Planning and Environmental Consultants

LAND, SOILS AND GEOLOGY

Seskin Renewables Wind Farm

Chapter 8 – Land, Soils and Geology

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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 significant effects of the Proposed Development. This chapter relates to potential effects on Land, Soils and Geology due to the construction, operation and decommissioning of the Proposed Seskin Renewables Wind Farm. Section 1.1.1 of Chapter 1 of this EIAR has set out the terminology used to describe each of the elements of the Proposed Development. The terminology of project elements used within this chapter is outlined below:

- Where the 'Proposed Development' is referred to this encompasses the entirety of the project for the purposes of this EIA in accordance with the EIA Directive.
- Where the 'Proposed Wind Farm' is referred to, this refers to the wind turbines and associated foundations and hard-standing areas, meteorological mast, access roads, temporary construction compounds, underground cabling, borrow pit, spoil management, site drainage, biodiversity enhancement, turbine delivery accommodation areas and all ancillary works and apparatus.
- Where the 'Proposed Grid Connection' is referred to, this refers to the 38kV onsite substation, Battery Energy Storage System (BESS), associated temporary construction compound and 38kV underground cabling connecting to the existing Ballyragget 110kV substation, and all ancillary works and apparatus.
- Where the 'Site' is referred to, this relates to the primary study area for the EIAR, as delineated by the EIAR Site Boundary in green as shown on Figure 1-1 of the EIAR and encompasses an area of approximately 302 hectares

This chapter provides a baseline assessment of the environmental setting of the Site in terms of land, soils and geology and discusses the potential significant effects that the construction, operation and decommissioning of the Proposed Development will have on them. Where required, appropriate mitigation measures to limit any identified significant effects to soils and geology are recommended and the residual effects of the Proposed Development post-mitigation are assessed.

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 includes soils, subsoils and geology. We routinely complete impact assessments for land soils and geology, hydrology and hydrogeology for a large variety of project types.

This chapter of the EIAR was prepared by Adam Keegan and Michael Gill.

Adam Keegan PGeo (B.Sc., M.Sc.) is a hydrogeologist with 7 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 mapped karst environments and experience in trial and production well drilling within areas mapped as Regionally Karstified Aquifers. Adam has

worked on several wind farm EIAR projects, including Seven Hills WF, Croagh WF, Lyrenacarriga WF (SID), Cleanrath WF, Carrownagowan WF (SID), and Coole WF.

Michael Gill PGeo (BA, BAI, MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 22 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 including private residential and commercial developments which are occasionally sited within areas of known karstification, particularly in the East Galway/Clare area. In addition, he has substantial experience in intrusive site investigation and site suitability assessments, karst and epikarst hydrology/hydrogeology within proposed wind farm sites, water resource assessments for commercial and public water supplies including trial and production well drilling within a karst environment, surface water drainage design and SUDs design, and surface water/groundwater interactions. In addition, Michael has worked on the EIARs for Seven Hills WF, Oweninny WF, Cloncreen WF, Derrinlough WF and Yellow River WF, and over 120 other wind farm-related projects.

8.1.3 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2014/92/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:

- S.I. No. 296/2018 European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2001-2018 (as amended);
- European Communities (Environmental Impact Assessment) Regulations 1989 to 2006 (as amended);
- S.I. No. 30/2000 the Planning and Development Act, 2000 (as amended); and,
- S.I. No. 4/1995: The Heritage Act 1995 (as amended).

8.1.4 Relevant Guidance

The land, soils and geology section 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 Preparation of Soils, Geology & Hydrogeology Chapters in 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 Union, 2017).

8.2 Assessment Methodology

8.2.1 Desk Study

A desk study of the Site and the surrounding area was completed in advance of undertaking the walkover surveys and site investigations in March 2024. This involved collecting all relevant geological data for the site and surrounding area. The desk study has been checked and updated where required in March 2025. This included consultation of the following:

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- EPA/Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 18 (Geology of Tipperary). Geological Survey of Ireland (GSI, 2005 & 2004);
- Groundwater Karst Viewer (GSI online mapping portal - www.gsi.ie);
- Department of Environment, Community and Local Government on-line mapping viewer (www.myplan.ie); and,
- Group Water Scheme ZOC Reports; Ballyconra PWS, Seskin GWS, Durrow PWS, Cullahill GWS, Fermoyle PWS.

8.2.2 Baseline Monitoring and Site Investigations

A comprehensive geological, hydrological and hydrogeological dataset has been collected as part of this assessment.

Initial walkover surveys and geological/hydrogeological mapping were conducted on 12th April 2024 and 13th May 2024. During these site visits observations were made on near surface geological and hydrogeological features including exposed soil/subsoil and bedrock and walkover surveys of mapped karst features.

Intrusive and extrusive site investigations were conducted between 13th – 17th May 2024. HES supervised the drilling of 4 no. groundwater monitoring wells during this time, to provide detail on the nature and extent of subsoils and bedrock and evidence for potential karstification of the limestone bedrock. Further intrusive site investigation was carried out by Ground Investigation Ireland (GII) between 04th – 11th November 2024, as well as a geophysical survey conducted by Apex Geophysics.

To date, site investigation data which has been gathered at the Site includes:

- 4 no. groundwater monitoring boreholes drilled at locations MW1-MW4 in May 2024;
- 1 no. geophysical survey completed by Apex Geophysics between 14th – 21st October 2024;
- 1 no. rotary core borehole drilled between 08th -11th November 2024;
- 27 no. trial pits excavated by machine between 04th – 11th November 2024;
- 10 no. infiltration tests carried out between 04th -11th November 2024; and,
- A further 4 no. trial pits excavated at the Proposed Borrow Pit in January 2025.

The locations of these site investigation points is included in Figure 8-3. In addition to the above site investigations, the following is a summary of the seasonal hydrological and hydrogeological monitoring that has been undertaken, which has also aided in forming an understanding of the underlying quaternary and bedrock geology:

- Seskin GWS - 12 months of monitoring groundwater level data obtained at 15 minute intervals;
- MW1 - 18 months of monitoring groundwater levels at 2 hour intervals;
- MW2 - 18 months of monitoring groundwater levels at 2 hour intervals;
- MW3 - 18 months of monitoring groundwater levels at 2 hour intervals;
- MW4 – 18 months of groundwater levels data at 2 hour intervals;
- GPS survey of groundwater wells in the area to determine water levels in metres OD;
- Domestic Well 1 (DW1) - 18 months of monitoring groundwater levels at 2 hour intervals;

- Tirlán Well 1 (GW1) - 12 months of monitoring groundwater levels at 2 hour intervals;
- Tirlán Well 2 (GW2) - 12 months of monitoring groundwater levels at 2 hour intervals;
- Surface water sampling completed at 3 no. locations in April 2025; and,
- Downloads and collation of surface water level and flow data in River Nore (2023-2025).

8.2.3 Scoping and Consultation

The scope for this assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process is outlined in Section 2.7 of this EIAR. Certain issues and concerns highlighted with respect land, soils and geology are summarised in Table 8-1 below.

Table 8-1: Summary of Scoping Responses Relating to Land, Soils and Geology

Consultee	Description	Addressed
GSI	**Geoheritage** - The audit for Co. Kilkenny was carried out in 2007 and revised in 2012. The audit for Laois was completed in 2016. Our records show that there are no County Geological Sites[1] in the vicinity of the proposed wind farm study EIAR study boundary. **Groundwater** - For areas underlain by limestone, please refer to the karst specific data layers (karst features, tracer test database; turlough water levels (gwlevel.ie). Background information is also provided in the Groundwater Body Descriptions. Please read all disclaimers carefully when using Geological Survey Ireland data. - The Groundwater Data Viewer indicates aquifers classed as a 'Regionally important gravel aquifer', a 'Regionally Important Aquifer - Karstified (diffuse)', a 'Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones' and a 'Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones' underlie proposed wind farm study EIAR study boundary. - The Groundwater Vulnerability map indicates the range of groundwater vulnerabilities within the area covered is variable. We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' in your assessments,	Geoheritage sites addressed in Section 8.3.7 Information regarding groundwater, hydrogeology and groundwater drinking water abstractions are addressed in Chapter 9.

[1] *County Geological Sites (CGSs) are the best examples of a given geological theme in each county. CGS status is conferred as part of the County Geological Heritage Audit process.*

	as any groundwater-surface water interactions that might occur would be greatest in these areas. › Our records show that there are groundwater drinking water abstractions (Ballyconra Public Water Supply (PWS) and Seskin Group Water Scheme (GWS), with zones of contribution/source protection areas within the proposed wind farm study EIAR study boundary. Key to groundwater protection in general, and protection of specific drinking water supplies, is preventing ingress of runoff to the aquifer. Design of drainage will need to be cognisant of the public water schemes and the interactions between surface water and groundwater as well as run-off. Appropriate design should be undertaken by qualified and competent persons to include mitigation measures as necessary, such as SUDs or other drainage mitigation measures. › Any excavation/cuttings required for realignment should ensure that groundwater flow within the zones of contribution to the groundwater abstraction points is not disrupted, resulting in diminished yields. Note that there could be other groundwater abstractions in the locality for which Geological Survey Ireland has not undertaken studies, and a robust assessment should be undertaken by qualified and competent persons including a survey of all current wells and water abstractions within the vicinity. › Given the nearby drinking water sources (Public Water Scheme, Group Water Scheme), the effects of any potential contamination as a result of the project would need to be assessed.	
Department of Agriculture, Food and the Marine	No items related to Land, Soils and Geology	› No specific Land, Soils and Geology items to address.
Uisce Eireann	All potential impacts arising from the development proposal on Uisce Éireann's abstraction points must be identified and addressed in the EIAR and planning application. This includes the Ballyragget Infiltration Gallery abstraction point located approximately 2km to the south of the main turbine site, while the proposed cabling associated with the proposed wind farm is located within the Groundwater Catchments Zone of Contribution (ZOC) for the Ballyragget abstraction. Any other surface water or groundwater abstraction points where a potential hydrological and	› Potential effects on water sources addressed in Chapter 9. › Backfilling of materials addressed in Section 8.4.2.2

	hydrogeological exists must also be identified and addressed in the EIAR and planning application. The EIAR must include and consider all direct, indirect and cumulative effects on the abstraction points and water sources and provide mitigations for same to ensure there is no impact to, nor deterioration of ground and surface water source(s) in the area. Where the development proposes the backfilling of materials, the applicant is required to include a waste sampling strategy to ensure the material is inert.	
IFI	The proposed mitigation measures to prevent erosion from soil disturbance in excavation areas and areas where there is significant movement of plant and machinery	› Addressed in Section 8.4.2.4

8.2.4 Impact Assessment Methodology

The EPA guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, 2022) require that the baseline environment be described in terms of the context, character, significance and sensitivity of the existing environment. The description of the baseline environment is Step 5 of the information which must be included in an EIAR as per EPA 2022.
Using information from the desk study and data from the site investigations, an assessment of the importance of the soil and geological environment within the study area and the Site is assessed 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 route 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 related 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 8.5. 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.

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 8-3: 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.

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

Impact Characteristics		Potential Geological and 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.
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.

Impact Characteristics		Potential Geological and Hydrological Impacts
Quality	Significance	
		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 Study Area

The study area for the land, soils and geological environment is limited to within the EIAR Site Boundary. There is no potential for the Proposed Development to effect the land, soils and geological environment outside of the Site.

8.2.6 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Land, Soils and Geology Chapter of the EIAR.

8.3 Existing Environment

8.3.1 Site Description and Topography

The Site is located between the towns of Durrow in Co. Laois and Ballyragget in Co. Kilkenny. The approximate centre of the Site is located at E241903, N174035. The northwest and centre of the Site are situated within an elevated area of ground (~150-200mOD (metres above Ordnance Datum)) within a broader area that slopes to the east and south to elevations of ~80-90mOD. The Proposed Grid Connection underground cabling route is situated along the N77 road, along the eastern margin of the Site at elevations of ~80mOD.The southern section of the Site extends towards Ballyragget along the N77 road and consists of mainly flat agricultural lands. The land is mainly agricultural improved grassland, primarily used for grazing.

A site location map is included as Figure 1-1 of Chapter 1.

8.3.1.1 Proposed Wind Farm

The Proposed Wind Farm is located approximately 2.5 kilometres south of the town of Durrow, Co. Laois, 3.2 kilometres northwest of the town of Ballyragget, Co Kilkenny and 5.8 kilometres east of the village of Cullahill, Co. Laois. The N77 National Secondary Road runs in a north-south orientation, east of the Site. It is proposed to access the Proposed Development via a new access junction off the L58333 Local Road, part of the old N77, on the eastern side of the Site. The Site is served by a number of existing public and agricultural roads and tracks. A site location context map is included as Figure 1-1 of Chapter 1, while a site location map is included as Figure 1-2 of Chapter 1.

8.3.1.2 Proposed Grid Connection

The Proposed Grid Connection includes underground cabling from the proposed turbines will connect to an onsite 38kV substation. This on-site substation will then connect to the existing 110kV Ballyragget Substation via ~3.4km long underground electrical cabling. The Ballyragget 110kV Substation is located ~ 2.9km southeast of the proposed on-site substation.

A site location map of the Proposed Grid Connection underground cabling route is given in Figure 4-1 of Chapter 4 of this EIAR.

8.3.2 Land and Landuse

8.3.2.1 Proposed Wind Farm

Based on Corine (2018) landcover mapping the Proposed Wind Farm site comprises of agricultural pastures.

Landcover and landuse at the Proposed Wind Farm site have been verified during site walkover surveys completed by HES, from the inspection of recent aerial imagery and from habitat mapping completed by ecologists as part of the baseline characterisation for Chapter 6.

Landuse at the Proposed Wind Farm site is generally agricultural, under grass pasture and used mainly for grazing of cattle. All Proposed Wind Farm infrastructure is located on land used for grassland pastures.

8.3.2.2 Proposed Grid Connection

The Proposed Grid Connection sections included throughout this EIAR chapter refers to the Grid Connection underground cabling route via a ~3.4km long route. The Proposed Grid Connection underground cabling route will originate at the proposed onsite substation, in the townland of Ballynaslee, Co. Kilkenny, and run east for 300 metres through agricultural pastoral land. The underground cabling route will then emerge on to the N77 National Secondary Road and run south for 2.2km before turning east into agricultural pastoral land in the townland of Ballyconra, Co. Kilkenny. The underground cabling will then cross beneath the River Nore via horizontal direction drilling and continue east through agricultural land before reaching the Ballyragget 110kV substation in the townland of Moatpark, Co. Kilkenny.

According to Corine land cover mapping (2018) (www.epa.ie), the lands surrounding the Proposed Grid Connection underground cabling route are mapped predominantly as agricultural pastures. A small area of industrial land is mapped by Corine in the townland of Ballyconra, associated with the existing Glanbia plant.

Landcover along the Proposed Grid Connection underground cabling route was verified during walkover surveys. Landuse along the Proposed Grid Connection underground cabling route is broadly in the carriageway of the existing public road network with the exception of ~1.2km which passes through agricultural grasslands in the vicinity of Ballyragget substation.

8.3.3 Soils and Subsoils

8.3.3.1 Proposed Wind Farm

The published Teagasc soils map (www.epa.ie) were queried for data on mapped soils across the Proposed Wind Farm site. Mainly basic, deep, well-drained mineral soils (BminDW) is the dominant

soil type mapped at the Proposed Wind Farm site. There is no peat mapped at or locally to the Proposed Wind Farm site.

The GSI subsoils map (www.gsi.ie) shows the mapped distribution of subsoil deposits around the Proposed Wind Farm site. The east of the Proposed Wind Farm site is mapped by the GSI as being underlain by gravels derived from Limestones. The north, south and west of the Proposed Wind Farm site is mapped as being underlain by till derived from Namurian sandstones and shales with some areas of bedrock outcrop or subcrop. A map of the local subsoil cover is included as Figure 8-2.

