

Appendix 7-2

Geology and Ground Condition Report



INTERNATIONAL

Timahoe North Solar Farm

ESB Wind Development Ltd and Bord na Móna
Powergen Ltd

Geology and Ground Conditions Information

Document No.: QS-000218-01-R460-003

Date: December 2018

ESB International, One Dublin Airport Central, Dublin Airport, Cloghran, Co. Dublin, K67 XF72, Ireland.

Phone +353 (0)1 703 8000

www.esbinternational.ie

File Reference:	QS-000218-01	
Client Recipient:	/ ESB Wind Development Ltd and Bord na Móna Powergen Ltd	
Project Title:	Timahoe North Solar Farm	
Report Title:	Geology and Ground Conditions Information	
Report No.:	QS-000218-01-R460-003	
Revision No.:	3	
Prepared by:	Ronan Canavan	Date: 6/12/2018
Title:	Senior Geotechnical Engineer	
Verified by:	Susan Stack	Date: 6/12/2018
Title:	Senior Geotechnical Engineer	
Approved by:	Michael Brides	Date: 6/12/2018
Title:	Senior Team Leader	

Copyright © ESB International Limited

All rights reserved. No part of this work may be modified, reproduced or copied in any form or by any means - graphic, electronic or mechanical, including photocopying, recording, taping or used for any purpose other than its designated purpose, without the written permission of ESBI Engineering & Facility Management Ltd., trading as ESB International.

Template Used: T-020-007-ESBI Report Template

Issue Sheet

Date	New Revision	Author	Summary of Change
February 2018	0	RC	First issue for information.
June 2018	1	RC	Minor changes to summary and final SI report reference issued.
August 2018	2	RC	Client name changed.
December 2018	3	RC	Front page and section 1.2 updated.

Executive Summary

The Timahoe North site is a cut over peat bog which has been out of commercial use for approximately 40 years. The proposed development site is located in north County Kildare, approximately 6.5 km (kilometres) north of the village of Allenwood, 6 km east of Carbury and 3 km 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 development comprises an application for planning permission for the development of a large scale solar PV farm with a capacity of approximately 70 Megawatts (MW). It will consist of a solar photovoltaic array and associated infrastructure, inverters, access roads and parking, site compounds and security fencing, amenity trails and landscaping, peat and spoil storage areas, site drainage and all associated works. The proposed development will also include the construction of a 110 kV substation within the site with a 20 MW battery storage compound adjacent this. 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 site is mainly overlain with cut over bog. The depth of peat across the site varies from less than 1 m to more than 5 m in certain areas.

Published geological mapping from the Geological Survey of Ireland (GSI) shows the underlying bedrock at the majority of the solar farm location comprises viséan limestone described as dark limestone and shale (calp) of the Lucan formation. A section of the southern end of the site comprises tournaisian waulsortian limestone. There are no known mapped faults on the site.

The entire site is located within the River Boyne catchment. There is a single watercourse located within the overall Timahoe North site. In addition, there are a number of nearby watercourses located in close proximity to the site boundary. A drinking water protection area is located close to the site.

There are 2 historic landslides located at Derrymullen and Edenderry at distances of 7.5 km and 13 km respectively. It is understood both have anthropogenic origins given that they both appear to relate to canal construction.

An extensive preliminary ground investigation comprising trial pits, boreholes, shear vanes and peat probing was carried out at the Timahoe North site between 2017 and 2018 by Irish Drilling Ltd. The ground conditions across the Timahoe North Solar Farm site generally consists of peat over glacial deposits interbedded with glacio-fluvial deposits over possible bedrock. 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. Bedrock was not proven during the Irish Drilling Ltd ground investigation.

