Drumlins Park Wind Farm

Chapter 6: Land & Soil

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Contents

6.1 Introduction

6.1.1 Background and Objectives

This chapter provides an assessment of the likely effects of the proposed development (including grid connection options and haul route works) near Newbliss Co. Monaghan on the land, soil and geological environment.

This report provides a baseline assessment of the environmental setting of the proposed development in terms of land, soils and geology and discusses the likely and significant effects that the construction, operation and decommissioning of the proposed development will have on them. Where required, appropriate mitigation measures to limit any identified impacts to land, soils and geology are recommended.

6.1.2 Development Description

The proposed development will comprise the installation of 8 no. turbines and all ancillary infrastructure including turbine foundations, hardstanding areas, access tracks, underground cabling, upgrades to haul roads and grid connection (3 no. options assessed). The full project description is provided at **Chapter 3** of this EIAR. The proposed development also includes 2 no. dedicated spoil deposition areas which will accommodate any excess excavated material which cannot be utilised during landscaping or reinstatement works.

6.1.3 Statement of Authority

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

Our core areas of expertise and experience include 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 is an Environmental Engineer with over 17 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.

David Broderick is a hydrogeologist with over 12 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.

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

6.1.5 Relevant Guidance

The Land & Soils chapter of this EIAR 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:

- 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; and,
- COFORD (2004): Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads.

6.1.6 Candidate Wind Turbine

As outlined in **Chapter 3**, a specific wind turbine model has not yet been selected and will only be confirmed following a pre-construction tendering process. While turbine selection is unlikely to result in any primary effects on land and soil, the candidate turbines outlined have slightly differing foundation requirements, particularly in terms of foundation diameter, thus requiring differing volumes of excavation. The General Electric GE 5.5-158 (Option TU1) wind turbine has the largest foundation of the candidate turbines and thus is considered to represent the 'worst-case' in terms of likely effects on land and soil and has, therefore, been selected as the basis for assessment within this chapter.

6.2 Methodology

6.2.2 Desk Study

A desk study of the proposed development study area was completed in advance of undertaking the walkover survey and site investigations. This involved collecting all relevant land and geological information for the wind farm site, grid route options and surrounding area. This included consultation of the following:

- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);

- Bedrock Geology 1:100,000 Scale Map Series, Sheet 15 (Geology of Monaghan Carlingford). Geological Survey of Ireland (GSI, 1996);
- 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).

6.2.3 Baseline Monitoring & Site Investigations

A detailed site walkover and geological mapping exercise was undertaken by HES on 25th and 26th of July and on the 15th August 2019. Intrusive site investigations (described below) were undertaken on 14th and 15th August 2019.

In summary, site investigations to address the land, soil and geology chapter of the EIAR included the following:

- Detailed site walkovers to assess ground conditions;
- Soil cores and probing were undertaken along the proposed access tracks to investigate soil subsoil type and lithology;
- A trial pit (~3.5 - 4m depth) was undertaken at each of the turbine locations and at the location of the 110kV substation (9 no. trial pits in total) to investigate subsoil depth and lithology;
- Logging of bedrock outcrops and subsoil exposures; and,
- Mineral subsoils and peat were logged according to BS: 5930 and Von Post Scale respectively.

6.2.4 Receptor Importance/Sensitivity Criteria

In addition to the utilisation of sensitivity and receptor importance criteria outline within the abovementioned EPA Guidance (EPA 2002 and 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.	• 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).

	• Volume of peat and/or soft organic soil underlying site is significant on a local scale.	• 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 site is moderate on a local scale.	• Contaminated soil on site with previous light industrial usage. • Small recent landfill site for mixed Wastes. • Moderately drained and/or moderate fertility soils. • Small existing quarry or pit. • Sub-economic extractable mineral resource.
Low	• Attribute has a low quality, significance or value on a local scale. • Degree or extent of soil contamination is minor on a local scale. • Volume of peat and/or soft organic soil underlying site is small on a local scale.	• Large historical and/or recent site for construction and demolition wastes. • Small historical and/or recent landfill site for construction and demolition wastes. • Poorly drained and/or low fertility soils. • Uneconomically extractable mineral resource.

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)

6.2.5 Scoping & Consultation

The scope for this assessment has been informed by consultation with statutory consultees and other bodies with environmental responsibility in both the Republic of Ireland and Northern Ireland.

