White Hill Wind Farm

Environmental Impact Assessment Report

Chapter 6: Land & Soil

White Hill Wind Limited

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6.1 Introduction

6.1.1 Background and Objectives

This chapter provides an assessment of the likely and significant effects of the White Hill Wind Farm; (along with its secondary and/or off-site elements which are described below) located c. 4km west of Oldleighlin (Co. Carlow) and c. 13km northeast of Kilkenny City; on the land, soil and geological environment.

This chapter provides a baseline assessment of the environmental setting of the project (wind farm site, grid connection route and haul route upgrade works locations) in terms of land, soils and geology and identifies the likely and significant effects that the construction, operation and decommissioning of the project will have on them, including an assessment of cumulative effects with other existing, permitted and proposed developments. Where required, appropriate mitigation measures to limit, reduce or avoid any identified effects on land, soils and geology are recommended.

6.1.2 Description of the Project

In summary, the project comprises the following main components as described in **Chapter 3**:-

- 7 no. wind turbines with an overall tip height of 185m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including the provision of site drainage infrastructure;
- Upgrades to the turbine component haul route; and,
- Construction of an electricity substation and installation of c. 15km of underground grid connection cable between the White Hill Wind Farm and the existing Kilkenny 110kV electricity substation.

The wind farm site traverses the administrative boundary between counties Carlow and Kilkenny; with 4 no. turbines located in Co. Carlow and 3 no. turbines within Co. Kilkenny. The electricity substation is located within Co. Carlow while the majority, c. 14km, of the underground electricity line is located in Co. Kilkenny. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route and associated upgrade works as described in **Chapter 3**. It is envisaged that the turbines will be transported from the Port of Waterford, through the counties of Kilkenny, Waterford, Carlow and Kildare to the project site. However, as the route follows motorway and national roads through counties Waterford and Kildare, it is assessed that there is no likelihood of effects on land & soil and, therefore, these areas have been screened out from further assessment.

A full description of the project is presented in **Chapter 3**.

6.1.3 Statement of Authority

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

Our core areas of expertise and experience include water and geology. We routinely complete impact assessments for land soils and geology, hydrology and hydrogeology for a large variety of project types, including wind farms and associated grid connections.

This chapter was prepared by Michael Gill and David Broderick.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 18 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology /hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIAR for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

David Broderick (BSc, H.Dip Env Eng, MSc) is a hydrogeologist with over 14 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland, working mainly on groundwater and source protection studies, David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has also completed numerous geology and water assessments for inclusion within EIARs for a range of commercial developments. David has worked on the EIS/EIAR for Oweninny WF, Cloncreen WF, Meenbog WF, Arderroo WF and Yellow River WF, and over 80 other wind farm related projects across the country.

6.1.4 Relevant Legislation

This chapter has been prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

Regard has also been had to the requirements of the following legislation:-

- S.I. No. 349/1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84/1995, S.I. No. 352/1998, S.I. No. 93/1999, S.I. No. 450/2000 and S.I. No. 538/2001), S.I. No. 30/2000, the Planning and Development Act, and S.I. 600/2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- Planning and Development Act, 2000, as amended; and,
- S.I. No 296/2018: S.I. No. 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of Directive 2014/52/EU into Irish law.

6.1.5 Relevant Guidance

This chapter has been prepared having regard, where relevant, to the guidance contained in the following documents:-

- *Guidance Document on Wind Energy Developments and EU Nature Legislation* (European Commission, 2020);
- 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*;
- Department of the Environment, Heritage, and Local Government (2006) *Wind Energy Development Guidelines for Planning Authorities 2006*;
- Forestry Commission (2004) *Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh*;
- COFORD (2004) *Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads*;
- Department of Housing, Planning & Local Government (2018) *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment*;
- European Union (2017) Guidance *on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);* and,
- Institute of Environmental Management (IEMA) (2022) *A New Perspective on Land and Soil in Environmental Impact Assessment*.

6.2 Methodology

6.2.1 Desk Study

A desk study of the project site and receiving environment (described below) was completed in advance of undertaking the walkover survey, visual assessments and site investigations. This involved collecting all relevant land, soil and geological information for the project site and surrounding area. Data sources included:-

- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland – Groundwater and Geological Database (www.gsi.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 16 (Geology of Kildare - Wicklow);
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets;
- Ordnance Survey Ireland (OSI) – 6" and 1;5000 scale basemaps; and,
- Aerial photography (www.bing.com/maps; www.google.com/maps).

6.2.2 Baseline Monitoring & Site Investigations

An initial site walkover, geological mapping and soil probing exercise was undertaken by HES on 31 August 2021. Further site investigations including trial pits were undertaken on 6 October 2021. Additional site walkovers and soil probes were completed on 10 and 30 March 2022.

A geotechnical assessment used to inform the assessment contained within this chapter was carried out by Fehily Timoney & Company (FT) and is enclosed in **Annex 6.1**. Separately, a Planning-Stage Spoil Management Plan has been prepared (see

Annex 3.4) which details the treatment and management of material excavated during the construction phase of the project.

In summary, site investigations to inform this assessment include the following:-

- Detailed site walkovers and visual inspections to assess ground conditions;
- Land and drainage mapping;
- A trial pit or soil gouge core was undertaken at each of the turbine locations, substation, energy storage system (ESS) area, construction compound and borrow pits to investigate subsoil depth and lithology. A total of 9 no. trial pits were completed along with 4 no. soil gouge cores);
- 40 no. soil probe locations along with slope angle measurements were carried out by FT as part of the geotechnical assessment;
- Logging of bedrock outcrops and subsoil exposures; and,
- Mineral subsoils were logged according to BS:5930.

6.2.3 Receptor Importance/Sensitivity Criteria

In addition to the utilisation of sensitivity and receptor importance criteria outlined within the above-mentioned EPA Guidance (EPA, 2022), this assessment, in accordance with National Roads Authority (NRA, 2008) guidance, quantifies the importance of the land, soil and geology environments at the project site by applying the criteria set out in **Table 6.1**, with the impact magnitude and impact rating subsequently assessed using **Table 6.2** and **Table 6.3.**

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/SAC). • 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 high 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	• Contaminated soil on site with previous light industrial usage. • Small recent landfill site for mixed

	contamination is moderate on a local scale. • Volume of peat and/or soft organic soil underlying site is moderate on a local scale.	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.

Table 6.1: Estimation of Importance of Soil and Geology Criteria (NRA, 2008)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	• Loss of high proportion of future quarry or pit reserves. • Irreversible loss of high proportion of local high fertility soils. • Removal of entirety of geological heritage feature. • Requirement to excavate / remediate entire waste site. • Requirement to excavate and replace high proportion of peat.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Loss of moderate proportion of future quarry or pit reserves. • Removal of part of geological heritage feature. • Irreversible loss of moderate proportion of local high fertility soils. • Requirement to excavate / remediate significant proportion of waste site. • Requirement to excavate and replace moderate proportion of peat. • organic soils and/or soft mineral soils beneath alignment.

Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Loss of small proportion of future quarry or pit reserves. • Removal of small part of geological heritage feature. • Irreversible loss of small proportion of local high fertility soils and/or High proportion of local low fertility soils. • Requirement to excavate / remediate small proportion of waste site. • Requirement to excavate and replace small proportion of peat. • Organic soils and/or soft mineral soils beneath alignment.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• No measurable changes in attributes

Table 6.2: Estimation of Magnitude of Impact (NRA, 2008)

	Magnitude of Impact			
Importance of Tribute	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/ Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/ Moderate

Table 6.3: Estimation of Rating of Impact (NRA, 2008)

6.2.4 Scoping & Consultation

The scope for this assessment has been informed by consultation with statutory consultees and other bodies with environmental responsibility.

