8. LAND SOILS AND GEOLOGY

8.1 Introduction

8.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO Ireland (MKO) to carry out an assessment of the potential significant impacts of the Proposed Development on the land, soil and geological environment.

This report provides a baseline assessment of the environmental setting of the Proposed Development, as described in Chapter 4, in terms of land, soils and geology and discusses the potential likely significant effects and cumulative effects that the construction, operation and decommissioning of the Proposed Development will have. A cumulative assessment is also undertaken. Where required, appropriate mitigation measures to avoid any identified significant effects to land, soils, geology and natural resources are recommended and the residual effects of the Proposed Development post-mitigation are assessed.

A full description of all elements of the Proposed Development is detailed in Chapter 4 of this EIAR. As detailed in Section 1.1.1 in Chapter 1, for the purposes of this EIAR, the various project components are described and assessed using the following references: 'Proposed Development', 'the Site', 'Wind Farm Site' and 'Grid Connection'.

8.1.2 Statement of Authority

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

Our core areas of expertise and experience includes soils, subsoils and geology. We routinely complete impact assessments for land, soils and geology, hydrology and hydrogeology for a large variety of project types including wind farms and renewable energy projects.

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

Michael Gill P.Geo (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous land, soils and geology impact assessments of wind farms and renewable projects in Ireland. In addition, he has substantial experience on projects with large earthworks and also with quarrying projects. For example, Michael has worked on the EIARs for Coole WF, Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm related projects across the country.

Adam Keegan (BSc, MSc) is a hydrogeologist with three years of experience in the environmental sector in Ireland. Adam has been involved in Environmental Impact Assessment Reports (EIARs) for numerous projects including wind farms, grid connections, quarries and small housing developments. Adam holds an MSc in Hydrogeology and Water Resource Management. Adam has worked on several wind farm EIAR projects on the land, soils and geological environment, including Croagh WF, Lyrenacarriga WF (SID), Cleanrath WF, Carrownagowan WF (SID), and Fossy WF.

Conor McGettigan (BSc, MSc) is a recently graduated environmental scientist. In recent times Conor has assisted in the preparation of Environmental Impact Assessment Reports (EIARs) for several projects including wind farms and quarries.

8.1.3 Scoping and Consultation

The scope for this assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties as summarised in Section 2.8 of Chapter 2 of the EIAR. Consultation responses relating to the land, soils and geological environment were received from Geological Survey Ireland, Office of Public Works, and the Department of Agriculture Food and the Marine.

8.1.4 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. The requirements of the following legislation are complied with:

- Planning and Development Acts, 2000, as amended;
- Planning and Development Regulations, 2001 (as amended);
- 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);
- S.I. No. 296 of 2018 European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018;
- European Communities (Environmental Impact Assessment) Regulations 1989 to 2017; and,
- S.I. No. 4 of 1995: The Heritage Act 1995, as amended.

8.1.5 Relevant Guidance

The Land, Soils and Geology chapter of this EIAR was prepared having regard to guidance contained in the following documents:

- Environmental Protection Agency (2022): Guidelines on the information to be contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013): Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Union, 2017).
- Department of Environment, Heritage and Local Government (DoEHLG); Wind Energy Development Guidelines for Planning Authorities (2006);

8.1.6 Limitations

No difficulties were encountered during the preparation of this chapter.

8.2 Assessment Methodology

8.2.1 Desk Study

A desk study of the Proposed Development site and receiving environment (described below) was completed in advance of undertaking the walkover survey and site investigations. This involved collecting all relevant geological data for the Proposed Development site and receiving environment. This included consultation with the following data sources:

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland – Geological Databases (www.gsi.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 15 (Geology of Galway-Offaly); Geological Survey of Ireland (GSI, 2005);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 12 (Geology of Longford-Roscommon); Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets; and,
- General Soil Map of Ireland 2nd edition (www.epa.ie); and,
- Aerial Photography, 1:5000 and 6 inch base mapping.

8.2.2 Baseline Monitoring and Site Investigations

Geological mapping and a detailed walkover survey within the Wind Farm Site was undertaken by HES on 03rd May 2021, with follow up visits on 14th May, 07th July and 14th July 2021. These site visits also included walkovers along the underground electrical cabling route.

Further site investigations including trial pitting were carried out by HES on 14th July 2021. Additional site visits were also completed within the Wind Farm Site on 18th November 2021 and 22nd March 2022 which included water sampling in local watercourses, which is further detailed in Chapter 9 of this EIAR: Water. In summary, site investigations to address the Lands, Soil and Geology chapter of the EIAR included the following:

Wind Farm Site

- Detailed site walkover;
- 8 no. trial pits were excavated across the Wind Farm Site;
- Geological mapping of exposed subsoil faces; and,
- Hand augering was attempted but could not penetrate below 0.2m.
- Dynamic Cone Penetration (DCP) analysis was completed at 42 no. locations within the Wind Farm Site, included as Appendix 8-1: Dynamic Cone Penetration (DCP) Report;
- Particle Size Distribution (PSD) analysis of 5 no. subsoil samples taken from 4 no. trial pits and 1 no. exposed face, included as Appendix 8-1: Trail Pitting Report;

Grid Connection

- Visual assessment of exposed soils, bedrock and visible topography along the underground electrical cabling route;
- 8 no. hand augering probes attempted in areas along the undergrounds electrical cabling route mapped as containing peat type subsoils; and,
- Walkover inspection (~1km) of area along road carriageway in which the underground electrical cabling route is located which is mapped as underlain by peat, situated between the townlands of Raheen and Gortnadufa.

8.2.3 Impact Assessment Methodology

Using information from the desk study and data from the site investigations, an assessment of the importance of the soil and geological environment within the Proposed Development site is assessed using the criteria set out in Table 8-1 (NRA, 2008).

Table 8-1 Estimation of Importance of Soil and Geology Criteria (NRA, 2008).

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

The guideline criteria (EPA, 2022) for the assessment of likely significant effects require that likely effects are described with respect to their extent, magnitude, type (i.e. negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). The descriptors

used in this environmental impact assessment report are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1 of this EIAR. In addition, the two impact characteristics proximity and probability are described for each impact and these are defined in Table 8-2.

In order to provide an understanding of this descriptive system in terms of the geological/hydrological environment, elements of this system of description of effects are related to examples of potential likely significant effects on the geology and morphology of the existing environment, as listed in Table 8-3.

Table 8-2: Additional Impact Characteristics.

Impact Characteristic	Degree/ Nature	Description
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Low	A low likelihood of occurrence of the impact.
	Medium	A medium likelihood of occurrence of the impact.
	High	A high likelihood of occurrence of the impact.