This consultation process is outlined in **Chapter 1** of this EIAR. Issues, concerns 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 1.4.**

Consultee	Summary of Response	Addressed in Section
Geological Survey	With the current development plans, the GSI do not envisage impact on	n/a

of Ireland (GSI)	the integrity of County Geological Sites (discussed below in chapter) by the proposed development.	
Inland Fisheries Ireland (IFI)	Concerns about the stability of soils and the impacts that works on both turbine and access roads will have either directly or by vibration. The IFI recommends that specialist personnel are employed to assess soil strength and suitability of the ground. This is particularly important with respect peat soils.	Section 6.3.2.2 Section 6.5.1.1 Section 6.5.2 Section 6.5.3
Irish Peatland Conservation Council (IPCC)	Where development is proposed within or in close proximity to peatland, the IPCC recommends that best practice guidelines from the BOGLAND publication are followed to ensure no damaging development occurs.	This does not apply to the proposed development as no construction on blanket bog or raised bog is proposed (refer to Section 6.3.2.2 for subsoil descriptions).
Department of Agriculture, Environment and Rural Affairs (Northern Ireland)	The Land and Groundwater Team (Regulation Unit) has considered the potential effects of the proposal on the water environment (especially groundwater) within Northern Ireland. On the basis of the information provided the Land and Groundwater Team, Regulation Unit of the NIEA has no comment to make.	n/a

Table 6.4: Summary of Scoping Responses

6.3 Description of the Existing Environment

6.3.2 Site Location & Description

The proposed wind farm site is located ~5km southeast of Clones and ~3km southwest of Newbliss, Co. Monaghan.

The topography of the wind farm site area is hilly due to a drumlin type landscape. The proposed wind farm itself is spread out over several drumlin hills with the overall site elevation ranging between approximately 100 and 170m OD (Ordnance Datum). Across the proposed development footprint, ground slopes are moderate to steep.

Current land use within the wind farm site is exclusively agricultural, with small pockets of commercial forestry within the wider landscape. Each of the proposed turbine locations and access roads are situated in grassland. Ground conditions are generally dry and firm with the exception of some wet/boggy ground on the lower-lying lands between drumlins where a number of small to medium sized watercourses are present. Generally, the soils and subsoils at the site are naturally poorly draining and therefore numerous manmade drains are present within the site, typically located along field boundaries and hedges.

The grid connection route option to the existing Clones 38kV substation (Option G1) runs in a north-westerly direction for approximately 5km. The grid connection comprises approximately 4km of overhead line (OHL) and 1km of underground line

(UGL). The route mainly passes through agricultural grassland. The ground elevation along the grid connection decreases from ~100m OD at the substation to ~50m OD at the northern end where the route crosses the Finn River valley just south of Clones.

The grid connection route option to the existing Shankill 110kV substation (Option G2) runs in a south-westerly direction for approximately 16km. The grid connection is comprised almost exclusively of OHL with only short sections of UGL at either end to facilitate connection to the respective substations. Similar to the Clones option, the route mainly passes through agricultural grassland with some marginal boggy land. The ground elevation along the grid connection decreases to ~60m OD at the central section where the route crosses the Annalee River valley, 7km north of Shankill.

The 110kV substation (Option G3), which is located in grassland to the southeast of the wind farm, will be connected by ~0.6km of internal wind farm cabling along a local public road. The elevation of the proposed substation location is approximately 100m OD with similar topography to that of the wind farm site.

The proposed haul route works are on national and regional roads and typically comprise road widening and road profile regrading. These works will be undertaken at various locations along the proposed turbine component haul route and are typically surrounded by grassland and/or artificial surfaces (e.g. roundabouts).

6.3.3 Superficial Geology

6.3.3.1 Soils

Based on the GSI/Teagasc soils mapping (www.gsi.ie), the proposed wind farm site is mainly underlain by poorly drained mineral soils (AminPD) and to a lesser extent deep well drained mineral (AminDW).

Pockets of alluvium and cutover bog are also mapped locally in the area of the wind farm site. The closest, and largest, mapped area of cutover bog is located just north of the proposed arterial access track. This mapped bog is actually a wetland rather than a cutover bog.

The proposed access road route is along grassland immediately to the south of the bog/wetland. Soil coring/probing undertaken along this proposed access track, confirms that the access track is underlain by mineral subsoils and not by peat. In addition, alluvium is mapped in areas proximate to the main watercourses which flow through the site.

The soil types along the Clones and Shankill grid connection route options are similar to the wind farm site with cutover bog becoming more dominant along the lower lying sections of the respective routes. On inspection, these mapped areas of cutover bog along the grid connection routes were mainly found to comprise improved grassland with peaty/boggy subsoil conditions in places.

Poorly drained mineral soils (AminPD) and alluvium are mapped in the area of the proposed 110kv substation to the southeast of the wind farm site. The soil types identified during the site investigations were relatively consistent with the GSI/ Teagasc mapping.

The haul route upgrade works are mainly along the carriageway of existing roads with the adjacent lands having a mixture of poorly draining and well draining soils.

6.3.3.2 Subsoils

GSI subsoils mapping (www.gsi.ie) show that sandstone and shale tills are the

dominant subsoil type in the area of the wind farm site and each of the grid connection route options. Pockets of cutover bog are mapped close to the wind farm site and along the grid connection route options. Cutover bog is discussed in **Section 6.3.3** above. None of the proposed wind farm infrastructure is located on bog/peatland. The cutover bog mapped along the grid connection route options was mainly found to comprise of improved grassland with peaty subsoil conditions.

