7 LAND, SOILS AND GEOLOGY

7.1 Introduction

7.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by McCarthy Keville O'Sullivan (MKOS), on behalf of Bord na Móna Powergen Ltd. and ESB Wind Development Ltd. to carry out an assessment of the likely significant effects of a Solar Farm and Substation and Grid Connection project at a proposed site at Timahoe, Co. Kildare on the land, soil and geological aspects of the receiving environment.

The Proposed Project site is located in northwest County Kildare, approximately 6.5km (kilometres) north of the village of Allenwood, 6km east of Carbury and 3km south of Johnstownbridge. The site is accessed from the south via the Derrymahon-Drehid local road L1019, which adjoins the R402 Regional Road to the west of the site.

The Proposed Project comprises a large scale solar PV farm with an export capacity of approximately 70 Megawatts (MW). It will consist of a solar photovoltaic array and associated infrastructure, a battery storage compound, inverters, access roads and parking, site compounds and security fencing, amenity trails and landscaping, peat and subsoil storage areas (repositories), site drainage and all associated works. The Proposed Project will also include the construction of a 110 kV substation within the site. It is then envisaged to connect from this substation to the Derryiron-Maynooth 110 kV overhead line that traverses the southern section of the Timahoe North site.

The objectives of the assessment are to:

- Produce a baseline study of the existing terrestrial environment (land, soil and geology) in the area of the Proposed Project;
- Identify likely significant effects of the Proposed Project on land, soil and geology during the construction phase, operational phase and decommissioning phase of each aspect of the development;
- Identify mitigation measures to avoid, remediate or reduce significant negative effects and,
- Assess significant residual effects and cumulative effects of each aspect of the Proposed Project and other local developments.

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

This chapter of the EIAR was prepared by Michael Gill and David Broderick.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 16 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. He has substantial experience in surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm related projects. Michael has also worked on over 20 solar projects across Ireland, including Clonfad Solar, Sronagh Solar, Tiglin Solar, Kilsallaghan Solar, Ballymacarney Solar.

David Broderick (BSc, H.Dip Env Eng, MSc) is a hydrogeologist with over 12 years' experience in both the public and private sectors. 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 completed numerous geology and water sections for input into EIAs for a range of commercial developments. For example, David has worked on the EIS for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm related projects across Ireland.

7.1.3 Relevant Legislation

The EIAR is carried out generally in accordance with the following legislation:

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

7.1.4 Relevant Guidance

The land, soils and geology section of this EIAR is carried out in accordance with guidance contained in the following documents:

- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);
- Environmental Protection Agency (August 2017) Draft - Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.
- Environmental Protection Agency (September 2015): Draft - Advice Notes on Current Practice (in the preparation on Environmental Impact Statements);
- Environmental Protection Agency (September 2015): Draft – Revised Guidelines on the Information to be Contained in Environmental Impact Statements;
- Environmental Protection Agency (2003): Advise Notes on Current Practice (in the Preparation on Environmental Impact Statements);
- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements; and,
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

7.2 Schedule of Works

7.2.1 Desk Study

A desk study of the Solar Farm site, Substation and Grid Connection works area, third party lands and third party turbary lands, and the surrounding study area (within 5km to cover local drainage patterns and geological deposits) was largely completed in advance of undertaking the walkover survey and site investigations. The desk study involved collecting all the relevant geological data for the Proposed Project study area. This included consultation with the following:

- Environmental Protection Agency database (**www.epa.ie**);
- Geological Survey of Ireland - National Draft Bedrock Aquifer map;
- Geological Survey of Ireland - Groundwater Database (**www.gsi.ie**);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 16 (Geology of Kildare - Wicklow);
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets;
- General Soil Map of Ireland 2nd edition (**www.epa.ie**); and,
- Department of Environment, Community and Local Government on-line mapping viewer (www.myplan.ie).

7.2.2 Baseline Mapping and Site Investigations

Detailed walkover surveys of the site were undertaken by HES on various dates, including 11th October 2017, 03rd January 2018, 11th January 2018, 08th February 2018, 22nd March 2018, and 18th, 23rd July 2018 and 27th September 2018. Preliminary geotechnical ground investigations, including extensive trial pitting and peat probing, were undertaken by Irish Drilling Ltd during 2017 and 2018, and the results have been summarised in Appendix 7-2 – Geology & Ground Conditions Report (ESBI, June 2018).

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

- 25 no. shell and auger boreholes were drilled;
- Standpipes, consisting of 50mm diameter uPVC pipes, were installed in Boreholes 1, 9, 15, 18 and 20 to allow monitoring of the water table;
- 96 no. trial pits at various locations within the site to investigate peat and mineral subsoil lithology;
- In-situ shear vane tests using the Geonor H10 (penetration) Shear Vane were carried out at 25 no. locations;
- A geophysical survey consisting of Ground Resistivity testing was carried out by Minerex Geophysics and a Thermal Resistivity survey was carried out by Irish Drilling Ltd;
- Laboratory testing was carried out on representative soil. Tests include natural moisture content, organic content, Atterberg Limits, Particle Size Distribution and Fall Cone tests;
- Chemical tests consisting of Sulphate & pH were carried out by ALS Laboratories; and,
- ~570 peat probes to determine the depth and geomorphology of the cutover peat at the site which includes the proposed Substation and Grid Connection area.

The Peat Stability Assessment report prepared by ESBI Ltd is included as Appendix 7-1 of this EIAR. The Geology & Ground Conditions Report (ESBI, June 2018) is attached as Appendix 7-2.

7.2.3 Impact Assessment Methodology

Using information from the desk study and data from the site investigation, an estimation of the importance of the land, soil and geological environment within the study area is assessed using the criteria set out in Table 7.1 (NRA, 2005).

Table 7.1. Estimation of Importance of Soil and Geology Criteria (NRA, 2005).

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 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.

The statutory criteria (EPA, 2017, EPA, 2003 and EPA, 2002) 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's (2017) Description 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 7.2.

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 7.3.

Table 7.2. Description of effects.

Impact Characteristic	Degree/ Nature	Description
Type of Effect	Direct	An impact which occurs within the area of the Proposed Project, as a direct result of the Proposed Project.
	Indirect	Impacts on the environment, which are not a direct result of the Proposed Project, often produced away from the Proposed Project site or because of a complex pathway.
Probability	Likely	The effects that can reasonably be expected to occur because of the Proposed Project if all mitigation measures are properly implemented
	Unlikely	The effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.

Table 7.3. Impact descriptors related to the receiving environment.

Significance	Description
Profound	An effect which **obliterates** sensitive characteristics
Very Significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment.
Significant	An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment

Moderate	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
Not significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
Imperceptible	An effect capable of measurement but without significant consequences

7.3 Existing Environment

7.3.1 Site Description and Topography

The Proposed Project is located in northwest Co. Kildare, approximately 6.5km (kilometres) north of the village of Allenwood, 6km east of Carbury and 3km south of Johnstownbridge. The Grid Reference coordinates (Irish National Grid) for the centre of the site are E 275,810 N 235,200. The Timahoe North site comprises the northern half of the Bord na Móna Timahoe bog unit, which forms part of the Allen bog group.