This consultation process is outlined in **Chapter 1** of this EIAR. Matters raised and recommendations highlighted by the responses in relation to land, soils and geology are summarised in **Table 6.4** below. The full response from each of the below consultees are provided in **Annex 1.8.**

Consultee	Summary of Response	Addressed
Geological Survey of Ireland (GSI)	The GSI does not envisage any impact on the integrity of County Geological Sites [discussed below in chapter] by the project as none are located nearby.	**Sections 6.3.5**, **6.3.6**, **6.3.7** & **Annex 6.1**

	Recommendation that geohazards be taken into consideration, especially when developing areas where these risks are prevalent.	
Carlow County Council	Impact on residential amenity and adjoining land use.	**Section 6.4.3.4**
	Must clearly identify all European Sites potentially impacted by the proposed development and identify mitigation measures that will reduce any impacts.	**Section 6.3.8**
	A geotechnical report should be done including slope stability assessment.	**Sections 6.3.5**, **6.3.6** & **Annex 6.1**
Kilkenny County Council	Earthworks – consideration of borrow pits, peat risk assessment and excess material from construction works (subsoil, rock and peat).	**Sections 6.4.1**, **Annex 6.1** & **Annex 3.4**
	Grid connection route location, geology, assessment relating to bedrock, karst and important aquifer.	**Sections 6.3.4**, **6.4.3.1**, **6.5.1.1** & **Chapter 7**

Table 6.4: Summary of Land and Soils Scoping Responses

6.3 Description of the Existing Environment

6.3.1 Site Location & Description

The wind farm site, which is located within an area of approximately 290ha, is located in west County Carlow and east County Kilkenny. The site is c. 4km west of Oldleighlin, c. 14km southwest of Carlow and c. 13km northeast of Kilkenny.

The wind farm site is located on an elevated plateau, known as the Castlecomer Plateau, which is located in south County Laois, northwest County Carlow and northeast County Kilkenny. The Castlecomer Plateau is characterised by undulating hills and steep escarpments at its fringes. Dissecting the lowlands on either side of the plateau are the rivers Barrow and Nore, which lie to the east and west respectively.

Current land use within the wind farm site is predominately commercial forestry and agricultural pastures, with small pockets of transitional woodland scrub within the wider landscape. Agricultural pastures are more dominant in the eastern and north-eastern section of the wind farm site.

The topography of the wind farm site is 'hilly-to-undulating' with the overall site elevation ranging between approximately 220m and 290m OD (Ordnance Datum). The higher elevations occur in the central and eastern areas of the site with the land sloping generally towards the north and west in the direction of the Coolcullen River which flows in a generally northerly direction through the wind farm site. The elevation of the electricity substation, located in the south of the wind farm site, is at approximately 280m OD.

The grid connection route runs in a southerly direction for approximately 15km between the electricity substation to the existing 110kV substation at Scart, Co. Kilkenny. The grid connection comprises underground cables to be located predominately within the carriageway of the public road network, with short sections at the respective substations being located within private lands. The ground elevation along the grid connection decreases to c. 65m OD at the substation near Kilkenny.

The haul route works are predominately located within motorway, national and regional roads. The majority of the works comprise the temporary removal of street furniture to accommodate the delivery of turbine components; along with the temporary removal of pier caps at 'Crettyard Bridge' and lowering of an adjacent wall (located approximately 10km north of the wind farm site), a temporary access track at the junction of the N78 and L1834 (also located approximately 10km north of the wind farm site), and carriageway strengthening works at a bridge ('Black Bridge', located approximately 3km north of the wind farm site) along the L1835.

The forestry replant lands are mainly agricultural pasture, with fields bounded by hedgerows and treelines. Ground elevations across the replant lands range generally between 110m OD and 140m OD.

6.3.2 Land & Land Use

The wind farm site comprises agricultural land (grassland pasture and arable land) and coniferous forestry. 5 no. of the 7 no. turbines are situated in grassland/pasture (T1, T2, T3, T5 and T6) with the remaining 2 no. located in forested areas (T4 & T7).

The spoil deposition areas (2 no.), borrow pits (3 no.) electricity substation, temporary compound, and meteorological mast are all located on agricultural grassland.

Based on the Corine (2018) mapping, the forestry at the project site is described mainly as 'forest and semi-natural areas' while the remainder of the site is 'agricultural areas'.

The 'agricultural areas' are predominantly used for cattle grazing.

The grid connection will be predominately located within the carriageway of the local road network, with c. 1.8km located within the R712 regional road. Approximately 200m of grid connection, between the electricity substation and the local road network which will be located adjacent to an access track, will be located within agricultural grassland.

The temporary access track to be created at the junction of the N78 and L1834 is located in agricultural grassland; while the works at 'Crettyard Bridge' and 'Black Bridge', to be undertaken within man-made surfaces/land-uses, are located in a rural/agricultural setting.

The replant lands in Co. Monaghan comprise a network of small-to-medium sized fields which are in agricultural pasture.

6.3.3 Superficial Geology

6.3.3.1 Mapped Soils & Subsoils

Based on the GSI/Teagasc soils mapping (www.gsi.ie), the wind farm site is mainly overlain by deep poorly drained mineral soils (AminPD) and, to a lesser extent, shallow well drained mineral soils (AminSW) of acidic nature. Some acid poorly drained mineral soils (AminSP) are also found in the east and southwest of the wind farm site and are mapped in the area of the electricity substation. Pockets of blanket peat (BktPt) and poorly drained mineral soils with a peaty topsoil (AminPDPT) are also mapped on the north of the wind farm site.

The soil types along the grid connection route are similar to the wind farm site, with alluvium mapped along many of the local rivers and streams in the area.

Poorly drained soil is mapped at the temporary access track at the junction of the N78 and L1834 and at the carriageway strengthening works along the L1835 ('Black Bridge') and at Crettyard Bridge.

The replant lands are mapped as comprising poorly drained mineral soil.

GSI subsoils mapping (www.gsi.ie) show that Till derived from Namurian sandstones and shales (TNSSs) is the dominant subsoil type at the wind farm site. Bedrock outcrop or subcrop is mapped on the more elevated central and eastern sections of the wind farm site. Localised patches of Blanket Peat (BktPt) are mapped on the north-western section of the project site. However, it should be noted that no infrastructure is located within areas mapped as Blanket Peat. The absence of peat at all wind turbine locations, and locations of other key infrastructure, was confirmed by site investigations (see **Section 6.3.3.2** below). No blanket peat was encountered or identified at any location within the project site.

Bedrock outcrop is dominant along much of the grid connection route, with the other subsoil types along the route similar to those mapped within the wind farm site (i.e. sandstones and shale tills).

Towards the southern end of the grid connection route, there are pockets of Karstified bedrock outcrop or subcrop (KaRck), Gravels derived from Namurian sandstones and shales (GNSSs) and Alluvium (A). Meanwhile, Till derived from limestones (TLs) is mapped to the far south of the grid connection and underlying the existing 110kV electricity substation.

Namurian sandstones and shales are also mapped at the temporary access track at the junction of the N78 and L1834, at the carriageway strengthening works along the L1835 (Black Bridge) and at Crettyard Bridge.

The subsoil type at the replanting lands is sandstone/shale tills.

A local subsoil geology map is shown in **Figure 6.1** below.