To investigate mineral subsoil lithology and depth at the wind farm site, a trial pit was undertaken at each of the proposed turbine locations and at the 110kV substation compound. The soil/subsoil profile at the turbine locations typically consisted of loamy topsoil (0.2 – 0.3mbgl), firm to very firm, orangey grey SILT/CLAY (0.6 – 2.3mbgl) which was underlain by stiff to very stiff, blueish grey, gravelly CLAY with cobbles and boulders. The general term for the latter CLAY dominant subsoil type is boulder clay which was deposited by glacial action, hence the drumlin type landscape. The trial pit logs are attached in **Annex 6.1**.

The soil/subsoil profile at the substation consisted of topsoil (0.15mbgl), firm, dark grey silty SAND which was underlain by firm, grey, gravelly SAND.

Soils cores undertaken along the wind farm access tracks mainly encountered firm glacial tills (SILT/CLAY) with a slightly softer SILT (alluvium) dominant subsoil type located close to the proposed watercourse crossings (i.e. between T1 and T2, T1 and T5, T2 and T3).

The haul route upgrade works are underlain by sandstone and shale tills (SILT/CLAY).

Based on criteria shown in the **Table 6.1** above, the local soils and subsoils have a Low to Medium Importance. Local subsoil geology maps are shown below as **Figure 6.1** and **Figure 6.2**.

6.3.4 Bedrock Geology

Based on the GSI bedrock mapping (www.gsi.ie), the wind farm site and the majority of the grid connection route options and haul route works areas are mapped to be underlain by Ordovician Metasediments which comprise mainly shale and greywacke in this area.

The northern end of the Clones grid connection option is mapped to be underlain by Dinantian sandstones, shales and limestones. Local bedrock geology maps for the area are shown below as **Figure 6.3** and **Figure 6.4.**

Due to the drumlin landscape (with large overburden depths), bedrock is at depth and any exposures are limited to some of the main watercourse routes. Bedrock was not intercepted at any location during the wind farm trial pit investigation. Bedrock depths at the proposed turbine locations are expected to be in excess of 15m, most likely between 15m and 30m.

There are mapped faults in the area of the proposed development, but these are likely to have no consequence for the development.