Contents

Executive Summary	ii
1 Introduction	1
1.1 Timahoe North Solar Farm	1
1.2 Scope of Report	1
2 Desktop Study	2
2.1 Site Location	2
2.2 Topography	2
2.3 Geology	3
2.4 Hydrology	5
2.5 Land Use	7
2.6 Bog Workings	7
2.7 Landslide Database	8
2.8 Desktop Information Sources	8
3 Historic and Recent Ground Investigations	10
3.1 Irish Drilling Ltd - Timahoe North Solar Farm Site Investigation Factual Report May 2018	10
3.2 Priority Geotechnical - Timahoe North Preliminary Geotechnical and Environmental Ground investigation Draft Factual Report 2010	11
4 Conclusions	12

Tables

Table 3-1 Summary of Ground conditions 10

Figures

Figure 2-1 Timahoe North Solar Farm Site Location (Google Maps)	2
Figure 2-2 Ordnance Survey Map of Timahoe North Solar Farm Site (OSI) .	3
Figure 2-3 Bedrock Geology at Timahoe Site (GSI)	4
Figure 2-4 Quaternary Mapping for Timahoe North (GSI)	5
Figure 2-5 Timahoe North Catchments	6
Figure 2-6 Protected Groundwater Source close to Timahoe North Site (shown in green)	7
Figure 2-7 Landslide Susceptibility Map	8

1 Introduction

1.1 Timahoe North Solar Farm

Timahoe North site is a cut over peat bog which has been out of commercial use for approximately 40 years. The proposed development site is located in north County Kildare, approximately 6.5 km (kilometres) north of the village of Allenwood, 6 km east of Carbury and 3 km 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 development comprises an application for planning permission for the development of a large scale solar PV farm with a capacity of approximately 70 Megawatts (MW). It will consist of a solar photovoltaic array and associated infrastructure, inverters, access roads and parking, site compounds and security fencing, amenity trails and landscaping, peat and spoil storage areas, site drainage and all associated works. The proposed development will also include the construction of a 110 kV substation within the site with a 20MW battery storage compound adjacent this. 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 Timahoe North Solar project is being developed as a joint venture between ESB Wind Development Ltd and Bord na Móna Powergen Ltd.

The site is mainly overlain with cut over bog. The depth of peat across the site varies from less than 1 m to more than 5 m in certain areas.

1.2 Scope of Report

ESB International were engaged by ESB Wind Development Ltd and Bord na Móna Powergen Ltd to undertake a report to summarise known information in relation to geology and ground conditions. The purpose of this report is to present a summary of the ground conditions from a combination of desk study information and historic and recent ground investigations carried out at the Timahoe North site. It should be noted that the detailed ground investigation information for this project is contained within the Irish Drilling Ltd Timahoe North Solar Farm Site Investigation Factual report (May 2018), furthermore this Geology and Ground Conditions Information Report is purely a high level summary of the Irish Drilling Factual report and other geological information referenced herein.

2 Desktop Study

2.1 Site Location

The proposed Timahoe North Solar Farm site is located approximately 8.4 km north of Allenwood and 7.1 km east of Carbury in Co. Kildare. The bog within which the site is situated occupies a total area of approximately 807.29 hectares (ha) (1995 acres) and lies within the townlands of Ballynamullagh, Coolree (Carbury By), Drehid, Killyon, Kilmurry (Carbury By), Mucklon and Mulgeeth. The approximate site location is indicated in Figure 2-1.