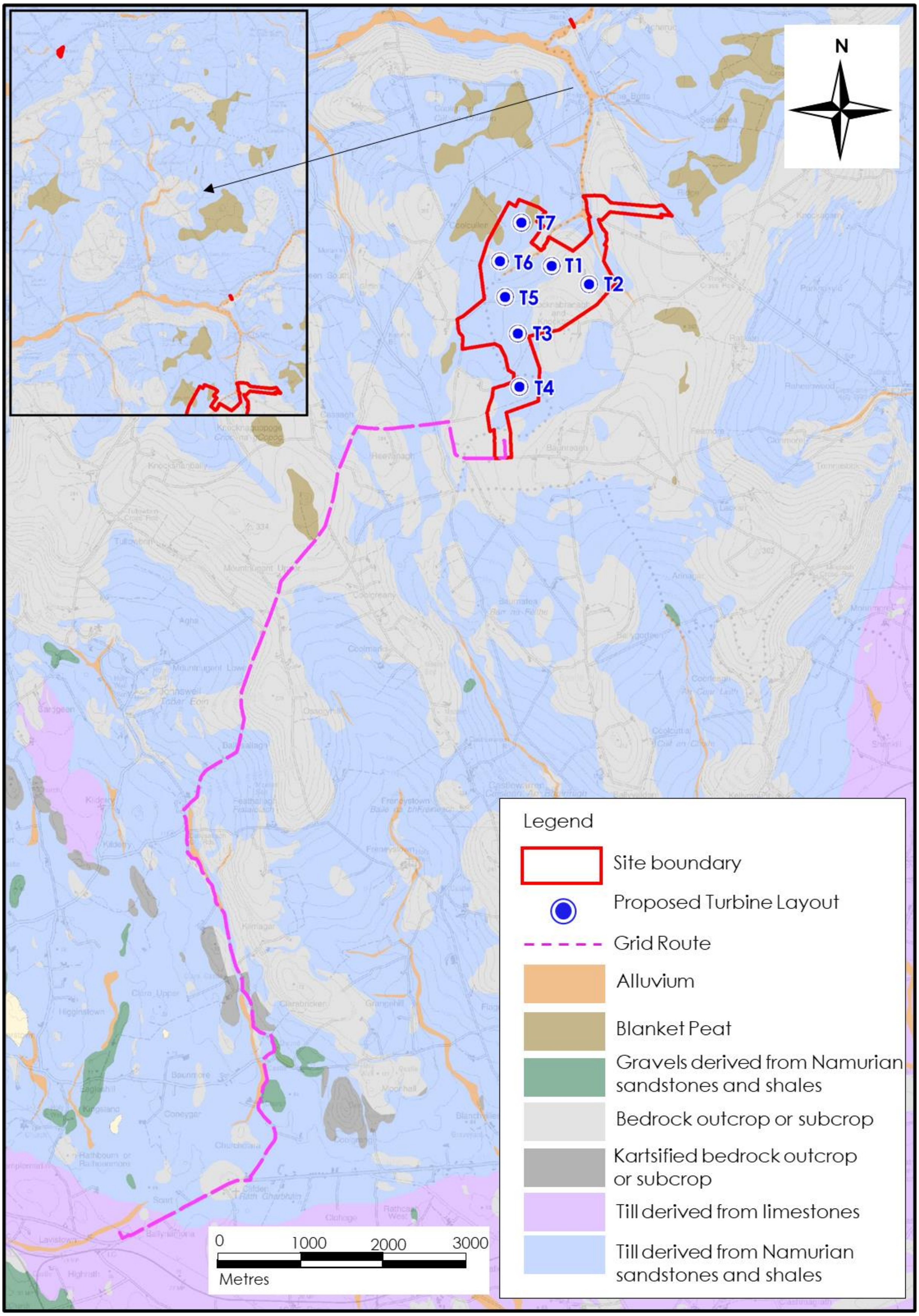

Figure 6.1: Local Subsoils Geology Mapping

6.3.3.2 Site Investigations

A total of 40 no. soil probes were carried out on site during the various site visits. Peat/peaty topsoil depths recorded across the site ranged from 0.0m (no peat) to 0.8m with an average depth of 0.12m. 70% of peat depth probes recorded no peat.

A number of localised readings were recorded where peat/peaty topsoil depths were between 0.5 and 0.8m. Peat of this depth (0.5–0.8m) is confined to very localised, isolated pockets at the construction compound and turbines T3, T4 and T7 (refer to **Table 6.4** below for summary peat depths).

Peat/peaty topsoil, where recorded, is shallow, localised in nature and confined to isolated pockets. Peat is described as firm with intact fibres visible. This is not an intact blanket bog deposit but is more likely to be a remnant of a more localised peat deposit in areas of historically poor drainage.

The peat/peaty topsoil depths recorded at the turbine locations varied from 0.0 to 0.6m with an average depth of 0.23m (refer to **Table 6.4** below).

With respect to access tracks, peat/peaty topsoil depths are typically less than 0.2m (average 0.12m) with localised pockets of up to 0.6m recorded.

Trial pits were undertaken at all turbine locations with the exception of turbine locations T4 and T7, which are located in dense coniferous forestry and are not accessible by track machine. Peat probes and soil gouge cores were carried out at turbines T4 and T7 as an alternative.

Table 6.5 includes a summary of peat depths, depth to bedrock and the mineral subsoil lithology. Trial pits logs and photographs are provided at **Annex 6.2**.

The overburden geology/mineral subsoils at the wind farm site typically comprises firm to very firm gravelly SILT or SILT/CLAY. 7 no. of the 9 no. trial pits encountered bedrock at depths varying between 0.5 and 2.9m.

No peat was recorded in any of the trial pits with the exception of a thin peaty topsoil layer. The trial pits at the turbine locations were generally carried out within the proposed turbine base footprint.

Bedrock was met at 4 no. of the 5 no. turbine locations (T1, T2, T3 & T5) where trial pits were carried out.

Trial pit, soil probe and soil gouge core locations are illustrated in **Figure 6.2** below.

Location	Peat Depth Range (m)[1]	Depth to Bedrock (m)	Summary of Subsoil Lithology
T1	0	1.9	SILT over Gravelly SILT/CLAY
T2	0	1	Gravelly SILT
T3	0.15-0.6	1.7	CLAY
T4	0-0.5	-	Gravelly SILT
T5	0	1.4	Gravelly SILT
T6	0	>2.9	Gravelly SILT
T7	0-0.5	-	Sandy, Gravelly SILT
Construction Compound	0-0.8	>2.6	Sandy SILT over Gravelly SILT/CLAY

Substation	0	1	Gravelly SILT
Energy Storage Area	0	0.5	Gravelly SILT
Met Mast	0	0.7	SILT
Borrow Pit 1	0	<0.5	Gravelly SILT/CLAY
Borrow Pit 2	0.1	<0.5	Gravelly SILT/CLAY
Borrow Pit 3	0-0.1	0.7	SILT
Spoil Deposition Area 1	0	-	Gravelly SILT/CLAY
Spoil Deposition Area 2	0	-	Gravelly SILT/CLAY

Note 1:
Peat depths are not consistent across the site or, indeed, at infrastructure locations which serves to demonstrate the isolated and localised nature of areas of peat/peaty topsoil

Table 6.5: Summary of Trial Pit, Soil Probes and Gouge Core Investigations

Based on the criteria in **Table 6.1** above, local soils and subsoils are assessed to be of Low-to-Medium importance.