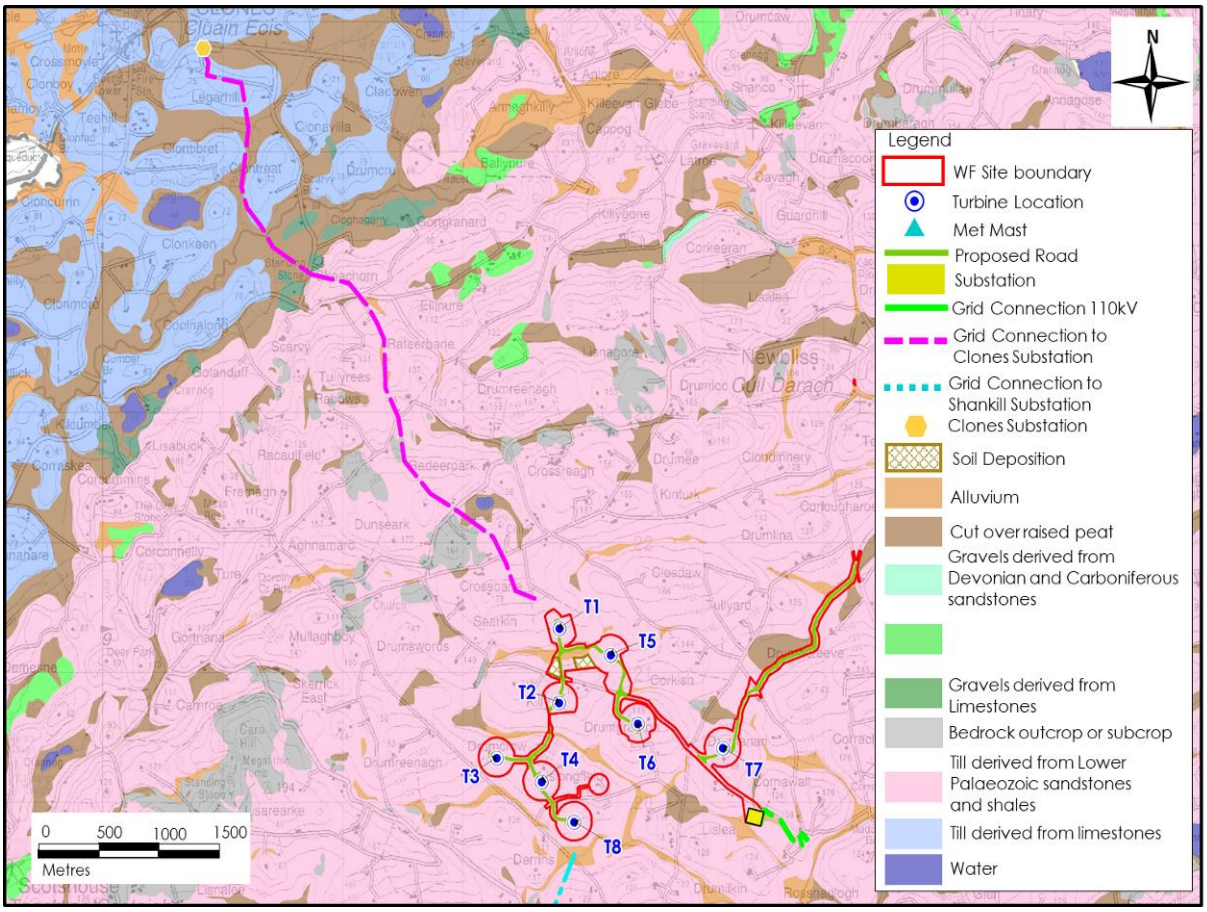

Figure 6.1: Local Subsoils Geology Mapping

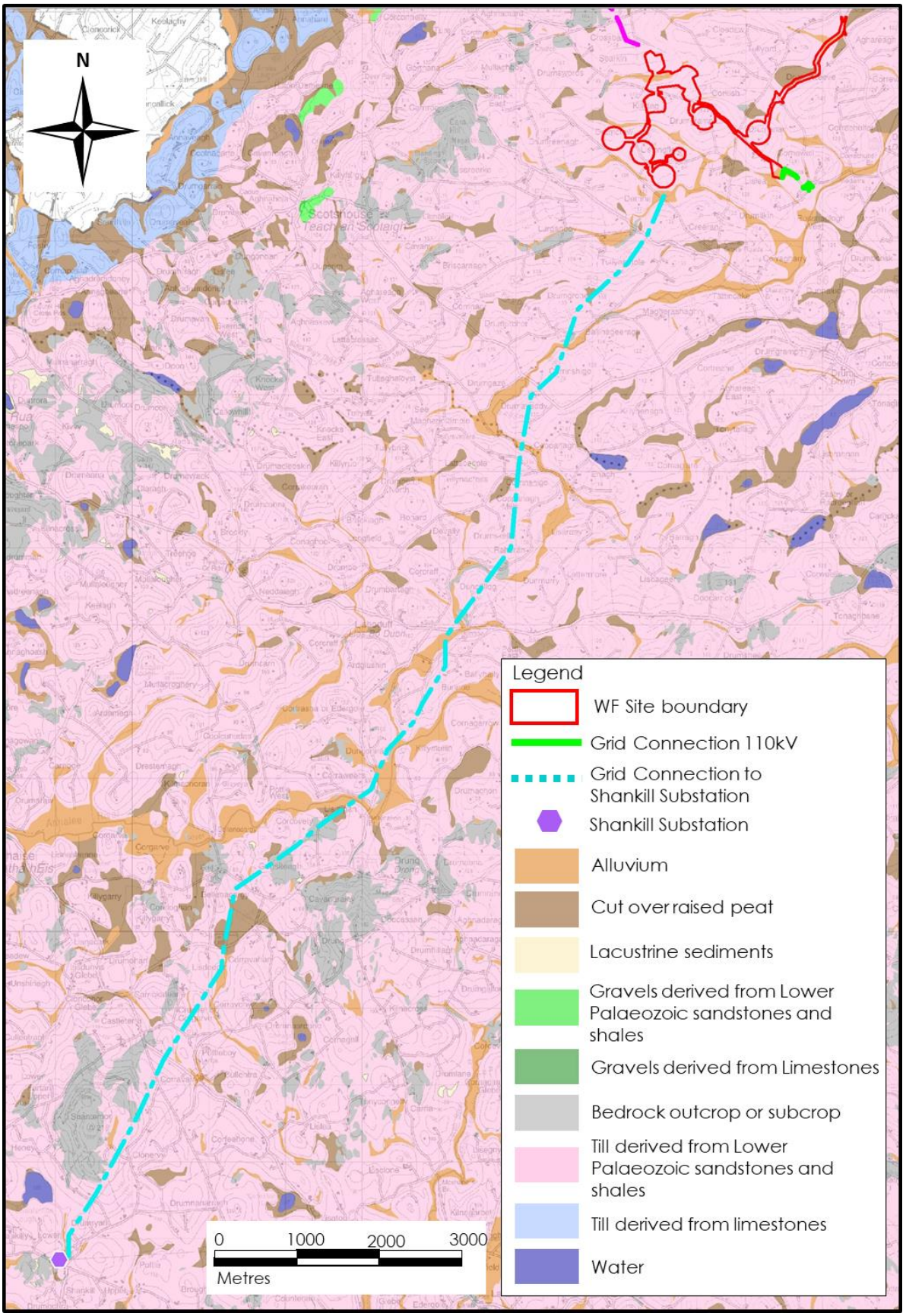

Figure 6.2: Local Subsoils Geology Mapping

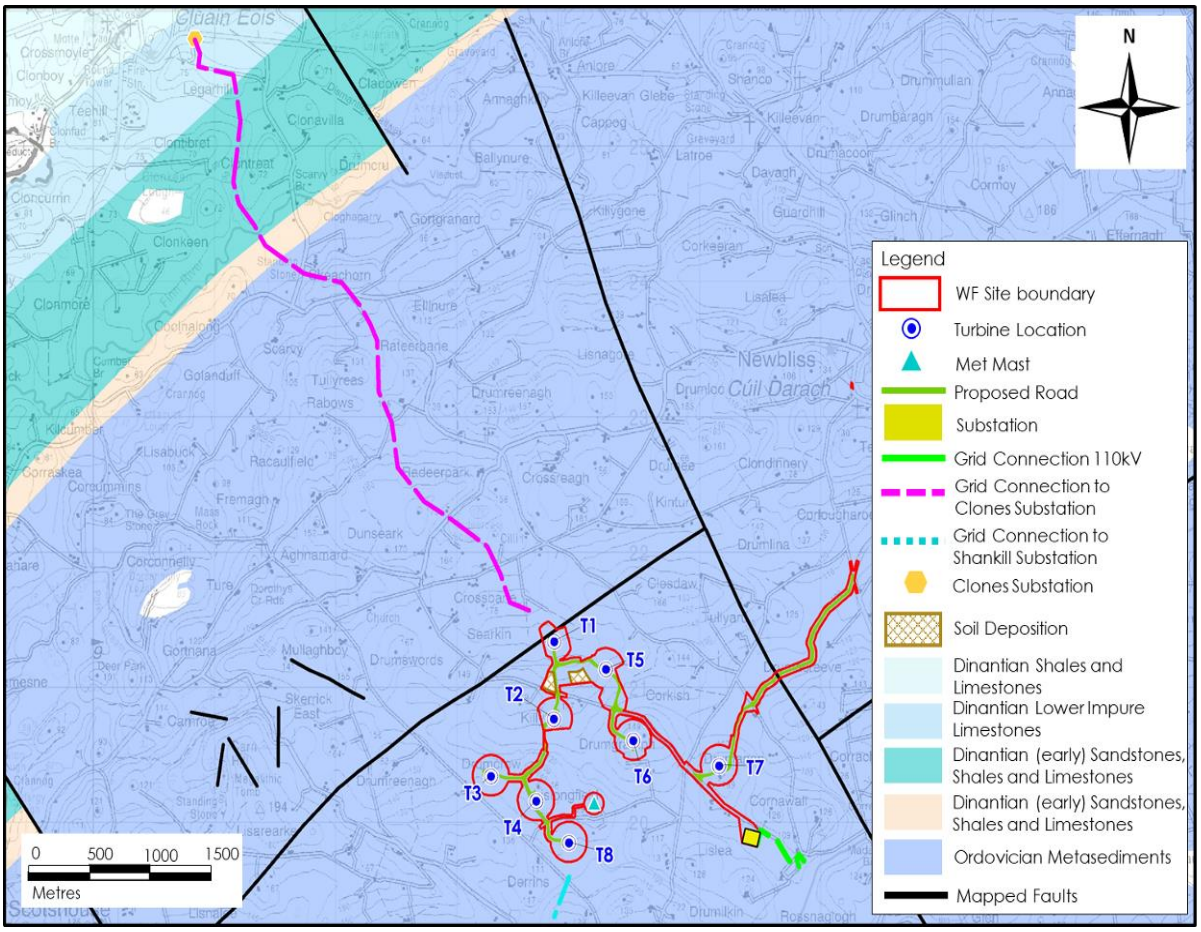

Figure 6.3: Local Bedrock Geology Mapping

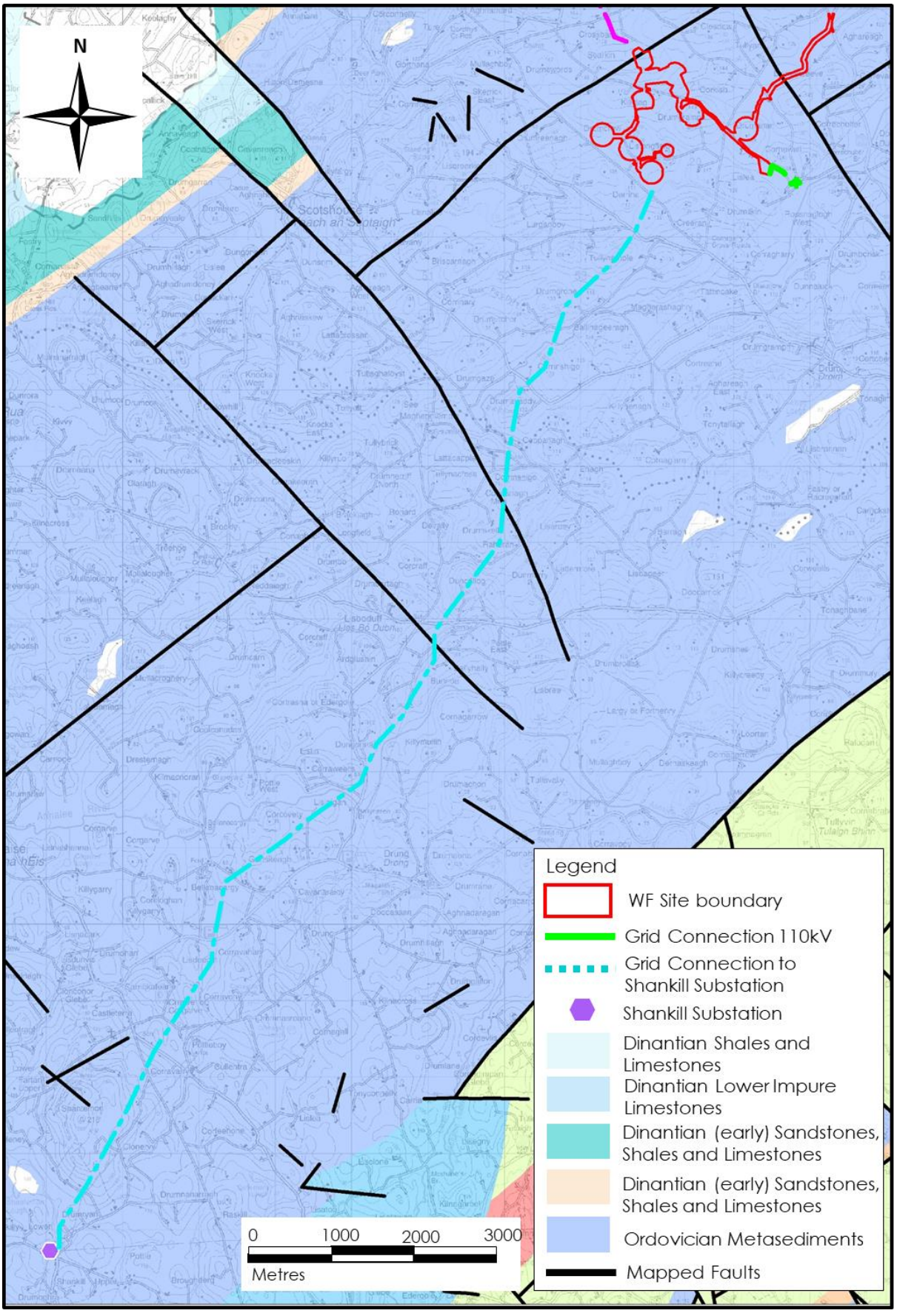

Figure 6.4: Local Bedrock Geology Mapping

6.3.5 Geological Resource Importance

The closest active quarry to the wind farm site is at Scotshouse, approximately 3.5km to the southwest of the site. Typically, the metasediments are of low geological resource importance.

According to the GSI natural resource mapping, the area of the wind farm has a low to moderate crushed aggregate potential and low to very low potential for granular aggregate.

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

Additionally, soils and subsoils at the site could be also classified as Low to Medium Importance due to their supportive role in agriculture.

6.3.6 Geological Heritage & Designated Sites

