Tirawley Wind Farm

Soils & Geology Assessment
Peat Landslide Hazard Risk Assessment

Report No: 2165-22

15th April 2026

This document has been prepared by Whiteford Geoservices Ltd on behalf of

Constant Energy Ltd

Jennings O'Donovan & Partners Ltd

Whiteford Geoservices Ltd, 2 Main Street, Straid, Co. Antrim, BT39 9NE
Tel: 0044 (0) 28 93349351 Fax: 0044 (0) 28 93349352
www.whitefordgeoservices.com

PEAT LANDSLIDE HAZARD AND RISK ASSESSMENT

A. STATEMENT OF AUTHORITY

John Whiteford BSc (Hons) Geophys MIOSH MEAGE FGS has more than 25 years of experience in the field of earth sciences, geotechnical engineering, and management. His academic qualifications are a BSc with Honours in Geophysics from Edinburgh University, with memberships of The European Association of Geoscientists and Engineers and The Institute of Safety and Health.

Commencing work with Kirk McClure Morton (Consulting Engineers) in Belfast since then has been engaged in full-time consultancy for the past 20 years and since 1996 trading as Whiteford Geoservices Ltd. The company deploys a staff of more than ten professional and technical personnel and has completed in excess two thousand contracts for clients within the construction and mineral exploration sectors where they have built up a recognised level of specialist experience, particularly in the field of Wind Energy. Working at home, in Europe and worldwide the company has been involved in more than 250 renewable power projects where our services have been sought in relation to foundation design, peat landslide risk assessment, geophysics, electrical earthing design and thermal resistivity analysis.

B. EXECUTIVE SUMMARY

An assessment of Peat Landslide Hazard was undertaken for the proposed 16 No. turbine site at Tirawley Wind Farm to determine the potential for peat instability.

Peat landslide risk analysis has indicated a NEGLIGIBLE risk of instability in relation to the proposed turbine, substation and met mast location, should all mitigation measures and recommendations be adhered to.

C. INTRODUCTION

1) Background

This Report has been prepared on behalf of Constant Energy Ltd and their engineer, Jennings O'Donovan & Partners Ltd (Consulting Engineers), in respect of a planning application for a 16 No. proposed wind energy development. This Report, which relates to Section 6 of the Environmental Impact Assessment Report (EIAR), forms part of the Further Environmental Information (FEI) to be submitted as an accompaniment to the planning application, for consideration by Sligo County Council.

Planning permission is being sought by Constant Energy Ltd for 16 No. wind turbines in the townlands of Conaghra, Barroe, Lissadrone East, Lissadrone West, Billoos, Lecarrowntemple, Lackanhill, Ballymurphy, Carrowmore, Castletown, Castlelackan Demense, Aghaleague, Carrowneden, Ballynaleck,

Carrowmachshane, Carn, Carrowmore, Glebe, Doonadoba, Carrowcor, Cloonanass, Barnhill Lower, Barnhill Upper, Cloonavarry and Carrickanass, between Ballycastle and Killala, in County Mayo.

At the request of Jennings O'Donovan & Partners Ltd Consulting Engineers (JOD), Whiteford Geoservices Ltd (WGS) undertook a geotechnical study and peat landslide risk assessment of the proposed site for Tirawley Wind Farm, Co. Mayo.

The purpose of this work was to:

- Undertake a study of soils, water and general ground stability conditions at the proposed site.
- Identify likely impacts of the proposed development upon these aspects of the environment including a peat landslide risk assessment.
- Identify mitigation measures to avoid, remediate or reduce the impacts identified.
- Identify residual impacts of the development after implementation of mitigation measures recommended.

The following report details the fieldwork undertaken to gather data required to determine the risk from peat instability to the surrounding environment. It also details the analytical process undertaken to apportion risk to the various construction elements, namely construction of the turbine bases and substation control building.

Background desk study information was obtained for the site, prior to initiating fieldwork (as per the requirements of the Scottish Guidance).

This Peat Stability and Landslide Hazard Assessment (PSLHA) report is a "stand-alone" document. No data acquired by third parties (at the site) has been used to augment the dataset acquired by Whiteford Geoservices Ltd, which has been used to produce this PSLHA report.

No data from outside the wind farm planning boundary has been employed for the purpose of determining peat landslide risk. Risk from natural events originating outside of the development has not been considered.

2) Relevant Legislation

The following report is based upon the guidance contained within the Scottish Executive's "*Peat Landslide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments*", published as a Second edition April 2017 (referred to as "the Scottish Guidance").

This Best Practice Guide was updated, in part, in April 2017, and for the purpose of clarity the protocol adopted to determine Peat Landslide Hazard Ranking are consistent with the version of the report, as published in 2017. Unless otherwise stated, all assessments and conclusions contained within this report are

made with reference to either the 2006 or 2017 publication. However, there are a number of variations from the guidance and where these occur the reason for this is provided, either within the text or as a footnote. These guidelines are commonly used in Ireland and have been accepted as authoritative, by the relevant Public Bodies.

3) Schedule of Works

Whiteford Geoservices Ltd (WGS) personnel visited the site during 2022, 2023 and again in 2024 to undertake an assessment of topography, geology, drainage and ground stability conditions at the proposed Tirawley Wind Farm site.

Table 1 – Summary of Ground Conditions

Key Dates	Activity	Turbines	Remarks
September 2022	Desk Study	Turbines AT01, AT02, AT03, AT04. AT05, AT06, AT07, AT08, AT09, AT10, AT11, AT12, AT13, AT14, AT15, AT16, AT17, AT18, AT19, AT20, AT21, AT22, AT23, AT24, AT25, AT26, AT27, AT28, AT29, BT01, BT02, BT03, BT04, BT05, CT01, CT02, CT03, CT04, CT05, CT06, CT07, CT08, CT09, CT10 & CT11	Layout was subsequently amended to avoid the constraints identified
October 2022	Baseline Investigations	As above	
August 2023	Peat depth probing, slope analysis, in-situ testing and von post assessment	Turbines AT01, AT02, AT03, AT04, AT05, AT06, AT07, AT08, AT09, AT10, AT11, AT12, AT13, AT14, AT15, AT16, AT17, AT18, AT19, AT20 & AT21	Detailed investigation undertaken for updated wind farm layout. Layout subsequently amended.
March and November 2024	Preliminary Investigation of soil and rock conditions at Turbines	Turbines AT01, AT02, AT03, AT05, AT06, AT07, AT08, AT09, AT11, AT13, AT14, AT16, Substation and Met Masts	Detailed analysis: walkover survey and targeted trial holes excavated, where accessible

D. METHODOLOGY

1) Desk Study

WGS carried out a desk study assessment of the soils, geology, hydrology and slope aspects of the proposed development site. This involved the following components:

- Acquire and compile all available maps of the proposed wind farm development.
- Study any geotechnical reporting available within the public domain for the locality (*www.gsi.ie Geological Survey Ireland Spatial Resources*).

- Study and assess the proposed locations of turbines with regard to available data on site topography and slope gradients (*www.osi.ie Ordnance Survey Ireland*).
- Study and assess the proposed locations of turbines with regard to available data on site soils, sub-soils and bedrock geology (*www.gsi.ie Geological Survey Ireland Spatial Resources*).
- Study and assess the proposed locations of turbines relative to aerial photographs.
- Overlay Geological Survey of Ireland (GSI) online data to determine site bedrock geology and the presence of any major faults or other anomalies.
- Use of Geological Survey Ireland (GSI) Quaternary mapping to determine soil classification on the site.
- Review Met Eireann Office meteorological records pertaining to the site.
- Review Water Service of Ireland to identify water supply sources in the vicinity of the proposed wind farm extension.
- Conduct peat landslide hazard risk assessment to identify any potential hazards at main wind farm infrastructure.
- Refer to Appendix E for report detailing findings of the initial Desk Study and Walkover Investigations.

The equipment, software and materials used during this study consisted of:

- AutoCAD v 2013 (Graphics)
- Surfer 16 (Graphics)
- Microsoft Excel (Database)
- Microsoft Word (Report)
- Adobe PDF (Report)
- Thales DGPS System
- Peat probing “depthing” rods
- Impact Field Shear Vane

2) Site Investigations

WGS conducted site investigations at the site of the proposed development initially during October 2022 in order to carry out a site visit and walkover survey, and then again in August 2023, following refinement of the proposed layout, to collect more detailed site investigation data. These site investigations are detailed in Section 6.3.3. Further investigation works were also undertaken during February 2023 to appraise a potential Borrow Pit Spoil Repository and again in March and September 2024 at revised Wind Turbine locations.

These site investigation works consisted of:

- Excavation of 12nr trial holes used to assess bedrock and sub-soils conditions at proposed turbine locations, with 3nr further trial holes at subsequently abandoned turbine positions and 5nr in the vicinity of AT16. Refer to Appendix C.

- Excavation of 6nr trial holes and assessment to determine ground conditions at proposed Borrow Pit Spoil Repository. Refer to Appendix F.
- 34 No. hand augured holes at proposed turbine locations to a maximum depth of 2.00m below existing ground level.
- Peat depth probing, undertaken manually by driving a series of "depthing" rods into the ground at turbine positions and across the site development boundary until a significant change in resistance was registered within the sub-soils. The depth of this increase in resistance was then measured and recorded. Refer to Appendix C.
- Shear strength of the peat was measured using a handheld shear vane. Refer to Appendix D.
- Von Post classification method was employed to determine the range of peat characteristics across the proposed development site. Refer to Appendix D.
- The purpose of these investigation methods was to assess the impact of external factors (such as local hydrology, vegetation etc) on the tensional forces binding the peat and hence its tendency towards failure, by shear, during construction works.
- Recording of Irish Transverse Mercator (ITM) coordinates for all investigation locations.

3) Impact Assessment Methodology

From the desk and field data acquired, the following calculations and assessments were undertaken in order to evaluate the stability and type of soils, geology, hydrology and slope aspects of the environment at the proposed development site for Tirawley Wind Farm.

- Characterisation of the sites topographical, geological, hydrological and geomorphological regime from the data acquired.
- Consideration of ground stability issues as a result of the proposed development, its design and methodology of construction.
- Assessment of the combined data acquired to evaluate any likely impacts on the soils, geology and hydrological aspects of the environment.
- If impacts are identified, consider measures that would mitigate or reduce the identified impact.
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

4) Characteristics of the Development

The proposed development comprises 16 No. wind turbines in the townlands of Conaghra, Barroe, Lissadrone East, Lissadrone West, Billoos, Lecarrowntemple, Lackanhill, Ballymurphy, Carrowmore, Castletown, Castlelackan Demense, Aghaleague, Carrowneden, Ballynaleck, Carrowmachshane, Carn, Carrowmore, Glebe, Doonadoba, Carrowcor, Cloonanass, Barnhill Lower, Barnhill Upper, Cloonavarry and Carrickanass Tirawley, between Ballycastle and Killala, in County Mayo.

The majority of the proposed development site consists of semi-improved grassland, mature forestry with isolated areas of blanket peatlands and turbury.

Analysis of the exploratory hole investigations indicates that topsoil or peat is underlain by a natural sequence of glacial soils. Weathered rock, in the form of sandstone or siltstone, was encountered during the intrusive investigations at a number of the turbine positions, with shale being encountered during investigations at the proposed peat repository at Lacken Hill. Groundwater was encountered within a number of these exploratory holes, either as seepage or weak / moderate groundwater flows recorded. Ground slope ranges are considered to be low to moderate across the survey area with the site of the development exhibiting slope gradients in the range 0 to 10^0 to the horizontal.

Primarily, the scope of the proposed development can be characterised as follows:

- Total site area **c. 108.06 ha** (redline boundary)
- Peat Depth Range **0.00 – 3.00m**. Average peat depth = **0.22m**.
- **16 No.** Vestas V117 wind turbines with an overall ground to blade tip height of 135m
- Construction of reinforced concrete base foundations for **16 No.** wind turbines, typically, circular with a foundation diameter of **21.6m**.
- Construction of crane hardstanding areas, temporary stoned hardstand, assist pads and blade lay-down fingers.
- Installation of **one** meteorological mast with a height of 80m and a 4m lightning pole on top.
- Construction of **one 110kV** electrical substation including **2 No**. control buildings with welfare facilities, all associated electrical plant and equipment, security fencing and gates, all associated underground cabling, wastewater holding tank, and all ancillary structures and works.
- Installation of battery arrays located within container units (20 no. units) and associated electrical plant for grid stabilisation adjacent to the Onsite Substation building (with up to **150 MW** storage capacity) with surrounding palisade fence 2.65 m in height.
- Two Temporary Contractors Compound (TCC) with associated temporary offices, parking areas and security fencing.
- Change of use of a residential site and vacant dwelling to a Permanent Operations Compound consisting of an operations office, storage area and staff parking.
- Development of **17 no.** permanent onsite spoil deposition areas
- Construct **5 no**. new permanent site entrances as described in the EIAR **Chapter 17: Traffic and Transport** and **Figure 2.1**.
- Upgrade **9 no**. existing site entrances as described in the EIAR **Chapter 17**: **Traffic and Transport** and **Figure 2.1.**
- Works for new and upgraded entrances include clearing visibility splays of vegetation, widening the entrances to allow HGVs turn onto local public roads and the R314, excavation to solid formation

level, installation roadside drainage features, placing entrance sub-base with rockfill materials, placing capping level and providing surface dressing where necessary.

- Road construction works along the TDR and the Wind Farm Site consisting of the construction of approximately **9.64 km** of new Site Access Tracks through the Wind Farm Site. The upgrading of **1.76 km** of private Access Tracks and sections of public roads along the TDR to include, road verge widening, hedge trimming and all associated infrastructure and drainage works as described in EIAR **Chapter 17: Traffic and Transport** and the **Turbine Delivery Route Report Appendix 17.1.**
- Forestry felling of approximately **31.84 ha** of coniferous forest will be required to facilitate the construction of the Proposed Development.
- Installation of **15.76km** of underground grid cable ducts from the turbines to the proposed substation. Cable trenches, which will typically be 0.60m in width and 1.335m in depth, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks. The excavated material will be laid alongside the trench for use in reinstatement following the emplacement of cables.
- Construction of **13.55km** of 110kV grid connection between the Substation at Tirawley Wind Farm and the existing 110kV Substation at Tawnaghmore at the Killala Business Park.
- The installation of a drainage system for the proposed hardstanding and road areas.
- The terrain is sloping with gradients generally between 0 – 10 degrees to the horizontal.
- Ground surface elevation ranging from 22m to 152m above sea level (Malin Head OD).

E. RECEIVING ENVIRONMENT

1) Geology

In terms of solid geology, the site is underlain by a faulted sequence of metamorphic rock formations.

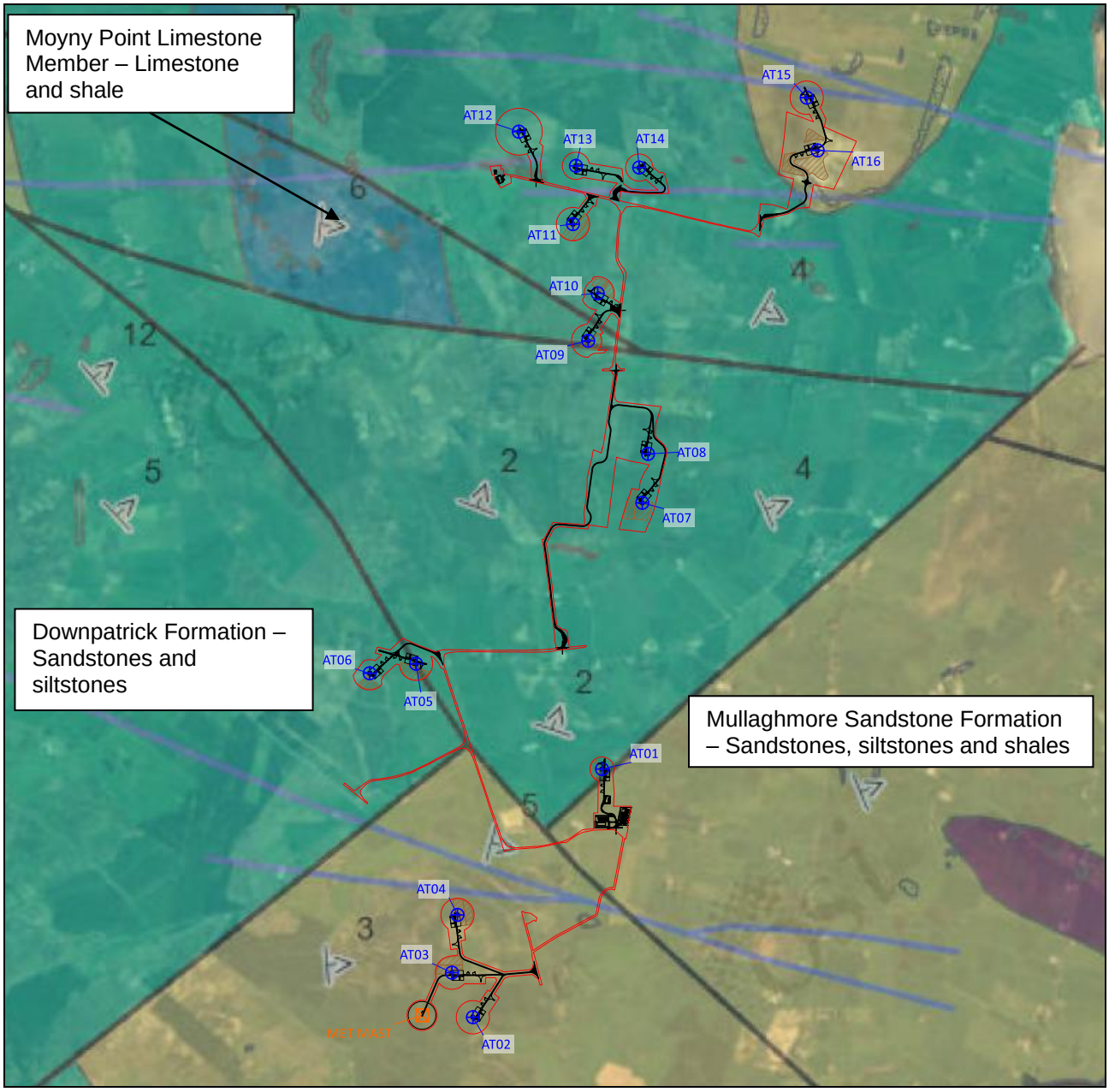


Figure 8.1A – Solid Geology ***(Reproduced from GSI Online Mapping)***

Reproduced courtesy of GSI Datasets Public Viewer

According to the GSI online database Tirawley Wind Farm site is predominantly underlain by the Downpatrick Formation, with the Moyny Point Limestone Member and Mullaghmore Sandstone Formation also present within the site boundary. See also Appendix, Figure 1.

The Downpatrick Formation is a sequence of interbedded sedimentary rock types comprising near shore marine mudstones and siltstones; alluvial and deltaic sandstones and siltstones and fully marine bioclastic

limestones interbedded with calcareous shales. Sandstone and siltstone rock pertaining to this formation were encountered during investigations at Wind Turbines, as was shale during the investigations for the Peat Spoil Repository.

The Moyny Point Limestone is characterised by tabular-bedded limestone and shale.

The Mullaghmore Sandstone Formation is a series of cyclical units of siltstones and shales which coarsen upwards into medium to coarse grained sandstones.

Consultation with the Geological Survey of Ireland indicates that the closest active rock quarry is Mullafarry Quarry (Limestone rock) 7 km south east of Tirawley Wind Farm. GSI records a series of mineral localities, yielding concentrations of copper, iron, chalcopyrite and calcite both surrounding the proposed wind farm, but those that have been exploited are now abandoned.

No shafts or adits were recorded within 10km of the proposed development site.

Records indicate that exploration for metals, probably copper and nickel, was undertaken in 1970 when a series of deep boreholes were drilled between Doonomar, Cloonboy, Rathfran, Mullnacross and Ross.

In terms of drift geology, the region within which the wind farm is located is characterised by mainly tills derived from sandstone and limestone, frequently mantled by topsoil or organic soils (blanket bog).

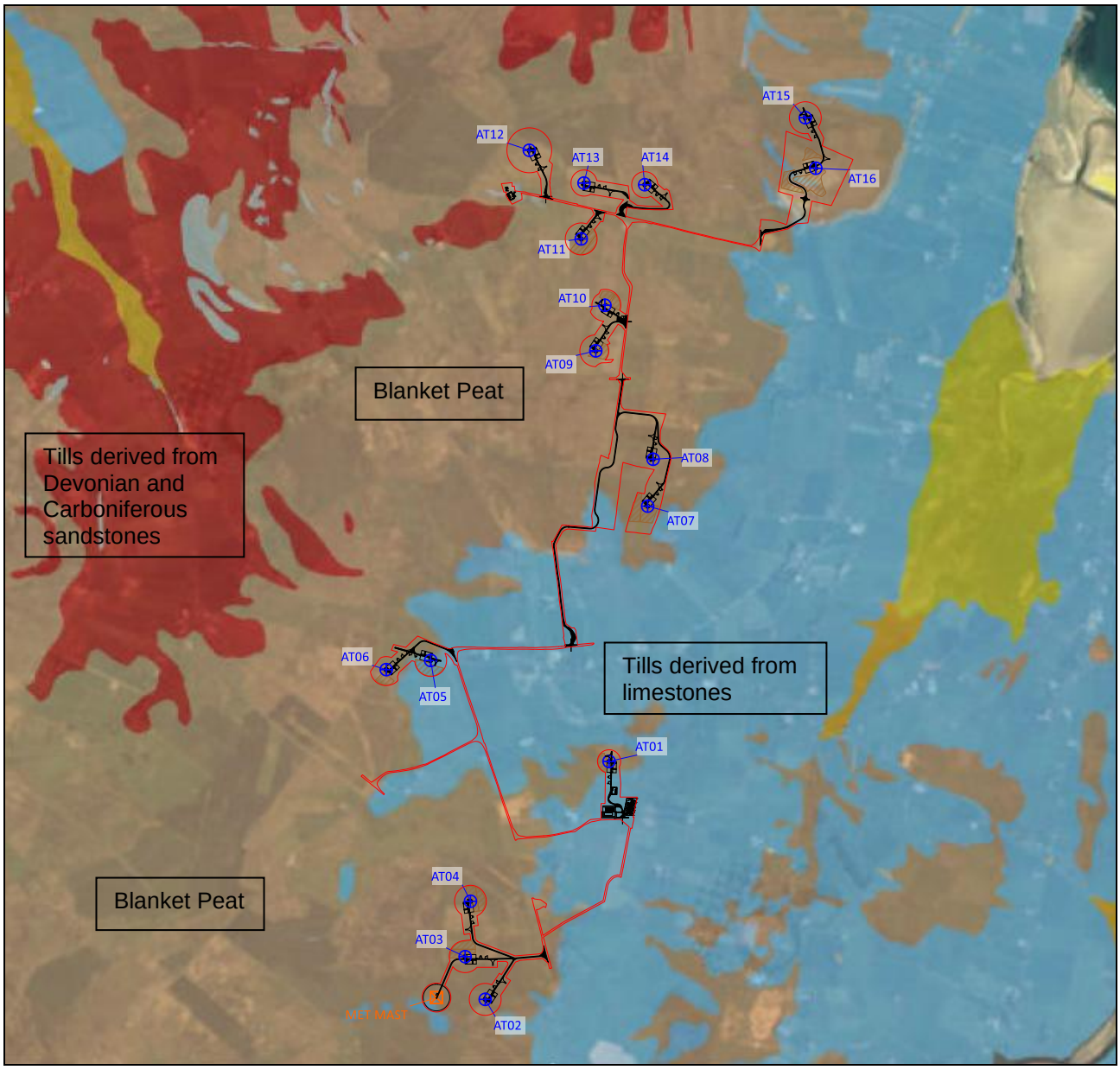


Figure 8.1B – Superficial Soils *(Reproduced from GSI Online Mapping)*

Reproduced courtesy of GSI Datasets Public Viewer

Superficial soils present within the wind farm boundary consist predominantly of: -

- Blanket Peat probably underlain by Till
- Till derived from sandstones (in the west)
- Till derived from limestones (in the east)
- Alluvium in river valley bottoms

2) Regional Hydrogeology

Aquifer Classification

A review was made with the Geological Survey of Ireland's National Draft Bedrock Aquifer map. See also Appendix, Figure 7. The geology of the site underlying the wind farm development comprises topsoil or

peat and superficial drift deposits overlying crystalline sandstones, siltstones or shale. The drift deposits generally consist of impermeable glacial till (boulder clay) derived from either Devonian sandstones and siltstones or from Carboniferous limestones. However, isolated zones of locally permeable material may be present in the locality. Refer to Figure 8.1B and also Appendix, Figure 2 for details.

Essentially, surface water is anticipated to enter the sub-surface where it is permeable (topsoil or blanket peat) and will continue vertically downwards until it comes into contact with either an impermeable stratum or the water table.

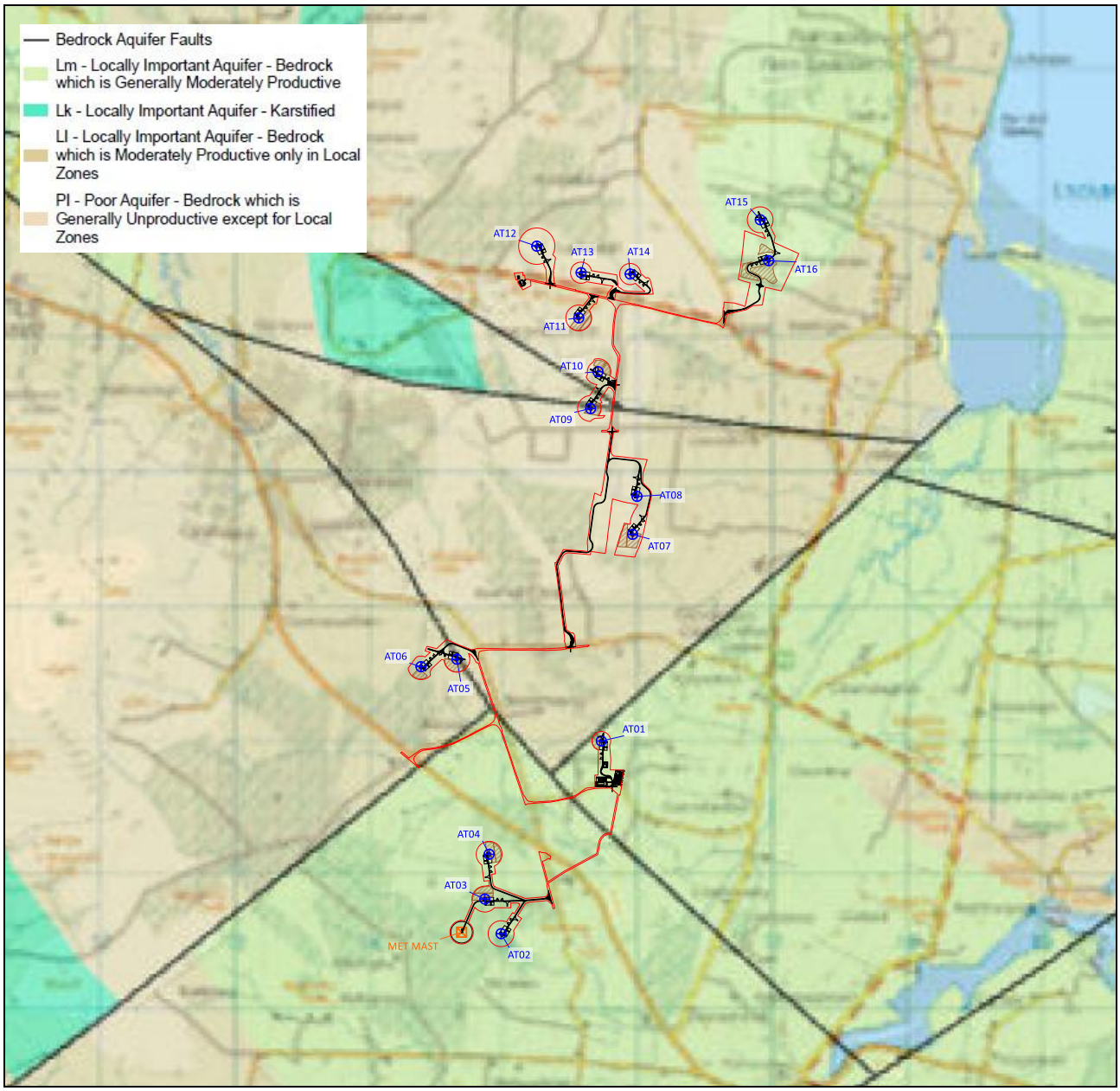


Figure 8.2 – Groundwater (Aquifers) Resources *(Reproduced from GSI Online Mapping)*

Reproduced courtesy of GSI Datasets Public Viewer

At this point the surface water will migrate in the same direction as the groundwater or according to the gradient of the impermeable stratum. Although records do not indicate it, within the redline boundary of the development, karstified rock may also be present

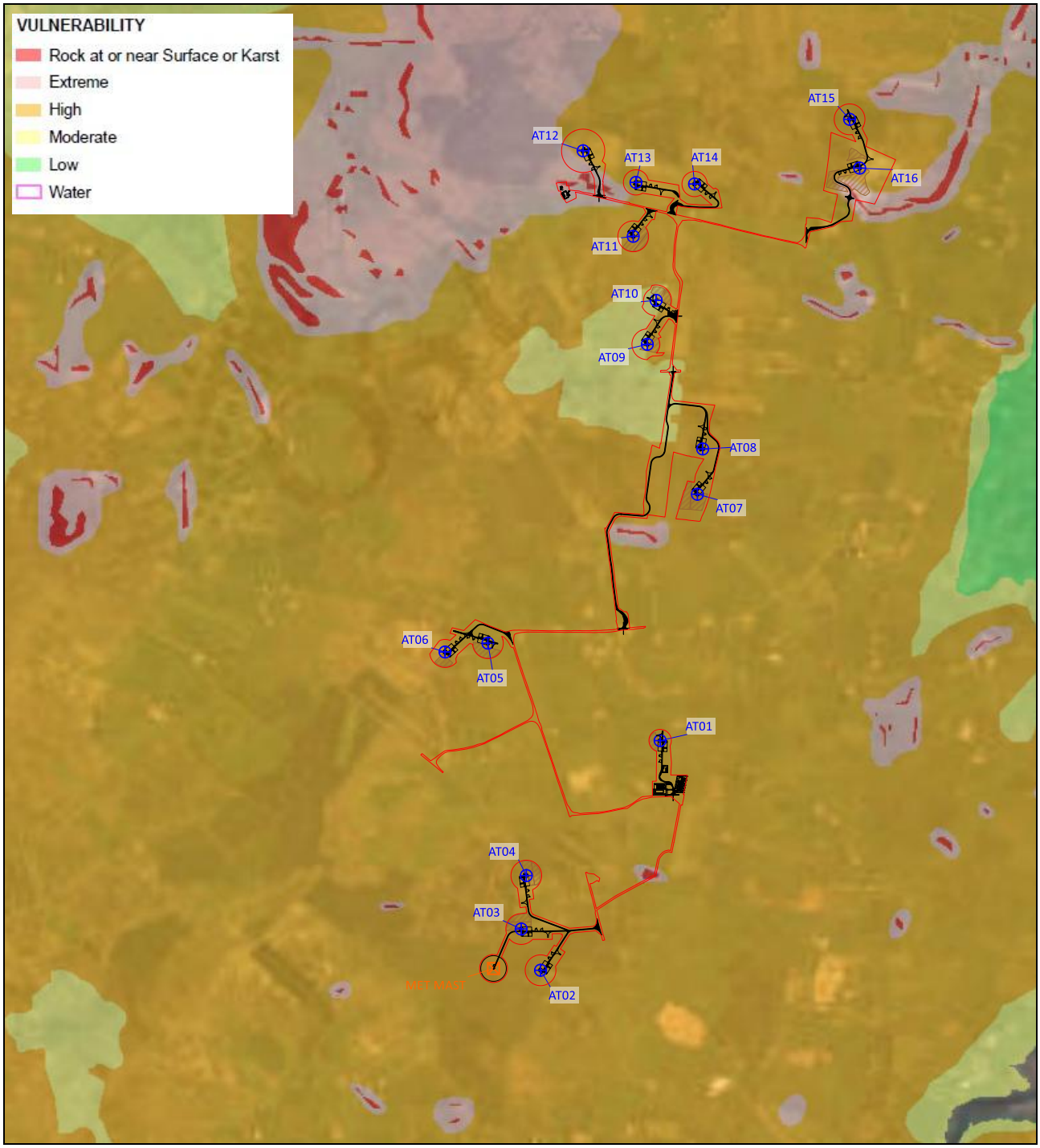


Figure 8.3 – Groundwater Vulnerability *(Reproduced from GSI Online Mapping)*

Reproduced courtesy of GSI Datasets Public Viewer

The National Draft Bedrock Aquifer map indicates that the proposed Tirawley Wind Farm site is predominantly underlain by poor generally unproductive Aquifers, however locally important potentially highly productive (potentially karstified) bedrock aquifers are to be present within the site boundary.

Potential superficial aquifers have not been identified within the site boundary.

Groundwater Vulnerability

The groundwater vulnerability within the boundaries of the proposed development site can be classified generally as high with localised discrete pockets of extreme and moderate vulnerability. See also Appendix, Figure 7.

Wind farm drainage will be designed to adequately cope with the groundwater conditions identified.

Well Database

The GSI database records groundwater abstraction wells to the north and north east of the site boundary. These wells are drilled within locations where the uppermost rock units are the poor-quality Downpatrick Formation and the locally productive Mullaghmore Sandstone Formation. It is not known what depths these wells extend to and whether they both intercept the same formation.

The potential for adverse impact to these abstraction wells, caused by the wind farm construction, is considered low.

3) Local Hydrology

Site Drainage

Drainage channels are evident across the proposed development, many of which are associated with forestry. Most are generally less than 1m in width and depth, constructed in a parallel arrangement approximately 10m apart or are situated adjacent to land boundaries, access tracks or to effect improved drainage. It was not possible to precisely map the full extent of the man-made drainage network at this time.

A low impact on the "natural hydrology", as a result of the development, is anticipated.

Please refer to the site walkover and reconnaissance section (Section 3.0) and Appendix A, Figure 4 for details of site water features within the site boundary.

Local Watercourses

For the purpose of defining watercourses as sensitive receptors these are deemed to fulfil the following criteria: -

1. Consistently contain flowing water / not ephemeral.

2. Be a natural watercourse with either a designated name or be a smaller tributary of a designated watercourse. i.e. Not man made in origin.

Where a watercourse does not fulfil these criteria, but where there is still potential connectivity the potential hazard is managed (for the purpose of peat stability) by considering an additional risk factor for drainage related issues.

The development site for Tirawley Wind Farm is located within the vicinity of number of minor tributaries of the Ballinglen River, Heathfield River and the Cloonalaghan River, all of which discharge to the sea.

The Ballinglen River and Heathfield River present within the wind farm boundary drain generally in a northernly direction to Bunatrahir Bay.

The Cloonalaghan River drains in north easterly direction to Lacken Strand which is part of the Lackan Saltmarsh and Kilcummin Head SAC and Killala Bay/Moy Estuary SPA.

Palaeo-Karstic Features

Karst topography is defined as "An assemblage of topographic forms resulting from dissolution of the bedrock and consisting primarily of closely spaced sinkholes." Karst topography can form in regions of exceptionally soluble rocks, including limestone. Although not specifically recorded by GSI to be the uppermost rock formation underlying the proposed development, the author believes that limestone could potentially present at discrete locations within the site.

GSI records do not record the presence of "karst" features within the site boundary and no landforms consistent with "karst" topography were identified during the walk over survey. GSI records do not show the presence of "karst" features surrounding the site.

In summary, the potential for "karstified rock" to affect the stability of installed structures and infrastructure is considered to be low to moderate and only affects the location of those turbines where limestone is the uppermost rock unit.

Specific supplementary ground investigation will be undertaken to determine detailed information on the rock formations underlying the most significant infrastructure, in order to screen for the presence of karst features prior to commencement of construction works.

Mining or Active Quarry Operations

Consultation with the Geological Survey of Ireland indicates that the closest active rock quarry is Mullafarry Quarry (Limestone rock) 6.1 km south east of Tirawley Wind Farm. GSI records a series of mineral localities, yielding concentrations of copper, iron, chalcopyrite and calcite both surrounding the proposed wind farm, but those that have been exploited are now abandoned. Refer to Appendix, Figure 6.

No shafts or adits were recorded within 10km of the proposed development site.

Records indicate that exploration for metals, probably copper and nickel, was undertaken in 1970 when a series of deep boreholes were drilled between Doonomar, Cloonboy, Rathfran, Mullnacross and Ross.

Peat Disturbance and Soil Removal

Tirawley Wind Farm is typified by lands consisting of forestry, cutover peat bog and improved lands used as rough pasture.

Evidence of localised historic peat cutting was recorded adjacent to the central portion of the Site during the walk over survey. Peat depths recorded ranged from 0m to 3.0m in thickness with a mean thickness of 0.36m. Refer to Drawings 2165-22 D1 and D2. 99.9% of the Site recorded peat thickness in the range 0m (absent) to 2m (Moderate). Only 2 No. peat measurements out of a total of 2310 (0.1%) recorded peat thickness of greater than 2m within the redline boundary for the Project.

Historic Landslides and Landslide Susceptibility

GSI records does not record any historic soils movements within the lands underlying or in the immediate vicinity of the proposed development. Refer to Appendix, Figure 5 for GSI Mapping identifying both known landslide events and mapped extents of historic areas of soil detachment.

The closest recorded soil movement was at Shanettra, approximately 8km south west of the proposed Development, where a peat landslide in 2000 recorded a total mapped length of 1187m. This particular soil movement occurred in a steep sided valley within an area of forestry and coincided with a GSI mapped region of moderately high landslide susceptibility.

Comparison of the wind farm layout to GSI mapping indicates that the vast majority of the wind farm infrastructure coincides with low to moderately low landslide susceptibility. Where infrastructure and access track impinge on moderately high susceptibility lands, the risk of instability is offset by the low mean peat thickness of < 0.5m.

4) Soils and Sub-soils

The following table summarises the ground conditions actually encountered at the proposed Tirawley Wind Farm site.

Table 2 – Summary of Ground Conditions

Stratum Encountered	Average Depth to Stratum (m)	Remarks
Topsoil / Peat	0.00	
Initially very soft to soft, becoming firm to stiff, silty, sandy, very gravelly CLAY / GRAVEL with angular to sub angular cobbles and boulders.	0m – >3.50	

Stratum Encountered	Average Depth to Stratum (m)	Remarks
Initially, extremely weak, SANDSTONE, SILTSTONE or SHALE.	Varies but generally > 1.00m depth wind farm	SANDSTONE or SILTSTONE was encountered at the following wind turbines: AT02, AT03, AT07, AT08, AT11, AT14 & AT16. SHALE was also encountered only at Spoil Repositories SD1, SD2 and SD3.

The following tables summarise the findings of the peat probing survey and illustrates the peat thickness across the general survey area. Peat thickness assessment at individual turbine infrastructure, was used for the purchase of screening the construction site for the risk of Peat Instability.

Current opinion is that lands mantled by >0.50m of peat are considered to be "bogland" with the peat being of sufficient thickness to influence ground stability. Peat <0.5m is not considered to influence soil stability any more than topsoil of a similar thickness would. This threshold has been employed to determine where detailed peat stability assessment is required to determine peat stability and landslide hazard.

Table 3 – Peat Depth Distribution

Peat Depth Range (m)	Peat Depth Distribution from analysed data (%)	Peat Thickness Sufficient to influence Ground Stability?
0.00 – 0.50	86.1	Very Unlikely
0.50 – 1.00	12.5	Likely
1.00 – 2.00	1.3	Likely
2.00 – 3.00	<0.1	Very Likely
3.00 – 4.00	<0.1	Very Likely
> 4.00	0	Very Likely

The mean peat depth encountered across the proposed Tirawley Wind Farm site was 0.36m, with a corresponding median value of 0.33m, whilst the peat thickness displayed a range from 0.00m to 2.00m within the proposed development area. 86.1% of the peat depths recorded <0.5m of peat cover and consequently negligible risk of peat instability.

The table below shows the range of peat thickness encountered within the confines of the proposed construction footprint, as assessed for the turbine infrastructure and determines whether detailed peat stability assessment is required. It is within this construction footprint, that direct disturbance will occur during both construction, operational and decommissioning phases and for this reason the peat characteristics from this zone are employed to determine the potential for peat landslide.

Table 4 – Variation of Peat Depth at proposed Turbine / Structural Locations

ID	Coordinates (ITM)		Within Construction Footprint (Infrastructure)	Remarks
	Easting	Northing		
AT01	515725	834020	0.7	Detailed peat assessment required
AT02	514978	832589	0.6	Within Forestry – detailed peat stability assessment required
AT03	514857	832846	0.9	Within Forestry – detailed peat stability assessment required
AT04	514889	833179	0.6	Within Forestry – detailed peat stability assessment required
AT05	514649	834627	0.3	Detailed peat stability assessment ***not*** required
AT06	514381	834572	0.4	Within Forestry – detailed peat stability assessment required
AT07	515958	835555	0.4	Detailed peat stability assessment ***not*** required
AT08	515991	835837	3.0	Detailed peat assessment required
AT09	515645	836489	0.9	Within Forestry – detailed peat stability assessment required
AT10	515700	836763	1.1	Within Forestry – detailed peat stability assessment required
AT11	515557	837162	0.7	Within Forestry – detailed peat stability assessment required
AT12	515244	837695	0.8	Within Forestry – detailed peat stability assessment required
AT13	515574	837498	1.0	Detailed peat assessment required
AT14	515940	837488	0.6	Detailed peat assessment required
AT15	516909	837891	0.5	Within Forestry – detailed peat stability assessment required
AT16	516972	837587	0.6	Detailed peat assessment required
Substation	515707	833741	0.5	Detailed peat assessment required

Table 5 – Details of Estimated Peat and Mineral Soils Excavation Required

Turbine	Total Vol. of excavated peat at structure (m^3)	Total Vol. of excavated mineral soils / rock at structure (m^3)
16 no. Turbine Hardstandings	27,202	9,005
16 no. Blade Laydown Areas	26,608	0
16 no. V117 Turbine Foundation	4,223	27,286
16.no Turbine Transformers (2.5 x 2.5)	175	49
Onsite Access Tracks	25,868	10,347
Temporary Construction Compounds	1,350	810
Electrical Substation and BESS	5,376	4,156
Met Mast	138	83
Electrical Substation Transformer Base	138	28
Internal Cable Trench	2,364	1,891
110kV Cable Trench	4,065	6,789
Total	97,507	60,444

Refer to **Table 2.6 Chapter 2 – Development Description**.

The following sections of this report detail the main peat stability and Landslide Hazard Assessment parameters employed for the analysis of Tirawley Wind Farm
Refer to drawings **2165-22 D1** for plot depicting discrete peat depth in the vicinity of each turbine location.

Drawings **2165-22 D2** illustrates the generalised peat depth at the proposed site of Tirawley Wind Farm in the form of a contoured plot, where access permitted evaluation, using a standard Kriging function.

Drawings **2165-22 D3** and **2165-22 D4** display the variation in ground surface as contoured plots of surface elevation and ground slope gradient respectively. All plots are provided as overlays on top of the wind farm layout.

F. PEAT STABILITY HAZARD ASSESSMENT

1.1 IINTRODUCTION

Peat landslides are caused by a combination of factors, triggering factors and preconditioning factors and thus the potential for peat landslide to occur can be considered to be a cumulative risk scenario. For the purpose of this report, we place most emphasis on the potential for construction of the new development to trigger a peat landslide, although it is also recognised that conditions could be such that this could have occurred naturally during the lifetime of the project.

According to the Scottish Guidance, "A number of preparatory factors also operate in peatlands which act to make peat slopes increasingly susceptible to failure without necessarily initiating a landslide. Triggering factors change the state of the slope from marginally stable to unstable and can be considered as the 'cause' of failure (DoE, 1996). There are also inherent characteristics (or preconditions) of some peat covered slopes which predispose them to failure."

Triggering factors have an immediate or rapid effect on the stability of a peat accumulation whereas preconditioning factors can influence peat stability over a much longer period. Only some of these factors can be addressed by site characterisation.

1.1.1 Preparatory Factors

The following are some of the ***Preparatory Factors*** which operate to reduce the stability of peat slopes in the short to medium term (tens to hundreds of years):

- ***Increase in mass of the peat slope through progressive vertical accumulation (deep peat formation).***
- Increase in mass of the peat slope through increases in water content.
- Increase in mass of the peat slope through growth of trees planted within the peat deposit (afforestation).
- ***Reduction in shear strength of peat or substrate from changes in physical structure caused by progressive creep and vertical fracturing (tension cracking or desiccation cracking), chemical or physical weathering or clay dispersal in the substrate.***
- Loss of surface vegetation and associated tensile strength (e.g., by dry-out, burning or pollution induced vegetation change).
- ***Increase in buoyancy of the peat slope through formation of sub-surface pools or water-filled pipe networks or wetting up of desiccated areas; and***
- Afforestation of peat areas, reducing water held in the peat body, and increasing potential for formation

Many ***Preparatory Factors*** are also ***Pre-Failure Indicators***.

1.1.2 Preconditions

Preconditions to slope instability in peatlands often act over longer periods of time and are generally considered static in nature, e.g.:

- Impeded drainage caused by a peat layer overlying an impervious clay or mineral base (hydrological discontinuity, especially an iron pan at the base of the peat deposit).
- ***Presence of peat on steep slopes***
- ***A convex slope or a slope with a break of slope at its head (concentration of subsurface flow).***
- Proximity to local drainage, either from flushes, pipes or streams (supply of water); and
- Connectivity between surface drainage and the peat/impervious Triggering factors are typically of short duration (minutes to hours) and any individual trigger event can be considered as a result of cumulative events:
- Focusing of drainage in a susceptible part of a slope by alterations to natural drainage patterns (e.g.by pipe blocking or drainage diversion); and
- Loading by plant, spoil or infrastructure.

1.1.3 Triggers

Peat landslides may be ***triggered*** by natural events and human activities. The following ***natural triggers*** have been reported in relation to peat instability.

- ***Intense rainfall causing development of transient high pore-water pressures along pre-existing or potential rupture surfaces (e.g., at the discontinuity between peat and substrate).***
- Snow melt causing development of high pore-water pressures, as above.
- ***Rapid ground accelerations (earthquakes) causing a decrease in shear strength.***
- Unloading of the peat mass by fluvial incision of a peat slope at its toe, reducing support to the upslope material; and
- Loading of the peat mass by landslide debris causing an increase in shear stress.

External environmental triggers such as rainfall and snowmelt cannot be mitigated, though they can be managed (e.g., by limiting construction activities during periods of intense rain). Unloading of the peat mass by excavation, loading by plant and focusing of drainage can be managed by careful design, site specific stability analyses, informed working practices and monitoring.

Triggers associated with human activities include:

- ***Alteration to natural drainage patterns focussing drainage and generating high pore-water pressures along pre-existing or potential rupture surfaces (e.g., at the discontinuity between peat and substrate).***

- ***Rapid ground accelerations (blasting or mechanical vibrations) causing an increase in shear stresses.***
- Unloading of the peat mass by cutting of peat at the toe of a slope reducing support to the upslope material (e.g., during track construction).
- ***Loading of the peat mass by heavy plant, structures or overburden causing an increase in shear stress; and***
- ***Digging and tipping, which may be associated with building, engineering, farming or mining (including subsidence).***

1.1.4 Pre-failure Indicators

The influence of ***Preparatory Factors*** or presence of ***Preconditions*** are often highlighted visually by **Pre-Failure Indicators**, i.e., landforms that results from their effects. Where Preparatory factors and Preconditions can often prove difficult to determine, Pre-failure Indicators are generally evident in the landscape as follows:

- Presence of historical and recent failure scars and debris.
- Presence of features indicative of tension.
- Presence of features indicative of compression.
- Evidence of 'peat creep'.
- Presence of subsurface drainage networks or water bodies.
- Presence of seeps and springs.
- Presence of artificial drains or cuts down to substrate.
- Concentration of surface drainage networks.
- Presence of soft clay with organic staining at the peat and (weathered) bedrock interface; and
- Presence of an iron pan within a mineral substrate.

Thus, in order to assess the stability of peatland sites there is a tendency to rely heavily on Pre-Failure Indicators and certain Preconditions (identified as bold italics text) in order to provide the necessary inputs to the algorithm for the purposes of risk determination.

Assessment of the risk of peat instability requires the assessment of the effect of these cumulative risk factors. In the case of ***triggers,*** we assume the "worst-case" external environmental impact attributable over a period equivalent to twice the "normal lifespan[1]" and assume that the trigger will be one of those highlighted in bold italic text above, most likely cumulative and loading / weather related. We caveat certain of the potential triggers such as "earthquake", "rapid ground accelerations", "alteration to natural drainage", "loading of peat mass"," digging or dumping" by the following respective practices: -

[1] 50 years

- Review of historic seismicity, in the context that Ireland is generally considered very low risk in this respect
- Determining whether quarry blasting occurs in the vicinity and assuming that "driven" piles will not be used as part of the construction method
- The drainage that is recommended is as a default "non-positive" primarily so that surface water will not develop significant momentum
- A competent contractor will undertake the works and understand the risks associated with construction of peatlands and will be capable of maintaining ground stability at all times
- Where ground conditions are particularly sensitive, we will advocate risk mitigation by suggesting the use of low-pressure plant, at least until construction works are complete. We assume our advice will be followed.

Thus, a mixture of desktop research, visual assessment, topographic analysis, in-situ testing and laboratory testing forms the basis of determine of the Hazard Ranking in respect to Peat Stability.