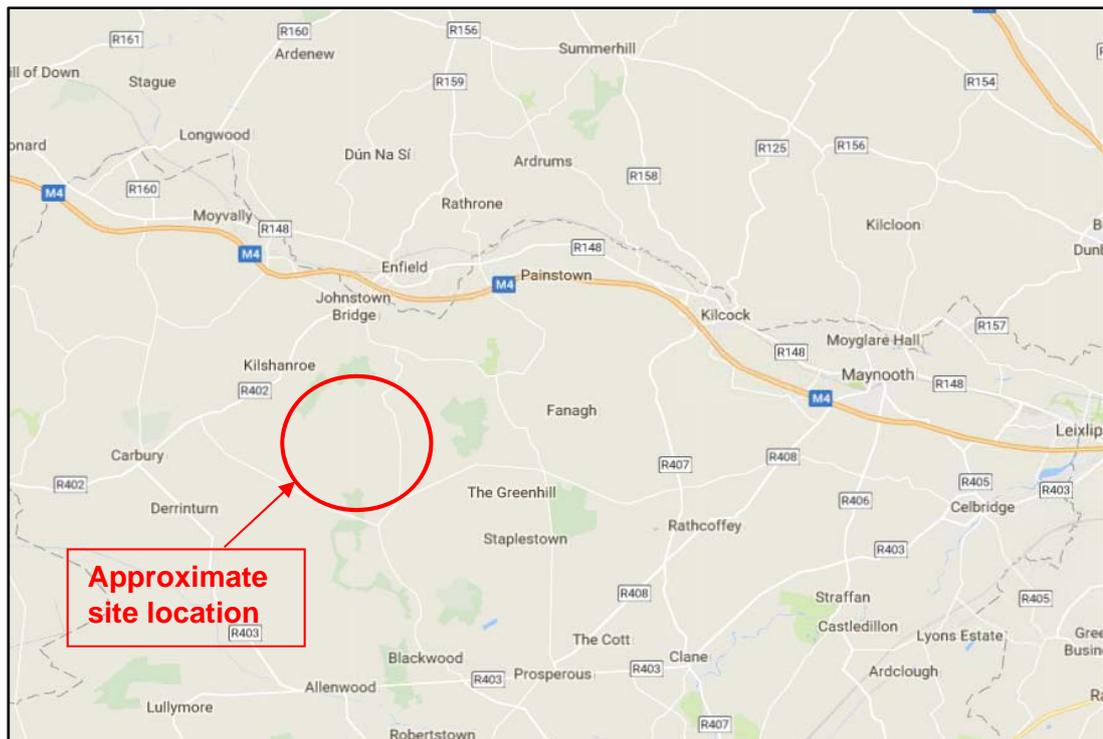


Figure 2-1 Timahoe North Solar Farm Site Location (Google Maps)

The main site entrance is located on the north side of local road L5025 which runs in an approximate east west direction. The L5025 connects to the R402 at its western end and local roads L1017 and L1019 at Timahoe Cross Roads at its eastern end. The site entrance is located approximately 2.3 km west of the cross roads.

2.2 Topography

The site is predominantly flat with elevation levels ranging from approximately 78 to 85 m OD across the majority of the site. Elevation levels for a small area in the southern part of the site reach 89 m OD. An ordnance survey map of the site is shown in Figure 2-2.

