site Road Maintenance (Proposed Project)

On-going maintenance will be required at the Proposed Wind Farm and Proposed Grid Connection. The Proposed Project is assessed herein.

In relation to indirect effects a small amount of granular material will be required to maintain access tracks/site roads during operation which will place intermittent minor demand on local quarries. The on-site borrow pits can continue to provide material as required.

Pathway: Soil, subsoil and bedrock pore space.

Receptor: Soil, subsoil and bedrock.

Potential Pre-Mitigation Effect: Negative, indirect, imperceptible, short term, likely effect on soil, subsoil and bedrock.

Proposed Mitigation Measures:

- Use of aggregate from authorised quarries for use in road and hardstand maintenance.

Post Mitigation Residual Effect: The use of aggregate for site road maintenance will be minor and infrequent, and all material will be imported to the Proposed Project site from local authorised quarries. The residual effect is negative, imperceptible, indirect, short-term, unlikely effect on bedrock.

Significance of Effects: For the reasons outlined above, no significant effects on land, soils or geology will occur.

8.6.3.2 Site Vehicle/Plant Use (Proposed Project)

Oils and fuels will be required for the Proposed Wind Farm and Proposed Grid Connection. The Proposed Project is assessed herein.

Plant and site vehicles used in site maintenance will be run on fuels and use hydraulic oils. Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to land, soils and associated ecosystems. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, and is persistent in the environment.

Pathway: Soil, subsoil and bedrock pore space.

Receptor: Soil, subsoil and bedrock.

Potential Pre-Mitigation Effect: Negative, direct, slight, short term, unlikely effect on soil, subsoil and bedrock.

Proposed Mitigation Measures:

- Vehicles used during the operational phase will be refuelled off site before entering the site;
- No fuels will be stored on-site during the operational phase;

- Spill kits will be available in all site vehicles to deal with an accidental spillage and breakdowns; and,
- An emergency plan for the operational phase to deal with accidental spillages and breakdowns will be contained in the Construction and Environmental Management Plan (**Appendix 4-3**).

Post-Mitigation Residual Effect: The use of hydrocarbons in plant and vehicles is a standard risk associated with all operational wind farm sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect is negative, imperceptible, direct, short-term, unlikely effect on soil, subsoils, and bedrock.

Significance of Effects: For the reasons outlined above, no likely significant effects on land, soils, subsoils or bedrock will occur.

8.6.3.3 Use of Oils in Transformers (Proposed Project)

Transformers are required for the Proposed Wind Farm and Proposed Grid Connection. The Proposed Project is assessed herein.

The transformer in the substation and transformers in each turbine is oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater. Hydrocarbon has a high toxicity to humans, and all flora and fauna, and is persistent in the environment.

Pathway: Soil, subsoil and bedrock pore space.

Receptor: Soil, subsoil and bedrock.

Potential Pre-Mitigation Effect: Negative, direct, slight, short term, unlikely effect on soil, subsoil and bedrock.

Proposed Mitigation Measures:

- All transformers and substation areas will be bunded to 110% of the volume of oil used in each transformer/substation;
- An emergency plan for the operational phase to deal with accidental spillages will be contained in the Construction and Environmental Management Plan; and,
- The BESS compound will be bunded for capture of any potential chemical leaks.

Post-Mitigation Residual Effect: The use of hydrocarbons in transformers and substations is a standard risk associated with all operational wind farm sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect is negative, imperceptible, direct, short-term, unlikely effect on soil, subsoils, and bedrock.

Significance of Effects: For the reasons outlined above, no likely significant effects on land, soils, subsoils or bedrock will occur.

8.6.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The potential effects associated with decommissioning of the Proposed Project will be similar to those associated with construction but of reduced magnitude.

During decommissioning, it will be possible to reverse or at least reduce some of the potential impacts caused during construction by rehabilitating construction areas such as turbine bases, hard standing areas. This will be done by covering with native soil to encourage vegetation growth and reduce run-off and sedimentation. Other impacts such as possible soil contamination by fuel leaks will remain but will be of reduced magnitude. However, as noted in the Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is therefore:

> *"best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm".*

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant.