Following an initial scoping assessment of the above factors / indicators, e.g., following the Desk Study and Walkover Survey report, a coarse assessment of the hazard ranking for Peat Stability was completed and deployed to assist in the production of the optimal Wind Farm layout plan.

Following this preliminary analysis further fieldwork was initiated to analyse and collect soil samples and more comprehensive information on rock composition and on soil stability within the construction footprint for the associated new infrastructure.

Further analysis was then made using available topographic, hydrological and other geological information, in-situ test data and collected peat depth data for each turbine to determine the potential for peat movement, particularly focusing on exposure / proximity to sensitive receptors from sources of potential triggering activities. This information was further augmented by laboratory testing undertaken on recover soil samples. From this analysis the following table of residual risks was produced, summarising appropriate mitigation.

Reference is made, in this section, to "*Peat Landslide Hazard and Risk Assessment Best Practice Guide for Proposed Electricity General Developments*" 2nd Edition, produced by The Scottish Executive & Halcrow Group Ltd (Apr 2017).

Table 6 – Summary of Peat Landslide Hazard Risk Assessment for Tirawley Wind Farm

Stability Issue	Turbine Infrastructure and Tracks
Existing Slopes	Slopes considered at the proposed turbine locations are low and display magnitudes of 0 – 5 degrees to the horizontal. Slopes are sometimes steeper, considered low to moderate and range from 0 – 10 degrees to the horizontal.

Stability Issue	Turbine Infrastructure and Tracks
Landslip / Peat Landslide	Analysis of available topographic information and peat depth data gives the following assessment for proposed turbine locations and the track network. <u>*Construction of Access Tracks and Met Mast*</u> Peat depth in places is not currently considered sufficient, in itself, for the use of "floated road" construction, unless required to fulfil some other purpose. The majority of the site tracks are anticipated to be either new traditionally constructed ones or upgraded existing tracks. The combination of shallow to moderately deep peat thickness, low peat strength and low to moderate slope gradient, as well as other factors, has been considered. Consequently, the proposed site track network can be classified to have a designation of NEGLIGIBLE TO LOW HAZARD, for the purposes of peat stability. Proposed mitigation will reduce the hazard further resulting in a post mitigation designation of **NEGLIGIBLE HAZARD.** <u>*Construction at Turbines*</u> At all turbine locations the combination of shallow to moderately deep peat thickness, peat strength and low to moderate slope gradient and other factors has been considered. Consequently, these proposed turbine locations can be classified to have a designation of NEGLIGIBLE TO LOW HAZARD, for the purposes of peat stability. Proposed mitigation will reduce the hazard further resulting in a post mitigation designation of **NEGLIGIBLE HAZARD.** These designations assume that the general procedures outlined in the *Recommendations* section will be adopted and implemented fully during the construction period.

1.2 ANALYTICAL ANALYSIS

The following analysis uses an analytical approach to determine factors of safety to quantify the risks of peat landslides and local rotational failure or engulfment of excavations occurring.

The Scottish Guidance suggests the application of Infinite Slope Stability Analysis be employed to gauge the stability of peat on slopes and determination of the relevant Factor of Safety (FoS).

As an additional observation the Stability of Excavations within peat at the site of approved turbine excavations has also been considered. Refer to the Appendix "Analytical Analysis" for detailed analysis in respect to the above.

Results of these analyses are presented in the tables provided below: -

Table 7 - Analytical assessment of Infinite Slope Stability

LOCATION	Max Slope (°)	z (m)	Undrained Condition		Dry Condition	
			Cu[2] (kPa)	Factor of Safety Sliding	Cu[3] (kPa)	Factor of Safety Sliding[4]
AT01	≤5	0.7	52	**57.04**	5	**5.48**
AT02	≤5	0.6	30	**38.39**	5	**6.40**
AT03	≤5	0.9	13	**11.09**	5	**4.27**
AT04	≤5	0.6	30	**38.39**	5	**6.39**
AT05	≤5	0.3	43	**110.05**	5	**12.80**
AT06	≤5	0.4	50	**95.98**	5	**9.60**
AT07	≤5	0.4	60	**95.98**	5	**8.00**
AT08	≤5	3.0	42	**10.75**	5	**1.28**
AT09	≤5	0.9	30	**25.60**	5	**4.27**
AT10	≤5	1.1	28	**19.54**	5	**3.49**
AT11	≤5	0.7	60	**65.81**	5	**5.48**
AT12	≤5	0.8	27	**25.91**	5	**4.80**
AT13	≤5	1.0	26	**19.96**	5	**3.84**
AT14	≤5	0.6	60	**76.78**	5	**6.40**
AT15	≤5	0.5	30	**46.07**	5	**7.68**
AT16	≤5	0.6	30[5]	**38.39**	5	**6.40**
Substation	≤5	0.5	27	**41.46**	5	**7.68**

[2] Minimum in-situ test values used

[3] Laboratory test values employed for similar peat soils recovered in the vicinity of Benbradagh, Co. Antrim.

[4] Dry peat immediately followed by saturation – “worst case scenario”

[5] Estimate based on value at AT15

Table 8 – Analytical assessment of Stability of Excavations

LOCATION	Cu (kPa)	Maximum Face Height Considered (m)	Factor of Safety Rotational Failure
AT01	52	0.7	>1.3
AT02	30	0.6	>1.3
AT03	13	0.9	>1.3
AT04	30	0.6	>1.3
AT05	43	0.3	>1.3
AT06	50	0.4	>1.3
AT07	60	0.4	>1.3
AT08	42	3.0	>1.3
AT09	30	0.9	>1.3
AT10	28	1.1	>1.3
AT11	60	0.7	>1.3
AT12	27	0.8	>1.3
AT13	26	1.0	>1.3
AT14	60	0.6	>1.3
AT15	30	0.5	>1.3
AT16	30	0.6	>1.3
Substation	27	0.5	>1.3

1.3 QUALITATIVE ANALYSIS

The following sections detail the assessment methodology[6] that has been employed to assess the stability of peat soils at Tirawley Wind Farm.

The Scottish Guidance originally proposed an assessment of "Degree of Risk", as described by Clayton in the Institution of Civil Engineers' publication, "Managing Geotechnical Risk" (2001).

DEGREE OF RISK = LIKELIHOOD X EFFECT

This original approach was later modified, and the final formulation conceived: -

HAZARD RANKING = HAZARD X EXPOSURE

The Scottish Guidance provides no definitive approach to determination of elements required to determine HAZARD or EXPOSURE although it does provide guidance. Neither does it provide the relative weighting that should be employed to each individual term to determine its severity. The Scottish Guidance also recommends a probabilistic approach to determining risk which, in the author's opinion, cannot hope to mirror complex cumulative risks appropriate to individual sites.

For this purpose, a factor-based analysis of hazard and exposure are used in this report to obtain a calculation of hazard ranking.

For this algorithm applied Likelihood / Hazard is represented by a range of factors determined from a selection of Preparatory Factors, Preconditions and Pre-Failure indicators as identified previously. These Hazards are weighted depending on the relative instability they tend to cause in the peat mass system. The treatment of potential Triggers is constrained as previously mentioned and Effect / Exposure relates to a spatial examination of sensitive receptors in relation to anticipated triggering location. These exposures are weighted depending on their adverse consequence.

Numerical calculation of peat stability is also employed but only as a check to the factor-based algorithm.

The parameters employed in this particular assessment of risk are given in the following sections.

HAZARD: *Likelihood of the peat landslide event occurring*
(This relates to the potential for a peat landslide to be triggered. Factors considered include the topographic

[6] Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, Prepared for Energy Consents Unit Scottish Government, Second Edition, April 2017

slope, peat thickness, strength of peat, type of peat present and method of construction proposed.)

The tables below give the factors used to establish overall Peat Stability HAZARD.

Table 9 – Qualitative assessment of Peat Landslide Hazard – Peat Depth

Scale of Risk	Hazard
0	Peat depth less than 0.5m
+1	Peat depth between 0.5 - 2.5m
+2	Peat depth between 2.5 – 4.0m
+3	Peat depth greater than 4.0m

Table 10 – Qualitative assessment of Peat Landslide Hazard – Slope

Scale of Risk	Hazard
0	Slopes < 5 degrees to the horizontal
+1	Slopes between 5 and 10 to the horizontal
+2	Slopes between 10 and 22.5 degrees to the horizontal
+3	Slopes > 22.5 degrees to the horizontal

Multiplication factor of 1.25 added for convex slopes

Table 11 – Qualitative assessment of Peat Landslide Hazard – Drainage

Scale of Risk	Hazard
0	Drainage issues not significant
+0.5	Drainage ditches within the vicinity
+1	Drainage issues significant

Table 12 – Qualitative assessment of Peat Landslide Hazard – Relic Peat Landforms

Scale of Risk	Hazard
0	Relic Peat Landforms do not present locally
+1	Relic Peat Landforms present in vicinity of construction zone

Table 13 – Qualitative assessment of Peat Landslide Hazard – Piling

Scale of Risk	Hazard
0	No Sonic/Seismic Activity locally (Piling or Blasting within 500m)
+1	Sonic/Seismic Activity locally (Piling or Blasting within 500m)

Table 14 – Qualitative assessment of Peat Landslide Hazard – Humification

Scale of Risk	Hazard
-0.5	H0 –H2 Von Post Classification of Peat Degradation [7] Where very low rates of degradation are present this tends to correspond to a highly organic silty clay soil and as such these soils exhibit a much-reduced risk of instability.
0	H3 –H8 Von Post Classification of Peat Degradation
+1	H9 –H10 Von Post Classification of Peat Degradation

Table 15 – Qualitative assessment of Peat Landslide Hazard – Shear Strength

Scale of Risk	Hazard
-0.5	>60 kPa Vane Test Classification of Shear Strength at 1.5m depth. Refer to Table 11. Applies where very low rates of decomposition are present and the soils are more akin to highly organic silty clays.
0	20-60 kPa Vane Test Classification of Shear Strength at 1.5m depth
+1	10-20 kPa Vane Test Classification of Shear Strength at 1.5m depth
+2	5-10 kPa Vane Test Classification of Shear Strength at 1.5m depth
+3	*<5 kPa Vane Test Classification of Shear Strength at 1.5m depth*

EXPOSURE: *Adverse Consequence / Impact that such an event might have at this particular location*

The Scottish Guidance assesses exposure in terms of impact, e.g. Very Low Impact to Extremely High Impact, but does not state directly what type of receptors are of concern. The two receptor types identified by the Scottish Guidance are potential for "Financial Impact" and / or "Environmental Impact". For this report a combination of Public Safety and Environmental Impact have been used to derive receptors.

The chosen rationale, for the selection of EXPOSURE receptors, in this report is as follows:

1. The main purpose of this report is to determine the risk to 3rd parties. That is infrastructure, structures and environmentally sensitive receptors, such as watercourses and protected zones, whilst avoiding determination of Hazard Ranking for the wind farm installation itself.

That being the case, the individual EXPOSURES employed, and their relative weighting are summarised in Table 16, below., which gives a general view of some examples of the factors used to establish EXPOSURE.

Table 16 – Qualitative Assessment of Peat Landslide Hazard Exposure

Scale of Exposure	Examples of Determining Factors	Impact upon total project
1	Flat agricultural land or blanket bog within 100m of structure or 50m for roads (i.e. Structure >100m or site tracks >50m from an unspecified environmental receptor, such as an undesignated stream,	Very low Impact (<1%)

[7] Negative factors are only employed where the positive sum of all other HAZARD factors >4

Scale of Exposure	Examples of Determining Factors	Impact upon total project
2.00	Structure <100m from minor water course or another sensitive landform. <50m in the case of site tracks Structure <200m from area of special scientific interest, special conservation area, or other designated European Site, where there is potential of indirect / downslope impact.	Low Impact (1% - 4%)
2.25* 2.5**	*If there is a sensitive receptor, such as a weak bridge (or other receptor that could be detrimentally impacted by entrained debris flow) within 5km down-steam, a factor of 0.25 can be added to the scale of exposure. **If there is a sensitive receptor within 1km downstream a factor of 0.25 is added to the scale of exposure.	Low Impact (1% - 4%)
3	Structure or site tracks <100m from receptor of high environmental sensitivity – e.g. major designated water course, or uninhabited buildings, structure or site tracks <300m from receptor of strategic importance, e.g. lightly trafficked minor roads, major public utilities	High Impact (4% - 10%)
4	Structure <300m from moderately to highly trafficked public road or minor rail lines, area of special scientific interest where there is potential for direct / downslope impact, sensitive buildings, water abstraction etc.	Very High Impact (10% - 100%)
5	Structure <300m proximity to temporarily or permanently inhabited buildings, areas of public congregation, primary rail lines and infrastructure or other sensitive facility.	Extremely High Impact (> 100%)

The precise classification of each EXPOSURE is determined by the consultant in consultation with other members of the team.

By assessing each peat landslide event against the scales given above, it is possible to assess the hazard ranking by multiplying the hazard and exposure of each event. This results in a Hazard Ranking value as follows.

HAZARD RANKING = HAZARD x EXPOSURE

The following table outlines the suggested action for the different levels of hazard ranking as determination by the factor-based risk assessment process. The rationale employed to determine the relative severity of Hazard Rankings is based upon the Scottish Guidance.

Table 17 – Hazard Ranking and Suggested Actions (Refer to "Peat Landslide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments", Dec 2017, Section 5, Table 5.3, Page 5-6)

Hazard Ranking	Hazard Ranking Level	Action Suggested
≥17	**High**	Avoid project development at these locations
11 – 16	**Medium**	Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to Low or Negligible
5 – 10	**Low**	Project may proceed through the use of mitigation techniques applied during construction.

Hazard Ranking	Hazard Ranking Level	Action Suggested
0 – 4	Negligible	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

The following tables summarise the relative Hazard Ranking of each Turbine, Structure and segment of new Access Track to be constructed at the Tirawley Wind Farm site. Refer to Table 16 for further details.

Table 18 – Hazard Ranking for each Structure at Tirawley Wind Farm

ID	ITM Co-ordinates		Peat Stability Hazard Ranking
	Easting	Northing	
AT01	515725	834020	3
AT02	514978	832589	4
AT03	514857	832846	3
AT04	514889	833179	6
AT05	514649	834627	1.5
AT06	514381	834572	1.5
AT07	515958	835555	1
AT08	515991	835837	5
AT09	515645	836489	3
AT10	515700	836763	4
AT11	515557	837162	9
AT12	515244	837695	9
AT13	515574	837498	6
AT14	515940	837488	6
AT15	516909	837891	6
AT16	516972	837587	2
Substation	514978	832589	5

Table 18A – Hazard Ranking for each stretch of new site access track

ID	Peat Stability Hazard Ranking
To AT01	**7.5**
Spur to AT02	**6**
To AT03 and at the Met Mast	**9**
Spur to AT04	**6**
Spur to AT05	**1.5**
To AT06	**3**
Spur to AT07	**3**
To AT08	**10**
To AT09	**6**
To AT10	**6**
To AT11	**9**
To AT12	**9**
To AT13	**6**
To AT14	**5**
To AT16	**5**
AT15 to AT16	**6**

Appraisal of the Hazard Rankings for each proposed turbine location provides the following findings. The following discourse offers an appraisal of ground conditions at each of the structural locations.

1. At turbine location **AT01** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.70m**	+1
C	Minor drainage issues anticipated	+0.5
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1 – H3**	0
G	Ave peat strength **52kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5

Potential Exposure Risk is 2. (Minor watercourse < 100m from the proposed turbine location)

This equates to a **Hazard Ranking of 3** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

2. At turbine location **AT02** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.60m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 2. (Minor watercourse < 100m from the proposed turbine location)

This equates to a **Hazard Ranking of 4** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

3. At turbine location **AT03** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.90m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **13kPa**	+1
Sum		**+3**

Preliminary Peat Landslide Hazard is 3

Potential Exposure Risk is 1. (No sensitive receptors within relevant buffer)

This equates to a **Hazard Ranking of 3** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

4. At turbine location **AT04** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0

B	Maximum peat thickness at the proposed turbine location is **0.60m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 6** and places turbine construction at this location in the **LOW RISK** Category.

5. At turbine location **AT05** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.30m**	0
C	Minor drainage issues anticipated	+0.5
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1**	0
G	Peat strength **43kPa**	0
Sum		**+0.5**

Preliminary Peat Landslide Hazard is 0.5

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 1.5** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

6. At turbine location **AT06** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.4m**	0
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1 / H3**	0
G	Peat strength **68kPa**	0

Sum		**+0.5**

Preliminary Peat Landslide Hazard is 0.5

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 1.5** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

7. At turbine location **AT07** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.40m**	0
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1 / H3**	0
G	Peat strength **60kPa**	0
Sum		**+0.5**

Preliminary Peat Landslide Hazard is 0.5

Potential Exposure Risk is 2. (<100m to minor watercourse)

This equates to a **Hazard Ranking of 1** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

8. At turbine location **AT08** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is 3**.00m**	**+2**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **42kPa**	0
Sum		**+2.5**

Preliminary Peat Landslide Hazard is 2.5

Potential Exposure Risk is 2. (Minor watercourse < 100m from the proposed turbine location)

This equates to a **Hazard Ranking of 5** and places turbine construction at this location in the **LOW RISK** Category.

9. At turbine location **AT09** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.90m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5

Potential Exposure Risk is 2. Minor watercourse < 100m from the proposed turbine location)

This equates to a **Hazard Ranking of 3** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

10. At turbine location **AT10** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **1.10m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H6**	0
G	Peat strength **28kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 2. (Minor watercourse < 100m from the proposed turbine location)

This equates to a **Hazard Ranking of 4** and places turbine construction at this location in the **NEGLIBIBLE RISK** Category.

11. At turbine location **AT11** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.70m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	Relic peat landforms in vicinity	**+1**

E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H6**	0
G	Peat strength **60kPa**	0
Sum		**+3**

Preliminary Peat Landslide Hazard is 3

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 9** and places turbine construction at this location in the **LOW RISK** Category.

12. At turbine location **AT12** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal..	0
B	Maximum peat thickness at the proposed turbine location is **0.80m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	Relic peat landforms in vicinity	**+1**
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H6**	0
G	Peat strength **60kPa**	0
Sum		**+3**

Preliminary Peat Landslide Hazard is 3

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 9** and places turbine construction at this location in the **LOW RISK** Category.

13. At turbine location **AT13** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **1.00m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H5**	0
G	Peat strength **26kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5.

Potential Exposure Risk is 4. (<300m from Sensitive Building)

This equates to a **Hazard Ranking of 6** and places turbine construction at this location in the **LOW RISK** Category.

14. At turbine location **AT14** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.60m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1 / H3**	0
G	Peat strength **60kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5

Potential Exposure Risk is 4. (<300m from Sensitive Building)

This equates to a **Hazard Ranking of 6** and places turbine construction at this location in the **LOW RISK** Category.

15. At turbine location **AT15** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.50m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	Relic peat landforms in vicinity	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)
This equates to a **Hazard Ranking of 6** and places turbine construction at this location in the **LOW RISK** Category.

16. At turbine location **AT16** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0

B	Maximum peat thickness at the proposed turbine location is **0.60m**	**+1**
C	Drainage issues anticipated	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 1. (No sensitive receptors within relevant buffer)

This equates to a **Hazard Ranking of 2** and places turbine construction at this location in the **NEGLIGIBLE RISK** Category.

17. At the **SUBSTATION** location the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness at the proposed turbine location is **0.50m**	**+1**
C	No significant drainage issues anticipated	0
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1 – H3**	0
G	Ave peat strength **27kPa**	0
Sum		**+1**

Preliminary Peat Landslide Hazard is 1

Potential Exposure Risk is 5. (Residential Property < 300m from the proposed substation location)

This equates to a **Hazard Ranking of 5** and places substation construction at this location in the **LOW RISK** Category.

An assessment of risk was also carried out for the proposed site access tracks, as follows:-

18. For the Access Track between the Public Road and **AT01** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is in the range **0.00m – 0.70m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0

F	Peat degradation **H1 – H3**	0
G	Ave peat strength **52kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5

Potential Exposure Risk is 5. (<300m from residential property)

This equates to a **Hazard Ranking of 7.5** and places track construction at this location in the **LOW RISK** Category.

19. For the Access Track from spur to **AT02** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is in the range **0 – 0.60m**	**+1**
C	Saturated ground anticipated (Forestry)	+1
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 6** and places track construction at this location in the **LOW RISK** Category.

20. For the Access Track to **AT03** and at the **Met Mast**, the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is **0.40 – 0.90m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **13kPa**	+1
Sum		**+3**

Preliminary Peat Landslide Hazard is 3

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 9** and places track construction at this location in the **LOW RISK** Category.

21. For the Access Track from **spur to AT04** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is ≤**0.80m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 6** and places track construction at this location in the **LOW RISK** Category.

22. For the Access Track from spur to **AT05** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is ≤**0.50m**	0
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1/H3**	0
G	Peat strength **43kPa**	0
Sum		0.5

Preliminary Peat Landslide Hazard is 0.5

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 1.5** and places track construction at this location in the **NEGLIGIBLE RISK** Category.

23. For the Access Track to **AT06** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor

A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is **0.40m**	0
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1**	0
G	Peat strength **68kPa**	0
Sum		**+1**

Preliminary Peat Landslide Hazard is 1

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 3** and places track construction at this location in the **NEGLIGIBLE RISK** Category.

24. For the Access Track to **AT08** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **5º - 10º** to horizontal.	**+1**
B	Maximum peat thickness along this section of track is **1.20m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **26kPa**	0
Sum		**+2.5**

Preliminary Peat Landslide Hazard is 2.5.

Potential Exposure Risk is 4. (<300m to sensitive buildings)

This equates to a **Hazard Ranking of 10** and places track construction at this location in the **LOW RISK** Category.

25. For the Access Track spur to **AT07** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of 0º **- 5º** to horizontal.	**0**
B	Maximum peat thickness along this section of track is **0.70m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **22kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5.

Potential Exposure Risk is 2. (Crosses minor watercourse)

This equates to a **Hazard Ranking of 3** and places track construction at this location in the **NEGLIGIBLE RISK** Category.

26. For the Access Track **to AT09** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is **1.10m**	+1
C	Saturated ground anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2.

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 6** and places track construction at this location in the **LOW RISK** Category.

27. For the Access Track to **AT10** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is **1.30m**	**+1**
C	Saturated ground anticipated (Forestry)	+1
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H6**	0
G	Peat strength **28kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 6** and places track construction at this location in the **LOW RISK** Category.

28. For the Access Track to **AT11** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is **0.70m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	Relic peat landforms in vicinity	**+1**
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H6**	0
G	Peat strength **60kPa**	0
Sum		**+3**

Preliminary Peat Landslide Hazard is 3

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 9** and places track construction at this location in the **LOW RISK** Category.

29. For the Access Track to **AT12** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is **0.90m**	**+1**
C	Saturated ground anticipated (Forestry)	**+1**
D	Relic peat landforms in vicinity	**+1**
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H5**	0
G	Peat strength **27kPa**	0
Sum		**+3**

Preliminary Peat Landslide Hazard is 3

Potential Exposure Risk is 3. (<300m from minor public road)
This equates to a **Hazard Ranking of 9** and places track construction at this location in the **LOW RISK** Category.

30. For the Access Track to **AT13** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is in the range **0.50m – 1.00m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	No relic peat landforms	0

E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H4 / H5**	0
G	Peat strength **26kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5.

Potential Exposure Risk is 4. (<300m from sensitive building)

This equates to a **Hazard Ranking of 6** and places track construction at this location in the **LOW RISK** Category.

31. For the Access Track to **AT14** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is **0.50m**	**+1**
C	Minor drainage issues anticipated	**+0.5**
D	Relic peat landforms in vicinity	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1 / H3**	0
G	Peat strength **60kPa**	0
Sum		**+1.5**

Preliminary Peat Landslide Hazard is 1.5.

Potential Exposure Risk is 4. (<300m from sensitive building)

This equates to a **Hazard Ranking of 6** and places track construction at this location in the **LOW RISK** Category.

32. For the Access Track to **AT16** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	**0**
B	Maximum peat thickness along this section of track is **0.60m**	**+1**
C	No drainage issues anticipated	0
D	Relic peat landforms in vicinity	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H1 / H3**	0
G	Peat strength **30kPa**	0
Sum		**+1**

Preliminary Peat Landslide Hazard is 1

Potential Exposure Risk is 5 (<300m to residential property)

This equates to a **Hazard Ranking of 5** and places track construction at this location in the **LOW RISK** Category.

33. For the Access Track from **AT16** to **AT15**, the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum gradient is in range of **0º - 5º** to horizontal.	0
B	Maximum peat thickness along this section of track is ≤**0.50m**	**+1**
C	Drainage issues anticipated (Forestry)	**+1**
D	No relic peat landforms	0
E	No sonic activity within 500m – Negligible seismic activity.	0
F	Peat degradation **H3 / H5**	0
G	Peat strength **30kPa**	0
Sum		**+2**

Preliminary Peat Landslide Hazard is 2

Potential Exposure Risk is 3. (<300m from lightly trafficked minor public road)

This equates to a **Hazard Ranking of 6** and places track construction at this location in the **LOW RISK** Category.

The above Hazard Rankings have been determined by analysis of site-specific ground conditions at the proposed Tirawley Wind Farm site in accordance with the guidelines outlined by The Scottish Executive & Halcrow Group Ltd in "*Peat Landslide Hazard and Risk Assessment - Best Practice Guide for Proposed Electricity Generation Developments*", April 2017.

1.4 RECOMMENDATIONS

Construction mitigation (specified in Table 19), where applied in full, will further reduce the hazard rankings recorded in Tables 18 / 18A to those indicated in Tables 20 / 20A.

1.4.1 Construction Mitigation of Risk

General Constraints and Anecdotal Evidence

Analysis of the historic conditions following peat Landslides indicates that the following main factors generally trigger slope failures:

1. Excessive quantities of spoil loaded onto sensitive peat covered sloping ground. (In such cases the gradient of the slope should be no more than an average of 5 degrees to the horizontal). Where peat is not of a sensitive nature, it will be possible to load spoil onto slopes up to a maximum of 10 degrees to the horizontal.

2. The angle of repose of the cut face of excavations is all too often found to be too high, sometimes 70 – 80 degrees to the horizontal. Battering back the sides of an excavation to approx. 45 degrees helps to reduce the potential for slippage, which will significantly reduce the potential for peat movement.

3. The consequences of peat landslide can be identified as Damage to Machinery, Damage or Loss of Access Track, Damage to Site Drainage, Site Works Damaged, Death or Injury to Personnel or Degradation to the Environment.

4. A contingency plan is to be compiled and will be enacted should peat movement occur.

1.4.2 Prevention of Peat Landslide and Bog Burst

Application of the following procedures will have the effect of reducing the Hazard Ranking associated with Peat Instability:

1. Excavated spoil will not be deposited on the down slope or up slope edges of the adjacent peat. This spoil will instead be deposited on the two flanks either side of the excavation (where gradient is least) and spread in such a way as to limit the surcharge pressure on sensitive peat.

2. Bog Burst is recognised to be a difficult condition to mitigate against. Bog Burst tends to occur within deep peat (> 2.50m) after very heavy or prolonged precipitation. To ward against this possibility the design of turbine bases should be engineered to ensure that excavations do not cut into deep peat (>2.50m). It is however considered acceptable, where slopes are less than 5 degrees, that floating roads may be placed within peat cover exceeding 2.50m depth.

3. The hardstanding areas surrounding the turbine bases will be designed in a manner such that crane loadings can be transferred directly onto the competent strata underlying the peat. In order to facilitate these works it will be necessary to undertake limited excavations. To ensure effective sidewall support during these operations the contractor will adopt an approved engineering solution (such as sheet piling) to maintain sidewall stability at all times.

4. Movement can often occur during or following severe rainstorm events, particularly when following a prolonged dry spell. Extra vigilance will be maintained at such times, during construction.

5. All slopes are to be regularly checked for development of tension cracks (caused by desiccation), indicative of slope movement.

6. Extra care will be taken where the peat has previously been tilled. Attention should be paid to any historic turbary nature of a site.

7. Method statements will be followed at all times. Where modification is required, this will be agreed by the supervising engineer.

8. Slopes will not be undercut or excavations left unsupported for periods in excess of 24 hours. Excavations are to be backfilled as soon as practicable. Excavation and filling operations shall be coordinated to minimise the time an excavation remains opened.

9. Pore water pressure within excavations should be kept low at all times by draining deliberate or intentional sumps at regular intervals. This is to prevent ponding of water within excavations which can in turn increase hydraulic heads locally and potentially lead to instability.

10. The potential for Peat Landslide will be monitored regularly during the construction works, by means of regular site visits and assessments, by a suitably qualified and experienced professional.

11. Only experienced and competent contractors will be appointed to carry out the construction works. Low ground bearing pressure machinery shall be used for transport of construction materials in sensitive areas. It is also recommended that the less sensitive areas are completed first to allow suitable construction practices to be established before works commence in the more difficult areas.

12. Site staff will also undergo induction training to learn about the risks associated with working on “upland environments” and procedures aimed at reducing Peat Landslide risk.

13. Sufficient time should be allowed to carry out the works in a safe and timely manner.

1.4.3 Spoil Disposal

Spoil will invariably be generated during excavations for foundations at turbines and along new access roads.

Minimisation of the production of this spoil will be treated as a high priority, but it is nevertheless expected that there will be in the region of 157,952 m^3 of peat soils and glacial till excavated during site works.

Analysis of peat depths recorded along proposed site tracks and turbine locations indicates a range of 0.00m to 3.00m across the development area with an average peat depth of 0.36m within the construction zone.

Assuming average peat depth prevails across the construction footprint, the volume of peat (or organic soils) extracted is estimated to be approximately 97,507 m^3.

Assuming an average depth to competent bearing stratum equivalent to peat thickness + 0.30m of soft silt for hard-standings and 3.50m for turbine foundations, the volume of drift / glacial till / rippable weathered rock to be extracted is estimated to be approximately 60,444 m^3.

Spoil types will be treated separately. Glacial soils and peat will be separated during excavation and these two types of spoil will be disposed of generally as follows:

A *Glacial soils will be deposited directly on top of other glacial soils. This will require the removal of peat where present to facilitate the process.*

B *Peat can be disposed of either on top of glacial soils, on top of inactive peat or on top of the "Acrotelm" where the "Top Mat" has been removed.*

1. Glacial and peat spoil disposal will take place at two main locations: 1) within 100m of each structure or 2) off-site at a suitable permanent waste repository. Peat spoil will also be side cast to form swales along the edges of suitable portions of the access road network and to form aprons around turbine hardstands, where constraints permit.

2. It is intended that spoil movements will be minimised by disposing of the material within or immediately adjacent to the construction footprint of the structure from whence it was excavated.

3. Preparation of the Spoil Disposal site will involve the removal of the "Top Mat" which will be transplanted to an area of inactive bog and maintained for re-use during restoration operations.

4. Spoil will be deposited, in layers of 0.50m and will not exceed a total thickness of 2.00m, unless contained by suitably designed berms.

5. Spoil will only be deposited on slopes of < 10 degrees to the horizontal and greater than 10m from the top of a cutting. The exact location of such areas will be determined on consultation with the geotechnical specialist.

6. A Peat Stability Register will record the location of each Spoil Disposal Site used and regular weekly assessment will be made by the construction manager or other suitably qualified individual.

7. Once disposal is complete the disposal sites will be re-vegetated with the "Top Mat" removed at the commencement of disposal operations. Upon commencement of the restoration phase guidance from a suitably qualified ecologist will be sought to provide a suitable methodology and programme of maintenance for the restored areas.

1.4.4 Adjustment factors for Hazard due to adoption of Mitigation Measures:

Table 19 – Hazard – Risk Reducing factors

Risk Reduction Factor	Scale of Risk	Hazard
A	-0.25	Limiting of construction during periods of heavy rainfall
B	-0.25	Direct support of peat faces at excavation locations
C	-0.50	Battering back of peat faces to 45 degrees within 100m of proposed works
D	-0.50	Engineered drainage solution
E	-0.25	Use of machinery with low ground bearing pressure for the transport of spoil and fill
F	-0.50	Staff Induction and regular program of surveillance by external geotechnical engineer

The reduction in risk due to the above measures is discussed below, and the Hazard Rankings have been updated for each location; refer to Tables 20 / 20A.

1.4.5 Post-Mitigation

Implementation of the mitigation measures contained within the previous section (Table 19 – Hazard – Risk Reducing Factors) allows the optimal level of risk to be attained at each turbine at the proposed development site of Tirawley Wind Farm.

Table 20 – Hazard Ranking for each turbine location following Mitigation Measures

Turbine Location	Pre-Mitigation			Risk Reduction Factors[8]						Post-Mitigation		
	Hazard	Exposure	HAZARD RANKING	A (-0.25)	B (-0.25)	C (-0. 5)	D (-0.5)	E (-0.25)	F (-0.5)	Hazard	Exposure	HAZARD RANKING
AT01	1.5	2	**3**						Y	1	2	**2**
AT02	2	2	**4**			Y			Y	1	2	**2**

[8] Refer to Table 19 for explanation of the Risk Reduction Factors (A – F)

AT03	3	1	**3**			Y			Y	2	1	**1**
AT04	2	3	**6**			Y			Y	1	3	**3**
AT05	0.5	3	**1.5**							0.5	3	**1.5**
AT06	0.5	3	**1.5**							0.5	3	**1.5**
AT07	0.5	2	**1**							0.5	2	**1**
AT08	2.5	2	**5**			Y		Y	Y	1.25	2	**2.5**
AT09	1.5	2	**3**			Y		Y		0.75	2	**1.50**
AT10	2	2	**4**			Y			Y	1	2	**2**
AT11	3	3	**9**	Y		Y		Y	Y	1.25	3	**3.75**
AT12	3	3	**9**	Y	Y	Y		Y	Y	1.25	3	**3.75**
AT13	1.5	4	**6**	Y					Y	0.75	3	**2.25**
AT14	1.5	4	**6**			Y			Y	0.5	4	**2**
AT15	2	3	**6**			Y			Y	1	3	**3**
AT16	2	1	**2**						Y	1.5	1	**1.5**
Substation	1	5	**5**						Y	0.5	5	**2.5**

Table 20A – Hazard Ranking for each stretch of new site access track following Mitigation Measures

Access Track Section	Pre-Mitigation			Risk Reduction Factors						Post-Mitigation		
	Hazard	Exposure	HAZARD RANKING	A (-0.25)	B (-0.25)	C (-0. 5)	D (-0.5)	E (-0.25)	F (-0.5)	Hazard	Exposure	HAZARD RANKING
To AT01	1.5	5	**7.5**			Y			Y	0.5	5	**2.5**
Spur to AT02	2	3	**6**			Y			Y	1	3	**3**
To AT03 and at the Met Mast	3	3	**9**	Y		Y		Y	Y	1	3	**1.5**
Spur to AT04	2	3	**6**			Y			Y	1	3	**3**
Spur to AT05	0.5	3	**1.5**							0.5	3	**1.5**
To AT06	1	3	**3**						Y	0.5	3	**1.5**

Spur to AT07	1	3	**3**					Y		0.5	3	**1.5**
To AT08	1.5	2	**10**						Y	1	2	**2**
To AT09	2	3	**6**			Y			Y	1	3	**3**
To AT10	2	3	**6**			Y			Y	1	3	**3**
To AT11	3	3	**9**	Y	Y	Y		Y	Y	1.25	3	**3.75**
To AT12	3	3	**9**	Y	Y	Y		Y	Y	1.25	1	**3.75**
To AT13	1.5	4	**6**			Y			Y	0.5	4	**2**
To AT14	1.5	4	**5**			Y			Y	0.5	4	**2**
To AT16	1	5	**5**			Y			Y	0.25	5	**1.25**
AT15 to AT16	2	3	**6**			Y			Y	1	3	**3**

G DO NOTHING IMPACT

Were the proposed development not to take place there would be a reduction in the hazard associated with peat instability. Contributory factors to peat instability can be split into two forms: -

1. Natural and pre-existing conditions, e.g. rainfall, existing slopes, existing peat thickness etc. and relative position in relation to sensitive receptors.
2. Man-made intervention, e.g. cutting into slopes, placement of foundations within soils, loadings imposed on peat and mineral soils by access track construction, spoil deposition and changes to the hydrological regime caused by new drainage.

The hazard associated with man-made interventions is in addition to the "Baseline Hazard" resulting from the natural and pre-existing conditions. As a result, the hazard of peat instability is greatest during the construction phase but also remains to a lesser degree during the lifetime of the project.

"Baseline Hazards" associated with natural or pre-existing conditions can be expected to continue throughout the lifetime of proposed development. and essentially equate to the "Do Nothing Impact", discussed here.

H POTENTIAL IMPACTS OF THE DEVELOPMENT

1.1 CONSTRUCTION PHASE

1.1.1 Earthworks Activities

Implementation of the proposed development will result in the removal of peat in parts of the site to facilitate excavation for the construction of access roads and platforms for the wind turbines to a competent stratum or bedrock suitable for the emplacement of foundations.

Ground conditions vary across the site with varying depths of topsoil and peat cover. Preliminary investigations indicate that, at the proposed turbine bases, an average of 3.50m will be required to reach a suitable bearing stratum.

1.1.2 Potential for Bog Failure

Consideration has been given to the potential for bog failures at the Tirawley Wind Farm site. These mass movements of peat can take the form of either bog burst or bog slide. Historical evidence suggests that raised bogs are more prone to bog bursts while bog slides are more common on blanket bogs, however it is noted that there is no historical or visually identifiable evidence of peat landslides or ground instability at the development site.

These peat failures generally occur either during or immediately after periods of heavy rainfall. Failures are especially likely to occur where there is a break of slope at the edge of an upland plateau of peat. Records indicate that bog bursts can naturally occur on shallow slope angles of less than 5 degrees while bog slides appear to occur on slopes that are steeper than 5 degrees. It is important to note that at such low angles the cause of failure is less associated with the actual topographic gradient and more to do with hydrostatic pressure, i.e. the water volume contained within. Peat movement on such low gradients tend to be initiated by a rupture within the peat body and not at contact between the peat base and the underlying formation.

Following well documented bogslides on the slopes of Dooncarton and Barnachuille mountains, Co. Mayo in September 2003 and at Derrybrien, Co. Galway in October 2003, the potential for bog failure has come to the fore in consideration of planning for wind farm development. At Derrysallagh Wind Farm located approximately 10 km west of Tullynamoyle on the Sligo / Roscommon border, a suspected peat landslide event in December 2016 resulted in a fatality. Significantly, a peat landslide originating on Shass Mountain near Drumkeeran, Co. Leitrim occurred in June 2020. A recent, well documented peat landslide event was also recorded at Meenbog Wind Farm, Co. Donegal during November 2020. The following potential causal factors for bog failure are identified following research and assessment of recent slides and from historical evidence over the last 200 years in Ireland.

Research into the history of bogslide occurrence indicates that the majority of bogslides have occurred on the blanket bogs in the west where rainfall is highest. Here, bogslides tend to be more frequent during the autumn and winter months.

The following criteria are considered to be the causal or contributory factors to bogslide occurrence:

(a) Slope is the single most important factor for blanket bogs. Bog slides are especially likely to occur where there is a break in slope at the edge of an upland plateau of blanket peat, providing a line of weakness. While initial failure is likely to be slippage (translational or rotational faults) semi-fluid to fully fluid behaviour is the main movement mechanism downslope. Slope gradient imparts kinetic energy to the sliding material.

(b) The depth of peat and its relationship to humification (the degree to which the fibre structure of the peat has decayed), pore water pressure, shear vane strength and other parameters generally indicates that the deeper the peat profile the more unstable it is, if external controls such as slope, drainage, removal of adjoining earth materials are changed. Exact depth thresholds for stability are not applicable due to the variability of peat environments (raised bog, blanket bog or fen habitats) and their site-specific conditions. However, as a rule of thumb peat of depths greater than >1.5m is significantly more vulnerable to instability than thinner peat at <1.5m depth, and peat thickness of ≤0.5m is usually capable of long-term self-support.

(c) The pattern of recent precipitation at the site over the last c. 30 years such as intense localised rainfall (or melting snow) is an important trigger mechanism.

(d) Antecedent weather conditions such as drought conditions are identified as a contributing factor. In the case of the landslides at Dooncarton and Barnachuille in September 2003 and at Derrybrien October 2003, short intense periods of heavy rainfall followed an exceptionally dry late summer. Historically, the Owenmore bogslide in Erris, Co. Mayo (1819) was also preceded by two months of drought. Sustained dry conditions leads to high soil moisture deficit (SMD). This dries the blanket peat, causing shrinkage and desiccation cracks.

(e) Some bogslides are caused by excessive interference – e.g. opening of turf banks, opening deep drains on blanket bog. All drains should be perpendicular to slope contour not parallel to it.

Finally, the following items are noted:

1. Geological structural features generally play no part in bogslide occurrence.
2. Bogslides are prone in certain upland locations due to their peculiar topography, ground composition and hydrology. When a slide occurs, it acts as a safety valve to restore equilibrium.
3. The most destructive bogslides involve the combination of slide materials with floodwaters, diluting the peat and mud in waterways and accelerating the velocity of the debris flow.

1.1.3 Water Quality

The following impacts both likely and potential are identified:

Suspended solids release during excavations

In a wind farm development, it is the construction phase that poses the highest risk to the site's hydrology, in particular to the quality of surface water due to generally poor aquifer conditions on high elevation terrain. The Tirawley Wind Farm site is situated on high elevation terrain. Nevertheless, it is likely that during excavation works, storage and re-use of materials, suspended solids will be entrained by sustained rainfall and surface water runoff.

The most vulnerable areas to surface water quality deterioration are (a) access road crossings of man-made drains and (b) turbine hardstand and infrastructure development at moderate gradient slopes proximal to existing waterways.

Some of the man-made drains have moderate gradients cut out, which should be considered if constructing new access tracks. This is considered to be short-term and temporary but could have a significant negative impact. With appropriate environmental engineering controls and measures, this impact can be negated and mitigated against.

Risk of pollution from hydrocarbons

The second pollutant of concern during the construction phase of the project is the potential spillage and release of hydrocarbons from plant equipment and associated transfer stations during the construction phase. An accidental hydrocarbon spillage would have a significant negative impact on both vegetation and water quality at the site.

Temporary sanitation

A temporary site office, service area and sanitation will be required for the construction stage of the development. Associated with this facility is the potential risk of water and soil contamination by wastewater release or chemical contamination of water and soil from temporary sanitation facilities. The level of risk posed is dependent on the type and location of facilities that are put in place.

The Water Framework Directive (WFD) highlights that all groundwater has a value irrespective of whether it occurs in a major or minor aquifer. Groundwater also contributes and maintains the surface water network and as a result its contamination should be mitigated against.

1.2 OPERATIONAL PHASE

1.2.1 Change to Hydrological Regime

The rate and amount of surface water run-off from the site will increase as a function of the replacement of vegetation, peat and sub-soils cover (which absorb rainfall) in parts of the site with a concrete / aggregate hardstand at turbine locations, and aggregate mix for proposed access tracks.

1.2.2 Water Quality

A potential impact on water aspects of the environment may arise during the operational phase of the development if regular maintenance, monitoring and auditing of mitigation structures and procedures are not undertaken during the lifetime of the project.

I MITIGATION MEASURES

1.1 CONSTRUCTION PHASE MITIGATION

1.1.1 Earthworks Activities

The removal of soils will be unavoidable in places, but every effort should be made to ensure that the amount of sub-soils to be removed is kept to a minimum in order to limit the impact on the geotechnical and hydrological balance of the site.

It is noted that the "natural hydrology" of parts of the site may have been significantly altered by land drainage, however measures will be emplaced to minimise any additional changes to the existing site hydrology resulting from the construction of the wind farm.

During the construction works, the excavation, storage and re-use of excavated materials have the potential to, directly or indirectly, negatively impact on water quality. Appropriate engineering controls, such as the installation of a drainage system with settlement / stilling ponds, silt traps, check dams and interceptor drains, will be carried out in tandem with, and where possible, prior to, any excavation work to mitigate potential impacts. In relation to construction works, the most important aspects of these recommendations involve:

1. Deep excavations at turbine base locations in order to construct turbine foundations and shallower excavations for the hardstandings to support crane loadings.

2. Construction of 9,642m of new site roads and the upgrade of 1,763m of existing private access tracks.

3. Some of the proposed site tracks are located within existing forestry for which peat thickness could not be assessed during the ground investigation campaign. Once the forestry has been felled, and ahead of construction, further construction stage peat investigation will be undertaken and the findings of this peat assessment report updated. Although, the majority of the new site tracks will be constructed within the natural mineral soils using tradition methods where peat thickness is less than 1.5m, "floated road" construction will also be employed where peat thickness exceeds 1.5m or to fulfil another geotechnical purpose.

4. Removal / transport of "waste" peat and glacial spoil and disposal either within designated disposal areas, side cast to form swales along the edges of the access road network or deposited in thin layers to form an apron around constructed hardstands, where constraints permit.

To allow specific assessment of the impact of these activities on soil and peat stability, construction stage site investigations will be undertaken to determine sub surface characteristics. Both intrusive (geotechnical) and non-intrusive (geophysical) investigations will be undertaken to better understand the behaviour of both

extant soils and underlying rock formations within the construction footprint, the findings of which will be employed to ensure the optimisation of engineering design.

These recommendations will be included in the Contractor's contract of works, who should be experienced in construction within peat environments. In addition, a construction environmental management plan will be in operation to check equipment, materials storage and transfer areas, drainage structures and their attenuation ability on a regular basis. The purpose of this management control is to ensure that the measures in place are operating effectively, prevent accidental leakages, and identify potential breaches in the protective retention and attenuation network during earthworks operations.

1.1.2 Potential for Bog Failure

Site investigations and assessment of the proposed Tirawley Wind Farm site indicate that the site is a low risk for slope failure or mass movements.

Applying the precautionary principle however, the following procedures are recommended as best-practise mitigation measures to avoid slope instability at wind farm sites.

- The contractor's methodology statement should be reviewed and approved by a suitably qualified geotechnical engineer with experience in peat environments prior to site operations.
- Any excavations that may tend to undermine the up-slope component of a peat and / or unstable sub-soils slope should be sufficiently supported by buttress, frame or rampart to resist lateral slippage.
- In areas where peat soils are to be excavated, machinery of a sufficient size to complete the works will be employed. Excessively heavy plant machinery will not be used in these areas. This measure is intended to avoid large vibrations disturbing the peat substrate.
- Drainage management measures will be installed to effectively drain grounds in tandem with access track construction. Such drains should be positioned at an oblique angle to slope contours to ensure ground stability. Drains on areas of the site with minimal risk of bog failure as identified by site investigations can be positioned at a more acute angle to the slope contour in order to reduce the velocity of surface water drainage.
- Due to peat's fluid-like properties, all peat excavated should be immediately removed from sloping sites. If peat is required for reinstatement, then acrotelm peat (<0.3m shallow, living layer) should be moved to a lower elevation part of the site that is characterised by near-horizontal slopes, is >100m away from any significant break of slope and is >50m away from drains and streams.
- If additional materials are required for the construction process, after exhausting excavated materials during road and infrastructure construction, additional materials may be acquired from external sources. Wherever possible any imported aggregates should consist of a similar geo-chemistry to the local geology of the site. It should be noted that this is dependent on the quality and variety of aggregate supplied by available quarries.

- From evidence (landslides in Mayo and Galway), excessively wet periods should be avoided in terms of scheduling significant excavations in peat substrates.
- Adherence to additional site-specific mitigation detailed in Tables 20 and 20A and referenced in Table 19.

1.1.3 Water Quality

During the construction phase, surface water drainage is generally found to be more at risk to water quality change than groundwater, where the majority of documented pollution events tend to involve suspended solids from sediment flows. The following mitigation measures are recommended to protect surface water and, to a lesser degree, groundwater quality

1.1.4 Groundwater Dewatering

Any water ingress that may be encountered in the upper weathered zone of the bedrock during the construction phase should be intercepted by a toe drain and diverted to an existing artificial drainage channel and attenuation before release.

The design of the drainage considers factors of slope stability and where possible should be sealed at the base.

1.2 OPERATIONAL PHASE MITIGATION

1.2.1 Change to Hydrological Regime

It is understood that stilling ponds and interceptors will be removed following the completion of construction works. Therefore, consideration should be given to the engineered design of roadside drains, the hardstanding areas and improved access roads to take the capacity of additional surface run-off arising from the proposed development.

The design must prevent both ***(a) hydraulic loading*** of the existing surface water network and ***(b) provide sufficient attenuation of suspended solids*** prior to outfall to the natural drainage network to maintain the existing environments baseline chemistry. Surface water flows in all existing waterways and drainage should not be impeded in any way by the proposed development. Access tracks that intercept existing waterways should have suitably designed culverts installed to maintain baseline flows, large enough to accommodate peak flow of a one in 100-year return period.

1.2.2 Water Quality

The following measures are recommended to mitigate pollution to surface waters and groundwaters during the lifetime of the project.

A regular programme of environmental site maintenance for the drainage network and drainage culverts to ensure their performance to standards at the site. Some changes in the drainage network may be required as a result of unanticipated changes in the hydrological regime at the site during the operation phase of the project.

If fuelling has occurred on site, the fuel tanks and oil interceptor used at the fuel transfer area should be removed by a suitably qualified contractor. An audit of ground and water conditions immediately under and around the transfer area is recommended to investigate whether any leakage has occurred to the hydrological system and whether some clean-up measures are required. Aside from the use of lubricant oils at the substation (low volume), any fuels stored on site will be kept within a bunded area that will have a capacity of at least 110% of the volume stored.