Table 8-3: Impact descriptors related to the receiving environment.

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

Impact Characteristics		Potential Hydrological Impacts
Quality	Significance	
		› Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time-dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

8.3 Existing Environment

8.3.1 Site Description and Topography

8.3.1.1 Wind Farm Site

The Wind Farm Site is located approximately 3.5km southwest of Ballymore village and 14km northwest of Athlone (distance from EIAR Site Boundary). The townlands in which the proposed Wind Farm Site is located are listed in Table 1-1 in Chapter 1 of this EIAR.

The Wind Farm Site comprises mainly improved grassland and agricultural pastures separated by hedgerows. A small area of forestry exists in the southwest of the Wind Farm Site. The topography of the Wind Farm Site is undulating with the Wind Farm footprint layout being spread over a series of small hills that range in elevation from 55 to 98m OD (Ordnance Datum), with greatest elevation occurring in the northwest of the Wind Farm Site. The overall slope of the land is towards the east. The Dungolman River bisects the south of the Wind Farm Site before running along the eastern boundary.

All proposed turbine locations (T1-T9), with the exception of T4, are situated on improved grassland T4 located in the southwest of the Wind Farm Site is situated in an area of coniferous forestry. The Wind Farm Site access roads are mainly located on improved grassland (with some use of existing tracks), but also through forestry near T4.

The Proposed Development site measures approximately 949 hectares. The footprint of the Proposed Development measures approximately 8.2 hectares, which represents only 0.9% of the EIAR Site Boundary.

8.3.1.2 Grid Connection

The Grid Connection encompasses a 110kV on-site substation within the Wind Farm Site, including underground 110kV cabling to connect to the national grid at Thornsberry 110kV substation, in the townland of Derrynagall or Ballydaly, near Tullamore, Co. Offaly. The underground electrical cabling route is 31km in length, through the village of Horseleap and bypassing the town of Kilbeggan until its termination point at the Thornsberry 110 kV substation, 2km northeast of Tullamore. The underground electrical cabling route is predominantly located primarily within public roads, with elevation ranging between 60-80mOD.

8.3.2 Land and Landuse

8.3.2.1 Wind Farm Site

The published Corine Land Cover Maps (www.epa.ie) show that much of the Wind Farm Site is located on agricultural pastures. Corine (2018) map T4 on an area of transitional woodland scrub, while the west of the Wind Farm Site including T6, T7 and T9 are mapped on non-irrigated arable land.

Agricultural pastures dominate the surrounding lands with a scattered pattern of rural dwellings and farmhouses. Corine (2018) map a small area of mixed forestry to the west of T3 and T4 and quarry immediately to the northeast of the Wind Farm Site and T1.

Due to the large scale nature of the Corine Land Cover Maps, land use/cover was verified during a site walkover on 03rd May 2021 which was in agreement with the mapping.

8.3.2.2 Grid Connection

Land use along the underground electrical cabling route is almost entirely as an existing road carriageway. Where the underground electrical cabling route enters the Wind Farm Site, from the existing public road carriageway, and connects to the onsite 110kV substation, the land use is primarily agricultural.

8.3.3 Soils and Subsoils

8.3.3.1 Wind Farm Site

The published soils map (www.epa.ie) for the Wind Farm Site shows that there is a wide variety of soil types mapped within the Wind Farm Site. Basic deep well drained mineral soils (BminDW) are mapped in the north of the Wind Farm Site, including at T2, and in the southeast of the Wind Farm Site at T7, T8 and T9. In the northeast of the Wind Farm Site, T1 is mapped on basic shallow well drained mineral soils (BminSW). A small area of poorly drained mineral soils with a peaty topsoil is mapped to the east of T3, however this was not confirmed during hand augering, where only relatively sandy, free draining subsoil was noted in this area. Towards the centre of the Wind Farm Site, T5 and T6 are located on basic deep poorly drained mineral soil (BminPD), while T7 is situated on alluvium (Lac). Mineral alluvium is also mapped along the Dungolman River to the northeast of the Wind Farm Site. A local subsoils map is shown in Figure 8-1-1 and Figure 8-1-2.

The published subsoils map (www.gsi.ie) shows that the majority of the Wind Farm Site is underlain by till derived from limestones (TLs). Localised pockets of Lacustrine sediments (Lac) occur throughout the south of the Wind Farm Site and are mapped immediately to the north of both T6 and T7. Fen peat (FenPt) is mapped in the west of the Wind Farm Site, underlying T3 and immediately to the east of T4, however this soil type was not identified during walkover surveys and hand augering. Other subsoils mapped within the Wind Farm Site include alluvium (A) along the Dungolman River to the east of T1 and T2 and eskers comprised of gravels of basic reaction (BasEsk) to the north of T3.

8 no. trial pits were excavated across the Wind Farm Site on 07th July 2021 and 1 no. face bank of exposed granular deposits was also logged. 5 no. samples were taken for PSD analysis. A summary of the trial pit lithology and the PSD analysis is given below in Table 8-4. A map of the trial pit locations is included as Figure B in Appendix 8-2.

