Bracklyn Wind Farm

Chapter 6:
Land & Soils

Bracklyn Wind Farm Limited

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Contents

6.1 Introduction

6.1.1 Background and Objectives

This chapter provides an assessment of the likely and significant effects of the proposed Bracklyn Wind Farm near Raharney, Co. Westmeath and its associated grid connection infrastructure (which extends into County Meath) on the land, soil and geological environment.

This chapter provides a baseline assessment of the environmental setting of the proposed development in terms of land, soils and geology and identifies the likely and significant effects that the construction, operation and decommissioning of the proposed development 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 to land, soils and geology are recommended.

6.1.2 Description of the Proposed Development

A full description of the proposed development is presented in **Chapter 3**. In summary, the proposed development comprises the following main components:-

- 9 no. wind turbines with an overall tip height of 185m, and all associated ancillary infrastructure;
- Upgrades to the turbine component haul route;
- Construction of a 110kV electricity substation and installation of 6.3km of underground electricity line between the proposed substation and the existing Corduff-Mullingar 110kV overhead electricity line; and
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure.

The majority of the proposed development is located within the administrative area of County Westmeath; while 2.5km of underground electricity line and the proposed end masts will be located within County Meath. Additionally, candidate quarries which may supply construction materials are also located within County Meath.

The indicative turbine component haul route is also located within the counties of Waterford, Kilkenny, Carlow, Kildare and Dublin.

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) 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 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 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

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

Regard has also been taken of the requirements of the following legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No. 30 of 2000, the Planning and Development Act, and S.I. 600 of 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 of 2018: S.I. No. 296 of 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 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:-

- Guidance Document on Wind Energy Developments and EU Nature Legislation (European Commission, 2020);

- Environmental Protection Agency (2017) *Draft 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*;
- *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);*
- *Westmeath County Development Plan 2021-2027*; and
- *Westmeath Peatlands Study* (Natura, 2005).

6.2 Methodology

6.2.1 Desk Study

A desk study of the proposed development and its environs was completed in advance of undertaking the walkover survey and site investigations. This involved collecting all relevant land and geological information for the proposed development 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 Bedrock Geology 1:100,000 Scale Map Series, Sheet 12 (Geology County Meath);
- 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 21 February 2020. Further site investigation including trial pits, peat probes and gouge cores were undertaken on 11 and 12 June 2020. Additional site walkovers were completed in February 2021.

A detailed geotechnical and peat stability assessment, used to inform the assessment contained within this chapter was carried out by Fehily Timoney & Company (FT) and is enclosed at **Annex 6.1**.

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

- Detailed site walkovers to assess ground conditions;
- Soil cores and probing (50+) were undertaken by HES and FT at the proposed development site to investigate peat depths, subsoil type and lithology;

- A trial pit (~2–3.5m depth) was undertaken at each of the turbine locations (or nearby) and the meteorological mast to investigate subsoil depth and lithology. A total of 13 no. trial pits were completed;
- Logging of bedrock outcrops and subsoil exposures; and,
- Mineral subsoils and peat were logged according to BS: 5930 and Von Post Scale respectively.

6.2.3 Receptor Importance/Sensitivity Criteria

In addition to the utilisation of sensitivity and receptor importance criteria outlined within the abovementioned EPA Guidance (EPA, 2017), this assessment, in accordance with National Roads Authority (NRA, 2008) guidance, quantifies the importance of the land, soil and geology environments within the study area 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 contamination is moderate on a local scale. • Volume of peat and/or soft organic soil underlying	• 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

	site is moderate on a local scale.	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,
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 at **Annex 1.6.**

Consultee	Summary of Response	Addressed in Section
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 proposed development. No incidences of landslide have been recorded in the townland of Bracklyn.	6.3.4.4.

Table 6.4: Summary of Land and Soils Scoping Responses

6.3 Description of the Existing Environment

6.3.1 Site Location & Description

The proposed development site, which is 275ha in area, is predominately located within a privately owned farm estate located ~4km north of Raharney, Co. Westmeath. The proposed wind farm and electricity substation is located entirely within a single landholding; while ancillary elements of the overall development,

including grid connection infrastructure and haul route upgrade works, are located on both private lands and within the public road network.