The substation compound is likely to require substation transformer cooling oil or gas. This should be stored in containers within a safe part of the substation compound, minimising accidental leakage and / or fire hazards. Consideration should also be given to a “bunded” area for the oil. Similarly, any other potentially harmful substances used to service the substation should be stored in an environmentally safe manner to mitigate impact to the soils and water.

J RESIDUAL IMPACTS OF THE DEVELOPMENT

Residual impacts that are most likely to occur at the proposed Tirawley Wind Farm site during the construction phase would be as follows:

There will be a change in ground conditions at the site with the replacement of natural materials such as peat, sub-soils and possibly bedrock by concrete, sub-grade and surfacing materials. This is a direct permanent change to the materials composition at the site.

Limited temporary decrease in water quality on a local level is likely to arise from the release of suspended solids and sediments during the excavation and construction process, particularly following rainfall events after a sustained dry period. This local deterioration in water quality will subsequently be reduced naturally by dilution and by managed mitigation prior to exiting from the site boundary to main catchments. Where construction works take place within 300m of particular environmental sensitivity, additional measures will be put in place to retain suspended solids and negate their migration further. The Construction Environmental Management Plan contain details for the arrangements to be applied in this case

Residual impacts that are most likely to occur at the Tirawley Wind Farm site during the operational phase would be as follows:

Changes in ground surfacing including areas of new hardstands will impact on the hydrology of the site and may result in increased run-off of rainwater and increased drainage discharge. It is assumed this should not have a significant impact on the hydrology of the site.

The drainage infrastructure that will be emplaced as part of the roads and turbines development will also change the subsurface hydrology by replacing a natural diffuse drainage system with line interceptors and point discharges to buffered outfalls. Careful design of this drainage to mimic natural conditions will help to mitigate negative impacts of artificial drainage.

The potential for Peat Landslide can be expected to reduce following the end of the life of the wind farm and the decommissioning of the structures. This reduction in risk can be attributed to reduced static and dynamic loads at decommissioned structures and reduced traffic loads on the site track network.

K MONITORING

All drainage systems should be properly maintained at regular intervals.

Slopes, disposal sites and roads should be inspected regularly.

Regular analysis of watercourses should be undertaken.

All activity on site and at boundaries should be monitored and a register kept.

Only authorised and suitably qualified personnel on-site – strictly controlled access at all times.

The site should be inspected regularly for fire hazards.

L CONCLUSION

Successful adherence to the mitigation measures contained within this report allows the optimal level of risk to be attained at each proposed turbine and other significant structures within the development site of Tirawley Wind Farm, with respect to peat landslide hazard.

Appraisal of the Hazard Rankings for each proposed turbine location indicates that the site is **NEGLIGIBLE *(at Turbines AT01, AT02, AT03, AT05, AT06, AT07, AT09, AT10 & AT16)* to LOW RISK (*at AT04, AT08, AT11, AT12, AT13, AT14, AT15, and the SUBSTATION)*** as determined in accordance with the guidelines outlined by The Scottish Executive & Halcrow Group Ltd in "*Peat Landslide Hazard and Risk Assessment - Best Practice Guide for Proposed Electricity Generation Developments*", April 2017.

Excavation of peat so that road bases can be founded directly onto the underlying glacial soils remains the optimal approach. There is normally a higher degree of risk associated with this method in areas where peat is greater than 1.50m in depth and in such cases "floating" road construction is the preferred method of access road emplacement.

Appraisal of the Hazard Rankings for each stretch of access track records that the majority of the access track network is registered as **NEGLIGIBLE *(track sections servicing AT05, AT06 and AT07* to LOW RISK (*for track sections servicing AT01, AT02, AT03, AT04, AT08, At09, AT10, AT11, AT12, AT13, AT14, AT15 and AT16)***, as determined in accordance with the guidelines outlined by The Scottish Executive & Halcrow Group Ltd in "*Peat Landslide Hazard and Risk Assessment - Best Practice Guide for Proposed Electricity Generation Developments*", April 2017.

Peat landslide risk analysis has indicated a **NEGLIGIBLE HAZARD** of instability in relation to the proposed turbine locations, associated infrastructure and proposed access tracks, should all mitigation measures and recommendations be adhered to, and as such the project should have no adverse effect on the soils, geology or surface water aspects in the vicinity of the proposed Tirawley Wind Farm development.

M REFERENCES

1. Geological Survey of Ireland Spatial Resources Viewer https://gsi.ie
2. Environmental Protection Agency, Ireland. EPA Online Data Portal https://gis.epa.ie/EPAMaps/
3. Ordnance Survey of Ireland. https://osi.ie
4. Geological Map of Ireland, 1:750,000 3rd Edition 1962.
5. Craig, R F. 1997. Soil Mechanics. Sixth Edition. E & FN Spon, London
6. Daly, D, And Warren, W. 1994. Mapping Of Groundwater Vulnerability to Pollution. Geological Survey of Ireland (Dublin) Guidelines.
7. Site Investigation Steering Group. 1993. Site Investigation in Construction – Without Site Investigation Ground Is a Hazard, Thomas Telford, London
8. Skinner, B J, And Porter S C. 1987. Physical Geology, John Wiley & Sons, Inc.
9. BS 1377: 1990 : Methods of test for soils for civil engineering purposes. British Standards Institution.
10. BS 1377: 2016 : Methods of test for soils for civil engineering purposes Part 1. British Standards Institution.
11. BS 1377: 2018 : Methods of test for soils for civil engineering purposes Part 3. British Standards Institution.
12. BS 5930: 2015 : Code of practice for site investigations (Amendment 2). British Standards Institution.
13. BS EN 1997-2: 2007 : Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.
14. BS EN ISO 14688-1: 2002 : Geotechnical investigation and testing - Identification and classification of soil - Part 1 Identification and description. British Standards Institution.
15. "*Peat Landslide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments*", Second edition April 2017.

DRAWINGS

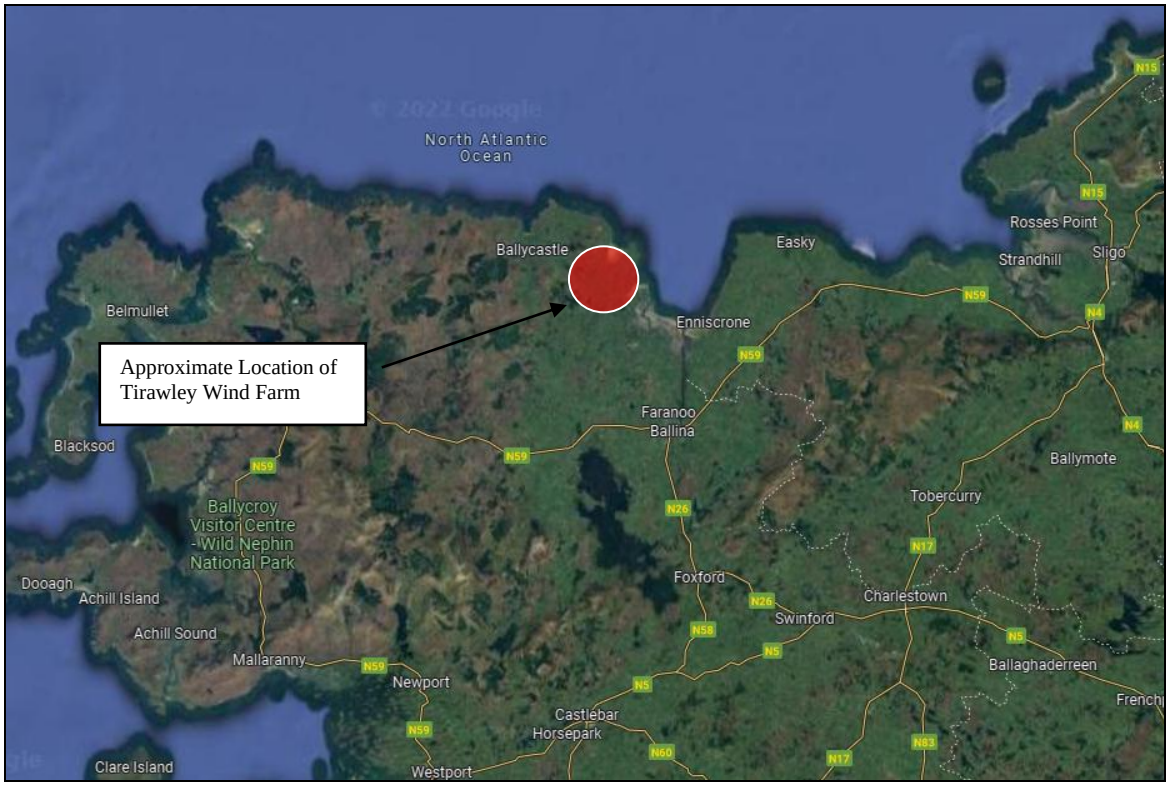
General Site Location Plan ***Figures P1 & P2***
Solid Geology ***Figure 1***
Superficial Geology ***Figure 2***
Groundwater (Aquifer) Resources ***Figure 3***
Karst, Springs, Wells and Watercourses ***Figure 4***
Landslide Susceptibility and Landslide Events ***Figure 5***
Minerals and Quarries ***Figure 6***
Groundwater Vulnerability ***Figure 7***
Aggregate Potential ***Figure 8***
Subsoil Permeability ***Figure 9***
Geological Heritage ***Figure 10***
EPA Protected Sites ***Figure 11 and 11A***
Location of Turbine Infrastructure and Exploratory Trial Holes ***Figure L1***
Classed Plot of Peat Depth ***Figure D1***
Contoured Plot of Peat Depth ***Figure D2***
Contoured Plot of Ground Surface Elevation ***Figure D3***
Contoured Plot of Ground Slope Gradient ***Figure D4***

APPENDICES

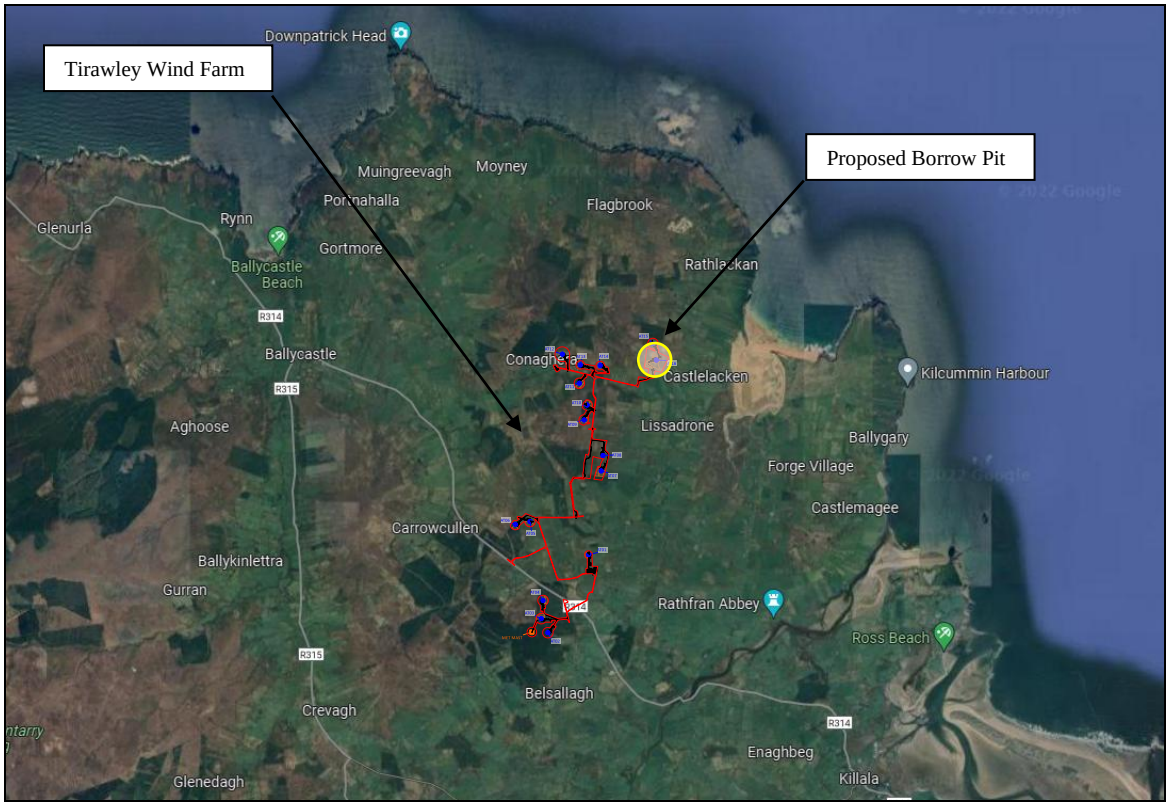
A Numerical Assessment of Sites Where Peat is a Key Constituent
B Analytical Analysis
C Peat Probing, Trial Hole Logs and Photographs
D Von Post Classification and Shear Strength Information
E Report 2165-22A Desk Study and Walkover Assessment for Preliminary Determination of Ground Conditions, 11th October 2022
F Report 2165-22B Site Investigation Works for Proposed Borrow Pit Site, Lacken Hill, 6km east of Ballycastle, 27th March 2023
G Peat Landslide Risk Assessment – "Preventative Action: A Guide for Workers"

DRAWINGS

General Site Location Plan Solid Geology **Figures P1 & P2**	1 x A4
Solid Geology **Figure 1**	1 x A3
Superficial Geology **Figure 2**	1 x A3
Groundwater (Aquifer) Resources **Figure 3**	1 x A3
Karst Springs and Watercourses **Figure 4**	1 x A3
Landslide Susceptibility and Recorded Events **Figure 5**	1 x A3
Minerals and Quarrying **Figure 6**	1 x A3
Groundwater Vulnerability **Figure 7**	1 x A3
Crushed Rock Potential Aggregate **Figure 8**	1 x A3
Subsoil Permeability **Figure 9**	1 x A3
Geological Heritage **Figure 10**	1 x A3
EPA Protected Sites **Figure 11 and 11A**	1 x A3
Location of Turbine Infrastructure and Exploratory Trial Holes **Figure L1**	1 x A3
Classed Plot of Peat Thickness Overlaid On Background Plot **Figure D1**	1 x A3
Contoured Plot of Peat Thickness Overlaid On Background Plot **Figure D2**	1 x A3
Contoured Plot of Ground Surface Elevation **Figure D3**	1 x A3
Contoured Plot of Ground Slope Gradient **Figure D4**	1 x A3
Spoil Deposition Arrangements **Figure SD1**	1 x A3



P1 - General Location Plan (Aerial view)
(© google maps 2026)

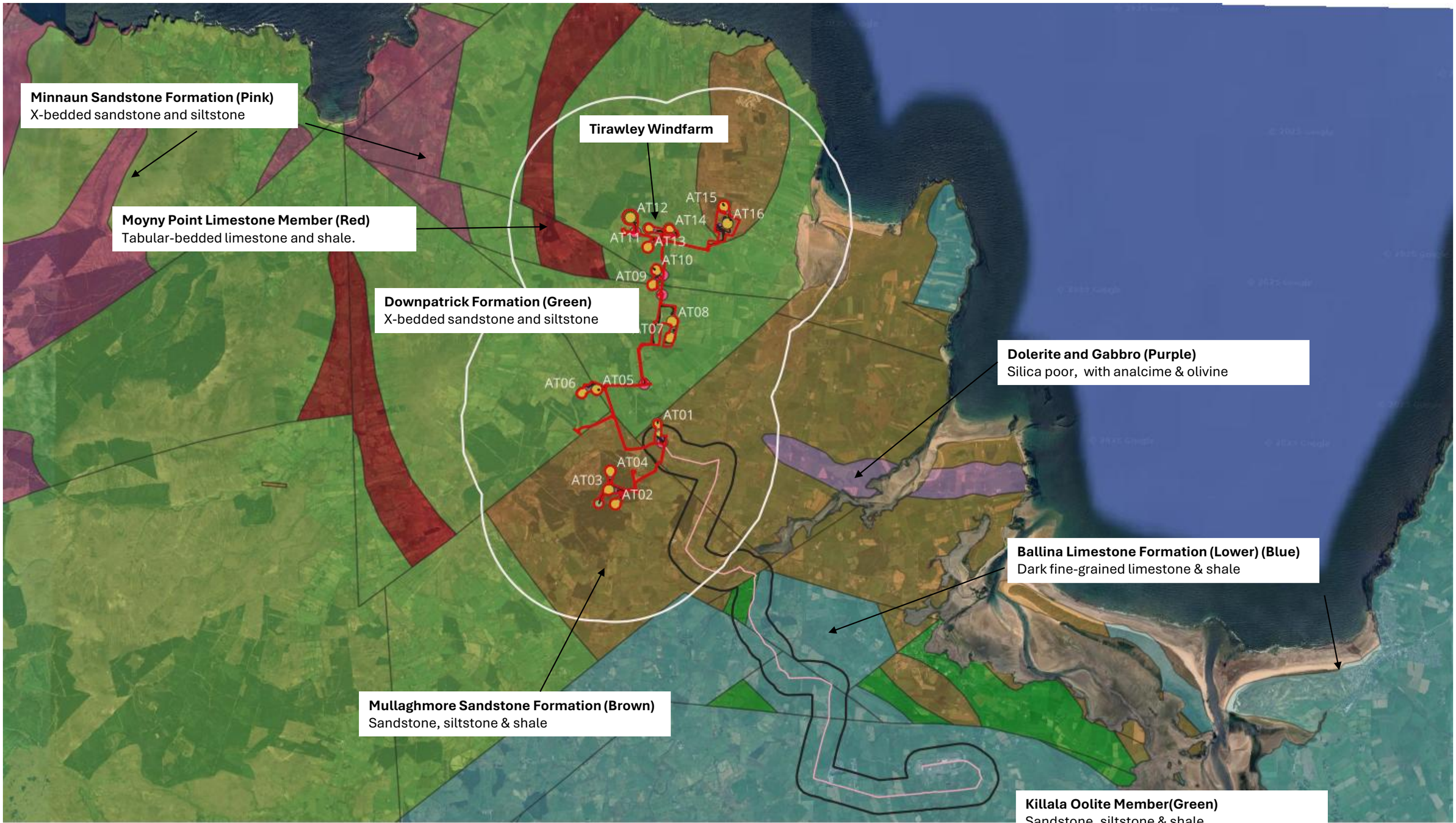


P2 - Local Location Plan (Aerial view)
(© google maps 2026)

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Solid Geology

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 1	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Solid Geology	Edition	Sheet
	1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Superficial Soils

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 2	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

2165-22 Tirawley Wind Farm
Soils and Geology Assessment

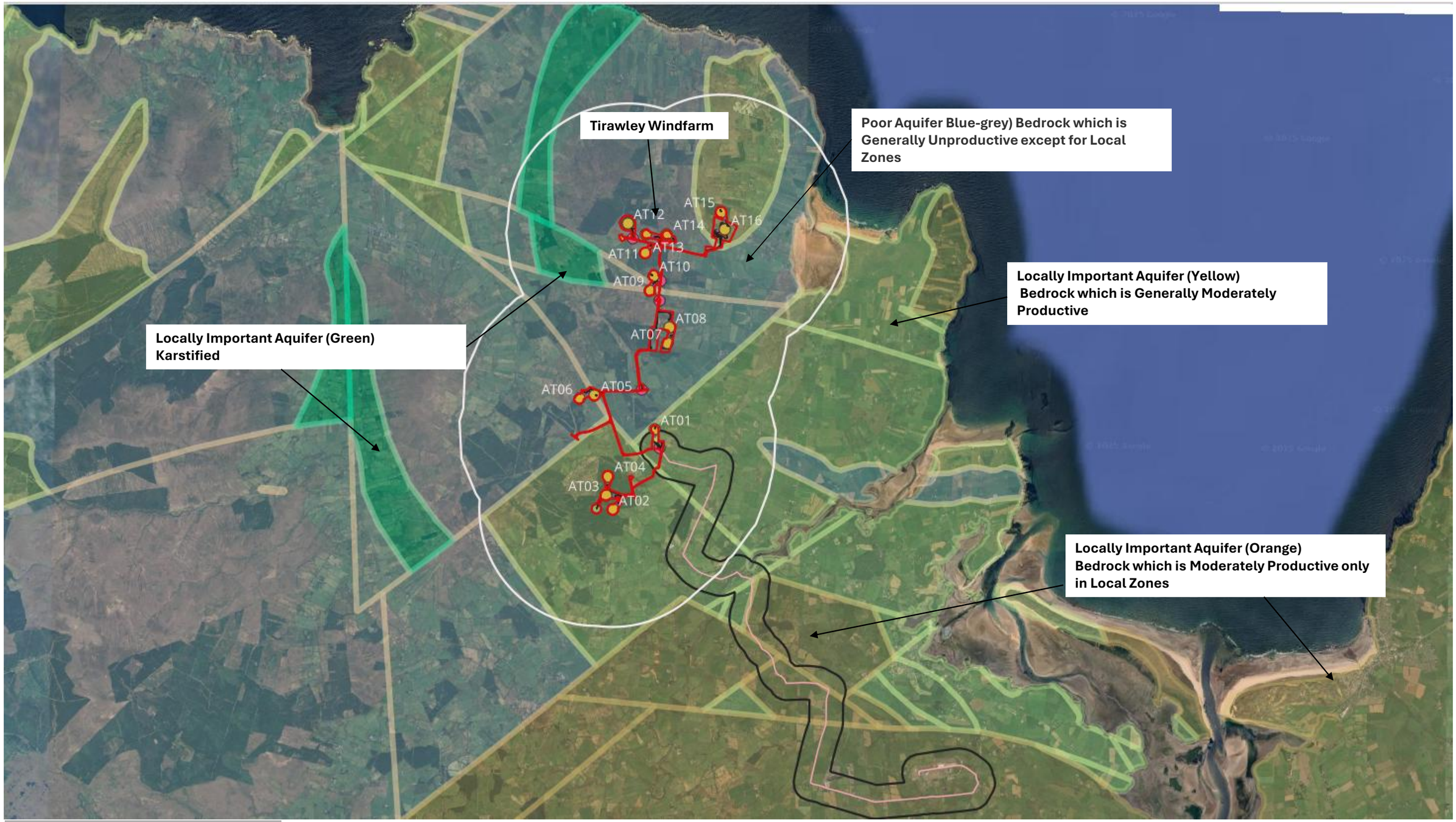
Superficial Soils

Edition	Sheet
1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Bedrock Aquifiers

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 3	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Bedrock Aquifiers

Edition	Sheet
1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Surface Water, Karst, Wells, and Springs

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 4	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Surface Water, Karst, Wells, and Springs	Edition	Sheet
	1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Landslide Susceptibility and Recorded Events

N



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

= Low
= Moderately Low
= Moderately High
= High
= Water

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 5	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Landslide Susceptibility and Recorded Events

Edition	Sheet
1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Minerals and Quarries

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

= Limestone
= Sandstone
= Pyrrhotite
= Iron
= Flagstone
= Chalcopyrite
= Tufa
= Copper
= Coal

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 6	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Minerals and Quarries	Edition	Sheet
	1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Groundwater Vulnerability

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

= Low
= Moderate
= High
= Extreme
= Rock or Karst at or near surface

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 7	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

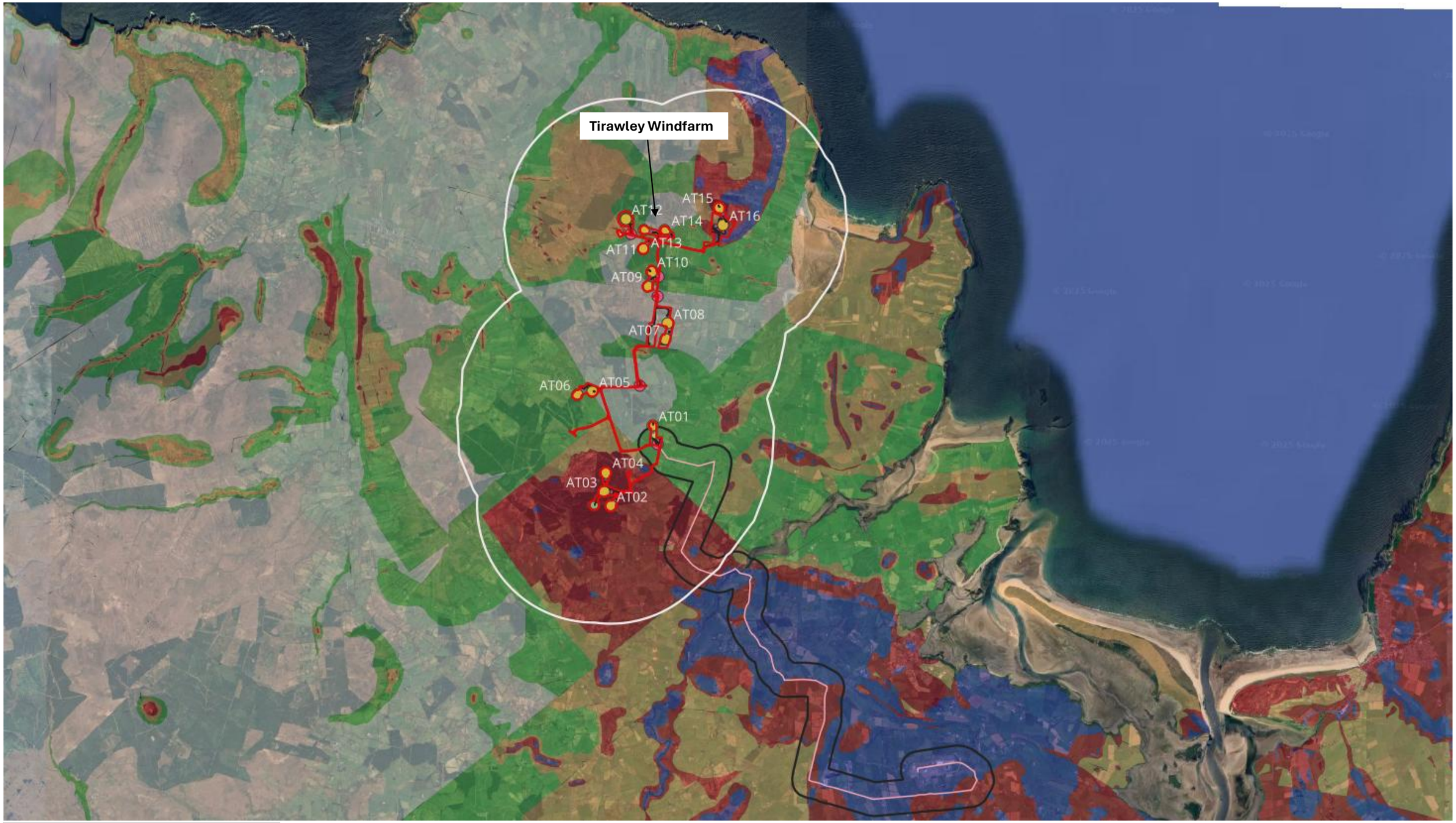
2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Groundwater Vulnerability	Edition	Sheet
	1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Aggregate Potential

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

= Very Low Potential
= Low Potential
= Moderate Potential
= High Potential
= Very High Potential

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 8	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

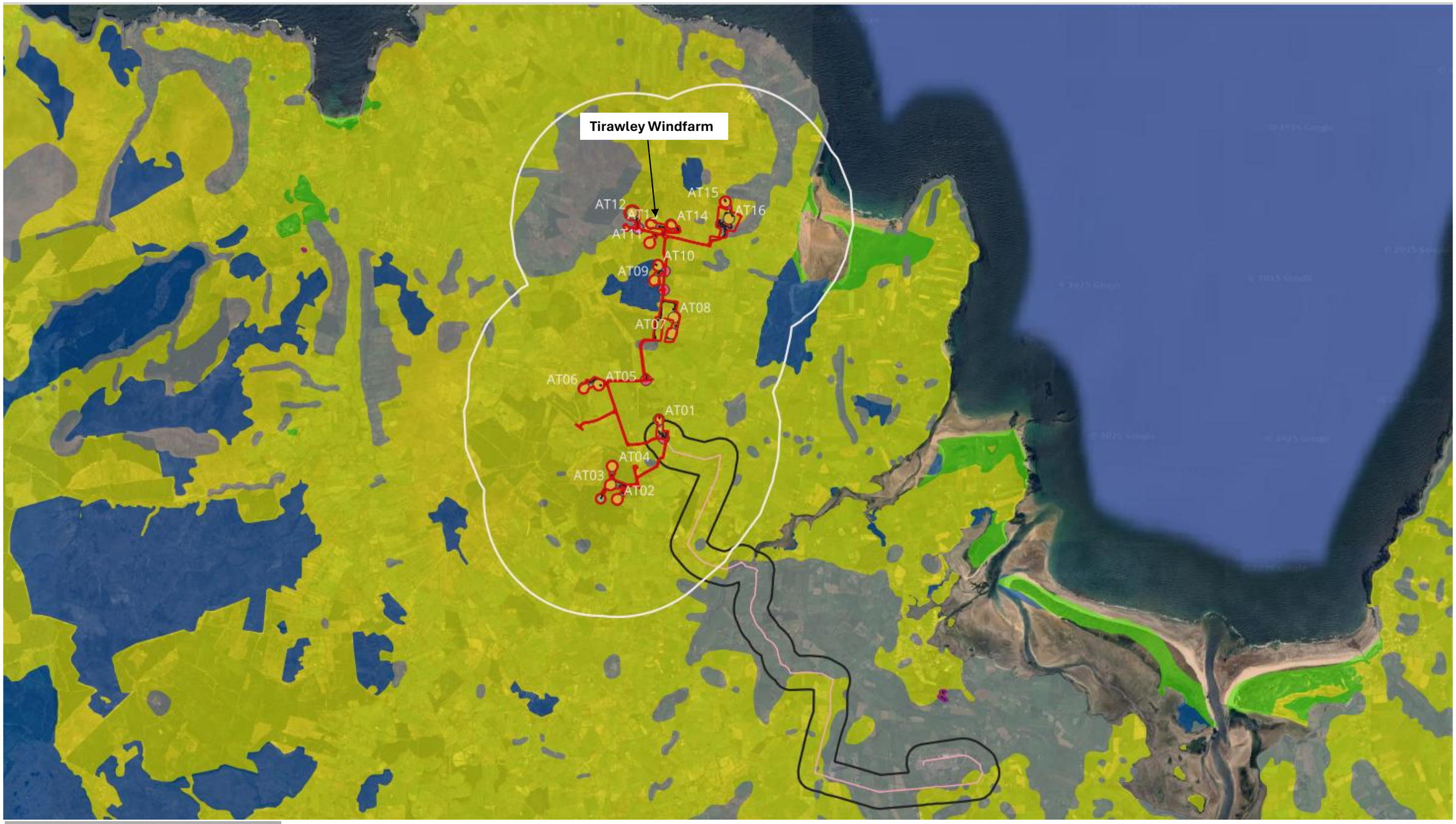
2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Aggregate Potential | Edition 1 | Sheet A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Subsoil Permeability

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

= Low
= Moderate
= High
= Not Mapped

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 9	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

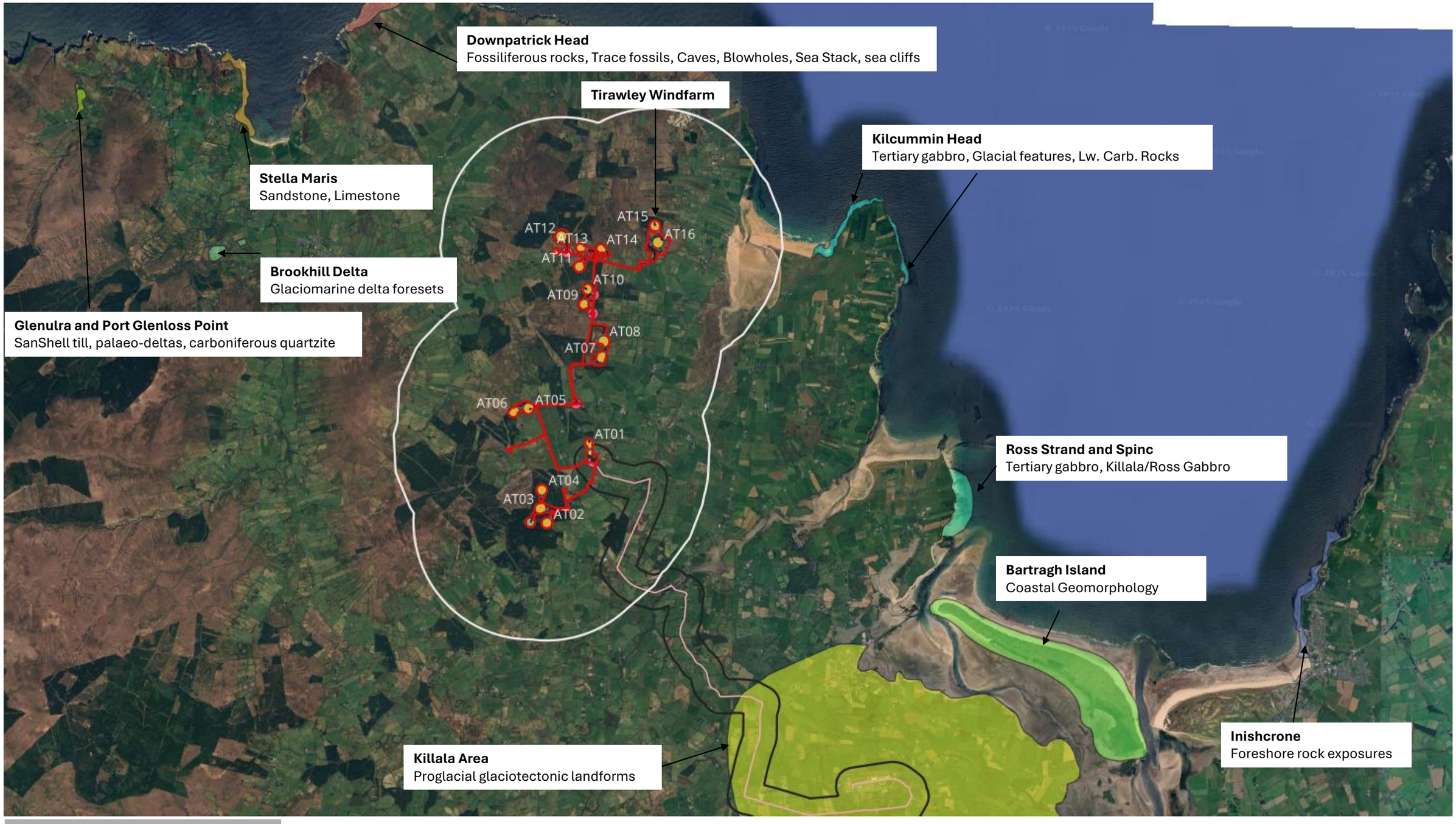
2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Subsoil Permeability	Edition	Sheet
	1	A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
Geological Heritage

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 10	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

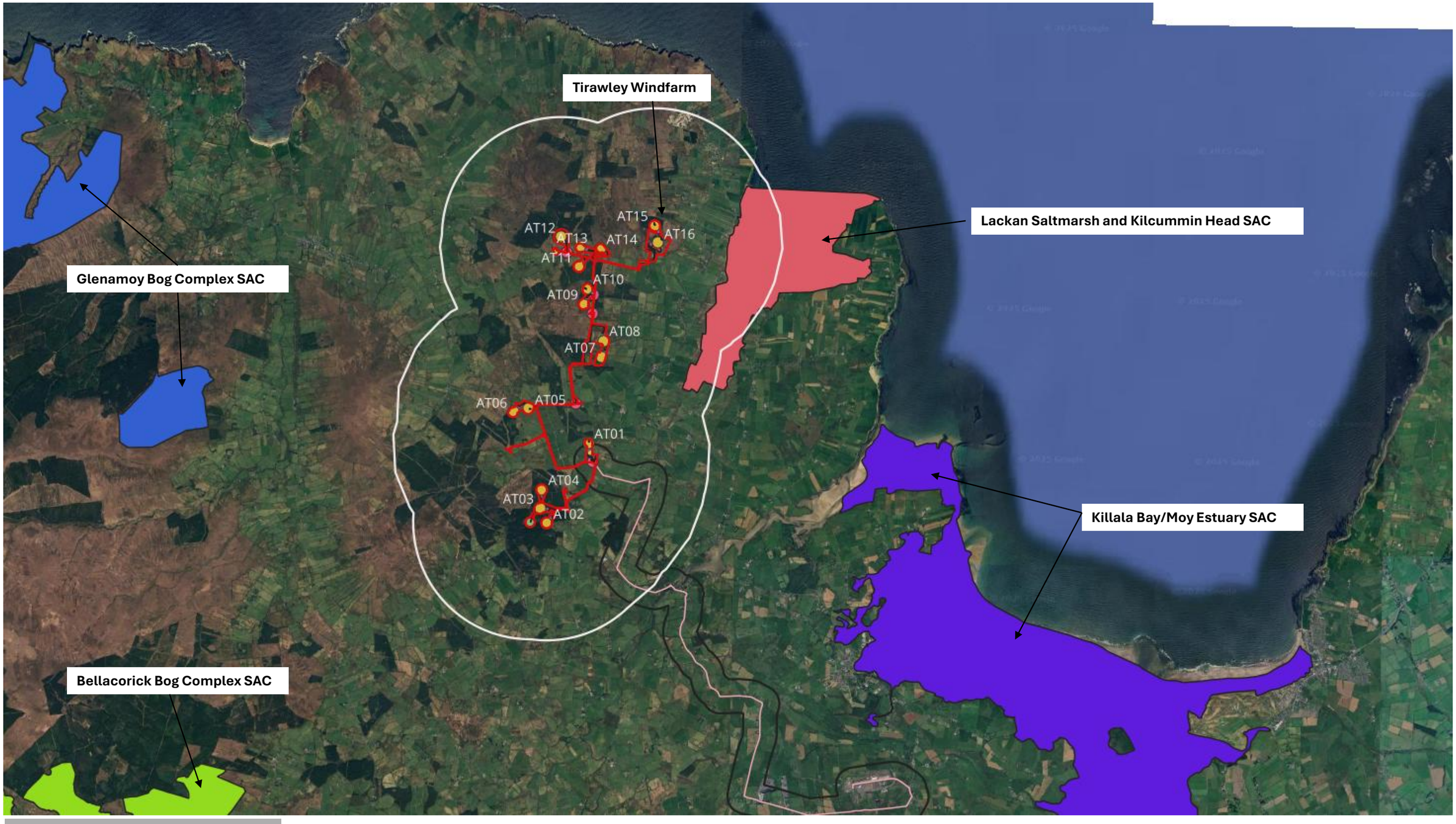
2165-22 Tirawley Wind Farm
Soils and Geology Assessment

Geological Heritage | Edition 1 | Sheet A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
EPA – Special Areas Conservation

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 11	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

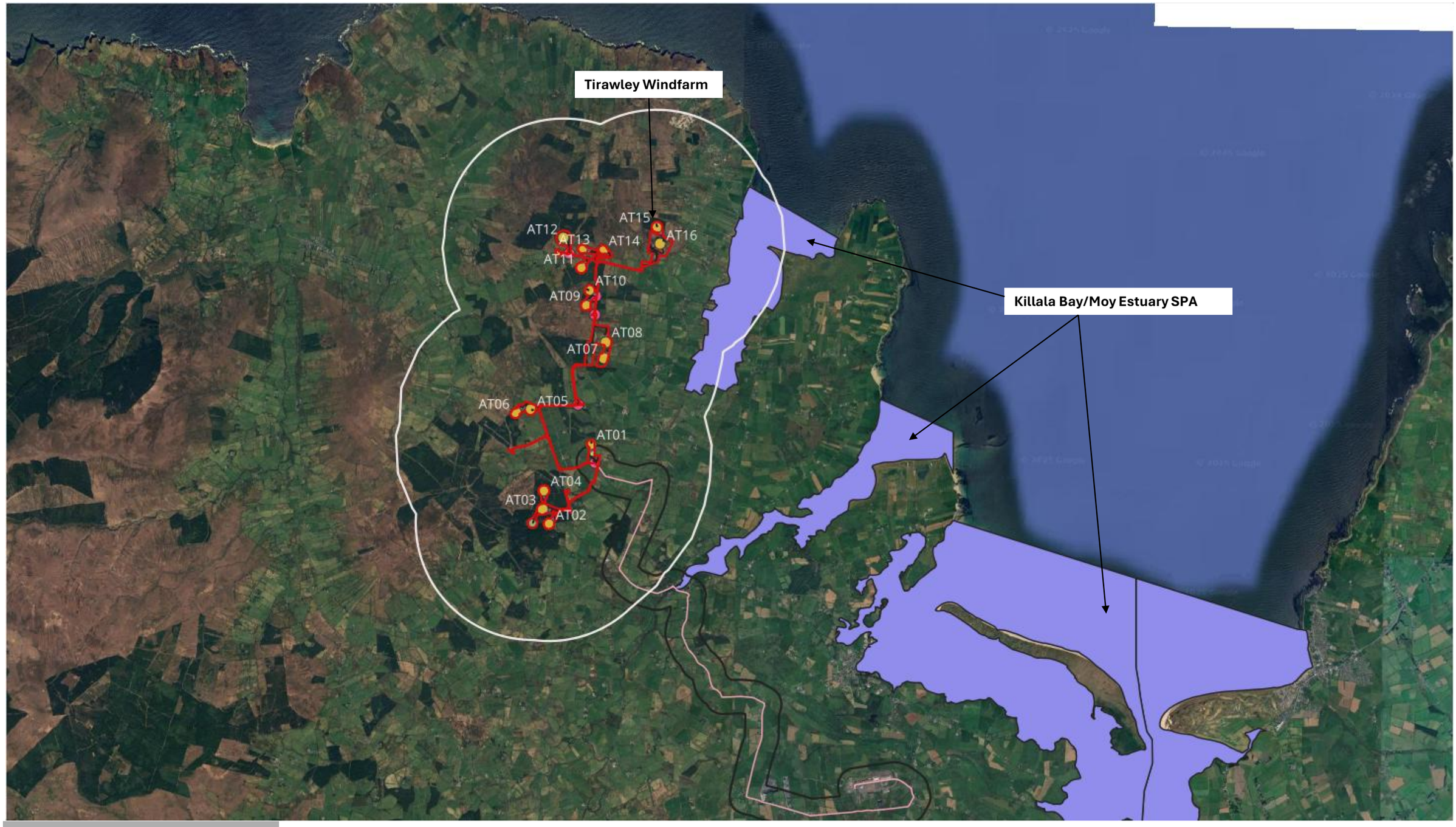
2165-22 Tirawley Wind Farm
Soils and Geology Assessment

EPA – Special Areas Conservation | Edition 1 | Sheet A3

2165-22 Tirawley Wind Farm
Soils and Geology Constraints
EPA – Special Protection Areas

N

whiteford
explore the possibilities



-- Study Area for Wind Farm
-- Windfarm Outline
-- Proposed Grid Connection Study Area
-- Proposed 110kv Grid Connection

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
HA.	JW.	JW. 15/04/26	Figure 11A	15/04/26	1:100000

Whiteford Geoservices Ltd
Straid House
2 Main Street, Straid,
BALLYCLARE, Co. Antrim,
UK BT39 9 NE

2165-22 Tirawley Wind Farm
Soils and Geology Assessment

EPA – Special Protection Areas	Edition	Sheet
	1	A3

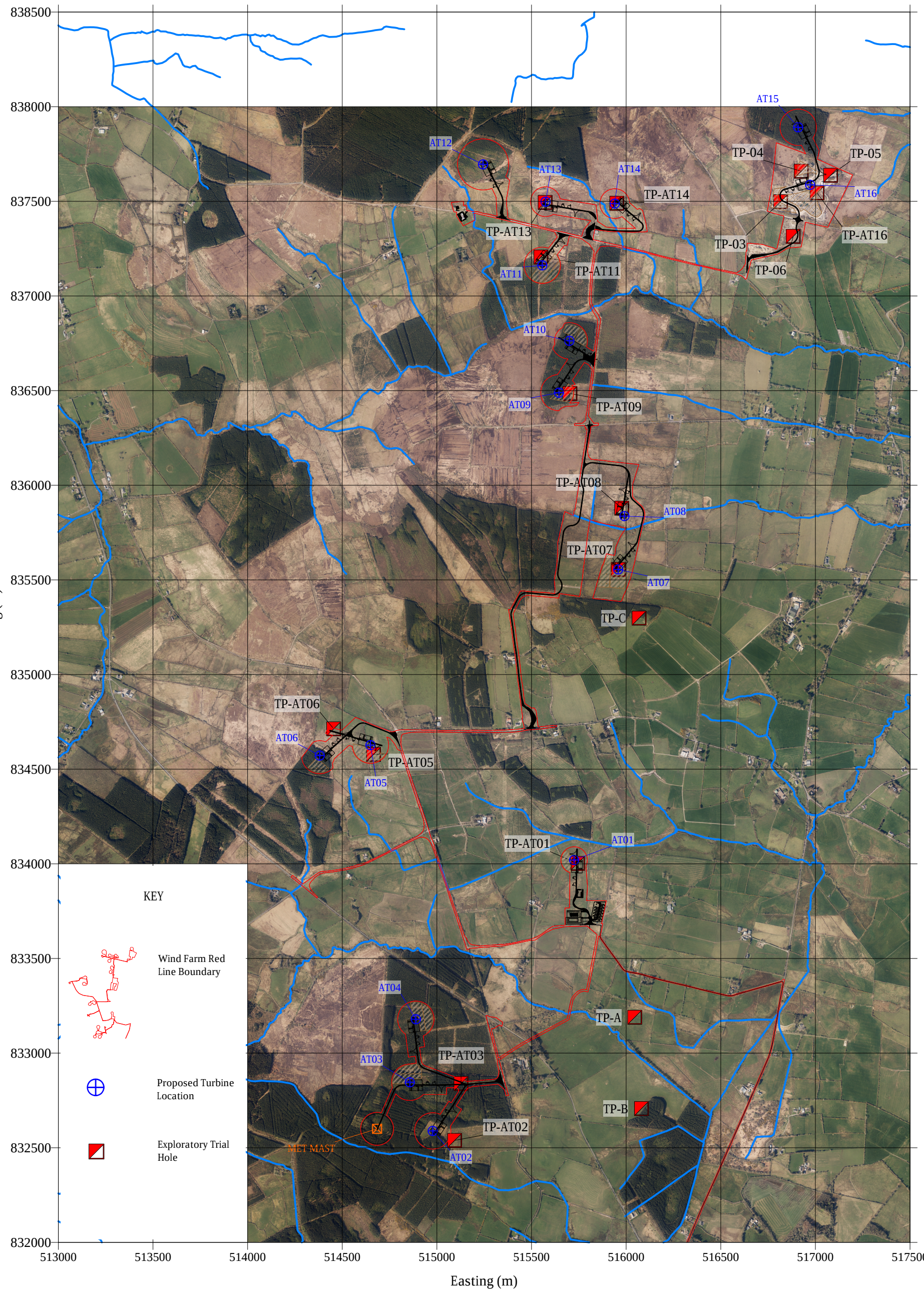
2165-22 Tirawley Wind Farm

Site Layout Plan - Location of Wind Farm Infrastructure and Exploratory Holes

14th April 2026

whiteford
explore the possibilities

N



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 14/04/2026	2165-22 L1	14/04/2026	1 : 20,000

Whiteford Geoservices Ltd
Straid House, 2 Main Street
Straid, BALLYCLARE,
Co. Antrim, Northern Ireland
BT39 9NE
UNITED KINGDOM

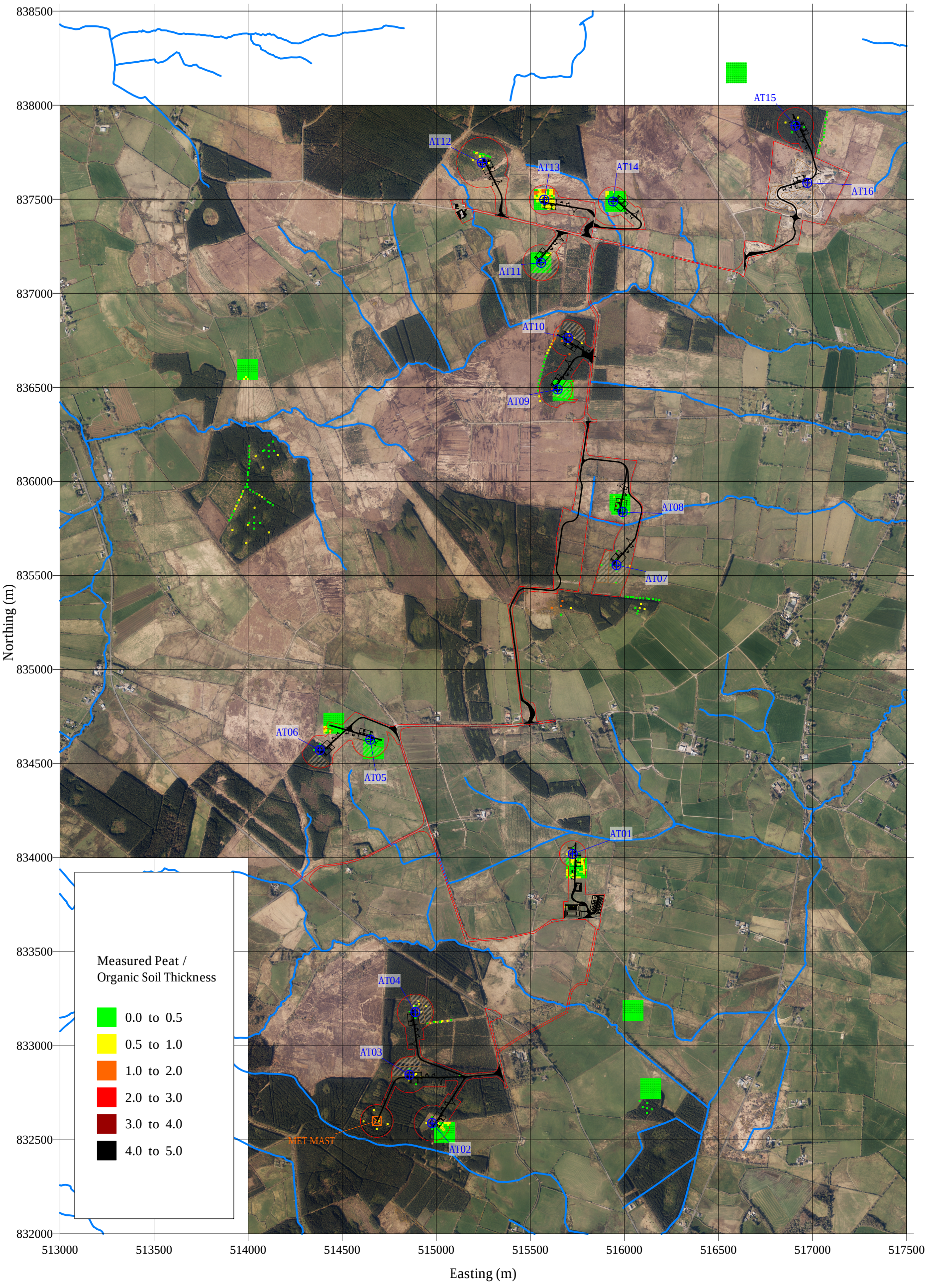
Tirawley Wind Farm - Soils and Geology Assessment