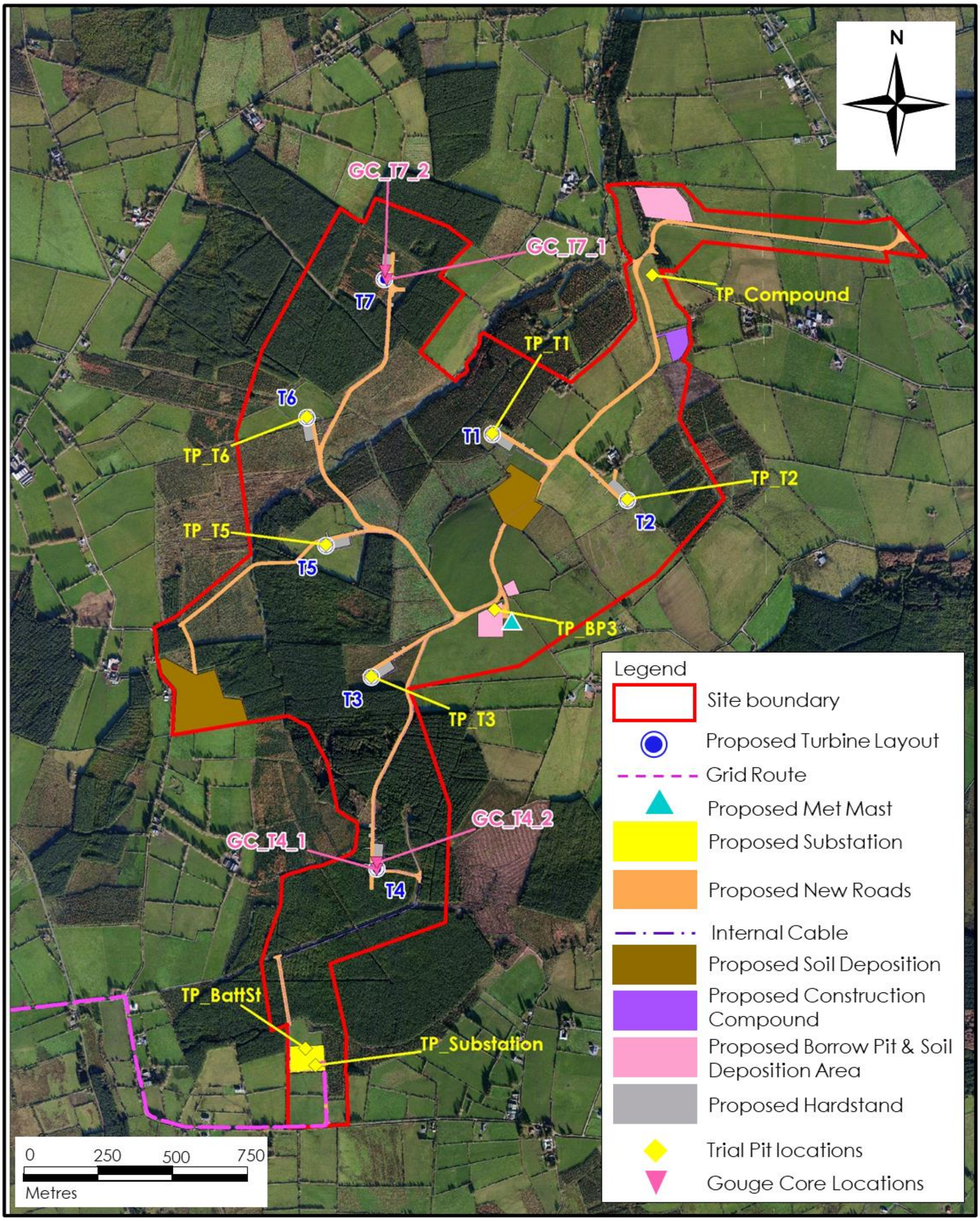

Figure 6.2: Site Investigation Map

6.3.3.3 Soil Contamination

There are no known areas of soil contamination within the project site or in its immediate environs. During the site walkovers and intrusive site investigations, no areas of contamination concern were identified.

According to the EPA online mapping database (http://gis.epa.ie/Envision), there are no licensed waste facilities within or in the immediate environs of the project site.

There are no historic mines within or in the immediate vicinity of the project site which are likely to have contaminated tailings and could give rise to adverse environmental effects.

6.3.4 Bedrock Geology

Based on the GSI bedrock mapping (www.gsi.ie), the wind farm site is underlain by Westphalian shales and Westphalian sandstones consisting of the Coolbaun Formation and the Swan Sandstone Member respectively. The Coolbaun Formation is described by the GSI as consisting of shales and sandstone with thin coals while the Swan Sandstone Member is composed of laminated dark-grey siliceous sandstone.

7 no. of the 9 no. trial pits met bedrock at depths varying between 0.5 and 2.9m. The bedrock encountered typically comprised soft weathered SHALE.

The northern section of the grid connection route is also underlain by Westphalian shales and sandstones of the Coolbaun Formation. Further to the southwest, the grid connection route is underlain by Namurian Sandstone of the Bregaun Flagstone Formation consisting of thick flaggy sandstone and siltstone. Namurian Shales of the Killeshin Siltstone Formation and the Luggacurren Shale Formation are located further south. The GSI describe the Killeshin Siltstone Formation as muddy siltstones and silty mudstones; while the Luggacurren Shale Formation consists of mudstone and shale interbedded with chert and limestone.

The southern half of the grid connection route is mapped to be underlain by Dinantian Pure Bedded Limestones of the Ballyadams Formation and the Clongrenan Formation. The Ballyadams Formation is known to consist of crinoidal wackestone/packstone limestones while the Clongrenan Formation is described as cherty, muddy and calcarenitic limestones. Further south, the GSI map Dinantian Upper Impure Limestones of the Butlersgrove Formation, consisting of argillaceous limestones.

The Coolbaun Formation is mapped at the temporary access track at the junction of the N78 and L1834 and at the carriageway strengthening works along the L1835 (Black Bridge) as well as at Crettyard Bridge.

Bedrock at the replant lands is mapped as Silurian metasediments and volcanics.

A bedrock geology map for the area is shown in **Figure 6.3** below.

There are no mapped faults within the wind farm site. However, there are several faults mapped along the grid connection route. These will have no consequence for the project due to the shallow nature of the grid connection works.