Current land use within the proposed wind farm site is predominately agricultural grassland, with small pockets of deciduous woodland and conifer tree plantations. The wind farm site is bordered by intact raised bog to the north, east and south, and with grassland to the west. Much of the grassland along the periphery of the proposed wind farm site is reclaimed cutover raised bog.

The topography of the proposed wind farm site is 'gently sloping to undulating' with the overall site elevation ranging between approximately 90m and 110m OD (Ordnance Datum). The central area of the subject site comprises a gently sloping hill and the land falls away in all directions from this high point. Bracklyn House is located in the central area of the site with various farm buildings and surrounding fields being connected by a network of farm tracks.

The proposed 110kV electricity substation is located within the overall footprint of the proposed wind farm. In order to connect the proposed wind farm to the existing Corduff-Mullingar 110kV overhead electrical transmission line, it is proposed to install c. 6km of underground electricity line within agricultural lands and along a local public road. Off-road section of the underground electricity line will be accompanied by c. 2.5km of access track.

6.3.2 Land and Land Use

The proposed development site comprises agricultural land (grassland pasture and arable land) and forestry/mixed woodland. Proposed turbines T1, T2 and T3, spoil deposition areas (2 no.), temporary compound, meteorological mast and site control building will be located on agricultural land; while the turbines (T4, T5, T6, T7, T10 and T11) are located in forestry/mixed woodland. Based on the Corine (2018) mapping, the forestry at the proposed development site is described as 'forest and semi-natural areas' while the remainder of the site is 'agricultural areas'. The agricultural land is predominantly used for tillage crops with cattle grazing on pasture. There are approximately 3.1km of existing farm/forestry tracks which will be upgraded and utilised in the proposed development.

The proposed 110kV electricity substation is located within an area of commercial forestry within the proposed wind farm site. The proposed 110kV underground electricity line between the proposed substation and the existing Corduff-Mullingar 110kV overhead electricity line will be located within forestry/mixed woodland, agricultural pasture, and within the carriageway of the local road network.

6.3.3 Superficial Geology

6.3.3.1 Soils

Based on the GSI/Teagasc soils mapping (www.gsi.ie); the central, southern and western areas of the proposed wind farm site are mainly underlain by deep, well-drained mineral soils (BminDW) with cutover bog mapped on the northern and eastern portion of the site. The proposed electricity substation is mapped as being underlain by cutover peat.

The soil type mapped along the proposed grid connection route is mainly cut peat with some peaty gleys towards the eastern side at the end mast location.

GSI subsoils mapping (www.gsi.ie) show that limestone tills are present in the central, southern and western areas of the proposed wind farm site and cutover bog mapped on the northern and eastern portion of the proposed wind farm site, including the location of the proposed electricity substation. Cutover bog is also mapped along the majority of the proposed grid connection route as well as the end mast locations. The subsoils at the haul route works areas are mapped as limestone tills.

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

Trial pits were undertaken at each of the proposed turbine locations (or nearby)[1] and proposed meteorological mast on the 11 and 12 June 2020. Summary logs are detailed at **Table 6.5** below. Trial pits logs and photographs are provided at **Annex 6.1**.

The overburden geology at proposed turbine locations and other infrastructure in agricultural land (i.e. T1, T2, T3, T4 and T11 site compound, control building and meteorological mast) typically comprised peaty topsoil over firm to very firm SILT/CLAY with cobbles and boulders).

Peat is more prevalent in areas under forestry (i.e. specifically turbine locations T5, T6, T7 and T10) with the deepest peat at turbine locations (2.5m) being found at T10 which is located in forestry on intact raised bog. The mineral subsoil lithology below peat typically comprised of SILT which is variably sandy and gravelly. Lacustrine CLAY was found to directly underlie peat at turbine T10. A trial pit was not undertaken at the proposed electricity substation; however, the location is similar to surrounding areas of forestry and is likely to comprise similar peaty characteristics.

Peat depths recorded by FT (refer to **Annex 6.2**) during the site walkovers from over 50 probes ranged from 0-2.5m with an average peat depth of 0.6m. 86% of the probes recorded peat depths of less than 1.0m with 95% of peat depth probes recorded peat depths of less than 2.0m. A number of localised readings recorded peat depths from 2.0 to 2.5m.

Probing undertaken along the access roads in agricultural areas demonstrate that peaty topsoil is typically present with some shallow pockets of peat between approximately 0.3 and 0.5m in depth. The peat is typically dry and very firm.