The Proposed Project is located in the townlands of Drehid, Mulgeeth, Mucklon, Ballynamullagh, Kilmurry (Carbury by), Killyon and Timahoe East.

The site topography is predominantly flat, lying at an elevation of approximately 79 mOD to 85mOD. Some small outcrops of higher elevation are located in the surrounding landscape, up to a height of 93 metres O.D.

The Proposed Project is within the Timahoe Bog site as indicated in Figure 4.1. The total site area is approximately 800ha, and the Proposed Project site footprint is approximately 238ha.

As noted previously in Section 7.1.1; the Proposed Project comprises a largescale PV Solar Farm with an export capacity of approximately 70 Megawatts (MW) and an associated Substation and Grid Connection. It will consist of a solar photovoltaic array and associated infrastructure, inverters, a battery storage compound, access roads and parking, site compounds and security fencing, amenity trails and landscaping, peat and material storage areas (repositories), site drainage and all associated works. The Proposed Project will also include the construction of a 110 kV substation within the site. It is then envisaged to connect from this substation to the Derryiron-Maynooth 110 kV overhead line that traverses the southern section of the Timahoe North site.

Land use in the surrounding area (within 1km of site boundary) includes more cutover/cutaway bog to the south and east of the proposed Solar Farm site with the remainder a combination of agriculture, forestry and scattered rural pattern of residential dwellings along the local roads to the east and north of the site. There is also an operational waste management facility at Drehid, located to 880m to the southwest of the Proposed Project boundary.

Peat harvesting ceased at the site in the early 1990's. Some infrastructure still exists on site including decommissioned railway lines and internal drainage system. The vast majority of the site comprises heavily drained cutover raised bog. The high voltage Derryiron to Maynooth 110 kV overhead electricity line crosses the main access route within the site, approximately 500 m from the site entrance.

The bog has large wide man-made drains running in a northwest to southeast direction. There are 11 main drains in total, and these are spaced at ~250m centers. These drains are c3-5m wide and of various depths. There are a number of other, similarly orientated, drains that are discontinued with standing water only. The remains of two raised disused rail line tracks which ran transversely across the bog from the southwest to northeast exist at the site. These previously facilitated a narrow-gauge rail line access to the site during peat production and harvesting.

The bog is bounded to the northwest and north by a tributary of the Fear English River which flows northwards away from the site and joins the Kells Blackwater (Boyne River System). To the south the bog is bounded by open drains that form the Mulgeeth tributary which flows southeast away from the site past Doran Nurseries before heading northeast and north to eventually join the Kells Blackwater.

The drainage and hydrology of the site is described in detail in Chapter 8.

7.3.1 Land Use

The current land use of the Timahoe North Bog would be categorised as peat harvesting as this is the historic land use within the site. Peat extraction has not been carried out by BNM at the site for over 20 years.

The lack of active peat harvesting has allowed the revegetation of large sections of the bog with large areas of birch and pine scrub/woodland in mosaic with dry heath.

Regarding the Solar Farm aspect of the development, given the nature of PV solar arrays, *i.e.* solar panels placed on frames raised above the peat ground level, this form of land use change is considered to be of a lower disruption that other land use changes involving significant ground works footprint, e.g. agricultural land to commercial.

Land use along the grid connection alignment is generally above ground and will have limited footprint at pole and angle mast locations. Excavations will be required for the substation foundations.

7.3.2 Topsoil and Agricultural Capability

The GSI soils map (www.gsi.ie) for the area shows that the entire area of the Proposed Project site is mapped as cutover/cutaway peat (Cut). The peat on the site is described as soft, dark orange/brown/black and fibrous with many rootlets (see PSRA Report in Appendix 7-1).

As expected in a bogland environment, the agricultural capacity of the Proposed Project site is low. In the past, the economic productivity of the site was based on the extraction of peat as a fuel source.

Based on the GSI soils mapping (**www.gsi.ie**)[1] the dominant soil types at the substation site and along the proposed grid connection route is cutover/cutaway peat.

[1] Data checked on 15th November 2018.

7.3.3 Subsoil Geology – Solar Farm

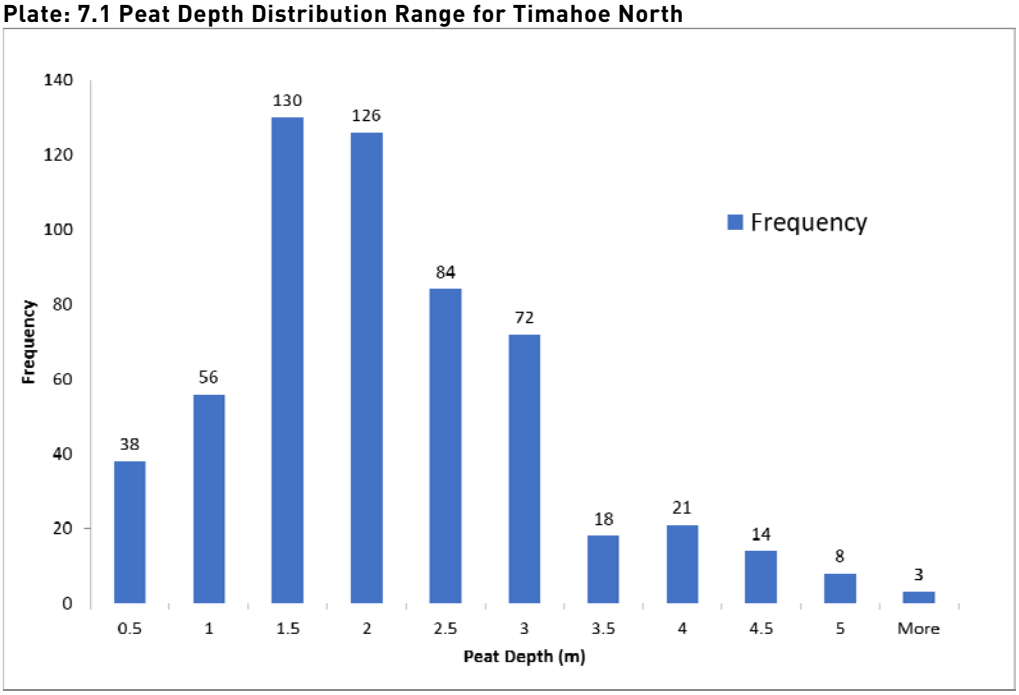
The published subsoils map (**www.epa.ie**)[2] for the area shows that cutaway raised bog is exclusively mapped in the Proposed Project site.

In the wider area outside of the site, and on higher ground, the subsoil type is predominantly mapped as till derived from limestones (TLs). A map of the local subsoil cover is attached as Figure 7.1 (**www.gsi.ie**) and again this shows the site to be entirely covered by cutover peat.

The peat is underlain by glacial deposits interbedded with glacio-fluvial deposits over limestone bedrock. The glacial deposits generally consist of soft to very stiff grey gravelly clay/silt. These deposits are interbedded with gravels and sands within the stratum.

The locations of the peat depths are shown on Figure 7.2 and a peat depth distribution analysis is shown on Plate 7.1 below. The majority of the peat depths (~92%) occur within the 0 – 3.5m range. Only 8% of the estimated peat depths exceeded 3.5m, and these are largely located on the northwestern perimeter of the bog and the centre of the bog where no Solar Farm infrastructure is proposed.