As Built SI Layout Plan: Wind Farm Infrastructure and Exploratory Holes | Edition **4** | Sheet **A3**

2165-22 Tirawley Wind Farm

Classed Plot of Peat Depth

14th April 2026



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.M - 14/04/2026	2165-22 D1	14/04/2026	1 : 20,000

Whiteford Geoservices Ltd
Straid House, 2 Main Street
Straid, BALLYCLARE,
Co. Antrim, Northern Ireland
BT39 9NE
UNITED KINGDOM

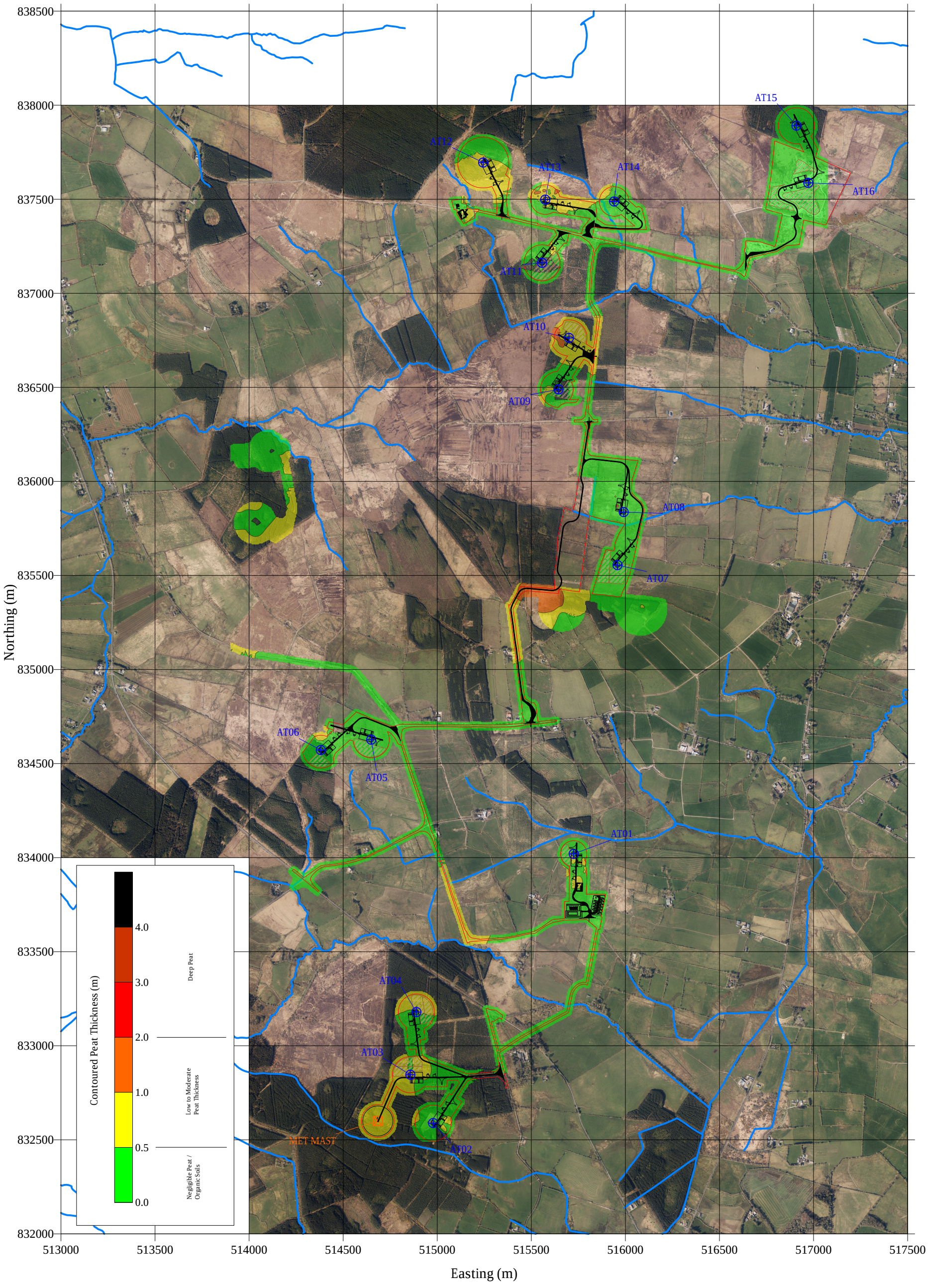
Tirawley Wind Farm - Soils and Geology Assessment

Classed Plot of Peat Depth | Edition 4 | Sheet A3

2165-22 Tirawley Wind Farm

Contoured Plot of Peat Depth

13th April 2026



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.M - 13/04/2026	2165-22 D2	13/04/2026	1 : 25,000

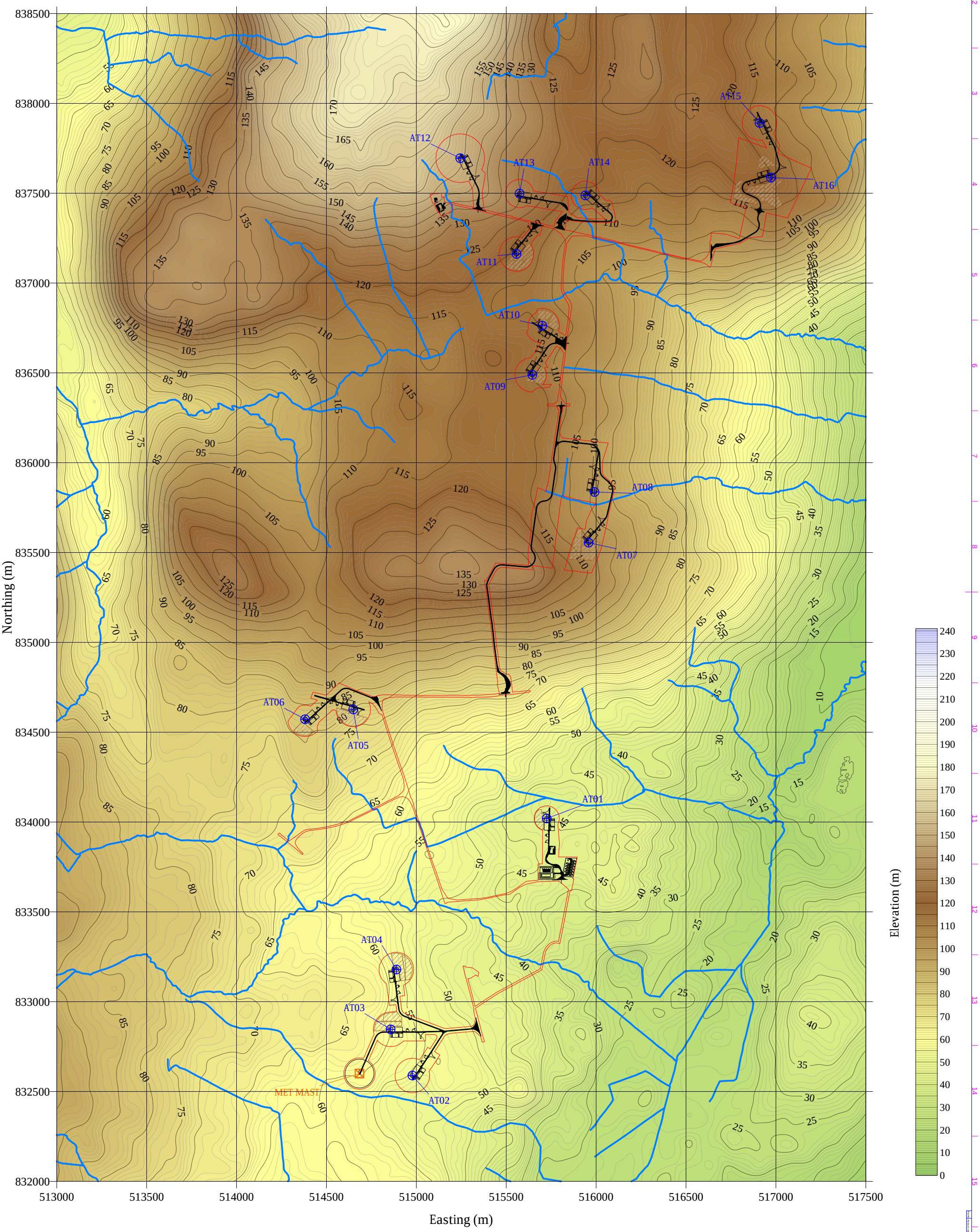
Whiteford Geoservices Ltd
Straid House, 2 Main Street
Straid, BALLYCLARE,
Co. Antrim, Northern Ireland
BT39 9NE
UNITED KINGDOM

Tirawley Wind Farm - Soils and Geology Assessment		
Contoured Plot of Peat Depth	Edition 4	Sheet A3

2165-22 Tirawley Wind Farm

Contoured Plot of Elevation

14th April 2026



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.M - 14/04/2026	2165-22 D3	14/04/2026	1 : 20,000

Whiteford Geoservices Ltd
Straid House, 2 Main Street
Straid, BALLYCLARE,
Co. Antrim, Northern Ireland
BT39 9NE
UNITED KINGDOM

Tirawley Wind Farm - Soils and Geology Assessment

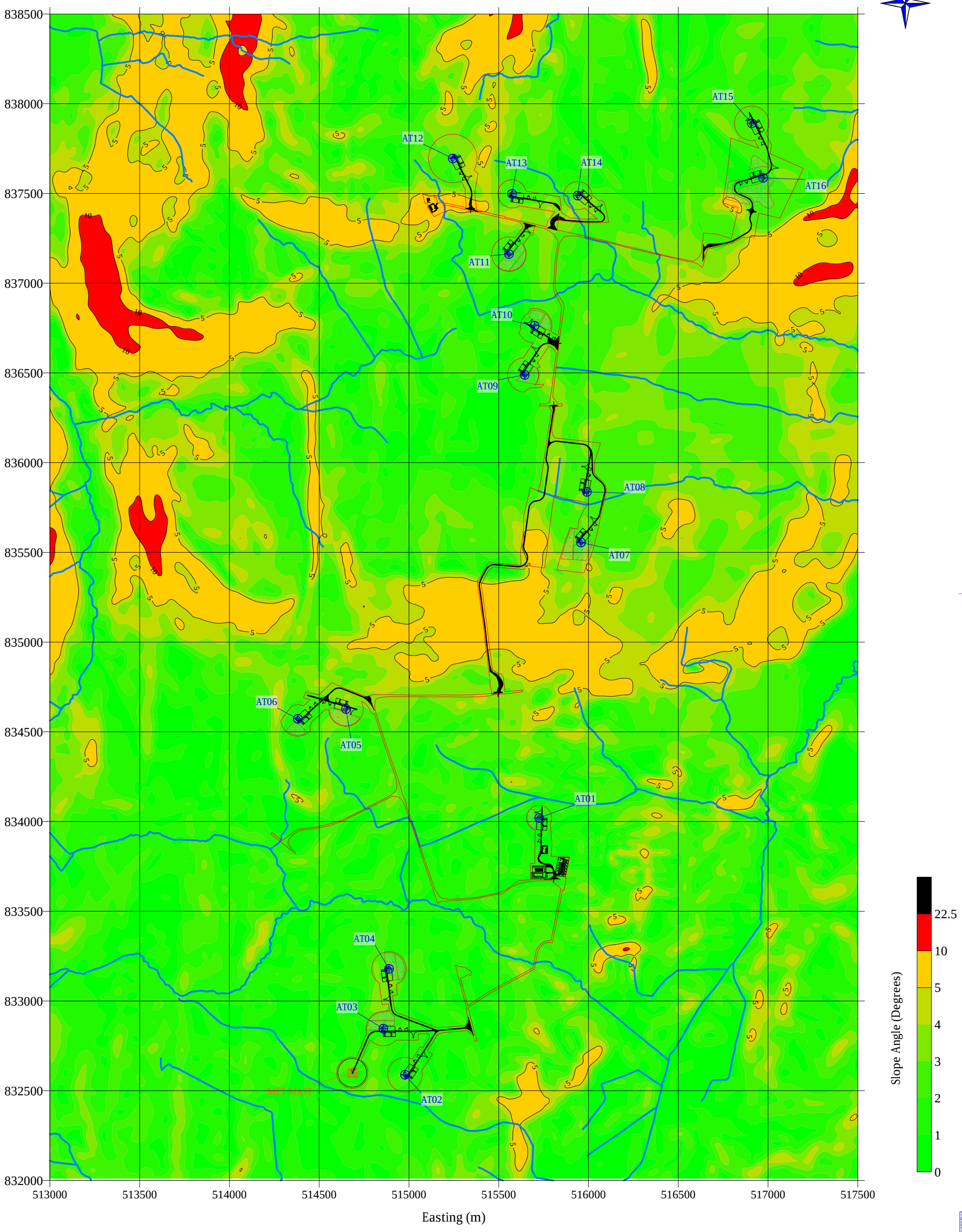
Contoured Plot of Elevation | Edition **4** | Sheet **A3**

2165-22 Tirawley Wind Farm

Contoured Plot of Slope Angle

14th April 2026

whiteford
explore the possibilities



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.M - 14/04/2026	2165-22 D4	14/04/2026	1 : 20,000

Whiteford Geoservices Ltd
Straid House, 2 Main Street
Straid, BALLYCLARE,
Co. Antrim, Northern Ireland
BT39 9NE
UNITED KINGDOM

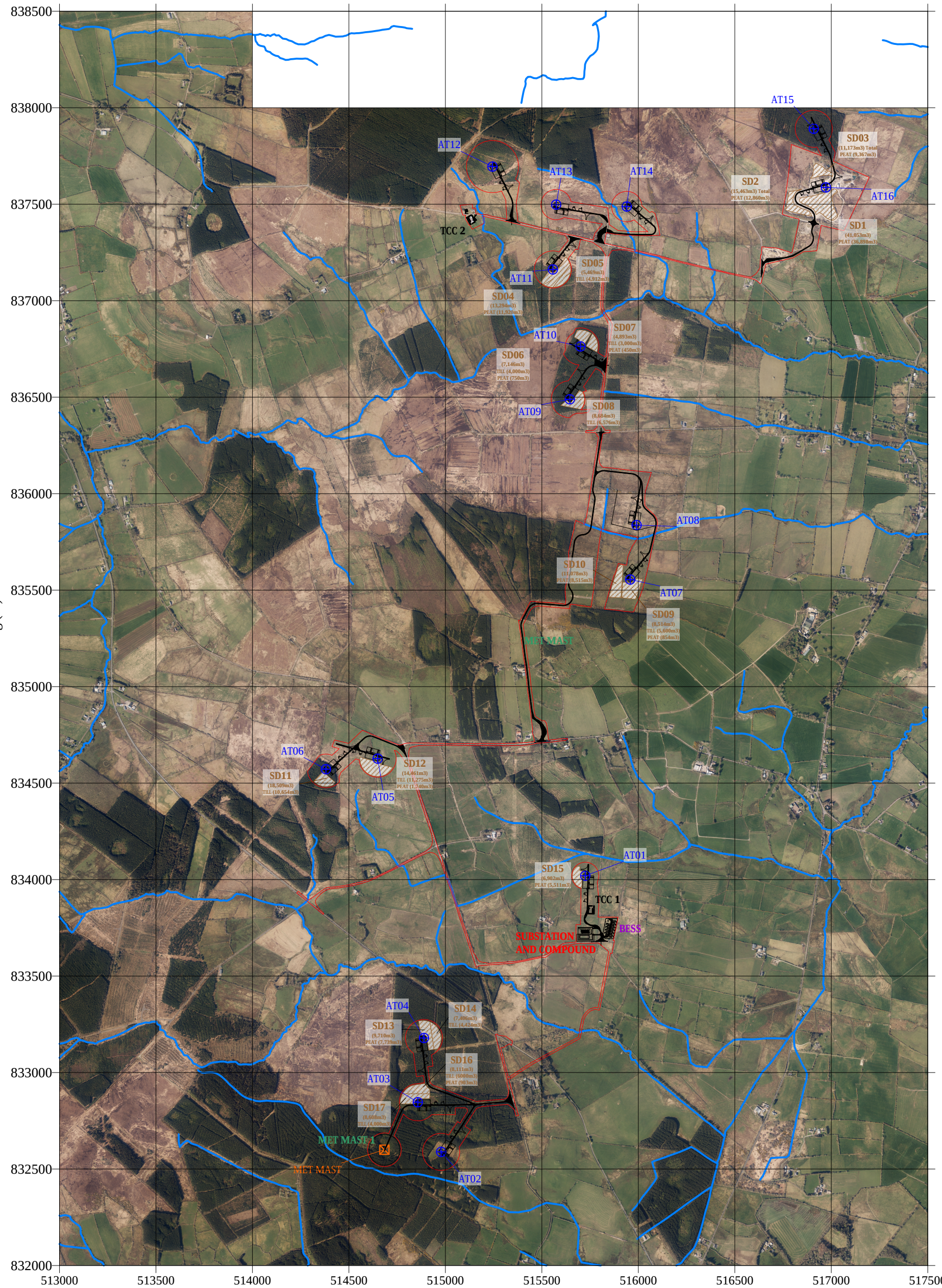
Tirawley Wind Farm - Soils and Geology Assessment

Contoured Plot of Slope Angle | Edition **4** | Sheet **A3**

2165-22 Tirawley Wind Farm

Potential Spoil Deposition Arrangements - Rev5

14th April 2026



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.W.	J.W.	J.M - 14/04/2026	2165-22 SD1	14/04/2026	1 : 20,000

Whiteford Geoservices Ltd
Straid House, 2 Main Street
Straid, BALLYCLARE,
Co. Antrim, Northern Ireland
BT39 9NE
UNITED KINGDOM

Tirawley Wind Farm - Soils and Geology Assessment

Potential Spoil Deposition Arrangements | Edition 6 | Sheet A3

APPENDIX A

Numerical Assessment of Sites Where Peat is a Key Constituent	1 x A4

Numerical Analysis of Key Indicators to Determine HAZARD for the Purposes of Peat Slide Risk Evaluation

Guidance Notes: Controlled Circulation Only ***Confidential***

HAZARD is essentially the apportioning of risk where certain factors contribute to the triggering of a peat slide.

Since peat instability is caused by a number of factors it is necessary to apply factors to each contributing element.

The following key indicators are the predominant causes of peat slides:-

1. Peat Thickness
2. Topography (i.e steepness of ground in the vicinity of the construction zone)
3. Drainage Issues
4. Historic, Active or Incipient Peat Landforms
5. Sonic / Seismic Activity (e.g. Quarrying, blasting etc.)
6. Degradation of Peat (i.e. Von Post classification)
7. Shear Strength of Peat (i.e Vane test data)

For the purposes of assessment all factors are deemed to be additive, and severity of certain factors yields a higher contribution to HAZARD.

e.g. Peat thickness of 3.10m; slope id 8º and Drainage Issues are SIGNIFICANT

HAZARD = +2 +1 +1 = 4

The table below illustrates the Factors associated with the Key Indicators for the site of the proposed Tirawley Wind Farm.

Item	Key Indicator	Numerical HAZARD Factor
1	Peat Thickness. (0.5 – 2.5m)	+1
2	Peat Thickness. (> 2.5m < 4.0m)	+2
3	Peat Thickness (> 4.0m)	+3
4	Topography. Slopes of < 5º to horizontal	0
5	Topography. Slopes of 5º to 10º to horizontal	+1
6	Topography. Slopes of > 10º < 22.5º to horizontal	+2
7	Topography. Slopes of > 22.5º to horizontal	+3
8	Drainage Issues are SIGNIFICANT (Variants exist)	+1
9	Relic Peat Landforms present in vicinity of construction zone	+1
10	Sonic / Seismic Activity. (Quarrying / Piling within 500m, blasting within 500m, earthquake risk etc.)	+1
11	Von Post Classification Of Peat Degradation = >H8 at base	+1
12	Von Post Classification Of Peat Degradation = <H3 at base	- 0.5
13	Vane Test Classification Of Shear Strength = < 5 at 1.5m depth (Variants exist)	+3
14	Vane Test Classification Of Shear Strength = >60 at 1.5m depth	-0.5

Table X1 – Numerical Calculation of Risk Parameters

APPENDIX B

Analytical Analysis	5 x A4

Analytical Analysis

The following analysis uses an analytical approach to determine factors of safety to quantify the risks of peat slides and local rotational failure or engulfment of excavations occurring. A separate qualitative risk assessment is described in the report followed by a Discussion of these analyses. The findings of each will be used to establish overall risks of peat movement occurring at various locations across the site.

The Scottish Guidance suggests the application of Infinite Slope Stability Analysis be employed to gauge the stability of peat on slopes and determination of the relevant Factor of Safety (FoS).

The analysis is based on a theoretical infinite slope which considers the resistance to failure (dependent on shear strength) and the active gravitational force (dependent on peat depth, weight and slope).

The minimum required FoS for stable slopes is 1.3, as specified in BS 6031:2009: Code of Practice for Earthworks (BSI, 2009). Where undrained parameters are used a FoS of 1.5 may be preferable.

For this purpose, the following modified formula, (Bromhead, 1986) is proposed:-

$$FoS = \frac{Cu + (\gamma - m\gamma_w) z \cos^2 \alpha \tan \phi'}{\gamma z \sin \alpha \cos \alpha}$$

where

FoS = Factor of Safety

C_u = Undrained Shear Strength (kPa)

γ = Bulk Unit Weight of Saturated Material (kN/m^3)

m = height of water table as a fraction of peat depth (m)

γ_w = Unit Weight of Water (kN/m^3)

ϕ = Angle of internal friction (deg)

z = Depth to Failure plane (Assumed depth of peat) (m)

α = Slope angle (deg)

However, the inclusion of the modification for water table fluctuation has the effect of increasing the factor of safety when the water level rises. Ultimately the peat slope is most vulnerable when water is not present, and the density of the peat material is at its highest.

For this purpose, the basic form of the equation has been employed and the most conservative value of density for the peat, (approximately 15kN/m^3 - where it has a relatively high clay content), has been considered. In general peat will be much less dense than this figure, especially if dry. However, in an effort to mimic the most extreme and unstable conditions that could possibly exist, a high value of density has been considered, which would return the most limiting values.

Infinite Slope Analysis

The formula used in this analysis to determine the FoS, for the undrained condition for a given slope, weight and strength of material (Bromhead, 1986), is therefore as follows:

$$FoS = \frac{Cu}{\gamma z \, Sin\alpha \, Cos\alpha}$$

Where,

FoS = Factor of Safety

C_u = Undrained Shear Strength (kPa)

γ = Bulk Unit Weight of Material (kN/m^3) – assumed as a worst-case, to be at 15kN/m^3

z = Depth to Failure plane (Max depth of peat measured in vicinity of turbine) (m)

α = Slope angle (deg)

The maximum slope at the proposed turbine positions has been employed for the calculations.

The results are summarised in the table below:

LOCATION	Max Slope (°)	z (m)	Undrained Condition		Dry Condition	
			Cu[1] (kPa)	Factor of Safety Sliding	Cu[2] (kPa)	Factor of Safety Sliding[3]
AT01	≤5	0.7	52	**57.04**	5	**5.48**
AT02	≤5	0.6	30	**38.39**	5	**6.40**
AT03	≤5	0.9	13	**11.09**	5	**4.27**
AT04	≤5	0.6	30	**38.39**	5	**6.39**
AT05	≤5	0.3	43	**110.05**	5	**12.80**
AT06	≤5	0.4	50	**95.98**	5	**9.60**
AT07	≤5	0.4	60	**95.98**	5	**8.00**
AT08	≤5	3.0	42	**10.75**	5	**1.28**
AT09	≤5	0.9	30	**25.60**	5	**4.27**
AT10	≤5	1.1	28	**19.54**	5	**3.49**
AT11	≤5	0.7	60	**65.81**	5	**5.48**

[1] Minimum in-situ test values used

[2] Laboratory test values employed for similar peat soils recovered in the vicinity of Benbradagh, Co. Londonderry, Northern Ireland

[3] Dry peat immediately followed by saturation – "worst case scenario"

AT12	≤5	0.8	27	**25.91**	5	**4.80**
AT13	≤5	1.0	26	**19.96**	5	**3.84**
AT14	≤5	0.6	60	**76.78**	5	**6.40**
AT15	≤5	0.5	30	**46.07**	5	**7.68**
AT16	≤5	0.6	30[4]	**38.39**	5	**6.40**
Substation	≤5	0.5	27	**41.46**	5	**7.68**

Table A – Analytical Assessment of Infinite Slope Stability

Stability of Excavations in Peat

As an additional observation it is useful to consider the stability of excavations within the peat at the site of proposed cuttings and / or excavations. The following formula allows a determination of the maximum height of a vertical slope that should be considered when excavating in peat soils.

a) Maximum height of vertical excavated faces:

The maximum height of an excavated vertical peat or soil face can be determined using Coulomb's expression for critical vertical height,

$$Hc = \frac{4Cu}{\gamma}.\frac{cos\varphi}{1 - sin\varphi}$$

Where

Hc = Critical Vertical Height (m)
C_u = Undrained Shear Strength (kPa)
γ = Bulk Unit Weight of Material (kN/m^3)
φ = Angle of Internal Friction of Material (°)

Taking the most conservative approach, assuming a zero angle of internal friction (φ=0°), and the lowest shear strength (measured at a proposed turbine location during dry conditions) of 5kPa with a materials partial safety factor of 1.3 applied to it, the **safe vertical height for short-term unsupported slopes would be 1.03m**.

This estimate of safe vertical height is taken into consideration in the risk assessment, construction method statements and mitigation measures. Based on the above analysis, it is likely that the cut faces of peat, with height is in excess of this figure, will require support at certain locations, either by battering back to 45° for shallower faces or use of sidewall support / plating in the case of deep excavations for hard standings. The excavation of peat will therefore have to be managed in order to mitigate against local peat face or slope failure.

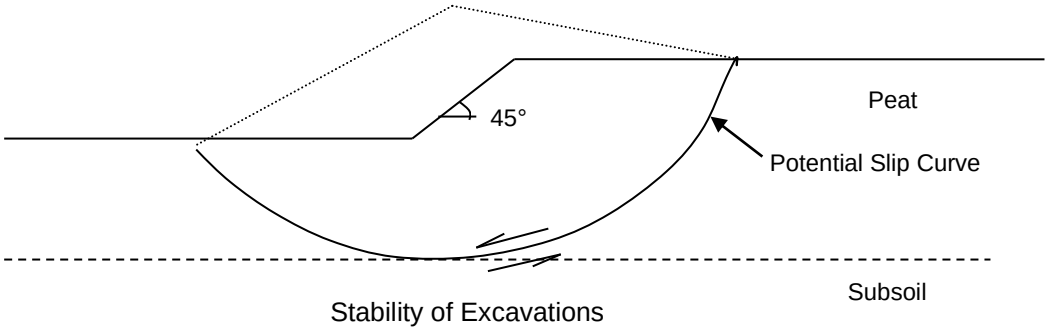
b) Rotational failure of battered back slopes:

Although this is not specifically considered in the Scottish Guidance, assessment of the potential stability of the face of a battered back excavation enables the engineer to determine the level of risk appropriate to excavations.

[4] Estimate based on value at AT15

It should be noted that local rotational failure is not restricted to sloping areas and can also occur on flat areas. This can result in engulfment of excavations which is a significant risk hazard and presents additional construction difficulties.

The theory is based on the short-term stability of excavations and involves dividing the peat mass into vertical slices and determining the overall horizontal and moment equilibrium about a potential slip curve tangential to the base of the peat (see diagram below) by equating the active and resisting forces along that curve. A Factor of Safety is therefore determined for both horizontal equilibrium and moment equilibrium. The lower of these values is tabulated in Table B.



Stability of Excavations

The analysis of the stability of excavations in peat was conducted to assess the potential risk of failure. In theory local failure is likely to occur where the Factor of Safety (FoS) is less than 1, but locations with a FoS of less than 1.3 should be given due attention.

The analysis is based on the following equilibrium equations [Bishop, 1955]:

$$FoS = \frac{\sum_1^n c_u \Delta b sec^2 \alpha}{\sum_1^n \Delta W tan\alpha}$$ (Horizontal equilibrium)

$$FoS = \frac{\sum_1^n c_u \Delta b sec\alpha}{\sum_1^n \Delta W sin\alpha}$$ (Moment equilibrium)

where Δb, ΔW and α are the width, weight and slope (of slip face to horizontal) of each vertical slice taken through the slip curve diagram above.

For 45 degree cut faces, within the maximum peat depth encountered at the proposed development site, the following rotational stability FoS has been calculated. See Table B overleaf.

ID	Cu (kPa)	Max Face Height Considered[5]	Factor of Safety Rotational Failure
AT01	52	0.7	>1.3
AT02	30	0.6	>1.3
AT03	13	0.9	>1.3
AT04	30	0.6	>1.3
AT05	43	0.3	>1.3
AT06	50	0.4	>1.3
AT07	60	0.4	>1.3

[5] Maximum height used relates to the maximum height only within the construction zone. i.e. where excavations are likely to take place.

AT08	42	3.0	>1.3
AT09	30	0.9	>1.3
AT10	28	1.1	>1.3
AT11	60	0.7	>1.3
AT12	27	0.8	>1.3
AT13	26	1.0	>1.3
AT14	60	0.6	>1.3
AT15	30	0.5	>1.3
AT16	30	0.6	>1.3
Substation	27	0.5	>1.3

Table B – Analytical Assessment of Stability of Excavations

Undrained factors of safety are in excess of 1.3. By battering back of the peat faces to slopes of 45° will render the risk of peat instability to be LOW for the peat strengths and slopes measured at the proposed Tirawley Wind Farm site (assuming minimal dewatering.

APPENDIX C

Peat Probing Data	40 x A4
Photographic Record of Ground Conditions Recorded during Walkover Survey	10 x A4
Trial Hole Records	20 x A4
Trial Hole Photographs	23 x A4

J/N: 2165/22

Tirawley Wind Farm - Peat Slandslide Hazard Assessment (PLHA)
Probed Peat Thickness

21st July 2025

Easting	Northing	Probed Peat Thickness (m)
515956	835869	3.0
515136	838703	2.0
515544	837538	1.5
515524	837538	1.4
515639	836779	1.3
515668	836748	1.3
514833	839009	1.2
515534	837538	1.2
515614	835328	1.2
514853	839009	1.1
515564	837548	1.1
515624	837528	1.1
515646	836799	1.1
515631	836759	1.1
515719	836742	1.1
514843	839009	1.0
514853	839019	1.0
515524	837528	1.0
515534	837528	1.0
515564	837538	1.0
515574	837548	1.0
515574	837538	1.0
515584	837508	1.0
515584	837548	1.0
515604	837518	1.0
515624	837538	1.0
515624	837548	1.0
514406	834685	1.0
515706	836773	1
515708	836675	1
515662	835337	1
515671	835365	1
514843	838939	0.9
514863	838939	0.9
514863	838949	0.9
514863	838959	0.9
515024	832570	0.9
515024	832560	0.9
515034	832570	0.9
515064	832590	0.9
515524	837518	0.9
515554	837548	0.9
515584	837528	0.9
515025	833127	0.9
515033	833132	0.9
515232	837720	0.9
513931	835855	0.9
514893	832850	0.9

Easting	Northing	Probed Peat Thickness (m)
514908	833221	0.9
514905	833238	0.9
515774	836736	0.9
514694	832602	0.9
514109	835729	0.9
515564	837498	0.8
514833	839019	0.8
514843	838999	0.8
514863	838929	0.8
515946	835919	0.8
515785	833975	0.8
515034	832550	0.8
515034	832560	0.8
515044	832560	0.8
515226	838733	0.8
515554	837528	0.8
515554	837508	0.8
515584	837538	0.8
515594	837518	0.8
515594	837478	0.8
515604	837478	0.8
515604	837548	0.8
515614	837548	0.8
515614	837538	0.8
514406	834665	0.8
515060	833133	0.8
515613	836730	0.8
515606	836714	0.8
515044	832540	0.8
514882	833211	0.8
515280	837694	0.8
515250	837662	0.8
514683	832558	0.8
515716	835327	0.8
513991	835672	0.8
515904	837528	0.7
515607	837202	0.7
514843	839019	0.7
514853	838929	0.7
514863	839019	0.7
515695	833905	0.7
515695	833915	0.7
515725	833995	0.7
515725	833985	0.7
515725	833975	0.7
515745	833895	0.7
515755	833895	0.7
515755	833975	0.7
515775	833985	0.7
515785	833945	0.7
515044	832550	0.7
515534	837508	0.7
515544	837518	0.7
515544	837528	0.7
515544	837548	0.7
515554	837538	0.7
515554	837518	0.7

Easting	Northing	Probed Peat Thickness (m)
515564	837458	0.7
515564	837488	0.7
515574	837528	0.7
515574	837458	0.7
515584	837468	0.7
515604	837488	0.7
515604	837538	0.7
515614	837528	0.7
515614	837478	0.7
515624	837468	0.7
514406	834695	0.7
514416	834685	0.7
514436	834665	0.7
515623	836748	0.7
515597	836697	0.7
515552	836427	0.7
515248	837732	0.7
515245	837715	0.7
515231	837730	0.7
513938	835871	0.7
513961	835919	0.7
515746	834026	0.7
514947	833212	0.7
514911	833180	0.7
515555	837187	0.7
515551	837133	0.7
515244	837701	0.7
514668	832657	0.7
514741	832583	0.7
514034	835861	0.7
515904	837538	0.6
515914	837538	0.6
515914	837528	0.6
515944	837538	0.6
515974	837518	0.6
515607	837212	0.6
514763	838969	0.6
514843	838979	0.6
514853	838999	0.6
514853	838919	0.6
515996	835899	0.6
515695	833925	0.6
515695	833935	0.6
515715	833975	0.6
515715	833995	0.6
515725	833915	0.6
515735	833895	0.6
515735	833985	0.6
515745	833985	0.6
515765	833975	0.6
515775	833965	0.6
515775	833995	0.6
515785	833965	0.6
515785	833925	0.6
515014	832570	0.6
515044	832590	0.6
515770	839410	0.6

Easting	Northing	Probed Peat Thickness (m)
515800	839380	0.6
514675	839335	0.6
515524	837508	0.6
515554	837498	0.6
515564	837528	0.6
515574	837508	0.6
515584	837478	0.6
515584	837488	0.6
515584	837498	0.6
515584	837518	0.6
515594	837498	0.6
515614	837508	0.6
515614	837488	0.6
515624	837478	0.6
515624	837498	0.6
515624	837518	0.6
514406	834675	0.6
514416	834675	0.6
514968	833123	0.6
515001	833126	0.6
515591	836682	0.6
515210	837747	0.6
513952	835903	0.6
513974	835947	0.6
514060	835926	0.6
515745	834003	0.6
515725	834005	0.6
514874	832830	0.6
514921	832832	0.6
515557	837162	0.6
515194	837708	0.6
515800	839370	0.52
515904	837518	0.5
515587	837202	0.5
515597	837202	0.5
514843	838949	0.5
514843	838989	0.5
514853	838939	0.5
514863	838969	0.5
514863	839009	0.5
515956	835889	0.5
515976	835899	0.5
515714	836455	0.5
515705	833895	0.5
515715	833905	0.5
515715	833985	0.5
515725	833965	0.5
515725	833905	0.5
515725	833895	0.5
515735	833935	0.5
515735	833995	0.5
515745	833995	0.5
515745	833975	0.5
515745	833915	0.5
515755	833935	0.5
515755	833965	0.5
515765	833985	0.5

Easting	Northing	Probed Peat Thickness (m)
515765	833965	0.5
515765	833925	0.5
515765	833895	0.5
515775	833925	0.5
515775	833975	0.5
515785	833995	0.5
515785	833955	0.5
515785	833935	0.5
515785	833915	0.5
515795	833935	0.5
515014	832580	0.5
515034	832580	0.5
515054	832590	0.5
515064	832580	0.5
515074	832590	0.5
515770	839400	0.5
515780	839400	0.5
515790	839390	0.5
515800	839360	0.5
515206	838673	0.5
515206	838693	0.5
515216	838763	0.5
515216	838733	0.5
515216	838723	0.5
515216	838713	0.5
515226	838723	0.5
515226	838743	0.5
514625	839305	0.5
514645	839295	0.5
514675	839325	0.5
514685	839335	0.5
515534	837498	0.5
515534	837488	0.5
515544	837488	0.5
515544	837498	0.5
515544	837508	0.5
515564	837468	0.5
515564	837478	0.5
515564	837508	0.5
515564	837518	0.5
515574	837518	0.5
515574	837498	0.5
515574	837488	0.5
515584	837458	0.5
515594	837488	0.5
515594	837468	0.5
515594	837458	0.5
515594	837448	0.5
515604	837448	0.5
515604	837458	0.5
515604	837468	0.5
515604	837498	0.5
515604	837508	0.5
515604	837528	0.5
515614	837498	0.5
515614	837458	0.5
515624	837448	0.5

Easting	Northing	Probed Peat Thickness (m)
515624	837458	0.5
515624	837488	0.5
514416	834695	0.5
514436	834675	0.5
513978	836545	0.5
513998	836545	0.5
513988	836555	0.5
515546	836452	0.5
515233	837713	0.5
515217	837744	0.5
517041	837797	0.5
514073	835916	0.5
516081	835326	0.5
516088	835348	0.5
516107	835321	0.5
516029	835548	0.5
515600	837161	0.5
516856	837908	0.5
516923	837934	0.5
514614	832598	0.5
515687	833739	0.5
515729	833739	0.5
514001	835768	0.5
513917	835742	0.5
514040	836136	0.5
514158	836140	0.5
514080	836074	0.5
515567	837212	0.45
515577	837212	0.45
515904	837498	0.4
515904	837508	0.4
515914	837518	0.4
515924	837538	0.4
515944	837518	0.4
515944	837528	0.4
515954	837538	0.4
515954	837518	0.4
515954	837498	0.4
515954	837488	0.4
515964	837518	0.4
515964	837528	0.4
515974	837528	0.4
515984	837538	0.4
515994	837538	0.4
516004	837538	0.4
515557	837212	0.4
515557	837202	0.4
515577	837202	0.4
515587	837212	0.4
515597	837212	0.4
514763	838949	0.4
514763	838979	0.4
514773	839019	0.4
514773	838989	0.4
514773	838959	0.4
514773	838949	0.4
514803	838939	0.4

Easting	Northing	Probed Peat Thickness (m)
514813	838969	0.4
514813	838959	0.4
514823	838999	0.4
514833	838999	0.4
514833	838959	0.4
514843	838959	0.4
514843	838969	0.4
514853	838989	0.4
514853	838969	0.4
514863	838919	0.4
514863	838989	0.4
514863	838999	0.4
515936	835899	0.4
515956	835859	0.4
515986	835869	0.4
515986	835879	0.4
515986	835889	0.4
515986	835899	0.4
516006	835879	0.4
516006	835889	0.4
515704	836435	0.4
515704	836485	0.4
515714	836485	0.4
515714	836475	0.4
515714	836465	0.4
515714	836445	0.4
515724	836445	0.4
515724	836455	0.4
515724	836465	0.4
515724	836485	0.4
515724	836495	0.4
515724	836505	0.4
515695	833945	0.4
515695	833955	0.4
515695	833965	0.4
515695	833975	0.4
515695	833985	0.4
515705	833995	0.4
515705	833975	0.4
515705	833965	0.4
515705	833955	0.4
515705	833945	0.4
515705	833935	0.4
515705	833915	0.4
515705	833905	0.4
515715	833895	0.4
515715	833925	0.4
515715	833955	0.4
515715	833965	0.4
515725	833955	0.4
515725	833925	0.4
515735	833905	0.4
515735	833915	0.4
515735	833925	0.4
515735	833945	0.4
515735	833975	0.4
515745	833965	0.4

Easting	Northing	Probed Peat Thickness (m)
515745	833925	0.4
515745	833905	0.4
515755	833905	0.4
515755	833915	0.4
515755	833925	0.4
515755	833955	0.4
515765	833995	0.4
515765	833955	0.4
515765	833945	0.4
515765	833935	0.4
515765	833915	0.4
515765	833905	0.4
515775	833895	0.4
515775	833905	0.4
515775	833915	0.4
515775	833935	0.4
515775	833945	0.4
515775	833955	0.4
515785	833985	0.4
515795	833945	0.4
515795	833955	0.4
515795	833975	0.4
515795	833985	0.4
515795	833995	0.4
515004	832590	0.4
515004	832580	0.4
515014	832590	0.4
515024	832590	0.4
515024	832580	0.4
515034	832590	0.4
515074	832540	0.4
515074	832580	0.4
515084	832590	0.4
515084	832580	0.4
515084	832560	0.4
515760	839400	0.4
515790	839400	0.4
515166	838773	0.4
515176	838673	0.4
515186	838683	0.4
515206	838753	0.4
515216	838773	0.4
515216	838743	0.4
515226	838673	0.4
515226	838703	0.4
515226	838753	0.4
514595	839295	0.4
514595	839305	0.4
514595	839315	0.4
514595	839335	0.4
514615	839325	0.4
514625	839295	0.4
514635	839295	0.4
514655	839345	0.4
514655	839355	0.4
514665	839345	0.4
514665	839335	0.4

Easting	Northing	Probed Peat Thickness (m)
514665	839325	0.4
514685	839345	0.4
514685	839325	0.4
514685	839305	0.4
514695	839375	0.4
514695	839385	0.4
514695	839395	0.4
515524	837498	0.4
515574	837468	0.4
515614	837468	0.4
515614	837448	0.4
515624	837508	0.4
516096	833228	0.4
514406	834705	0.4
514416	834665	0.4
514426	834665	0.4
514426	834685	0.4
514436	834695	0.4
514436	834685	0.4
514018	836545	0.4
514048	836545	0.4
514028	836555	0.4
514954	833119	0.4
515584	836667	0.4
515549	836539	0.4
515540	836483	0.4
515245	837724	0.4
515202	837749	0.4
515234	837740	0.4
515242	837739	0.4
515275	837729	0.4
513900	835793	0.4
513925	835841	0.4
513944	835888	0.4
513967	835934	0.4
514006	836071	0.4
514005	836091	0.4
514006	836129	0.4
514006	836143	0.4
514007	836164	0.4
514006	836187	0.4
514087	835909	0.4
514104	835892	0.4
514131	835873	0.4
514898	832826	0.4
514892	832796	0.4
516058	835329	0.4
515511	837159	0.4
516903	837904	0.4
516956	837884	0.4
516890	837855	0.4
515707	833739	0.4
514132	836212	0.4
515924	837528	0.3
515934	837518	0.3
515934	837508	0.3
515954	837528	0.3

Easting	Northing	Probed Peat Thickness (m)
515954	837508	0.3
515964	837538	0.3
515974	837538	0.3
515994	837528	0.3
516004	837528	0.3
515507	837212	0.3
515547	837212	0.3
515567	837202	0.3
514763	838959	0.3
514763	838989	0.3
514763	839019	0.3
514773	838979	0.3
514773	838969	0.3
514783	838949	0.3
514783	838959	0.3
514783	838979	0.3
514783	838989	0.3
514803	838949	0.3
514803	838959	0.3
514813	838999	0.3
514813	838989	0.3
514813	838979	0.3
514813	838949	0.3
514823	838929	0.3
514823	838959	0.3
514823	838969	0.3
514833	838969	0.3
514843	838929	0.3
514863	838979	0.3
515926	835889	0.3
515936	835909	0.3
515946	835839	0.3
515946	835929	0.3
515956	835919	0.3
515956	835899	0.3
515956	835879	0.3
515956	835839	0.3
515966	835849	0.3
515966	835859	0.3
515966	835899	0.3
515976	835909	0.3
515996	835889	0.3
516006	835899	0.3
516016	835889	0.3
516026	835889	0.3
516026	835909	0.3
516026	835919	0.3
515704	836445	0.3
515704	836455	0.3
515704	836465	0.3
515704	836495	0.3
515704	836515	0.3
515714	836495	0.3
515714	836435	0.3
515724	836435	0.3
515724	836475	0.3
515724	836515	0.3

Easting	Northing	Probed Peat Thickness (m)
515695	833895	0.3
515695	833995	0.3
515705	833985	0.3
515705	833925	0.3
515715	833915	0.3
515735	833955	0.3
515745	833955	0.3
515745	833935	0.3
515755	833945	0.3
515755	833985	0.3
515785	833905	0.3
515785	833895	0.3
515795	833895	0.3
515795	833905	0.3
515795	833915	0.3
515795	833925	0.3
515795	833965	0.3
514994	832590	0.3
515044	832580	0.3
515044	832570	0.3
515054	832540	0.3
515054	832550	0.3
515054	832560	0.3
515054	832570	0.3
515054	832580	0.3
515064	832570	0.3
515064	832560	0.3
515064	832530	0.3
515074	832510	0.3
515074	832530	0.3
515074	832550	0.3
515074	832560	0.3
515074	832570	0.3
515084	832570	0.3
515084	832550	0.3
515084	832530	0.3
515084	832510	0.3
515730	839400	0.3
515740	839340	0.3
515740	839390	0.3
515750	839410	0.3
515750	839400	0.3
515750	839390	0.3
515750	839370	0.3
515750	839330	0.3
515750	839320	0.3
515760	839330	0.3
515780	839380	0.3
515790	839420	0.3
515790	839380	0.3
515790	839370	0.3
515136	838693	0.3
515156	838773	0.3
515166	838673	0.3
515186	838673	0.3
515186	838733	0.3
515196	838703	0.3

Easting	Northing	Probed Peat Thickness (m)
515196	838673	0.3
515206	838723	0.3
515206	838743	0.3
515226	838683	0.3
515226	838713	0.3
515226	838773	0.3
514595	839325	0.3
514595	839345	0.3
514595	839355	0.3
514595	839385	0.3
514605	839365	0.3
514605	839345	0.3
514605	839335	0.3
514605	839325	0.3
514605	839315	0.3
514605	839305	0.3
514605	839295	0.3
514615	839295	0.3
514615	839305	0.3
514615	839315	0.3
514615	839375	0.3
514625	839335	0.3
514635	839305	0.3
514635	839355	0.3
514645	839345	0.3
514645	839315	0.3
514655	839295	0.3
514655	839305	0.3
514655	839335	0.3
514655	839365	0.3
514655	839375	0.3
514655	839385	0.3
514655	839395	0.3
514665	839385	0.3
514665	839375	0.3
514665	839365	0.3
514675	839295	0.3
514675	839315	0.3
514675	839345	0.3
514675	839375	0.3
514675	839385	0.3
514675	839395	0.3
514685	839395	0.3
514685	839385	0.3
514685	839355	0.3
514685	839315	0.3
514695	839295	0.3
514695	839315	0.3
514695	839335	0.3
514695	839345	0.3
514695	839365	0.3
515524	837488	0.3
515524	837548	0.3
515534	837518	0.3
515534	837478	0.3
515534	837458	0.3
515544	837468	0.3

Easting	Northing	Probed Peat Thickness (m)
515544	837478	0.3
515554	837488	0.3
515554	837468	0.3
515554	837458	0.3
515554	837448	0.3
515574	837478	0.3
515574	837448	0.3
515594	837538	0.3
515594	837528	0.3
515594	837508	0.3
515614	837518	0.3
516130	832762	0.3
516170	832762	0.3
516180	832762	0.3
516096	833238	0.3
514416	834715	0.3
514416	834705	0.3
513988	836545	0.3
514008	836545	0.3
514028	836545	0.3
514048	836555	0.3
514018	836555	0.3
513998	836555	0.3
516006	835388	0.3
516019	835386	0.3
516047	835385	0.3
515080	833135	0.3
515553	836558	0.3
515544	836521	0.3
515255	837738	0.3
515266	837732	0.3
515287	837726	0.3
517071	837926	0.3
517067	837907	0.3
517064	837868	0.3
517038	837781	0.3
517033	837762	0.3
513908	835807	0.3
513916	835823	0.3
513984	835968	0.3
513994	835973	0.3
514000	836034	0.3
514008	836108	0.3
514010	835953	0.3
514025	835946	0.3
514045	835935	0.3
514118	835885	0.3
515958	835555	0.3
515663	835292	0.3
515707	833748	0.3
514086	836165	0.3
515924	837508	0.23
515904	837438	0.2
515904	837468	0.2
515904	837488	0.2
515914	837508	0.2
515914	837458	0.2