Table 8-5: Summary of trial pit logs

Location	Lithological Summary Information	PSD
TP-BP01	0 – 0.20: TOPSOIL 0.20 – 0.90: Soft to firm, brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.90 – 2.20: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with medium cobble content 2.20 – 2.60: Presumed Weathered Bedrock, recovered as grey slightly clayey angular fine to coarse Gravel with medium cobble content	At 0.5m Silt: 31% Sand: 17% Gravel: 12% Cobbles: 39% At 1.5m Silt: 33.9% Sand: 28% Gravel: 38%
TP-BP02	0 – 0.20: TOPSOIL 0.20 – 0.90: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.90 – 1.20: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content 1.20 – 2.00: Presumed Weathered Bedrock recovered as grey slightly clayey, angular fine to coarse Gravel, with medium cobble content	
TP-BP03	0 – 0.25: TOPSOIL 0.25 – 0.60: Soft brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.60 – 1.60: Firm, brownish grey, slightly sandy, gravelly CLAY 1.60 – 2.30: Presumed Weathered Bedrock recovered as grey slightly clayey angular fine to coarse Gravel	At 1.70m Silt: 2.4% Sand: 4% Gravel: 93 %
TP-BP04	0 – 0.30: TOPSOIL 0.30 – 1.00: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 1.00 – 1.20: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content 1.20 – 1.50: Presumed Weathered Bedrock recovered as grey slightly clayey angular fine to coarse Gravel with medium cobble content	
TP-SA01	0 – 0.10: TOPSOIL 0.10 – 0.80: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 1.90: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with low cobble and boulder content	At 1.8m Silt: 35.4% Sand: 27% Gravel: 14% Cobbles: 24%
TP-SA02	0 – 0.20: TOPSOIL 0.20 – 0.60: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.60 – 1.80: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content	

Location	Lithological Summary Information	PSD
TP-SA03	0 – 0.15: TOPSOIL 0.15 – 0.80: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 1.20: Firm, greyish brown, sandy gravelly CLAY with low cobble and boulder content 1.20 – 1.80: Brownish grey, slightly clayey, sandy, angular to subrounded fine to coarse GRAVEL with low cobble and boulder content	At 1.5m Silt: 11.6% Sand: 24% Gravel: 32% Cobbles: 32%
TP-SA04	0 – 0.20: TOPSOIL 0.20 – 0.40: Brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.40 – 0.60: Presumed Weathered Bedrock recovered as grey slightly clayey, angular fine to coarse GRAVEL with medium cobble content	
TP-SA05	0 – 0.15: TOPSOIL 0.15 – 0.6: Soft to firm, brown, slightly sandy, slightly gravelly CLAY	
TP-SA06	0 – 0.30: TOPSOIL 0.30 – 0.80: Firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 1.5: Firm, greyish brown, slightly sandy, gravelly CLAY with low cobble and boulder content	At 0.5m Silt: 60.9% Sand: 21% Gravel: 18%
TP-SA06A	0 – 0.40: TOPSOIL 0.40 – 1.50: Firm, brown, slightly sandy, slightly gravelly CLAY with medium cobble content and low boulder content	
TP-SA07	0 – 0.20: TOPSOIL 0.20 – 0.60: Firm, brown, slightly sandy, slightly gravelly CLAY with high cobble and boulder content 0.60 – 0.90: Presumed Weathered Bedrock recovered as angular Cobbles and Boulders	
TP-SA08	0 – 0.50: TOPSOIL 0.50 – 1.4: Firm, brown, slightly sandy, slightly gravelly CLAY with low cobble and boulder content	
TP-SA09	0 – 0.35: TOPSOIL 0.35 – 1.50: Firm, brown, slightly sandy, slightly gravelly CLAY with medium cobble and boulder content	
TP-SA10	0 – 0.1: TOPSOIL 0.1 – 1.2: Firm, brown, slightly sandy, gravelly CLAY with high cobble and boulder content 1.2 – 1.5: Firm, light brown, slightly sandy, slightly gravelly CLAY with medium cobble and boulder content	
TP-SS01	0 – 0.20: TOPSOIL	
TP-SS02	0 – 0.25: TOPSOIL	
TP-T01	0 – 0.15: TOPSOIL 0.15 – 0.4: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.4 – 0.6: Presumed Weathered Bedrock recovered as grey slightly sandy clayey angular fine to coarse Gravel with low cobble content	

Location	Lithological Summary Information	PSD
	0.6 – 0.9: Presumed Weathered Bedrock recovered as grey slightly clayey slightly sandy angular fine to coarse Gravel with low cobble content	
TP-T02	0 – 0.20: TOPSOIL 0.20 – 0.80: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 2.0: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content 2.0 – 2.30: Presumed Weathered Bedrock recovered as slightly clayey slightly sandy angular fine to coarse Gravel with low cobble content	At 1.5m Silt: 23.2% Sand: 24% Gravel: 21% Cobbles: 32%
TP-T03	0 – 0.20: TOPSOIL 0.2 – 0.80: Soft, brown, slightly sandy, slightly gravelly CLAY 0.80 – 3.20: Firm to stiff, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content	At 2.5m Silt: 34.7% Sand: 26% Gravel: 39%
TP-T04	0 – 0.20: TOPSOIL 0.20 – 0.60: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.60 – 2.0: Firm, brownish grey, slightly sandy, gravelly CLAY with low cobble and boulder content	At 1.50 Silt: 42.5% Sand: 26% Gravel: 16% Cobbles: 16%
TP-T05	0 – 0.20: TOPSOIL 0.20 – 0.50: Firm, brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.50 – 0.70: Presumed Weathered Bedrock recovered as Cobbles with some clayey angular fine to coarse Gravel	
TP-T05A	0 – 0.30: TOPSOIL 0.30 – 0.60: Firm, brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.60 – 0.80: Presumed Weathered Bedrock recovered as Cobbles and Boulders with some clayey angular fine to coarse Gravel	
TP-T06	0 – 0.15: TOPSOIL 0.15 – 0.70: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.70 – 2.60: Firm, brown, slightly sandy, gravelly CLAY with medium cobble and boulder content 2.60 – 3.10: Very stiff, light grey, slightly sandy, gravelly CLAY with medium cobble and boulder content	At 1.5m Silt: 32.8% Sand: 22% Gravel: 45%
TP-T07	0 – 0.30: TOPSOIL 0.30 – 0.70: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.70 – 2.80: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with medium cobble and boulder content	At 0.5m Silt: 66.2% Sand: 18% Gravel: 16% At 2.7m Silt: 32.3% Sand: 25% Gravel: 43%

Location	Lithological Summary Information	PSD
TP-T08	0 – 0.15: TOPSOIL 0.15 – 0.60: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.60 – 2.90: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with medium cobble and boulder content 2.90 – 3.5: Stiff, grey, slightly sandy, gravelly CLAY with low cobble content	At 1.5m Silt: 30% Sand: 21% Gravel: 28% Cobbles: 21% At 3.5m Silt: 36.2% Sand: 22% Gravel: 42%
TP-TH01	0 – 0.20: TOPSOIL 0.20 – 0.70: Soft to firm, greyish brown, slightly sandy, slightly gravelly CLAY 0.70 – 1.30: Presumed Weathered Bedrock recovered as grey angular fine to coarse GRAVEL with low cobble content	At 1.2m Silt: 46.3% Sand: 32% Gravel: 22%

8.3.3.2 Proposed Grid Connection

Soils along the Proposed Grid Connection underground cabling route are broadly mapped as basic, shallow, well-drained mineral soils (BMinSW) (www.gsi.ie). Where the Proposed Grid Connection underground cabling route passes through the townland of Ballyconra, the soils are mapped as made ground. This area of made ground is associated with the Glanbia plant. There is no peat soil mapped along or near the Proposed Grid Connection underground cabling route. Meanwhile, alluvial soils are mapped along the River Nore.

In terms of subsoils, the GSI (www.gsi.ie) map the Proposed Grid Connection underground cabling route to be underlain predominantly by gravels derived from limestones. Alluvial subsoils are mapped along the River Nore.

Soils and subsoils have been logged during the trial pitting of 27 no. trial pits across the Proposed Wind Farm site by GII on between 04th – 11th November 2024. An additional 4 no. trial pits were excavated at the Proposed Borrow pit area under the supervision of HES in January 2025, at the site of the proposed borrow pit location.

The soils and subsoils logged by GII were broadly described as soft to firm, brown to grey, slightly sandy, slightly gravelly CLAY. Weathered bedrock, recovered as fine to coarse gravels was also encountered in TP-BP01 to TP-BP04, TP-SA04, TP-SA07, as well as in TP-T01, TP-T02, TP-T05 and TP-T05A. The presence of this weathered bedrock indicates that depth to bedrock across the Proposed Wind Farm site is broadly shallow, generally within 2-3m of surface. The trial pit logs have been summarised in Table 8-5. The original logs are included in Appendix 8-1.

The 4 no. trial pits supervised and logged by HES near T3 encountered topsoil ranging in thickness from 0.1-0.3m. The topsoil was underlain by typically light greyish brown, silty sandy subsoil. Limestone bedrock was met in each of these trial pits at depths ranging between 0.25-1.7m. These logs are included as Appendix 8-2

Laboratory analysis of samples recovered from the excavated trial pits was also completed. A PSD analysis (particle size distribution) was completed on 15 no. samples (please see Figure 8-1 below). The PSD data indicates that sand and silt dominate the subsoil with generally low gravel and cobble content , however this is variable. The majority of samples aggregate around the region of 30-35% of material passing through the fine 0.063mm sieve.

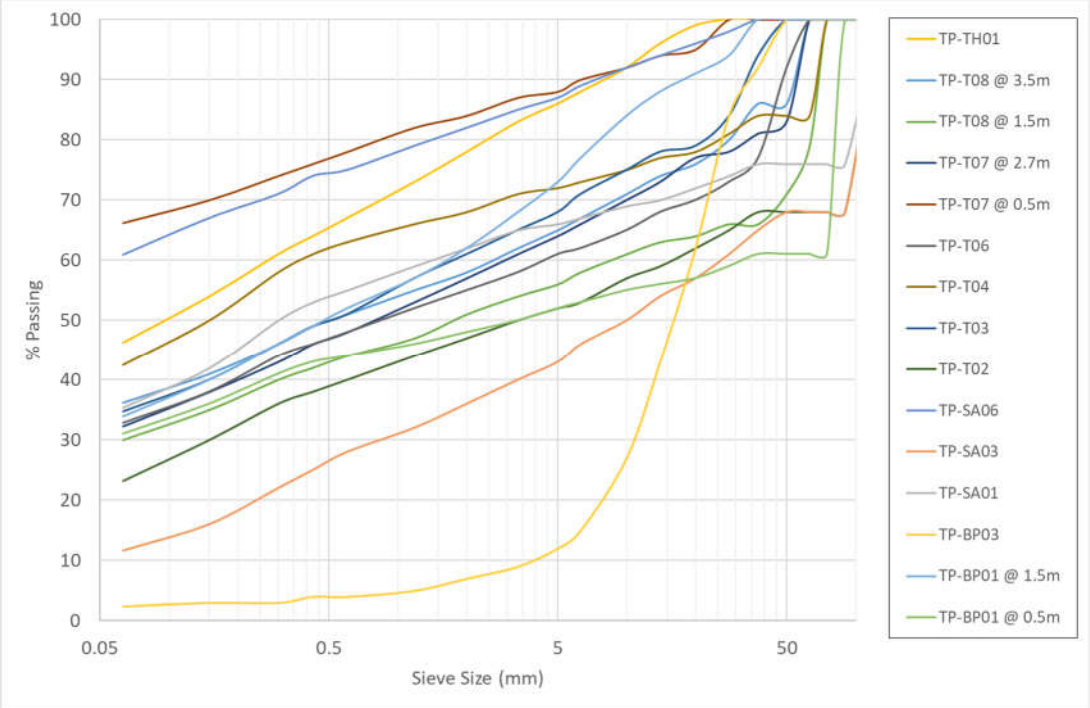


Figure 8-1: PSD analysis of subsoil across Proposed Wind Farm site

Subsoils were also logged during the drilling of the 4 no. monitoring wells (MW1-MW4) (refer to Table 8-5) and 1 no. rotary core borehole (BH01) drilled in May 2024.

Throughout the drilling, the returns from the subsoils were generally described as firm brown gravelly clays, with some sand and cobbles within the clay matrix, but generally with a low boulder content. The subsoils range in depth between 2.6-10.6mbgl within the 4 no. monitoring wells (MW1-MW4) drilled in May 2024. The soils/subsoils encountered during the drilling of the rotary core borehole (BH01) are described as 0.2m of topsoil, overlying sandy, slightly gravelly clay to 1.6m.

The borehole and trial pit logs are included in Appendix 8-1 along with photographs of the trial pits and core samples. A map of intrusive site investigations is shown in Figure 8-3.

Table 8-5: Summary of trial pit logs

Location	Lithological Summary Information	PSD
TP-BP01	0 – 0.20: TOPSOIL 0.20 – 0.90: Soft to firm, brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.90 – 2.20: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with medium cobble content 2.20 – 2.60: Presumed Weathered Bedrock, recovered as grey slightly clayey angular fine to coarse Gravel with medium cobble content	At 0.5m Silt: 31% Sand: 17% Gravel: 12% Cobbles: 39% At 1.5m Silt: 33.9% Sand: 28% Gravel: 38%
TP-BP02	0 – 0.20: TOPSOIL 0.20 – 0.90: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.90 – 1.20: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content 1.20 – 2.00: Presumed Weathered Bedrock recovered as grey slightly clayey, angular fine to coarse Gravel, with medium cobble content	
TP-BP03	0 – 0.25: TOPSOIL 0.25 – 0.60: Soft brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.60 – 1.60: Firm, brownish grey, slightly sandy, gravelly CLAY 1.60 – 2.30: Presumed Weathered Bedrock recovered as grey slightly clayey angular fine to coarse Gravel	At 1.70m Silt: 2.4% Sand: 4% Gravel: 93 %
TP-BP04	0 – 0.30: TOPSOIL 0.30 – 1.00: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 1.00 – 1.20: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content 1.20 – 1.50: Presumed Weathered Bedrock recovered as grey slightly clayey angular fine to coarse Gravel with medium cobble content	
TP-SA01	0 – 0.10: TOPSOIL 0.10 – 0.80: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 1.90: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with low cobble and boulder content	At 1.8m Silt: 35.4% Sand: 27% Gravel: 14% Cobbles: 24%
TP-SA02	0 – 0.20: TOPSOIL 0.20 – 0.60: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.60 – 1.80: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content	
TP-SA03	0 – 0.15: TOPSOIL 0.15 – 0.80: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 1.20: Firm, greyish brown, sandy gravelly CLAY with low cobble and boulder content	At 1.5m Silt: 11.6% Sand: 24% Gravel: 32%