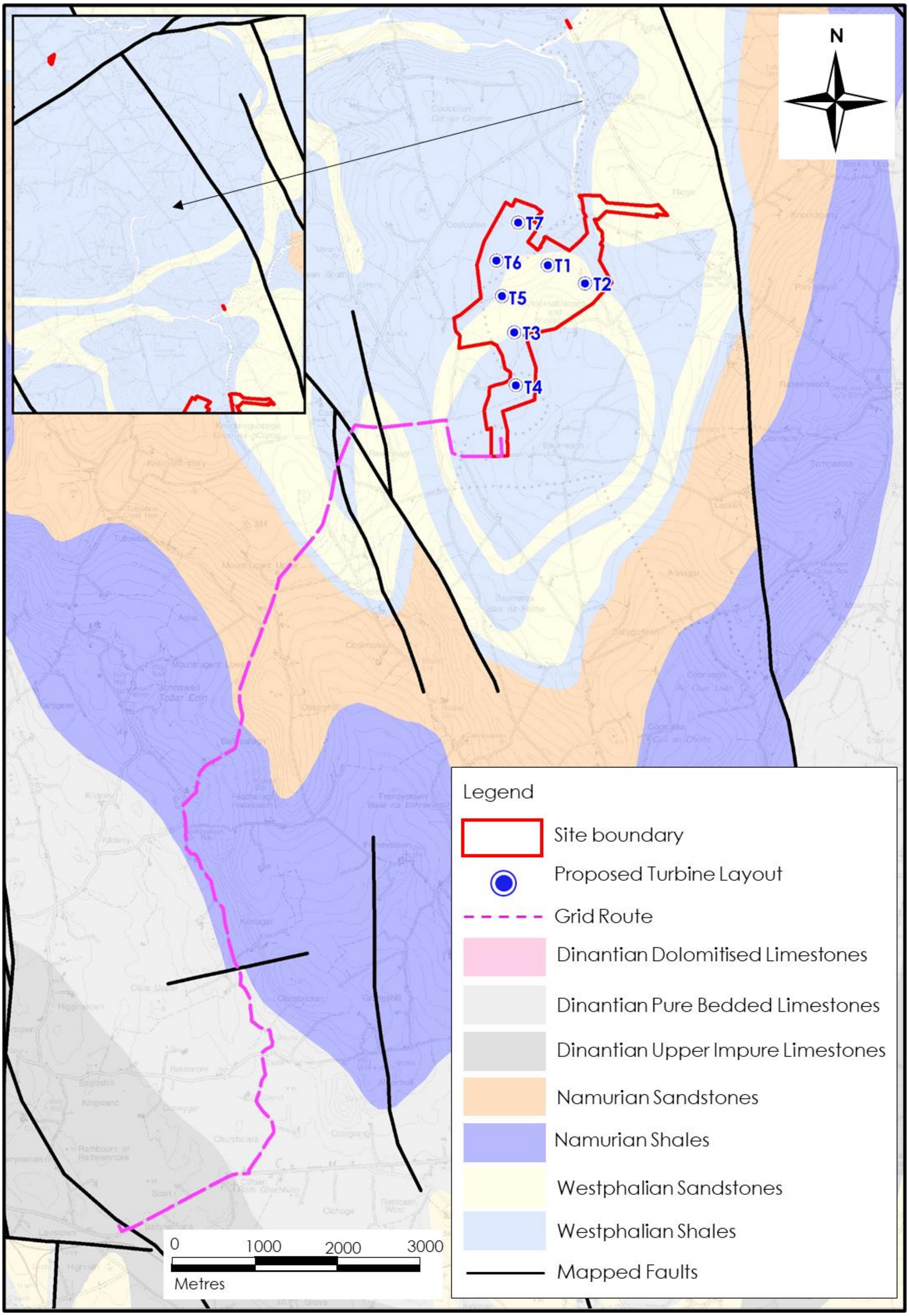

Figure 6.3: Local Bedrock Geology Mapping

6.3.5 Peat Stability Analysis Introduction

An analysis of peat stability was carried out at all the main infrastructure locations where peat was identified. The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes. The minimum required Factor of Safety (FoS) is 1.3 based on *BS6031:1981: Code of Practice for Earthworks* (BSI, 2009). The assigned probability of instability associated with a given FoS value is described in **Table 6.6** below. Hydrological and hydrogeological factors were also assessed in the Geotechnical and Peat Stability Assessment Report (**Annex 6.1**).

No peat failures/landslides are recorded at the wind farm site which suggests that conditions do not pre-dispose themselves to failures/landslides.

A walkover/drive survey of the grid connection route and haul route works identified no peat stability issues and therefore there was no requirement to carry out the detailed analysis as described below for the wind farm site.

The soil hand vane results indicate undrained shear strengths in the range of 21 to 54kPa, with an average value of about 40kPa. This strength range is to be expected due to the shallow and isolated peat pockets at the wind farm site.

The recorded undrained strength at the wind farm site is significantly greater than the lower bound values for Derrybrien Wind Farm, for example, indicating that there is no close correlation to the peat conditions at the Derrybrien Wind Farm site and that there is significantly less likelihood of failure on the subject site.

Scale	Factor of Safety	Probability
1	1.30 or greater	Negligible/None
2	1.29 to 1.20	Unlikely
3	1.19 to 1.11	Likely
4	1.01 to 1.10	Probable
5	<1.0	Very Likely

Table 6.6: Probability Scale for Factor of Safety.

6.3.6 Peat Stability Results

Stability of a peat slope is dependent on several factors. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in peat failure. The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety for peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat failures.

To assess the factor of safety for a peat slide, an undrained[1] (short-term stability) and drained (long-term stability) analysis has been undertaken to determine the stability of the peat slopes on site:-

[1] For the stability analysis two load conditions were examined; namely, Condition 1: no surcharge loading, and Condition 2: surcharge of 10 kPa, equivalent to 1 m of stockpiled peat assumed as a worst case.

- The undrained loading condition applies in the short-term during construction and until construction induced pore water pressures dissipate; and,
- The drained loading condition applies in the long-term. The condition examines the effect of in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

A summary of the 'undrained analysis' is presented in **Table 6.7** and the 'drained analysis' in **Table 6.8**; while full results can be found in **Annex 6.1**.

In summary, the findings demonstrate that the wind farm site has an acceptable margin of safety, is suitable for wind farm development and is considered to be at low risk of peat failure or ground instability. The findings include recommendations and control measures for construction work in peat lands to ensure that all works adhere to an acceptable standard of safety.

Infrastructure ID	Factor of Safety for Load Condition	
	Condition 1	Condition 2
T1	No Peat Encountered	
T2	No Peat Encountered	
T3	38.23	14.34
T4	30.61	10.20
T5	No Peat Encountered	
T6	No Peat Encountered	
T7	22.99	7.66
Meteorological Mast	No Peat Encountered	
Construction Compound	11.52	5.12
Electrical Substation	No Peat Encountered	
Borrow Pit 1	No Peat Encountered	
Borrow Pit 2	92.14	8.38
Borrow Pit 3	92.14	8.38
Spoil Deposition Area 1	No Peat Encountered	
Spoil Deposition Area 2	No Peat Encountered	

Table 6.7: Factor of Safety Results (Undrained Condition)

Turbine No./Waypoint	Factor of Safety for Load Condition	
	Condition 1	Condition 2
T1	No Peat Encountered	
T2	No Peat Encountered	
T3	19.11	15.51
T4	15.31	11.03
T5	No Peat Encountered	
T6	No Peat Encountered	

T7	11.50	8.28
Meteorological Mast	No Peat Encountered	
Construction Compound	5.76	5.52
Electrical Substation	No Peat Encountered	
Borrow Pit 1	No Peat Encountered	
Borrow Pit 2	46.07	9.03
Borrow Pit 3	46.07	9.03
Spoil Deposition Area 1	No Peat Encountered	
Spoil Deposition Area 2	No Peat Encountered	

Table 6.8: Factor of Safety Results (Drained Condition)

6.3.7 Geological Resource Importance

According to the GSI natural resource mapping, the wind farm site has a 'very low to high' crushed aggregate potential and 'low to very low' potential for granular aggregate potential. The bedrock underlying the majority of the grid connection route has similar aggregate potential as the wind farm site. However, to the south, the limestones of the Ballyadams Formation are mapped as having 'high to very high' crushed aggregate potential.

The crushed aggregate potential at the temporary access track at the junction of the N78 and L1834 and at the carriageway strengthening works along the L1835 (Black Bridge) as well as Crettyard Bridge is 'high to very high' with no granular aggregate potential.

Crushed rock potential at the replant lands is 'moderate to high' with no granular potential.

Based on the criteria in **Table 6.1** and the GSI aggregate potential above, the local bedrock underlying the wind farm site has a Low to Medium Importance. Meanwhile, the bedrock along the grid connection route has a Low to Very High Importance.

6.3.8 Geological Heritage & Designated Sites

No element of the project is located within a geological heritage site or designated site (see **Figure 6.4** below).

The closest geological heritage site to the project site is Ballyfoyle Channels (Site Code: KK005), consisting of a series of deeply incised channels, located c. 7km to the west of the project site.

Two geological heritage areas are located to the south of the grid connection route and the existing 110kV electricity substation. The Dunbell M9 cutting (Site Code: KK023), located less than 2km south of the grid connection route, is a road cutting along the M9 motorway with good exposures of the limestone rocks of the Butlersgrove Formation. Meanwhile, Bennettsbridge Quarry (Site Code: KK010) is located approximately 2.5km south of the grid connection. Bennettsbridge Quarry is an active quarry where aggregate extraction is ongoing.

Based on the criteria in **Table 6.1** above, geological heritage sites have a High Importance.

Designated sites include Natural Heritage Areas (NHAs), proposed Natural Heritage Areas (pNHAs), candidate Special Areas of Conservation (cSAC), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs). There are no designated sites within the project site or adjacent to it which can be directly affected (from a land, soil and geology perspective) by the construction, operation or decommissioning of the project.

The closest designated site to the project is the River Barrow and River Nore SAC (Site Code: 002162). At its closest point, this designated site is located approximately 1.5km to the north (as crow flies) of the wind farm site and is downstream (hydrologically connected) via the Coolcullen River.

In addition, all of the surface waterbodies draining the grid connection route drain into the River Barrow and River Nore SAC and the River Nore SPA (Site Code: 004233).

Further details of the assessment of hydrological effects, including on the River Barrow and River Nore SAC, can be found in **Chapter 7**. Based on the criteria in **Table 6.1** above, designated sites have a Very High Importance.