Trial pit and peat probe locations are illustrated on **Figure 6.2** below.

Location	Average Peat Depth (m)	Summary of Subsoil Lithology
T1	0	Slightly sandy SILT over sandy, gravelly SILT
T2	0	Slightly sandy SILT over SILT/CLAY
T3	0	SILT/CLAY with cobbles
T4	0.25	Slightly gravelly SILT/CLAY over sandy, gravelly SILT/CLAY
T5	0.7	Gravelly, sandy SILT
T6	0.7	Sandy, gravelly SILT

[1] Due to the presence of forestry and related access constraints, a trial pit could not be undertaken at the exact location of all turbines and, in this scenario, the trial pit was located as close as possible to the proposed turbine location. Please refer to the trial pit logs for further details.

T7	0.75	Sandy, gravelly SILT
T10	1.8	Lacustrine CLAY over sandy GRAVEL (fine)
T11	0	SILT/CLAY with cobbles and boulders
Meteorological Mast	0	SILT/CLAY with cobbles and boulders
Temporary Compound	0	Slightly sandy SILT over SILT/CLAY
Site Control Building	0	Slightly gravelly SILT/CLAY
Substation	1	Sandy gravelly SILT

Table 6.5: Summary of Trial Pit and Gouge Core Investigation

Based on criteria at **Table 6.1** above, the local soils and subsoils have a Low-to-Medium importance.

6.3.3.2 Peat Stability Assessment Summary

A peat stability risk assessment was carried out by FT for the main infrastructural elements at the proposed development site (refer to **Annex 6.2**).

The risk assessment uses the results of the stability analysis (deterministic approach) in combination with qualitative factors, which cannot be reasonably included in a stability calculation but nevertheless may affect the occurrence of peat instability, to assess the risk for each infrastructure element.

For each of the main infrastructure elements, a risk rating (product of probability and impact) is calculated and rated as detailed at **Table 6.6**. Where a subsection is rated 'Medium' or 'High', control measures are required to reduce the risk to at least a 'Low' risk rating. Where a subsection is rated 'Low' or 'Negligible', only routine control measures are required.

The 'pre-control measure implementation' risk rating for all locations except turbine T10 is 'Negligible'. The pre-control measure rating at T10 is 'Low' but can be reduced to 'Negligible' with only routine control measures.

In summary, the findings of the peat assessment showed that the proposed development site has an acceptable margin of safety, is suitable for the proposed development and is considered to be at low risk of peat failure (refer to **Annex 6.2**).

Risk Rating	Description
17 to 25	High: avoid works in area or significant control measures required
11 to 16	Medium: notable control measures required
5 to 10	Low: only routine control measures required
1 to 4	Negligible: none or only routine control measures required

Table 6.6: Peat Stability Risk Rating

6.3.3.3 Soil Contamination

There are no known areas of soil contamination within the proposed development site or in its immediate environs. During the site walkovers and 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 proposed development site.

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

6.3.3.4 Bedrock Geology

Based on the GSI bedrock mapping (www.gsi.ie), the majority of the proposed development is mapped to be underlain by Dinantian Pure Unbedded Limestones; while the far eastern portion of the proposed wind farm site and section of the proposed grid connection are mapped to be underlain by Dinantian Upper Impure Limestones.

The southwestern corner of the WF site is mapped to be underlain by Dinantian Lower Impure Limestones.

No bedrock exposures were noted during the site visit. Bedrock (limestone) was only encountered in 1 no. trial pit (TP-T2) at 0.4m which was located in close proximity to proposed turbine T2. A bedrock geology map for the area is provided at **Figure 6.3.** There are mapped faults within the proposed development site and in the wider area but, due to the shallow depth of excavations associated with the proposed development, there will be no effect on or interaction with the mapped faults.