Location	Lithological Summary Information	PSD
	1.20 – 1.80: Brownish grey, slightly clayey, sandy, angular to subrounded fine to coarse GRAVEL with low cobble and boulder content	Cobbles: 32%
TP-SA04	0 – 0.20: TOPSOIL 0.20 – 0.40: Brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.40 – 0.60: Presumed Weathered Bedrock recovered as grey slightly clayey, angular fine to coarse GRAVEL with medium cobble content	
TP-SA05	0 – 0.15: TOPSOIL 0.15 – 0.6: Soft to firm, brown, slightly sandy, slightly gravelly CLAY	
TP-SA06	0 – 0.30: TOPSOIL 0.30 – 0.80: Firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 1.5: Firm, greyish brown, slightly sandy, gravelly CLAY with low cobble and boulder content	At 0.5m Silt: 60.9% Sand: 21% Gravel: 18%
TP-SA06A	0 – 0.40: TOPSOIL 0.40 – 1.50: Firm, brown, slightly sandy, slightly gravelly CLAY with medium cobble content and low boulder content	
TP-SA07	0 – 0.20: TOPSOIL 0.20 – 0.60: Firm, brown, slightly sandy, slightly gravelly CLAY with high cobble and boulder content 0.60 – 0.90: Presumed Weathered Bedrock recovered as angular Cobbles and Boulders	
TP-SA08	0 – 0.50: TOPSOIL 0.50 – 1.4: Firm, brown, slightly sandy, slightly gravelly CLAY with low cobble and boulder content	
TP-SA09	0 – 0.35: TOPSOIL 0.35 – 1.50: Firm, brown, slightly sandy, slightly gravelly CLAY with medium cobble and boulder content	
TP-SA10	0 – 0.1: TOPSOIL 0.1 – 1.2: Firm, brown, slightly sandy, gravelly CLAY with high cobble and boulder content 1.2 – 1.5: Firm, light brown, slightly sandy, slightly gravelly CLAY with medium cobble and boulder content	
TP-SS01	0 – 0.20: TOPSOIL	
TP-SS02	0 – 0.25: TOPSOIL	
TP-T01	0 – 0.15: TOPSOIL 0.15 – 0.4: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.4 – 0.6: Presumed Weathered Bedrock recovered as grey slightly sandy clayey angular fine to coarse Gravel with low cobble content 0.6 – 0.9: Presumed Weathered Bedrock recovered as grey slightly clayey slightly sandy angular fine to coarse Gravel with low cobble content	
TP-T02	0 – 0.20: TOPSOIL	At 1.5m

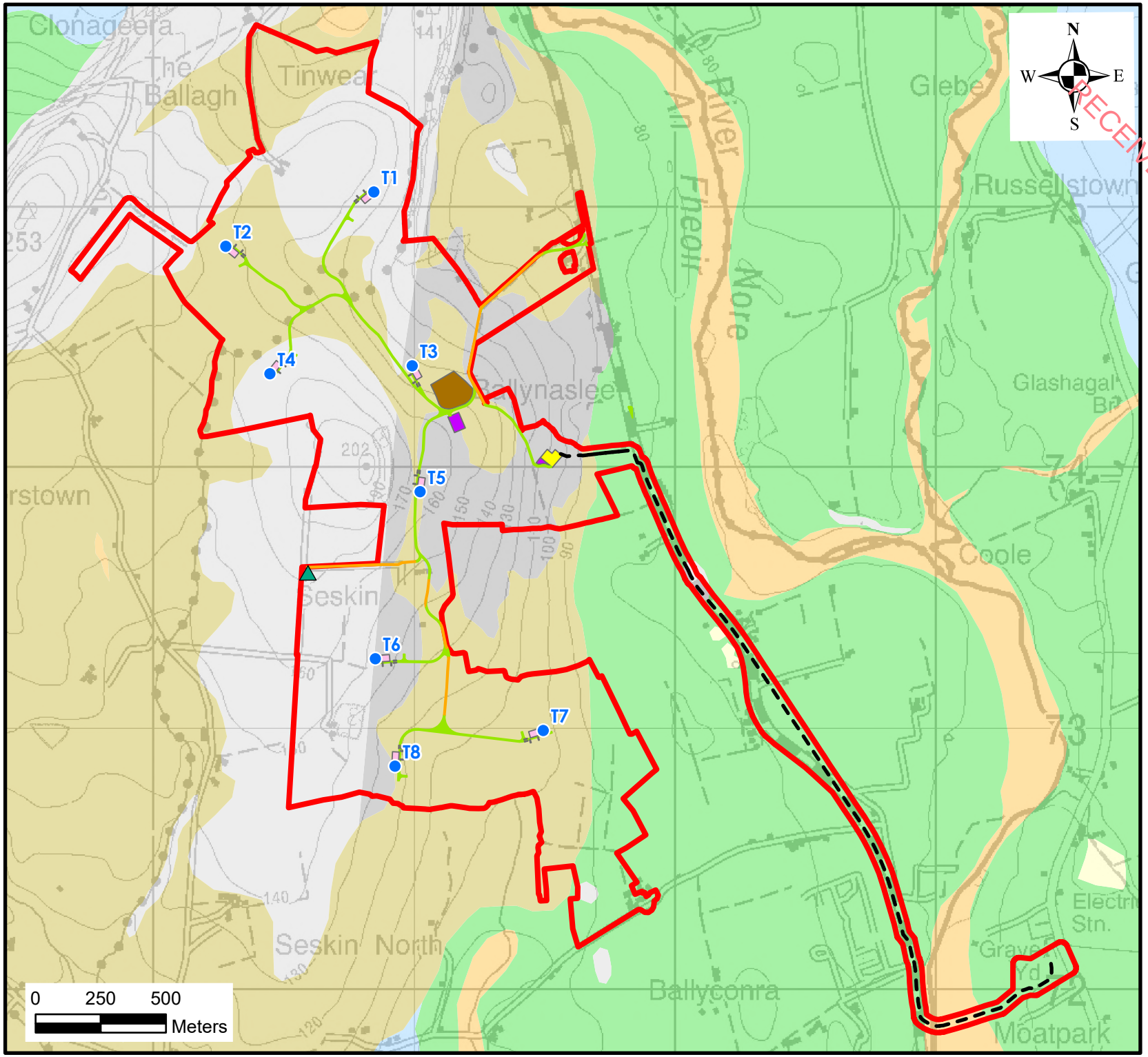
Location	Lithological Summary Information	PSD
	0.20 – 0.80: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.80 – 2.0: Firm, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content 2.0 – 2.30: Presumed Weathered Bedrock recovered as slightly clayey slightly sandy angular fine to coarse Gravel with low cobble content	Silt: 23.2% Sand: 24% Gravel: 21% Cobbles: 32%
TP-T03	0 – 0.20: TOPSOIL 0.2 – 0.80: Soft, brown, slightly sandy, slightly gravelly CLAY 0.80 – 3.20: Firm to stiff, brownish grey, slightly sandy, gravelly CLAY with medium cobble and boulder content	At 2.5m Silt: 34.7% Sand: 26% Gravel: 39%
TP-T04	0 – 0.20: TOPSOIL 0.20 – 0.60: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.60 – 2.0: Firm, brownish grey, slightly sandy, gravelly CLAY with low cobble and boulder content	At 1.50 Silt: 42.5% Sand: 26% Gravel: 16% Cobbles: 16%
TP-T05	0 – 0.20: TOPSOIL 0.20 – 0.50: Firm, brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.50 – 0.70: Presumed Weathered Bedrock recovered as Cobbles with some clayey angular fine to coarse Gravel	
TP-T05A	0 – 0.30: TOPSOIL 0.30 – 0.60: Firm, brown, slightly sandy, slightly gravelly CLAY with low cobble content 0.60 – 0.80: Presumed Weathered Bedrock recovered as Cobbles and Boulders with some clayey angular fine to coarse Gravel	
TP-T06	0 – 0.15: TOPSOIL 0.15 – 0.70: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.70 – 2.60: Firm, brown, slightly sandy, gravelly CLAY with medium cobble and boulder content 2.60 – 3.10: Very stiff, light grey, slightly sandy, gravelly CLAY with medium cobble and boulder content	At 1.5m Silt: 32.8% Sand: 22% Gravel: 45%
TP-T07	0 – 0.30: TOPSOIL 0.30 – 0.70: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.70 – 2.80: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with medium cobble and boulder content	At 0.5m Silt: 66.2% Sand: 18% Gravel: 16% At 2.7m Silt: 32.3% Sand: 25% Gravel: 43%
TP-T08	0 – 0.15: TOPSOIL 0.15 – 0.60: Soft to firm, brown, slightly sandy, slightly gravelly CLAY 0.60 – 2.90: Firm to stiff, greyish brown, slightly sandy, gravelly CLAY with medium cobble and boulder content	At 1.5m Silt: 30% Sand: 21% Gravel: 28% Cobbles: 21%

Location	Lithological Summary Information	PSD
	2.90 – 3.5: Stiff, grey, slightly sandy, gravelly CLAY with low cobble content	At 3.5m Silt: 36.2% Sand: 22% Gravel: 42%
TP-TH01	0 – 0.20: TOPSOIL 0.20 – 0.70: Soft to firm, greyish brown, slightly sandy, slightly gravelly CLAY 0.70 – 1.30: Presumed Weathered Bedrock recovered as grey angular fine to coarse GRAVEL with low cobble content	At 1.2m Silt: 46.3% Sand: 32% Gravel: 22%

8.3.3.3 Proposed Grid Connection

Soils along the Proposed Grid Connection underground cabling route are broadly mapped as basic, shallow, well-drained mineral soils (BMinSW) (www.gsi.ie). Where the Proposed Grid Connection underground cabling route passes through the townland of Ballyconra, the soils are mapped as made ground. This area of made ground is associated with the Glanbia plant. There is no peat soil mapped along or near the Proposed Grid Connection underground cabling route. Meanwhile, alluvial soils are mapped along the River Nore.

In terms of subsoils, the GSI (www.gsi.ie) map the Proposed Grid Connection underground cabling route to be underlain predominantly by gravels derived from limestones. Alluvial subsoils are mapped along the River Nore.



Legend

- EIAR Site Boundary
- Proposed Turbine Layout
- Potential Grid Route
- Met Mast Location
- Potential 38kV Substation
- Indicative Borrow Pit Location
- Temporary Construction Compounds
- Proposed New Roads
- Proposed Road Amendments Existing Roads
- Proposed Hardstands

Subsoils

- A, Alluvium
- GLs, Gravels derived from Limestones
- KaRck, Kartsified bedrock outcrop or subcrop
- L, Lacustrine sediments
- Rck, Bedrock outcrop or subcrop
- TLs, Till derived from limestones
- TNSSs, Till derived from Namurian sandstones and shales

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Client: MKO

Job: Seskin Renewable Energy Development, Co. Kilkenny/Co. Laois

Title: Local Subsoils Map

Figure No: 8-2

Drawing No: P1653-1-0625-A4-802-00A

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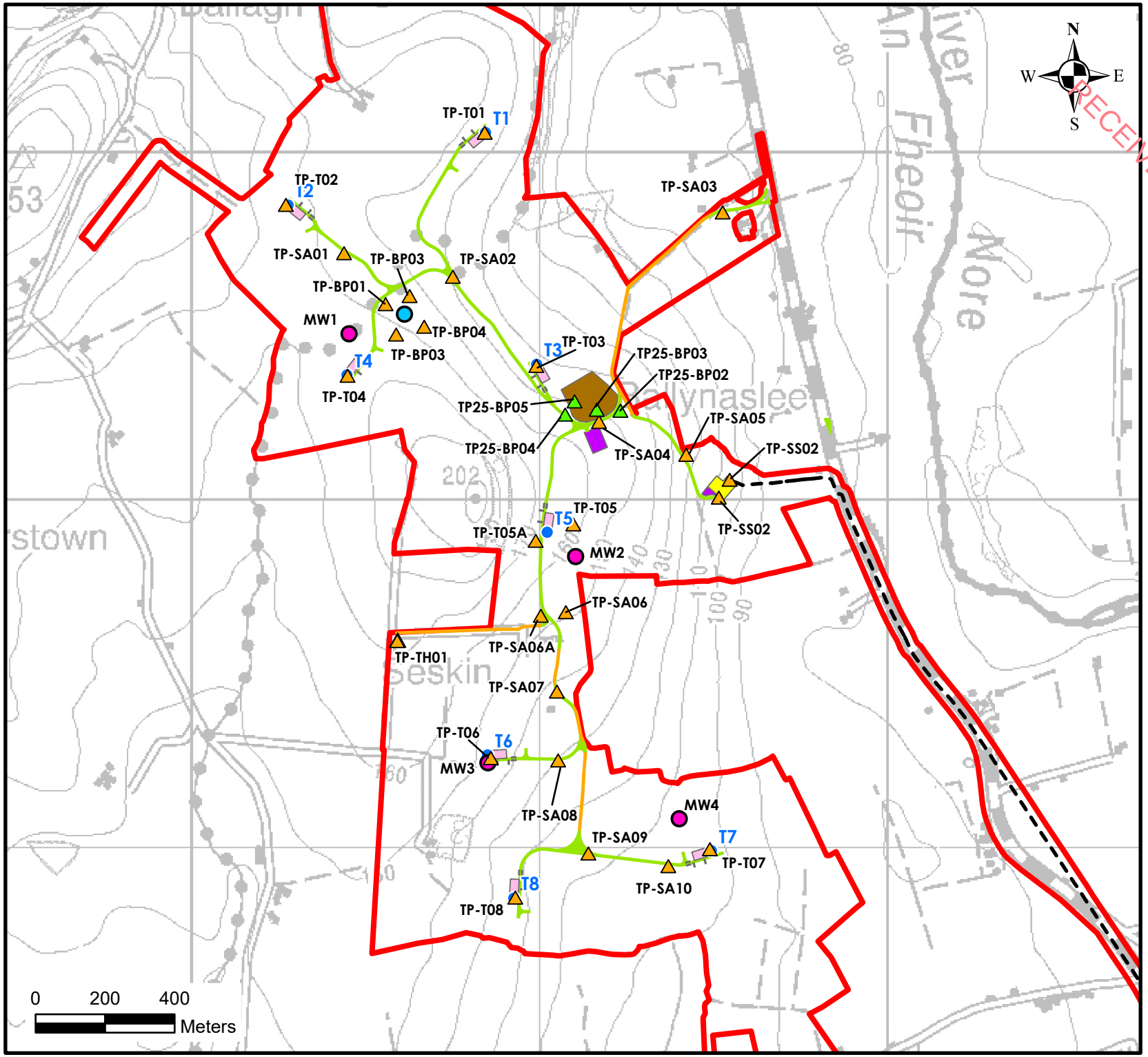
Scale: 1:20,000	Drawn By: GA
Date: 24/06/2025	Checked By: MG



Legend

- EIAR Site Boundary
- Proposed Turbine Layout
- Potential Grid Route
- Met Mast Location
- Potential 38kV Substation
- Indicative Borrow Pit Location
- Temporary Construction Compounds
- Proposed New Roads
- Proposed Road Amendments Existing Roads
- Proposed Hardstands
- Monitoring Well Locations
- Rotary Corehole Location_GII
- Trial Pit locations_GII
- Trial Pit locations_HES

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Job: Seskin Renewable Energy Development, Co. Kilkenny/Co. Laois

Title: Site Investigation Map

Figure No: 8-3

Drawing No: P1653-1-0625-A4-803-00A

Sheet Size: A4	Project No: P1653-1
Scale: 1:15,000	Drawn By: GA
Date: 24/06/2025	Checked By: MG

8.3.4 Bedrock Geology

8.3.4.1 Proposed Wind Farm

Based on the GSI Bedrock Geology 110k mapping (www.gsi.ie), the Proposed Wind Farm site is underlain by a total of 5 no. bedrock geological formations.

The east of the Proposed Wind Farm site is mapped to be underlain by the Clogrenan Formation. This formation comprises of cherty, muddy calcarenitic limestones. The southeastern corner of the Proposed Wind Farm site is mapped to be underlain by the Ballyadams Formation, which consists of crinoidal wackestone/packstone limestone. The western section of the Proposed Wind Farm site is mapped to be underlain predominantly by the Bregaun Flagstone Formation, which consists of thick, flaggy sandstone and siltstone. A small area in the northwest of the Proposed Wind Farm is underlain by the Moyadd Coal Formation, which consists of shale, siltstone and minor sandstone. Finally a small area towards the centre of the Proposed Wind Farm site is underlain by the Killeshin Siltstone Formation which comprises of muddy siltstone.