The closest geological heritage site to the proposed wind farm site is Rockcorry-Cootehill Ribbed Moraines (Site Code MN015) which located less than 1km southeast of the site. This is a large geological heritage site covering an area over 100km^2; however, no element of the proposed development is located inside this geological heritage site.

Another geological heritage site, the Mid-Cavan Drumlinised Ribbed Moraines (Site Code CN013), is located approximately 8km to the south of the wind farm site. The grid connection option to the existing Shankill substation is located within this geological heritage site for approximately 6km.

Based on criteria shown in the **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 in the area of the proposed development that can be directly affected (from a land, soil and geology perspective) by the proposed development. The likelihood for indirect hydrology effects on downstream designated sites in the Republic of Ireland and Northern Ireland are assessed in **Chapter 7**.

6.3.7 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 on or within the immediate environs of the proposed development.

There are no historic mines at or in the immediate vicinity of proposed development that are likely to have contaminated tailings and result in adverse environmental effects.

6.4 Description of Likely Effects

6.4.2 Characteristics of the Proposed Development

The development of the proposed wind farm will typically involve removal of soil and subsoil (bedrock unlikely) for the emplacement of access tracks, turbine foundations,

and crane hardstandings and underground electrical cabling. Crushed rock for construction will be sourced from local quarries. Excess overburden/spoil that's remains after landscaping and reinstatement and which cannot be accommodated within the on-site spoil deposition areas will be removed off-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 Monaghan which currently accept soil and rock arising from construction projects.