Table 8-4: Summary of trial pit logs and PSD Analysis

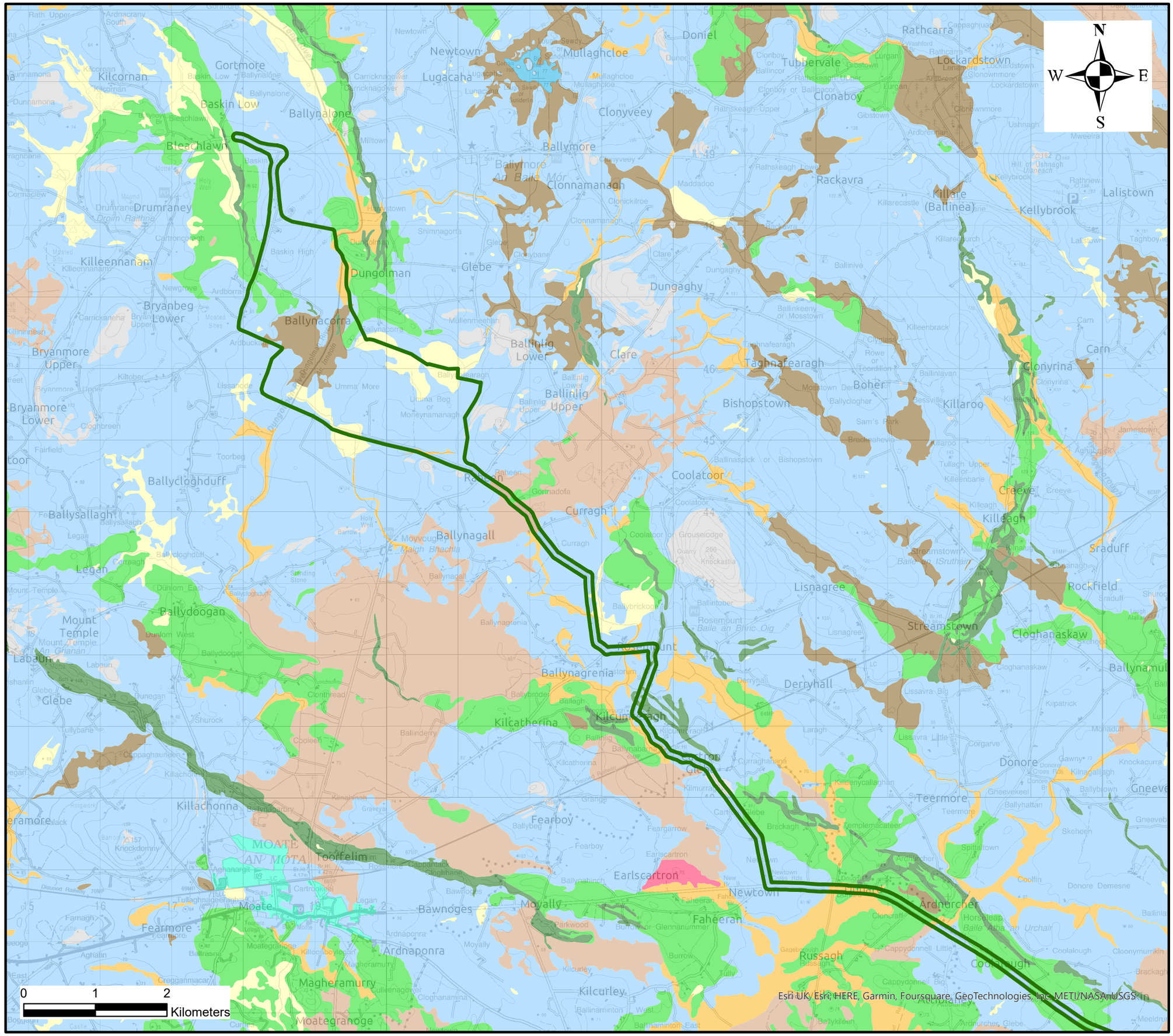
Trial Pit	Trial Pit Depth (m)	Subsoil	Moisture Content	PSD Analysis			
				Silt (%)	Sand (%)	Gravel (%)	Cobbles (%)
TP-1	2.7	0.2m of Topsoil over 0.5m Clay over 2m of sandy GRAVEL/silty SAND	3.4%	6.9	23.3	59.8	10
TP-1.2	2.2	0.2m Topsoil over 2m CLAY		No Sample			
TP-1.3	1.5	0.7m sandy gravelly COBBLES over >0.8m of gravelly COBBLES		No Sample			
TP-2	2.3	0.2m Topsoil over 2.1m CLAY		No Sample			

TP-3	2.5	0.4m Topsoil over 2.1m fine-coarse SAND	1.2%	9.2	53.4	37.4	0
TP-4	2.2	0.5m Topsoil over 1.7m clayey sandy SILT		No Sample			
TP-5	2.4	0.3m Topsoil over 0.3m silty CLAY over 1.8m fine-medium grained SAND	15.7%	18.5	81.3	0.2	0
TP-6	2.4	0.2m Topsoil over 1.6m SAND over 0.6m sandy SILT	3.4%	11.9	62.8	14.5	10.8
Existing Bank Face	N/A	0.7m silty cobbly GRAVEL over 0.7m of sandy silty GRAVEL over 1.1m of gravelly, cobbly SAND	5%	5.4	24.7	57.4	12.5

The trial pits were generally logged as 0.2 – 0.4m TOPSOIL over SILT/SAND/GRAVEL. Clay was logged in TP-1.2, TP-2 and TP-5. No peat was logged in any of the 8 no. trial pits.

8.3.3.2 DCP Analysis

Dynamic cone penetration (DCP) testing has been undertaken at 42 no. locations along the proposed access roads within the Wind Farm Site. These data indicate a stable underlying subsoil formation with an average penetration rate of 28.9mm/blow, ranging between 7.5 – 101.25 mm/blow, with a comparative average CBR value of 12.88%, ranging between 2-41%. The original DCP analysis results, along with their locations are attached as **Appendix 8-1.**



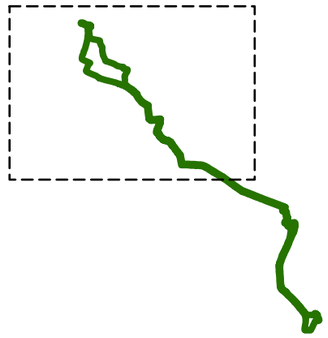
Legend

- EIAR Site Boundary

Subsoils

- A, Alluvium
- BasEsk, Eskers comprised of gravels of basic reaction
- Cut, Cut over raised peat
- FenPt, Fen Peat
- GLs, Gravels derived from Limestones
- L, Lacustrine sediments
- Mrl, Lake marl
- Rck, Bedrock outcrop or subcrop
- TDSs, Till derived from Devonian sandstones
- TLs, Till derived from limestones
- Urban
- Water