Easting	Northing	Probed Peat Thickness (m)
515914	837438	0.2
515924	837518	0.2
515934	837538	0.2
515934	837528	0.2
515944	837468	0.2
515944	837478	0.2
515954	837478	0.2
515984	837528	0.2
515527	837212	0.2
515537	837212	0.2
515537	837202	0.2
515547	837202	0.2
514763	838919	0.2
514763	838929	0.2
514763	838939	0.2
514763	838999	0.2
514763	839009	0.2
514773	839009	0.2
514773	838999	0.2
514773	838939	0.2
514773	838929	0.2
514773	838919	0.2
514783	838919	0.2
514783	838929	0.2
514783	838939	0.2
514783	838969	0.2
514783	838999	0.2
514783	839009	0.2
514783	839019	0.2
514793	839019	0.2
514793	839009	0.2
514793	838999	0.2
514793	838989	0.2
514793	838979	0.2
514793	838969	0.2
514793	838959	0.2
514793	838949	0.2
514793	838939	0.2
514793	838919	0.2
514803	838919	0.2
514803	838929	0.2
514803	838969	0.2
514803	838979	0.2
514803	838989	0.2
514803	838999	0.2
514803	839009	0.2
514803	839019	0.2
514813	839019	0.2
514813	839009	0.2
514813	838939	0.2
514813	838929	0.2
514813	838919	0.2
514823	838919	0.2
514823	838939	0.2
514823	838949	0.2
514823	838979	0.2
514823	838989	0.2

Easting	Northing	Probed Peat Thickness (m)
514823	839009	0.2
514823	839019	0.2
514833	838989	0.2
514833	838979	0.2
514833	838949	0.2
514833	838939	0.2
514833	838929	0.2
514833	838919	0.2
514843	838919	0.2
514853	838979	0.2
514853	838959	0.2
514853	838949	0.2
516545	838162	0.2
516545	838182	0.2
516555	838222	0.2
516555	838212	0.2
516555	838192	0.2
516555	838162	0.2
516555	838142	0.2
516555	838132	0.2
516565	838132	0.2
516565	838152	0.2
516565	838162	0.2
516565	838192	0.2
516565	838222	0.2
516575	838222	0.2
516575	838212	0.2
516575	838182	0.2
516575	838142	0.2
516585	838152	0.2
516585	838212	0.2
516595	838172	0.2
516595	838162	0.2
516605	838132	0.2
516605	838152	0.2
516615	838192	0.2
516615	838182	0.2
516615	838142	0.2
516625	838152	0.2
516625	838202	0.2
516635	838202	0.2
516635	838192	0.2
516645	838162	0.2
516645	838222	0.2
515926	835869	0.2
515926	835879	0.2
515926	835909	0.2
515926	835929	0.2
515936	835929	0.2
515936	835889	0.2
515936	835849	0.2
515936	835829	0.2
515946	835829	0.2
515946	835849	0.2
515946	835859	0.2
515946	835869	0.2
515946	835879	0.2

Easting	Northing	Probed Peat Thickness (m)
515946	835889	0.2
515946	835899	0.2
515956	835909	0.2
515956	835849	0.2
515956	835829	0.2
515966	835829	0.2
515966	835839	0.2
515966	835869	0.2
515966	835879	0.2
515966	835929	0.2
515976	835929	0.2
515976	835919	0.2
515976	835879	0.2
515976	835869	0.2
515976	835859	0.2
515976	835849	0.2
515976	835839	0.2
515986	835829	0.2
515986	835839	0.2
515986	835849	0.2
515986	835859	0.2
515986	835909	0.2
515986	835919	0.2
515986	835929	0.2
515996	835929	0.2
515996	835919	0.2
515996	835909	0.2
515996	835879	0.2
515996	835869	0.2
515996	835859	0.2
515996	835849	0.2
516006	835839	0.2
516006	835849	0.2
516006	835869	0.2
516006	835919	0.2
516006	835929	0.2
516016	835919	0.2
516016	835909	0.2
516016	835899	0.2
516016	835879	0.2
516016	835869	0.2
516016	835859	0.2
516016	835849	0.2
516016	835839	0.2
516016	835829	0.2
516026	835829	0.2
516026	835869	0.2
516026	835879	0.2
516026	835899	0.2
516026	835929	0.2
515704	836475	0.2
515704	836505	0.2
515714	836525	0.2
515714	836515	0.2
515714	836505	0.2
515724	836525	0.2
515715	833935	0.2

Easting	Northing	Probed Peat Thickness (m)
515715	833945	0.2
515725	833945	0.2
515725	833935	0.2
515735	833965	0.2
515745	833945	0.2
515755	833995	0.2
514994	832580	0.2
515064	832550	0.2
515064	832540	0.2
515064	832520	0.2
515074	832520	0.2
515084	832540	0.2
515084	832520	0.2
515084	832500	0.2
515094	832490	0.2
515094	832500	0.2
515094	832510	0.2
515094	832520	0.2
515094	832530	0.2
515094	832540	0.2
515094	832550	0.2
515094	832560	0.2
515094	832570	0.2
515094	832580	0.2
515094	832590	0.2
515720	839390	0.2
515720	839410	0.2
515730	839390	0.2
515740	839320	0.2
515740	839330	0.2
515740	839350	0.2
515740	839370	0.2
515740	839400	0.2
515740	839410	0.2
515740	839420	0.2
515750	839380	0.2
515760	839320	0.2
515760	839340	0.2
515760	839410	0.2
515770	839390	0.2
515770	839380	0.2
515770	839340	0.2
515780	839320	0.2
515780	839330	0.2
515780	839340	0.2
515780	839370	0.2
515780	839420	0.2
515790	839410	0.2
515790	839360	0.2
515790	839320	0.2
515800	839390	0.2
515800	839420	0.2
515126	838673	0.2
515126	838753	0.2
515136	838723	0.2
515136	838713	0.2
515136	838683	0.2

Easting	Northing	Probed Peat Thickness (m)
515146	838673	0.2
515146	838703	0.2
515146	838733	0.2
515146	838773	0.2
515156	838723	0.2
515156	838693	0.2
515166	838693	0.2
515166	838713	0.2
515166	838753	0.2
515166	838763	0.2
515176	838773	0.2
515176	838763	0.2
515176	838753	0.2
515176	838733	0.2
515176	838723	0.2
515176	838693	0.2
515176	838683	0.2
515186	838693	0.2
515186	838723	0.2
515186	838753	0.2
515186	838763	0.2
515186	838773	0.2
515196	838773	0.2
515196	838763	0.2
515196	838753	0.2
515196	838733	0.2
515196	838683	0.2
515206	838683	0.2
515206	838703	0.2
515206	838713	0.2
515206	838733	0.2
515206	838763	0.2
515216	838753	0.2
515216	838703	0.2
515216	838693	0.2
515216	838683	0.2
515216	838673	0.2
515226	838693	0.2
514595	839365	0.2
514595	839375	0.2
514595	839395	0.2
514605	839395	0.2
514605	839385	0.2
514605	839375	0.2
514605	839355	0.2
514615	839335	0.2
514615	839345	0.2
514615	839365	0.2
514615	839385	0.2
514615	839395	0.2
514625	839365	0.2
514625	839325	0.2
514625	839315	0.2
514635	839315	0.2
514635	839325	0.2
514635	839335	0.2
514635	839345	0.2

Easting	Northing	Probed Peat Thickness (m)
514645	839375	0.2
514645	839365	0.2
514645	839355	0.2
514645	839335	0.2
514655	839315	0.2
514655	839325	0.2
514665	839395	0.2
514665	839355	0.2
514665	839315	0.2
514665	839305	0.2
514665	839295	0.2
514675	839305	0.2
514675	839355	0.2
514675	839365	0.2
514685	839375	0.2
514685	839365	0.2
514685	839295	0.2
514695	839305	0.2
514695	839325	0.2
514695	839355	0.2
515534	837548	0.2
515534	837468	0.2
515534	837448	0.2
515544	837448	0.2
515544	837458	0.2
515554	837478	0.2
515564	837448	0.2
515594	837548	0.2
516150	832762	0.2
516160	832762	0.2
516190	832752	0.2
516036	833238	0.2
514426	834675	0.2
514426	834695	0.2
514636	834579	0.2
514676	834529	0.2
513958	836545	0.2
513968	836545	0.2
514008	836555	0.2
513958	836555	0.2
513968	836565	0.2
513998	836565	0.2
514028	836565	0.2
513988	836575	0.2
516034	835385	0.2
516065	835381	0.2
516083	835380	0.2
516100	835378	0.2
516119	835378	0.2
516130	835375	0.2
516169	835372	0.2
516186	835369	0.2
514988	833125	0.2
515020	833128	0.2
515577	836649	0.2
515572	836632	0.2
515568	836614	0.2

Easting	Northing	Probed Peat Thickness (m)
515564	836593	0.2
515559	836573	0.2
515543	836503	0.2
517077	837962	0.2
517076	837946	0.2
517065	837887	0.2
517062	837851	0.2
517049	837813	0.2
517031	837748	0.2
513995	835986	0.2
513999	836009	0.2
514001	836038	0.2
514000	836051	0.2
514001	835970	0.2
516120	832668	0.2
516122	832695	0.2
516145	832662	0.2
516119	832643	0.2
515764	834004	0.2
516072	835310	0.2
515878	835555	0.2
515961	835629	0.2
515707	833725	0.2
515156	838743	0.12
515904	837448	0.1
515904	837458	0.1
515904	837478	0.1
515914	837478	0.1
515914	837468	0.1
515914	837448	0.1
515924	837438	0.1
515924	837448	0.1
515924	837458	0.1
515924	837468	0.1
515924	837478	0.1
515934	837478	0.1
515934	837468	0.1
515934	837458	0.1
515934	837448	0.1
515934	837438	0.1
515944	837438	0.1
515944	837448	0.1
515944	837458	0.1
515954	837468	0.1
515954	837458	0.1
515954	837448	0.1
515954	837438	0.1
515964	837438	0.1
515964	837448	0.1
515964	837458	0.1
515964	837468	0.1
515964	837478	0.1
515964	837488	0.1
515964	837498	0.1
515964	837508	0.1
515974	837508	0.1
515974	837498	0.1

Easting	Northing	Probed Peat Thickness (m)
515974	837488	0.1
515974	837478	0.1
515974	837468	0.1
515974	837458	0.1
515974	837448	0.1
515974	837438	0.1
515984	837438	0.1
515984	837448	0.1
515984	837458	0.1
515984	837468	0.1
515984	837478	0.1
515984	837488	0.1
515984	837498	0.1
515984	837508	0.1
515984	837518	0.1
515994	837518	0.1
515994	837508	0.1
515994	837498	0.1
515994	837488	0.1
515994	837478	0.1
515994	837468	0.1
515994	837458	0.1
515994	837448	0.1
515994	837438	0.1
516004	837438	0.1
516004	837448	0.1
516004	837458	0.1
516004	837468	0.1
516004	837478	0.1
516004	837488	0.1
516004	837498	0.1
516004	837508	0.1
516004	837518	0.1
515517	837212	0.1
515517	837202	0.1
515517	837192	0.1
515527	837182	0.1
515527	837192	0.1
515527	837202	0.1
514793	838929	0.1
516545	838122	0.1
516545	838132	0.1
516545	838122	0.1
516545	838132	0.1
516545	838142	0.1
516545	838152	0.1
516545	838172	0.1
516545	838192	0.1
516545	838202	0.1
516545	838212	0.1
516545	838222	0.1
516555	838202	0.1
516555	838182	0.1
516555	838172	0.1
516555	838152	0.1
516555	838122	0.1
516565	838122	0.1

Easting	Northing	Probed Peat Thickness (m)
516565	838142	0.1
516565	838172	0.1
516565	838182	0.1
516565	838202	0.1
516565	838212	0.1
516575	838202	0.1
516575	838192	0.1
516575	838172	0.1
516575	838162	0.1
516575	838152	0.1
516575	838132	0.1
516575	838122	0.1
516585	838122	0.1
516585	838132	0.1
516585	838142	0.1
516585	838162	0.1
516585	838172	0.1
516585	838182	0.1
516585	838192	0.1
516585	838202	0.1
516585	838222	0.1
516595	838222	0.1
516595	838212	0.1
516595	838202	0.1
516595	838192	0.1
516595	838182	0.1
516595	838152	0.1
516595	838142	0.1
516595	838132	0.1
516595	838122	0.1
516605	838122	0.1
516605	838142	0.1
516605	838162	0.1
516605	838172	0.1
516605	838182	0.1
516605	838192	0.1
516605	838202	0.1
516605	838212	0.1
516605	838222	0.1
516615	838222	0.1
516615	838212	0.1
516615	838202	0.1
516615	838172	0.1
516615	838162	0.1
516615	838152	0.1
516615	838132	0.1
516615	838122	0.1
516625	838122	0.1
516625	838132	0.1
516625	838142	0.1
516625	838162	0.1
516625	838172	0.1
516625	838182	0.1
516625	838192	0.1
516625	838212	0.1
516625	838222	0.1
516635	838222	0.1

Easting	Northing	Probed Peat Thickness (m)
516635	838212	0.1
516635	838182	0.1
516635	838172	0.1
516635	838162	0.1
516635	838152	0.1
516635	838142	0.1
516635	838132	0.1
516635	838122	0.1
516645	838122	0.1
516645	838132	0.1
516645	838142	0.1
516645	838152	0.1
516645	838172	0.1
516645	838182	0.1
516645	838192	0.1
516645	838202	0.1
516645	838212	0.1
515926	835849	0.1
515926	835859	0.1
515926	835899	0.1
515926	835919	0.1
515936	835919	0.1
515936	835839	0.1
515966	835889	0.1
515966	835909	0.1
515966	835919	0.1
515976	835889	0.1
515976	835829	0.1
515996	835839	0.1
515996	835829	0.1
516006	835829	0.1
516006	835859	0.1
516006	835909	0.1
516016	835929	0.1
516026	835839	0.1
516026	835849	0.1
516026	835859	0.1
515700	839320	0.1
515700	839330	0.1
515700	839340	0.1
515700	839350	0.1
515700	839360	0.1
515700	839370	0.1
515700	839380	0.1
515700	839400	0.1
515700	839410	0.1
515700	839420	0.1
515710	839410	0.1
515710	839400	0.1
515710	839390	0.1
515710	839380	0.1
515710	839370	0.1
515710	839360	0.1
515710	839350	0.1
515710	839340	0.1
515710	839330	0.1
515710	839320	0.1

Easting	Northing	Probed Peat Thickness (m)
515720	839320	0.1
515720	839330	0.1
515720	839340	0.1
515720	839350	0.1
515720	839360	0.1
515720	839370	0.1
515720	839380	0.1
515720	839400	0.1
515720	839420	0.1
515730	839420	0.1
515730	839410	0.1
515730	839380	0.1
515730	839370	0.1
515730	839360	0.1
515730	839350	0.1
515730	839340	0.1
515730	839330	0.1
515730	839320	0.1
515740	839360	0.1
515740	839380	0.1
515750	839420	0.1
515750	839360	0.1
515750	839350	0.1
515750	839340	0.1
515760	839350	0.1
515760	839360	0.1
515760	839370	0.1
515760	839380	0.1
515760	839390	0.1
515760	839420	0.1
515770	839420	0.1
515770	839370	0.1
515770	839360	0.1
515770	839350	0.1
515770	839330	0.1
515770	839320	0.1
515780	839350	0.1
515780	839360	0.1
515780	839390	0.1
515780	839410	0.1
515790	839350	0.1
515790	839340	0.1
515790	839330	0.1
515800	839320	0.1
515800	839330	0.1
515800	839340	0.1
515800	839350	0.1
515800	839400	0.1
515800	839410	0.1
515126	838683	0.1
515126	838693	0.1
515126	838703	0.1
515126	838713	0.1
515126	838723	0.1
515126	838733	0.1
515126	838743	0.1
515126	838763	0.1

Easting	Northing	Probed Peat Thickness (m)
515126	838773	0.1
515136	838773	0.1
515136	838763	0.1
515136	838753	0.1
515136	838743	0.1
515136	838733	0.1
515136	838673	0.1
515146	838683	0.1
515146	838693	0.1
515146	838713	0.1
515146	838723	0.1
515146	838743	0.1
515146	838753	0.1
515146	838763	0.1
515156	838763	0.1
515156	838753	0.1
515156	838733	0.1
515156	838713	0.1
515156	838703	0.1
515156	838683	0.1
515156	838673	0.1
515166	838683	0.1
515166	838703	0.1
515166	838723	0.1
515166	838733	0.1
515166	838743	0.1
515176	838743	0.1
515176	838713	0.1
515176	838703	0.1
515186	838703	0.1
515186	838713	0.1
515186	838743	0.1
515196	838743	0.1
515196	838723	0.1
515196	838713	0.1
515196	838693	0.1
515206	838773	0.1
515226	838763	0.1
514615	839355	0.1
514625	839395	0.1
514625	839385	0.1
514625	839375	0.1
514625	839355	0.1
514625	839345	0.1
514635	839365	0.1
514635	839375	0.1
514635	839385	0.1
514635	839395	0.1
514645	839395	0.1
514645	839385	0.1
514645	839325	0.1
514645	839305	0.1
515524	837448	0.1
515524	837458	0.1
515524	837468	0.1
515524	837478	0.1
515584	837448	0.1

Easting	Northing	Probed Peat Thickness (m)
516090	832732	0.1
516090	832742	0.1
516090	832752	0.1
516090	832762	0.1
516090	832772	0.1
516090	832782	0.1
516090	832792	0.1
516090	832802	0.1
516090	832812	0.1
516090	832822	0.1
516100	832822	0.1
516100	832812	0.1
516100	832802	0.1
516100	832792	0.1
516100	832782	0.1
516100	832772	0.1
516100	832762	0.1
516100	832752	0.1
516100	832742	0.1
516100	832732	0.1
516110	832732	0.1
516110	832742	0.1
516110	832752	0.1
516110	832762	0.1
516110	832772	0.1
516110	832782	0.1
516110	832792	0.1
516110	832802	0.1
516110	832812	0.1
516110	832822	0.1
516120	832822	0.1
516120	832812	0.1
516120	832802	0.1
516120	832792	0.1
516120	832782	0.1
516120	832772	0.1
516120	832762	0.1
516120	832752	0.1
516130	832772	0.1
516130	832782	0.1
516130	832792	0.1
516130	832802	0.1
516130	832812	0.1
516130	832822	0.1
516140	832822	0.1
516140	832812	0.1
516140	832802	0.1
516140	832792	0.1
516140	832782	0.1
516140	832772	0.1
516140	832762	0.1
516140	832752	0.1
516150	832772	0.1
516150	832782	0.1
516150	832792	0.1
516150	832802	0.1
516150	832812	0.1

Easting	Northing	Probed Peat Thickness (m)
516150	832822	0.1
516160	832822	0.1
516160	832812	0.1
516160	832802	0.1
516160	832792	0.1
516160	832782	0.1
516160	832772	0.1
516170	832772	0.1
516170	832782	0.1
516170	832792	0.1
516170	832802	0.1
516170	832812	0.1
516170	832822	0.1
516180	832822	0.1
516180	832812	0.1
516180	832802	0.1
516180	832792	0.1
516180	832782	0.1
516180	832772	0.1
516190	832762	0.1
516190	832772	0.1
516190	832782	0.1
516190	832792	0.1
516190	832802	0.1
516190	832812	0.1
516190	832822	0.1
515996	833138	0.1
515996	833148	0.1
515996	833158	0.1
515996	833168	0.1
515996	833178	0.1
515996	833188	0.1
515996	833198	0.1
515996	833208	0.1
516006	833228	0.1
516006	833218	0.1
516006	833208	0.1
516006	833198	0.1
516006	833188	0.1
516006	833178	0.1
516006	833168	0.1
516006	833158	0.1
516006	833148	0.1
516006	833138	0.1
516016	833138	0.1
516016	833148	0.1
516016	833158	0.1
516016	833168	0.1
516016	833178	0.1
516016	833188	0.1
516016	833198	0.1
516016	833208	0.1
516016	833218	0.1
516016	833228	0.1
516016	833238	0.1
516026	833238	0.1
516026	833228	0.1

Easting	Northing	Probed Peat Thickness (m)
516026	833218	0.1
516026	833208	0.1
516026	833198	0.1
516026	833188	0.1
516026	833178	0.1
516026	833168	0.1
516026	833158	0.1
516026	833148	0.1
516026	833138	0.1
516036	833138	0.1
516036	833148	0.1
516036	833158	0.1
516036	833168	0.1
516036	833178	0.1
516036	833188	0.1
516036	833198	0.1
516036	833208	0.1
516036	833218	0.1
516036	833228	0.1
516046	833238	0.1
516046	833228	0.1
516046	833218	0.1
516046	833208	0.1
516046	833198	0.1
516046	833188	0.1
516046	833178	0.1
516046	833168	0.1
516046	833158	0.1
516046	833148	0.1
516046	833138	0.1
516056	833138	0.1
516056	833148	0.1
516056	833158	0.1
516056	833168	0.1
516056	833178	0.1
516056	833188	0.1
516056	833198	0.1
516056	833208	0.1
516056	833218	0.1
516056	833228	0.1
516056	833238	0.1
516066	833238	0.1
516066	833228	0.1
516066	833218	0.1
516066	833208	0.1
516066	833198	0.1
516066	833188	0.1
516066	833178	0.1
516066	833168	0.1
516066	833158	0.1
516066	833148	0.1
516066	833138	0.1
516076	833138	0.1
516076	833148	0.1
516076	833158	0.1
516076	833168	0.1
516076	833178	0.1

Easting	Northing	Probed Peat Thickness (m)
516076	833188	0.1
516076	833198	0.1
516076	833208	0.1
516076	833218	0.1
516076	833228	0.1
516076	833238	0.1
516086	833238	0.1
516086	833228	0.1
516086	833218	0.1
516086	833208	0.1
516086	833198	0.1
516086	833188	0.1
516086	833178	0.1
516086	833168	0.1
516086	833158	0.1
516086	833148	0.1
516086	833138	0.1
516096	833138	0.1
516096	833148	0.1
516096	833158	0.1
516096	833168	0.1
516096	833178	0.1
516096	833188	0.1
516096	833198	0.1
516096	833208	0.1
516096	833218	0.1
514406	834715	0.1
514406	834725	0.1
514406	834735	0.1
514406	834745	0.1
514406	834755	0.1
514406	834765	0.1
514416	834765	0.1
514416	834755	0.1
514416	834745	0.1
514416	834735	0.1
514416	834725	0.1
514426	834705	0.1
514426	834715	0.1
514426	834725	0.1
514426	834735	0.1
514426	834745	0.1
514426	834755	0.1
514426	834765	0.1
514436	834765	0.1
514436	834755	0.1
514436	834745	0.1
514436	834735	0.1
514436	834725	0.1
514436	834715	0.1
514436	834705	0.1
514616	834529	0.1
514616	834539	0.1
514616	834549	0.1
514616	834559	0.1
514616	834569	0.1
514616	834579	0.1

Easting	Northing	Probed Peat Thickness (m)
514616	834589	0.1
514616	834599	0.1
514616	834609	0.1
514616	834619	0.1
514616	834629	0.1
514626	834589	0.1
514626	834579	0.1
514626	834569	0.1
514626	834559	0.1
514626	834549	0.1
514626	834539	0.1
514626	834529	0.1
514636	834589	0.1
514636	834599	0.1
514636	834609	0.1
514636	834619	0.1
514636	834629	0.1
514646	834629	0.1
514646	834619	0.1
514646	834609	0.1
514646	834599	0.1
514646	834589	0.1
514646	834579	0.1
514646	834569	0.1
514646	834559	0.1
514646	834549	0.1
514646	834539	0.1
514646	834529	0.1
514656	834529	0.1
514656	834539	0.1
514656	834549	0.1
514656	834559	0.1
514656	834569	0.1
514656	834579	0.1
514656	834589	0.1
514656	834599	0.1
514656	834609	0.1
514656	834619	0.1
514656	834629	0.1
514666	834629	0.1
514666	834619	0.1
514666	834609	0.1
514666	834599	0.1
514666	834589	0.1
514666	834579	0.1
514666	834569	0.1
514666	834559	0.1
514666	834549	0.1
514666	834539	0.1
514666	834529	0.1
514676	834539	0.1
514676	834549	0.1
514676	834559	0.1
514676	834569	0.1
514676	834579	0.1
514676	834589	0.1
514676	834599	0.1

Easting	Northing	Probed Peat Thickness (m)
514676	834609	0.1
514676	834619	0.1
514676	834629	0.1
514686	834629	0.1
514686	834619	0.1
514686	834609	0.1
514686	834599	0.1
514686	834589	0.1
514686	834579	0.1
514686	834569	0.1
514686	834559	0.1
514686	834549	0.1
514686	834539	0.1
514686	834529	0.1
514696	834529	0.1
514696	834539	0.1
514696	834549	0.1
514696	834559	0.1
514696	834569	0.1
514696	834579	0.1
514696	834589	0.1
514696	834599	0.1
514696	834609	0.1
514696	834619	0.1
514696	834629	0.1
514706	834629	0.1
514706	834619	0.1
514706	834609	0.1
514706	834599	0.1
514706	834589	0.1
514706	834579	0.1
514706	834569	0.1
514706	834559	0.1
514706	834549	0.1
514706	834539	0.1
514706	834529	0.1
514716	834529	0.1
514716	834539	0.1
514716	834549	0.1
514716	834559	0.1
514716	834569	0.1
514716	834579	0.1
514716	834589	0.1
514716	834599	0.1
514716	834609	0.1
514716	834619	0.1
514716	834629	0.1
514038	836545	0.1
514038	836555	0.1
513978	836555	0.1
513968	836555	0.1
513948	836565	0.1
513958	836565	0.1
513978	836565	0.1
513988	836565	0.1
514008	836565	0.1
514018	836565	0.1

Easting	Northing	Probed Peat Thickness (m)
514038	836565	0.1
514038	836575	0.1
514028	836575	0.1
514018	836575	0.1
514008	836575	0.1
513998	836575	0.1
513978	836575	0.1
513968	836575	0.1
513958	836575	0.1
513948	836575	0.1
513948	836585	0.1
513958	836585	0.1
513968	836585	0.1
513978	836585	0.1
513988	836585	0.1
513998	836585	0.1
514008	836585	0.1
514018	836585	0.1
514028	836585	0.1
514038	836585	0.1
514048	836585	0.1
514048	836595	0.1
514038	836595	0.1
514028	836595	0.1
514018	836595	0.1
514008	836595	0.1
513998	836595	0.1
513988	836595	0.1
513978	836595	0.1
513968	836595	0.1
513958	836595	0.1
513948	836595	0.1
513948	836605	0.1
513958	836605	0.1
513968	836605	0.1
513978	836605	0.1
513988	836605	0.1
513998	836605	0.1
514008	836605	0.1
514018	836605	0.1
514028	836605	0.1
514038	836605	0.1
514038	836615	0.1
514028	836615	0.1
514018	836615	0.1
514008	836615	0.1
513998	836615	0.1
513988	836615	0.1
513978	836615	0.1
513968	836615	0.1
513958	836615	0.1
513948	836615	0.1
513948	836625	0.1
513958	836625	0.1
513968	836625	0.1
513978	836625	0.1
513988	836625	0.1

Easting	Northing	Probed Peat Thickness (m)
513998	836625	0.1
514008	836625	0.1
514018	836625	0.1
514028	836625	0.1
514038	836625	0.1
514038	836635	0.1
514028	836635	0.1
514018	836635	0.1
514008	836635	0.1
513998	836635	0.1
513988	836635	0.1
513978	836635	0.1
513968	836635	0.1
513958	836635	0.1
513948	836635	0.1
513948	836645	0.1
513958	836645	0.1
513968	836645	0.1
513978	836645	0.1
513988	836645	0.1
513998	836645	0.1
514008	836645	0.1
514018	836645	0.1
514028	836645	0.1
514038	836645	0.1
516152	835375	0.1
517060	837832	0.1
516097	832675	0.1
515955	835460	0.1
515914	837498	0
515914	837488	0
515924	837488	0
515924	837498	0
515934	837498	0
515934	837488	0
515944	837488	0
515944	837498	0
515944	837508	0
515507	837112	0
515507	837122	0
515507	837132	0
515507	837142	0
515507	837152	0
515507	837162	0
515507	837172	0
515507	837182	0
515507	837192	0
515507	837202	0
515517	837182	0
515517	837172	0
515517	837162	0
515517	837152	0
515517	837142	0
515517	837132	0
515517	837122	0
515517	837112	0
515527	837112	0

Easting	Northing	Probed Peat Thickness (m)
515527	837122	0
515527	837132	0
515527	837142	0
515527	837152	0
515527	837162	0
515527	837172	0
515537	837192	0
515537	837182	0
515537	837172	0
515537	837162	0
515537	837152	0
515537	837142	0
515537	837132	0
515537	837122	0
515537	837112	0
515547	837112	0
515547	837122	0
515547	837132	0
515547	837142	0
515547	837152	0
515547	837162	0
515547	837172	0
515547	837182	0
515547	837192	0
515557	837192	0
515557	837182	0
515557	837172	0
515557	837162	0
515557	837152	0
515557	837142	0
515557	837132	0
515557	837122	0
515557	837112	0
515567	837112	0
515567	837122	0
515567	837132	0
515567	837142	0
515567	837152	0
515567	837162	0
515567	837172	0
515567	837182	0
515567	837192	0
515577	837192	0
515577	837182	0
515577	837172	0
515577	837162	0
515577	837152	0
515577	837142	0
515577	837132	0
515577	837122	0
515577	837112	0
515587	837112	0
515587	837122	0
515587	837132	0
515587	837142	0
515587	837152	0
515587	837162	0

Easting	Northing	Probed Peat Thickness (m)
515587	837172	0
515587	837182	0
515587	837192	0
515597	837192	0
515597	837182	0
515597	837172	0
515597	837162	0
515597	837152	0
515597	837142	0
515597	837132	0
515597	837122	0
515597	837112	0
515607	837112	0
515607	837122	0
515607	837132	0
515607	837142	0
515607	837152	0
515607	837162	0
515607	837172	0
515607	837182	0
515607	837192	0
515936	835879	0
515936	835869	0
515936	835859	0
515946	835909	0
515956	835929	0
515624	836435	0
515624	836445	0
515624	836455	0
515624	836465	0
515624	836475	0
515624	836485	0
515624	836495	0
515624	836505	0
515624	836515	0
515624	836525	0
515624	836535	0
515634	836535	0
515634	836525	0
515634	836515	0
515634	836505	0
515634	836495	0
515634	836485	0
515634	836475	0
515634	836465	0
515634	836455	0
515634	836445	0
515634	836435	0
515644	836435	0
515644	836445	0
515644	836455	0
515644	836465	0
515644	836475	0
515644	836485	0
515644	836495	0
515644	836505	0
515644	836515	0

Easting	Northing	Probed Peat Thickness (m)
515644	836525	0
515644	836535	0
515654	836535	0
515654	836525	0
515654	836515	0
515654	836505	0
515654	836495	0
515654	836485	0
515654	836475	0
515654	836465	0
515654	836455	0
515654	836445	0
515654	836435	0
515664	836435	0
515664	836445	0
515664	836455	0
515664	836465	0
515664	836475	0
515664	836485	0
515664	836495	0
515664	836505	0
515664	836515	0
515664	836525	0
515664	836535	0
515674	836535	0
515674	836525	0
515674	836515	0
515674	836505	0
515674	836495	0
515674	836485	0
515674	836475	0
515674	836465	0
515674	836455	0
515674	836445	0
515674	836435	0
515684	836435	0
515684	836445	0
515684	836455	0
515684	836465	0
515684	836475	0
515684	836485	0
515684	836495	0
515684	836505	0
515684	836515	0
515684	836525	0
515684	836535	0
515694	836535	0
515694	836525	0
515694	836515	0
515694	836505	0
515694	836495	0
515694	836485	0
515694	836475	0
515694	836465	0
515694	836455	0
515694	836445	0
515694	836435	0

Easting	Northing	Probed Peat Thickness (m)
515704	836525	0
515704	836535	0
515714	836535	0
515724	836535	0
514994	832490	0
514994	832500	0
514994	832510	0
514994	832520	0
514994	832530	0
514994	832540	0
514994	832550	0
514994	832560	0
514994	832570	0
515004	832570	0
515004	832560	0
515004	832550	0
515004	832540	0
515004	832530	0
515004	832520	0
515004	832510	0
515004	832500	0
515004	832490	0
515014	832490	0
515014	832500	0
515014	832510	0
515014	832520	0
515014	832530	0
515014	832540	0
515014	832550	0
515014	832560	0
515024	832550	0
515024	832540	0
515024	832530	0
515024	832520	0
515024	832510	0
515024	832500	0
515024	832490	0
515034	832490	0
515034	832500	0
515034	832510	0
515034	832520	0
515034	832530	0
515034	832540	0
515044	832540	0
515044	832530	0
515044	832520	0
515044	832510	0
515044	832500	0
515044	832490	0
515054	832490	0
515054	832500	0
515054	832510	0
515054	832520	0
515054	832530	0
515064	832510	0
515064	832500	0
515064	832490	0

Easting	Northing	Probed Peat Thickness (m)
515074	832490	0
515074	832500	0
515084	832490	0
515700	839390	0
515710	839420	0
516090	832722	0
516100	832722	0
516110	832722	0
516120	832742	0
516120	832732	0
516120	832722	0
516130	832722	0
516130	832732	0
516130	832742	0
516130	832752	0
516140	832742	0
516140	832732	0
516140	832722	0
516150	832722	0
516150	832732	0
516150	832742	0
516150	832752	0
516160	832752	0
516160	832742	0
516160	832732	0
516160	832722	0
516170	832722	0
516170	832732	0
516170	832742	0
516170	832752	0
516180	832752	0
516180	832742	0
516180	832732	0
516180	832722	0
516190	832722	0
516190	832732	0
516190	832742	0
515996	833218	0
515996	833228	0
515996	833238	0
516006	833238	0
514446	834665	0
514446	834675	0
514446	834685	0
514446	834695	0
514446	834705	0
514446	834715	0
514446	834725	0
514446	834735	0
514446	834745	0
514446	834755	0
514446	834765	0
514456	834765	0
514456	834755	0
514456	834745	0
514456	834735	0
514456	834725	0

Easting	Northing	Probed Peat Thickness (m)
514456	834715	0
514456	834705	0
514456	834695	0
514456	834685	0
514456	834675	0
514456	834665	0
514466	834665	0
514466	834675	0
514466	834685	0
514466	834695	0
514466	834705	0
514466	834715	0
514466	834725	0
514466	834735	0
514466	834745	0
514466	834755	0
514466	834765	0
514476	834765	0
514476	834755	0
514476	834745	0
514476	834735	0
514476	834725	0
514476	834715	0
514476	834705	0
514476	834695	0
514476	834685	0
514476	834675	0
514476	834665	0
514486	834665	0
514486	834675	0
514486	834685	0
514486	834695	0
514486	834705	0
514486	834715	0
514486	834725	0
514486	834735	0
514486	834745	0
514486	834755	0
514486	834765	0
514496	834765	0
514496	834755	0
514496	834745	0
514496	834735	0
514496	834725	0
514496	834715	0
514496	834705	0
514496	834695	0
514496	834685	0
514496	834675	0
514496	834665	0
514506	834665	0
514506	834675	0
514506	834685	0
514506	834695	0
514506	834705	0
514506	834715	0
514506	834725	0

Easting	Northing	Probed Peat Thickness (m)
514506	834735	0
514506	834745	0
514506	834755	0
514506	834765	0
514626	834629	0
514626	834619	0
514626	834609	0
514626	834599	0
514636	834529	0
514636	834539	0
514636	834549	0
514636	834559	0
514636	834569	0
513948	836545	0
513948	836555	0
514048	836565	0
514048	836575	0
514048	836605	0
514048	836615	0
514048	836625	0
514048	836635	0
514048	836645	0
515725	834020	0.3
514978	832589	0.6
514857	832846	0.6
514889	833179	0.4
514649	834627	0.2
514381	834572	0.3
514033	835779	0
514109	836162	0
515958	835555	0.2
515991	835837	0.3
515645	836489	0.9
515700	836763	0.3
515725	834050	0.1
514978	832619	0.3
514857	832876	0.4
514889	833209	0.4
514649	834657	0.3
514381	834602	0.4
514033	835809	0
514109	836192	0
515958	835585	0.4
515991	835867	0.2
515645	836519	0.6
515700	836793	0.5
515755	834020	0.1
515008	832589	0.6
514887	832846	0.7
514919	833179	0.5
514679	834627	0.2
514411	834572	0.2
514063	835779	0
514139	836162	0
515988	835555	0.3
516021	835837	0.7
515675	836489	0.9

Easting	Northing	Probed Peat Thickness (m)
515730	836763	0.5
515725	833990	0.6
514978	832559	0.1
514857	832816	0.7
514889	833149	0.4
514649	834597	0.3
514381	834542	0.3
514033	835749	0
514109	836132	0
515958	835525	0.2
515991	835807	0.1
515645	836459	0.5
515700	836733	0.7
515695	834020	0.5
514948	832589	0.5
514827	832846	0.9
514859	833179	0.4
514619	834627	0.2
514351	834572	0.1
514003	835779	0
514079	836162	0
515928	835555	0.4
515961	835837	0.4
515615	836489	1.1
515670	836763	0.4
516081	832707	0
516045	833189	0
515743	834002	0
515094	832538	0
515128	832839	0
514665	834578	0
514455	834713	0
516069	835298	0
515959	835555	0
515976	835879	0
515703	836485	0
515550	837205	0
515572	837494	0.4
515951	837490	0



Plate 1—Typical conditions around TP-A



Plate 2—Typical conditions around TP-B



Plate 3—Typical conditions around AT-01



Plate 4—Typical conditions around AT-02



Plate 5—Typical conditions around AT-03



Plate 6—Typical conditions around AT-04



Plate 7—Typical conditions around AT-05



Plate 8—Typical conditions around AT-06



Plate 9—Typical conditions west of AT-07



Plate 10—Typical conditions around AT-08



Plate 11—Typical conditions around AT-09



Plate 12—Typical conditions around AT-10



Plate 13—Typical conditions around AT-11



Plate 14—Typical conditions around AT-12



Plate 15—Typical conditions around AT-13



Plate 16—Typical conditions around AT-14



Plate 17—Typical conditions around AT-15



Plate 18—Typical conditions around AT-16

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 06/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515743.30 N834002.30
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT01	TP	42.93m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.20	42.73		Brown, silty, organic TOPSOIL
					0.70	42.23		Firm, grey mottled orange, gravelly, slightly sandy CLAY with low cobble content. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular.
		2.00	B					Medium dense to dense, bluish grey, clayey, SAND and GRAVEL with low cobble and low boulder content. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular.
		2.70	B		2.60	40.33		Firm to stiff, bluish grey, gravelly SILT / CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular. Possible residual rock.
	▼				3.50	39.43		End of Pit at 3.500m

1 2 3 4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.90	Sides unstable and prone to collapse	None		0.00	3.50	Arisings

Remarks

Groundwater struck at 3.50m b.g.l. - Weak flow. Standing water just covering base after 20 mins. Sides very unstable - frequent sidewall collapse below 2.60m depth.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515094.00 N832538.80
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT02	TP	50.69m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown, organic, silt TOPSOIL
					0.40	50.29		Loose, grey, fine SAND
					0.60	50.09		Firm, grey, slightly sandy, silty CLAY with low cobble content. Sand is fine to coarse grained. Some sub angular boulders below 1.60m depth.
		1.00	B					
					2.00	48.69		Firm, grey, slightly sandy, slightly gravelly SILT
	▼				2.90	47.79		Probably weak, grey, distinctly weathered to destructured, fine grained, SANDSTONE
		3.00	B					
					3.40	47.29		End of Pit at 3.400m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.20	1.90	Sides stable	None		0.00	3.40	Arisings

Remarks

Groundwater struck at 2.90m b.g.l. - Weak flow. Standing water at 2.90m on completion. Excavation stable.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 08/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515127.60 N832839.30
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT03	TP	51.40m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	50.90		Brown, organic, silty TOPSOIL
					0.90	50.50		Soft, grey, slightly sandy, very gravelly CLAY with medium cobble content. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular.
		1.00	B					Loose, grey mottled orange, slightly clayey, very sandy, GRAVEL with low cobble and boulder content. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular.
		1.90	B		1.90	49.50		Probably weak, orange, distinctly weathered, fine to medium grained SANDSTONE
					1.95	49.45		End of Pit at 1.950m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.30	1.90	Sides stable	None		0.00	1.95	Arisings

Remarks

Groundwater seepage at 1.00m and 1.90m b.g.l. only. Refusal on rock at 1.95m.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 06/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E514665.60 N834578.10
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT05	TP	75.37m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	75.17		Brown, silt TOPSOIL
					0.50	74.87		Firm, grey mottled orange, slightly sandy, gravelly CLAY. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular.
					1.20	74.17		Loose to medium dense, grey, SAND and GRAVEL. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular.
		1.50	B					Firm, grey, slightly sandy, clayey, GRAVEL. Sand is fine grained. Gravel is fine to coarse, sub angular to sub rounded.
					2.10	73.27		Medium dense, grey, very sandy, GRAVEL with medium cobble content. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular.
		2.80	B					
					3.00	72.37		End of Pit at 3.000m

1
2
3
4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.00	1.80	Sides unstable and prone to collapse	None		0.00	3.00	Arisings

Remarks

No groundwater encountered during excavation works. Sidewalls of excavatioin prone to collapse below 3.0m depth. Land drain encountered at 1.0m depth.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 06/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E514454.90 N834713.10
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT06	TP	83.42m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	83.22		Brown, silt TOPSOIL
					0.50	82.92		Medium dense, grey mottled orange, fine SAND
					1.00	82.42		Soft, grey, gravelly CLAY. Gravel is fine to coarse, sub angular.
		2.00	B					Loose to medium dense, brownish grey, slightly silty, sandy GRAVEL with medium cobble and low boulder content. Gravel is fine to coarse, sub angular to angular.
					2.80	80.62		End of Pit at 2.800m

1
2
3
4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.90	Sides unstable and prone to collapse	None		0.00	2.80	Arisings

Remarks

Groundwater seepage at 1.00m and 1.90m b.g.l. only. Terminated due to collapsing sidewalls at 2.80m within medium dense silty sandy gravels.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515958.70 N835555.20
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT07	TP	102.27m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15	102.12		Brown, silt TOPSOIL
								Firm, brown mottled orange and grey, gravelly CLAY. Gravel is fine to coarse, sub angular.
		0.80	B		0.70	101.57		Soft, grey, very gravelly, slightly sandy CLAY with low cobble content.
					1.00	101.27		
					1.05	101.22		Probably weak, dark grey, distinctly weathered, fine grained SANDSTONE
								End of Pit at 1.050m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.00	1.80	Sides stable	None		0.00	1.05	Arisings

Remarks

Groundwater seepage at 0.70 - 1.00m depth. Hard digging below 1.05m leading to virtual refusal within the probably weak sandstone stratum.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515976.60 N835878.80
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT08	TP	96.92m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.10	96.82		Brown, silt TOPSOIL
								Soft, grey, gravelly, slightly sandy CLAY with low cobble content. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular to angular.
					0.80	96.12		Soft to firm, grey, very gravelly CLAY with low cobble content (angular and tabular in shape). Gravel is fine to coarse, angular
		1.00	B					
					1.40	95.52		Extremely weak, grey, destructured, fine grained, SANDSTONE.
					1.70	95.22		Probably weak to medium strong, grey, partially weathered, fine grained, SANDSTONE
		1.90	B					
					2.00	94.92		End of Pit at 2.000m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.10	1.90	Sides stable	None		0.00	2.00	Arisings

Remarks

Groundwater seepage at 1.30m depth. Refusal on probably weak to medium strong sandstone rock at 2.00m depth.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515703.30 N836484.50
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT09	TP	109.20m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown, organic, silt TOPSOIL
					0.30	108.90		Soft to firm, brown, very gravelly CLAY with low cobble content. Gravel is fine to coarse, angular.
					0.70	108.50		Extremely weak, grey, destructured, fine grained, thinly bedded SANDSTONE
		1.00	B					
					1.60	107.60		
		1.70	B		1.70	107.50		Probably weak, grey, distinctly weathered, fine grained, thinly to thickly bedded, SANDSTONE
								End of Pit at 1.700m

1
2
3
4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.80	1.80	Sides stable	None		0.00	1.70	Arisings

Remarks

No groundwater encountered during excavation works. Sidewalls stable. Terminated at 1.70m depth within probably weak sandstone rock.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515550.00 N837205.60
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT11	TP	117.06m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30	116.76		Brown, silt TOPSOIL
		1.00	B					Firm, grey, very gravelly CLAY. Gravel is fine to coarse, angular.
					1.30	115.76		
		1.40	B					Probably weak to moderately weak, yellowish orange, distinctly weathered to partially weathered, fine grained SANDSTONE
					1.50	115.56		End of Pit at 1.500m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.20	1.80	Sides stable	None		0.00	1.50	Arisings

Remarks

Groundwater seepage at 1.00m depth. Pit terminated at 1.50m depth within probably weak to moderately weak sandstone rock.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515572.20 N837493.90
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT13	TP	128.11m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Soft, brown PEAT
					0.40	127.71		Firm, grey, gravelly CLAY. Gravel is fine to coarse, sub angular
					1.50	126.61		Loose, grey, slightly sandy, very clayey GRAVEL with low cobble and boulder content. Sand is fien to coarse grained. Gravel is fine to coarse, sub angular to sub rounded.
		2.50	B					
	▽	3.00	B		2.80	125.31		Dense, greenish grey, sandy, very clayey GRAVEL. Sand is fine to coarse grained. Gravel is fine to coarse, angular. Extremely weathered rock "structure" observed in one face of the pit - excavates as gravel.
					3.10	125.01		End of Pit at 3.100m

1 2 3 4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.10	1.90	Sides unstable and prone to collapse	None		0.00	3.10	Arisings

Remarks

Groundwater seepage at 3.00m depth. Sides very unstable below 3.00m depth. Pit terminated at 3.10m within probably extremely weak destructured rock.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E515950.70 N837489.60
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT14	TP	115.89m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown, silt TOPSOIL
					0.40	115.49		Firm, grey mottled brown and orange, very gravelly CLAY.
					1.30	114.59		Probably very weak, grey, distinctly weathered, fine grained, SILTSTONE
	▽	2.00	B					
		2.10	B		2.05	113.84		End of Pit at 2.050m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.20	1.90	Sides stable	None		0.00	2.05	Arisings

Remarks

Groundwater seepage at 2.00m depth. Sidewalls stable. Refusal encountered within probably very weak siltstone rock at 2.05m depth.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E517008.83 N837543.99
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-AT16	TP	115.74m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.60	115.14		Soft, dark brown PEAT
					1.20	114.54		Firm, grey, sandy SILT
		1.50			2.80	112.94		Extremely weak to very weak, dark grey, destructured SHALE
		3.00			3.20	112.54		Weak, dark grey, partially weathered SANDSTONE
					3.30	112.44		Moderately weak, dark grey, partially weathered SANDSTONE
								End of Pit at 3.300m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	3.20	Arisings

Remarks

Groundwater encountered 1.2m b.g.l (Seepage).

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 06/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E516045.40 N833189.30
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-A	TP	30.85m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Brown, silt TOPSOIL
					0.40	30.45		Loose to medium dense, brown, very clayey GRAVEL with low cobble content. Gravel is fine to coarse, sub angular.
		1.00	B					
					2.00	28.85		Loose to medium dense, brownish grey and grey, SAND and GRAVEL Sand is fine grained. Gravel is fine to coarse, sub angular.
		2.50	B					
					3.20	27.65		End of Pit at 3.200m

1 2 3 4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.20	1.90	Sides unstable and prone to collapse	None		0.00	3.20	Arisings

Remarks

Groundwater struck at 2.70m b.g.l. - Moderate flow. Standing water at 3.00m on completion after 20 mins. Sides extremely unstable - prone to sidewall collapse.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 08/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E516081.10 N832706.80
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-B	TP	23.27m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.50	22.77		Brown, slightly sandy, silt TOPSOIL
					1.00	22.27		Soft, brown, sandy CLAY
		1.10	B					Soft to firm, grey, sandy, very gravelly CLAY with low cobble content. Sand is fine to coarse grained. Gravel is fine to coarse, sub rounded to sub angular.
	▼				1.50	21.77		Loose, brown, clayey, SAND and GRAVEL with medium cobble content and low boulder content. Sand is fine grained. Gravel is fine to coarse, sub angular.
		2.50	B					
					2.60	20.67		End of Pit at 2.600m

1
2
3
4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
4.10	1.80	Sides unstable and prone to collapse	None		0.00	2.60	Arisings

Remarks

Groundwater struck at 1.80m b.g.l. - Moderate flow. Standing water at 1.80m on completion after 20 mins. Sides extremely unstable - prone to sidewall collapse.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 07/03/2024
		Contractor: Whiteford Geoservices Ltd	Co-ords: E516068.60 N835298.00
Location:		Sub Contractor: Plant supplied by J.J. Clifford Plant Hire	Equipment: JCB JS131 13T Tacked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-C	TP	100.73m AoD	J. Whiteford	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.30	100.43		Brown, silt TOPSOIL
								Firm, brownish grey, very gravelly CLAY. Gravel is fine to coarse grained, angular.
		1.50	B		1.40	99.33		Loose to medium dense, grey, very clayey, slightly sandy, GRAVEL with low cobble content. Gravel is fine to coarse, sub angular.
					1.90	98.83		Medium dense to dense, greenish grey, slightly sandy, very clayey GRAVEL. Sand is fine to coarse grained. Gravel is fine to coarse, sub angular to sub rounded.
		2.50	B					
		3.60	B		3.50	97.23		Stiff, dark grey, gravelly CLAY containing very large sub angular BOULDER
					3.70	97.03		End of Pit at 3.700m

1
2
3
4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
2.65	1.90	Sides unstable and prone to collapse	None		0.00	3.70	Arisings

Remarks

Field drain at 1.20m depth resulting in weak flow of water. Soils very unstable below 1.40m depth. Refusal on very large boulder at 3.70m depth.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E517067.75 N83746.61
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-01	TP	114.14m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30	113.84		Soft, dark brown PEAT
					0.70	113.44		Firm, grey, sandy SILT
		0.80			0.80	113.34		Very weak to weak, dark grey, partially weathered SHALE
					0.90	113.24		Medium strong, grey, unweathered SANDSTONE
								End of Pit at 0.900m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	0.80	Arisings

Remarks

No groundwater encountered.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E516816.32 N837498.06
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-03	TP	114.72m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	114.52		Medium strong to strong, light grey, partially weathered SANDSTONE
								End of Pit at 0.200m

1
2
3
4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	0.20	Arisings

Remarks

No groundwater encountered.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E516925.32 N837658.99
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-04	TP	118.89m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Probable MADE GROUND; Dense, grey, clayey SAND and GRAVEL with a high boulder and cobble content [QUARRY FILL]
		2.00						
	▼				2.30	116.59		Medium strong, grey, partially weathered SANDSTONE
					2.40	116.49		End of Pit at 2.400m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides unstable upon completion	None		0.00	2.40	Arisings

Remarks

Groundwater encountered 2.4m b.g.l (Seepage).