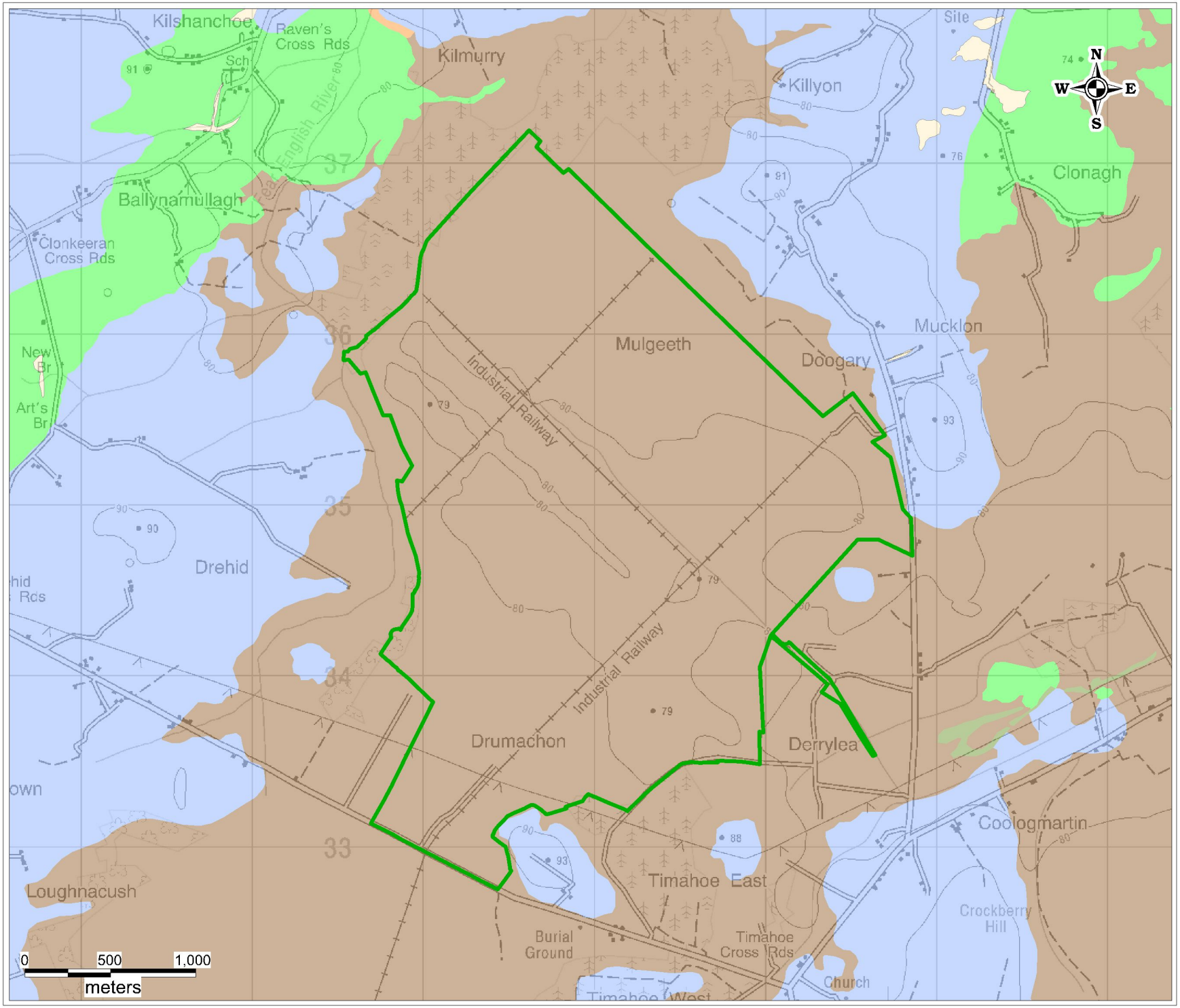
Plate: 7.1 Peat Depth Distribution Range for Timahoe North



A total of approximately 570 no. peat probes were undertaken at the Proposed Project site as part of the investigations. The peat probes were undertaken along the footprint of the Proposed Project (*i.e.* along proposed access roads, the solar array area, substation and grid connection locations, etc.). Information relating to peat depths within the Solar Farm are noted in this section. Further information on peat depths at the Substation and Grid Connection are described further in Section 7.3.4.

Overall peat depths recorded during the peat probing investigation ranged from 0.05 to 5.2mbgl. The peat depth range distribution plot for the proposed infrastructure

[2] Data checked on 15th November 2018.



Legend

- Project Boundary
- Alluvium
- Eskers comprised of gravels of basic reaction
- Cut over raised peat
- Gravels derived from Limestones
- Lacustrine sediments
- Till derived from limestones

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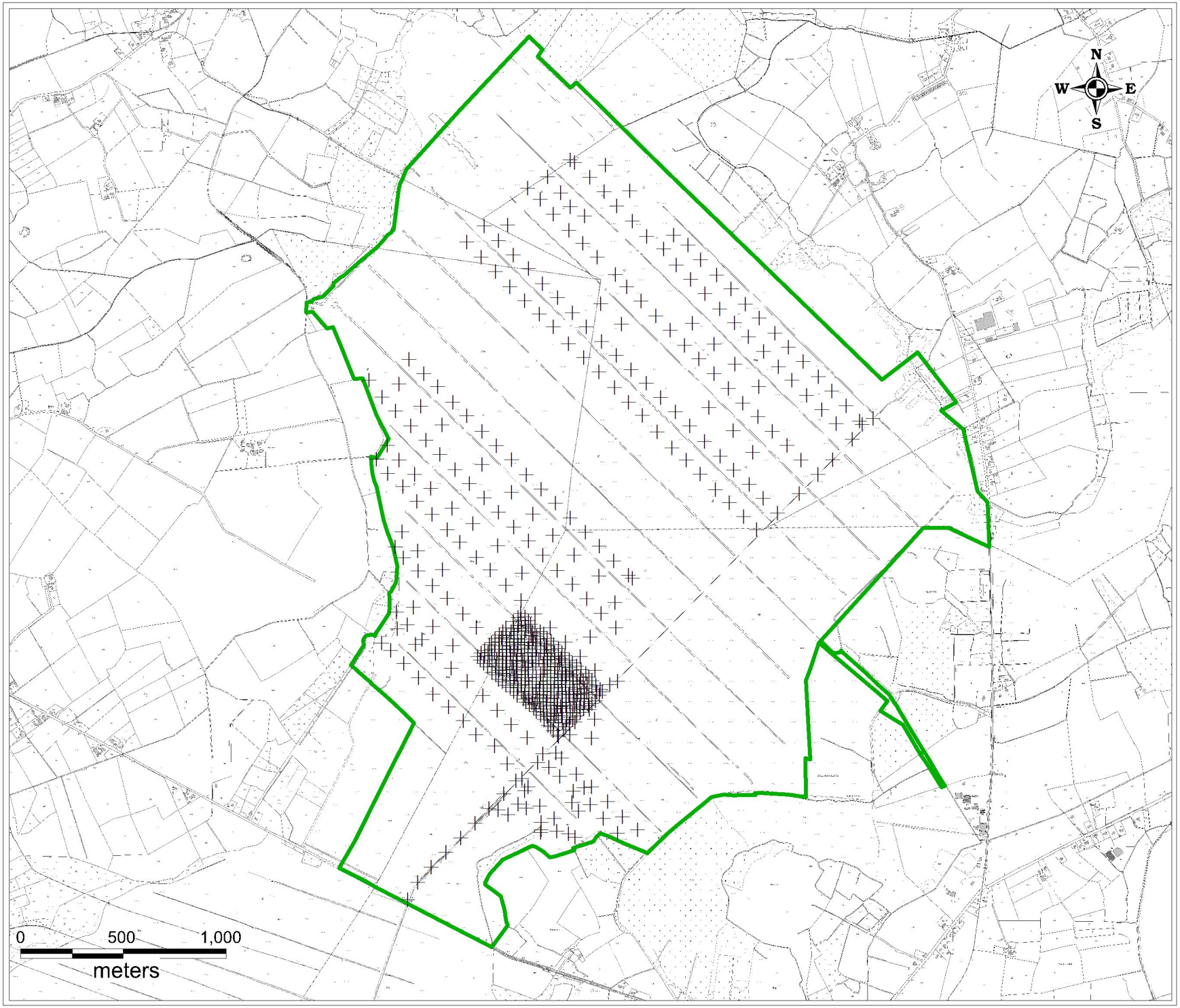
Title: Local Subsoils Cover Map	
Client: McCarthy Keville O'Sullivan	
Job: Timahoe, Co. Kildare	
Project No: P1418-0	
Figure No: 7.1	
Sheet Size: A4	
Drawing No: P1418-0-1218-A4-701-0A	
Date: 03/12/2018	
Scale: 1:30,000	
Drawn By: GD	Checked By: MG