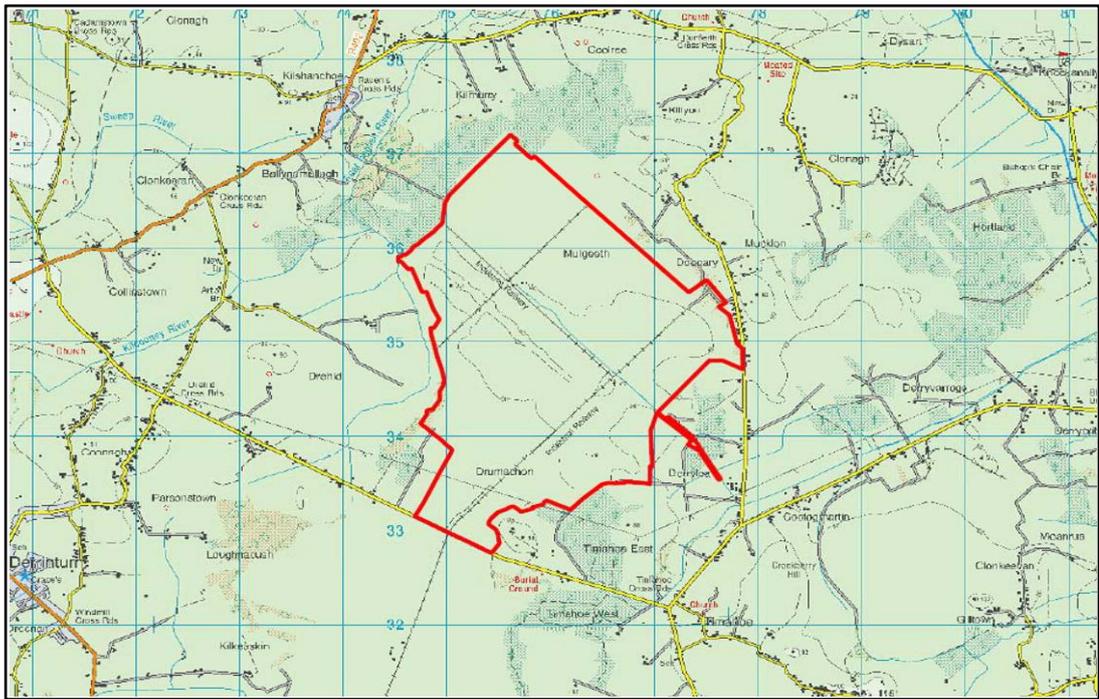


Figure 2-2 Ordnance Survey Map of Timahoe North Solar Farm Site (OSI)

2.3 Geology

2.3.1 Bedrock Geology

Published geological mapping from the Geological Survey of Ireland (GSI) is presented in Figure 2-3. This shows the underlying bedrock at the majority of the solar farm location comprises visean limestone described as dark limestone and shale (calp) of the Lucan formation. A section of the southern end of the site comprises tournaisian waulsortian limestone. There are no known mapped faults on the site.

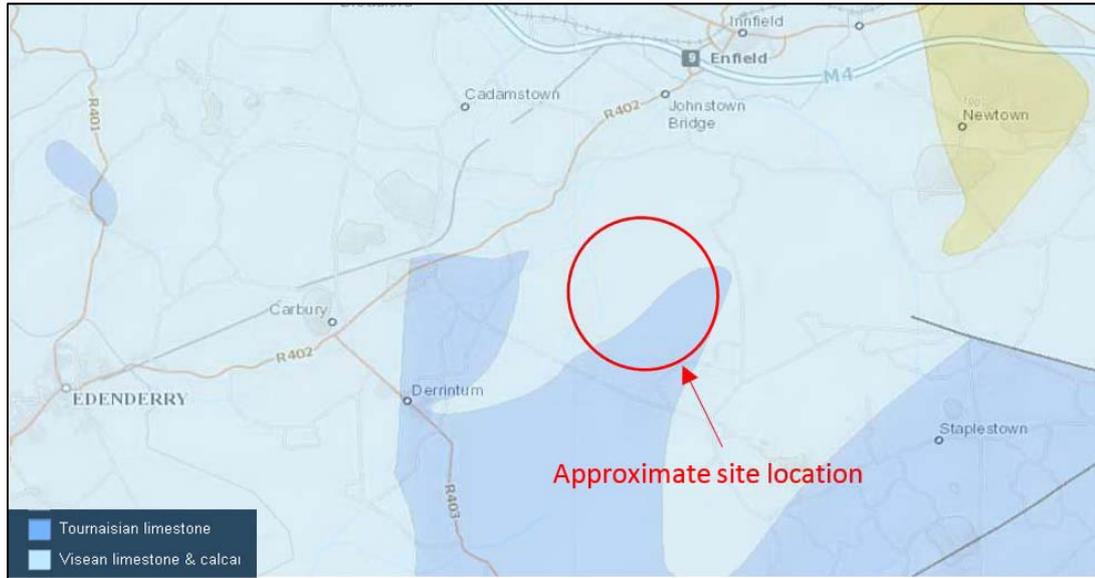


Figure 2-3 Bedrock Geology at Timahoe Site (GSI)

2.3.2 Quaternary Geology

The quaternary geology of the site has been mapped by the Geological Survey of Ireland (GSI). The mapping of the area is shown in Figure 2-4. The GSI mapping describes the lithology of the site as cut over raised peat. It is therefore anticipated that peat will be encountered at all development locations. Peat is an organic soil derived by the accumulation of partially decomposed plant matter in favourable locations, following the end of the last ice age. The extent of peat is readily identifiable from its colour in Figure 2-7.