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E517080.46 N837637.46
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-05	TP	112.17m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
	▼							Probable MADE GROUND; Dense, grey, clayey SAND and GRAVEL with a high cobble and boulder content [QUARRY FILL]
		2.50			2.50	109.67		Probable MADE GROUND; Dense, COBBLES and BOULDERS [QUARRY FILL]
					3.00	109.17		End of Pit at 3.000m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides unstable upon completion	None		0.00	3.00	Arisings

Remarks

Groundwater encountered 2.3m b.g.l (Weak flow).

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E516882.88 N837314.67
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-06	TP	108.95m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30	108.65		Soft, brown, sandy TOPSOIL
					1.20	107.75		Firm, slightly gravelly, very sandy SILT/CLAY
		1.50			1.90	107.05		Extremely weak to very weak, dark grey, distinctly weathered SANDSTONE
					2.00	106.95		Medium strong, grey, partially weathered SANDSTONE
								End of Pit at 2.000m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	2.00	Arisings

Remarks

No groundwater encountered.

AGS



Plate 1—Trial Pit TP-AT03 (Turbine AT01)



Plate 2—Trial Pit TP-AT03 (Turbine AT01)



Plate 3—Trial Pit TP-AT03 (Turbine AT01)



Plate 4—Trial Pit TP-AT04 (Turbine AT02)



Plate 5—Trial Pit TP-AT04 (Turbine AT02)



Plate 6—Trial Pit TP-AT04 (Turbine AT02)



Plate 7—Trial Pit TP-AT05 (Turbine AT-03)



Plate 8—Trial Pit TP-AT05 (Turbine AT-03)



Plate 9—Trial Pit TP-AT05 (Turbine AT03)



Plate 10—Trial Pit TP-AT07 (Turbine AT05)



Plate 11—Trial Pit TP-AT07 (Turbine AT05)



Plate 12—Trial Pit TP-AT07 (Turbine AT02)



Plate 13—Trial Pit TP-AT08 (Turbine AT06)



Plate 14—Trial Pit TP-AT08 (Turbine AT06)



Plate 15—Trial Pit TP-AT08 (Turbine AT06)



Plate 16—Trial Pit TP-AT11



Plate 17—Trial Pit TP-AT11



Plate 18—Trial Pit TP-AT11



Plate 19—Trial Pit TP-AT12 (Turbine AT07)



Plate 20—Trial Pit TP-AT12 (Turbine AT07)



Plate 22—Trial Pit TP-AT12 (Turbine AT07)



Plate 23—Trial Pit TP-AT13 (Turbine AT08)



Plate 24—Trial Pit TP-AT13 (Turbine AT08)



Plate 25—Trial Pit TP-AT13 (Turbine AT08)



Plate 26—Trial Pit TP-AT14 (Turbine AT09)



Plate 27—Trial Pit TP-AT14 (Turbine AT09)



Plate 28—Trial Pit TP-AT14 (Turbine AT09)



Plate 29—Trial Pit TP-AT16 (Turbine AT11)



Plate 30—Trial Pit TP-AT16 (at Turbine AT11)



Plate 31—Trial Pit TP-AT16 (at Turbine AT11)



Plate 32—Trial Pit TP-AT18 (Turbine AT13)



Plate 33—Trial Pit TP-AT18 (Turbine AT13)



Plate 34—Trial Pit TP-AT18 (Turbine AT13)



Plate 35—Trial Pit TP-AT18 (Turbine AT14)



Plate 36—Trial Pit TP-AT19 (Turbine AT14)



Plate 37—Trial Pit TP-AT19 (Turbine AT14)



Plate 38—Trial Pit TP-02 (Turbine AT16)



Plate 39—Trial Pit TP-02 (Turbine AT16)



Plate 40—Trial Pit TP-02 (Turbine AT16)



Plate 41—Trial Pit TP-A



Plate 42—Trial Pit TP-A



Plate 43—Trial Pit TP-A



Plate 44—Trial Pit TP-B



Plate 45—Trial Pit TP-B



Plate 46—Trial Pit TP-B

APPENDIX D

Von Post Classification and Shear Strength Information	3 x A4

I.D.	Geographic Coordinates		Von Post Peat Characteristics (H*)					Peat Thickness(m) (Average)
	Easting	Northing	0.0 - 0.25m	0.25 - 0.50m	0.50 - 1.0m	1.0 - 2.0m	Maximum	
AT01	515725	834020	1				1	0.30
AT-01-1	515745	834003	1	3			3	0.80
AT02	514978	832589	3				3	0.3
AT02-1	515044	832540	3	5			5	0.90
AT03	514857	832846	3				3	0.7
AT03-1	514898	832830	3	5			5	0.90
AT04	514889	833179	4				4	0.4
AT04-1	514905	833218	3	5			5	0.90
AT05	514649	834627	1				1	0.2
X1	514456	834714	1	3			3	1.00
AT06	514381	834572	1				1	0.3
AT05-1	514666	834579	1	3			3	0.20
X2	514001	835743	3	5			5	0.90
X3	514109	836162	3	5			5	0.50
AT07	515958	835555	3				3	0.3
AT07-1	515958	835555	1	3			3	0.50
AT08	515991	835837	3				3	0.3
AT08-1	515976	835879	3	5			5	0.90
AT09	515645	836489	5				5	0.8
AT09-1	515674	836485	3	5			5	0.50
AT10	515700	836763	4				4	0.5
AT10-1	515700	836738	4	5	6		6	1.30
AT11	515557	837162	4	6			6	0.70
AT12	515244	837705	4	5			5	0.90
AT13	515574	837498	4	5	5		5	1.50
AT14	515951	837488	1	3			3	0.70
AT15	516905	837903	3	5			5	0.50
X6	516081	835322	1	3			3	0.50
X7	516120	835668	1	3			3	0.30
X8	516046	833188	1	3			3	0.40
X9	516595	838172	1	3			3	0.30
SUBSTATION	515707	833747	1	3			3	0.40
MET MAST2	515662	835329	1	3	3		3	1.00
MET MAST1	514684	832600	3	5			5	0.90

I.D.	Geographic Coordinates		Von Post Peat Characteristics (H*)					Peat Thickness(m) (Average)
	Easting	Northing	0.0 - 0.25m	0.25 - 0.50m	0.50 - 1.0m	1.0 - 2.0m	Maximum	

Peat Characteristics

H1 - Completely undecomposed peat; only clear water can be squeezed from peat.

H2 - Almost undecomposed; mud free peat; water squeezed from peat is almost clear.

H5 - Somewhat decomposed;muddy growth structure discernible but distinct; some peat passes through fingers when squeezed; compressed residue is muddy.

H6 - Somewhat decompsed; muddy; growth structure indistinct; less than one-third of peat passes through fingers when squeezed; residue very muddy.

H7 - Well decomposed; very muddy; growth structure indistinct; about one-half of peat passes through fingers when squeezed; exuded liquid has a "pudding-like" consistency.

H8 - Well decomposed; growth structure very indistinct; about two-thirds of peat passes through fingers when squeezed; residue consists mainly of roots and resistant fibers.

H9 - Almost completely decomposed; peat is mud-like; almost no growth structure can be seen; almost all of peat passes through the fingers when squeezed.

H10 - Completely decomposed; no discernible growth structure; entire peat mass passes through the fingers when squeezed.

Notes:

(Coordinates in ITM)

I.D.	Geographic Coordinates		Vane test (kPa)					Peat Thickness(m) (Average)
	Easting	Northing	0.0 - 0.25m	0.25 - 0.50m	0.50 - 1.0m	1.0 - 2.0m	Minimum	
AT01	515725	834020	76				76	0.30
AT-01-1	515745	834003	56	52			52	0.80
AT02	514978	832589	30				30	0.30
AT02-1	515044	832540	51	41			41	0.90
AT03	514857	832846	13				13	0.70
AT03-1	514898	832830	34	29			29	0.90
AT04	514889	833179	30				30	0.40
AT04-1	514905	833218	48	47			47	0.90
AT05	514649	834627	43				43	0.20
X1	514456	834714	64	50			50	1.00
AT06	514381	834572	68				68	0.30
AT05-1	514666	834579	56				56	0.20
X2	514001	835743	41	26			26	0.90
X3	514109	836162	40	22			22	0.50
AT07	515958	835555	67				67	0.30
AT07-1	515958	835555	64	60			60	0.50
AT08	515991	835837	42				42	0.30
AT08-1	515976	835879	62	54			54	0.90
AT09	515645	836489	82				82	0.80
AT09-1	515674	836485	47	30			30	0.50
AT10	515700	836763	78				78	0.50
AT10-1	515700	836738	43	32	28		28	1.30
AT11	515557	837162	68	60			60	0.70
AT12	515244	837705	39	27			27	0.90
AT13	515574	837498	42	28	26		26	1.50
AT14	515951	837488	62	60			60	0.70
AT15	516905	837903	41	30			30	0.50
X6	516081	835322	55	36			36	0.50
X7	516120	835668	48				48	0.30
X8	516046	833188	62	54			54	0.40
X9	516595	838172	12				12	0.30
SUBSTATION	514684	832600	32	27			27	0.90
MET MAST2	515662	835329	30	34	30		30	1.00
MET MAST1	515707	833747	48	42			42	0.40

APPENDIX E

Report 2165-22A Desk Study and Walkover Assessment for Preliminary Determination of Ground Conditions, 11th October 2022	95 x A4

Tirawley Wind Farm

Desktop Study and Walkover Survey for Preliminary Determination of Ground Conditions

Report No: 2165-22A

11th October 2022

This document has been prepared by Whiteford Geoservices Ltd on behalf of

Constant Energy Ltd

Whiteford Geoservices Ltd, 2 Main Street, Straid, Co. Antrim, BT39 9NE
Tel: 0044 (0) 28 93349351 Fax: 0044 (0) 28 93349352
www.whitefordgeoservices.com

C O N T E N T S

		Page
	STATEMENT OF AUTHORITY	**2**
1.0	**INTRODUCTION**	**3**
2.0	**EXISTING ENVIRONMENT**	**6**
2.1	Topography	
2.2	Land Usage	
2.3	Services & Utilities	
2.4	Geology	
2.5	Regional Hydrogeology	
2.6	Local Hydrology	
2.7	Mining	
2.8	Peat Disturbance and Soil Removal	
2.9	Potential Contamination	
2.10	Analysis of Existing SI Information	
3.0	**SUMMARY OF DESK STUDY**	**14**
4.0	**SITE WALKOVER SURVEY**	**16**
4.1	Introduction	
4.2	Survey Date	
4.3	Survey Strategy	
5.0	**PREVAILING SITE CONDITIONS**	**17**
5.1	Superficial Deposits	
5.2	Solid Geology	
5.3	Existing Slopes	
5.4	Observations	
5.5	Existing Mining Activities	
5.6	Existing Services / Utilities	
5.7	Potential Sensitive Receptors	
5.8	Potential Preconditions Identified within the immediate vicinity of the proposed development	
5.9	Pre-Failure Indicators within the immediate vicinity of the proposed development	
6.0	**REFERENCES**	**45**

APPENDICES

Appendix	Title	Pages
1	General Site Location Plans – P1 / P2 Overall Site Location Plan - 6289-JOD-TWF-XX-DR-PR-100_DRAFT_0 Tirawley SAC Mapping – Local (EPA Online Environment Viewer)	1 x A4 1 x A3 1 x A4
	Plot Depicting location of sensitive receptors, as well as identified preconditions and pre-failure indicators in the immediate vicinity of wind farm development [2165-22-PL]	1 x A3
	Geological Survey of Ireland Public Viewer Data – Solid and Structural Geology Geological Survey of Ireland Public Viewer Data – Superficial Soils and Landforms Geological Survey of Ireland Public Viewer Data –Subsoil Permeability Geological Survey of Ireland Public Viewer Data –Karst Data, Wells and Springs Geological Survey of Ireland Public Viewer Data –Groundwater Aquifer Potential Geological Survey of Ireland Public Viewer Data – Groundwater Vulnerability Geological Survey of Ireland Public Viewer Data –Landslide Susceptibility Historic Landslide Events (GSI Data Viewer Analysis) 2165-22A-LE1	1 x A4 1 x A4 1 x A4 1 x A4 1 x A4 1 x A4 1 x A4 1 x A3
2	Preliminary Plot of Peat Thickness (compiled from preliminary data collected during walkover survey)	1 x A3
	Preliminary Peat Data	2 x A4
3	Preliminary Plot of Ground Elevation (compiled from OSI DTM Elevation data)	1 x A3
4	Preliminary Plot of Ground Slopes (compiled from OSI DTM Elevation data)	1 x A3
5	Preliminary Assessment of Peat Slide Risk Hazard (Compiled following analysis of site conditions and potential receptors)	1 x A3
6	Walkover Survey Photographic Record	21 x A4

Desktop Study and Walkover Survey – Tirawley Wind Farm, near Tobercurry, County Silgo, Ireland

Client: **Constant Energy Ltd**

Date: **11th October 2022**

Report No. 2165-22A

Statement of Authority

John Whiteford BSc (Hons) Geophys AMIOSH MEAGE FGS has more than 20 years of experience in the field of earth sciences, geotechnical engineering and management. His academic qualifications are a BSc with Honours in Geophysics from Edinburgh University, with memberships of The European Association of Geoscientists and Engineers and The Institute of Safety and Health.

Commencing work with Kirk McClure Morton (Consulting Engineers) in Belfast, he has been engaged in full-time consultancy for the past 20 years and since 1996 trading as Whiteford Geoservices Ltd. The company and its staff of professional and technical personnel and has completed in excess 2000 contracts for clients within the construction and mineral exploration sectors where they have built up a recognised level of specialist experience, particularly in the field of Wind Energy. Working at home, in Europe and worldwide the company has been involved in more than 100 wind power projects where our services have been sought in relation to foundation design, peat slide risk assessment, geophysics, electrical earthing design and thermal resistivity analysis.

The following report contains an analysis of the soils and geology present at the target site and also assesses the particular risk presented by organic soils / peat.

Assessment of the former draws from, 'Design Manual for Roads and Bridges ("DMRB") Volume 11, Section 3 (Environmental Assessment), Part 11: Geology and Soils, but also references, the current best practice guidance presented in the English Nature publication 'Geological conservation – a guide to good practice'.

Assessment of the latter employs guidance contained within the Scottish Executive's "Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments", published as a Second Edition April 2017 (referred to as "the Scottish Guidance").

This Best Practice Guide was updated, in part, in April 2017, and for the purpose of clarity the protocol adopted to determine Peat Slide Hazard Ranking are consistent with the version of the report, as published in 2017. Unless otherwise stated, all assessments and conclusions contained within this report are made with reference to either the 2006 or 2017 publication. However, there are a number of variations from the guidance and where these occur the reason for this is provided, either within the text or as a footnote.

This report details the works undertaken by Whiteford Geoservices Ltd at the site of the proposed Tirawley Wind Farm near Killala, Co. Mayo.

Dated: 11th July October

1.0 INTRODUCTION

1.1 Background and Purpose of Desk Study and Walkover Survey

This report relates to the first stage of an assessment into the stability of Peat soils at Tirawley Wind Farm near Killala, Co. Mayo.

In June 2022 Whiteford Geoservices Ltd was commissioned by Jennings O'Donovan Ltd to undertake an assessment of peat stability at Tirawley Wind Farm.

Reporting for the purposes of this Peat Stability Assessment has been split into three (3) distinct elements, as follows:

1. Desktop Study and Walkover Survey Report 2165-22A. This report details the findings of desktop analysis and site scoping of the general area within which the proposed wind farm is to be constructed. This report identifies the existing site conditions, potential sensitive receptors, potential preconditions that increase the risk of peat instability and pre-failure indicators present at the site. The report culminates with a preliminary assessment of the Hazard of Peat Slide occurrence.
2. Preliminary Site Investigation Works Report 2165-22B. This report presents the findings of further field work undertaken after optimisation of the turbine layout plan, following on from the preliminary assessment of hazard. Further investigations to determine peat thickness, gouge coring, Von Post classification, shear strength analysis and slope modelling were undertaken with closer precision within the footprint of the proposed construction zone. The information contained in this report provides the further detail required for the final assessment of peat stability.
3. Chapter 6 Soils and Geology Report (including Peat Stability and Risk Assessment Analysis) 2165-22C. This report takes the preliminary findings from Item 1 above and reviews the information in light of both the final development layout plan and the more detailed site investigation works carried out and reported as Item 2. In this particular case the "Peat Stability and Hazard Assessment" is wholly included in the Report 2165-21C.

The purpose of this reporting is to determine the impact of existing ground conditions on the construction of new proposed turbines, tracks and infrastructure throughout the proposed lifetime of the scheme.

This portion of the soils and geology assessment consists of both an initial desktop review of available ground information, a walkover survey and a preliminary assessment of peat stability at the proposed development site. The findings of this assessment have been employed to obtain a baseline overview with respect to the soils and solid geology present within the boundary of the proposed development site.

This initial layout was later refined to allow for consideration of the constraints identified.



Figure 1 – General Site Location
(Reproduced courtesy of Google maps)

The purpose of this stage of the assessment is as follows:

- Undertake an initial study of the existing geology, topography, ground stability and hydrology surrounding the site using available resources.
- Identify the potential impacting factors upon the site, such as contamination, weak soils, soils instability, karst, seismic activity etc.
- Identify all factors likely to impact upon either the construction and / or operation of the approved wind energy development.

Environmental legislation that is relevant to the hydrological aspects of this study is as follows:

- Quality of Water Intended for Human Consumption (80/778/EEC) and Quality of Water Intended for Human Consumption Directives (98/83/EC).

The Water Framework Directive (WFD) which was passed by the European Union (EU) in 2000 is a wide-reaching legislation that will eventually replace a number of the previous water quality directives (for example, those on Water Abstraction) while implementation of others (for example, The Integrated Pollution Prevention and Control and Habitats Directives) will form part of the 'basic measures' for the Water Framework Directive.

1.2 Timescale

Desktop based research and the initial walkover surveys were carried out during September and October 2022 by Mr John Whiteford of Whiteford Geoservices Ltd.

Assisting in these preliminary works was Mr Jaime Stothers, who collected stage 1 peat depth data along with other site-specific data.

2.0 EXISTING ENVIRONMENT

2.1 Topography

Analysis of topographic information indicates that the Tirawley Wind Farm occupies relatively three different types of terrain. Turbines prefixed “A” occupy the relatively flat low lands within the south east of the site, those prefixed “B” occupy elevated, but low gradients lands within the north east and those prefixed by “C” are situated on elevated lands to the west on what are often moderately steep slopes.

Ground surface level elevations within the wind farm vary between approximately 20m to 230m above Ordnance Datum (Malin Head).

2.2 Land Usage

2.2.1 Current

The land usage appears to vary significantly across the number of land holdings which make up the Tirawley Wind Farm development. The predominant land usage is rough grazing sheep and cattle; followed by forestry. In addition, there are areas within the development used for peat cutting, both actively and “cut-over”.

Industrial heritage is also evident within the site, with a number of cleared and levelled zones, metalled tracks, compounds and buildings. This industrial heritage relates to mainly to agricultural land use.

The closest active quarrying operations to the site are at Mullafarry Quarry approximately 7km to the sound east. However, there are also quarry workings c.300m south east and 1.8km north east of Turbine A12. It is uncertain whether these sites are currently active.

Site code 000516 Lackan Saltmarsh and Kilcummin Head SAC is a Special Area of Conservation in the vicinity of the development. Refer to Appendix 1 for specific mapping detailing SAC locations.

There appear to be at least two watersheds applicable to the wind farm site, Water Sub Catchment 33 (vast majority of site) and Water Sub Catchment 34 (small portion in the south). Surface water from the western and north western portion of Tirawley Wind Farm can ultimately be expected to drain towards the Heathfield River and Ballinglen River both of which discharge into the Bunatrahir Bay. Lands within the south and south east discharge towards the Cloonalaghan River which discharges to the sea at Lackan Strand. Lands to the north and north east discharge via a series of minor water courses to the Atlantic Ocean.

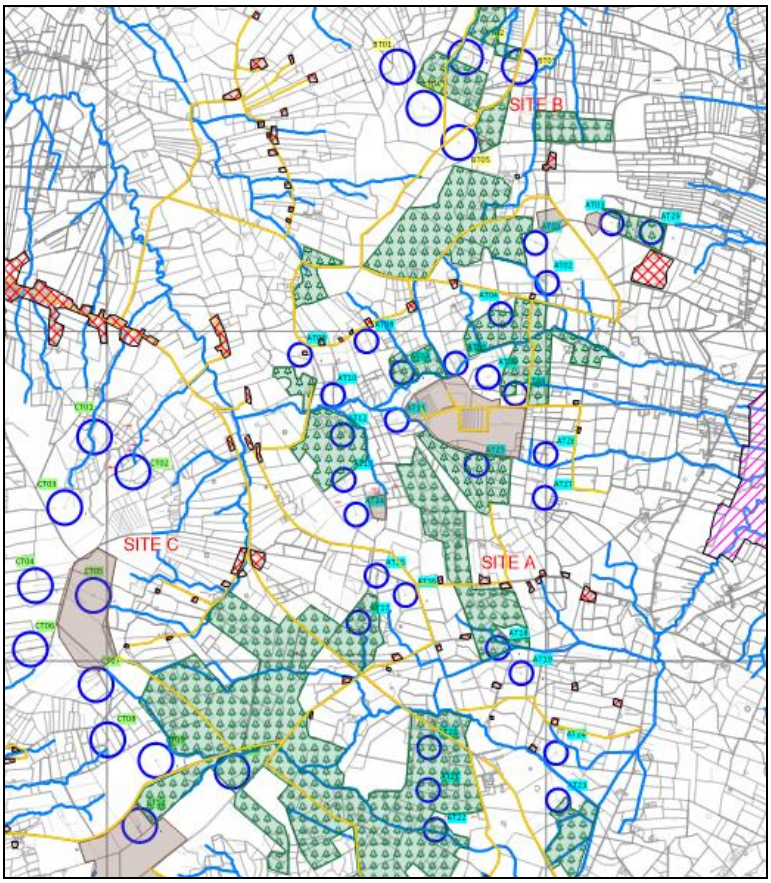


Figure 1A – General Site Location Annotated with Local Features

There are a number of abandoned residential dwellings and buildings of an agricultural nature located within the site boundary, with the closest inhabited buildings being approximately 800m from the wind farm boundary.

2.2.2 Historic

A review of historical mapping, courtesy of OSI, suggests that the site of Tirawley Wind Farm has not changed in land use from that recorded on the 6" Second Edition Mapping, 1842 - 1937.

2.3 Services & Utilities

Overhead services were identified close to Turbine A08 and Turbine A09 and immediately adjacent to the site boundaries.

Utilities are also anticipated to be present along the public roads and private access roads within the verge, and adjacent to the site entrance.

2.4 Geology

2.4.1 Soils and Sub-soils

A study was made of available geological information for the area (OSI Online Database). This study indicated that the following natural geology is present across the site of Tirawley Wind Farm;

- Peat (Blanket Bog)
- Boulder Clay (Glacial Till / Diamicton)
- Alluvium (River deposits)

2.4.2 Solid Geology

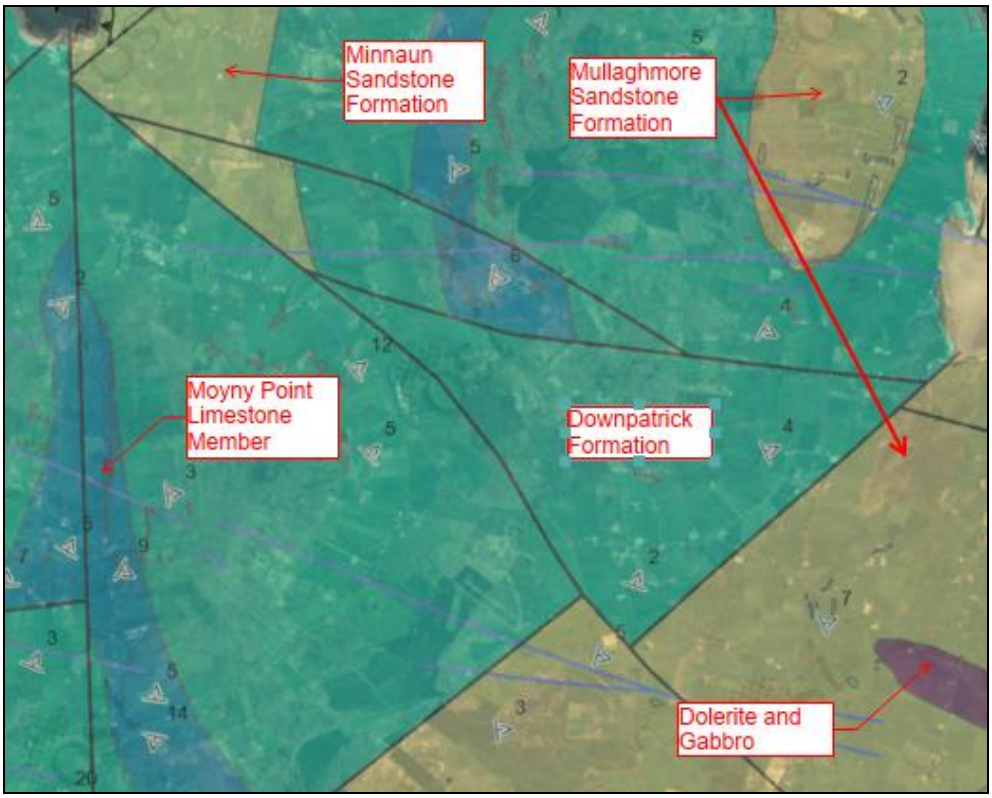


Figure 2A – Bedrock Solid Geology
Reproduced courtesy of GSI Datasets Public Viewer

According to the GSI online database Tirawley Wind Farm site is predominantly underlain by the Downpatrick Formation, with the Moyny Point Limestone Member and Mullaghmore Sandstone Formation also present within the site boundary.

The Downpatrick Formation is a sequence of interbedded sedimentary rock types comprising: near shore marine mudstones and siltstones; alluvial and deltaic sandstones and siltstones and fully marine bioclastic limestones interbedded with calcareous shales

The Moyny Point Limestone is characterised by tabular-bedded limestone and shale.

The Mullaghmore Sandstone Formation is a series of cyclical units of siltstones and shales which coarsen upwards into medium to coarse grained sandstones.

2.4.3 Superficial Geology

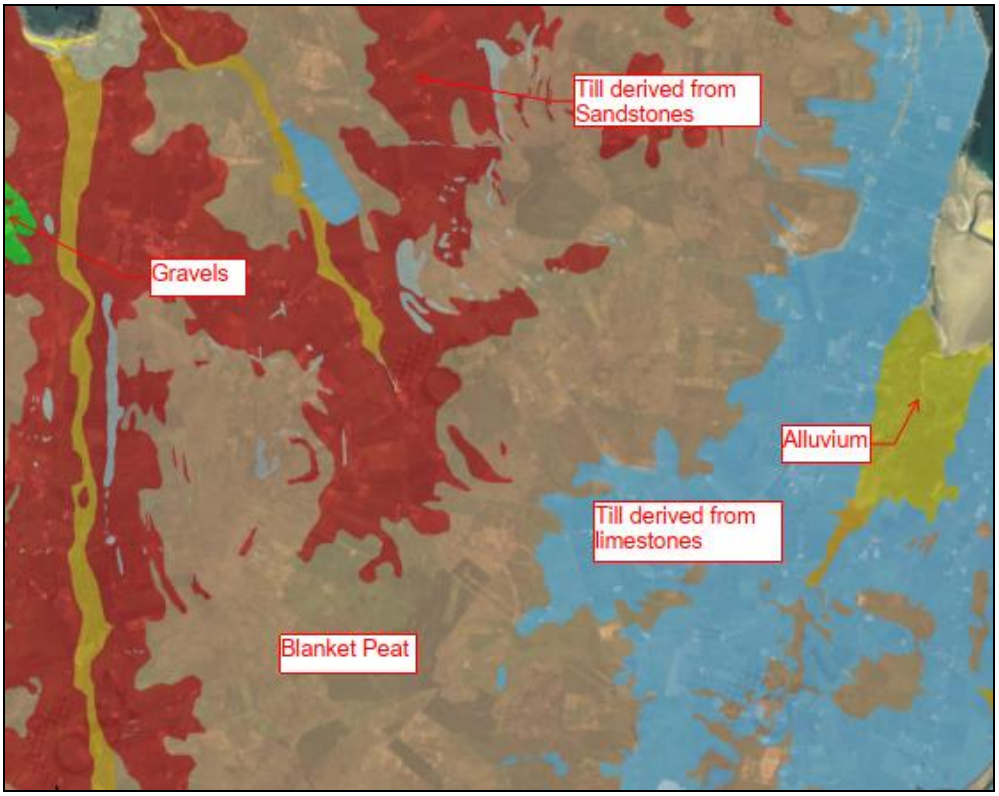


Figure 2B – Superficial Geology
Reproduced courtesy of GSI Datasets Public Viewer

Superficial soils present within the wind farm boundary consist predominantly of: -

- Blanket Bog probably underlain by Till
- Till derived from sandstones (in the west)
- Till derived from limestones (in the east)
- Alluvium in river valley bottoms

2.5 Regional Hydrogeology

2.5.1 Aquifer Classification

A review of site hydrogeology was undertaken with respect to the Geological Survey of Ireland (GSI) Database's Aquifer Bedrock Potential, Superficial Aquifers and Groundwater Vulnerability Mapping.

Surface water is anticipated to enter the subsurface where the surface is permeable and can be expected to continue vertically downwards until it comes in contact with either an impermeable stratum or the water table. At this point the surface water will migrate in the same direction as the groundwater or according to the gradient of the impermeable stratum.

GSI database mapping indicates that the site is predominantly underlain by poor generally unproductive Aquifers, however both locally important potentially highly productive (karstified) bedrock aquifers and moderately productive sandstone Aquifers are to be expected within the site boundary.

Potential superficial aquifers have not been identified within the site boundary.

2.5.2 Groundwater Vulnerability

The groundwater vulnerability varies within the site boundary of the development but is generally high at sites "A" and "C". At site "B", in particular Turbines B01,.B04 and B05 the groundwater vulnerability is extreme, with outcropping bedrock and the presence of karst features in the immediate vicinity.

2.5.3 Well Database

The GSI database records groundwater abstraction wells (No: 1431SEW005 and 1431SEW006) to the north and north east of the site boundary. These wells are drilled within locations where the uppermost rock units are the poor-quality Downpatrick Formation and the highly productive Mullaghmore Sandstone Formation. It is not known what depths these wells extend to and whether they both intercept the same formation.

The potential for adverse impact to these abstraction wells, caused by the wind farm construction, is considered low.

2.6 Local Hydrology

2.6.1 Site Drainage

Drainage channels are evident across the proposed development. Most are generally less than 1m in width and depth and situated adjacent to land boundaries, access tracks or to effect improved drainage. It was not possible to precisely map the full extent of the man-made drainage network at this time.
A low impact on the "natural hydrology", as a result of the development, is anticipated.

Please refer to the site walkover and reconnaissance section (Section 3.0) and Appendix A, for details of site drainage features identified within the site boundary.

2.6.2 Local Watercourses

For the purpose of defining watercourses as sensitive receptors these are deemed to fulfil the following criteria: -

1. Consistently contain flowing water / not ephemeral.
2. Be a natural watercourse with either a designated name or be a smaller tributary of a designated watercourse. i.e. Not man made in origin.

Where a watercourse does not fulfil these criteria, but where there is still potential connectivity the potential hazard is managed (for the purpose of peat stability) by considering an additional risk factor for drainage related issues.

The development site for Tirawley Wind Farm is located within the vicinity of number of minor tributaries of the Ballinglen River, Heathfield River and the Cloonalaghan River, all of which discharge to the sea.

The Ballinglen River and Heathfield River present within the wind farm boundary drain generally in a northernly direction to Bunatrahir Bay.

The Cloonalaghan River drains in north easterly direction to Lacken Strand which is part of the Lackan Saltmarsh and Kilcummin Head SAC and Killala Bay/Moy Estuary SPA.

2.6.3 Palaeo-Karst Features

Karst topography is defined as "An assemblage of topographic forms resulting from dissolution of the bedrock and consisting primarily of closely spaced sinkholes." [1] Karst topography can

[1] (Skinner and Porter, 1987: p259)

form in regions of exceptionally soluble rocks, including Limestone. Karst features are potentially present at this site.

GSI records do not record the presence of “karst” features within the site boundary and no landforms consistent with “karst” topography were identified during the walk over survey. GSI records do not show the presence of “karst” features surrounding the site.

In summary, the potential for “karstified rock” to affect the stability of installed structures and infrastructure is considered to be moderate and only affects the location of those turbines where limestone is the uppermost rock unit.

Specific supplementary investigation is recommended prior to commencement of construction works.

2.7 Mining or Active Quarry Operations

Review of the GSI Online Database data indicates that there are no quarries within 5km of the site. The closest quarries / pits are as follows:

1. Mullafarry Quarry (Limestone rock) 7 km south east of Tirawley Wind Farm

No records of shafts or adits associated with mineral exploration were observed within 10km of the site.

2.8 Peat Disturbance and Soil Removal

At the site of Tirawley Wind Farm some areas of small to medium-scale peat harvesting are evident. Much of these locations consists of cut-over bog with some small peat banks remaining of less than 1.5m in height.

No significant or commercial peat extraction is anticipated to have taken place.

2.8.1 Historic Landslides and Landslide Susceptibility

Records indicate no significant historic soils or rock movement within the site boundary.

GSI landslide susceptibility mapping also shows that the site has a predominately low to moderately low landslide susceptibility within sites A” and “B”, although small discrete areas of high susceptibility are also present. Similarly, landslide susceptibility within site C is generally low to moderate, although larger areas of high to high landslide susceptibility flank the edges of the steep sided terrain.

The Geological Survey of Ireland (GSI) records show the closest landslide events are approximately 6.3km north west and 6.0km south west of the site

Please refer to Appendix 1 for further details.

2.9 Potential Contamination

2.9.1 Land Contamination

The site is not known to have been subject to the action of activities that have the potential to contaminate the soils at the site.

Land use is predominantly as agricultural pastureland with extensive areas where peat harvesting has already taken place.

There is potential for a low negative impact on natural soils as a result of exposure to historic contamination at the site, arising from its previous land use.

2.9.2 Contaminated Watercourses

There is no evidence to suggest that any potential contaminants have significantly affected existing watercourses at the Tirawley Wind Farm site.

Assess of surface and groundwater should be included within the contaminated land investigations.

2.10 Analysis of Existing SI Information

A search for existing site investigation information within the immediate vicinity of the proposed new development did not yield any previous reporting:

3.0 SUMMARY OF DESK STUDY

The following summarises the findings of the desktop study carried out to determine local conditions at the site of Tirawley Wind Farm.

- The lands are classed as agricultural with no recorded significant industrial heritage associated with the site. Apart from the construction of small sections of metalled track surface, the proposed development of the wind farm will take place on natural soils and rock formations. For the purpose of construction these lands would be mainly classified as “greenfield”.
- Geological studies indicate that the uppermost rock formation, for the majority of the site, is sandstone and siltstone pertaining to the Downpatrick Formation, which is in turn mantled by drift geology of peat and probable glacial till.
- Limestone rock pertaining to the Moyny Point Limestone Formation is present within two regions within the wind farm site. Where Limestone formations are the uppermost rock units “karst” type structures, such as sinkholes, caves or cavities can potentially occur. Such features are associated with ground instability, particularly for proposed infrastructure and are a recognised geo-hazard when encountered close to the surface.
- Given the presence of peat and the magnitude of some existing slope gradients, a preliminary / scoping assessment of peat stability hazard was carried out at Walkover Phase. Where this screening assessment indicates the presence of more than negligible quantities of peat, further detailed site investigation and testing will be recommended in order to refine the calculation of peat stability hazard and to enable optimisation of the wind farm design layout.
- This further SI will be contained within an accompany report (see Report 2165-22B) and the recovered supplementary information used to produce a detailed Peat Stability / Slide Risk Assessment (PSRA) (see “Soils and Geology Report” including PSRA, 2165-22C).
- Records indicate that the closest active quarrying operations are; hard rock extraction at Mullafarry Quarry (7km SE). Although, hard rock aggregate quarries often have a requirement for rock blasting, resulting in the transmission of sonic and vibrational energy, any such negative impacts at 7km are anticipated to be negligible in the case of Tirawley Wind Farm.
- Tributaries of the following two watercourses; the Heathfield River and Cloonalaghan River are present within the site boundary (refer to appendix for relevant mapping) and care should be taken to ensure that any possible environmental impact caused to these, by the construction process, is minimised by implementing effective mitigation controls. Further fieldwork has been carried

out at walkover and detailed SI stages to assess how these features interact with the proposed infrastructure. Other sensitive receptors in the immediate and wider vicinity, such as SAC sites, bridge structures, etc. have been considered.

- Direct impact on other more significant receptors, by either construction works or operations has not been ruled out. In the event of a peat debris flow reaching a watercourse, there is potential for the wider environment to be impacted. The mechanisms for this impact would be by:
    - siltation pollution of watercourses and those into which they flow.
    - deterioration in river water quality and that of waterways into which they flow.
    - impact to water borne flora and fauna.
    - damage to highways and third-party structures.
    - damage to overhead and underground services.
    - damage to bridge or culvert structure crossing the affected watercourse.

  For these reasons, impact on designated watercourses is considered critical and directly related to the potential for impact of other sensitive receptors downstream. Once a debris flow reaches a water body its impact can be transmitted far from its initial point of entry. Consideration of designated watercourses as sensitive receptors thus includes for the potential impacts detailed above. Refer to the Preliminary Risk Plot[2] for an initial assessment of the Hazard of Peat Instability with respect to all receptors.

- The majority of the site is of high groundwater vulnerability with localized areas of extreme groundwater vulnerability and outcropping rock, particularly in site “C”. Care must therefore be taken when carrying out works in these areas to avoid any possible contamination of the soils, as this has the potential to rapidly enter the underlying bedrock aquifer.

[2] Finalised following walk over survey fieldwork and testing

4.0 SITE WALKOVER SURVEY

4.1 Introduction

A reconnaissance / walk over survey was undertaken by Whiteford Geoservices Ltd at the proposed site of Tirawley Wind Farm following completion of the desk-based study. This had the general objective of identifying and assessing on-site features, which could affect both the construction and / or operation of the wind energy development.

This walkover survey (see section 4.0) has taken into account the findings of the initial desktop study and includes a preliminary investigation of the potential receptors, preconditions and failure mechanisms. Following the walkover survey further ground investigations have also been recommended (see Report, 2165-22B); specified in order to aid production of a Peat Stability Hazard Assessment (See Report 2165-22C)

4.2 Survey Date

The initial site walkover survey was carried out by Jaime Stothers of Whiteford Geoservices Ltd between 14th and 21st September 2022.

Generally mild temperatures with overcast and light but at times heavy precipitation conditions were experienced during the site walkover survey

4.3 Survey Strategy

The site walkover survey was carried out in order to determine the following general on-site features, and act as a confirmatory method to the desk-based study:

- "Spot" checks on peat depth
- Nature of superficial deposits
- Existing bedrock geology (where exposed)
- Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note.
- Topography – significant slopes
- Location of potential receptors such as building, roads, etc.
- Location of any services / utilities
- Identification of any other forms of receptor or sensitive ground

In order to do this an assessment was made at a number of positions in the vicinity of the proposed turbine infrastructure, in order to gain a preliminary understanding of any geological features and ground conditions which may impact upon the stability of lands at and surrounding the wind energy development.

5.0 PREVAILING SITE CONDITIONS

The following section details the soils and geology characteristics encountered across the proposed site of Tirawley Wind Farm during the walkover survey.

5.1 Superficial Deposits

The majority of the proposed development site consists of upland bog, cut-over bog, heath, semi to improved grassland and forestry plantations. The lands are currently in use as small scale peat cutting, forestry and rough grazing land.

Desk study analysis indicates that the soils consist of glacial tills (diamicton) and are mantled by peat within the construction zone. The walkover survey generally confirms this to be the case.

5.2 Solid Geology

During the site reconnaissance survey, it was not possible to determine the depth that bedrock will be encountered across the development site, nor the rock type, as probes collected on site are likely to have terminated on a hard stratum located above the bedrock level.

No regions of outcropping rock were encountered within the proposed development site during the walkover survey. Only Peat soils or thin organic topsoils were identified.

The Author believes that the solid geology of the site is not dissimilar to what has been published by the GSI.

No further information with respect to the solid geology was added following the walkover.

5.3 Existing Slopes

A preliminary analysis of OSNI topographic data was undertaken to identify the variation in gradient applicable to the existing slopes within the vicinity of the proposed wind farm development.

Both Evans and Warburton (2007) and Boylan et al. (2008) found from their analysis of recorded failures in blanket bog, that these were often recorded for slopes of typically 4 – 8 degrees to the horizontal. However, it is not wise to suggest that the slope angle, as represented by the top of the bog, is of significance in the hierarchy of preconditioning when it comes to bog failure. In such cases the mechanism of failure is almost certainly, exclusively, by “bog burst” (i.e. peat, on average, greater than 2.5m thick) where the cause is a build-up of excessive hydrostatic pressure in the peat mass.

Often the peat failure mechanism is internal and not due to a detaching of the peat soils from the underlying mineral substrate or as a result of activation along on surface tear. A common mechanism for internal failure is increased hydrostatic pressure which occurs when significant rainfall falls on peat soils. This both increases the weight of the peat bog and can cause any minor weaknesses in the bog structure to be activated as the system attempts to reduce the internal pressure. Such internal failure is then likely to cause detachment to occur below the failure point, resulting in the peat mass moving under gravity along the water-lubricated basal plane; where the peat – mineral soil friction may never have been exceeded.

Of course, friction at the base of the peat is nonetheless important and thus it is important to consider the existing slope gradient as a potential trigger and precondition for a peat slide. This is especially the case where thinner peat thicknesses are present for which "bog burst" is much less likely to occur.

For this reason, we advocate a banded factor-based approach to apportioning risk. The following bands are used for this purpose, based on our experience with accidently triggered peat slides at over 100 different wind farm sites.

Existing Slope Angle (*Measured at Surface of Peat, Angle to Horizontal)*	**Risk Factor Assigned *(Using Factor Based Probabilistic Analysis)***	**Remarks**
0 - ≤5	0	Negligible influence
5 - ≤ 10	1	Low
10 - ≤ 22.5	2	Medium
>22.5	3	High

This additional risk of internal failure relating to "bog burst", is allowed for by apportioning an additional risk factor to the peat soils in excess of 2.5m thick.

5.4 Observations

The following is an appraisal of ground conditions at the site of the approved Tirawley Wind Farm. Mapping is provided which indicates the point survey locations which have informed this assessment.

Point 1 - Turbine A01

Nature of Assessment	Observations
Position (ITM)	515876, 837808
Peat Depth	1.60m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches, some surface water within the vicinity of the turbine location and evidence of small-scale peat cutting to the north
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area of heavily vegetated (moss and heather) blanket bog so peat depth could vary

Point 2 - Turbine A02

Nature of Assessment	Observations
Position (ITM)	515983, 837449
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and minor stream within the vicinity of the turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road and water tower)
Utilities: Underground or overhead	None evident in the vicinity - however potential water services within 200m of turbine
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds, water runoff from fields flowed down the nearby minor road

Point 3 - Turbine A03

Nature of Assessment	Observations
Position (ITM)	516589, 837890 – *Point taken approx. 100m from Turbine centre due to personal safety*
Peat Depth	3.60m - *taken approx. 100m from turbine centre*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and significant surface water within the vicinity of the turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area blanket bog seemingly prepped for turf cutting with extensive drainage ditches however at the time of visiting the surface was noticeably saturated with many pools of standing water making the surface very weak, in places when stepped sinking knee high – **Turbine centre not reached**

Point 4 - Turbine A04

Nature of Assessment	Observations
Position (ITM)	515555, 837201 – *Turbine is in forestry approx. 40m to the south*
Peat Depth	0.40m – *point taken within the adjacent field*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and surface water within the adjacent field
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road)
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 5 - Turbine A05

Nature of Assessment	Observations
Position (ITM)	515443, 836591
Peat Depth	0.50m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with a minor stream approx. 230m to the north and evidence of ongoing small to medium scale peat cutting surrounding the Turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine on a raised area within blanket bog so peat depth could vary especially in lower lying land

Point 6 - Turbine A06

Nature of Assessment	Observations
Position (ITM)	515149, 836720
Peat Depth	0.30m – Possible soft SILT / CLAY
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with a minor stream approx. 60m to the south east
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 100m buffer of minor stream
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within poor semi improved grassland

Point 7 - Turbine A07

Nature of Assessment	Observations
Position (ITM)	514757, 836533 *Turbine is in forestry approx. 140m to the north*
Peat Depth	0.30m – *Point taken at the minor stream 140m south of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches associated with the forestry anticipated. Minor stream approx. 130m to the south of Turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 8 - Turbine A08

Nature of Assessment	Observations
Position (ITM)	514334, 836917
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Minor stream within 250m of turbine location
Topography	0-5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road, overhead cable and farm buildings)
Utilities: Underground or overhead	Overhead cable within 100m of Turbine location
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds

Point 9 - Turbine A09

Nature of Assessment	Observations
Position (ITM)	513726, 836792
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	None evident in the vicinity
Topography	<10 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road, overhead cable and farm buildings)
Utilities: Underground or overhead	Overhead cable within 50m of Turbine location
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds

Point 10 - Turbine A10

Nature of Assessment	Observations
Position (ITM)	514030, 836428
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network for newly planted forestry and a minor stream within 120m to the south of the turbine location.
Topography	Generally <5 degrees to horizontal however some areas up to 10 degrees are present
Sensitive Receptors	Turbine within 100m buffer of minor stream
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area newly planted forestry

Point 11 - Turbine A11

Nature of Assessment	Observations
Position (ITM)	514628, 836208 - *Turbine is in forestry approx. 20m to the west*
Peat Depth	0.60m – Possible soft SILT / CLAY from 0.30m b.g.l
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with a minor stream approx. 100m to the north.
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 100m buffer of minor stream
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds

Point 12 - Turbine A12

Nature of Assessment	Observations
Position (ITM)	514237, 835732 - *Turbine is in forestry approx. 320m to the north west*
Peat Depth	0.60m - *taken approx. 320m south east turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network for forestry to be expected and a minor stream within 150m to the north east of the turbine location.
Topography	Anticipated to be <5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 13 - Turbine A13

Nature of Assessment	Observations
Position (ITM)	514124, 835658
Peat Depth	0.50m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with a minor stream approx. 280m to the east
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location

Point 14 - Turbine A14

Nature of Assessment	Observations
Position (ITM)	514243, 835345
Peat Depth	0.50m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with a minor stream approx. 280m to the east
Topography	5-10 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location and minor road is 300m to the south which at the time of the visit had surface water runoff. flowing down it.