Legend

Project Boundary

Peat Depths Location

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Title: Peat Depth Location Map

Client: McCarthy Keville O'Sullivan

Job: Timahoe, Co. Kildare

Project No: P1418-0

Figure No: 7.2

Sheet Size: A4

Drawing No: P1418-0-1218-A4-702-0A

Date: 03/12/2018

Scale: 1:25,000

Drawn By: GD | Checked By: MG

areas (refer to Plate 7.1) shows that the intervals with highest number of peat depths were 1.5 to 2.0 and 2.0 to 2.5m (~45% of 570 probes).

The peat depths recorded for the northeastern panel area range between 1.0 to 3.5m, and slope angles are all <3°.

The peat depths recorded for the southwestern panel area range between 1.0 to 4.0m, and slope angles are all <3°.

Peat depths recorded along proposed access roads and cable routes are also between 1.0 to 3.5m, and slope angles are all <3°.

Peat depths recorded at proposed peat repositories range between 0.50 to 4.0m, and slope angles are all <3°.

Trial pits (generally between 4m and 5m in depth) and boreholes (generally between 6 and 12m in depth) were undertaken to determine the geology below the peat (Irish Drilling Ltd, May 2018). Generally, the trial pits and boreholes encountered very soft brown peat over a thin layer of green/grey slightly sandy calcareous silt, over grey Glacial Till of varying consistency. The peat is generally very soft to soft and fibrous and tends to become woody with increasing depth. The Glacial Till consists of grey, firm to stiff and frequently soft to firm (and sticky) slightly gravelly, slightly sandy clay, with cobbles. Towards the northern area of the site, the Till grades into a very stiff to hard 'cemented' Till. There were some layers of sand and silts recorded in the glacial till deposits.

7.3.4 Soils and Subsoils – Substation and Grid Connection

The published subsoils map (**www.epa.ie**)[3] for the area shows that cutaway raised bog is exclusively mapped in the area of the Substation and Grid Connection.

The peat depths at the proposed substation location range between 0.5 to 3.0m, and ground slopes are <3°. Subsoils geology generally comprises silt/clay over gravels, and drilling refusals on hard strata and possible rock occurred between 5.2 to 7.2 mbgl.

The peat depths along the proposed grid connection route range between 0.5m and 3.0m, and locally up to 4.5m. Subsoils geology generally comprises silt over gravels, and drilling refusals on hard strata and possible rock occurred between 8.6 and 10.3 mbgl.

Based on the available site investigation data summarised within the Geology and Ground Conditions Report in Appendix 7-2 (ESBI, June 2018), the peat at the substation is underlain by glacial deposits interbedded with glacio-fluvial deposits over probable limestone bedrock. The glacial deposits consist of soft to very stiff grey gravelly clay/silt. These deposits are interbedded with gravels and sands within the stratum, with gravels generally occurring at depth and probably just above the underlying bedrock.

7.3.5 Bedrock Geology

Based on the GSI bedrock map of the area, the Proposed Project site is underlain by two different bedrock formations. The northern and western sections of the proposed

[3] Data checked on 15th November 2018.

site are mapped to be underlain by Dinantian Upper Impure Limestones (DUIL) (Dark Limestone and Shale, *i.e.* Calp Limestone) and the southern and eastern sections are underlain by Dinantian Pure Unbedded Limestones (DPUL) (Waulsortian Limestone). Based on available mapping the majority of the proposed site and solar arrays is mapped as being underlain by Calp Limestone, and the Substation and Grid Connection area is mapped as being underlain by Waulsortian Limestone.

There are no mapped faults intersecting the site, however a number of faults exist 6 – 10km to the south of the site.

Based on drilling completed at the site, which is summarised in Appendix 7-2, it appears that depths to bedrock are >7mbgl, and drilling returns confirms limestone below the till deposits at the site.

A bedrock geology map of the area is attached as Figure 7.3.

7.3.6 Unplanned Events/Geohazards

The Proposed Project site at Timahoe North for the Solar Farm aspects of the development is underlain by limestone bedrock. There are no known or evident karst solution features at the Proposed Project site.

It is considered that the area around the application site, including the grid connection and substation elements, has low landslide susceptibility (National Landslide Susceptibility Mapping, 2013). This classification takes into account the site's slope, soil type and concentration/dispersion of overland flow. No historic landslides are identified in the surrounding area by the Irish Landslides Working Group (GSI, July 2006).

Two recorded landslides have occurred within proximity of the Proposed Project site, both of which were related to canal embankment construction. As detailed in ESBI PSRA (Appendix 7-1), the slides occurred at Derrymullen and Edenderry.