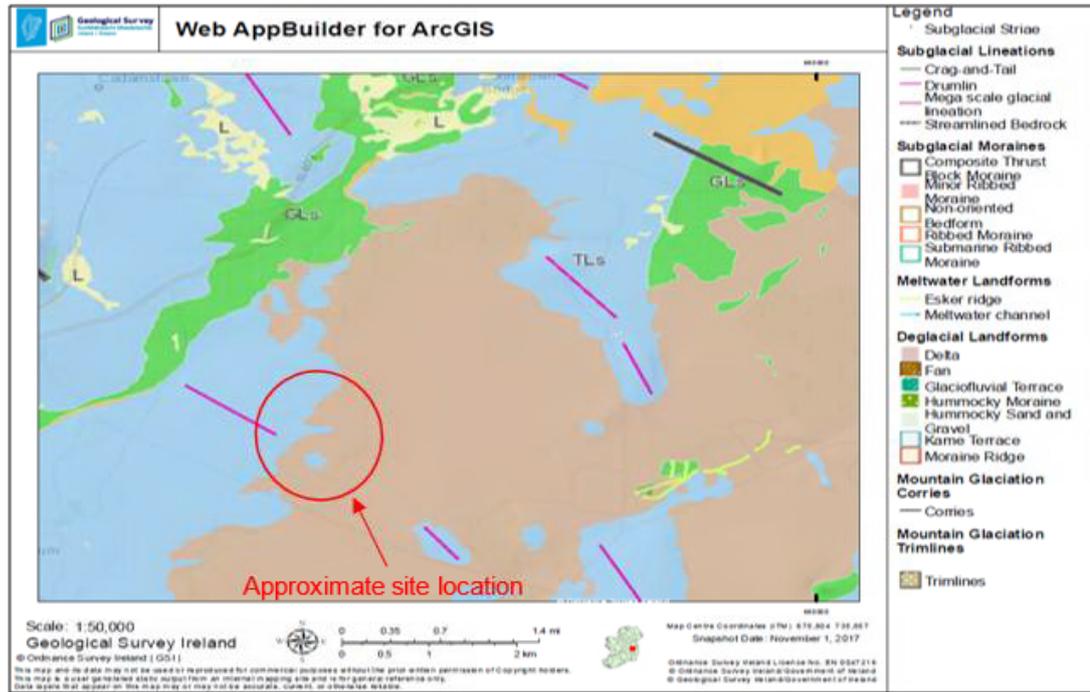


Figure 2-4 Quaternary Mapping for Timahoe North (GSI)

2.4 Hydrology

2.4.1 Watercourses

There is a single watercourse located within the overall Timahoe North site, as shown in Figure 2-5, in addition to a number of nearby watercourses located in close proximity to the site boundary. A drinking water protection area is located close to the site, shown in Figure 2-6.

The entire site is located within the River Boyne catchment. The River Boyne predominantly runs in a south-west to northeast direction. It joins the River Blackwater in Navan, Co. Meath before discharging to the Irish Sea east of Drogheda along the border of Co. Louth and Co. Meath. The discharge location of the River Boyne is within the Boyne Coast and Estuary Special Area of Conservation (SAC) and the Boyne Estuary Special Protected Area (SPA), designated Natura 2000 sites under the EU Habitat's Directive. This SAC and SPA is located more than 56 km from the Timahoe North site. The hydrology is described in detail in the EIS.