Key plan



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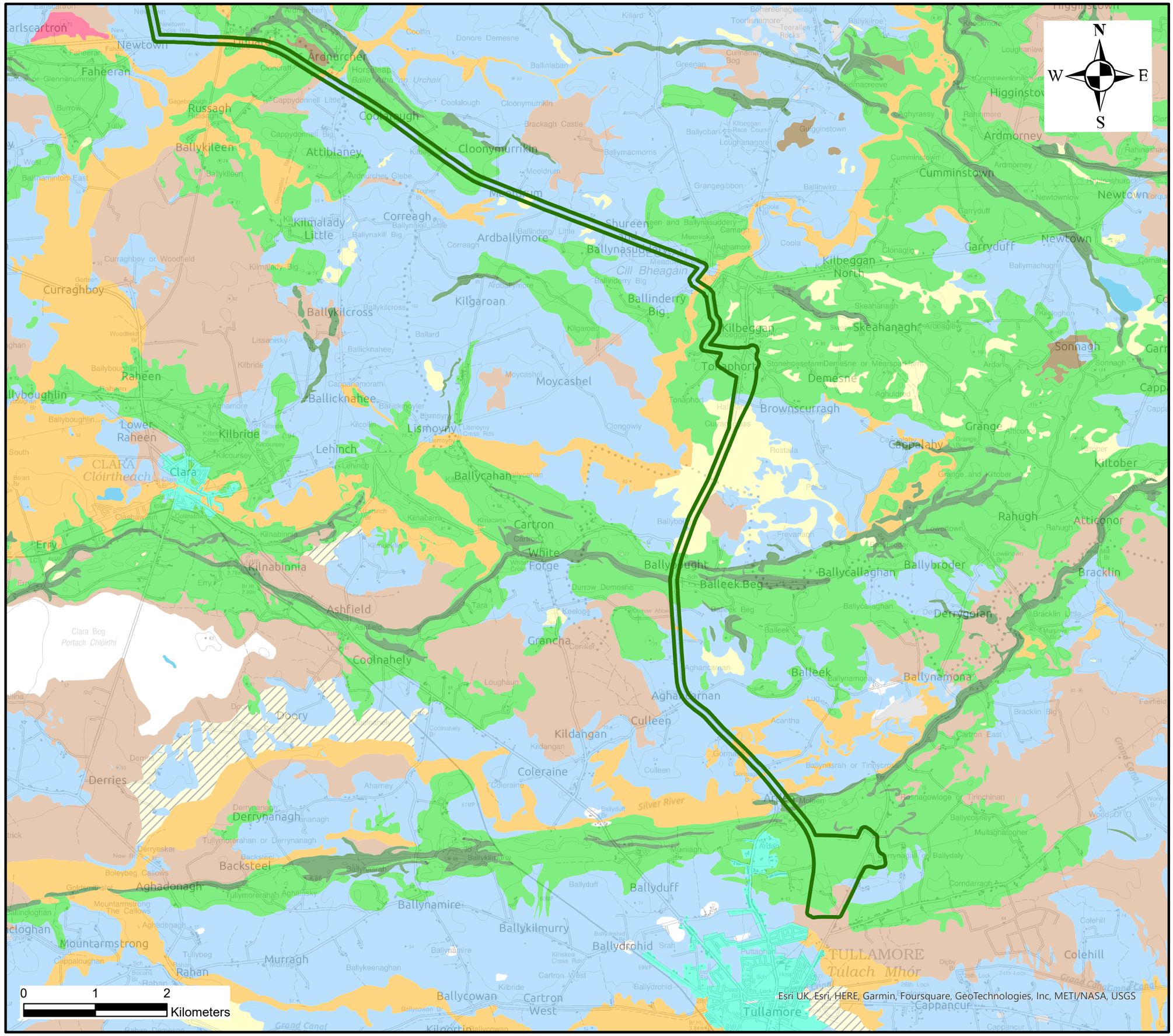
Client: MKO	
Job: Umma More Renewable Energy Development	
Title: Local Subsoils Map	
Figure No: 8-1-1	
Drawing No: P1553-0-0123-A3-801-1-00A	
Sheet Size: A3	Project No: P1553-0
Scale: 1:50,000	Drawn By: GD
Date: 31/01/2023	Checked By: MG



Legend

- EIAR Site Boundary

Subsoils

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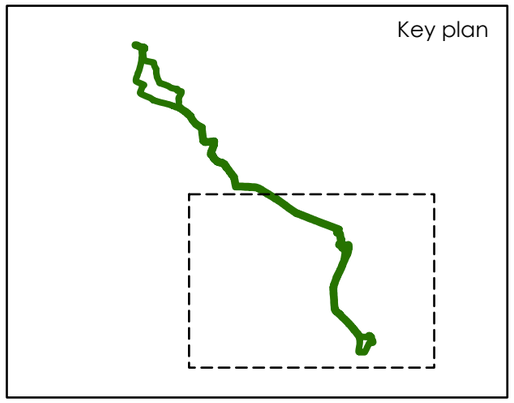
- Urban
- Water



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Client: MKO	
Job: Umma More Renewable Energy Development	
Title: Local Subsoils Map	
Figure No: 8-1-2	
Drawing No: P1553-0-0123-A3-801-2-00A	
Sheet Size: A3	Project No: P1553-0
Scale: 1:50,000	Drawn By: GD
Date: 31/01/2023	Checked By: MG

8.3.3.3 Grid Connection

Soils and subsoils along the underground electrical cabling route are mainly mapped as basic Tills derived from Limestone, with some areas of mapped Cut over Raised Peat, Alluvium, Eskers and Gravels derived from Limestone. The Gravels are mainly mapped towards the south of the underground electrical cabling route near Tullamore, while the small area of Cutover Raised peat is mapped at the northern end of the underground electrical cabling route.

Peat augering was conducted along this stretch of mapped Peat and at 2 no. smaller (~50 - 100m long) stretches of the underground electrical cabling route where Peat is mapped.

6 no. peat probes were attempted within the area of mapped Peat situated between the townlands of Raheen and Gortnadufa. Penetration below 0.2m was only possible at one location, which was a small area of afforested ground situated ~20m off the road carriageway. A profile of 0.2m of firm brown topsoil over 0.2m of dark brown firm peat over 0.05m of stiff grey sandy subsoil was observed. The road section along ~0.5km of this stretch of mapped peat has been built up ~1.2 – 1.5m with hardcore material. The surrounding land is broadly well drained and appears to consist of a peaty topsoil which is used for grazing. An exposed section of 0.3m of dark brown gravelly soil was observed at the southern end of this mapped peat section, however no peat was observed. Local subsoils are shown in Figure 8-1-1 and Figure 8-1-2.

8.3.4 Bedrock Geology

8.3.4.1 Wind Farm Site

Based on the GSI bedrock mapping (www.gsi.ie), the underlying bedrock across the majority of the Wind Farm Site is mapped as the Lucan Formation which comprises dark limestone and shale. There are no mapped faults running through the Wind Farm Site.

The Lucan Formation is generally described as dark limestone and shale (calp). The Lucan Formation is a graded, intraclastic skeletal packstones interbedded with shales, laminated calcisiltites, argillaceous micrites and locally abundant chert representative of the basinal facies of the 'Calp'. Basal part of the Calp is dominated by dark grey, calcareous, bioturbated mudstones and wackestones also referred to at the Tober Colleen formation.

The southeast of the Wind Farm Site including the proposed location of T9, is mapped to be underlain by massive, unbedded lime mudstones of the Waulsortian Limestone Formation. The GSI provide the following lithological description: "Sometimes informally called "reef" limestones, although inaccurately. Dominantly pale-grey, crudely bedded or massive limestones".