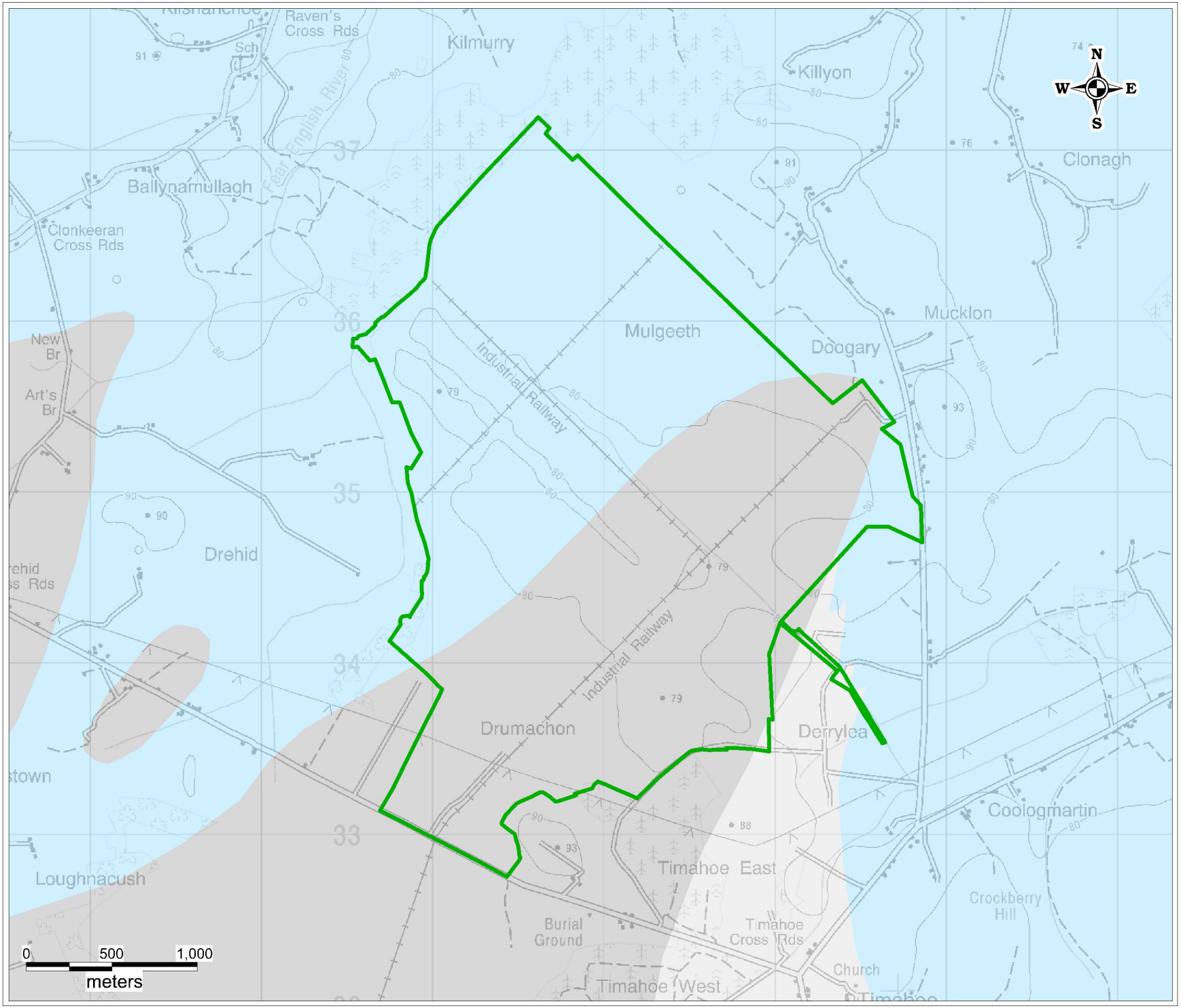
The details provided for these landslides are:

- Derrymullen: The GSI database shows that a landslide occurred at Derrymullen, approximately 7.5km south of the Drehid cluster boundary. This was a landslide that occurred in peat bog adjacent to the Grand Canal in 1839.
- Edenderry: The GSI database shows that a peat landslide took place approximately 13km west of the proposed Solar Farm site in 1916 following a period of heavy rain and flooding. The 270m long slide occurred on the north bank of the Grand Canal with no apparent impact. A breach occurred again in 1989.

7.3.7 Geological Resource Importance

The limestone bedrock underlying the site is classified as "low" importance. The bedrock could be used on a "sub-economic" local scale for construction purposes. The bedrock has not been used in the past at the site for this purpose and is unlikely to be accessible due to the overlying peat and till cover.

The overlying peat deposits at the site is classified as "Low" importance as the peat is not designated in this area and is significantly degraded/drained in most places at the site as a result of industrial peat production/extraction and drainage. The peat is also a low fertility soil, and of little agricultural benefit.



Legend

- Project Boundary
- Dinantian Pure Bedded Limestones
- Dinantian Pure Unbedded Limestones
- Dinantian Upper Impure Limestones

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Scale: 1:30,000
Drawn By: GD | Checked By: MG

7.3.8 Geological Heritage and Designated Sites

There are no recorded Geological Heritage sites, mineral deposit sites or mining sites (current or historic) within the Proposed Project area.

Within the Republic of Ireland designated sites include National Heritage Areas (NHAs), Proposed National Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs).

There are no designated sites within the Proposed Project site for the Solar Farm, nor for the Substation and Grid Connections elements of the development. Furthermore, there are no designated sites of relevance to this hydrological / hydrogeological assessment as all designated sites are sufficiently remote from the Proposed Project site to state with confidence that they are hydrogeologically disconnected from the Proposed Project site.

7.3.9 Peat Stability Assessment

This section summarises the report on assessment of peat stability undertaken by ESBI (February 2018) for the proposed Solar Farm and related infrastructure, including the Substation and Grid Connection elements. The peat stability assessment report is included as Appendix 7-1 of this EIAR.

Timahoe North site is a cut over peat bog which has been out of commercial use for over 20 years. The site is overlain with cut over bog. The depth of peat across the site varies from 0.05 m to 5.2m in certain local areas. The mean peat depths determined from 570 peat probes is ~1.9m.

The ground conditions across the site consists of peat (0.05 to 5.2m) over glacial deposits interbedded with glacio-fluvial deposits over limestone bedrock. The peat across the site has been harvested resulting in residual peat depth varying between 0.05 – 5.2mbgl. The peat on the site is described as soft, dark orange/brown/black and fibrous with many rootlets which extend into the subsoil layer on occasion. The glacial deposits generally consist of soft to very stiff grey gravelly clay/silt. These deposits are interbedded with gravels and sands within the stratum. These are generally over consolidated strata. The consistency of these strata typically tends to improve with depth. Shear vane data recorded at the site (within the peat deposits) ranged between 3 and 47 kPa (mean: 8.5 kPa).

The completed PSRA has been carried out in accordance with the best practice guidelines for peat landslide risk assessments published by the Scottish Government Energy Consents Unit in the report "Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition, April 2017)", and is supplemented by the experiences of ESB International on previously developed sites.

Information on the ground conditions, topography, hydrology, ecology, land use and other factors were used to determine the likelihood of peat failure at each location analysed. The impact of a potential peat slide was also considered. The likelihood and impact of a peat failure at different areas of the site were combined to form the risk. The results of the PSRA at 49 locations (29 invertors, 7 peat repositories, 9 overhead line structure locations, the substation, site compound, temporary site compound, and the remainder of the site) within the Proposed Project site indicate that the peat stability risk rating across the site is low.

The peat risk has been minimised by optimising the design of the Solar Farm and will be further mitigated by choosing a safe and controlled construction methodology, having a rigorous documentation and quality control system during construction and by controlling construction activities carefully.