There are 2 faults mapped at the Proposed Wind Farm site that run from north to south and from north to southwest. The GSI map shows the limestone bedrock of the Ballyadams Formation to be dipping 26° to the northeast, while the flagstone/sandstone bedrock of the Breguan Formation is mapped as dipping 50° to the east/southeast. This GSI map the occurrence of several areas of bedrock outcrop in the Proposed Wind Farm site.

The local geological map of the area is shown as Figure 8-4.

Table 8-6: Summary of geological data at the Proposed Wind Farm site

Location	Lithological Summary Information
MW1	0-0.2m Topsoil 0.2-3.4m: Firm brown gravelly CLAY 3.4-7.7m: Firm brown very sandy gravelly CLAY 7.7-12.5m: Firm to stiff, light grey, gravelly, silty CLAY [BOULDER CLAY] 12.5-45.5m: Medium strong, grey SILTSTONE/MUDSTONE
MW2	0-0.3m Topsoil 0.3-2.6m: Firm brown, very sandy, gravelly CLAY with frequent limestone cobble content 2.6-3.5m: Weak weathered brownish grey LIMESTONE 3.5-51m: Strong grey LIMESTONE with occasional fractures
MW3	0-0.3m Topsoil 0.3-3.2m: Firm brown gravelly CLAY 3.2-3.9m: Firm to stiff, grey, gravelly, silty CLAY with medium cobble content [BOULDER CLAY] 3.9 – 17.5m: Soft black MUDSTONE/SHALE 17.5-45m: Strong grey LIMESTONE
MW4	0-0.3m TOPSOIL 0.3-7.4m: Firm to stiff brown, silty, sandy, gravelly CLAY medium cobble content 7.4-10.6m: Firm to stiff, orangish brown, gravelly CLAY with frequent limestone fragments, possible highly weathered rock. 10.6- 13m: Medium strong, weathered grey LIMESTONE with frequent clay infill 13-45.5m: Strong grey LIMESTONE with occasional fractures.

BH1	0-0.2m TOPSOIL 0.2-1.6m Brown, slightly sandy, slightly gravelly Clay, 1.6-2m Gravelly cobbles of Limestone and Sandstone, 2-30.2 Bedrock – Siltstone/Sandstone

The bedrock geology has been further characterised through intrusive investigations, including the drilling the 4 no. rotary (down the hole hammer (DTH)) groundwater monitoring wells and 1 no. rotary core borehole (BH1).

Bedrock was encountered in all 4 no. groundwater monitoring wells at depths ranging between 2.6–10.6mbgl. Bedrock at MW1 to MW4 was encountered at 7.7m, 2.6m, 3.9m and 10.6m respectively. The bedrock at MW2 to MW4 is described as strong grey limestone with occasional fractures, while the bedrock at MW1 is described as medium to strong grey siltstone and mudstone. The bedrock at MW3 consists of dark grey mudstone/shale from 3.9-17.5m, which is underlain by strong grey limestone. The bedrock geology observed at MW1-MW4 is outlined in Table 8-6. The original logs are included within Appendix 8-1. In general, the bedrock encountered during the intrusive site investigations is consistent with the mapped geology.

The bedrock geology has been further described through the drilling of a rotary core borehole, BH1, situated near the proposed turbine T4. The bedrock met during the drilling of this borehole is summarised in Table 8-6 and consists of interbedded layers of sandstone and siltstone.

There was no evidence of karstified limestone encountered during the drilling of the 4 no. DTH boreholes, 1 no. rotary core borehole or within any of the trial pits where bedrock was met.

As described in Section 8.3.3.1, weathered bedrock was recorded in TP-BP01 to TP-BP04, TP-SA04, TP-SA07, as well as in TP-T01, TP-T02, TP-T05 and TP-T05A, indicating that depth to bedrock across the site is broadly shallow, generally within 2-3m of surface.

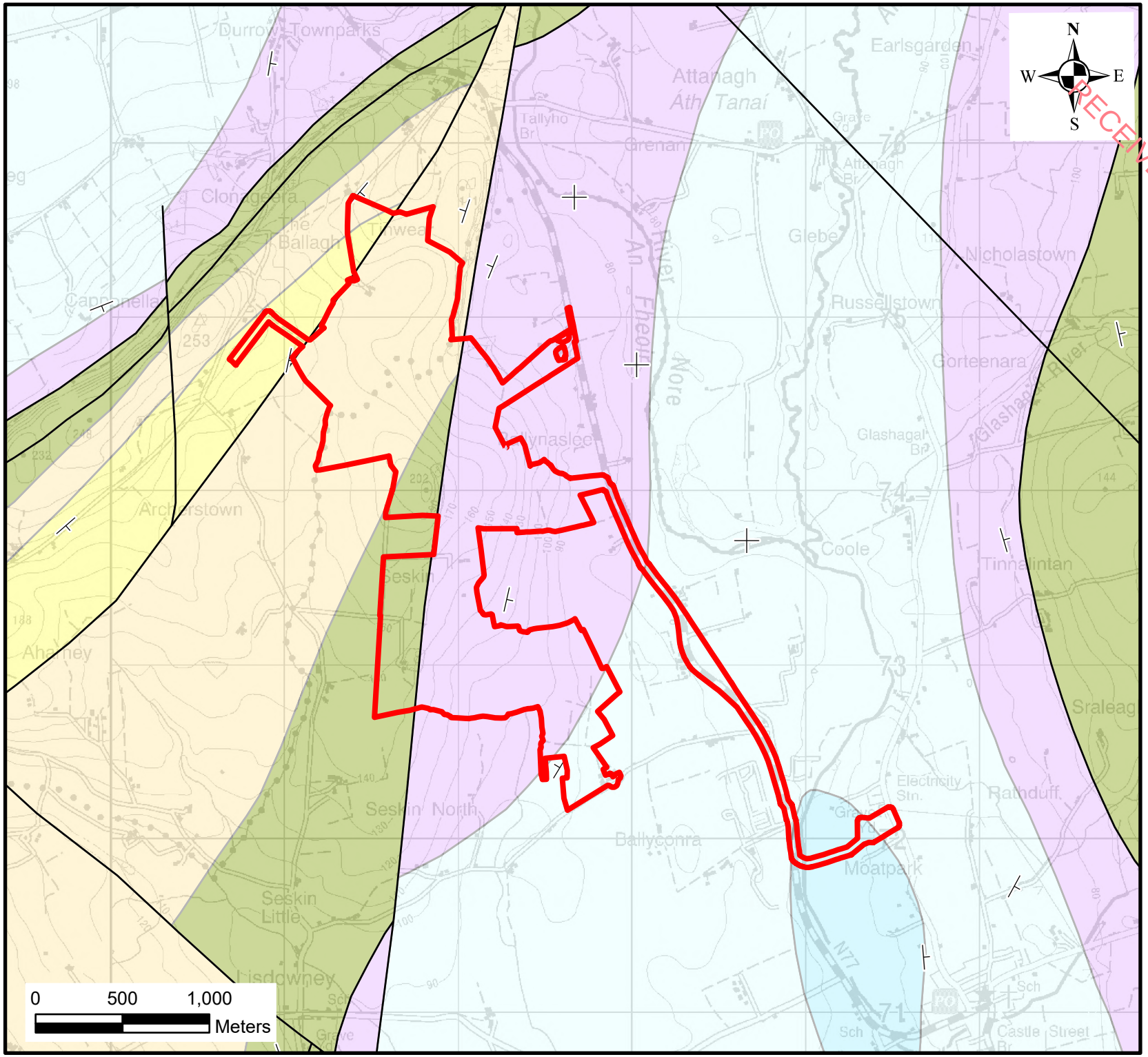
A geophysical survey has been carried out at the Proposed Wind Farm site, completed by Apex Geophysics Ltd. in October 2024.

The geophysics broadly aligns with the findings of the intrusive site investigations. Thin subsoils are present across the geophysical profiles, overlying a layer of moderately weathered bedrock, over competent Hard Limestone. The results of the geophysical survey are detailed further in Section 8.3.9 and included in Appendix 8-1.

Table 8-6: Summary of geological data at the Proposed Wind Farm site

Location	Lithological Summary Information
MW1	0-0.2m Topsoil 0.2-3.4m: Firm brown gravelly CLAY 3.4-7.7m: Firm brown very sandy gravelly CLAY 7.7-12.5m: Firm to stiff, light grey, gravelly, silty CLAY [BOULDER CLAY] 12.5-45.5m: Medium strong, grey SILTSTONE/MUDSTONE
MW2	0-0.3m Topsoil 0.3-2.6m: Firm brown, very sandy, gravelly CLAY with frequent limestone cobble content 2.6-3.5m: Weak weathered brownish grey LIMESTONE 3.5-51m: Strong grey LIMESTONE with occasional fractures
MW3	0-0.3m Topsoil 0.3-3.2m: Firm brown gravelly CLAY 3.2-3.9m: Firm to stiff, grey, gravelly, silty CLAY with medium cobble content [BOULDER CLAY] 3.9 – 17.5m: Soft black MUDSTONE/SHALE 17.5-45m: Strong grey LIMESTONE

MW4	0-0.3m TOPSOIL 0.3-7.4m: Firm to stiff brown, silty, sandy, gravelly CLAY medium cobble content 7.4-10.6m: Firm to stiff, orangish brown, gravelly CLAY with frequent limestone fragments, possible highly weathered rock. 10.6- 13m: Medium strong, weathered grey LIMESTONE with frequent clay infill 13-45.5m: Strong grey LIMESTONE with occasional fractures.
BH1	0-0.2m TOPSOIL 0.2-1.6m Brown, slightly sandy, slightly gravelly Clay, 1.6-2m Gravelly cobbles of Limestone and Sandstone, 2-30.2 Bedrock – Siltstone/Sandstone



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Client: MKO

Job: Seskin Renewable Energy Development, Co. Kilkenny/Co. Laois

Title: Local Bedrock Geology Map

Figure No: 8-4

Drawing No: P1653-1-0625-A4-804-00A

Sheet Size: A4	Project No: P1653-1
Scale: 1:30,000	Drawn By: GA
Date: 24/06/2025	Checked By: MG

8.3.4.2 Proposed Grid Connection

The bedrock geology mapped along the Proposed Grid Connection underground cabling route predominantly comprises of the Ballyadams Formation, described by the GSI as crinoidal wackestone/packstone limestone. Meanwhile, in the vicinity of the Proposed Wind Frm site the Proposed Grid Connection underground cabling route is underlain by the Clongrenan Formation. The southern section of the Proposed Grid Connection underground cabling route is mapped to be underlain by the Durrow Formation which comprises of shaly fossiliferous and oolitic limestones.

There are no faults mapped by the GSI along the Proposed Grid Connection underground cabling route.

No deep, intrusive investigations, such as rotary core boreholes were carried out along the Proposed Grid Connection underground cabling route, due to the depth and nature of the proposed grid connection excavation (a ~1.3m deep trench, cut and backfilled). Observations were made along the N77 during ongoing (as of April 2025) road improvement works. Excavated material was observed along the roadside, which consisted of sandy, gravelly silt.

8.3.5 Geological Resource Importance

There is 1 no. active quarry, Lisduff Quarry, mapped ~ 4km northeast of the Site where the limestone bedrock is extracted and crushed for aggregate material. The limestone bedrock in the area is considered to be of high resource importance.

There is a mapped mineral locality ~4km northwest of the Site, near Lisduff Quarry. Chalcopyrite is mapped at this location and referred to as a source of copper ore. There are 3 no. mineral localities mapped within the Proposed Wind Farm site. These localities are located in the north of the Proposed Wind Farm site, and they consist of brick, referred to as disused brick works, clay, used for the manufacturing of culm briquettes, and Namurian shale, referred to as a disused quarry for the manufacturing of bricks.

The GSI online Aggregate Potential Mapping Database shows that the Proposed Wind Farm site is not located within an area mapped as containing granular aggregate potential. The Proposed Wind Farm site is mapped as having “High” to “Very High Potential” in terms of crushed rock aggregate potential.

Crushed rock aggregate potential along the Proposed Grid Connection underground cabling route is broadly mapped as being of “Moderate” to “High” resource potential.

Granular aggregates of “Moderate” to “Very High” potential are mapped along the Proposed Grid Connection underground cabling route.

8.3.6 Geological Heritage and Designated Sites

8.3.6.1 Proposed Wind Farm

There are no recorded Geological Heritage sites or mining sites (current or historic) within the Proposed Wind Farm site. There are 3 mineral localities and past mineral deposit sites in the north of the Proposed Wind Farm site, as mentioned above in Section 8.3.5. Lisdowney Quarry (KK004) is the nearest geological heritage site to the Proposed Wind Farm site, situated ~ 2.5km to the south. This site consists of "*A disused historical limestone quarry showing important Lower Carboniferous crinoid fauna with natural exposures of rock along a ridge*".

The Abbeyleix Bog (LS001) is another geological heritage site located ~5km north of the Proposed Wind Farm site. The Abbeyleix Bog geological heritage site is described by the GSI as "An *extensive area of peatland extending in a low-lying hollow, north to south, for approximately 3 kilometres south of Abbeyleix Town".* Approximately 6.5km to the west of the Proposed Wind Farm site, the M8 Road Cut – Addergoole (LS023) is mapped. This is described as "*An 800m long road cut through limestone bedrock on the M8 motorway*". Ballyragget Quarry (KK009), another geological heritage site, is located ~3.5km southeast of the Proposed Wind Farm site and consists of "*exposed faces of limestone overlain by thick glacial deposits*".

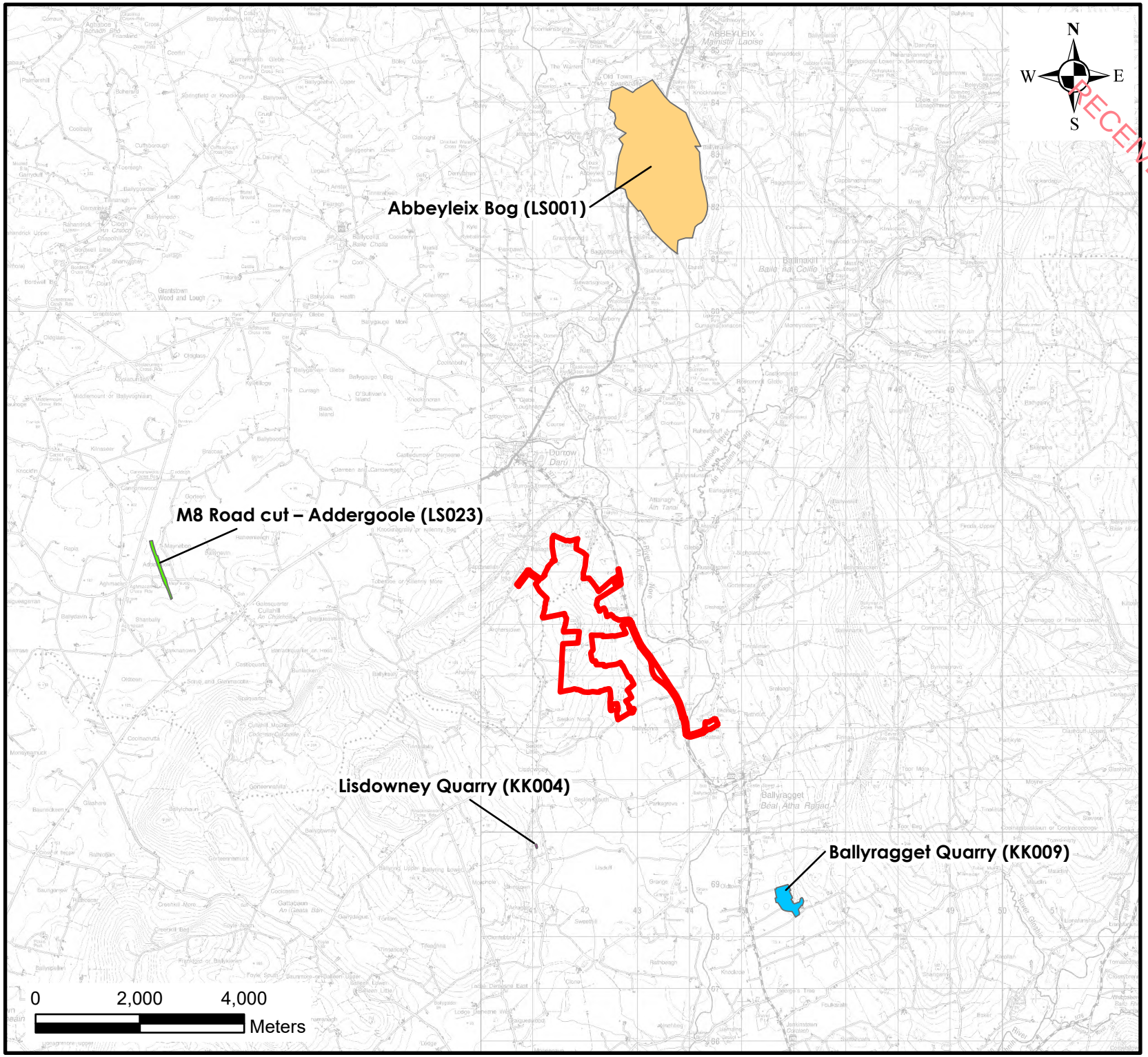
The Proposed Wind Farm site is not located within any designated site. The nearest SAC is the River Barrow and River Nore SAC located along the River Nore which runs east along the border of the Site. The River Nore SPA is also located to the east of the Site, as well as the River Nore/Abbeyleix Woods Complex pNHA. The Cullahill Mountain SAC and the Spahill and Clomantagh Hill SAC are located ~6.7km and ~10.3km west of the Site respectively. Lisbigney Bog is also an SAC located ~4.3km northeast of the Site. Designated sites near the Proposed Wind Farm site are listed in Table 8-7.