Some of the effects will be avoided by leaving elements of the Proposed Project in place where appropriate. The 110kV electrical substation and cabling will be retained by EirGrid. The turbine bases will be rehabilitated by covering with local topsoil in order to regenerate vegetation which will reduce runoff and sedimentation effects. Internal roads will remain as amenity pathways and forestry access roads. Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures.

No significant effects on the land, soils and geological environment will occur during the decommissioning stage of the Proposed Project.

8.6.5 Risk of Major Accidents and Disasters (Proposed Project)

Due to the Proposed Wind Farm site ground conditions (i.e. absence of blanket peat, the firm nature of thin overburden/glacial till coverage, the competency of the underlying bedrock, the lack of recorded historic landslide events along with the predominately Low Landslide Susceptibility rating from the GSI) the risk of ground instability/landslide occurring at the Proposed Wind Farm site is low.

For potential fires at the BESS compound a Fire Risk Management & Emergency Response Plan has been prepared for Proposed Wind Farm (refer to **Appendix 4-4**).

8.6.6 Human Health Effects (Proposed Project)

Potential health effects arise mainly through the potential for soil and ground contamination. The Proposed Project is not a recognized source of pollution (e.g. it's not a waste management site, or a chemical plant), and so the potential for effects during the operational phase is very low.

Hydrocarbons will be used onsite during construction; however, the volumes will be small in the context of the scale of the Proposed Project and will be handled and stored in accordance with best practice mitigation measures. The potential residual effects associated with soil or ground contamination and subsequent health effects are imperceptible.

The BESS compound will be bunded for capture of any potential chemical leaks.

8.6.7 Potential Cumulative Effects

The geological impact assessment undertaken above in this chapter outlines that significant effects are unlikely due to the localized nature of the construction works. Impacts on land soil and geology will not

extend beyond the immediate vicinity of the Site (Proposed Wind Farm site and Proposed Grid Connection cable route). The proposed enhancement lands and TDR works will not have any effect on land, soils and geology.

Tree felling has a negligible effect on land, soils and geology as no significant excavations are required during tree felling and therefore the surrounding commercial forestry will not contribute to cumulative effects associated with wind farm or cable route construction.

Therefore, no cumulative impacts between the Proposed Project (Proposed Wind Farm and Proposed Grid Connection including TDR works and Biodiversity Enhancement Lands), and other existing, permitted or proposed projects, listed in Section 2.7 of this EIAR, on land soils and geology will occur as there can be no interaction due to distance and separation.

8.6.8 Post Construction Monitoring

None required.

8.7 EIA Classification Table

Table 8-8 EIA Classification Table

Topic	Pre-Mitigation Effect	Mitigation Section Reference	Residual Effect	Significance
Construction Phase				
Land and Land-Take	Permanent, Slight, Negative	Section 8.6.2.1	Permanent, Slight, Negative	Not Significant
Soil, Subsoil and Bedrock Excavation	Permanent, Moderate, Negative	Section 8.6.2.2	Permanent, Sight, Negative	Not Significant
Contamination of Soil/Subsoil Leakages and Spillages	Short-Term, Slight, Negative	Section 8.6.2.3	Short-Term, Imperceptible, Negative	Not Significant
Erosion of Exposed Subsoils	Short-Term, Slight, Negative	Section 8.6.2.4	Short-Term, Slight, Negative	Not Significant
Potential Effects from the Proposed Biodiversity Enhancement and Management Plan (BEMP)	Permanent, Imperceptible, Positive	Section 8.6.2.5	Positive Residual Effect	Not Significant
Proposed Turbine Delivery Route Works	Temporary, Slight, Negative	Section 8.6.2.6	Temporary, Imperceptible, Negative	Not Significant
Operational Phase				
Site Road Maintenance	Short-Term, Imperceptible, Negative	Section 8.6.3.1	Short-Term, Imperceptible, Negative	Not Significant
Site Vehicle / Plant Use	Short-Term, Slight, Negative	Section 8.6.3.2	Short-Term, Imperceptible, Negative	Not Significant
Use of Oil in Transformers	Short-Term, Slight, Negative	Section 8.6.3.3	Short-Term, Imperceptible, Negative	Not Significant
Decommissioning Phase				
Land Soils and Geology	The potential impacts associated with decommissioning of the Proposed Project will be similar to those associated with construction but of reduced magnitude.	N/A	N/A	Not Significant