The turbine foundations will be gravity design and will be constructed on the underlying boulder clay deposits. Foundations depths are expected to be c. 3m deep with an approximate diameter of 24m.

The Shankill and Clones grid connection options will comprise mainly overhead line (OHL) transmission line with short sections underground line (UGL) at the start and end of the routes, which each option being accompanied by an on-site 38kV wind farm substation. A new 110kV substation is proposed as one of the grid connection options and this will be connected to the windfarm site by UGL along a local public road and within private lands.

The overhead line sections (OHL) will be mainly constructed using single wooden poles as intermediate structures, with double pole structures being located in some positions as required by directional changes. At locations of significant directional changes, the wooden poles may also be accompanied by stay-wires. At locations where the OHL terminates, three-pole structure will be erected. Access to the pole sites will be fully agreed with landowners prior to construction, and the use of bog mats may be required in some areas to avoid land damage.

The excavation for each pole will be carried out using a tracked excavator. Excavations will be to a depth of approximately 2.3m. Excavated material will be side cast and used for the reinstatement/backfilling of the pole. In the event of poles being located in soft or saturated ground (bog), wooden sleepers may be installed to aid the stability of the pole, and this will require a slightly larger excavation area adjacent to the pole.

The trench, within which the UGL sections will be placed, will be typically 0.6m wide by 1.2m deep. The trench will be reinstated to ESB specifications and backfilled with subsoil and finished with topsoil as appropriate.

Estimated volumes of overburden (soil and subsoils) to be removed for each element of the proposal are shown in **Table 6.5**. It is again reiterated that only one of the grid connection options will be constructed.

Element	Estimated Total Excavation Volume (m^3)	Estimated Total Reinstatement Volume (m^3)	Estimated Volume for On-site and Off-site Storage (m^3)

Wind Farm	59,803m³	32,331m³	27,472m³ in spoil deposition area
Clones Grid Connection Option (incl. substation)	300m³	30m³	270m³ in spoil deposition area
Shankill Grid Connection Option (incl. substation)	600m³	60m³	270m³ in spoil deposition area and 270m³ to licensed waste disposal facility
110kV Grid Connection Option (incl. substation)	14,132m³	-	14,132m³ in spoil deposition area
Haul Route Works	1,000m³	300m³	700m³ to licensed waste disposal facility

Table 6.5: Summary Excavation Volumes

6.4.3 Construction Phase

6.4.3.1 Soil and Subsoil Excavation

The excavation of soil and subsoils will be required for all groundworks; including site levelling, the installation of infrastructure (e.g. electrical cabling), for wind turbine and access track foundations and to facilitate upgrade works to the turbine component haul route. Excavation of soils and subsoils will also be required for each of the grid connection options; including substation foundations, pole installations and trenching. This will result in a direct, permanent loss of soil and subsoil at excavated locations. The estimated excavation volumes are shown in **Table 6.5** above.

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

- The soils and subsoils at the proposed wind farm site, along the proposed grid connection route options and haul route can be classified as "low to medium" importance;
- A minimal volume of soil and subsoil in comparison to the total resource present on the site will be removed to allow for infrastructural work to take place;
- The soil and subsoil which will be removed during the construction phase will be localised to the turbine location, cable trenches, pole locations and access tracks;
- No turbines or related infrastructure will be constructed within or near any designated sites for the protection of geological feature such as NHAs or SACs; and,
- Due to the absence 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 soil and subsoil is an inevitable part of the proposed development; however, given that the overall impact magnitude is determined to be 'Moderate to Small Adverse', it is assessed that the effects will not be significant.

The soil and subsoil excavation final impact is summarised in **Table 6.6** below.

Attribute	Description

Receptor	Soils and subsoils
Pathway/Mechanism	Excavations
Final Impact	Negative, direct, moderate to slight, likely, permanent impact on soil and subsoil

Table 6.6: Soil and Subsoil Excavation Impact

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

Exposure of soil and subsoils at excavation spoil storage areas at the wind farm site, along the proposed grid connection route options and haul route works locations can increase the likelihood for soil erosion resulting in a direct physical impact on the land and soil environment. The overall impact is determined to be 'Small Adverse' due, predominately, to the small development footprint area in comparison to the overall landholding.

The soil and subsoil erosion pre-mitigation impact is summarised in **Table 6.7** below.

Attribute	Description
Receptor	Soil and subsoils
Pathway/Mechanism	Vehicle movement, surface water erosion, and wind action.
Pre-mitigation Impact	Negative, direct, slight, likely impact on soil and subsoils.

Table 6.7: Soil and Subsoil Erosion Impact

6.4.3.3 Contamination of Soils and Subsoils by leakages, Spillages of Hydrocarbons or other Chemicals

Contamination of soils and subsoils presents a direct impact on the geology of the wind farm site, along the proposed grid connection route options and haul route works areas. The overall likely impact is determined to be only '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 impact is summarised in **Table 6.8** below.