Table 8-7: Designated sites near the Proposed Wind Farm site

Site	Designations	Distance from Site
River Barrow and River Nore SAC	› SAC › pNHA › SPA	0.33km from the Proposed Wind Farm site footprint Overlap with Grid Connection route along N77
River Nore SPA	› SPA	0.33km from the Proposed Wind Farm site footprint Overlap with Grid Connection route along N77
Cullahill Mountain	› SAC › pNHA	6.7km from the Proposed Development site Proposed Wind Farm (8.1km from the Proposed Grid Connection Route)
Spahill and Clomantagh Hill SAC	› SAC › pNHA	10.3km from Proposed Development site Proposed Wind

Site	Designations	Distance from Site
		Farm (11.8km from the Proposed Grid Connection Route)
River Nore/Abbeyleix Complex pNHA	› pNHA	0.33km from the Proposed Wind Farm site footprint Overlap with Grid Connection route along N77
Lisbigney Bog SAC	› SAC › pNHA	4.3km from the Proposed Development site (5.1km from the Proposed Grid Connection Route)

A Geological heritage sites map is included as Figure 8-5 and a designated sites map is included as Figure 8-6.



Legend

- EIAR Site Boundary

Geological Heritage Sites

- Abbeyleix Bog
- Ballyraggett Quarry
- Lisdowney Quarry
- M8 Road cut - Addergoole

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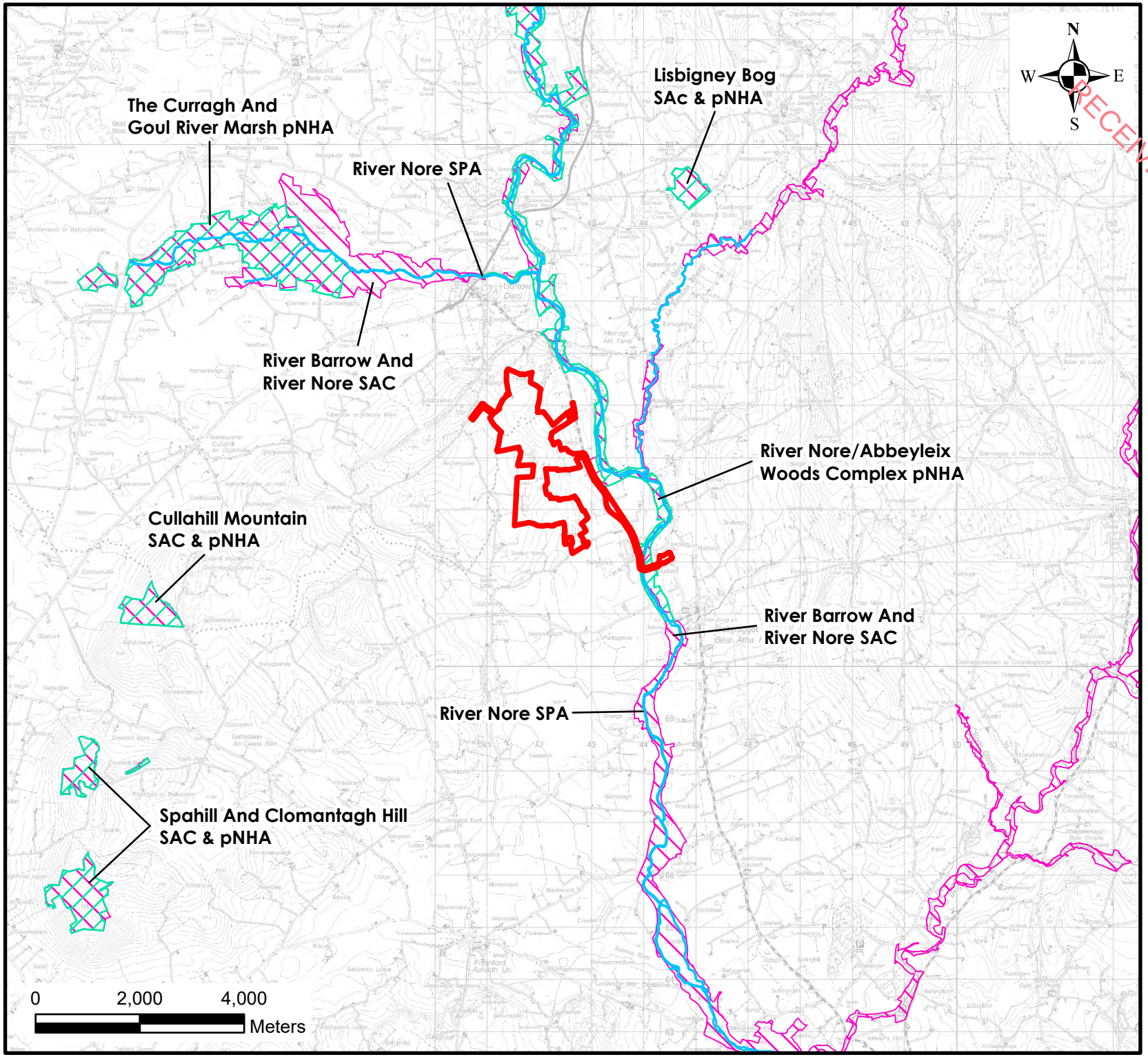
Client: MKO	
Job: Seskin Renewable Energy Development, Co. Kilkenny/Co. Laois	
Title: Geological Heritage Sites Map	
Figure No: 8-5	
Drawing No: P1653-1-0625-A4-805-00A	
Sheet Size: A4	Project No: P1653-1
Scale: 1:100,000	Drawn By: GA
Date: 24/06/2025	Checked By: MG



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Client: MKO	
Job: Seskin Renewable Energy Development, Co. Kilkenny/Co. Laois	
Title: Designated Sites Map	
Figure No: 8-6	
Drawing No: P1653-1-0625-A4-806-00A	
Sheet Size: A4	Project No: P1653-1
Scale: 1:100,000	Drawn By: GA
Date: 24/06/2025	Checked By: MG

8.3.6.2 Proposed Grid Connection

There are 3 no. designated sites situated along the Proposed Grid Connection underground cabling route. These designated sites comprise of the River Nore SPA, River Barrow and River Nore SAC and River Nore/Abbeyleix Woods Complex pNHA. The Proposed Grid Connection underground cabling route crosses the River Nore, and these designated sites, to the west of Ballyragget substation.

There are no geological heritage sites along the Proposed Grid Connection underground cabling route.

8.3.7 Soil Contamination

8.3.7.1 Proposed Wind Farm

There are no known areas of soil contamination on the Proposed Wind Farm site. During the site walkovers, 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 within the immediate environs of the Proposed Wind Farm site.

There are no historic mines at or in the immediate vicinity of the Proposed Wind Farm site that could potentially have contaminated tailings.

8.3.7.2 Proposed Grid Connection

There are no known areas of soil contamination along the Proposed Grid Connection underground cabling route. During the site walkover of this area, 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 within the immediate environs of the site of the Proposed Grid Connection underground cabling route.

8.3.8 Geohazards

8.3.8.1 Slope Stability

8.3.8.1.1 *Proposed Wind Farm*

There are no landslide areas or events mapped within the area of the Proposed Wind Farm site on the GSI Landslide events online mapping viewer (www.gsi.iei). The majority of the Proposed Wind Farm site is mapped as “Low” on the GSI’s Landslide susceptibility classification (GSI). Elevated areas in the centre and northwest of the Proposed Wind Farm site are mapped as “Moderately High” to “High”.

The site investigation data indicates that there are no peat soil/subsoils present at the Proposed Wind Farm site. The overburden is typically glacial till/boulder clay derived from Namurian sandstones and shales with areas of gravels and outcrop/subcrop.

Walkover surveys and inspections of the Proposed Wind Farm site did not encounter any stability issues.

8.3.8.1.2 *Proposed Grid Connection*

There are no historic landslides mapped within the area of the Proposed Grid Connection underground cabling route. The route is mapped as “Low” on the Landslide susceptibility classification (GSI).

Walkover surveys and inspections along the Proposed Grid Connection underground cabling route identified no stability issues.

8.3.8.2 Peat Soils

8.3.8.2.1 *Proposed Wind Farm*

No peat is recorded at the Proposed Wind Farm site, either from desk study sources, or from the significant number of site investigation points completed as part of this study.

8.3.8.2.2 *Proposed Grid Connection*

There are no peat soils mapped along the Proposed Grid Connection underground cabling route.

8.3.8.3 Bedrock Faults

There is 1 no. significant fault mapped across the Proposed Wind Farm site which separates the Namurian sandstone and shales to the west from the Carboniferous limestones to the east. There are visible indicators of this fault across the Proposed Wind Farm site. A section of displaced (1-2m upwards) limestone exists ~220m from turbine T5 (see Plate 8-1), while a small ravine and stream (refer to Section 0 below) runs along the approximate position of the mapped fault, approximately 150m from the exposure shown in Plate 8-1. The fault is inactive and where boreholes have been drilled through the fault, so significant fault gouge has been observed. This fault will not have any significant effect on the Proposed Development.

Plate 8-1: Interpreted exposure of fault uplift near T5 Karst

8.3.8.4 Karst

Karst features are mapped by the GSI and available through the GSI online viewer. There are 3 no. karst features mapped at the Proposed Wind Farm site. These consist of 3 no. swallow holes located in the southern region of the Proposed Wind Farm site. There are several additional karst features mapped in the lands surrounding the Proposed Wind Farm site. A spring is mapped ~1.85km to the east of the Proposed Wind Farm site. There are also 8 no. springs mapped ~2.2km west of the Proposed Wind Farm site.

During a visit, the wooded/scrub area north and northeast of T6 was investigated. A small spring emerges as a seepage face near a farm track. This then flows down a stream channel which becomes increasingly steep as it flows south. The channel ravine becomes 2-3m deep in sections. The

hydrochemistry of this water indicates it is derived from or flowing over the siltstone/mudstone rather than limestone (*i.e.* low conductivity water between 150-200 µS/cm).

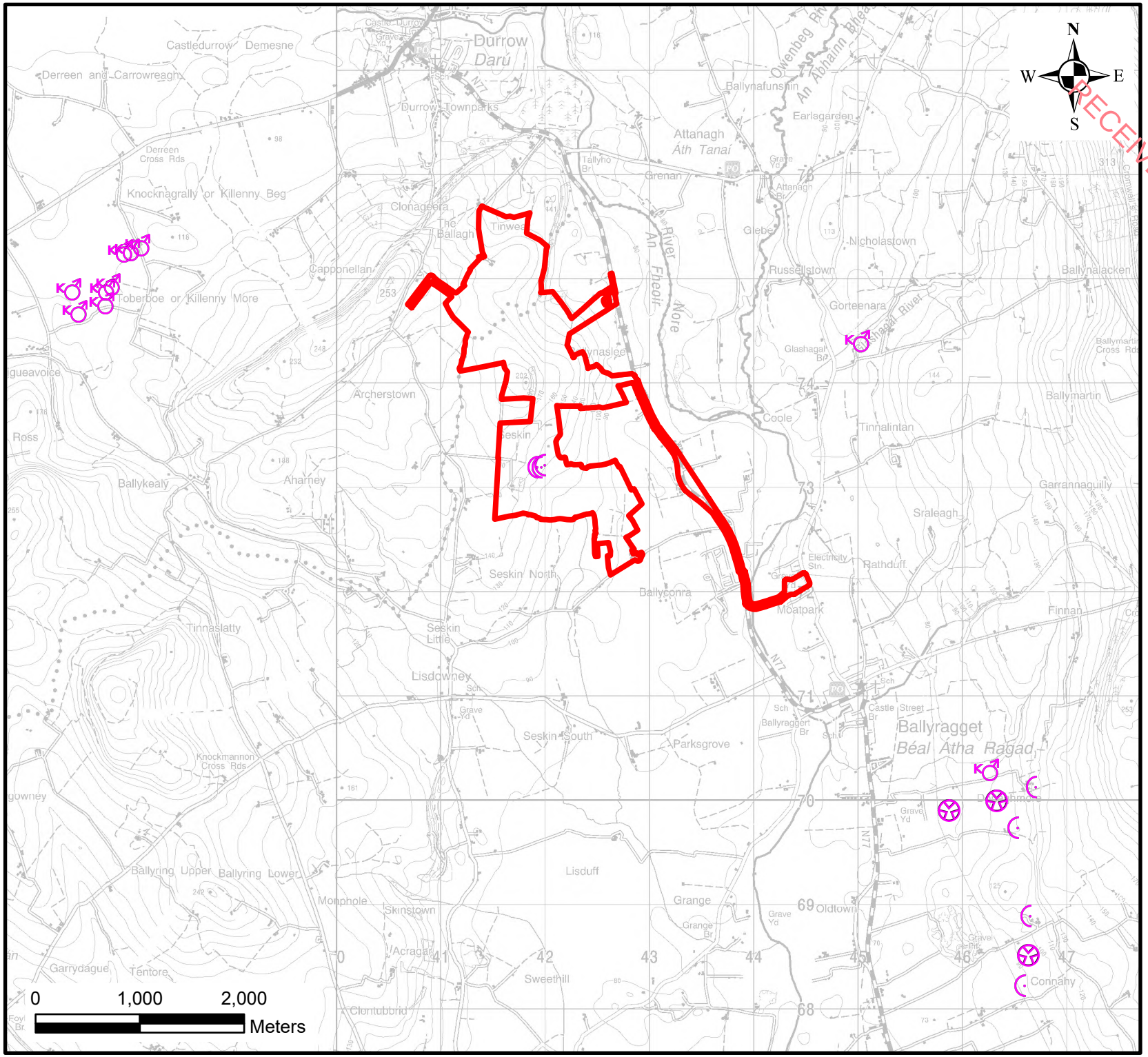
The water then flows into a swallow hole situated 180m north of T6 (~1-2 L/s), while some of the water (~0.25 L/s) cascades over a limestone face. The orange deposit which has built up on this face was tested with 10% hydrochloric acid and did not react, therefore it is not a calcium carbonate deposit. This deposit can be seen in **Plate B**. The swallow hole was measured at ~6m deep. Fracturing and faulting of the rock can be observed in this area, with limestone blocks showing displacement of 10-20cm. There was no visible discharge point after the swallow hole. The swallow hole is attributed to the mapped fault in this area, rather than a karst feature. There are no indications of any other karst features at ground surface, and none were observed during the site investigation works and numerous site walkovers. MW3 was drilled at the proposed location of T6 (~180m from swallow hole) which encountered dark shaley mudstone to 17.5m, underlain by competent limestone with no evidence of karstification.