In summary, the findings of the PSRA, which involved analysis of over 49 no. locations, have shown that there is a low risk of peat instability at the Proposed Project site (Solar Farm and Substation and Grid Connection works areas) in the absence of mitigation measures. This risk has been minimised by optimising the design of the Proposed Project. The implementation of mitigation measures during the detailed design and construction stages of the Proposed Project will further reduce the risk rating of peat instability across the site. The flat topography and the drained nature of the terrain on site are critical factors for the low risk of peat failure determined for the Proposed Project.

7.4 Characteristics of the Proposed Project

The Proposed Project is described in 2 no. different components based on the nature of that aspect of the development. These components are as follows:

- PV Solar Farm and associated infrastructure; and,
- The Substation and Grid Connection.

The construction of the PV Solar Farm and associated infrastructure will involve removal of vegetation initially and then peat and subsoils for access roads, internal access road networks, internal cable network, inverter hardstandings, site compounds etc. Aggregate for construction work will be sourced off site and transported to the site by road.

The construction process will include the following:

- Tree felling & vegetation clearance;
- Construction of site entrances, upgrade of existing access track and construction of new access tracks throughout site;
- Establishing temporary site facilities including site offices, car parking, construction laydown and storage areas;
- Two temporary compounds/laydown areas;
- Earthworks and drainage for the provision of solar panel access, invertor pads and the Substation;
- Insert piles to support framework for solar panels;
- Reinstatement of cable trenches and track edges;
- Works to facilitate delivery of solar panels and frames to site;
- Erection of frames and fitting of solar panels;
- Installation of underground cabling from each invertor to the 110 kV Substation;
- Installation of battery storage compound;
- Deer fencing which will be erected around the perimeter of the site for safety and security;
- Erect infra-red activated security cameras;
- Access track leading to the electrical substation; and,
- Construction of amenity proposals including walkways and carpark.

Further to the above, the following will also be undertaken:

- Excavation of peat and subsoils from 110kV substation area and aggregate up fill to proposed levels;
- Construction of 110kV substation and surrounding infrastructure; and,
- Connection to existing 110kV line within the site.

Peat excavation for various components of the development is estimated to be 63,400m^3 of which approximately 25,000m^3 of this will be from the proposed substation area.

In terms of peat handling and long-term storage, it is proposed to place excavated peat and material into 7 no. proposed peat repositories, and the total volume of these is 95,126m^3. Bord na Móna has considerable experience in this area (moving and storing peat), both during peat production operations and during the rehabilitation processes associated with its cutaway bogs. This experience has shown that the most environmentally sensitive and stable way of handling and movement of excavated peat is its placement across the site and at locations as close as possible to the intended extraction/excavation areas. As such, the proposed peat repositories are distributed across the site, at suitable locations as close as possible to the main intended excavation as shown on Figure 4.1.

The proposed substation will require earthworks for site preparation. As set out above, this includes the removal of 25,000m^3 of peat from the construction footprint, and the importation of rock fill for site levelling (excavate and replace method). Works will also include the installation of surface water drainage pipework and an 18m^3 foul water holding tank.

For the control buildings, excavation of foundations and the pouring of concrete will be required. The specific detail on the proposed substation are described in Chapter 4.

7.4.1 Characteristics of the proposed Substation and Grid Connection

Construction of the proposed grid connection involves overhead lines electrical works from the existing 110kV line running through the Proposed Project site to the new substation.

The proposed 110kV line will be constructed of double wood polesets at intermediate locations and galvanised steel lattice towers at angle positions going towards the sub-station. This style of construction is the standard type of construction used for 110kV single circuit lines in Ireland. Double wood polesets are used for all straight-structures, angle towers are only used where the line changes direction.

The polesets are installed using an excavator into an open hole, and stay wires are included if necessary. The hole is backfilled once the poles are in the correct position. After excavation and erection of the poleset a further excavation 0.8m deep is necessary. This is a linear excavation perpendicular to the line necessary to install wooden sleepers. These sleepers add additional stability to the poleset and are attached to the poleset using a u-bolt. An earthgrid is installed at each poleset.

Stay wires (if used) add stability to the pole and are supported by means of stayblocks. These stayblocks are made of concrete and are buried underground.

The steel lattice towers will be set out and pegged prior to foundation excavation. Excavations are set out specifically for the type of tower and the type of foundation required for each specific site. A larger footing may be required in the case of weak

soils, pile foundations may be required in the case of deep bog, this will be decided at detailed design stage. The tower stubs (lower part of tower leg) will be concreted into the ground, and the steel lattice is constructed once the foundation is in place.

7.5 Proposed Project Impact Assessment

7.5.1 Do Nothing Scenario – the Baseline

7.5.1.1 Do Nothing Scenario - PV Solar Farm and Substation and Grid Connection

If the Proposed Project is not constructed, the current vegetation cover will continue to grow in its current manner, and perimeter third party peat cutting will continue.

Without the immediate need for vegetation removal, the existing vegetation would continue in its current state. Therefore, if the Proposed Project was not developed, the site will continue to function as it does at present, with no changes made to the current land-use which includes naturally developing woodland, existing peatland and turf cutting on the spread. The site is also used as an informal site for members of the public for walking.

7.5.2 Likely Significant Effects and Mitigation Measures – Construction Phase

The likely significant effects of the Proposed Project and mitigation measures that will be put in place during the construction phase to eliminate or reduce them are shown below. The assessment addresses the relevant aspects of the Proposed Project with the potential to cause effects on land. soils and geology and concludes of the potential significance of the effects of the entire project.

7.5.2.1 Topsoil/Peat and Subsoil Excavation – Solar Farm

Excavation of peat and subsoil will be required during construction for the installation of the Solar Farm, foundations for the access roads, invertor hardstand areas, battery storage area and internal cable networks. This will result in a permanent removal of vegetation, peat and subsoil at most excavation locations, but some reinstatement will also be completed (e.g. within cable trenches). Estimated volumes of peat and subsoils to be relocated are set out above in Section 7.4. In general, excavation of peat associated with the amenity proposals will not be required.

Mechanism: Excavation.
Receptor: Peat and subsoil.
Potential Impact: Negative, slight/moderate, direct, likely, permanent effect on peat and subsoil.

7.5.2.1.1 Proposed Mitigation Measures – Solar Farm

- Placement of project infrastructure that require excavation in areas with shallower peat where possible (mitigation by avoidance);
- The peat and subsoil which will be removed during the construction phase will be localised to the infrastructure footprint location and access roads;
- The absence of designated sites, such as NHAs and SACs, within the Proposed Project site ensures no impacts to the land, soil or geology within a designated site as a result of the Proposed Project;
- A minimal volume of peat and subsoil will be removed to allow for infrastructural work to take place in comparison to the total volume present on the site due to optimisation of the layout by mitigation by design;
- Excavated peat will only be moved short distances from the point of excavation to peat and soil repositories within the site;

- Stockpiling of materials and the parking of plant on peat will be avoided;
- Tracking machinery on peat will be minimised, and bog mats will be used where required;
- Low bearing pressure machines will be used;
- The length of unsupported excavations in peat will be minimised;
- Side slopes of cuttings in peat will be trimmed back to stable permanent side slopes. In soft potentially unstable peat a berm of mineral soil will be constructed across the top of the cutting slopes to support the peat face;
- No work will be carried out down slope of a peat excavation at any time;
- Water build up in excavations will be avoided, either through backfilling or pumping to suitable surface water features for treatment;
- Peat excavations will not be left unsupported for extended periods or overnight;
- Vibrating rollers will not be used on site (dead weight permitted);
- Stringlines with posts at 10m centres downslope of works in deep peat areas will be installed prior to commencement of construction and remain in place for the duration of the works to monitor for any potential movements;
- Upslope cut-off drains will be installed in advance of construction;
- The existing drainage patterns in the peat will be maintained as far as is practicable;
- There will be no uncontrolled discharges of water onto peat. All site water will be managed within the site drainage system;
- Construction of any required settlement ponds will be volume neutral, and all excess material will be used locally to form pond boundary bunds, and excess material will be used locally for surrounding landscaping;
- The granular soil at the site can be classified as of "Medium" importance; and,
- The peat deposits at the site are classified as of "Low" importance as the raised bog is already degraded by harvesting and drainage.