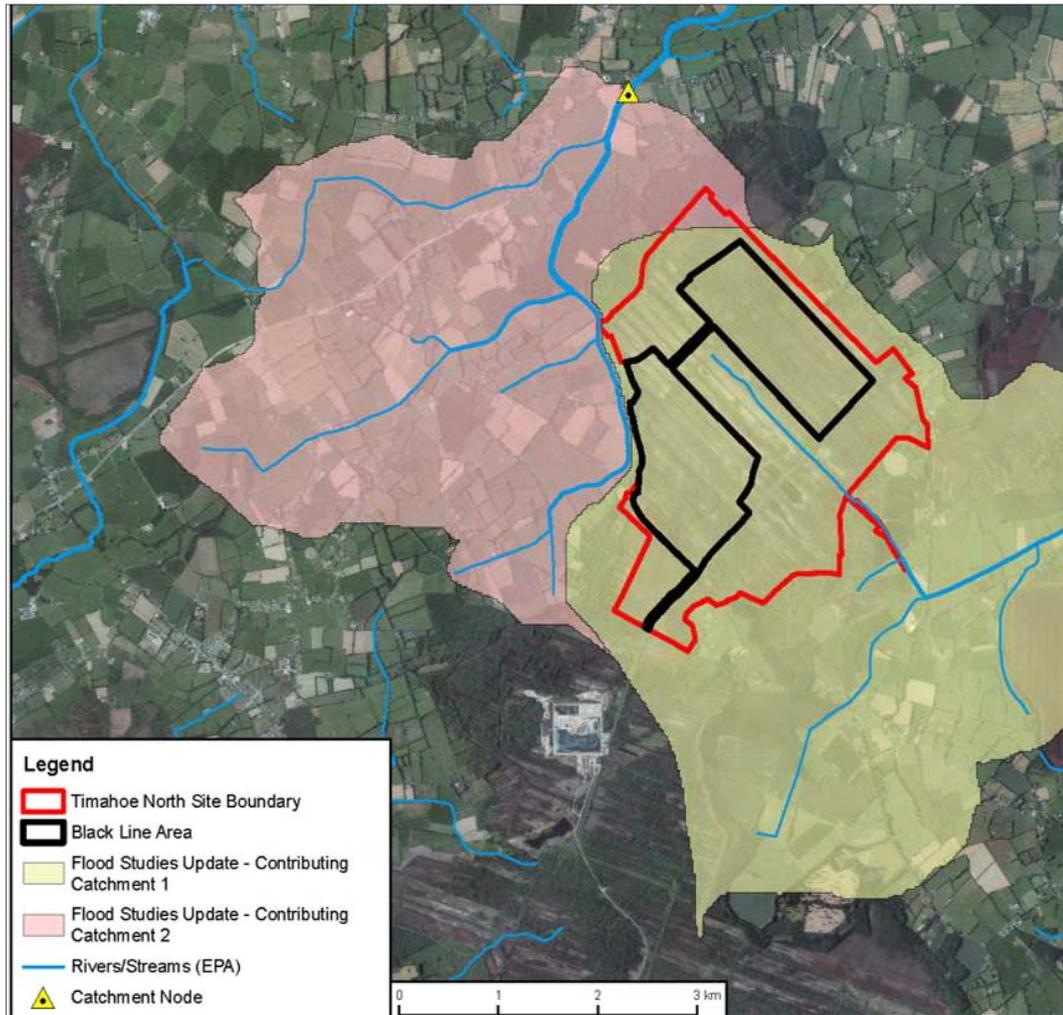


Figure 2-5 Timahoe North Catchments

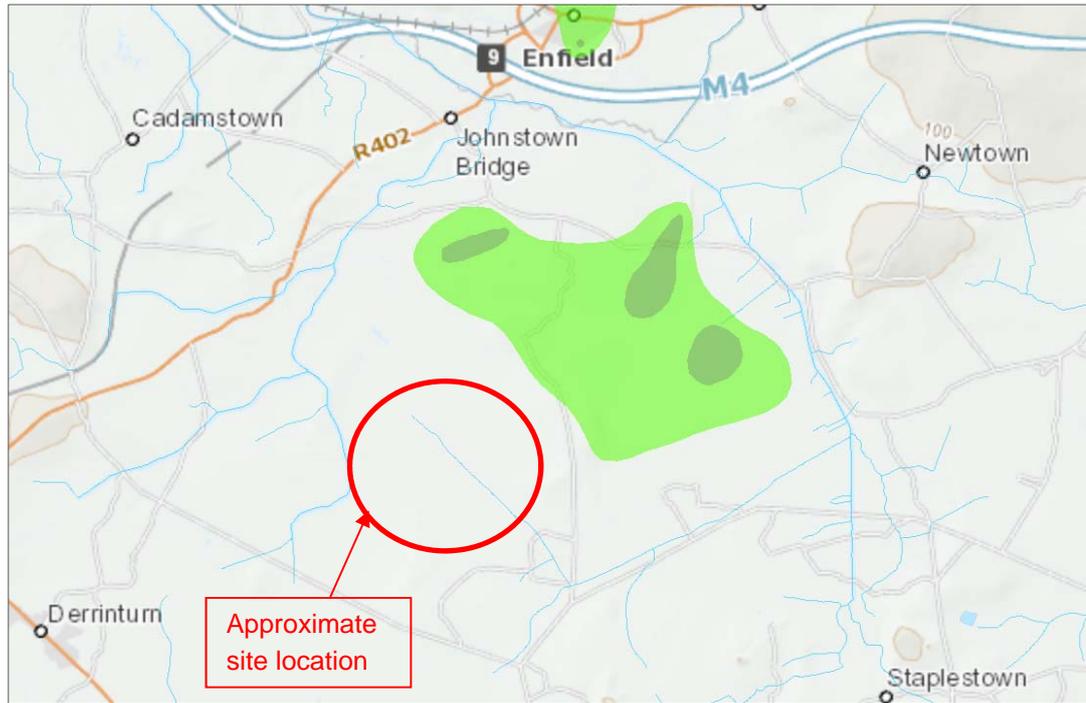


Figure 2-6 Protected Groundwater Source close to Timahoe North Site (shown in green)

2.4.2 Groundwater

The GSI National Draft Bedrock Aquifer map indicates that the bedrock aquifer can be classified as either a locally important aquifer where bedrock is generally moderately productive, or where bedrock is moderately productive only in local zones.

Groundwater was encountered at most trial pit locations during site investigation works. Seepage was largely classed as moderate to very slow with fast to moderate in some locations.

2.5 Land Use

The site is on land owned by Bord na Móna however production has been ceased at the site since the 1980s. Some infrastructure still exists on site including decommissioned railway lines and electricity cables.

The high voltage Derryiron to Maynooth 110 kV overhead electricity line crosses the main access route to the site, approximately 500 m from the site entrance.

2.6 Bog Workings

The peatland at Timahoe North has been a cutaway bog for an extensive period of time. This has enabled the development of large areas of birch and pine scrub/woodland in mosaic with dry heath. The majority of the site has revegetated in some form except for locations where private peat harvesting is still carried out.

2.7 Landslide Database

GSI have developed a land slide database that contains locations and details of recorded landslides throughout the Republic of Ireland. Two recorded landslides have occurred within in proximity to the Timahoe North site, both of which were related to canal embankment construction. The slides occurred at Derrymullen and Edenderry. Both locations are marked on the Landslide Susceptibility Map generated by GSI shown in Figure 2-7. The details provided for these landslides are:

- Derrymullen: The GSI database shows that a landslide occurred at Derrymullen, approximately 7.5 km 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 13 km west of the proposed solar farm site in 1916 following a period of heavy rain and flooding. The 270 m long slide occurred on the north bank of the Grand Canal with no apparent impact. A breach occurred again in 1989.



Figure 2-7 Landslide Susceptibility Map

2.8 Desktop Information Sources

- Google Maps
- Bing Maps
- Geological Survey of Ireland (GSI)
- Ordnance Survey Ireland (OSI)
- Met Éireann

- LiDar
- Aerial photography
- Drone survey

3 Historic and Recent Ground Investigations

The preliminary site investigation data for the project referred to in the following subsections is contained in the planning submission.