The topography at T6 slopes to the east and, therefore with the swallow hole located to the north, drainage from the turbine will not flow in the direction of the swallow hole.

There are no karst features situated within fields adjacent to the N77 road along the Proposed Grid Connection underground cabling route.

The locations of the mapped karst features within the Site and in the vicinity are shown in Figure 8-7. It should be noted that there are 3 no. swallow holes noted, however only one swallow hole was observed after numerous walkovers. It is possible that the same swallow hole was recorded multiple times during the compilation of the karst feature directory by the GSI.

Plate B: Swallow Hole (left) and seepage face with iron oxide buildup (right).



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Client: MKO	
Job: Seskin Renewable Energy Development, Co. Kilkenny/Co. Laois	
Title: GSI Karst Features Map	
Figure No: 8-7	
Drawing No: P1653-1-0625-A4-807-00A	
Sheet Size: A4	Project No: P1653-1
Scale: 1:50,000	Drawn By: GA
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8.3.9 Geological Site Model

A geological site model is detailed below, which incorporates the various intrusive site investigation (trial pits and borehole/monitoring well drilling) along with the 1 no. geophysical survey conducted at the Proposed Wind Farm site and builds a detailed understanding of the overlying (soils and subsoils) and underlying (bedrock) geology at the site.

The geology of the Proposed Wind Farm site, which is detailed further below in Table 8-7 and Table 8-8 can be summarised as follows:

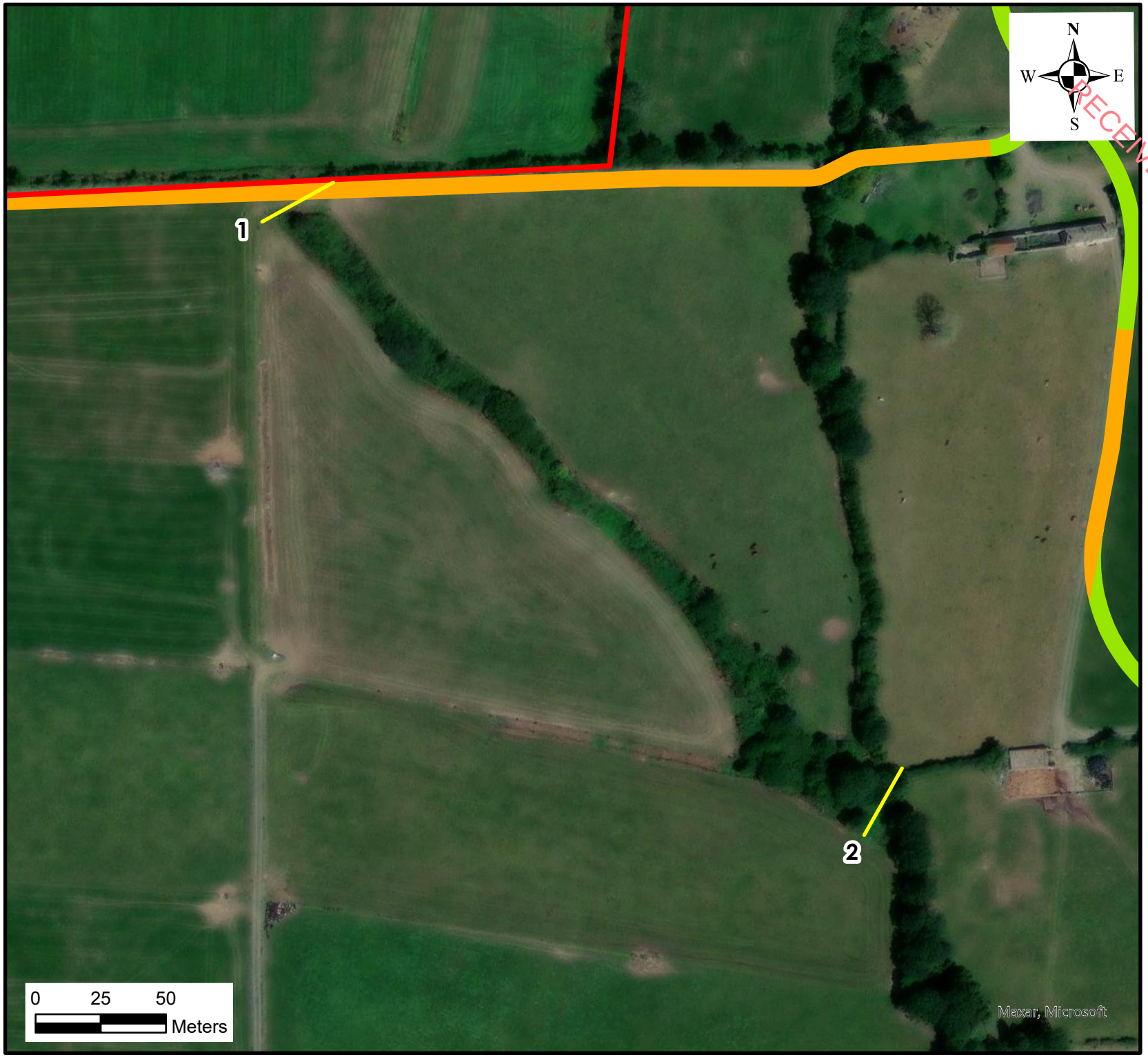
- There is no peat present at the Proposed Wind Farm Site;
- There are shallow soils/subsoils across the Proposed Wind Farm site, which are derived from a mixture of Namurian sandstone/shale (predominantly to northwest) and/or limestone parent material (predominantly to southeast) and are typically 0.5-2.0m thick, but extend deeper to ~12.5m depth in parts (as at MW1);
- The soils/subsoils are underlain by a layer of typically moderately weathered bedrock at surface (both the Namurian sandstone/shale and the limestone are typically weathered/fractured near surface) which generally exists within the top 1-3m of the bedrock; and,
- Below this zone of moderate weathering, the bedrock becomes hard and competent. This is evident from the monitoring well drilling and rotary core drilling. No evidence of wide scale karstification was observed. No karst type water strikes (*i.e.* significant water with clay returns) were encountered during the drilling of the monitoring wells.

As part of the design process for the Proposed Development, numerous intrusive and non-intrusive site investigations were undertaken across the Proposed Wind Farm site, to provide detail and clarity on the nature and extent of subsoils and bedrock as a means of characterising the Proposed Wind Farm site and provide information on the both the sandstone/shale and the limestone bedrock. This assisted in providing additional information on the most suitable location for turbines and associated infrastructure.

Apex Geophysics Ltd carried out a Geophysical Investigation on the Proposed Wind Farm site, with the purpose being to assess the sub-soil conditions at the proposed turbine bases and at the proposed substation location. The objectives of the geophysical investigation were to provide information on soil type, thickness and stiffness, depth to and type of bedrock, weathering and excitability of the bedrock, to identify potential karst features and fault/fissure zones within the bedrock and to propose locations for intrusive investigations.

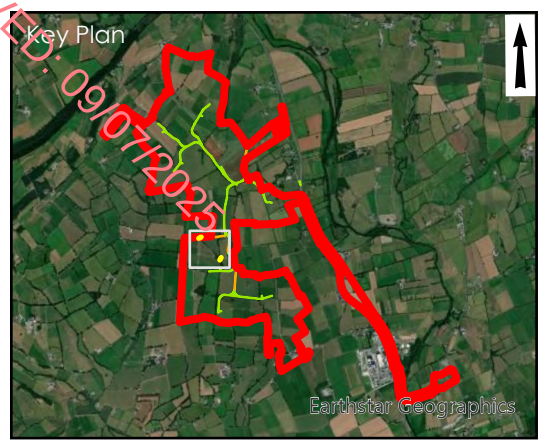
The Geophysical Investigation was carried out between the 14th and 21st October 2024. The geophysical investigation consisted of 2D Electrical Resistivity Tomography (ERT), Seismic Refraction profiling and Multi-channel Analysis of Surface Waves to examine the subsoil conditions at the 8 no. turbine bases, at the substation and at 2 no. further specified cross sections where a swallow hole was mapped.

The results of the geophysical survey and the interpretation of the data collected are summarised below in Table 8-8. The survey lines completed are included in Figure 8-8.



Legend

- EIAR Site Boundary
- Proposed New Roads
- Proposed Road Amendments Existing Roads
- Geophysics Lines



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Client: MKO	
Job: Seskin Renewable Energy Development, Co. Kilkenny/Co. Laois	
Title: Geophysics survey lines and locations	
Figure No: 8-8	
Drawing No: P1653-1-0625-A4-808-00A	
Sheet Size: A4	Project No: P1653-1
Scale: 1:2,000	Drawn By: GA
Date: 24/06/2025	Checked By: MG

Table 8-8: Summary of Geophysical Survey Data, Trial pitting data and drilling data

Location	Soils	Bedrock geology
Turbine Base T1	**Geophysics** 0.1 – 1.0m: Soft, sandy, gravelly Clay with pockets of loose clayey sand/gravel. **Trial Pitting:** 0.15 – 0.4m: Soft to firm brown slightly sandy slightly gravelly CLAY 0.4 – 0.9m: Presumed Weathered Bedrock recovered as grey slightly sandy clayey angular fine to coarse Gravel with low cobble content	**Geophysics** 1.0-3.5m: Weathered mudstone/shale **Trial Pitting** Weathered bedrock from 0.4-0.9m
Turbine Base T2	**Geophysics** 0 – 0.9m: Soft, sandy, gravelly Clay with pockets of loose clayey sand/gravel. 0.5m thick at turbine base 0.9 – 2.9m: Firm, sandy, gravelly CLAY 2.9m: Weathered mudstone/shale bedrock **Trial Pitting:** 0-0.2m: Topsoil 0.20 – 2.0m: Soft to firm brown slightly sandy slightly gravelly CLAY 2.0-2.3m: Presumed Weathered Bedrock recovered as grey slightly sandy clayey angular fine to coarse Gravel with low cobble content	**Geophysics** 2.9m: Weathered mudstone/shale **Trial Pitting** 2.0m: Weathered bedrock
Turbine Base T3	**Geophysics** 0-1.4m: Soft sandy gravelly clay 1.4-4.1m: Firm sandy gravelly Clay 4.1-21m: stiff to very stiff sandy gravelly clay **Trial Pitting:** 0-0.2m: Topsoil 0.20 – 0.8m: Soft brown slightly sandy slightly gravelly CLAY 0.8-3.2m: Firm to stiff brownish grey slightly gravelly CLAY	**Geophysics** Bedrock interpreted at 10-32.7mbgl. **Trial Pitting** Limestone bedrock met between 0.25-1.7mbgl during trial pitting for borrow pit in same field. The site specific trial pitting data contradicts the Geophysical interpretation in terms of bedrock depth.
Turbine Base T4	**Geophysics** 0-0.6m: Soft sandy gravelly clay 0.6-2.6m: Firm sandy gravelly Clay 2.6-8.7m: Moderately weathered mudstone/shale **Trial Pitting:** 0-0.2m: Topsoil	**Geophysics** Moderately weathered mudstone/shale interpreted from ~2.6mbgl **Trial Pitting** Bedrock not met during trial pitting **Drilling**

Location	Soils	Bedrock geology
	0.20 – 0.8m: Soft brown slightly sandy slightly gravelly CLAY 0.8-3.2m: Firm to stiff brownish grey slightly gravelly CLAY	Borehole MW1 drilled 120m from T4. Siltstone/Mudstone bedrock met at 12.5mbl, consisting of medium strong grey siltstone and mudstone.
Turbine Base T5	**Geophysics** 0-0.7m: Loose clayey sand and gravel 0.6-2.2m: Weathered Limestone with firm sandy gravelly Clay 2.2-5.1m: Moderately weathered Limestone **Trial Pitting:** 0-0.2m: Topsoil 0.3 – 0.6m: Firm brown slightly sandy slightly gravelly CLAY 0.5-0.7m: Weathered bedrock	**Geophysics** Moderately weathered Limestone from 2.2-5.1m. Slightly weathered to fresh Limestone from 5.1mbgl **Trial Pitting** Presumed weathered bedrock met at 0.5m in TP-T05 and at 0.6mbgl in TP-T05A. Both trial pits terminated shallow due to bedrock. **Drilling** Borehole MW2 drilled 110m southeast of T5. Weak weathered Limestone logged from 2.6-3.5m overlying strong Limestone from 3.5-51mbgl.
Turbine Base T6	**Geophysics** 0-1.0m: Soft, sandy gravelly Clay 1.0-2.6m: Firm sandy gravelly Clay with possibly weathered bedrock 2.6-5.7m: moderately weathered mudstone/shale **Trial Pitting** 0-0.15m: Topsoil 0.15-0.7m: Soft to firm slightly sandy gravelly Clay 0.70 – 2.60: Firm brown slightly sandy gravelly CLAY with medium cobble and boulder content 2.60 – 3.10: Very stiff light grey slightly sandy gravelly CLAY with medium cobble and boulder content	**Geophysics** Moderately weathered mudstone/shale from 2.6-5.7m Slightly weathered to fresh mudstone/shale from 5.7m. Change to limestone noted 25m east of turbine where possible fault contact exists. **Trial Pitting** No bedrock met during trial pitting **Drilling** MW3 drilled 23m south of T6. Soft black mudstone logged from 2.9-17.5m. Strong grey Limestone logged from 17.5-45mbgl. No significant fault zone mapped in the contact between both lithologies. Bedrock remained relatively hard during the change.
Turbine Base T7	**Geophysics** 0-0.9m: Soft sandy gravelly Clay 0.9-3.4m: Firm sandy gravelly clay 3.4-21.4m: stiff to very stiff sandy gravelly clay	**Geophysics** 21.4-27mbgl: Moderately weathered Limestone >27.0mbgl: Slightly weathered to fresh Limestone

Location	Soils	Bedrock geology
	21.4-27mbgl: Moderately weathered Limestone **Trial Pitting** 0 – 0.30: TOPSOIL 0.30 – 0.70: Soft to firm brown slightly sandy slightly gravelly CLAY 0.70 – 2.80: Firm to stiff greyish brown slightly sandy gravelly CLAY with medium cobble and boulder content	**Trial Pitting** No bedrock encountered during the trial pitting **Drilling** Borehole MW4 drilled 130m northwest of T7.
Turbine Base T8	**Geophysics** 0-1.2m: Soft sandy gravelly clay 1.2-4.0m: Firm sandy gravelly Clay 4.0-18.2m: Stiff to very stiff gravelly clay **Trial Pitting** 0 – 0.15: TOPSOIL 0.15 – 0.60: Soft to firm brown slightly sandy slightly gravelly CLAY 0.60 – 2.90: Firm to stiff greyish brown slightly sandy gravelly CLAY with medium cobble and boulder content 2.90 – 3.5: Stiff grey slightly sandy gravelly CLAY with low cobble content	**Geophysics** 18.2-27mbgl Moderately weathered Limestone >27mbgl: Slightly weathered to fresh Limestone **Trial Pitting** No bedrock encountered during trial pitting
Substation	**Geophysics** 0-0.7m: Loose clayey sand/gravel 0.7-2.5m: Highly weathered Limestone 2.5-6.1mbgl: Moderately weathered Limestone **Trial Pitting** Bedrock met at 0.2m and 0.25m respectively in TP-SS01 and TP-SS02. Refusal at these depths due to bedrock.	**Geophysics** 0.7-2.5mbgl: Highly Weathered Limestone 2.6-61mbgl: Moderately weathered Limestone **Trial Pitting** Bedrock met at 0.2m in TP-SS01 and at 0.25m in TP-SS02

From these data, it can be seen that the majority of the turbine locations are underlain by silty sandy gravelly clay to moderate depths (typically <5m), which are underlain by mudstone/shale or limestone bedrock which is typically weathered within the first 2-3m, becoming fresh/hard with depth. There is no evidence of widespread karstification of the limestone bedrock.