7.5.2.1.2 Residual Impact

Negative, direct, slight, likely, permanent effect on peat and subsoils.

7.5.2.1.3 Significance of Effects

No significant effects on soils and subsoils are anticipated.

7.5.2.2 Topsoil/Peat and Subsoil Excavation – Substation and Grid Connection

Excavation of topsoil, peat or otherwise, and subsoil will be required during construction of the substation and the associated grid connection, particularly for site levelling and the installation of stable building foundations, and anglemasts and pole and steel lattice tower foundations. Estimated volumes of peat and subsoils to be relocated are set out above.

Mechanism: Extraction/excavation.
Receptor: Peat and subsoil.
Potential Impact: Negative, slight/moderate, direct, likely, permanent effect on peat and subsoil.

7.5.2.2.1 Proposed Mitigation Measures – Substation and Grid Connection

- The peat and subsoil which will be removed during the construction phase will be localised to the infrastructure footprint location of the substation and access tracks and foundation locations for the grid connection;

- A minimal volume of peat and subsoil will be removed to allow for infrastructural work to take place in comparison to the total volume present on the site due to optimisation of the layout of the substation buildings, *i.e.* mitigation by design;
- Excavated peat will only be moved short distances from the point of excavation to peat and soil repositories within the site;
- Stockpiling of materials and the parking of plant on peat will be avoided;
- Tracking machinery on peat will be minimised, and bog mats will be used where required;
- Low bearing pressure machines will be used;
- The length of unsupported excavations in peat will be minimised.
- Side slopes of cuttings in peat will be trimmed back to stable permanent side slopes. In soft potentially unstable peat a berm of mineral soil will be constructed across the top of the cutting slopes to support the peat face.
- No work will be carried out down slope of a peat excavation at any time;
- Water build up in excavations will be avoided, either through backfilling or pumping to suitable surface water features for treatment;
- Peat excavations will not be left unsupported for extended periods or overnight;
- Vibrating rollers will not be used on site (dead weight permitted);
- Upslope cut-off drains will be installed in advance of construction;
- The existing drainage patterns in the peat will be maintained as far as is practicable;
- There will be no uncontrolled discharges of water onto peat. All site water will be managed within the site drainage system;
- Construction of any required settlement ponds will be volume neutral, and all excess material will be used locally to form pond boundary bunds and for surrounding landscaping; and,
- The absence of designated sites, such as NHAs and SACs, within close proximity to the substation ensures no impacts to the land, soil or geology within a designated site as a result of the Proposed Project.

7.5.2.2.2 Residual Impact

Negative, direct, slight, likely, permanent effect on peat and subsoils at the Substation and Grid Connection works area.

7.5.2.2.3 Significance of Effects

No significant effects on soils and subsoils are anticipated.

7.5.2.3 Topsoil/Peat and Subsoil Excavation – Proposed Project

Excavation of peat and subsoil will be required during construction for the installation of the Solar Farm, foundations for the access roads, invertor hardstand areas, battery storage area and internal cable networks, and during construction of the substation and the associated grid connection, particularly for site levelling and the installation of stable building foundations, and angle masts and pole and steel lattice tower foundations. This will result in a permanent removal of peat and subsoil at most excavation locations, but some reinstatement will also be completed (e.g. within cable trenches). Estimated volumes of peat and subsoils to be relocated are set out above. In general, excavation of peat associated with the amenity proposals will not be required.

Mechanism: Excavation.
Receptor: Peat and subsoil.

Potential Impact: Negative, slight/moderate, direct, likely, permanent effect on peat and subsoil.

7.5.2.3.1 Proposed Mitigation Measures

- Placement of project infrastructure that require excavation in areas with shallower peat where possible (mitigation by avoidance);
- The peat and subsoil which will be removed during the construction phase will be localised to the infrastructure footprint location and access roads;
- The absence of designated sites, such as NHAs and SACs, within the Proposed Project site ensures no impacts to the land, soil or geology within a designated site as a result of the Proposed Project;
- A minimal volume of peat and subsoil will be removed to allow for infrastructural work to take place in comparison to the total volume present on the site due to optimisation of the layout by mitigation by design;
- Excavated peat will only be moved short distances from the point of excavation to peat and soil repositories within the site;
- Stockpiling of materials and the parking of plant on peat will be avoided;
- Tracking machinery on peat will be minimised, and bog mats will be used where required;
- Low bearing pressure machines will be used;
- The length of unsupported excavations in peat will be minimised;
- Side slopes of cuttings in peat will be trimmed back to stable permanent side slopes. In soft potentially unstable peat a berm of mineral soil will be constructed across the top of the cutting slopes to support the peat face;
- No work will be carried out down slope of a peat excavation at any time;
- Water build up in excavations will be avoided, either through backfilling or pumping to suitable surface water features for treatment;
- Peat excavations will not be left unsupported for extended periods or overnight;
- Vibrating rollers will not be used on site (dead weight permitted);
- Stringlines with posts at 10m centres downslope of works in deep peat areas will be installed prior to commencement of construction and remain in place for the duration of the works to monitor for any potential movements;
- Upslope cut-off drains will be installed in advance of construction;
- The existing drainage patterns in the peat will be maintained as far as is practicable;
- There will be no uncontrolled discharges of water onto peat. All site water will be managed within the site drainage system;
- Construction of any required settlement ponds will be volume neutral, and all excess material will be used locally to form pond boundary bunds, and for surrounding landscaping;
- The granular soil at the site can be classified as of "Medium" importance; and,
- The peat deposits at the site could be classified as of "Low" importance as the raised bog is already degraded by harvesting and drainage.

7.5.2.3.2 Residual Impact

Negative, direct, slight, likely, permanent effect on peat and subsoils.

7.5.2.3.3 Significance of Effects

No significant effects on soils and subsoils are anticipated.

7.5.2.4 Peat Instability and Failure – Proposed Project

As there is no separable difference between the various elements of the Proposed Project, for clarity, we have assessed the PV Solar Farm and associated infrastructure, the Substation and Grid Connection, and the Proposed Project in its entirety.