The GSI do not map the presence of any bedrock outcrop, faults or folds within the Wind Farm Site. The closest mapped fault is mapped approximately 500m to the southeast. No karst features were identified within the Wind Farm Site following a review of the GSI database or during the site walkover. A number of karst features are noted in the surrounding lands. The closest karst feature is located some 630m to the southwest of the Wind Farm Site where a spring was noted. A second spring is mapped by the GSI approximately 1.2km to the northwest.

No bedrock was encountered during the excavation of the trial pits. Local mapped bedrock is shown in Figure 8-2.

N
W E
S

0 2 4
Kilometers

Legend

EIAR Site Boundary

Geological Linework

Structural Symbols

Dip of bedding or main foliation, old GSI data

Horizontal Bedding

Strike and dip of bedding, right way up

Strike and dip of bedding, way up unknown

Bedrock

Agglomerate

Visean Limestones (undifferentiated

Allenwood Formation

Old Red Sandstone (undifferentiated

Navan Beds

Lucan Formation

Ballysteen Formation

Waulsortian Limestones

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Client: MKO

Job: Umma More Renewable Energy Development

Title: Local Bedrock Geology Map

Figure No: 8-2

Drawing No: P1553-0-0123-A3-802-00A

Sheet Size: A3	Project No: P1553-0
Scale: 1:90,000	Drawn By: GD
Date: 31/01/2023	Checked By: MG

8.3.4.2 Grid Connection

The bedrock geology along the underground electrical cabling route consists mostly of Waulsortian Limestone, with areas of Lucan Formation Limestone towards the north of the underground electrical cabling route and Ballysteen Formation and Allenwood Formation Limestone towards the centre and south of the underground electrical cabling route. Local bedrock geology is shown in Figure 8-2.

8.3.5 Soil Contamination

8.3.5.1 Wind Farm Site

There are no known areas of soil contamination on the Wind Farm Site. During the site walkovers, no areas of particular contamination concern were identified. The walkover also included area where machinery traffic would converge, such as loading areas, and compounds, and no areas of contamination concern were noted or observed.

According to the EPA online mapping (http://gis.epa.ie/Envision), there are no licenced waste facilities on or within the immediate environs of the Wind Farm Site. There are no existing IPCC licenses granted within or near the Wind Farm Site.

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

8.3.5.2 Grid Connection

There are no known areas of soil contamination along the underground electrical cabling route. There are no licensed waste facilities along the underground electrical cabling route, nor are there any historic mines which could potentially have contaminated tailings.

8.3.6 Economic Geology

8.3.6.1 Wind Farm Site

The GSI Online Minerals Database accessed via the Public Data Viewer shows a small number of active and historic quarries, pits, mines and mineral occurrences near the Wind Farm Site. An active quarry, Baskin Pit, is found immediately to the northeast of the Wind Farm Site. The products are listed as mostly sand and drainage pebble. Several historic sand and gravel pits are also recorded in the surrounding lands but not within the Wind Farm Site. A disused roadstone limestone quarry is located approximately 1.5km west of the Wind Farm Site. The nearest active bedrock quarry identified is a Waulsortian limestone quarry located approximately 3.3 km southeast of the Wind Farm Site.

The GSI online Aggregate Potential Mapping Database shows that the Wind Farm Site is not located within an area mapped as being of Very High or High granular aggregate potential (i.e. potential for gravel reserves). As mentioned above there is an active sand and gravel pit to the northeast of the Wind Farm Site with this area having a Moderate to High granular aggregate potential. In contrast GSI record the aggregate potential of the Wind Farm Site to have Very Low potential. The bedrock which underlies the proposed Wind Farm Site, generally coincides with areas mapped as being of Moderate for crushed rock aggregate (i.e. potential for a rock quarry).

There are a number of prospecting licences held for this area of County Westmeath for minerals including base metals, barytes, gypsum, gold and silver. There are drilling records for prospecting conducted in the 1980s' and in 1999.

It is a policy of the Westmeath County Development Plan 2021 – 2027 (CPO 9.63) to 'Facilitate adequate supplies of aggregate resources to meet the future growth needs of the County and the wider region where there is a proven need for a certain mineral/aggregate and to exercise appropriate control (including ongoing consideration of environmental impacts) while addressing key environmental, traffic and social impacts and details of rehabilitation'. It is not envisaged that the Proposed Development will prejudice the future development of pits, quarries or mines in the area of the Wind Farm Site.

8.3.6.2 Grid Connection

Granular aggregate potential is mapped as high to very high within the southern section of the underground electrical cabling route, between Clara and Tullamore. Crushed rock aggregate potential is mapped as high to very high along the majority of the underground electrical cabling route. There are 3 no. historic gravel aggregate pits located near the R420 Clara to Tullamore road.

8.3.7 Geological Heritage Sites

8.3.7.1 Wind Farm Site

There are no recorded Geological Heritage sites within the Wind Farm Site. The closest geological heritage site is the Calliaghstown – Milltown Esker (Site Code: WH002). This is located approximately 300m west of the Wind Farm Site and 500m east of T1. The Calliaghstown – Milltown Esker is a striking example of an esker ridge and stands proud of the surrounding landscape. It has no connection to the Wind Farm Site and will not be affected in any way by the Proposed Development.

Other regional geological heritage sites in the surrounding areas are included in Table 8-5 below. These are too far removed from the Wind Farm Site and will not be impacted by the Proposed Development. A map of geological heritage sites near the Wind Farm Site and the Grid Connection are show in Figure 8-3.