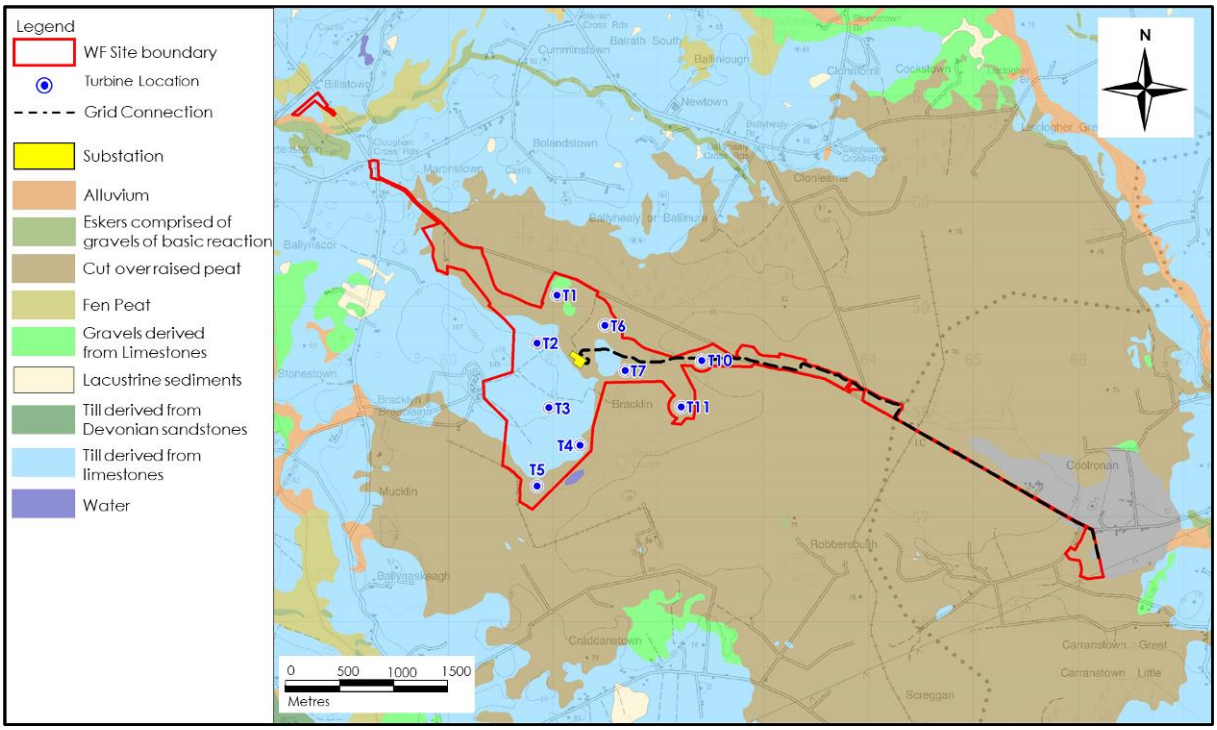

Figure 6.1: Local Subsoils Geology Mapping

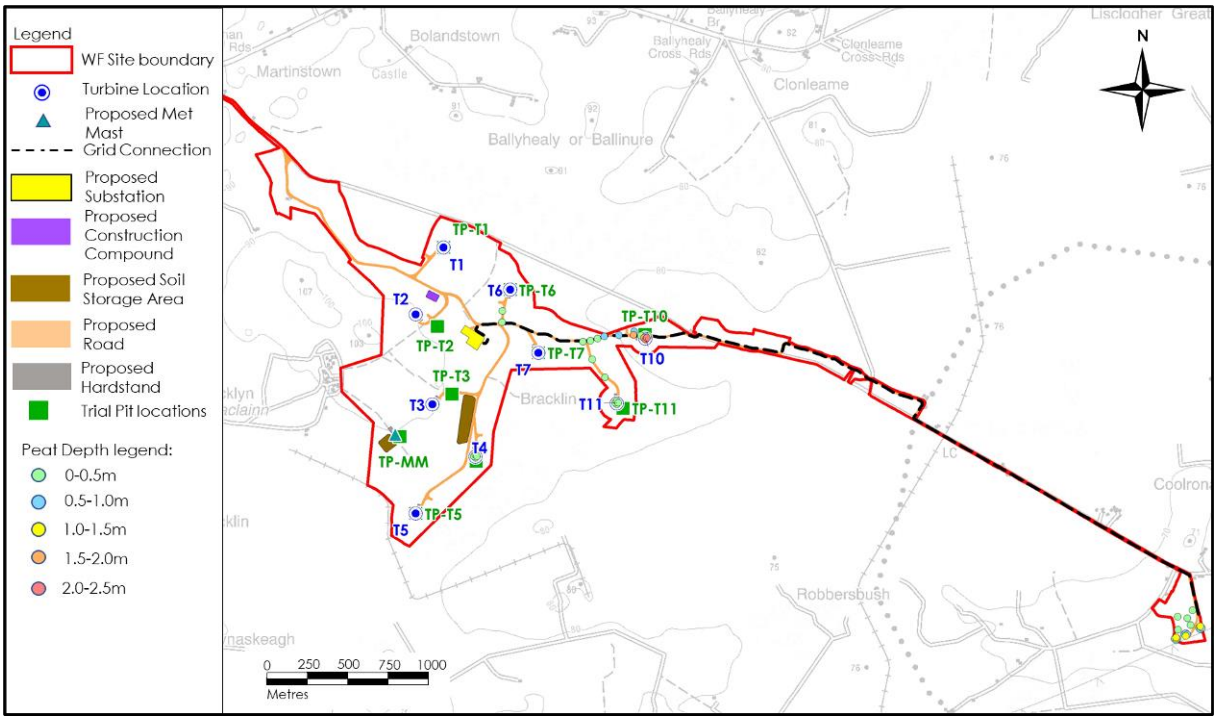

Figure 6.2: Site Investigation Map

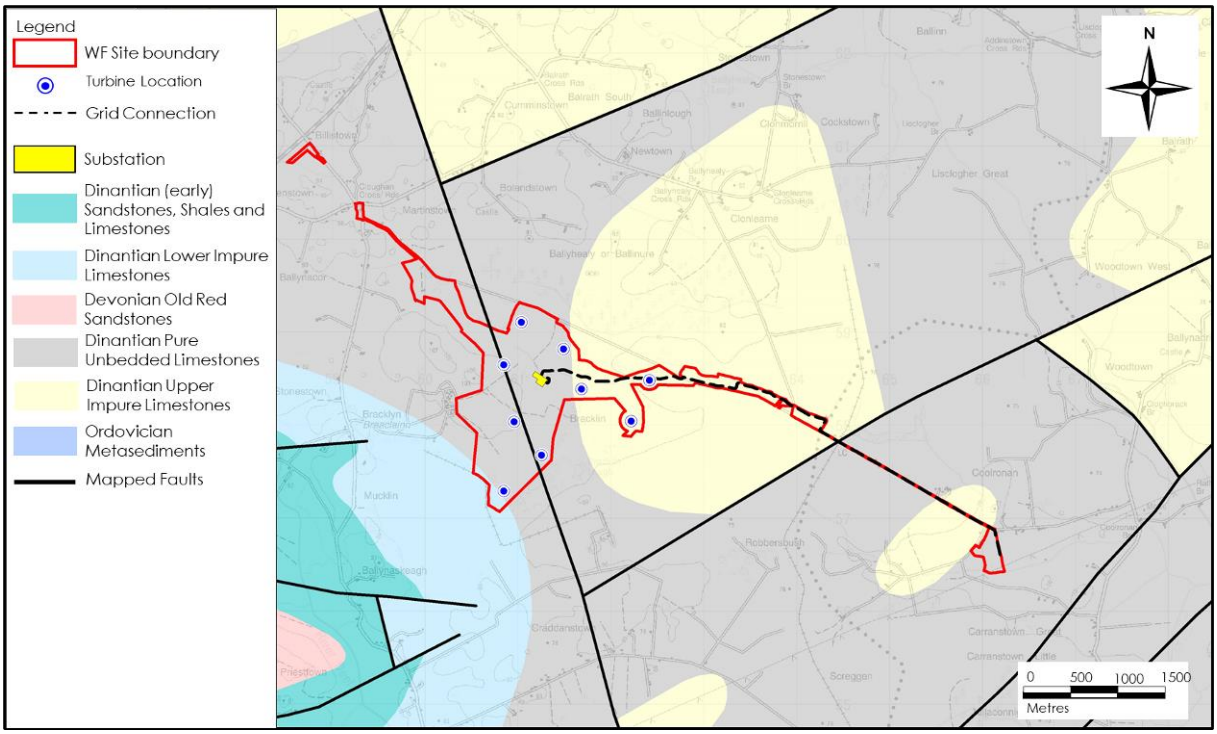

Figure 6.3: Local Bedrock Geology Mapping

6.3.3.5 Geological Resource Importance

According to the GSI natural resource mapping, the proposed development site, and its environs, has a 'high to very high' crushed aggregate potential and 'low to very low' potential for granular aggregate potential.