3.1 Irish Drilling Ltd - Timahoe North Solar Farm Site Investigation Factual Report May 2018

A preliminary site investigation was carried out on the site by Irish Drilling Ltd in 2017/2018. The preliminary site investigation consisted of 25 no. shell and auger boreholes, 96 no. trial pits and extensive peat probing and shear vane testing across the site.

3.1.1 Irish Drilling Ltd - Summary of Ground Conditions

The ground conditions as described from the Irish Drilling report are as follows:

“Generally the trial pits boreholes and peat probes encountered very soft brown peat over a thin layer of green slightly sandy calcareous silt, over 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 firm to stiff and frequently soft to firm (and sticky) slightly gravelly, slightly sandy clay, with cobbles. At many locations, particularly towards the northern area of the site, the Till grades into a very stiff to hard ‘cemented’ Till. There were some layers of sand (TP 19), which occasionally became ‘runny’ when disturbed.”

The Irish Drilling peat probing established that the depth of peat varied from less than 1 m to more than 5 m throughout the site.

Groundwater was encountered at most trial pit locations during site investigation works. Seepage was largely classed as moderate to very slow with fast to moderate in some locations. Table 3-1 summarises ground conditions as encountered during the Shell and Auger boreholes.

Table 3-1 Summary of Ground conditions

Stratum	Depth to top (m bgl)	Thickness (m)
Peat	0.0	0.7 – 4.7
Glacial Till (grey clay/silt sands and gravels)	0.7 – 4.7	3.0 – 10.5
Possible Bedrock/Refusal*	5.2 – 12.6	-

**Rotary coring was not carried out during this ground investigation and therefore this row may represent refusal or possible bedrock*

3.2 Priority Geotechnical - Timahoe North Preliminary Geotechnical and Environmental Ground investigation Draft Factual Report 2010

Priority Geotechnical Ltd were contracted by Bord na Móna In June 2010, to carry out a preliminary geotechnical and environmental ground investigation for the Timahoe North (Report no. P10031_TN).

The purpose of was to determine the depth of overburden deposits and bedrock underlying the study area, to assess the geotechnical characteristics and hydro-geological conditions and to define the baseline environmental conditions on site.

The investigations consisted of boreholes carried out at 6 discreet locations throughout the site. 2 no. boreholes were cable tool only boreholes, 4 were a combination of cable tool and rotary cored boreholes whilst 1 location had a rotary open cored borehole.

It is noted that currently only a draft copy of this report is available and as a consequence it may not be included in the planning submission. Therefore this paragraph may be removed in a subsequent revision of this document.

3.2.1 Priority Geotechnical - Summary of Ground Conditions

The ground conditions from the Priority report were described as follows:

“peat up to 4.5m below ground level, underlain by slightly gravelly slightly sandy clay, gravelly slightly sandy SILT, clayey gravelly SAND and clayey sandy GRAVEL to depths up to 20.4m below existing ground level, bgl. The depth to rock was variable. LIMESTONE was encountered at depths of 7.5m bgl”

4 Conclusions

The Timahoe North Solar Farm site is mainly overlain with cut over bog. The depth of peat across the site varies from less than 1 m to more than 5 m in certain areas.

Published geological mapping from the Geological Survey of Ireland (GSI) shows the underlying bedrock at the majority of the solar farm location comprises visean limestone described as dark limestone and shale (calp) of the Lucan formation. A section of the southern end of the site comprises tournaisian waulsortian limestone. There are no known mapped faults on the site.

An extensive preliminary ground investigation comprising trial pits, boreholes, shear vanes and peat probing was carried out at the site between 2017 and 2018 by Irish Drilling Ltd. The ground conditions across the Timahoe North Solar Farm site generally consists of peat over glacial deposits interbedded with glacio-fluvial deposits over possible bedrock. 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. Bedrock was not proven during the Irish Drilling Ltd ground investigation.