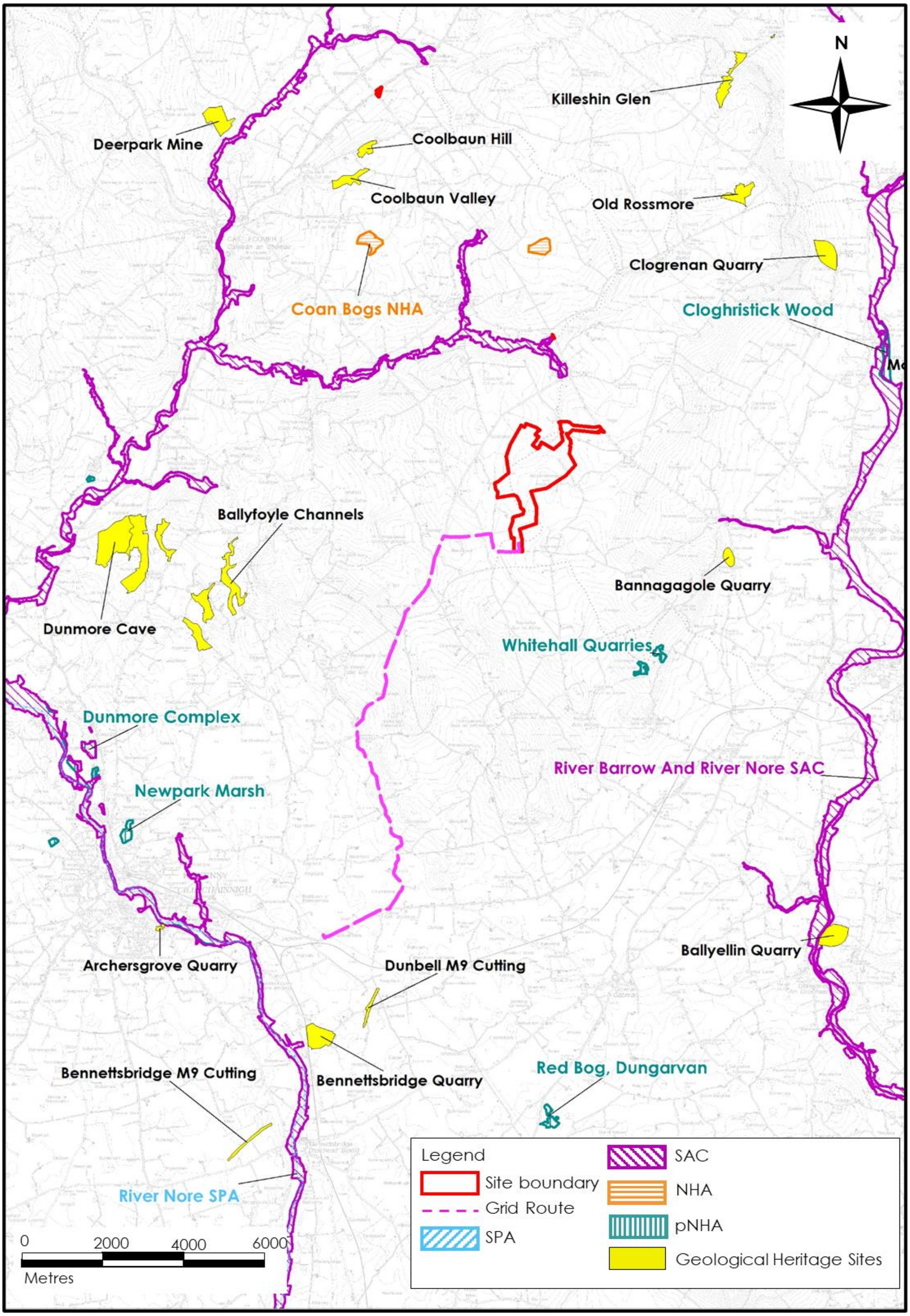

Figure 6.4: Designated Sites & Geological Heritage Sites

6.4 Assessment of Likely Effects

6.4.1 Characteristics of the Project

The project will typically involve the removal of soil, subsoil and bedrock to facilitate the emplacement of access tracks, turbine foundations, crane hardstandings, substation and battery storage area foundations, meteorological mast foundation, and underground electrical cabling.

During preliminary site investigations, it was identified that significant volumes of rock are present within the project site either at or near the surface and a substantial volume of rock will be encountered during excavations. Accordingly, the excavated rock shall be utilised in the construction of access tracks and crane hardstandings. While it is estimated that sufficient rock material will be encountered and will be available for the construction phase (excluding the topping layer which will be imported from a local quarry (or quarries); 3 no. suitable borrow pit locations have been identified and may be utilised to provide rock/stone. These borrow pits will only be utilised where sufficient rock cannot be extracted from excavations elsewhere within the wind farm.

Overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material, or material which cannot be used for reinstatement, will be stored, permanently, at 2 no. dedicated spoil deposition areas and in the 3 no. spent borrow pits (if developed).

The designated spoil deposition areas can accommodate c. 103,000m^3 of material while the 3 no. borrow pits could, if developed, accommodate c. 19,500m^3 of material.

To maintain the geological integrity of the project site, it is proposed that generated spoil will firstly be deposited locally to its point of origin or at a location of similar geological characteristics.

Following the completion of the spoil deposition process, the dedicated spoil storage areas and borrow pits will also be graded to match existing profiles and reseeded.

It is, therefore, predicted that all spoil generated, which is suitable for storage via this method, will be stored permanently within the wind farm site. However, certain materials (e.g. tarmac/road cuttings from haul route works and grid connection works) will be removed from site and disposed of at a licensed waste facility. As waste license permits are subject to renewal, it is not currently possible to confirm the precise location for the disposal of excess spoil; however, having reviewed the National Waste Collection Permit Office (NWCPO) database, there are a number of facilities within counties Carlow and Kilkenny which currently accept soil, rock and other materials arising from construction projects.

The turbine foundations will generally be gravity design and will be constructed on the underlying mineral soil deposits. Foundations depths are expected to be between 3m and 5m deep, depending on ground conditions at each turbine location, with an approximate diameter of 22m.

The trench, within which the underground electricity line (grid connection) will be placed, will be typically 0.6m wide by 1.2m deep. The trench will be located predominately within the carriageway of public roads. It is predicted that c. 12,500m^3 of spoil will be generated during trench excavation with the majority being removed and stored at the permanent spoil deposition areas. It is estimated that only c. 100m³ will be re-used in the reinstatement process. The trench will be backfilled and reinstated to the required specifications, and finished as appropriate to the satisfaction of the respective landowners or local authority.

The haul route works will largely involve road furniture alternation, however minor excavations will be required for the temporary access track at the junction of the N78 and L1834 junction and the carriageway strengthening works along the L1835. No excavations are required in respect of the works at Crettyard Bridge. The replanting will be carried out by hand or by using light machinery. Therefore, due to the very minor and localised nature of the groundworks associated with the haul route and replanting works, they have been scoped out from further assessment.

Estimated volumes of overburden and rock to be removed for each element of the proposal are indicated in **Table 6.9** below.

Please refer to the Spoil Management Plan (**Annex 3.4**) prepared by Galetech Energy Services for further details on the management and storage of spoil.

Element	Total (m^3)	Soil/Subsoil (m^3)	Rock (m^3)	Road Cuttings (m^3)
Access Track Construction	4,871	4,743	128	-
Site Entrances (3 no.)	3,227	3,226	1	-
Turbine Foundations & Hardstands (7 no.)	87,715	32,299	55,416	-
Grid Connection	12,622	11,777	-	845
Electricity Substation & Access Track	1,680	1,680	-	-
Haul Route Works	879	879	-	-
Miscellaneous (construction compound, met mast, drainage, ducting, etc.)	10,596	6,326	4,270	-
Total	121,590	60,930	59,815	845

Table 6.9: Summary of Estimated Excavation Volumes

6.4.2 'Do-Nothing' Impact

In the event that the project is not progressed, existing land uses will continue and there will be no alteration to the land, soil or geological environment.