Based on criteria shown in **Table 6.1** above and the GSI aggregate potential, the local bedrock has a 'Low to High' importance.

6.3.3.6 Geological Heritage & Designated Sites

The closest Geological Heritage site to the proposed development site is Ballycor Mushroom Rocks (IGH1 – Lower Carboniferous), approximately 8km west of the proposed development. The proposed development will have no effect on this geological heritage site.

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

Designated sites include National Heritage Areas (NHAs), Proposed National 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 proposed development site which can be directly affected (from a land, soil and geology perspective) by the construction, operation or decommissioning of proposed development.

The closest designated site to the proposed development is the River Boyne and River Blackwater SAC. The River Deel, to which the proposed development site drains via a number of lower order watercourses, forms part of the River Boyne and River Blackwater SAC. Therefore, the proposed development is hydrologically connected to the River Boyne and River Blackwater SAC. Further details of the assessment of hydrological effects, including on the River Boyne and River Blackwater, can be found at **Chapter 7**. Based on the criteria at **Table 6.1** above, designated sites have a High Importance.

6.4 Assessment of Likely Effects

6.4.1 Characteristics of the Proposed Development

The proposed development will typically involve the removal of peat, soil and subsoil (bedrock unlikely) to facilitate the emplacement of access tracks, turbine foundations, crane hardstandings, substation and site control building foundations, meteorological mast foundation, and underground electrical cabling. Crushed rock for construction will be sourced from local, authorised, quarries.

Overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material or material which cannot be used for this purpose will be stored, permanently, in 2 no. dedicated spoil deposition areas or, where appropriate, will be spread across areas where felling has occurred. The designated Soil deposition area (between T3 and T4) can accommodate c. 22,859m^3 of material while the peat deposition area, adjacent to the proposed meteorological mast location, can accommodate c. 10,971m^3 of material.

To maintain the geological integrity of the proposed development site, it is proposed that generated spoil will be deposited local to its point of origin or at a location of similar geological characteristics i.e. where excess peat material arises, it will be spread around a turbine where peat is the predominant soil type (i.e. T5, T6, T7 and T10). Similarly, the smaller (western) deposition area is likely to be dedicated to the storage of peat material and will be capped with soil, graded to match surrounding gradients and reinstated. The larger deposition area is likely to be dedicated to the storage of generated soil and subsoil and will, as above, 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 proposed development 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 County Westmeath 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; however, due to existing ground conditions, it is highly likely that T10 will require a piled foundation design. Foundations depths are expected to be c. 3m deep with an approximate diameter of 22m.

The trench, within which the proposed underground electricity line (grid connection) will be placed, will be typically 0.6m wide by 1.2m deep. The trench will be located within both private lands and the public road network. Within private lands, soil and subsoil will be side cast for re-use in the reinstatement process (where appropriate) or will be removed for permanent storage within the proposed deposition areas. Within the public road network, usable material will be stored temporarily adjacent to the trench for re-use while excess soil, subsoil and peat (if present) will be removed for permanent storage The trench will be reinstated to ESB/EirGrid specifications, backfilled and finished as appropriate to the satisfaction of the respective landowners or local authority.

Estimated volumes of overburden and rock to be removed for each element of the proposal are indicated at **Table 6.7** below.

Please refer to the Spoil Management Plan (**Annex 3.8**) prepared by Jennings O'Donovan & Partners Consulting Engineers for further details on the management and storage of peat and spoil.

Element	Total (m^3)	Peat (m^3)	Soil (m^3)	Rock (m^3)	Road Cuttings (m^3)	Road Sub-Base (m^3)
Access Track Construction	16,934	4,798	12,136	-	-	-
Turbine Foundations & Hardstands	45,214	10,592	33,854	768	-	-
Grid Connection and associated Access Track (incl. end masts)	14,200	10,820	-	-	390	2,990
110kV Substation	4,535	4,535	-	-	-	-
Site Control Building	95	19	76	-	-	-
Site Cabling	778	230	548	-	-	-