Point 15 - Turbine A15

Nature of Assessment	Observations
Position (ITM)	514425, 834785
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and minor stream within the vicinity of the turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 100m buffer of minor stream
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds with a minor road 220m north of turbine location

Point 16 - Turbine A16

Nature of Assessment	Observations
Position (ITM)	514690, 834609
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road and overhead cable)
Utilities: Underground or overhead	Overhead cable within 50m of Turbine location
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds with a minor road and over head cables 130m north east of turbine location

Point 17 - Turbine A17

Nature of Assessment	Observations
Position (ITM)	514454, 834343 - *Turbine is in forestry approx. 200m to the west*
Peat Depth	0.20m - *taken approx. 200m east of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network for forestry to be expected
Topography	Unknown
Sensitive Receptors	None evident in the vicinity – however appears to be next to a major drainage ditch or minor stream
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 18 - Turbine A18

Nature of Assessment	Observations
Position (ITM)	515550, 834060- *Turbine is in forestry approx. 70m to the north west*
Peat Depth	0.30m - *taken approx. 70m south west of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network for forestry and within fields with a minor stream within the vicinity.
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 100m buffer of minor stream
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in forestry adjacent to semi improver grassland – **Unable to reach turbine centre**

Point 19 - Turbine A19

Nature of Assessment	Observations
Position (ITM)	515747, 833895
Peat Depth	0.30m – soft, organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with a minor stream 220m north of turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds

Point 20 - Turbine A20

Nature of Assessment	Observations
Position (ITM)	514947, 833119- *Turbine is in forestry approx. 100m to the north west*
Peat Depth	0.40m - *taken approx. 100m south west of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network anticipated.
Topography	Anticipate <5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road)
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre,** with a minor road within 200m north of turbine location

Point 21 - Turbine A21

Nature of Assessment	Observations
Position (ITM)	514962, 832632- *Turbine is in forestry approx. 200m to the north west*
Peat Depth	0.90m - *taken approx. 200m south west of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network anticipated.
Topography	Anticipate <5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 22 - Turbine A22

Nature of Assessment	Observations
Position (ITM)	514913, 832558- *Turbine is in forestry approx. 100m to the south east*
Peat Depth	0.90m - *taken approx. 100m north west of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network anticipated.
Topography	Anticipate <5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 23 - Turbine A23

Nature of Assessment	Observations
Position (ITM)	516083, 832738
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Minor stream approx. 200m north east of the turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area of semi improved grassland bordered on the east by forestry, with some marshy areas containing reeds with a minor stream 200m north east of turbine location

Point 24 - Turbine A24

Nature of Assessment	Observations
Position (ITM)	516057, 833179
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with a minor stream approx. 120m to the south west
Topography	0 - 10 degrees to horizontal
Sensitive Receptors	Overhead utilities < 200m north east of turbine
Utilities: Underground or overhead	See above
Any other observations	Turbine in area of semi improved grassland, with some marshy areas containing reeds with a minor road and over head cables 130m north east of turbine location

Point 25 - Turbine A25

Nature of Assessment	Observations
Position (ITM)	515380, 835990 - *Turbine is in forestry approx. 200m to the south west*
Peat Depth	1.30m - *taken approx. 200m north east of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network anticipated. What appears to be a minor stream 150m to the west and evidence of medium scale peat cutting to the north.
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity - However minor stream just outside of buffer
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 26 - Turbine A26

Nature of Assessment	Observations
Position (ITM)	515968, 835898
Peat Depth	0.30m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with what appears to be a minor stream 120m to the south
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity - However minor stream and road just outside of relevant buffers
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area of poor semi improved grassland, with some marshy areas containing reeds with a minor stream 120m south of turbine location and minor road 250m to the east

Point 27 - Turbine A27

Nature of Assessment	Observations
Position (ITM)	515963, 835491
Peat Depth	No peat encountered at turbine centre - Soft organic TOPSOIL
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity - However minor road just outside buffer
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine in area of semi improved grassland with a minor road 260m to the north east

Point 28 - Turbine A28

Nature of Assessment	Observations
Position (ITM)	515553, 836423 - *Turbine is in forestry approx. 140m to the east*
Peat Depth	1.00m - *taken approx. 140m west of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network anticipated
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road)
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre**

Point 29 - Turbine A29

Nature of Assessment	Observations
Position (ITM)	516961, 838014 - *Turbine is in forestry approx. 100m to the south*
Peat Depth	0.80m - *taken approx. 100m north of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network anticipated
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of quarry workings
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre,** a quarry is located 200m south of the turbine location, unknown if still active

Point 30 - Turbine B01

Nature of Assessment	Observations
Position (ITM)	514614, 839415
Peat Depth	0.40m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location
Topography	5-10 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location

Point 31 - Turbine B02

Nature of Assessment	Observations
Position (ITM)	515234, 839498
Peat Depth	0.30m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with what appears to be a minor stream 50m to the west of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 100m buffer of minor stream and 200 buffer of minor road
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location, the turbine is also in the vicinity of a very low trafficked track most likely for the farmer and forestry access

Point 32 - Turbine B03

Nature of Assessment	Observations
Position (ITM)	515728, 839414
Peat Depth	0.30m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location with what appears to be a minor stream 50m to the south of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 100m buffer of minor stream 200 buffer of minor road
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location, the turbine is also in the vicinity of a very low trafficked track most likely for the farmer and forestry access

Point 33 - Turbine B04

Nature of Assessment	Observations
Position (ITM)	514857, 839033
Peat Depth	0.40m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and some areas of standing water within the vicinity of the turbine location
Topography	5-10 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location

Point 34 - Turbine B05

Nature of Assessment	Observations
Position (ITM)	515179, 838728
Peat Depth	0.40m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location
Topography	5-10 degrees to horizontal
Sensitive Receptors	Turbine within 200 buffer of minor road
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location, the turbine is also in the vicinity of a very low trafficked track most likely for the farmer and forestry access

Under recent advice turbine locations C01 to C03 have been removed from the walkover survey assessment. Deep peat is known to be present within the immediate vicinity at these locations and has led to the removal of these turbines from the development scheme.

Point 35 - Turbine C04

Nature of Assessment	Observations
Position (ITM)	511317, 834692
Peat Depth	2.30m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location. Saturated ground. Peat cuttings in the vicinity.
Topography	5-10 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location

Point 36 - Turbine C05

Nature of Assessment	Observations
Position (ITM)	511846, 834599
Peat Depth	0.20m cut away peat, 1.20m uncut peat
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and saturated ground. Peat cutting within the vicinity of the turbine location and what appears to be a minor stream 170m south of the turbine location
Topography	5-10 degrees to horizontal
Sensitive Receptors	None evident in the vicinity however minor stream is 170m down-slope from the turbine location
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog which appears to be cut so peat depth could vary around the location between the cut and uncut peat, also the slope further up the hill is greater than the slope at the turbine location

Point 37 - Turbine C06

Nature of Assessment	Observations
Position (ITM)	511276, 834115
Peat Depth	0.30m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Evidence of past surface water flow in the vicinity. Potential ephemeral watercourse in vicinity.
Topography	5-10 degrees to horizontal
Sensitive Receptors	Ephemeral watercourse within 100m.
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the turbine location

Point 38 - Turbine C07

Nature of Assessment	Observations
Position (ITM)	511872, 833792
Peat Depth	0.90m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Evidence of past surface water flow in the vicinity and what appears to be a stream 150m to the east. Potential ephemeral watercourse in vicinity.
Topography	5-10 degrees to horizontal
Sensitive Receptors	Potential ephemeral watercourse / area of flush within 100m.
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the turbine location

Point 39 - Turbine C08

Nature of Assessment	Observations
Position (ITM)	511980, 833291
Peat Depth	0.60m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches within the vicinity of the turbine location. Saturated ground.
Topography	<5 degrees to horizontal
Sensitive Receptors	Area of flush / potentially ephemeral watercourse within 100m.
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog so peat depth could vary around the location

Point 40 - Turbine C09

Nature of Assessment	Observations
Position (ITM)	512417, 833101
Peat Depth	3.00m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and the surface was saturated with some standing water within the vicinity of the turbine location. Peat bank degraded by erosion in vicinity.
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident in the vicinity
Utilities: Underground or overhead	Turbine within 200m buffer of infrastructure (minor road)
Any other observations	Turbine within blanket bog so peat depth could vary around the location, minor road approx..160m south of turbine location

Point 41 - Turbine C10

Nature of Assessment	Observations
Position (ITM)	513211, 833182 - *Turbine is in forestry approx. 200m to the south west*
Peat Depth	0.50m - *taken approx. 200m north east of turbine*
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Extensive drainage network anticipated. A stream is present 130m to the north and a major drainage ditch on south side of forestry
Topography	Anticipate 5 – 10 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road)- Minor stream just outside buffer.
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	**Turbine in forestry unable to reach turbine centre;** minor road approx..160m north of turbine location

Point 42 - Turbine C11

Nature of Assessment	Observations
Position (ITM)	512262, 832572
Peat Depth	0.5m
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches and the surface was saturated with some standing water within the vicinity of the turbine location which is in an area of small-scale peat cutting.
Topography	<5 degrees to horizontal
Sensitive Receptors	Turbine within 200m buffer of infrastructure (minor road)
Utilities: Underground or overhead	None evident in the vicinity
Any other observations	Turbine within blanket bog which appears to have small scale peat cutting works so peat depth could vary around the location, minor road approx..160m south of turbine location

5.5 Existing Mining Activities

The walkover survey confirms that there are no current quarrying operations evident within the site boundary.

However, small-scale, possibly historic quarrying / "borrow pits" are present within the north of the site and in the immediate vicinity. It cannot be determined whether these facilities are currently active or disused.

The closest active quarrying operation is approximately. 7km from the site.

5.6 Existing Services / Utilities

No further evidence of existing services / utilities was recorded during the walkover survey. However, given the large area that the site covers, underground services are a medium risk occurrence, particularly where turbines are close to public roads and private access roads.

5.7 Potential Sensitive Receptors

Analysis of desk study resources and follow up walkover survey have identified the following receptors with the potential to be susceptible to peat instability generated by activity related to the proposed wind farm construction and / or operation.

Receptor	**Minimum distance to Development Boundary**	**Exposure Factor Assigned** ***(Using Factor Based Probabilistic Analysis)***	**Remarks**
Peatlands / Bog	0m (within site)	1	
Agricultural Lands	0m (within site)	1	
Minor Utilities	0m (within site	2	Assumed Water / Telecom within vicinity of l/R roads traversing the site
Designated Minor Watercourses / Water Bodies	0m (within site)	2	Tributaries of the Heathfield and Cloonalaghan Rivers
Designated Major Watercourses / Water Bodies	c. 1.00km	3	Heathfield and Cloonalaghan Rivers
Undesignated Watercourses / Drainage	0m (within site)	1	e.g. ditches and man-made watercourses, ephemeral run-off channels
Minor Public Roads	c. <50m	3	

Moderately to highly trafficked Public Road	c. 1.00km	4	R134
Dwellings	c. 500m	4	
Commercial Property	c. 500m	3	
Significant Utilities (Overhead) / Underground	<100m	3	In the vicinity of AT09 and AT08.
Population centre / Urban area	c.3km	5	Ballycastle – population 219 (2016)[3]

5.8 Potential Preconditions Identified within the immediate vicinity of the proposed development

Analysis of desk study resources and follow up walkover survey have identified the following static or inherited factors that could potentially act as preconditions to slope instability in peatlands.

Precondition	Minimum distance to Development (m)	Remarks
Concentrated drainage network / presence of standing water / area of flush / springs, or rises	Within wind farm	
Significant slopes	Slopes of >10^{o} are resent within site boundary and around some infrastructure	Turbines in the vicinity of Significant slopes; AT09, CT05, CT06
Significant peat thickness	Peat depth of >2.5m present in the vicinity of AT03, CT04 and CT09	Peat thickness capable of inducing “bog burst” was recorded (c. >2.5m). [Significance based on probabilistic factor assigned to banding of depth].
Very highly decomposed Peat	Not at assessed infrastructure	Low likelihood given shallow depth of peat identified. [Assessed according to Von Post]. All Von Post classifications are H5 or lower.
Very weak Peat and underlying mineral soils	Weak Peat identified at AT03, AT25	Very weak peat identified at T1
Potential sonic vibration or ground accelerations	No piling works anticipated during construction that might adversely affect peat stability. Potential for blasting at a Quarry is considered low.	Vibrationally induced energy, e.g. from quarry blasting >5km away is deemed negligible at the site.

[3] Source: Wikipedia: https://en.wikipedia.org/wiki/Ballycastle,_County_Mayo

5.9 Pre-Failure Indicators within the immediate vicinity of the proposed development

Pre-failure indicators are physical landforms that are “tell-tale” signs of stress within the peatland environment.

The following pre-failure indicators have been considered for the proposed development at Tirawley Wind Farm: -

- Historical evidence of previous movement / Peat cutting
- Tension or compression features
- Soil creep
- Cracking / desiccation
- Other[4]

The following pre-failure indicators are present within the immediate vicinity of the proposed development.

Pre-Failure Indicator	Minimum distance to Development (m)	Remarks
Historic peat cutting	0m (within site)	Moderately frequent occurrence within the wind farm boundary
Evidence of historical peat / soil movement	Not at assessed infrastructure	
Evidence of tension cracking or compression features	0m (within site)	Infrequent evidence. Further detailed assessment required to determine potential risk to development
Evidence of soil creep	0m (within site)	Infrequent evidence. Further detailed assessment required to determine potential risk to development
Cracking / desiccation	Not at assessed infrastructure	

5.10 Summary of Prevailing Site Conditions

Analysis of Desk Study and Walkover Survey data allows the following preliminary geotechnical appraisal for the Triawley Farm site: -

1. Superficial soils consisting of peat and glacial tills mantle the site. Peat represents a potential stability risk and therefore a medium hazard with respect to the development.

[4] The Scottish Guidance notes other potential pre failure indicators such as artificial drainage, concentrated drainage networks, seeps, springs, soft clays and iron pans. The author considers these to be preconditions and not pre failure indicators.

2. Rock often outcrops at the surface within the proposed development site and in particular within site “C”. For the majority of the sites “B” and “C” the author believes that the surface of the underlying rock formation is probably <3m below the existing ground surface and that gravity base foundations are a viable consideration. Within site “A” there is a higher probability of deeper soils and a consequent risk that the rock unit may not be accessible for shallow gravity base foundations. Significant excavation or piling may be required to reach a suitable bearing stratum on which to place wind turbine generators. turbine hard stand infrastructure. “Floated” road construction methods may prove more economically viable than tradition construction for parts of the access track network, where deep peat soils are present. There is a medium risk that traditional foundations (e.g. gravity base foundation for turbines) may not be viable.

3. The underlying rock formations predominantly contain either sandstone or mudstone, which should provide a suitable formation on which to place turbine foundations, either using gravity base spread foundations or by piling. Within two small regions limestone interbedded with shale is the uppermost formation and this is likely to present potential stability issues for the installed infrastructure. Limestone exhibit karst landscape features such as sinkholes, cavities or subterranean drainage networks. These “karst” landscape features have the ability to affect the stability of turbine infrastructure. Although, no such features, expressed at the surface, have been observed within the vicinity of the proposed turbines during the walkover surface they are potentially present elsewhere within the site. It is possible that the buried rock surface could be highly variable in both its depth of burial and competence that could give rise to differential settlement in installed structures, unless detailed analysis of the subsurface is obtained. The hazard that this represents to construction of wind turbine foundations is considered to be medium.

4. Further supplementary SI is recommended prior to construction to assess the nature of the rock formation present at each turbine base. Where this coincides with the Moyny Point Limestone Member being the uppermost rock unit these investigations will be enhanced to allow for significant variation in subsurface rock competence.

5. Given the shallow ground slopes and proximity to a number of watercourses and open water bodies the potential for a high water table and flooding is of Medium Hazard to the proposed development. The presence of a high water table will have an effect on the construction methods employed, particularly for the construction of turbine foundations, and may also give rise to a need for regular maintenance within the lifetime of the scheme. There is a medium risk that a buoyant foundation design may be required where gravity base foundations are to be deployed.

6. Peat soils are present at wind farm infrastructure consistent with Bog land Habitat and generally in excess of 0.5m thick.

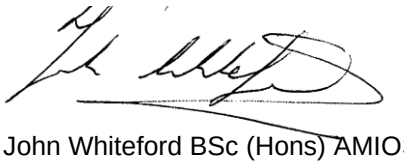
7. Preliminary Peat Stability assessment indicates Low to High Hazard of peat instability, depending on the location of particular infrastructure within the windfarm development. Designations of “High” Hazard are currently based on the classification of access roads as minor public roads. Confirmation that this classification can be downgraded will have a positive impact on the assessed Hazard.

8. Further detailed investigation is recommended to assess the hazard of peat instability across the entire wind farm site.

This report has been prepared on behalf of Constant Energy Ltd

by

Whiteford Geoservices Ltd



John Whiteford BSc (Hons) AMIOSH MEAGE FGS
Technical Director

6.0 REFERENCES

1. Design Manual for Roads and Bridges ("DMRB") Volume 11, Section 3 (Environmental Assessment), Part 11: Geology and Soils

2. English Nature publication 'Geological conservation – a guide to good practice'

3. Ordnance Survey Ireland www.osi.ie

4. Geological Map of Ireland, 1:750,000, 3rd Edition 1962, Ordnance Survey Ireland

5. Geological Survey of Ireland Spatial Resources Viewer www.gsi.ie

6. Ordnance Survey of Ireland. www.osi.ie

7. Craig, R F. 1997. Soil Mechanics. Sixth Edition. E & FN Spon, London

8. Daly, D, And Warren, W. 1994. Mapping of Groundwater Vulnerability to Pollution. Geological Survey of Ireland (Dublin) Guidelines.

9. Site Investigation Steering Group. 1993. Site Investigation in Construction – Without Site Investigation Ground Is A Hazard, Thomas Telford, London

10. Skinner, B J, And Porter S C. 1987. Physical Geology, John Wiley & Sons, Inc.

11. BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

12. BS 5930: 2015: Code of practice for site investigations (Amendment 2). British Standards Institution.

13. BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

14. BS EN ISO 14688-1: 2002: Geotechnical investigation and testing - Identification and classification of soil - Part 1 Identification and description. British Standards Institution.

15. "Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments", Second edition April 2017.

16. "Mass Movements in Peat: A Formal Classification Scheme", Dykes, A.P., Warburton, J., Apr 2007, Geomorphology 86(1): 73-93.

17. "Peat Slope Failure in Ireland", Boylan, N., Jennings, P., Long, M., Quarterly Journal of Engineering Geology and Hydrogeology, 41, 93-108, Feb 2008.

18. BS 1377: 1990 : Methods of test for soils for civil engineering purposes. British Standards Institution.

19. BS 5930:2015 + A1:2020 Code of practice for ground investigations. British Standards Institution.

20. BS EN 1997-2: 2007 : Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

21. BS EN ISO 14688-1: 2002 : Geotechnical investigation and testing - Identification and classification of soil - Part 1 Identification and description. British Standards Institution.

22. BS EN ISO 14689-1: 2003 : Geotechnical investigation and testing - Identification and classification of rock - Part 1 Identification and description. British Standards Institution.

23. BS EN ISO 22475-1: 2006 : Geotechnical investigation and testing – Sampling methods and groundwater measurements - Part 1 Technical principles for execution. British Standards Institution.

24. BS EN ISO 22476-2: 2005 : Geotechnical investigation and testing - Field testing - Part 2 Dynamic probing. British Standards Institution.

25. BS EN ISO 22476-3: 2005 : Geotechnical investigation and testing - Field testing - Part 3 Standard penetration test. British Standards Institution.

.

Appendices

Appendix A - Drawings

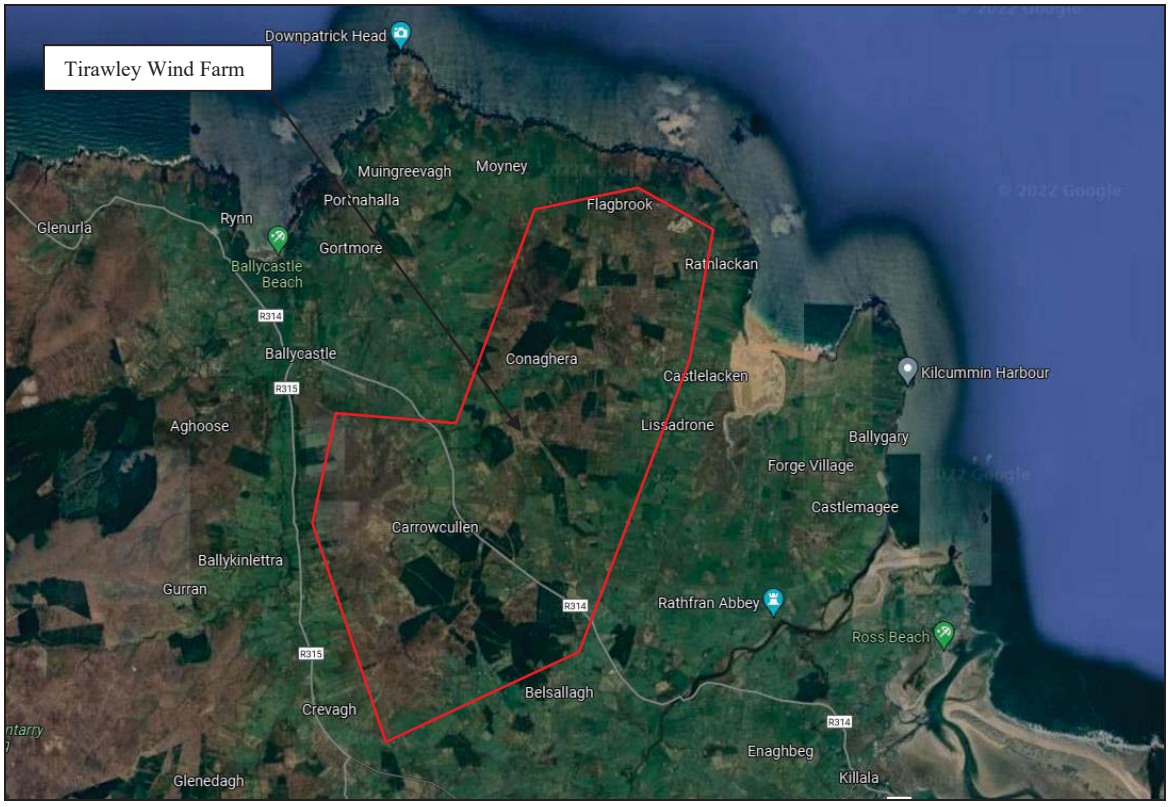
General Site Location Plan – P1 / P2
Site Investigation Layout Plan - P3

EPA Online Environment Viewer – SAC and Natural Heritage Mapping

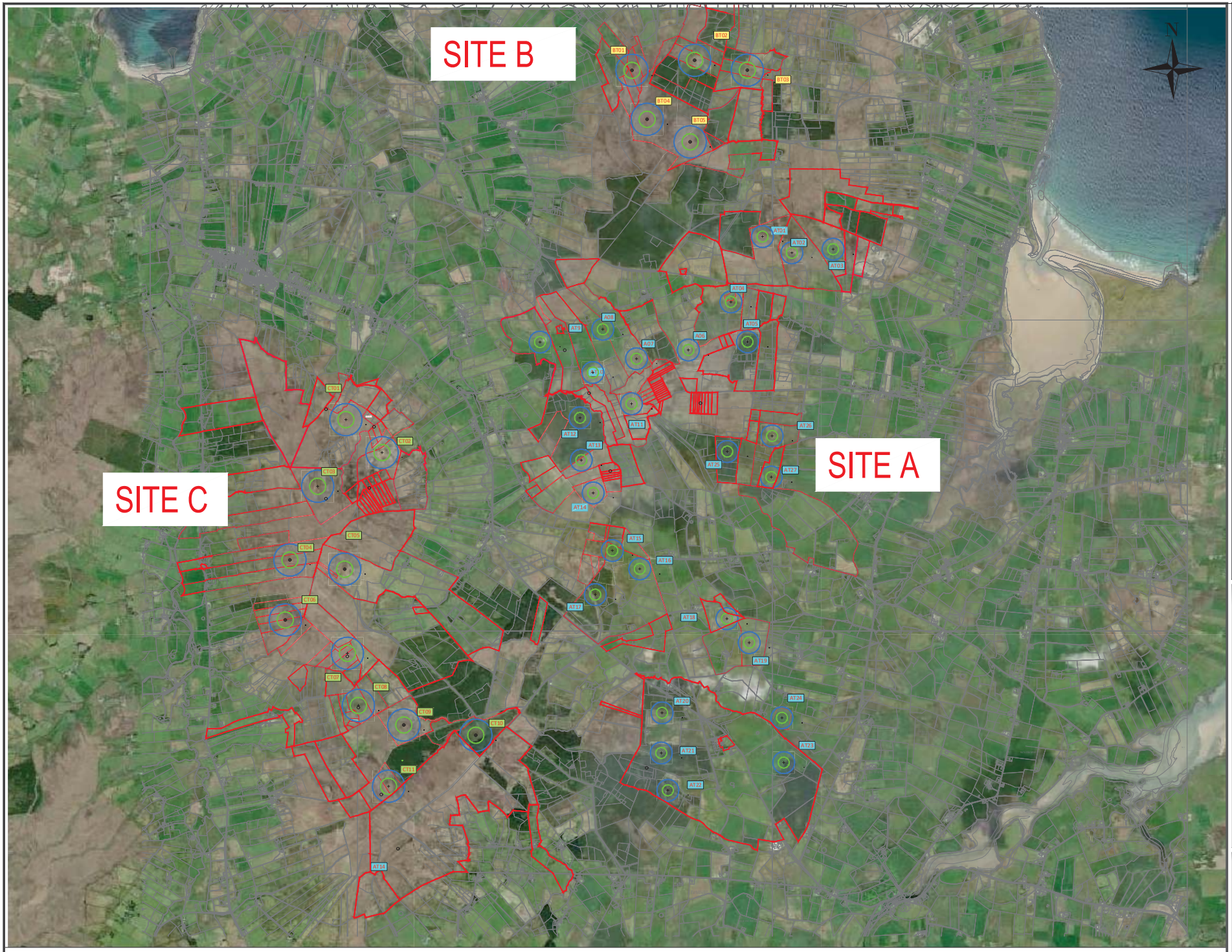
Geological Survey of Ireland Public Viewer Data – Solid and Structural Geology
Geological Survey of Ireland Public Viewer Data – Aggregate Potential
Geological Survey of Ireland Public Viewer Data – Superficial Soils and Landforms
Geological Survey of Ireland Public Viewer Data – Subsoil Permeability
Geological Survey of Ireland Public Viewer Data –Groundwater Aquifer Potential
Geological Survey of Ireland Public Viewer Data – Groundwater Vulnerability
Geological Survey of Ireland Public Viewer Data –Karst, Springs and Watercourses
Geological Survey of Ireland Public Viewer Data – Landslide Susceptibility



P1 - General Location Plan (Aerial view)
(© google maps 2021)



P2 - Local Location Plan (Aerial view)
(© google maps 2021)



NOTES:
1 FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING.
2 ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE.
3 ENGINEER TO BE INFORMED OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES.
4 THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
5 THIS DRAWING BASED ON 6289-JOD-TWF-XX-DR-C-1000 REV C 6289•PR•100_REV J

LEGEND

FOLIO OUTLINE

155M ROTOR DIAMETER WTG
1D (155M) SETBACK FROM BOUNDARY

DRAFT_0

rev.	modifications	by	chkd	date

Client
Mercury Renewables (Carrowleagh) Limited

Project
Tirawley Wind Farm
Co. Mayo

Stage
PRELIMINARY

Title
Overall Site Layout Plan

Scales
1:12,500 (A1)

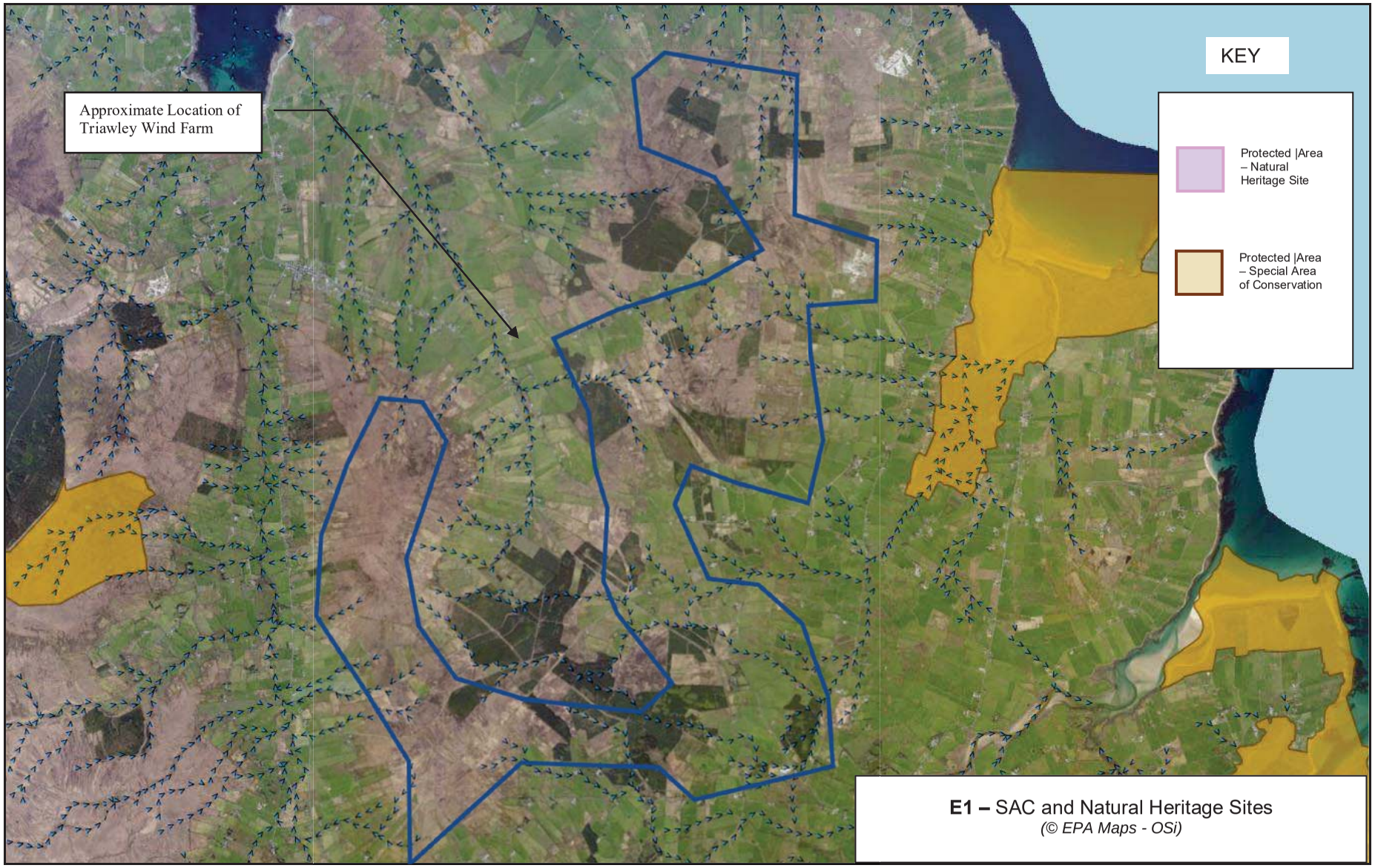
Surveyed	Prepared By	Checked	Date
	JOD	JL	FEB. 2022

© COPYRIGHT OF
JENNINGS O'DONOVAN & PARTNERS LIMITED,
CONSULTING ENGINEERS,
FINISKLIN,
SLIGO,
IRELAND.
TEL. (0035371) 9161416.
FAX. (0035371) 9161080.
Email. info@jodireland.com
Web. www.jodireland.com

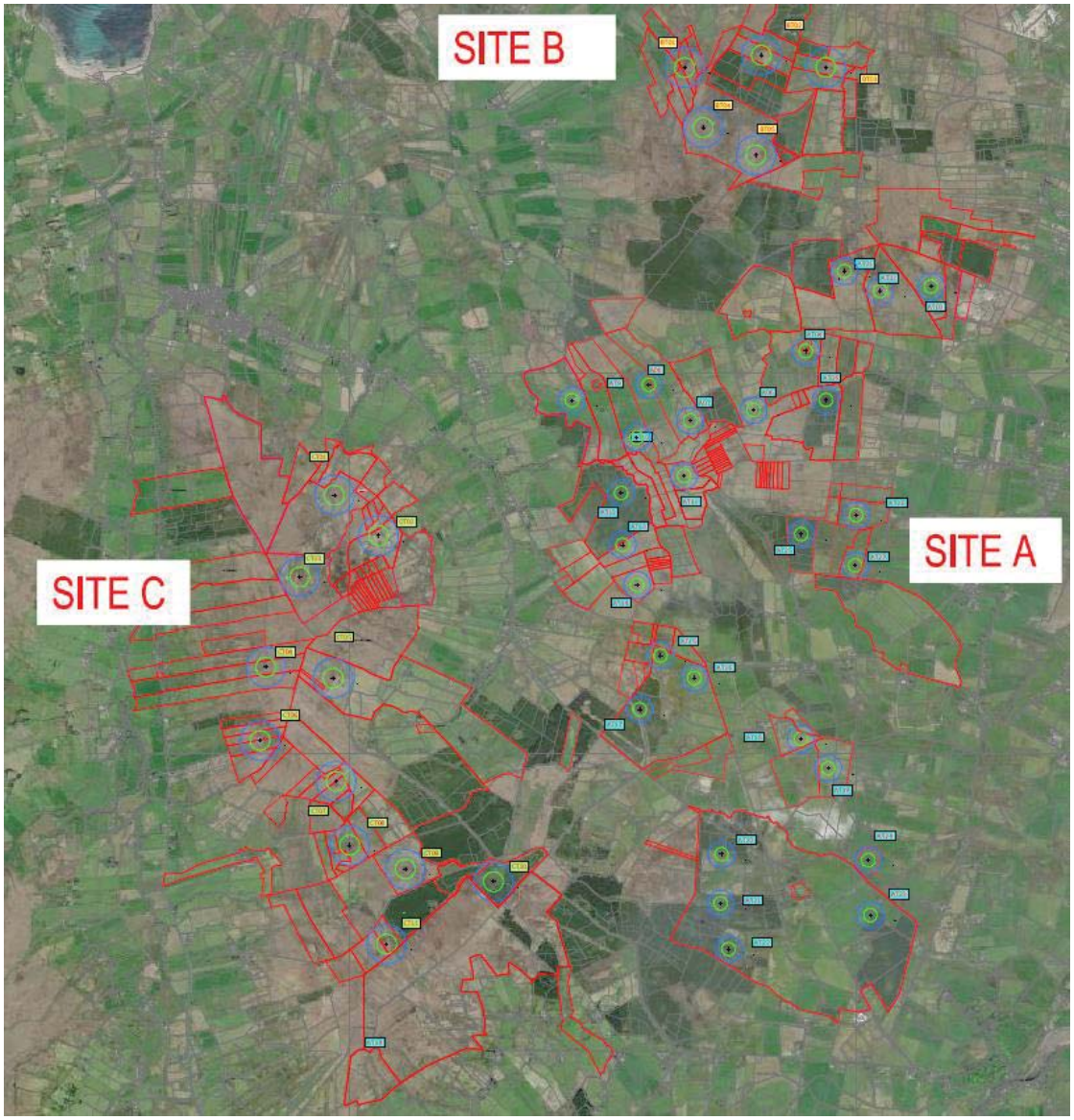
SITE LAYOUT PLAN
Scale 1:12,500 (A1)

Drawing No.
6289-JOD-TWF-XX-DR-PR-100

Revision



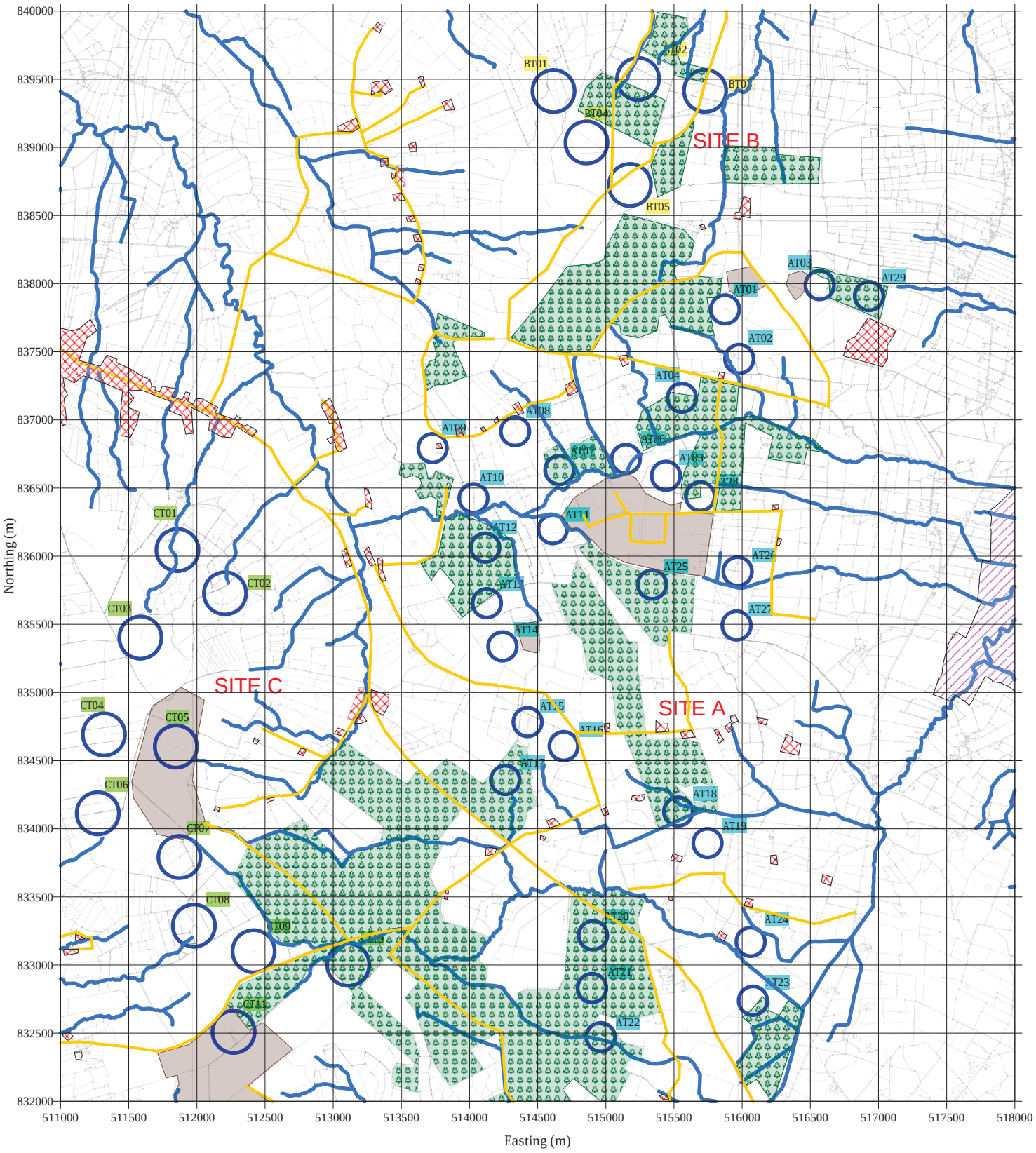
E1 – SAC and Natural Heritage Sites
(© EPA Maps - OSi)


SITE B
SITE A
SITE C

2165-22 Tirawley Wind Farm

Plot of Potential Local Exposures, Pre-conditions and Pre-failure indicators of slope instability Preliminary Assessment

10th October 2022



Exposures
- Existing Public Roads
- Streams / Water Bodies
- Forestry
- Industrial Infrastructure / Residential Buildings Farm Buildings
- Protected Habitats

Preconditions
- Marshy wetlands
- Convex Slopes (Direction)
- Potential Peat Landforms / Historical Peat Cutting and associated drainage

Pre-Failure Indicators
- Artificial / undesignated Drainage
- Concentrated Drainage Networks

Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 12/10/2022	2165-22 D-PE	12/10/2022	1 : 27,500

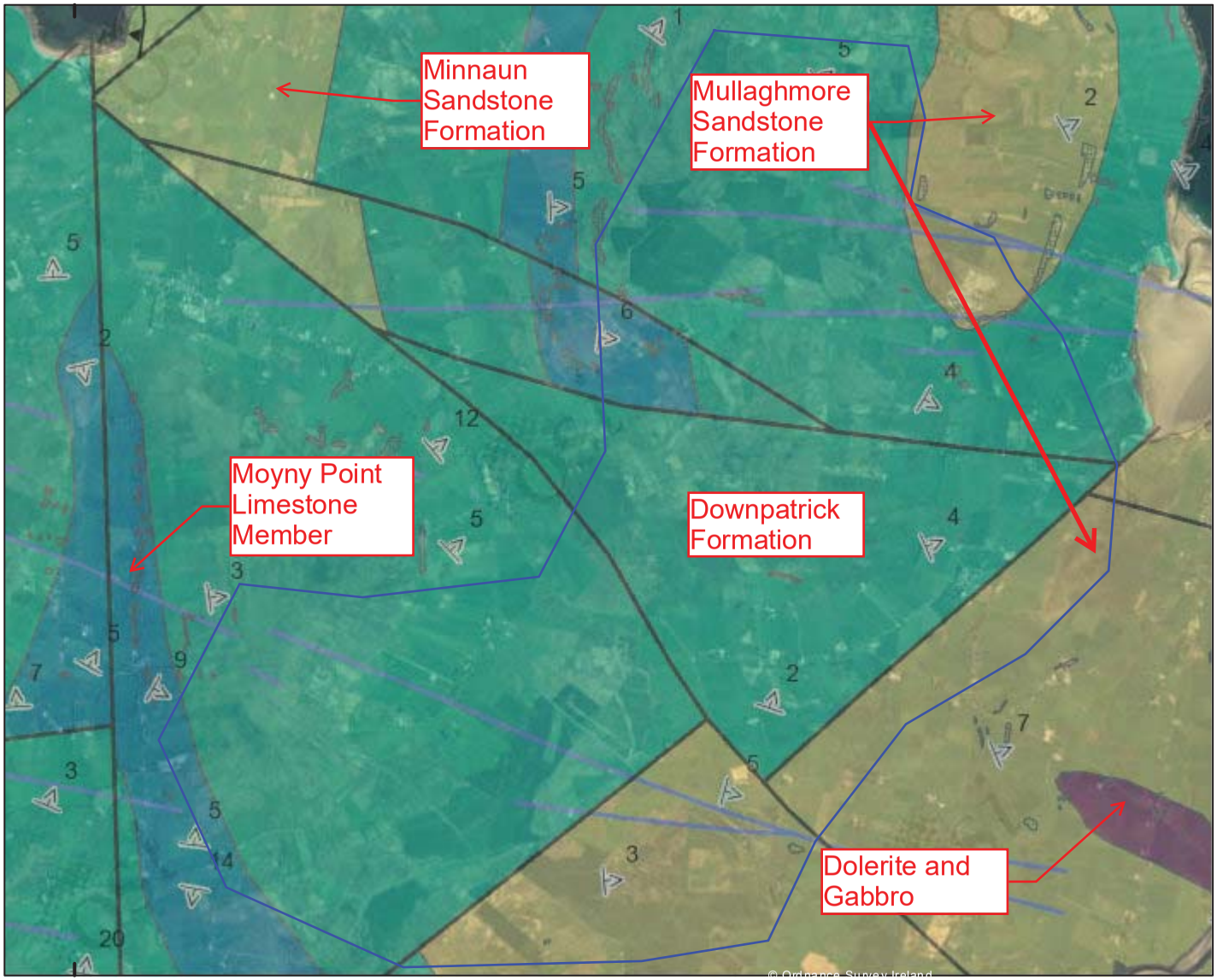
DRAFT

Whiteford Geoservices Ltd
Strold House, 2 Main Street, Strael, BALLYCLARE, Co. Antrim, Northern Ireland BT39 9NE UNITED KINGDOM

Tirawley Wind Farm - Soils and Geology Assessment

Exposure Plot | Edition 0 | Sheet A3

GSI - Solid Geology - Tirawley WFs



Scale: 1:50,000

Geological Survey Ireland

Creative Commons Attribution 4.0 International license

0 0.35 0.7 1.4 mi

0 0.5 1 2 km

Map Centre Coordinates (ITM) 514,136 836,017

9/5/2022, 2:49:39 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Legend

Structural Symbols 100K ITM 2018

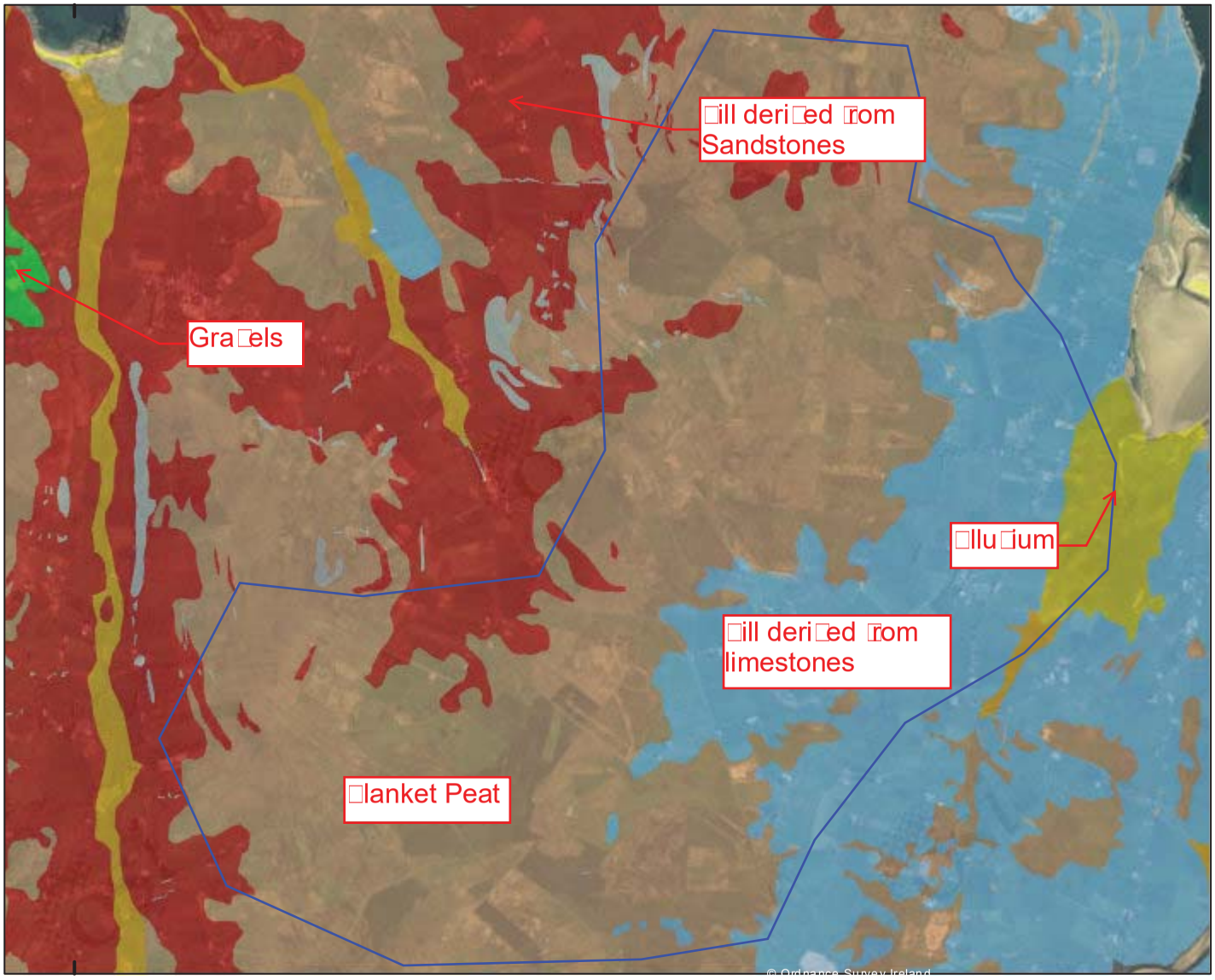
- Dip of bedding or main foliation, old GSI data
- First foliation parallel to bedding
- Foliation trend, Thorr and Rosses Granites
- Horizontal Bedding
- Strike and dip of bedding, right way up
- Strike and dip of bedding, way up unknown
- Strike and dip of first foliation
- Strike and dip of overturned bedding
- Strike and dip of second foliation
- Strike and dip of third foliation
- Strike and plunge of first generation fold axis
- Strike and plunge of second generation fold axis
- Strike and plunge of third generation fold axis
- Strike of vertical bedding/foliation
- Strike of vertical first foliation
- <all other values>

- Bedrock Outcrops 100 ITM 2018

Bedrock Linework 100k ITM 2018

- Anticlinal Axis
- Antiformal axis
- Aquifer Boundary
- Area
- Coal seam
- Dyke
- Fault
- Ghost Line
- Goniatite marine band (R1-R4)
- Lithological boundary offshore
- Metadolerite sheet, mainly sills
- Paleogene/ Tertiary Dyke
- Synclinal Axis
- Synformal axis
- Tectonic Slide, barbs on hanging-wall
- Thin stratigraphical unit, diagrammatic
- Thrust, barbs on hanging-wall side
- Tuff band
- Unconformity, dots on younger side
- X-Section

GSI - Superficial Soils - Tirawley WFs



Legend

Scale: 1:50,000

Geological Survey Ireland

Creative Commons Attribution 4.0 International license

N W E S

0 0.35 0.7 1.4 mi

0 0.5 1 2 km



Map Centre Coordinates (ITM) 514,136 836,017

9/5/2022, 2:51:25 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Subsoil Permeability