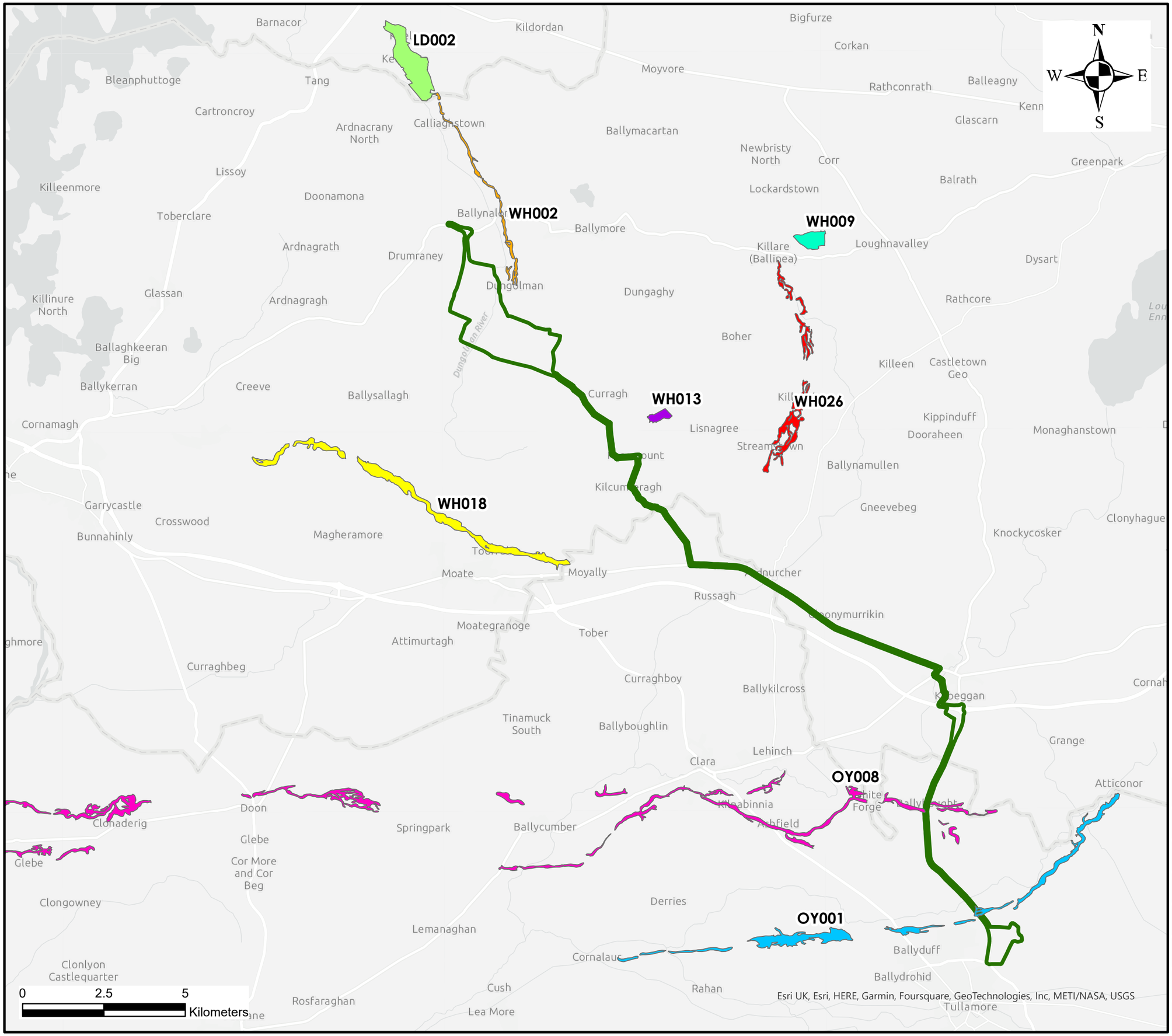
Table 8-5: Regional Geological Heritage Sites

Site Code	Site Name	IGH Theme	Features	Distance from WF
WH002	Calliaghstown – Milltown Esker	IGH7	Long linear series of esker segments	300m W
WH013	Knockastia Hill and Quarry	IGH8	Disused Waulsortian limestone quarry on Knockastia Hill add natural exposures on the summit of the hill	3.5km SE
LD002	Ballymahon Esker	IGH 7	Fine example of a beaded esker, one of a series of north-south orientated eskers	4.5km SW
WH018	Mounty Temple Esker	IGH 7	One of the longest esker systems in the country and a superb example of a subglacial conduit relict	5.2km NW
WH026	Streamstown Esker	IGH7	One of several north-south eskers which records the retreat of the ice in this part of Westmeath	6.7km W

Site Code	Site Name	IGH Theme	Features	Distance from WF
WH009	Hill of Uisneach	IGH7	A prominent hill rising from a gently undulating landscape of raised bogs and pasture. Recognised due to its extensive outcrop exposures	8.4km W

8.3.7.2 Grid Connection

There is 1 no. geological heritage site located along the underground electrical cabling route, which has previously been cut through by a road carriageway. The Clonmacnoise Esker is situated along the N52 road, 4km south of Kilbeggan.



Legend

- EIAR Site Boundary

Geological Heritage Sites

- Ballyduff Esker (OY001)
- Ballymahon Esker (LD002)
- Calliaghstown-Milltown Esker (WH002)
- Clonmacnoise Esker (OY008)
- Hill of Uisneach (WH009)
- Knockastia Hill and Quarry (WH013)
- Mount Temple Esker (WH018)
- Streamstown Esker (WH026)

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Title: Geological Heritage Sites Map

Figure No: 8-3

Drawing No: P1553-0-0123-A3-803-00A

Sheet Size: A3	Project No: P1553-0
Scale: 1:90,000	Drawn By: GD
Date: 31/01/2023	Checked By: MG

8.4 Characteristics of the Proposed Development

The Proposed Development is defined in Section 4.1 of Chapter 4. The main characteristics of the Proposed Development that could impact on soils and geology, and hydrogeology (which is dealt with in Chapter 9) are:

The development description for the current planning application as appears in the public notices is as follows:

The Proposed Development will consist of the provision of the following:

i. *9 No. wind turbines with an overall ground-to-blade tip height of 185 metres; a rotor blade diameter of 162 metres; and hub height of 104 metres, and associated foundations and hard-standing areas;*
ii. *A thirty-year operational life from the date of full commissioning of the wind farm and subsequent decommissioning;*
iii. *A meteorological mast with a height of 30 metres, and associated foundation and hard-standing area;*
iv. *Junction accommodation works and temporary access roads to facilitate turbine delivery to an existing entrance on L5363.*
v. *Upgrade of existing entrance on L5363 for provision of site entrance;*
vi. *Upgrade of existing tracks/ roads and provision of new site access roads, junctions and hardstand areas;*
vii. *Underground electrical (33kV) and communications cabling;*
viii. *A temporary construction compound;*
ix. *Spoil Management;*
x. *Site Drainage;*
xi. *Tree Felling;*
xii. *Operational stage site signage; and*
xiii. *All ancillary works and apparatus.*

The application is seeking a ten-year planning permission.

The Grid Connection, which will be subject to a separate planning application, includes for a 110kV on-site substation compound (2 no. control buildings with welfare facilities, all associated electrical plant and apparatus, security fencing, underground cabling, waste water holding tank, site drainage and all ancillary works), a temporary construction compound and approximately 31km of underground 110kV electrical cabling connecting the proposed on-site substation to the existing Thornsberry 110kV substation, near Tullamore, Co. Offaly.

The Proposed Development will typically involve removal of soil and subsoils for the 9 no. proposed turbine foundations, access roads and ancillary works.

The total volume of spoil (soil and subsoil deposits) requiring placement/reinstatement within the Wind Farm Site is estimated at 76,750m^3 (refer to Table 8-6 below).