Meteorological Mast	480	-	480	-	-	-
Temporary Site Compound	1,200	-	1,200	-	-	-
Road Widening Works	2,120	1,620	500	-	-	-
Total	85,556	32,614	48,794	768	390	2,990
Total Volume (incl. 20% Bulking Factor)*	**102,668**	**39,137**	**58,553**	**922**	**468**	**3,588**

**A factor of 20% (bulking factor of 15% and contingency factor of 5%) has been applied to the excavated spoil volumes to allow for expected increase in volume upon excavation and to allow for a variation in ground conditions across the site.*

Table 6.7: Summary Estimated Excavation Volumes

6.4.2 'Do-Nothing' Impact

In the event that the proposed development 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 Peat, soil, subsoil and bedrock excavation

The excavation of peat, soil and subsoils will be required for all groundworks; including site levelling, the installation of infrastructure (e.g. turbine foundations, piling, 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 peat, 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 is also expected to be encountered, particularly at T2; however, the predicted volumes to be excavated are low.

These works will result in a direct, permanent loss of peat, soil, subsoil and bedrock at excavated locations. The estimated excavation volumes are detailed at **Table 6.7** above.

The overall impact magnitude (**Table 6.3**) is determined to be 'Small Adverse' due to the following:-

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

- Due to the absence of significant volumes of rock at or near the surface, aggregates and stone material for construction purposes will be sourced off-site thus avoiding the excavation of large on-site borrow pits.

The excavation and relocation of material is an inevitable part of the proposed development; however, given that the overall impact magnitude is determined to be 'Small Adverse', it is assessed that the effects will not be significant.

The overall effect of the excavation of peat, soil, subsoil and bedrock is summarised in **Table 6.8** below.

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

Table 6.8: Peat, Soil and Subsoil Excavation Effect

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

The exposure of peat, 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 and spoil storage areas in the context of the overall proposed development site, the overall impact is determined to be 'Small Adverse'.

The peat, soil and subsoil erosion pre-mitigation effect is summarised in **Table 6.9** below.

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

Table 6.9: Peat, Soil and Subsoil Erosion Effect

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

The contamination of peat, soils and subsoils presents a direct effect on the geology of the proposed development 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 overall likely effect is determined to be 'Small to Negligible Adverse' due to the relatively low volumes of fuels/chemicals that will be kept on-site at any one time.

The soil contamination pre-mitigation effect is summarised in **Table 6.10** below.

Attribute	Description
Receptor	Peat, soil and subsoils
Pathway	Peat, soil and subsoil pore space.
Pre-Mitigation Effect	Negative, direct, slight, short term, likely effect on, peat, soils and subsoils.

Table 6.10: Soil and Subsoil Contamination Effect

6.4.3.4 Effects on Land and Land Use

The construction of the proposed development will result in the loss of 5ha of agricultural land and 28ha of forestry land. The loss of 5ha of agricultural land is imperceptible and will not materially affect land use within the proposed development site. Existing agricultural operations can readily co-exist and there will be no perceptible effect on these activities.

The construction of the proposed development will result in the felling of 28ha of existing commercial forestry. This forestry will be felled to accommodate the construction of the proposed development (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 re-plant same at an alternative location. The replanting of forestry is subject to a separate licensing and consenting process which incorporates an environmental assessment of the subject re-plant lands. It is not possible, at this point, to specify a particular parcel of land where re-planting will take place; however, the appropriateness of this land will be assessed through the separate consenting process. Notwithstanding this, given the relatively small area of land which will be subject to felling and, separately, planting, 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 re-planting activities; significant adverse effects on soils are unlikely to arise.

There will be no adverse effects on land and soil beyond the proposed development site. Therefore, it is assessed that the proposed development will not affect any proposed bog rehabilitation plans which may be undertaken in the future on any adjoining boglands. Any rehabilitation plans will also be required to be undertaken in a manner which will not affect neighbouring lands (i.e. the proposed development) and, consequently, no effects on the proposed development site are anticipated.

The overall land and land use effect is summarised at **Table 6.11** below.

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

Table 6.11: Land and Land Use Effect

6.4.4 Operational Phase

Following the completion of the construction phase, including the appropriate reinstatement and landscaping of the proposed development site which will avoid the likelihood of erosion effects, very few direct effects (if any) on land and soils are likely during the operational phase of the proposed development.