8.3.10 Characteristics of the Proposed Development

8.3.10.1 Engineering Design

The Proposed Development comprises 8 no. wind turbines with associated infrastructure including hardstands, access roads, a met mast, borrow pit and substation, as well as 2 no. temporary construction compounds.

The engineering design of the Proposed Wind Farm is underpinned by a comprehensive site investigation dataset. The Proposed Wind Farm site layout optimisation and the design process was iterative, and through this iterative process, the proposed infrastructure is sited in areas of optimum ground conditions.

Table 8-9 provides a summary of proposed turbine foundation designs (i.e., design response at each turbine base (ground bearing foundation or piled, excavate to rock)).

Table 8-9: Proposed Turbine Foundation Type

ID	Foundation Type	Formation Level (mbgl)	Formation Material (based on SI data)	Stone Upfill Depth (m)
T1	Ground-Bearing Gravity	3.1	Clay	0.1
T2	Ground-Bearing Gravity	3	Clay/Sand	0
T3	Likely Ground-Bearing Gravity, with minor possibility of piled foundation	3	Clay/Gravel	0
T4	Ground-Bearing Gravity	4.5	Clay	1.5
T5	Ground-Bearing Gravity	3.0	Rock	0
T6	Ground-Bearing Gravity	3.0	Rock	0
T7	Ground-Bearing Gravity	3.0	Gravel/Rock	0
T8	Ground-Bearing Gravity	3.0	Gravel/Cobbles	0
Substation	Ground-Bearing Gravity	0	Clay	0

Access roads will be founded on competent subsoil or potentially bedrock where shallow bedrock exists. Material volumes for spoil management are outlined below. In terms of the construction methodology, the potential for a piled foundation at turbine T3 is assessed in Section 8.4.2.9.

8.3.10.2 Material Quantities/Volumes

During the Proposed Wind Farm site and Proposed Grid Connection works spoil will invariably be generated during excavations for roads, hardstands, wind turbine foundations, drainage swales, trenches etc. Minimisation of the production of this spoil is to be treated as a high priority, but there will be generation of excess spoil in the form of a mixture of topsoil, rock and sandy gravelly clay.

It is proposed that the majority surplus spoil material will be managed around each turbine and hardstand and roadside berms. The remainder of the excavated spoil will be transported directly from the excavation for placement within one of the identified spoil management areas. This helps reduce the need for transportation of spoil across large areas and results in a reduced risk of dirty water generation (i.e. from tracking/transporting spoil over large areas with machinery).

A Spoil Management Plan is included within Section 4.3.3 of Chapter 4. For the construction phase of the Proposed Development the activities that are considered likely to generate spoil are as follows:

- Construction of new access roads;
- Excavations for 8 no. turbine bases, crane hardstands, substation and the temporary site construction compounds; and,
- Excavation of the Proposed Grid Connection underground cabling trench.

Estimated volumes of subsoil and bedrock to be excavated and accommodated within the Proposed Wind Farm site are shown in Table 8-10. Any bedrock excavated during cut and fill works will be used for hardcore material in construction of the development footprint. Soil and subsoil excavated during the works will be used to backfill the proposed borrow pit. Any additional soil and subsoil will be used for site landscaping or will be placed alongside site access roads and turbine hardstands.

Table 8-10: Estimated Spoil Management Volumes and crushed stone requirements for the Proposed Development

Development Component	Spoil Volume(m3) (approx.)	Crushed Stone Requirement (m3) (approx.)
Proposed Wind Farm		
8 no. Turbines and Hardstanding Areas (including foundations)	38,285	27,400
Access Roads (including met mast hardstand and security cabin)	38,010	40,670
Temporary Construction Compound	2,430	1,755
Met Mast	225	175
Total	78,950	70,000
Proposed Grid Connection		
Onsite Substation (including temporary construction compound)	10,230	2,785
Cabling Trench	2,045	920
Total	12,275	3,705
Total	91,225	73,705
Total (including 10% contingency)	100,350	81,075

8.4 Likely and Significant Effects on Land, Soils and Geology

8.4.1 Do Nothing Scenario

An alternative land-use option to the development of a renewable energy project at the Site would be to leave the Site as it is, with no changes made to existing land-use practices. Agriculture would continue at the site. In implementing the 'Do-Nothing' alternative, however, the opportunity to capture a significant part of the country's renewable energy resource would be lost, as would the opportunity to 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, development contributions, rates and investment in the local area would also be lost. On the basis of the positive environmental effects arising from the project, the do–nothing scenario was not the chosen option. The existing agricultural operations can and will continue in conjunction with the Proposed Development use of the site.

8.4.2 Construction Phase - Likely Significant Effects and Mitigation Measures

The likely effects of the Proposed Development and mitigation measures that will be put in place to eliminate or reduce them are shown below. The assessment considers the Proposed Development as a whole i.e. both the Proposed Wind Farm and the Proposed Grid Connection. Where this is required to be assessed separately, this is noted in the text.

8.4.2.1 Effects on Land and Landuse

The construction of the Proposed Development will result in the change in land-use of approximately 7.6ha of agricultural land. The Proposed Wind Farm construction works will result in local topographic changes with the removal of glaciofluvial and glacial overburden and some bedrock from the Proposed Wind Farm site.

The Proposed Grid Connection underground cabling route will result in the excavation of a narrow trench to accommodate the cabling. This trench will be reinstated once the cabling is emplaced with a comparable ground surface (tarmacadam or subsoil/topsoil). Therefore, no effects on land or landuse will occur along the Proposed Grid Connection underground cable route. The off-road section of the proposed route will be reinstated and works will be completed over a very short time period in these agricultural lands.

There will be no effects on the lands adjoining the Site.

Pathway: Excavation of soil/subsoil and bedrock.

Receptor: Land and Landuse (i.e. the land upon which the development will occur)

Potential Pre-mitigation Effect: Negative, slight, direct, likely, permanent effect on land and landuse within the Proposed Wind Farm site.

Negative, slight, direct, likely, permanent effect on land and landuse along the Proposed Grid Connection underground cabling route.

Impact Assessment/Mitigation Measures:

- The loss of 7.6ha of agricultural land resulting from the Proposed Development on a local or regional scale is minimal and therefore the effects of actual agricultural land loss is negligible.
- This loss of land represents ~2.5% of the EIAR Site Boundary.
- No mitigation is proposed with regard to the loss of this agricultural lands as it is an accepted part of the Proposed Development.
- Given the undulating nature of local topography resulting from the quaternary deposits and the uneven weathering of the Mudstone, Shale and Limestone bedrock, any change in topography is likely to be minimal in the overall landscape.

Post Mitigation Residual Effect: Agricultural land used for grazing is the dominant landuse in the area of the Proposed Development. Due to the relatively small footprint of the Proposed Development on a local scale and the undulating topography, the residual effect is considered Negative, direct, slight, likely, permanent effect on land and landuse.

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

8.4.2.2 Soil, Subsoil Excavation and Bedrock Excavation

Excavation of soil, subsoil and bedrock will be required for site levelling, bedrock quarrying at the borrow pit and for the installation of infrastructure, foundations for the access roads, turbines and substation, and underground cabling trench. This will result in a permanent removal of soil/subsoil and bedrock at excavation locations. Estimated volumes of soil, subsoil and bedrock to be removed are shown in Table 8-10 above.

However, there will be no loss of spoil from the Proposed Wind Farm site, as it will be relocated and stored within the proposed onsite borrow pit, in the designated spoil management areas or in linear berms along access roads and turbine hardstands where appropriate. Excavated spoil material can also be reused as fill material while the excavated rock will be used to facilitate the construction of the Proposed Development.

Excavation of subsoils will also be required along the Proposed Grid Connection underground cabling route. These deposits will be removed from the underground electrical cabling trench and will be transported to the proposed borrow pit within the Proposed Wind Farm site within the Proposed Wind Farm site. All excavated tar material will be transported to an appropriately licenced facility.

Mechanism: Extraction/excavation.

Receptor: Soil, subsoil and bedrock within the Proposed Wind Farm site and the Proposed Grid Connection underground cabling route.

Pre-Mitigation Potential Effect: Negative, slight/moderate, direct, likely, permanent effect on soils, subsoil and bedrock due to relocation within the Site.

Impact Assessment:

- The bedrock at the Proposed Wind Farm site is classified as “Medium to High” importance. Excavation volumes of soils and subsoils/bedrock are relatively small in comparison to the scale of the Proposed Wind Farm site (124,280 m^3 in total, with all soils, subsoils and bedrock re-used within the site). The soils and subsoil deposits and mineral soil at the Proposed Wind Farm site is classified as “Low to Moderate” importance as these materials are present across the region.

Mitigation Measures:

Proposed Wind Farm site

- Placement of turbines and associated infrastructure in areas with suitable ground conditions (based on detailed site investigation data);
- The soils and subsoil 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 borrow pit;
- The majority of the excavated soil/subsoil will be used to reinstate the borrow pit. This will significantly reduce the amount of spoil stored at the natural ground level across the site, which might be subject to erosion from rainfall runoff;
- Excavated soils/subsoils shall be excavated and stored separately to topsoil; this will prevent mixing of materials and facilitate reuse afterwards;
- Where soils/subsoils are stored alongside roads or turbine hardstands, the vegetative top-soil 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 placement of spoil will be restricted to a maximum height of 1.0m, subject to confirmation by the Geotechnical Engineer;

- Where practical, the surface of the placed spoil is shaped to allow efficient run-off of surface water. Where possible, shaping of the surface of the spoil will be carried out as placement of spoil within the area progresses. This will reduce the likelihood of debris run-off and ensure stability of the placed spoil;
- Finished/shaped side slopes of the placed spoil will be not greater than 1 (v): 1 (h) alongside access tracks and adjacent to turbine hardstands;
- Inspections of the spoil stored within the borrow pit and alongside access tracks/hardstands will be made by a Geotechnical Engineer through regular monitoring of the works. The appointed contractor will review work practices at these locations when periods of heavy rainfall are expected so as to prevent excessive dirty water runoff from being generated;
- All materials which require management will be stockpiled at low angles (< 5-10°) to ensure their stability and secured using silt fencing where necessary. This will help to mitigate erosion and unnecessary additions of suspended solids to the drainage system;
- Spoil management will take place within a minimal distance of each turbine to avoid excessive transport of materials within the Site;

Proposed Grid Connection underground cabling route

- Soils and subsoils excavated along the Proposed Grid Connection underground cabling route will be temporarily stored in covered stock piles along the edge of the road carriageway or alongside the excavated trench within agricultural lands.
- Once the emplacement of the cable has been completed, the stored soils and subsoils will be reinstated, with the minimal amount of compaction required to level the top surface.
- The tarmacadam road surface will be replaced with the same design standard as the surrounding carriageway. The topsoil surface will be reinstated in agricultural fields.

Post Mitigation Residual Effect: The cohesive and granular soil/subsoil at the Proposed Wind Farm site are classified as of "Low to Moderate" importance as they are present across the region. The effect is the disturbance and relocation of c. 124,280 m^3 of soil and subsoil during construction within the Wind Farm site. The site layout design has been iteratively developed using comprehensive site-specific site investigation dataset, which includes boreholes, trial pits, geophysical survey data and geotechnical soil analysis. The residual effect is negative, slight, direct, high probability, permanent effect on soils/subsoils and bedrock due to disturbance and relocation within the Proposed Wind Farm site.

The cohesive and granular soil/subsoil along the Proposed Grid Connection underground cabling route are classified as of "Low to Moderate" importance. Following the excavation and construction of the grid connection, the area excavated will be reinstated with a comparable ground cover. The residual effect is negative, slight, direct, high probability, permanent effect on soils/subsoils and bedrock due to disturbance and relocation along the Grid Connection route.

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

8.4.2.3 Contamination of Soil by Leakages and Spillages

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk. 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 and pollution of the underlying aquifer) on the geological and water environment. Additionally, waste tar, removed from the road hardstanding along the Proposed Grid Connection underground cabling route has the potential to affect soil/subsoil geochemistry.

Pathway: Soil, subsoil and underlying bedrock pore space.

Receptor: Soil, subsoil and bedrock.

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

Proposed Mitigation Measures:

- Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Where possible, off-site refuelling will occur at a controlled fuelling station;
- On-site re-fuelling will be undertaken using a refuelling truck with spill kits kept onboard;
- 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 on-site 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;
- All waste tar material arising from works on hard top roads will be removed off-site and taken to licenced waste facility; and,
- An emergency response plan for the construction phase to deal with accidental spillages is contained within the Construction and Environmental Management Plan (which is contained in Appendix 4-2).

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. Waste tar will be removed off-site and taken to a licensed waste facility. The residual effect is considered to be - Negative, imperceptible, direct, short-term, unlikely effect on soil, subsoils and bedrock.

Significance of Effects: For the reasons outlined above, and with the application of the mitigation measures outlined above, no significant effects on land, soils, subsoils or bedrock will occur.

8.4.2.4 Erosion of Exposed Soils/Subsoils During Construction

Erosion of soil/subsoil by the pathways listed below, can have the effect of reducing the overall volume of soil/subsoil at the Site, with the potential for some eroded subsoils to reach watercourses, leading to water quality issues such as high turbidity. Erosion of soils/subsoils may occur at any works area where excavation is ongoing i.e turbine foundations, access roads and hedgerow removal areas within the 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.

Pathway: Vehicle movement, surface water and wind action.

Receptor: Soils and subsoils.

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

Proposed Mitigation Measures:

- Soil/subsoil removed from the turbine locations and associated access roads will be used to restore the borrow pit, used for landscaping, or placed/spread locally alongside the excavation.
- Temporary drainage systems will be required to limit runoff impacts during the construction phase.
- Soils/subsoils removed from the Proposed Grid Connection groundworks will be removed and either used for Proposed Wind Farm site borrow pit reinstatement or taken to an appropriately licenced facility.

Residual Effect Assessment: Following implementation of these measures the residual effects will be - Negative, slight, direct, short-term, likely effect on subsoils by erosion and wind action.

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

8.4.2.5 Ground Instability and Failure

Ground instability or failure refers to a significant mass movement of a body of ground that would have an adverse impact on the environment as a result of the Proposed Development.

A significant amount of site investigation data has been acquired across the Proposed Wind Farm site. These data provide confidence on the depth of subsoil and the subsoil type. Subsoils are logged as generally silty, sandy clay, which would not be associated with ground instability or a risk of landslides. There is no peat identified within the Proposed Wind Farm site.

The subsoils range in depth between 0.25 – 12.5m across the Proposed Wind Farm site gathered from trial pitting and borehole drilling data. These data, along with the geophysical survey analysis and interpretation also outline the absence of any significant karst features below the subsoil layers which could impact on ground instability.

Mechanism: Vehicle movement and excavations.

Receptor: Soil, subsoils and weathered/karstified bedrock.