Attribute	Description
Receptor	Soil and subsoils
Pathway	Soil and subsoil pore space.
Pre-mitigation Impact	Negative, direct, slight, short term, likely impact on, soils and subsoils

Table 6.8: Soil and Subsoil Contamination Impact

6.4.4 Operational Phase

Very few likely direct effects (if any) on land and soils are envisaged during the operational phase of the proposed development and any that do occur are likely to imperceptible (negligible) adverse.

These may include:

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

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 have the potential to affect land & soil include the removal and reinstatement of turbine foundations, hardstand areas and access tracks.

6.4.6 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 relatively small construction footprint and shallow earth works of the grid connection options (mainly OHL with short sections of UGL), including associated substations, and the nature of the proposed haul route upgrade works; 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 these secondary/off-site developments and any effects are assessed to be negligible.

Therefore, and given the absence of likely significant effects arising from the proposed development individually; there is no likelihood for significant cumulative effects, arising from the entire proposed development, with any existing, permitted or proposed development on land, soils and geology. All effects relating to the proposed development are assessed to be direct and contained within the immediate vicinity of the proposed development and it is assessed that there is no pathway for the development to act in combination with other projects.

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 for likely significant cumulative effects.

6.4.7 Assessment of Likely Health Effects

The potential for health effects, albeit unlikely, arises mainly from the potential for soil and ground contamination during construction. A wind farm or grid connection, such as the proposed development, is not a recognised source of land or soil pollution and so the likelihood for effects during the construction or operational phases are negligible.

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

6.4.8 Do Nothing Effects

The land, soils and geology of the proposed development site would remain largely unaltered as a result of the Do-Nothing Scenario.

6.4.9 'Worst-Case' Effects

On the basis of this assessment, the 'worst-case' effects are likely to occur on land and soil as a direct result of the excavation and relocation of soil and subsoil. These effects are an inevitable part of the development and, subject to the implementation of appropriate mitigation measures, significant effects can be appropriately ameliorated.

6.4.10 Transboundary Effects

The proposed development site is located within ~5km of the Northern Ireland border. However, due to the separation distance to the border and the localised nature of the likely effects on land, soils and geology, no transboundary effects on this receptor are likely.

6.5 Mitigation and Monitoring

6.5.2 Construction Phase

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

Mitigation by Prevention:

- Excavated soil will be side cast and stored temporarily adjacent to excavation areas for use during reinstatement and landscaping;
- Silt fences 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;
- 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;
- 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;
- Bog mats will be used, as necessary, to support construction plant and machinery on soft ground, thus reducing the likelihood for soil and subsoil erosion and avoiding the formation of rutted areas. This will substantially reduce the likelihood for surface water ponding to occur;
- 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; and,
- In respect of the proposed grid connection options; excavated material at the respective substation locations will be utilised for reinstatement and landscaping purposes. At UGL locations, the trench will be reinstated and graded in accordance with the specifications of the local authority or

landowner as appropriate. The ground around the OHL pole locations will be reinstated back to its natural level and profile to the satisfaction of the landowner and reseeded or allowed to vegetate naturally.

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

Mitigation by Prevention:

- 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 and accidental spillage in and outside the re-fuelling area;
- All waste tar material arising from road cuttings (from trenching in public roads) will be removed off-site and taken to licenced 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 3.7**). This emergency plan will be further developed by the contractor prior to the commencement of construction.

6.5.3 Operational Phase

Following the completion of construction activities and the reseeding of exposed soil as a result of excavations, 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, so any leaks would be contained within the turbine thus eliminating any pathway for leakages to affect land and soil.

6.5.4 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, hardstanding areas, and the substation location. 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 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 soils and geology environment are likely during the decommissioning stage of the proposed development.

6.5.5 Monitoring Measures

There is no proposed monitoring programme with respect of 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

6.6.2 Construction Phase

Excavation and relocation of soil, subsoil and possible bedrock is an inevitable part of the development works and therefore no mitigation measures, other than standard construction best practices, with respect excavation works are proposed. As a result, the likely effect with respect to soil and subsoil excavation is assessed to be the same as the pre-mitigation effects, which is Moderate.

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

6.6.3 Operational Phase

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

6.6.4 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 and for each of the grid connection options including substation (however, only one such option will be constructed). This will result in a permanent removal of soil and subsoil (unlikely to include bedrock) at excavation locations. Excavated soil and subsoil will be used for reinstatement and landscaping 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 options works and haul route works, these works are not anticipated to result in a likely cumulative effect with the wind farm development of the proposed development will be negligible. 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 potential for likely significant cumulative impacts.

In conclusion, this assessment has determined that the proposed development (including grid connection options and haul route upgrade works), will not result in any likely significant effects on land and soil. Where effects are likely to occur, such as soil contamination, the implementation of appropriate mitigation measures will ensure that any effects are negligible and 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 moderate and will not be significant.