6.4.3 Construction Phase

6.4.3.1 Soil, subsoil and bedrock excavation

The excavation of soil, subsoil and bedrock will be required for all groundworks; including site levelling, the installation of infrastructure (e.g. turbine foundations, substation foundation, hardstands and electrical cabling) and for access track formation and will, therefore, give rise to direct effects on these receptors. The excavation of soils and subsoils will also be required along the grid connection route; while minor levels of excavation are predicted at haul route works locations.

Bedrock will be encountered at most locations due to its relatively shallow nature, as evidenced by the results of the preliminary site investigations undertaken.

Due to the shallow nature of the works along the grid connection (~1.2m) and the fact that the cable will largely be placed within the carriageway of public roads effects on soils, subsoil and bedrock will be not be significant.

These works will result in a direct, permanent loss of soil, subsoil and bedrock at excavated locations. The estimated excavation volumes are detailed in **Table 6.9** above.

The overall effect is determined not to be significant due to the following:-

- The soils, subsoils and bedrock at the project site are generally classified as 'low to medium' importance;
- A minimal volume of soil, subsoil and bedrock; in comparison to the total resource present on the site; will be removed to allow for the construction of the project;
- The soil, subsoil, and bedrock which will be removed during the construction phase will be localised to the footprint of infrastructure only; and,
- No turbines or related infrastructure will be constructed within or near any designated sites for the protection of ecological features or geological heritage.

The excavation and relocation of material is an inevitable part of the project and no mitigation is required. The excavation of materials will be completed in accordance with best practice for the management and treatment of such materials. The overall effect of the excavation of soil, subsoil and bedrock is summarised in **Table 6.10** below.

Attribute	Description
Receptor	Soils, subsoils and bedrock
Pathway/Mechanism	Excavations
Overall Effect	Negative, direct, slight, likely, permanent effect on soil, subsoil and bedrock

Table 6.10: Soil & Subsoil Excavation Effect

6.4.3.2 Erosion of exposed soil and subsoil at excavation and storage areas

The exposure of soil and subsoils at locations of excavation and of spoil storage can increase the likelihood of soil erosion resulting in a direct physical effect on land and soil. However, given the small footprint of the proposed excavation (including the haul route upgrade works, grid connection works, and forestry replanting) and spoil storage areas in the context of the overall project site, the pre-mitigation effect will not be significant.

The pre-mitigation effects of soil and subsoil erosion are summarised in **Table 6.11** below.

Attribute	Description
Receptor	Soils and subsoils
Pathway/Mechanism	Vehicle movement, surface water erosion, and wind action.
Pre-Mitigation Effect	Negative, direct, slight, likely effect on soil and subsoils.

Table 6.11: Soil & Subsoil Erosion Effect

6.4.3.3 Contamination of soils and subsoils by leakages or spillages of hydrocarbons or other chemicals

The contamination of soils and subsoils presents a direct effect on the geology of the project site. 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 are likely to result in significant effects (i.e. contamination of soils and subsoil on the geological environment. The likely pre-mitigation effect is assessed to be not significant due to the relatively low volumes of fuels/chemicals that will be kept on-site (including along the grid connection route and forestry replant lands))at any one time.

The pre-mitigation effect of soil contamination is summarised in **Table 6.12** below.

Attribute	Description
Receptor	Soil and subsoils
Pathway	Soil and subsoil pore space.
Pre-Mitigation Effect	Negative, direct, moderate, short-term, likely effect on, soils and subsoils.

Table 6.12: Soil & Subsoil Contamination Effect

6.4.3.4 Effects on Land & Land Use

The construction of the project will result in the loss of c. 5.5ha of agricultural land and 15ha of commercial forestry. The loss of c. 5.5ha of agricultural land is imperceptible (in the content of the overall wind farm site area of 290ha which equates to a 1.9% loss) and will not materially affect land use within the project site. Existing agricultural operations can readily co-exist and there will be no perceptible effect on these activities.

The construction of the project will result in the felling of 15ha of existing commercial forestry. This forestry will be felled to accommodate the construction of the project (i.e. physical placement of infrastructure) and to facilitate its effective and efficient operation of this infrastructure (i.e. wind turbines). It is not, therefore, proposed to replace this forestry on-site but to replant same off-site.

The replanting of forestry is subject to a separate licensing and consenting process which incorporates an environmental assessment of the subject replant lands. While it is not possible, at this point, to specify a particular parcel of land where replanting will take place; a parcel of land has been identified in Co. Monaghan where replanting is likely to be undertaken (see **Chapter 3**). Given the relatively small area of the wind farm site which will be subject to felling (c. 5%) and, separately, planting; the methodologies involved in the felling and replanting processes; and the characteristics of the replant lands; it is assessed that there will be no likely significant effect on land or on land-use.

It is similarly assessed that, through adherence to best practice techniques and methodologies, and the appropriate implementation of environmental control measures where necessary, during the felling and replanting activities; significant adverse effects on soils are unlikely to arise.

The presence of the grid connection will not, being entirely sub-surface, result in any alteration to land or land-use. Similarly, the characteristics of the haul route upgrade works will not result in any effect on land or land-use.

The pre-mitigation effect on land and land-use is summarised in **Table 6.13** below.

Attribute	Description
Receptor	Land & Land Use
Pathway	Excavation and infrastructure construction
Pre-Mitigation Effect	Negative, slight, direct, likely, permanent effect on land and land use.

Table 6.13: Land & Land Use Effect

6.4.4 Operational Phase

Following the completion of the construction phase, including the appropriate reinstatement and landscaping of the project site which will avoid the likelihood of erosion effects, very few (if any) effects on land and soils are likely during the operational phase of the project. These may include:-

- Minor accidental leaks or spills of fuel/oil from vehicles associated with the occasional maintenance of the wind farm; and,
- The transformer in the substation and transformers in each turbine will be oil-cooled. There is a risk of spills/leaks of oils from this equipment resulting in contamination of soils.

6.4.5 Decommissioning Phase

The likely effects associated with decommissioning of the project will be similar to those associated with construction but of a substantially reduced magnitude (i.e. imperceptible to slight). Activities which are likely to affect land & soil include the removal and reinstatement of turbine hardstand areas and access tracks (where not retained); while some sub-surface elements will be left *in situ* to reduce effects.

6.4.6 Assessment of Cumulative Effects

The land and soil impact assessment concludes that, in relation to the wind farm, significant effects are unlikely to arise predominately due to the localised and near surface nature of the construction works and the absence of likely significant effects during the operation and decommissioning phases.

Similarly, and given the small construction footprint and shallow earthworks proposed at the electricity substation and grid connection infrastructure; it is assessed that significant cumulative effects on land, soils and geology are unlikely to arise in-combination with the wind farm as a result of this secondary/off-site development and any effects are assessed to be not significant. It is also assessed that other secondary/off-site works; including haul route upgrade works and forestry replanting; are unlikely to be of a sufficient scale such that significant effects could occur in cumulation with the wind farm and grid connection. Overall, therefore, it is assessed that there is no likelihood of the overall project giving rise to likely significant effects on land & soil.

Given that all likely effects relating to the project are assessed to be direct, contained within the immediate vicinity of the project, and unlikely to extend beyond the project site; it is assessed that there is no pathway for the project to act in combination with other existing, permitted and proposed developments.

All known existing, permitted and proposed developments (as listed in **Chapter 1**) in the vicinity of the project have been assessed to determine the likelihood of cumulative effects arising. The majority of other developments are assessed to be of an insufficient scale such that significant cumulative effects could not arise or there is a substantial separation distances between the respective projects (e.g. Gortahile Wind Farm, Bilboa Wind Farm, and Freneystown Wind Farm) and, therefore, an absence of connectivity.

The proposed Seskin Wind Farm is located c. 2km to the northeast of the project and will be predominately located on shales and sandstone tills with areas of mapped peat (blanket peat) also present. It is assessed, therefore, that having regard to the characteristics of the geological environment; the general absence of sensitive soil types/conditions within the project site; and the localised and direct nature of effects with regard land, soils and geology; there is no likelihood of the subject project acting cumulatively with the proposed Seskin Wind Farm to result in likely significant effects.