Peat instability or failure refers to a significant mass movement of a body of peat that would have an adverse impact on the proposed Solar Farm development and the surrounding environment. The consequence of peat failure at the study area may result in:

- Death or injury to site personnel;
- Damage to machinery;
- Damage or loss of infrastructure;
- Drainage disruption;
- Site works damage or instability;
- Contamination of watercourses, water supplies by particulates;
- Degradation of the peat environment.

Mechanism: Vehicle movement and excavations.
Receptor: Peat and subsoils.
Potential Impact: Direct, negative, significant, unlikely effect on peat and subsoils.

The findings of the PSRA, which involved analysis of over 49 no. locations pertaining to all elements of the development including the PV Solar Farm and associated infrastructure and the Substation and Grid Connection, have shown that there is a low risk of peat instability at the Proposed Project site in the absence of mitigation measures. This risk has been minimised by optimising the design. The implementation of mitigation measures during the detailed design and construction stages of the Proposed Project will further reduce the risk rating of peat instability across the site. The flat topography and the drained nature of the terrain on site are critical factors for the low risk of peat failure determined for the Proposed Project.

Please refer to the ESBI PSRA (Appendix 7-1) for proposed specific peat stability mitigation measures.

7.5.2.4.1 Residual Impacts

There are no significant residual effects anticipated on the soils and geological environment.

7.5.2.4.2 Significance of Effects

No significant effects on soils and subsoils are anticipated.

7.5.2.5 Contamination of Soil by Leakages and Spillages and Alteration of Peat/Soil Geochemistry – Proposed Project

As there is no separable difference between the various elements of the Proposed Project, for clarity, we have assessed the PV Solar Farm and associated infrastructure, the Substation and Grid Connection, and the Proposed Project in its entirety.

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk. The accumulation of spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the

environment. Large spills or leaks have the potential to result in significant effects on the geological and water environment.

Pathway: Topsoil/peat and subsoil pore space.
Receptor: Topsoil/peat and subsoil.
Potential Impact: Negative, direct, slight, short term, unlikely effect on peat and subsoils.

7.5.2.5.1 Proposed Mitigation Measures

- Minimum maintenance of construction vehicles and plant will take place on site during the removal of vegetation, with the majority occurring offsite;
- On site re-fuelling will be undertaken using a double skinned bowser with spill kits on the ready for accidental leakages or spillages;
- Fuels stored on site will be minimised. Storage areas where required will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor;
- The electrical control building will be bunded appropriately to the volume of oils likely to be stored, and to prevent leakage of any associated chemicals and to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan. Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

7.5.2.5.2 Residual Impact

Negative, Imperceptible, direct, short term, unlikely effect.

7.5.2.5.3 Significance of Effects

No significant effects on soils and subsoils are anticipated.

7.5.2.6 Vegetation Removal

As there is no separable difference between the various elements of the Proposed Project, for clarity, we have assessed the PV Solar Farm and associated infrastructure, the Substation and Grid Connection, and the Proposed Project in its entirety.

Excavation of topsoil, peat, subsoil or otherwise will not be required during vegetation removal. However, some topsoil is expected to be extracted where it is integrated with the surface vegetation. Tree roots will remain in-situ. The topsoil affected by the vegetation removal is peat as the vegetation is located within Timahoe Bog.

Mechanism: Excavation
Receptor: Peat
Potential Impact: Negative, slight/moderate, direct, likely, permanent effect on topsoil/peat and subsoil.

7.5.2.6.1 Proposed Mitigation Measures

- Minimisation of the site footprint and hence, amount of vegetation clearing required will be undertaken;
- Extracted/excavated peat will only be moved short distances from the point of excavation to peat and peat repositories within the site;
- Stockpiling of materials and the parking of plant on peat will be avoided;
- Tracking machinery on peat will be minimised, and bog mats will be used where required;
- Low bearing pressure machines will be used; and,
- The existing drainage patterns in the peat will be maintained as far as is practicable.

7.5.2.6.2 Residual Impact

Negative, direct, slight, likely, permanent effect on topsoil/peat and subsoil for the Solar Farm and the Substation and Grid Connection works.

7.5.2.6.3 Significance of Effects

No significant effects on soils and subsoils are anticipated.

7.5.3 Likely and Significant Effects – Operational Phase

There will be no requirement for significant excavation of peat and subsoils during the operational phase nor will there be any requirement to store significant volumes of potentially polluting substances and therefore no significant effects on the land, soils and geology are anticipated.

7.5.4 Decommissioning Phase

There will be no requirement for significant excavation of peat and subsoils during the decommissioning phase and therefore no significant effects on the land, soils and geology are anticipated.

The substation will remain in-situ after decommissioning as it will be part of the national network.

7.5.5 Assessment of Effects – Proposed Project

The assessment of the Proposed Project components including the Solar Farm and Substation and Grid Connection works during the construction, operational and decommissioning phases has shown that the residual impacts are generally no more than negative, slight and direct effects on peat and subsoils. The Proposed Project, once constructed in accordance with the design and mitigation measures outlined in the EIAR will not have any significant residual effects on land, soils and geology.

7.5.6 Human Health Effects

Potential health effects arise mainly through the potential for soil and ground contamination. A Solar Farm and Substation and Grid Connection are 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 Project and will be handled and stored in accordance with best practice mitigation measures. The potential residual impacts associated with soil or ground contamination and subsequent health effects are negligible.

7.5.7 Cumulative Impacts

We have reviewed and assessed (from a land, soils and geology perspective) other existing local developments including:

- Turf cutting
- Drehid Waste Management Facility
- Other solar developments within 5km of the site

Due to the localised nature of the proposed construction works which will be kept within the Proposed Project boundary, there is no potential for significant cumulative effects on land, soils and geology in-combination other local developments. The construction of the Solar Farm and the Substation and Grid Connection and all associated site infrastructure will only require relatively localised excavation works the output of which will be retained onsite and therefore will not contribute to any significant cumulative effects on geology.

7.5.8 Conclusion

The baseline site geology for the Proposed Project has been characterised using significant quantity of site investigation data.

Peat depths at the site range between 0.05 to 5.2m. The peat is underlain by glacial deposits interbedded with glacio-fluvial deposits over limestone bedrock. The glacial deposits generally consist of soft to very stiff grey gravelly clay/silt. These deposits are interbedded with gravels and sands within the stratum.

The Proposed Project will consist of a solar photovoltaic array and associated infrastructure, inverters, battery storage compound, access roads and parking, site compounds and security fencing, amenity trails and landscaping, peat and material storage areas (repositories), site drainage and all associated works, including a substation and grid connection works. All proposed construction works will be at or within a couple of metres (*i.e.* shallow earthworks) of existing ground surface.

Estimated volumes of peat to be excavated are 63,400m^3. Excavated peat will also be used for any required reinstatement and landscaping works as close to the excavation point as possible, and residual material will be placed in peat repositories.

Storage and handling of hydrocarbons/chemicals will be carried out using best practice methods. Measures to prevent peat and subsoil erosion during excavation, and reinstatement will be undertaken to prevent water quality impacts.

No significant effects on the land, soil and geology of the site will occur. A peat stability assessment undertaken for the Proposed Project demonstrates that the risk of peat failure is low. A number of control measures are given in the ESBI peat stability assessment to manage all risks associated with peat instability.

There will be no cumulative impacts on the land, soils and geology environment as a result of the Proposed Project.