Once excavated, spoil will be temporarily stored in localised areas adjacent to excavations before being placed into the identified spoil management areas or reused for landscaping purposes. All temporary storage areas will be upslope of founded roads/hardstand areas and will be inspected by a suitably qualified person before material is stored in the area.

The total volume of spoil to be managed for the Grid Connection is 35,620 m^3. The spoil volume requiring management for the Grid Connection underground electrical cabling route has been taken account in the total spoil volume requiring management for the Proposed Development. As detailed below, there is capacity for the total volume of spoil requiring management for the Proposed

Development in the spoil management areas within the Wind Farm Site. However, some of the Grid Connection underground electrical cabling route materials will go to an appropriate licenced facility as required. This is dependent on the road makeup at locations along the underground electrical cabling route and the distance from the underground electrical cabling route to the Wind Farm Site, the main contractor will determine the appropriate location for management of arisings from the Grid Connection underground electrical cabling route.

Table 8-6: Proposed spoil volumes to be removed at Wind Farm Site and Grid Connection

Development Component	Area (m2) (approx.)	Spoil Volume(m3) (approx.)
Wind Farm Site		
9 no. Turbines and Hardstanding Areas	32,150	50,400
Access Roads	61,250	24,500
Meteorological Mast	375	150
Temporary Construction Compound	4,250	1,700
Total		**76,750**
Grid Connection		
Onsite Substation	12,000	12,000
Temporary Construction Compound	3,150	1,300
Cabling Trench	18,600	22,320
Total		**35,620**
Total Spoil to be managed		**112,370**

The total capacity of the spoil management areas within the Wind Farm Site is 127,500m^3, providing enough capacity for the total volume of spoil requiring management for the Proposed Development as detailed in Table 8-6 above.

8.5 Likely Significant Effects and Associated Mitigation Measures

8.5.1 Do Nothing Scenario

If the Proposed Development were not to proceed, coniferous plantation and agriculture will continue to function and may be extended to occupy a larger portion of the land. Coniferous forestry will be

felled as forestry compartments reach maturity. Re-planting of these areas with coniferous plantation is likely to occur. The opportunity to capture the available renewable energy resource would be lost.

8.5.2 Construction Phase - Likely Impacts and Mitigation Measures

The likely impacts of the Proposed Development, including construction works at the Wind Farm Site and the Grid Connection, and mitigation measures that will be put in place to eliminate or reduce them are shown below. These relate to the construction stage. It should be noted that the main potential impacts on the soils and geology environment will occur during the construction stage.

8.5.2.1 Soil, Subsoil Excavation and Bedrock Excavation

Excavation of mineral soil/subsoil and bedrock will be required for the installation of foundations for the access roads, turbine hardstands and bases, temporary construction compound, meteorological mast, for landscaping, and cable trenching within the Wind Farm Site, and for the Grid Connection temporary construction compound, onsite substation and underground electrical cabling route. Minor excavations will take place at junction improvement works. These works will result in temporary disturbance or permanent removal of soil, subsoil and bedrock at various excavation locations. Minor haul route works will have minimal impact on soils and geology.

The soil/subsoil can be classified as of "Medium" importance. The bedrock, where encountered, can also be classified as of "Medium" importance.

Pathway: Extraction/excavation.

Receptor: Soil, mineral subsoils and bedrock.

Pre Mitigation Potential Effects: Negative, slight/moderate, direct, high probability, permanent effect on soils, mineral subsoil and bedrock.

Proposed Mitigation Measures by Design:

- The soils and subsoil which will be removed during the construction of turbine hardstands will be localised to the turbine locations. The soil/subsoil will be placed/spread locally alongside the excavations or accommodated within the spoil management areas;
- Excavated soils/subsoils shall be excavated and stored separately to topsoil; this will prevent mixing of materials and facilitate reuse afterwards;
- All materials which require storage will be stockpiled at low angles (< 5-10˚) to ensure their stability and secured using silt fencing where necessary. This will help to mitigate erosion and unnecessary additions of suspended solids to the drainage system;
- Spoil will be deposited, in layers of 0.50m and will not exceed a total thickness of 1m;
- No turbines or related infrastructure will be constructed in any designated sites such as NHAs or SACs;
- Placement of internal cable trenching will also be volume neutral, and all excess material will be managed locally and,
- Excess spoil from the underground electrical cabling route works will be placed within the spoil management areas within the Wind Farm Site or disposed at an off site licenced facility.

Residual Effect: The granular soil at the site can be classified as of "Medium" importance. The overall site area is extensive while the Proposed Development footprint is approximately 0.9% of the overall Wind Farm Site area. The impact is the disturbance and relocation of c 76,750 m3 of soil and subsoil during construction within the Wind Farm Site and 35,620 m^3 for the Grid Connection. The design measures incorporated into the Proposed Development as described above means that the residual effect is considered - Negative, direct, slight, high probability, permanent effect on soils, mineral subsoils, and bedrock.

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

8.5.2.2 Contamination of Soil by Leakages and Spillages

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk. The accumulation of small spills of fuels and lubricants during routine plant use can also be a significant pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. Large spills or leaks have the potential to result in significant effects (i.e. contamination of soil, subsoils and pollution of the underlying aquifer) on the geological and water environment, depending on where a spill may occur, *i.e* Wind Farm Site and Grid Connection.

Pathway: Soil, mineral subsoil and bedrock pore space.

Receptor: Soil, mineral subsoil and bedrock.

Pre-Mitigation Potential Effect: Negative, direct, slight, short term, medium probability effect on soil, soils and bedrock.

Proposed Mitigation Measures:

- Where possible maintenance of construction vehicles or plant will take place off-site. This applies to both at the Wind Farm Site and the Grid Connection. Minimal maintenance of construction vehicles or plant will take place on-site;
- On-site re-fuelling will be undertaken using a double skinned bowser with spill kits on the ready for any minor accidental leakages or spillages;
- Fuels stored on Site will be minimised but will be appropriately bunded;
- All waste tar and chip material arising during construction of the underground electrical cabling route will be removed off-site and taken to an appropriately licenced facility;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan (CEMP) Appendix 4-2 of this EIAR. Spill kits will be available to deal with accidental spillage in and outside of re-fuelling areas.

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

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

8.5.2.3 Erosion of Exposed Subsoils During Construction of Wind Farm Site (Felling in T4 area, Access Road Construction and Turbine Base Construction)

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

Pathway: Vehicle movement, surface water and wind action.

Receptor: Soil, subsoil & weathered bedrock within the Wind Farm Site.

Pre-Mitigation Potential Effect: Negative, direct, slight, high probability effect on soil, subsoils and bedrock.