Pre-Mitigation Potential Effect: Negative, slight, direct, unlikely, permanent effect on subsoils and weathered bedrock.

Impact Assessment:

The findings of the comprehensive site investigation indicate good ground conditions, and all proposed turbines can be founded on subsoils or bedrock. The engineering design of the Proposed Wind Farm site is underpinned by a comprehensive site investigation dataset. The Proposed Wind Farm layout optimisation and design process was iterative, and through this iterative process the areas with optimum ground conditions have been selected.

Due to the nature of the soil/subsoil along the Proposed Grid Connection underground cabling route, there will be no effect on ground stability. The formation of the underground cabling trench will be within the underlying competent subsoil.

Mitigation Measures:

The following measures which will be implemented during the construction phase of the Proposed Development will assist in the management of the geotechnical risks for this site.

- Appointment of experienced and competent contractors;
- The site will be supervised by experienced and qualified engineering/geotechnical personnel;
- Allocate sufficient time for the project;
- Prevent undercutting of slopes and unsupported excavations;
- Maintain a managed suitable drainage system;
- Ensure construction method statements are followed or where agreed modified/ developed; and,
- Revise and amend the Geotechnical Risk Register as construction progresses.

Post Mitigation Residual Effects: The engineering design of the Proposed Wind Farm site is underpinned by a comprehensive site investigation dataset. The Proposed Wind Farm site layout optimisation and design process was iterative, and through this iterative process the areas with optimum ground conditions have been selected. The risk of ground failure during construction is very low. The residual effect is – No effects on subsoil/weathered bedrock and ground.

Due to the nature of the underground cabling trench (~1.3m deep narrow trench) and the soil/subsoil mapped along the route, the risk of ground failure during construction is negligible. The residual effect is – No effects on soils or subsoils.

Significance of Effects: For the reasons outlined above, and with the application of the mitigation measures outlined above, no significant effects on land, soils, subsoils or bedrock will occur.

8.4.2.6 Potential Effects on Geological Heritage Sites

There are a number of geological heritage sites mapped locally to the Proposed Wind Farm site. The Lisdowney Quarry (KK004) is situated ~2.5km south of the Proposed Wind Farm site. The works proposed as part of the Proposed Wind Farm, including turbine base excavations, access road excavation and emplacement and all other works involving movement of soils, subsoils and bedrock are remote from the geological heritage sites listed in Section 8.3.6.

There are no geological heritage sites mapped along the Proposed Grid Connection underground cabling route.

Pathway: There is no pathway for effects between the Geological Heritage Sites and the Proposed Wind Farm site and Proposed Grid Connection underground cabling route.

Receptor: Geological Heritage Sites.

Pre-Mitigation Potential Effect: No potential for effects.

Residual Effects: There will be no residual effects on geological heritage sites as a result of the Proposed Development.

Significance of effects: No effects.

8.4.2.7 Potential Effects on Designated Sites

No designated sites are mapped within the Proposed Wind Farm site. The closest designated site to the Proposed Wind Farm site is the River Barrow and River Nore SAC which is located 0.33km from the Proposed Wind Farm site footprint. Therefore, there is no potential for the works associated with the

Proposed Wind Farm to impact the land, soils and geological aspects of the River Barrow and River Nore SAC and/or any other designated sites.

Meanwhile, the Proposed Grid Connection underground cabling route overlaps with designated sites at the proposed crossing location over the River Nore. These designated sites include the River Barrow and River Nore SAC, the River Nore SPA and the River Nore/Abbeyleix Complex pNHA. However, the potential for effects is limited due to the scale and transient nature of the works proposed in comparison with the overall size of these designated sites.

The Proposed Development has no potential to impact the land, soils and geological characteristics of any other designated site due to their distant location from the proposed works. The potential hydrological and hydrogeological effects on downstream and downgradient designated sites are assessed in Chapter 9 of this EIAR.

Pathway: Excavation/removal of soils and subsoils.

Receptor: Designated Sites

Pre-Mitigation Potential Effect:

Proposed Wind Farm: No potential for effects.

Proposed Grid Connection: Negative, slight, direct, temporary, effect on land, soils and geology along the Proposed Grid Connection underground cable route and the River Barrow and River Nore SAC, the River Nore SPA and the River Nore/Abbeyleix Complex pNHA.

Impact Assessment:

Potential effects exist along the Proposed Grid Connection underground cabling route, where ~9,350 m^2 of the proposed route overlaps with the River Barrow and River Nore SAC, the River Nore SPA and the River Nore/Abbeyleix Complex pNHA. However, the works associated with the Proposed Grid Connection underground cabling route are temporary, transient and minor. It is proposed to cross the River Nore by Horizontal Directional Drilling (HDD) which will therefore avoid any direct impacts on the SPA which is delineated at this location by the river channel. The effects on the SAC and pNHA will be temporary and the land will be reinstated with a comparable surface once the works have been completed. Furthermore, the SAC and pNHA are extensive sites which span significant area. The proposed works associated with the Proposed Grid Connection underground cable route which overlap with these designated sites is infinitely small.

Proposed Mitigation Measures:

The mitigation measures outlined in terms of the land, soils and geology in relation to designated sites are essentially the same as those outlined in the preceding sections (refer to Sections 8.4.2.1 (land), 8.4.2.2 (soil and subsoil excavation), 8.4.2.3 (contamination of soils/subsoils) and 8.4.2.2 (erosion of soils/subsoils). Furthermore, mitigation measures in relation to the protection of the water environment are prescribed in Section 9.4.2.2 of the Water chapter, which deals with suspended sediment entrainment from the excavation works.

The design measures to achieve these mitigation measures are included in detail within Section 9.4.2.2 of Chapter 9, but briefly include the use of:

- Source controls such as interceptor drains, sandbags and the covering of stockpiles;
- Silt bags and silt fences; and,
- Pre-emptive site drainage management such as the use of general weather forecasts and rainfall radar images to plan and coordinate site works.

Post Mitigation Residual Effect:

Proposed Wind Farm

No residual effects on designated sites as a result of construction phase activities within the Wind Farm Site.

Proposed Grid Connection

With the implementation of the proposed mitigation measures, the residual effects on the River Barrow and River Nore SAC, the River Nore SPA and the River Nore/Abbeyleix Complex pNHA are considered to be – negative, direct, imperceptible, likely and temporary.

Significance of Effects For the reasons outlined above, no significant effects on the land soils and geological environments are anticipated at any of the listed designated sites in Table 8-7.

8.4.2.8 TDR/Haul Route Works

Works such as road widening are sometimes required along proposed turbine transport routes to accommodate the large turbine components and associated vehicles seeking to access wind farm sites. The proposed transport route for the Proposed Development has been the subject of a route assessment to determine if any works are required along its length. Full details of the assessment are included as part of the traffic impact assessment set out in Section 14.1.8 of this EIAR and summarised below. There are sections on the route where the vertical alignment may require specialist transport vehicles. Temporary accommodation works will be required at two locations to facilitate the delivery of turbine components and other abnormal loads to the Proposed Wind Farm during the construction phase. The accommodation works will be located within the village of Durrow, Co. Laois, at the Chapel Street/Mary Street (N77) junction and at the junction between the N77/L58333 in the townland of Ballynaslee, Co. Kilkenny. The locations of the accommodation works are shown on Figure 1-2 of Chapter 1.

Pathway: Placement of crushed stone at Location 1 and Location 2 to accommodate turbine delivery

Receptor: Land

Pre-Mitigation Potential Impact:

Neutral, slight, direct, temporary effect on land along turbine delivery route.

Proposed Mitigation Measures:

No mitigation measures required. Only limited amounts of crushed stone will be temporarily emplaced to allow for the turbine delivery.

Residual Effect Assessment: Due to the limited nature of accommodation works along the turbine delivery route, which include temporary emplacement of crushed stone, moving of traffic lights and street furniture, before being reinstated, the residual effects on the land, soils and geology environment is considered to be – no residual effect.

Significance of Effects For the reasons outlined above, no significant effects on soils and subsoil permeability will occur, and no significant effects on landcover will occur.

8.4.2.9 Piling Works

Piling foundations may be required at T3 (as the geophysics indicates the potential for deep subsoils at this location). The requirement for piling at T3 will be determined during post-consent ground

investigations. Based on the available site investigation data piling works are not envisaged at the other proposed turbine locations, however, taking a precautionary approach an assessment of piling at all proposed turbines has been included below.

Pathway: Piling works.

Receptor: Soils and subsoils.

Pre-Mitigation Potential Effect: Negative, slight, direct, permanent, unlikely effect on subsoils by piling works.

Proposed Mitigation Measures:

Piles have a very small footprint and will result in the displacement of small volumes of spoil. The small spoil volumes can be easily managed at the Site with excess spoil being removed for permanent storage in the on-site borrow pit or within the spoil management areas. Spoil volumes generated by any potential piling works will only amount to a very small percentage of the overall spoil volumes for the Proposed Project.

No mitigation measures are proposed or required for soils and geology environment. Proposed mitigation to protect the water environment are outlined in Chapter 9.

Residual Effect Assessment: The residual effects are considered - negative, direct, imperceptible, permanent, unlikely effect on soil, subsoil or bedrock by piling works.

Significance of Effects For the reasons detailed above, and with the implementation of the proposed mitigation measures, no significant effects on soil, subsoil or bedrock will occur.

8.4.3 Operational Phase - Likely Significant Effects and Mitigation Measures

Very few potential direct impacts are envisaged during the operational phase of the Proposed Development. 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.

8.4.3.1 Site Road Maintenance

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.

Pathway: Soil, subsoil and bedrock pore space.

Receptor: Soil, subsoil and bedrock.

Potential Pre-Mitigation Effect: Negative, indirect, imperceptible, short term, likely effect on peat, 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 Wind Farm site from local authorised quarries. The residual effect is considered to be - 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.

8.4.3.2 Site Vehicle/Plant Use

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; and
- 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 CEMP (Appendix 4-2).

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 considered to be - 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.

8.4.3.3 Use of Oils in Transformers

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. 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 Environmental Management Plan.

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 considered to be - 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.

8.4.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The potential effects associated with decommissioning of the Proposed Development will be similar to those associated with construction but of reduced magnitude (i.e., soil/subsoil/bedrock excavation; Contamination by Leakage/Spillages).

The wind turbines proposed as part of the Proposed Wind Farm site are expected to have a lifespan of approximately 35 years. Following the end of their useful life, the equipment may be replaced with a new technology, subject to planning permission being obtained, or the Proposed Wind Farm site may be decommissioned fully.

Upon decommissioning of the Proposed Wind Farm site, the wind turbines will be disassembled in reverse order to how they were erected. The turbines will be disassembled with a similar model of crane that was used for their erection. The turbine components will be separated and removed offsite. The turbine materials will be transferred to a suitable recycling or recovery facility. Leaving the turbine foundations in-situ is considered a more environmentally prudent option, as to remove that volume of reinforced concrete from the ground could result in unnecessary environment emissions such as noise, dust and/or vibration.

The underground electrical cabling connecting the turbines to the on-site substation will be removed from the cable ducts. The cabling will be pulled from the cable ducts using a mechanical winch which will extract the cable and re-roll it on to a cable drum. This will be undertaken at the original cable jointing pits which will be excavated using a mechanical excavator and will be fully re-instated once the cables are removed. The cable ducting will be left in-situ as it is considered the most environmentally prudent option, avoiding unnecessary excavation and soil disturbance. The cable materials will be transferred to a suitable recycling or recovery facility.

Site roadways could be in use for purposes other than the operation of the Proposed Development by the time the decommissioning of the Proposed Wind Farm is to be considered, and therefore it may be more appropriate to leave the Site roads in situ for future use. It is envisaged that the roads will serve as agricultural roads for local landowners.

The Proposed Grid Connection underground electrical cabling route and onsite substation will remain in place as it will be under the ownership and control of the ESB and Eirgrid.

A Decommissioning Plan has been prepared (Appendix 4-4) the detail of which will be agreed with the local authority prior to any decommissioning. The Decommissioning Plan will be updated prior to the end of the operational period in line with decommissioning methodologies that may exist at the time and will agreed with the competent authority at that time. The potential for effects during the decommissioning phase of the Proposed Development has been fully assessed in the EIAR.

During decommissioning, it may be possible to reverse or at least reduce some of the potential effects caused during construction by rehabilitating construction areas such as turbine bases. This will be done by covering with soils/subsoils and vegetation to encourage vegetation growth and reduce run-off and sedimentation. Other effects such as possible soil compaction and 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 (i.e., mitigation outlined at Sections 8.4.2). Some of the effects will be avoided by leaving elements of the Proposed Development in place where appropriate *i.e* the 110 kV substation and underground cabling. 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 soils and geology environment are envisaged during the decommissioning stage of the Proposed Development.

8.4.5 Assessment of Human Health Effects

Potential health effects arise mainly through the potential for soil and ground contamination. A wind farm is not a recognized source of pollution and so the potential for effects during the operational phase are negligible. Hydrocarbons will be used onsite during construction however the volumes will be small in the context of the scale of the Proposed Development 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.

8.4.6 Risk of Major Accidents and Disasters

Due to the absence of peat and the absence of any significant karst features, there is a low risk of a landslide occurring.

Refer to Chapter 16: Major Accidents and Natural Disasters for a full assessment.

8.4.7 Potential Cumulative Effects

The potential for impact between the Proposed Development, and other relevant developments has been carried out with the purpose of identifying what influence the Proposed Development (Proposed Wind Farm and Proposed Grid Connection underground cabling route combined) will have on the surrounding environment when considered cumulatively and in combination with relevant existing permitted or Proposed Developments and plans in the vicinity of the Site, as set out in Chapter 2 of this EIAR. Please see Section 2.8 of Chapter 2 for cumulative assessment methodology.

A dataset of 3,910 no. planning applications within the defined potential cumulative boundary (defined by boundaries of downgradient water catchments) has been completed. Of the 3,910 no. applications, 406 no. applications are for agricultural buildings, typically slatted sheds and milking parlors. There are 163 no. commercial units within the dataset and 2,288 no. residential dwellings. There are 22 no. wind farms listed within 25km of the Site.

The proposed planning applications within the dataset have been analysed, with particular emphasis on the larger projects listed. Following this analyses, there will be no cumulative effects on the land, soils and geology environment as a result of the Proposed Development.

Due to the localised nature of the proposed construction works which will be kept within the Site boundary, there is no potential for significant cumulative effects in-combination with other local developments on the land, soils and geology environment as all effects are direct within the Site. Other projects outside the Site do not have the potential to reduce or increase the magnitude of effects of the Proposed Development on Land, Soils and Geology.

The only way the Proposed Development can have cumulative effects with other off-site projects and plans is via the drainage and off-site surface water network, and this hydrological pathway is assessed in Chapter 9. The construction of the Proposed Grid Connection works will only require relatively localised excavation works within the Site boundary and therefore will not contribute to any significant cumulative effects.

The construction of the Proposed Grid Connection underground cabling route will only require relatively localised excavation works within the site boundary and therefore will not contribute to any significant cumulative effects. Following a review of other planning applications it is revealed that the proposed HDD location over the River Nore is the same as that proposed for the Briskalagh Wind Farm, the timing of works will be coordinated to ensure that there is concurrent works, and therefore no cumulative effect.

Also, in the vicinity of Ballyragget substation there are applications for the construction battery energy storage systems. A hydrological and hydrogeological assessment report and drainage strategy was submitted along with the Environmental Report for the Power Reserve Project at Ballyragget. This report detailed mitigation measures for the protection of the geological and hydrological/ hydrogeological environment through all phases of that development.

As such, the works along the Proposed Grid Connection are minor and transient, similar to roadworks being completed across the country and have no potential for significant cumulative effects on the land soils and geology environment.

8.4.8 Post Construction Monitoring

None required.