6.4.7 Assessment of Likely Health Effects

The possibility of health effects, albeit unlikely, arises mainly from the potential for soil and ground contamination during construction. A type of development, such as the project proposed, is not a recognised source of land or soil pollution and therefore the potential for effects during the construction, operational or decommissioning phases is unlikely.

Hydrocarbons will be used onsite during construction; however, the volumes will be small and will be handled and stored in accordance with best practice mitigation measures. As a result, it is assessed that the likely residual effects associated with soil or ground contamination and subsequent health effects will be imperceptible.

6.5 Mitigation and Monitoring

6.5.1 Construction Phase

6.5.1.1 Soil, subsoil and bedrock excavation

The excavation of soil, subsoil and bedrock will have a direct effect on the geological environment and no specific mitigation measures are proposed. The excavation of materials will be completed in accordance with best practice for the management and treatment of such materials.

6.5.1.2 Erosion of Exposed Soil and Subsoil at Excavation and Storage Areas

The following avoidance and design measures are proposed to reduce erosion effects at excavation and spoil storage areas:-

- Mats will be used, as necessary, to support construction plant and machinery on soft ground, thus reducing the likelihood of soil and subsoil erosion and avoiding the formation of rutted areas. This will substantially reduce the likelihood for surface water ponding to occur;
- Excavated soil will be side cast and stored temporarily adjacent to excavation areas for use during reinstatement and landscaping. Where material is not required for reinstatement or landscaping, it shall be immediately transported to the spoil deposition areas;
- Silt fences, and all necessary surface water management measures (including upslope interceptor drains), will be installed around all temporary stockpiles to limit movement of entrained sediment in surface water runoff. All slopes will be sealed with the bucket of an excavator;

- In order to minimise erosion during the construction phase, works will not take place during periods of intense or prolonged rainfall (to prevent increased silt laden runoff). Drainage systems, as outlined in **Chapter 7**, will be implemented to limit runoff effects during the construction phase;
- At the designated spoil deposition areas, material will be placed in layers to ensure stability is maintained and works will be undertaken in accordance with best practice construction methodologies. Works at the spoil deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a 6 no. month period thereafter, by an appropriately qualified Geotechnical Engineer. In the event that any ground stability issues arise, the Engineer will have the power to cease works until such time as remedial works have been completed to his/her satisfaction;
- Permanently mounded soils and subsoils; for example, berms surrounding turbines and hardstands, berms located along access tracks and at the spoil deposition areas; will be seeded and grassed over at the earliest opportunity to prevent erosion;
- The electricity line (grid connection) trench will be reinstated to the required specification and in accordance with landowner requirements and will be reseeded or allowed to vegetate naturally (on agricultural land) or topped with tarmacadam (or similar along public roads) at the earliest opportunity to prevent erosion.

6.5.1.3 Contamination of Soils and Subsoils by leakages, spillages of hydrocarbons or other chemicals

The following measures are proposed to specifically prevent contamination of soils and subsoils:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated, trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be available to deal with any accidental spillages within the temporary construction compound and during re-fuelling;
- All waste tar material arising from road cuttings (from trenching in public roads and haul route upgrade works) will be removed off-site and disposed of at a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works or to store it within the spoil deposition areas; and

- An emergency plan for the construction phase to deal with accidental spillages is contained within the Planning-Stage Construction and Environmental Management Plan (**Annex 3.4**). This emergency plan will be further developed by the contractor prior to the commencement of construction.

6.5.1.4 Land and Land Use

The loss of agricultural land within the project site is minimal (1.9% loss) and therefore the effects of are assessed to be not significant. The loss of land from agricultural production is assessed to be an acceptable part of the project and therefore no mitigation is proposed.

15ha of forestry will be felled to accommodate wind farm infrastructure. However, all tree coverage felled will be replaced at a replanting site(s) which will be subject to technical approval through a separate consenting process. No specific measures, other than best-practice felling and replanting methodologies are proposed and the efficacy and appropriateness of these measures will be assessed, separately, through the felling and replanting licensing process. However, subject to the adherence to standard methodologies, no significant effects are assessed as likely.

6.5.2 Operational Phase

Following the completion of construction activities and the reseeding of exposed soil as a result of excavations and spoil storage, it is assessed that due to the absence of likely soil erosion effects, no mitigation measures are required.

Oil used in transformers (at the substation and within each turbine) and storage of oils at the substation could leak during the operational phase and result in effects on soil and subsoils. The substation transformer and oil storage tanks will be located in a roofed concrete bund capable of holding 110% of the stored oil volume. Turbine transformers will be located within the turbines, and any leaks will be fully contained within the turbine thus eliminating any pathway for leakages to affect land and soil.

6.5.3 Decommissioning Phase

During decommissioning, it may be possible to reverse or at least reduce some of the likely effects caused during construction by rehabilitating construction areas such as turbine foundations and hardstanding areas. This will be done by removing wind farm infrastructure and restoring disturbed ground with previously excavated material where possible.

Other effects such as possible soil compaction and any contamination by fuel leaks will remain but will be of a substantially 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 and within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is therefore:-

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

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant. Some of the effects will be avoided by retaining some elements of the project in place where appropriate; for example, access tracks within the site may be retained for agricultural and forestry uses. Mitigation measures, to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant and machinery, will be implemented as per the construction phase mitigation measures.

No significant effects on the land, soils and geology environment are likely during the decommissioning stage of the project.

6.5.4 Monitoring Measures

There is no proposed monitoring programme for land and soils. However, during and post-construction all excavated or raised areas (i.e. cut and fill) and reinstated/landscaped ground, including the spoil deposition areas, will be inspected for signs of erosion and instability by the Geotechnical Engineer. These inspections will be undertaken on a weekly basis during the construction phase and monthly, for a six-month period, post-construction.

6.6 Residual Effects

6.6.1 Construction Phase

The loss of land/land-use from agricultural production, and the excavation and relocation of soil, subsoil and bedrock is an inevitable part of the development works and therefore no mitigation measures, other than standard construction best practices, are proposed. As a result, the likely residual effect with respect to soil, subsoil, and bedrock excavation and loss of land/land use is assessed to be the same as the pre-mitigation effects, which is Slight.

The residual effects with respect to soil/subsoil erosion and contamination effects are assessed to be imperceptible.

6.6.2 Operational Phase

No significant residual effects are assessed as likely to occur during the operational phase.

6.6.3 Decommissioning Phase

No significant residual effects are assessed as likely to occur during the decommissioning phase.

6.7 Summary

Excavations will be required for site levelling and for the installation of turbine foundations, crane hardstands, access tracks, electrical cabling, electricity substation and grid connection infrastructure. This will result in the permanent removal of soil, subsoil and bedrock at excavation locations. Excavated soil and subsoil will be used for reinstatement and landscaping, where appropriate; while excavated bedrock will be used in the construction of crane hardstandings and access tracks (where possible); and where excess material arises, this will be disposed of at the dedicated spoil disposal areas.

Due to the geographically spread out and transient nature of the grid connection works and haul route upgrade works, these are not anticipated to result in a likely cumulative effect with the wind farm development. Furthermore, all other existing, permitted and proposed developments in the vicinity of the project have been assessed to determine their likelihood to act cumulatively with the project; however, it is concluded that there is no likelihood of significant cumulative impacts.

In conclusion, this assessment has determined that the project (including grid connection, haul route works and forestry replanting), will not result in any likely significant effects on land, soils and the geological environment. Where effects are likely to occur, such as soil erosion or contamination, the implementation of best-practice construction techniques and appropriate mitigation measures will ensure that any residual effects are imperceptible. Where it is not possible to implement mitigation measures, such as in respect of the direct excavation of soil and subsoil, the level of effect is considered to be slight and will not likely be significant.