Proposed Mitigation Measures:

- Soil/subsoil removed from the Wind Farm Site infrastructure footprint will be used for landscaping, or accommodated in the identified spoil management areas within the Wind Farm Site.
- Temporary drainage systems will limit runoff impacts during the construction phase.
- In forestry areas (near T4) brash mats will be used to support vehicles on soft ground, reducing soil erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting.

Residual Effects: Soil and subsoil can be eroded by vehicle movements, wind action and by water movement. To prevent this all excavation works will be temporary, stockpiles will be covered or sealed with excavator bucket, and silt fencing will be used. Following implementation of these measures the residual effected is considered to be - Negative, slight, direct, likely effect on soil and subsoils, and possibly bedrock.

Significance of Effects: For the reasons outlined above, no significant effect on soils, subsoils or bedrock will occur within the Wind Farm Site.

8.5.2.4 Erosion of Exposed Subsoils During Construction of the Grid Connection

Erosion of soil/subsoil by the pathways listed below, can have the effect of reducing the overall volume of soil/subsoil at the Site, with the potential for some eroded subsoils to reach watercourses, leading to water quality issues such as high turbidity. Erosion of soils/subsoils may occur at any works area where excavation is ongoing i.e Grid Connection underground electrical cabling route, and proposed temporary construction compound and onsite substation within Wind Farm Site).

Pathway: Vehicle movement, surface water and wind action along the underground electrical cabling route.

Receptor: Soil, subsoil & weathered bedrock along the underground electrical cabling route.

Pre-Mitigation Potential Effect: Negative, direct, slight, high probability effect on soil, subsoils and bedrock.

Proposed Mitigation Measures:

- Soil/subsoil removed from the underground electrical cabling route trench will be transported to the on-site spoil management areas or to a local licenced facility.
- Temporary drainage systems will limit runoff impacts during the construction phase.
- The underground electrical cabling route will be constructed in a stepwise manner along its length. This will minimise the time any particular section of the underground electrical cabling route trench is open before being reinstated.

Residual Effects: Soil and subsoil can be eroded by vehicle movements, wind action and by water movement. To prevent this, all excavation works will be temporary and silt fencing will be used where appropriate near surface watercourses. Following implementation of these measures the residual effected is considered to be - Negative, slight, direct, likely effect on soil and subsoils, and possibly bedrock.

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

8.5.3 Operational Phase - Likely Impacts and Mitigation Measures

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

- Some construction traffic may be necessary for maintenance of turbines which could result in minor accidental leaks or spills of fuel/oil.
- The grid transformer in the onsite substation and transformers in each turbine are oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater.
- Emergency repair works to the underground electrical cabling which are highly unlikely.

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

Mitigation measures for soils and geology during the operational stage of the Proposed Development include the use of aggregate from authorised quarries for use in road and hardstand maintenance. Oil used in transformers (at the substation and within each turbine) and storage of oils in tanks at the substation will be bunded capable of holding 110% of the oil in the transformer and storage tanks. Turbine transformers are located within the turbines, so any leaks would be contained. These mitigation measures are considered sufficient to reduce risk to soil/soils and subsoils, and groundwater and surface water quality.

8.5.4 Decommissioning Phase - Likely Impacts and Mitigation Measures

The potential impacts associated with decommissioning will be similar to those associated with construction but of reduced magnitude, as it is envisaged that elements of the Proposed Development, such as turbine bases will be rehabilitated rather than removed. This reduces the level of traffic and disruptive works within the Wind Farm Site. The Grid Connection underground electrical cabling route and onsite substation will remain in place, which will avoid decommissioning works on this part of the Proposed Development.

During decommissioning, it may be possible to reverse or at least reduce some of the potential effects caused during construction by rehabilitating construction areas such as turbine bases. This will be done

by covering with vegetation/scraw to encourage vegetation growth and reduce run-off and sedimentation. The underground electrical cabling connection the turbines to the on-site substation will be removed from the cable ducts. Removal of the cabling will be carried out by re-opening the cable jointing locations and rolling the cables onto a cable drum for removal off-site. The cable ducting will be left in-situ as it is considered the most environmentally prudent option, avoiding unnecessary excavation and soil disturbance. Other effects such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude. However, as noted in the Scottish Natural Heritage 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. 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'.

A Decommissioning Plan is included as Appendix 4-6 of this EIAR, the detail of which will be agreed with the local authority prior to any decommissioning. The potential for effects during the decommissioning phase of the Proposed Development has been fully assessed in the EIAR.

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant. Some of the effects associated with reinstatement of the Wind Farm Site (excavation of turbine bases, access tracks etc.) will be avoided by leaving these in place. The bases will be rehabilitated by covering with local topsoil in order to regenerate vegetation which will reduce runoff and sedimentation effects. 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 in Section 8.5.1.

No significant cumulative effects on the soils and geology environment are envisaged during the decommissioning stage.

8.5.5 Assessment of Human Health Effects

Potential human health effects arise mainly through the potential for soil and ground contamination. A wind farm/grid connection route is not a recognized source of pollution and so the potential for effects during the operational phase are negligible. Hydrocarbons will be used onsite during construction however the volumes will be small in the context of the scale of the Proposed Development and will be handled and stored in accordance with best practice mitigation measures. The potential residual effects associated with soil or ground contamination and subsequent health effects are negligible.

8.5.6 Cumulative Effects

Construction Phase

The nature of the construction works within the Proposed Development site mean that the effects on the land, soils and geology environment are restricted to the immediate areas of the construction works. The only cumulative effect of the Proposed Development with respect to the lands, soils and geology will be due to the removal and transport of spoil to a licensed waste facility, where required. This spoil will typically be placed within designated spoil management areas on-site. The environmental effects of the placement of spoil material within licenced facility will have been previously assessed during the licensing process of this facility. There will be no further cumulative effects on the land, soils and geology environment during the construction phase of the Proposed Development. All identified developments within Section 2.7 of Chapter 2 have been considered.

Operational Phase

During the operational phase of the Proposed Development all aspects of the land, soils and geology environment will remain constant, with no alteration of any aspect of this environment. As a result,

there will be no cumulative effects due to the Proposed Development. All identified developments within Section 2.7 of Chapter 2 have been considered.

Decommissioning Phase

During the decommissioning phase, there will be minimal disturbance of soil/subsoil. The underground electrical cabling ducting will be left in-situ and turbine bases will not be removed, but covered over with soil/subsoil. These works will be limited in scale and there is no potential for cumulative effects with other nearby developments. All identified developments within Section 2.7 of Chapter 2 have been considered.

8.6 Post Construction Monitoring

None required.