These may include:-

- Minor accidental leaks or spills of fuel/oil from vehicles associated with the occasional maintenance of the proposed development; 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 proposed development will be similar to those associated with construction but of a substantially reduced magnitude (i.e. negligible to slight). Activities which are likely affect land & soil include the removal and reinstatement of turbine hardstand areas and access tracks; while some sub-surface elements will be left *in situ* to reduce effects.

As set out at **Chapter 3** (**Sections 3.2** and **3.8**), the proposed electricity substation, underground grid connection electricity line, and end masts will form part of the national electricity network and decommissioning of these elements is not proposed.

6.4.6 Assessment of Cumulative Effects

The land and soil impact assessment concludes that, in relation to the proposed 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 earth works of the proposed 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 proposed wind farm as a result of this secondary/off-site development and any effects are assessed to be negligible. It is also assessed that other secondary/off-site works; including haul route upgrade works and forestry re-planting; are unlikely to be of a sufficient scale such that significant effects could occur in combination with the proposed wind farm and grid connection. Overall, therefore, it is assessed that there is no likelihood of the overall proposed development giving rise to likely significant effects on land & soil.

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

All existing, permitted and proposed developments (as listed in **Chapter 1**) in the vicinity of the proposed development have been assessed to determine the likelihood of in combination effects arising. The majority of other developments are assessed to be of an insufficient scale such that significant cumulative effects could arise or there is a substantial separation distances between the respective distances

and, therefore, an absence of connectivity.

The proposed Ballivor Wind Farm is located to the immediate east and southeast of the proposed Bracklyn Wind Farm and will be predominately located on cutover bog. It is assessed, therefore, that having regard to the degraded nature of the peatlands within which the proposed Ballivor Wind Farm will be located, the general absence of sensitive soil types/conditions within the proposed Bracklyn Wind Farm site, and the general avoidance of identified areas of localised peat within the proposed Bracklyn Wind Farm site, and the localised, direct nature of effects with regard land, soils and geology; there is no likelihood of the subject proposed development acting in combination with the proposed Ballivor 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 that proposed development, is not a recognised source of land or soil pollution and therefore the likelihood of effects during the construction, operational or decommissioning phases are negligible.

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 are negligible.

6.5 Mitigation and Monitoring

6.5.1 Construction Phase

6.5.1.1 Peat, soil, subsoil and bedrock excavation

The excavation of peat, soil and subsoil 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 Peat, 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:-

- Bog mats will be used, as necessary, to support construction plant and machinery on soft ground, thus reducing the likelihood of peat, 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 runoff 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; and
- Following the installation of the proposed end masts, excavated material will be reinstated, graded to match the surrounding ground profile and reseeded or allowed to vegetate naturally.

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

The following measures are proposed to specifically prevent contamination of peat, 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; and

- An emergency plan for the construction phase to deal with accidental spillages is contained within the Outline Construction and Environmental Management Plan (**Annex 3.8**). 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 proposed development site is minimal (3.1% loss) and therefore the effects of are assessed to be negligible and not significant. The loss of land from agricultural production is assessed to be an acceptable part of the proposed development and therefore no mitigation is proposed.

28ha of forestry will be felled to accommodate wind farm infrastructure. However, all tree coverage felled will be re-placed at replanting sites which will be subject to technical approval through a separate consenting process. No specific measures, other than best-practice felling and re-planting 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 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, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is therefore:-

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

Mitigation measures applied during decommissioning activities will be similar to those

applied during construction where relevant. Some of the effects will be avoided by retaining some elements of the proposed development 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 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 proposed development.

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. 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 peat, 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 peat, soil and subsoil excavation and loss of land/landuse is assessed to be the same as the pre-mitigation effects, which is Slight.

The residual effects with respect 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 peat, soil, subsoil and bedrock at excavation locations. Excavated peat, soil and subsoil will be used for reinstatement and landscaping (where appropriate) and where excess material arises, this will be disposed at the dedicated spoil disposal areas.

Due to 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 proposed development have been assessed to determine their likelihood to act in combination with the

proposed development; however, it is concluded that there is no likelihood of significant cumulative impacts.

In conclusion, this assessment has determined that the proposed development (including grid connection), 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 negligible and imperceptible. Where it is not possible to implement mitigation measures, such as in respect of the direct excavation of peat, soil and subsoil, the level of effect is considered to be moderate and is not likely to be significant.