Legend

Subsoil_Permeability_40K_IE26_ITM

PERM

- High
- Moderate
- Low
- Water
- Not mapped

Scale: 1:105,502

Geological Survey Ireland

N W E S

0 0.75 1.5 3 mi
0 1.25 2.5 5 km

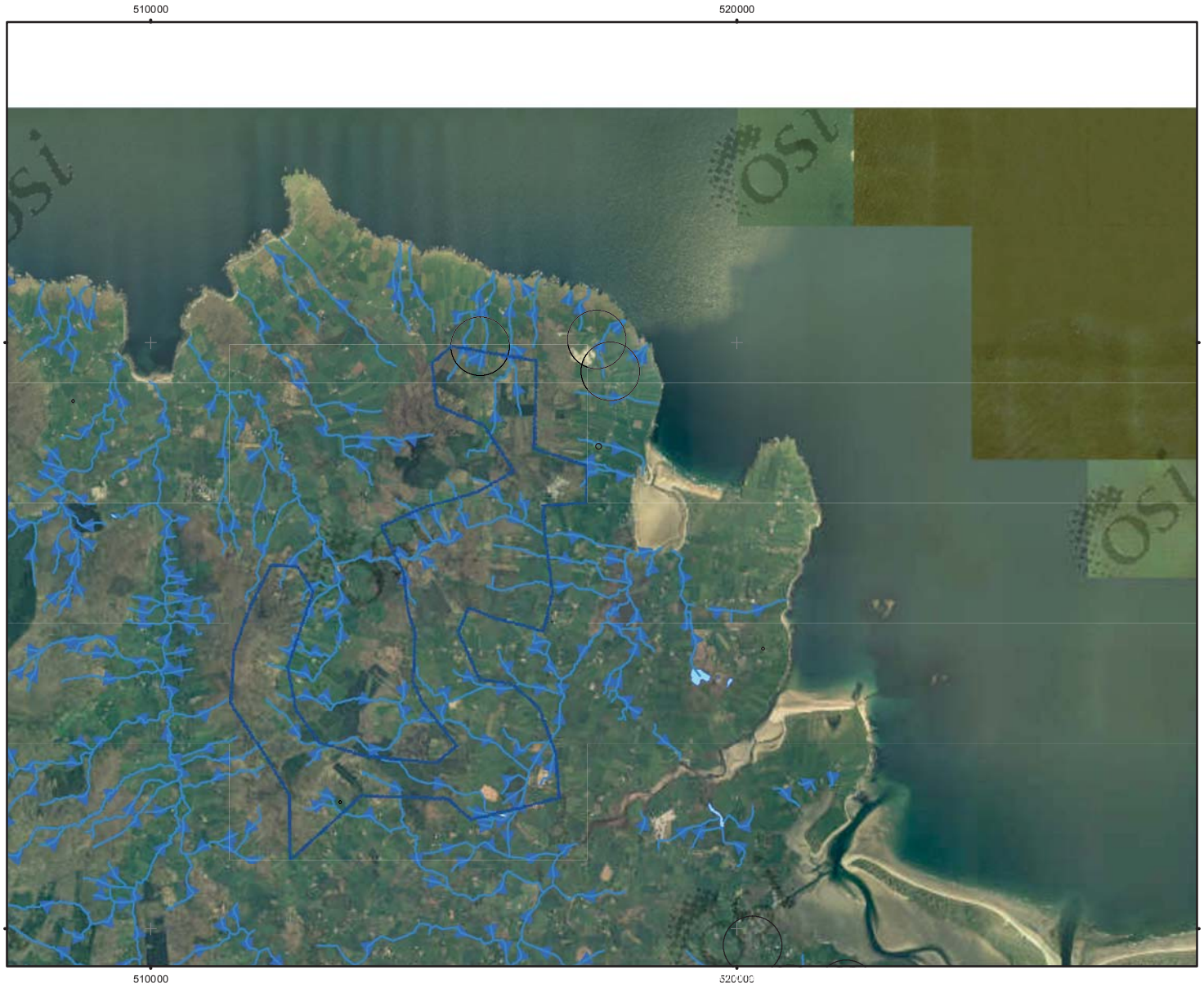
Map Centre Coordinates (ITM) 516,589 836,727
10/27/2022, 6:31:57 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047221
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Groundwater - Karst, Springs and Watercourses



Legend

- Groundwater Wells and Springs
- River Network and River Flow Direction Arrows
- Lake Segments

Scale: 1:105,502

Geological Survey Ireland

N W E S

0 0.75 1.5 3 mi
0 1.25 2.5 5 km

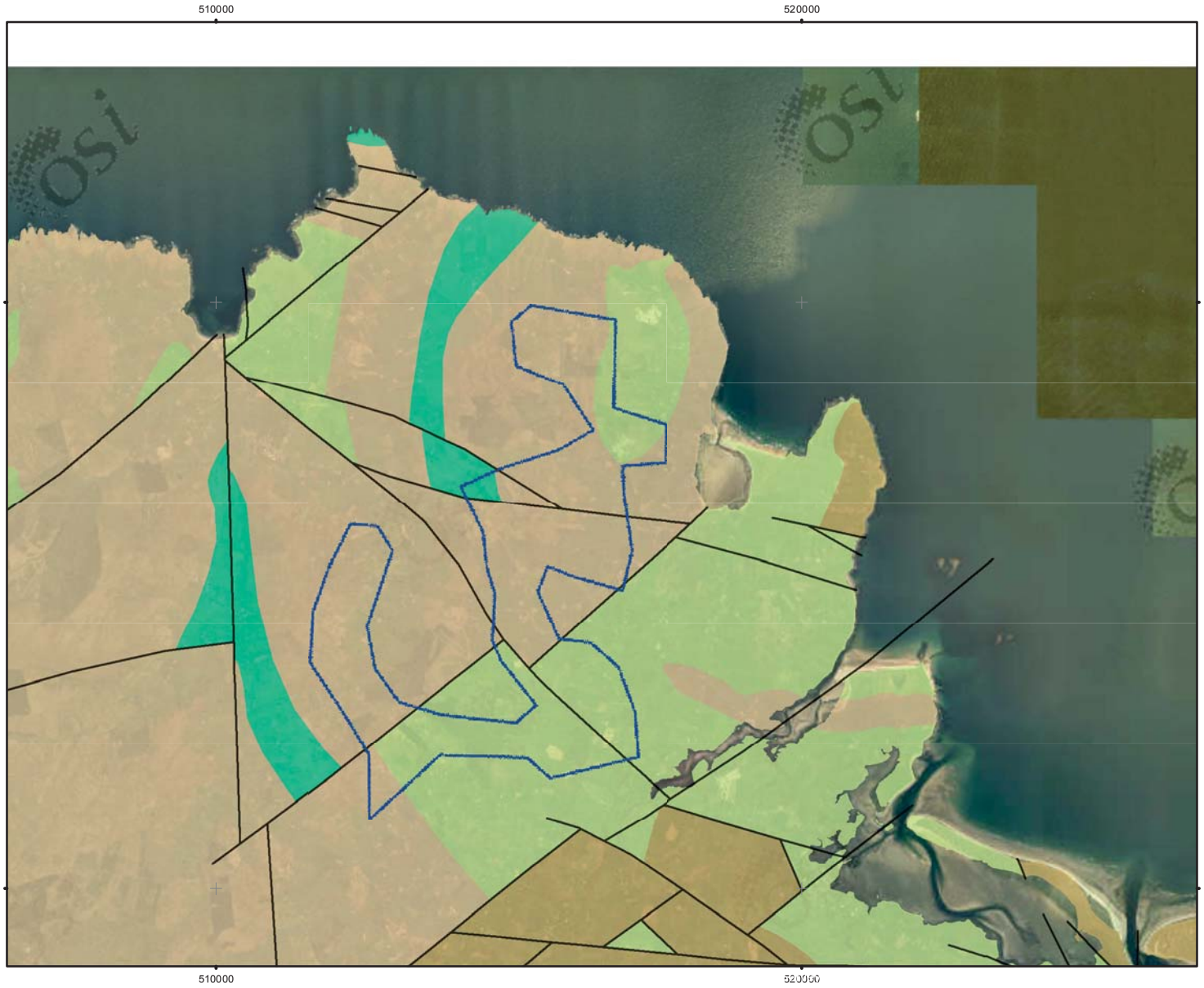
Map Centre Coordinates (ITM) 517,700 837,415
10/27/2022, 3:29:02 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047221
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Groundwater Aquifer Potential



Legend

- Bedrock Aquifer Faults
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Lk - Locally Important Aquifer - Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones

Scale: 1:105,502

Geological Survey Ireland

N W E S

0 0.75 1.5 3 mi
0 1.25 2.5 5 km

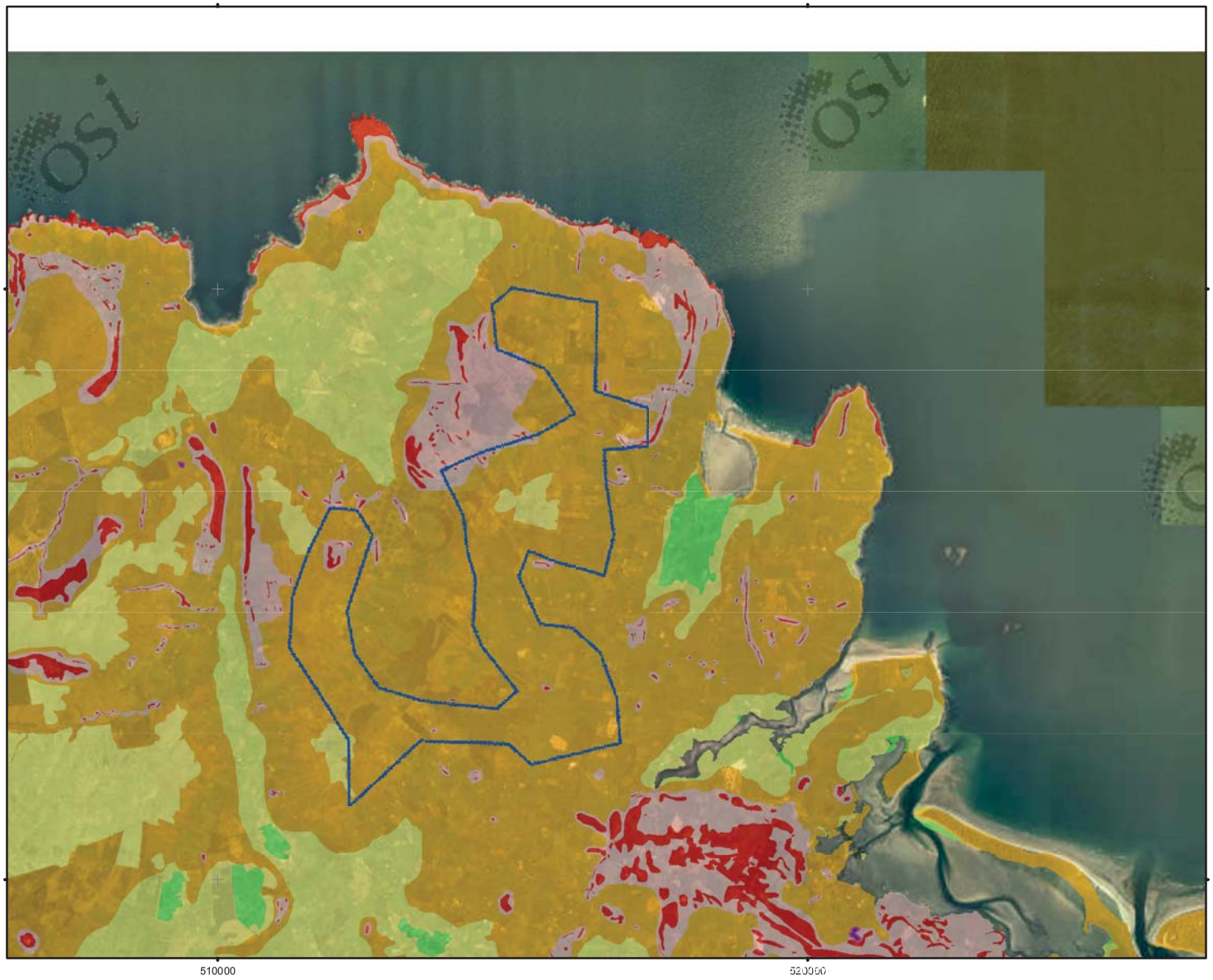
Map Centre Coordinates (ITM) 516,589 836,727
10/27/2022, 3:41:40 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047221
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Groundwater Vulnerability



Legend

Groundwater Vulnerability

VULNERABILITY

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low
- Water

Scale: 1:105,502

Geological Survey Ireland

N W E S

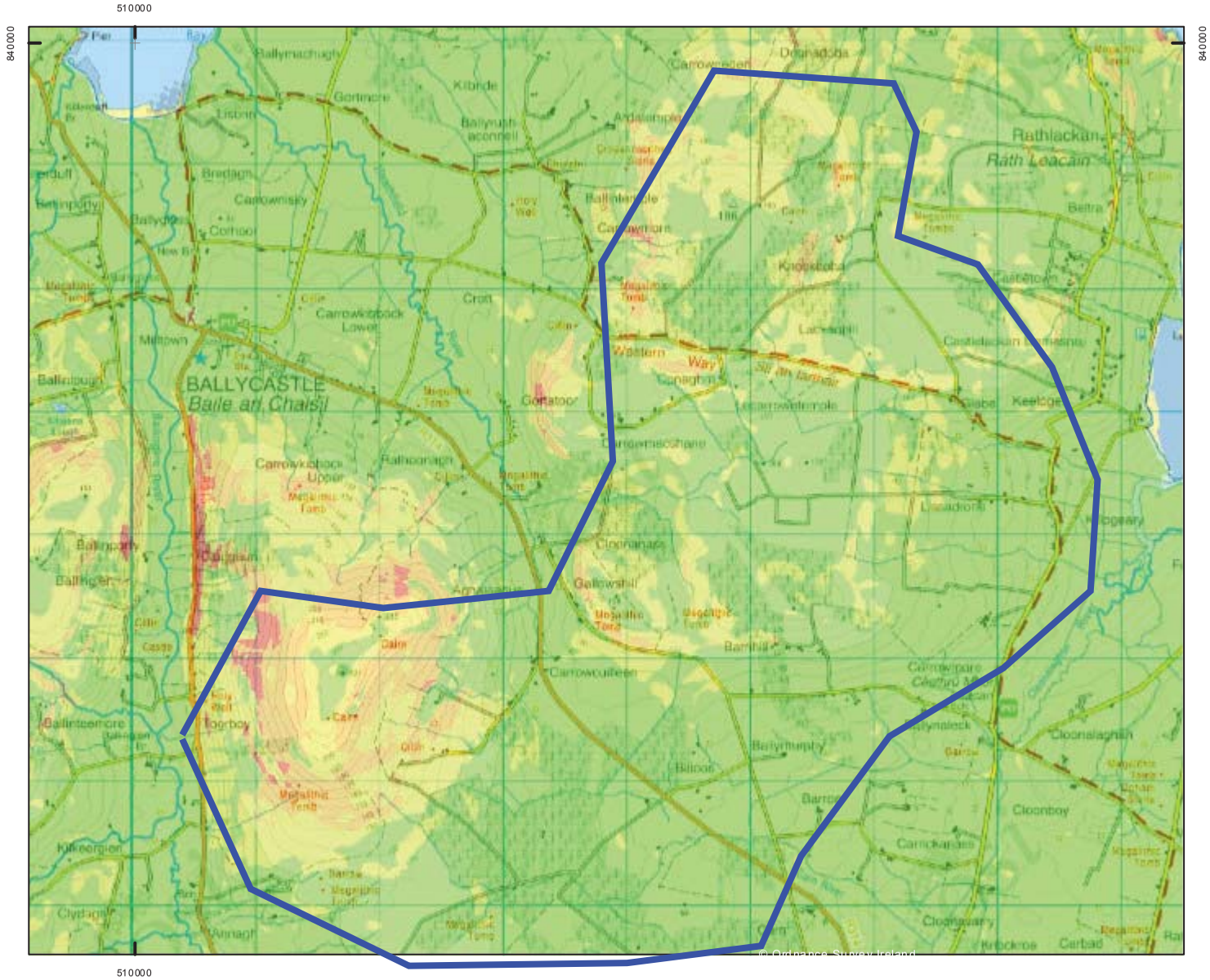
0 0.75 1.5 3 mi
0 1.25 2.5 5 km

Map Centre Coordinates (ITM) 516,589 836,727
10/27/2022, 3:37:27 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047221
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

GSI - Landslide Susceptibility Map



Legend

- Landslide Locations Ireland ITM
- Landslide Extents Ireland ITM

Landslides Susceptibility Classification

- Unclassified
- Low
- Low (inferred)
- Moderately Low
- Moderately Low (inferred)
- Moderately High
- Moderately High (inferred)
- High
- High (inferred)
- Made
- Water

Scale: 1:50,000

Geological Survey Ireland

0 0.35 0.7 1.4 mi

0 0.5 1 2 km

Map Centre Coordinates (ITM) 513,816 836,369

9/5/2022, 4:09:21 PM

CC-BY 4.0

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Landslide Events

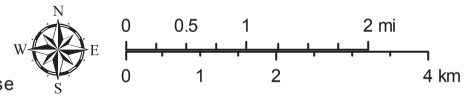


Legend

- Landslide Locations Ireland ITM
- Landslide Extents Ireland ITM

Scale: 1:100,000

Geological Survey Ireland





Map Centre Coordinates (ITM) 514,759 834,015

12/10/2022, 14:58:56

Creative Commons Attribution 4.0 International license

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Appendix 2

Preliminary Plot of Peat Thickness

(Compiled from preliminary data collected at proposed Turbine Base locations

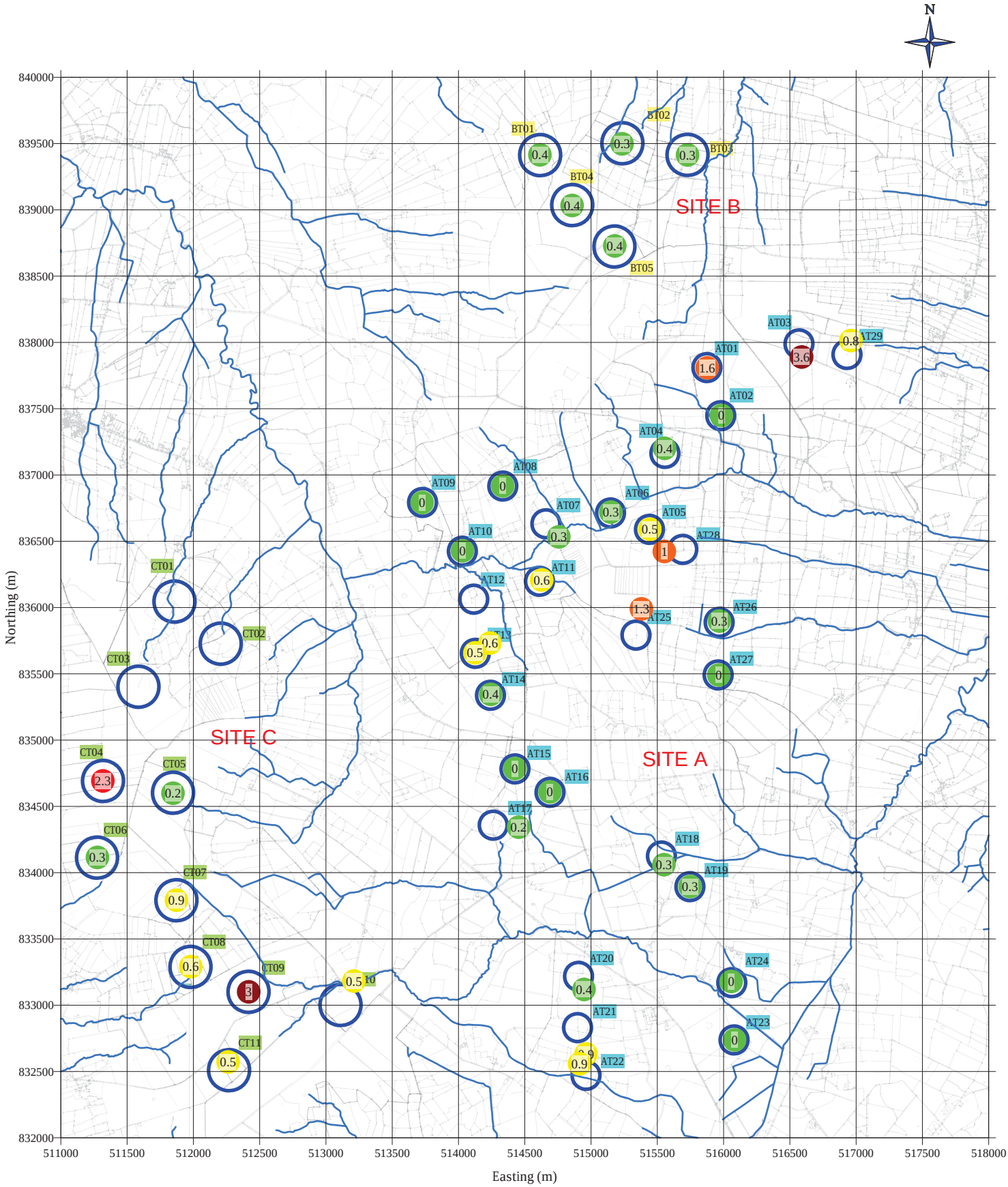
Preliminary Peat Depth Data

2165-22 Tirawley Wind Farm

Classed Plot of Peat Depth - Preliminary Data

Site Layout Plan (6289-JOD-TWF-XX-DR-C-100 Rev01)

10th October 2022



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

DRAFT

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 11/10/2022	2165-22 D1-P	11/10/2022	1 : 27,500

Whiteford Geoservices Ltd

Tirawley Wind Farm - Soils and Geology Assessment

Classed Plot of Peat Depth | Edition 0 | Sheet A3

2165-22 - Tirawley Wind Farm
Preliminary Data of Peat Depth at Turbines

Location	Easting	Northing	Depth	Comments
AT-1	515876	837808	1.6	
AT-2	515983	837449	0	
AT-3	516589	837890	3.6	*Point taken approx. 100m from Turbine centre due to personal safety*
AT-4	515555	837201	0.4	*Turbine is in forestry approx. 40m to the south*
AT-5	515443	836591	0.5	
AT-6	515149	836720	0.3	
AT-7	514757	836533	0.3	*Turbine is in forestry approx. 140m to the north*
AT-8	514334	836917	0	
AT-9	513726	836792	0	
AT-10	514030	836428	0	
AT-11	514628	836208	0.6	
AT-12	514237	835732	0.6	*Turbine is in forestry approx. 320m to the north west*
AT-13	514124	835658	0.5	
AT-14	514243	835345	0.4	
AT-15	514425	834785	0	
AT-16	514690	834609	0	
AT-17	514454	834343	0.2	
AT-18	515550	834060	0.3	*Turbine is in forestry approx. 70m to the north west*
AT-19	515747	833895	0.3	
AT-20	514947	833119	0.4	*Turbine is in forestry approx. 100m to the north west*
AT-21	514962	832632	0.9	*Turbine is in forestry approx. 200m to the north west*
AT-22	514913	832558	0.9	*Turbine is in forestry approx. 100m to the south east*
AT-23	516083	832738	0	
AT-24	516057	833179	0	
AT-25	515380	835990	1.3	*Turbine is in forestry approx. 200m to the south west*
AT-26	515968	835898	0.3	
AT-27	515963	835491	0	
AT-28	515553	836423	1	*Turbine is in forestry approx. 140m to the east*
AT-29	516961	838014	0.8	*Turbine is in forestry approx. 100m to the south*
BT-1	514614	839415	0.4	
BT-2	515234	839498	0.3	
BT-3	515728	839414	0.3	
BT-4	514857	839033	0.4	
BT-5	515179	838728	0.4	
CT-4	511317	834692	2.3	
CT-5	511846	834599	0.2	
CT-6	511276	834115	0.3	
CT-7	511872	833792	0.9	

2165-22 - Tirawley Wind Farm
Preliminary Data of Peat Depth at Turbines

Location	Easting	Northing	Depth	Comments
CT-8	511980	833291	0.6	
CT-9	512417	833101	3	
CT-10	513211	833182	0.5	*Turbine is in forestry approx. 200m to the south west*
CT-11	512262	832572	0.5	

Appendix 3

Preliminary Plot of Ground Elevation

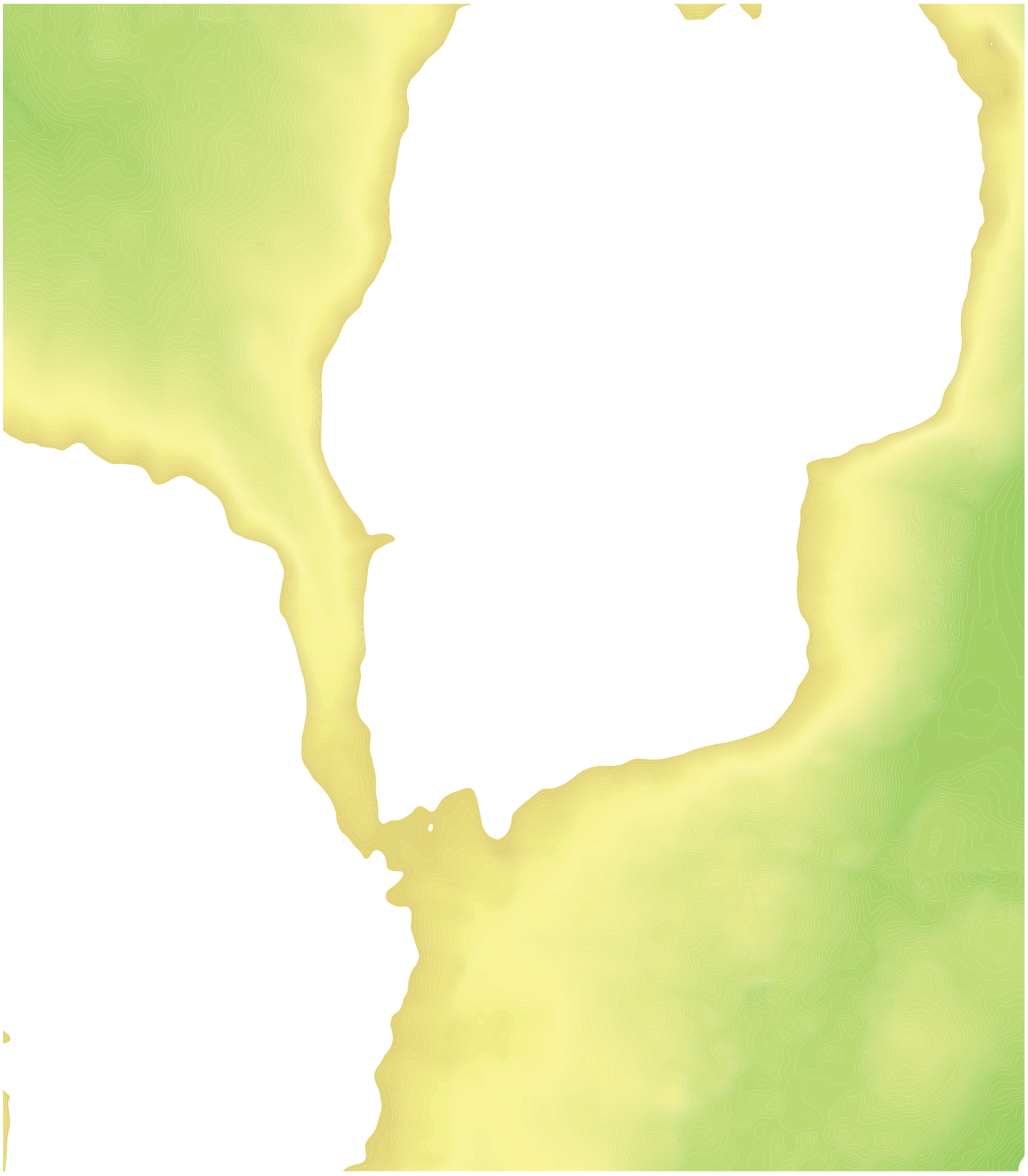
(10mx 10m data compiled using OSI DTM elevation data)

2165-22 Tirawley Wind Farm

Contoured Plot of Elevation - Preliminary Data

Site Layout Plan (6289-JOD-TWF-XX-DR-C-100 Rev01)

10th October 2022



Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 11/10/2022	2165-22 D3	11/10/2022	1 : 27,500

Whiteford Geoservices Ltd
Strald House, 2 Main Street
Strael, BALLYCLARE,
Co. Antrim, Northern Ireland
BT39 9NE
UNITED KINGDOM

Tirawley Wind Farm - Soils and Geology Assessment

Contoured Plot of Elevation | Edition 0 | Sheet A3

Appendix 4

Preliminary Plot of Ground Slopes

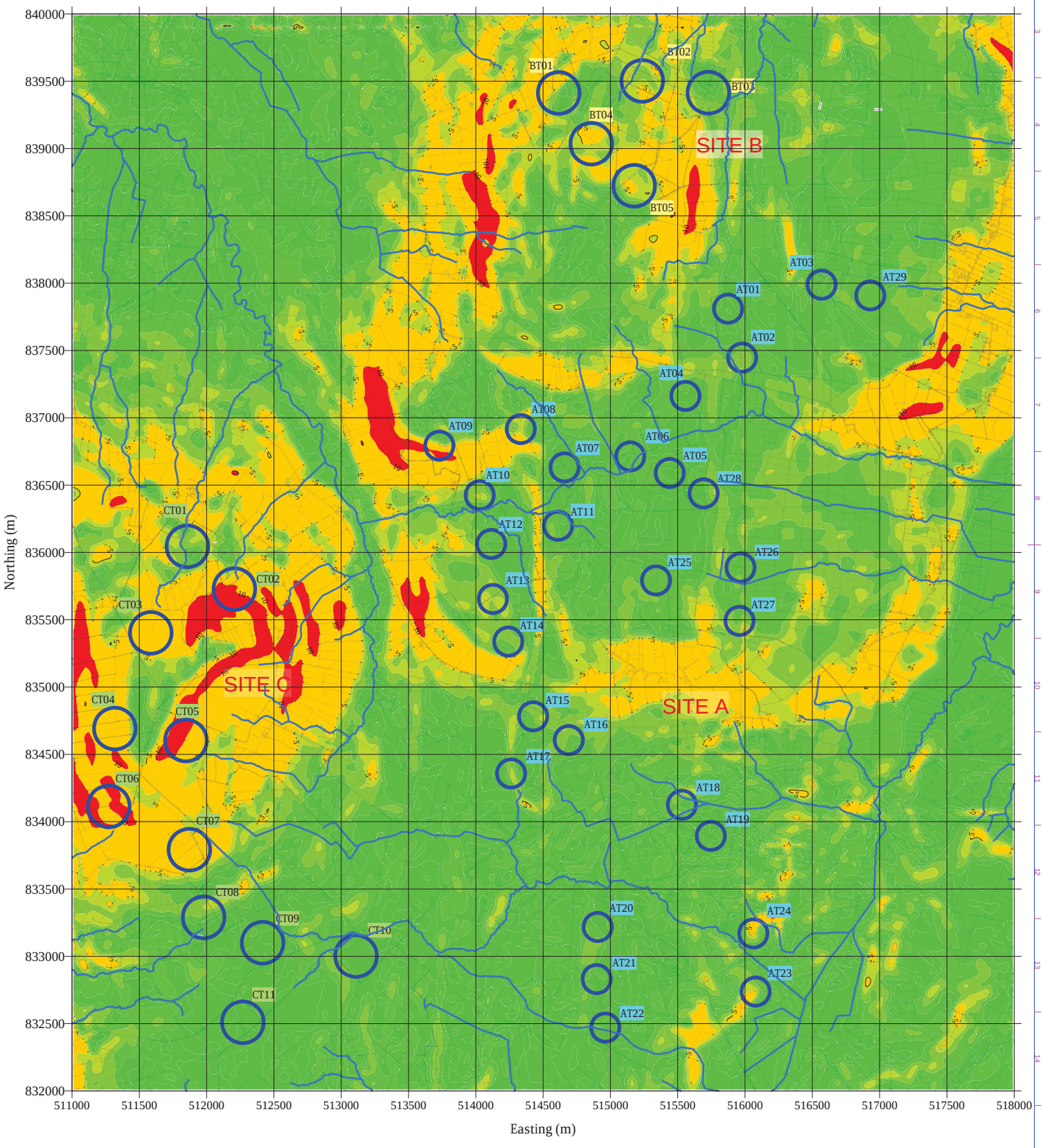
(Calculus applied to determine Gradient of 10m x 10m Data used to compile Ground Elevation Plot – Appendix 3

2165-22 Tirawley Wind Farm

Contoured Plot of Slope Angle - Preliminary Data

Site Layout Plan (6289-JOD-TWF-XX-DR-C-100 Rev01)

10th October 2022



Slope Angle (Degrees)

0 1 2 3 4 5 10 22.5

Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

DRAFT

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 11/10/2022	2165-22 D4	11/10/2022	1 : 27,500

Whiteford Geoservices Ltd

Tirawley Wind Farm - Soils and Geology Assessment

Contoured Plot of Slope Angle | Edition 0 | Sheet A3

Appendix 5

Preliminary Assessment of Peat Stability Hazard

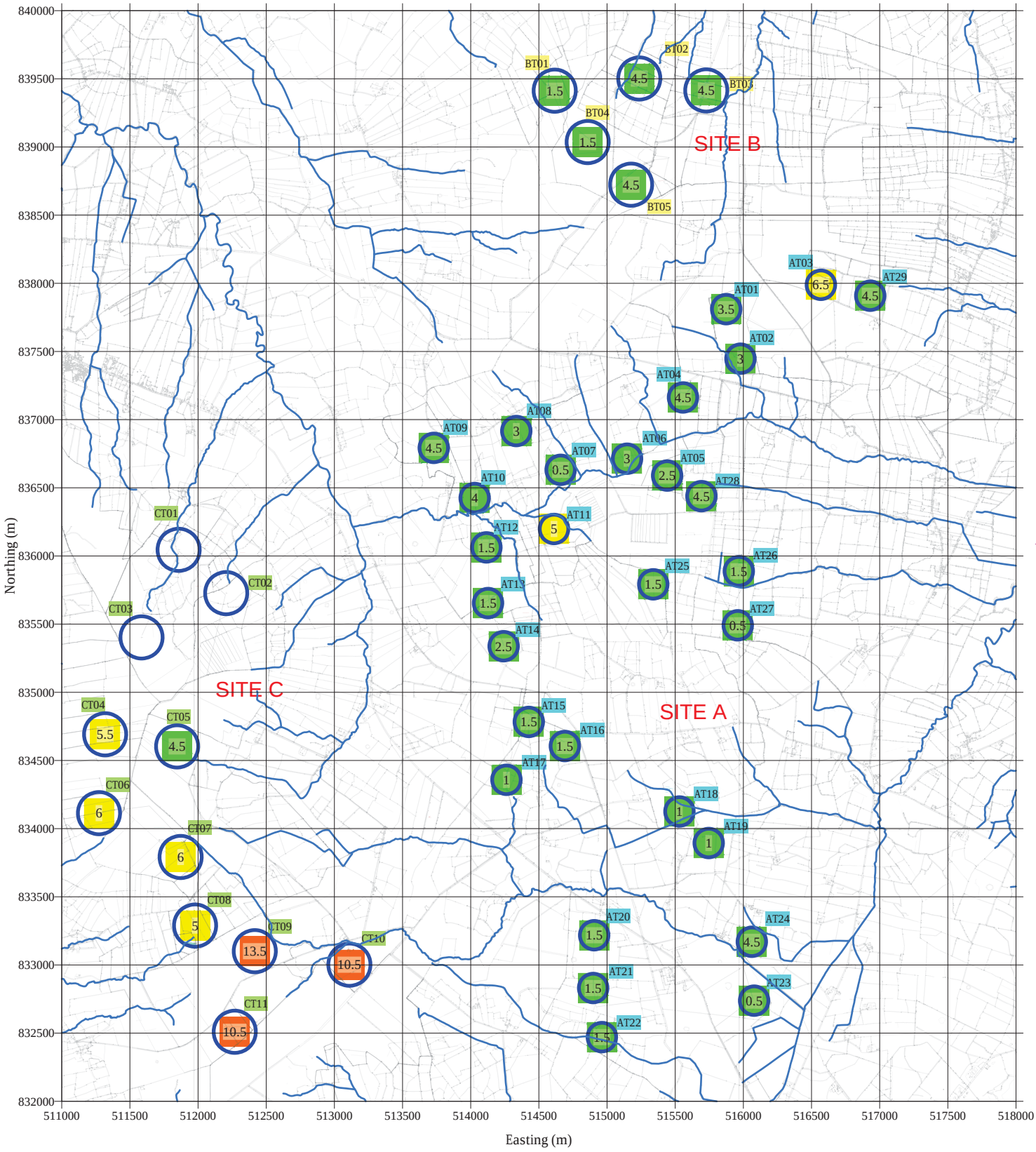
(Compiled following analysis of site conditions and potential receptors)

2165-22 Tirawley Wind Farm

Classed Plot of Hazard Ranking - Preliminary Data

Site Layout Plan (6289-JOD-TWF-XX-DR-C-100 Rev01)

10th October 2022



Hazard Ranking Level

- Negligible
- Low
- Medium
- High

DRAFT

Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 11/10/2022	2165-22 D1-P	11/10/2022	1 : 27,500

Whiteford Geoservices Ltd

Tirawley Wind Farm - Soils and Geology Assessment

Classed Plot of Hazard Ranking | Edition 0 | Sheet A3

Appendix 6

Walkover Survey Photographic Record



Plate 1—Typical conditions around AT-01



Plate 2—Typical conditions around AT-02



Plate 3—Typical conditions around AT-03



Plate 4—Typical conditions around AT-04



Plate 5—Typical conditions around AT-05



Plate 6—Typical conditions around AT-06



Plate 7—Typical conditions around AT-07



Plate 8—Typical conditions around AT-08



Plate 9—Typical conditions around AT-09



Plate 10—Typical conditions around AT-10



Plate 11—Typical conditions around AT-11



Plate 12—Typical conditions around AT-12



Plate 13—Typical conditions around AT-13



Plate 14—Typical conditions around AT-14



Plate 15—Typical conditions around AT-15



Plate 16—Typical conditions around AT-16



Plate 17—Typical conditions around AT-17



Plate 18—Typical conditions around AT-18



Plate 19—Typical conditions around AT-19



Plate 20—Typical conditions around AT-20



Plate 21—Typical conditions around AT-21



Plate 21—Typical conditions around AT-21



Plate 23—Typical conditions around AT-23



Plate 24—Typical conditions around AT-24



Plate 25—Typical conditions around AT-25



Plate 26—Typical conditions around AT-26



Plate 27—Typical conditions around AT-27



Plate 28—Typical conditions around AT-28



Plate 29—Typical conditions around AT-29



Plate 30—Typical conditions around BT-01



Plate 31—Typical conditions around BT-02



Plate 32—Typical conditions around BT-03



Plate 33—Typical conditions around BT-04



Plate 34—Typical conditions around BT-05



Plate 35—Typical conditions around CT-04



Plate 36—Typical conditions around CT-05



Plate 37—Typical conditions around CT-06



Plate 38—Typical conditions around CT-07



Plate 39—Typical conditions around CT-08



Plate 40—Typical conditions around CT-09



Plate 41—Typical conditions around CT-10



Plate 42—Typical conditions around CT-11

APPENDIX F

Report 2165-22B Site Investigation Works for Proposed Borrow Pit Site, Lacken Hill, 6km east of Ballycastle, 27th March 2023	43 x A4

Triawley Wind Farm, Ballycastle, Co. Mayo, Ireland

Site Investigation Works for Proposed Borrow Pit Site, Lacken Hill, 6km east of Ballycastle

Report No: 2184-22B

27st March 2026

This document has been prepared by Whiteford Geoservices Ltd on behalf of

Constant Energy Ltd

Whiteford Geoservices Ltd, 2 Main Street, Straid, Co. Antrim, BT39 9NE

Tel: 0044 (0) 28 93349351 Fax: 0044 (0) 28 93349352

www.whitefordgeoservices.com

CONTENTS

1 INTRODUCTION 1

2 SITE AND GEOLOGY 2
2.1 The Site
2.2 Published Geology

3 FIELDWORK 4
3.1 General
3.2 Exploratory Holes
3.3 Topographical Survey

4 LABORATORY TESTING 5
4.1 Geotechnical Testing

5 SUMMARY OF FINDINGS 6

6 REFERENCES

APPENDICES
A DRAWINGS
B EXPLORATORY TRIAL HOLE LOGS
C LABORATORY TESTING
D TRIAL HOLE PHOTGRAPHS

1 INTRODUCTION

This report should be read in conjunction with the Triawley Wind Farm - Desktop Study and Walkover Survey for Preliminary Determination of Ground Conditions Report 2165-22A.

In October 2022 Whiteford Geoservices Ltd was commissioned by Jennings O'Donovan Limited, on behalf of their Client Constant Energy Ltd, to undertake investigation works at the location of a proposed Borrow Pit for Triawley Wind Farm. The potential site was located within the Triawley Wind Farm red-line boundary, approximately 6km east of Ballycastle, County Mayo, Ireland.

The investigation was required to determine the quality of the rock resource present and its suitability for the production of aggregate for the proposed wind farm construction works.

The site investigation works undertaken during this fieldwork campaign consisted of the following elements; aimed at assessing the suitability of the aggregate available resource.

The scope of these works was as follows: -

Ref	SI Component	Remarks
A	Trial Holes undertaken at Turbines	A Komatsu PW118MR tracked excavator was employed to excavate inspection pits to a maximum depth of 4.5m or refusal on hard strata from which samples were recorded for laboratory testing. Each pit was logged to produce an engineering record.
B	Laboratory testing undertaken to determine rock properties	A suite of laboratory tested suitable for assessing rock competence and suitability for crushing to form aggregate.

The investigation was performed in accordance with the relevant standards (see References) and data presented within the relevant appendix to this report.

This report presents the factual records of the investigations undertaken.

2 SITE AND GEOLOGY

2.1 The Site

The Borrow Pit proposed for Triawley Wind Farm is located approximately 6km east of Ballycastle, County, Mayo and is situated on Wind Farm is situated approximately 3.5km south east of Ardara, Co. Donegal and is situated on gently sloping bog land, just north of Lacken Hill.

Together these lands slope generally to towards the south and south east. Ground elevations vary from 94m to 120m A.O.D.

Land usage is understood to be upland bog.

Within the proposed Borrow Pit site there is already distinct evidence of previous excavations to extract aggregate, although the history of usage is unclear.

The closest active quarrying operations to the site are at Mullafarry Quarry approximately 10km to the south east. However, there are also a number of historic workings close to the Proposed Development. These relate to historic Tufa workings 3.8km west of Turbine AT06, historic iron workings 1km south west of the Met Mast and flagstone workings 600m east of AT04. These working are understood to be no longer active.

Site code 000516 Lackan Saltmarsh and Kilcummin Head SAC is a Special Area of Conservation, approximately1km east of the proposed Borrow Pit. Refer to Appendix 1 for specific mapping detailing SAC locations.

2.2 Published Geology

A study was made of available geological information for the area of the proposed Borrow Pit (OSI Online Database). This study indicated that the following natural geology is present across the site:

- Peat (Blanket Bog)
- Boulder Clay (Glacial Till / Diamicton)
- Sandstone / Siltstone and Shale pertaining to Mullaghmore Formation in the north and Downpatrick Formation in the south.
- Intrusive Dolerite Dykes

2.2.1 Solid Geology

The majority of the proposed Borrow Pit site is within the Mullaghmore Formation, which forms the uppermost rock sequence. Underlying this rock formation, the Downpatrick formation is exposed in the south part of the site, where the Mullaghmore Formation is absent.

The Mullaghmore Formation is described as;

A series of cyclical units of siltstones and shales which coarsen upwards into medium to coarse grained sandstones.

The Downpatrick Formation is described as:

A sequence of interbedded sedimentary rock types comprising: near shore marine mudstones and siltstones; alluvial and deltaic sandstones and siltstones and fully marine bioclastic limestones interbedded with calcareous shales

2.2.2 Superficial Geology

Superficial soils present within the borrow pit boundary consist predominantly of blanket bog, probably overlying sands and gravels / boulder clay (Glacial Till derived from limestones).

To the east of the site tills derived from limestones and shales are also present.

For further information pertaining to site geology refer to the Desk Study and Walkover Survey Report (2165-22A).

3 FIELDWORK

3.1 General

The fieldwork was carried out in general accordance with BS 5930:2015+A1:2020 and other related standards.

Please refer to Appendix A for the location of all geotechnical investigations undertaken.

3.2 Exploratory Holes

The exploratory holes are detailed within the following table.

METHOD	QUANTITY	MAXIMUM DEPTH (m)	EQUIPMENT
Trial Holes	6 nr	3370	Trial holes were excavated using a Komatsu PW118MR tracked excavator.

3.3 Topographical Survey

The topographical survey was undertaken post-completion of all associated investigation works and is detailed in the table below.

EQUIPMENT	COORDINATE SYSTEM
Leica RTK / GNSS DGPS System	Irish Transverse Mercator (ITM) / Malin Head (Ordnance Datum)

4 LABORATORY TESTING

4.1 Geotechnical Testing

The geotechnical laboratory testing was scheduled by Whiteford Geoservices Ltd and carried out in accordance with BS 1377 Part1 (2016), Part2 (2022), Part3 (2018) and Parts 4 – 9 (1999).

All laboratory testing was undertaken by Whiteford Geoservices Ltd.

This testing is summarised in the table below and the results are presented within Appendix C.

TYPE	QUANTITY	STANDARD
Bulk Density	3	BS 1377- Part 2 (2022)
Moisture Content	3	BS 1377- Part 2 (2022)
Sulphate Content of Water Extract	1	BS 1377- Part 3 (2018)
Chloride Content of Water Extract	1	BS 1377- Part 3 (2018)
Sulphide Content of Water Extract	1	BS 1377- Part 3 (2018)
pH	1	BS 1377- Part 3 (2018)
Dry Density	3	BS 1377- Part 2 (2022)
Point Load	4	ASTM D5731-08

Table 4 Geotechnical Soils and Rock Testing

5 SUMMARY OF FINDINGS

The following table summarises the main findings of the Site Investigation campaign in respect to Borrow Pit potential.

REF.	ITEM	DETAIL
1	Rock Type	Carboniferous Shale and Sandstone pertaining to the Mullaghmore and Downpatrick Formations. Shale strata were observed to overlie the sandstone strata within the existing quarry in the northern part of the site. In the southern part of the site only sandstone strata were observed
2	Rock Competence	Marginally rippable sandstone where slightly weathered is generally WEAK (i.e. 5 to 12.5MPa) Non rippable sandstone, where un-weathered is generally MEDIUM STRONG (i.e. 25 - 50 MPa) Rippable shale is generally EXTREMELY WEAK (i.e. 0.6 – 1.0MPa or VERY WEAK (i.e. 1 to 5MPa)
3	GSI – Crushed Rock Aggregate Potential	According to Geological Survey Ireland, the Aggregate Potential for the Borrow Pit site can be summarised as follows: - High to Very High - Main Portion of existing Quarry; northern 2/3 of land holding Low – Southern 1/3 of the site.
4	Rock Strength of Coarse Irregular Rock Fragments Recovered from Trial Holes	VERY WEAK where slightly weathered and marginally rippable (1 to 4MPa) or shale. WEAK to MEDIUM STRONG, where unweathered and non-rippable. (>5MPa) sandstone
5	Typical Overburden	Peat Bog over Boulder Clay. Some areas of granular FII were indented at TP04 and TP05.
6	Typical Overburden Thickness (m)	0 to >3.00. Average = 1.87
7	Groundwater Regime	Weak flow at 2.3m (TP05 Seepage at 2.4m (TP04) Seepage at 1.2m (TP02) No groundwater encountered at TP01, TP03 and TP06
8	Predicted Performance as a construction fill material	**Suitable.** Sandstone (Mullaghmore Formation) is more suitable than the Shale. Shale (Downpatrick Formation) will degrade rapidly to fine material where left exposed to weather and traffic.
	Predicted Performance as a construction aggregate	**Only the Medium Strong Sandstone rock strata has potential,** which outcrops in the northern 2/3rds of the site is a viable construction aggregate. This contains significantly lower fine content than the shale strata that overlies the sandstone and visible within the northern workings.

Table 5 Summary of Findings

6 REFERENCES

Design Manual for Roads and Bridges ("DMRB") Volume 11, Section 3 (Environmental Assessment), Part 11: Geology and Soils

English Nature publication 'Geological conservation – a guide to good practice'

Ordnance Survey Ireland www.osi.ie

Geological Map of Ireland, 1:750,000, 3rd Edition 1962, Ordnance Survey Ireland

Geological Survey of Ireland Spatial Resources Viewer www.gsi.ie

Ordnance Survey of Ireland. www.osi.ie

Craig, R F. 1997. Soil Mechanics. Sixth Edition. E & FN Spon, London

Daly, D, And Warren, W. 1994. Mapping of Groundwater Vulnerability to Pollution. Geological Survey of Ireland (Dublin) Guidelines.

Site Investigation Steering Group. 1993. Site Investigation in Construction – Without Site Investigation Ground Is A Hazard, Thomas Telford, London

Skinner, B J, And Porter S C. 1987. Physical Geology, John Wiley & Sons, Inc.

BS 1377: Part 1 (2016): Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 1377: Part 2 (2022): Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 1377: Part 3 (2018): Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 1377: Parts 4 - 9 (1999): Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930:2015 + A1:2020 Code of practice for ground investigations. British Standards Institution.

BS EN 1997-2: 2007 : Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

BS EN ISO 14688-1: 2002 : Geotechnical investigation and testing - Identification and classification of soil - Part 1 Identification and description. British Standards Institution.

BS EN ISO 14689-1: 2003 : Geotechnical investigation and testing - Identification and classification of rock - Part 1 Identification and description. British Standards Institution.

BS EN ISO 22475-1: 2006 : Geotechnical investigation and testing – Sampling methods and groundwater measurements - Part 1 Technical principles for execution. British Standards Institution.

BS EN ISO 22476-2: 2005 : Geotechnical investigation and testing - Field testing - Part 2 Dynamic probing. British Standards Institution.

BS EN ISO 22476-3: 2005 : Geotechnical investigation and testing - Field testing - Part 3 Standard penetration test. British Standards Institution.

ISRM: 2007: The Complete ISRM Suggested Methods for Rock Characterisation, Testing and Monitoring (1974-2006). Commission on Testing Methods, International Society for Rock Mechanics (Editors Ulusay R & Hudson JA).

ASTM D5731-08: Standard test method for determination of the point load strength index of rock and application to rock strength

APPENDICES

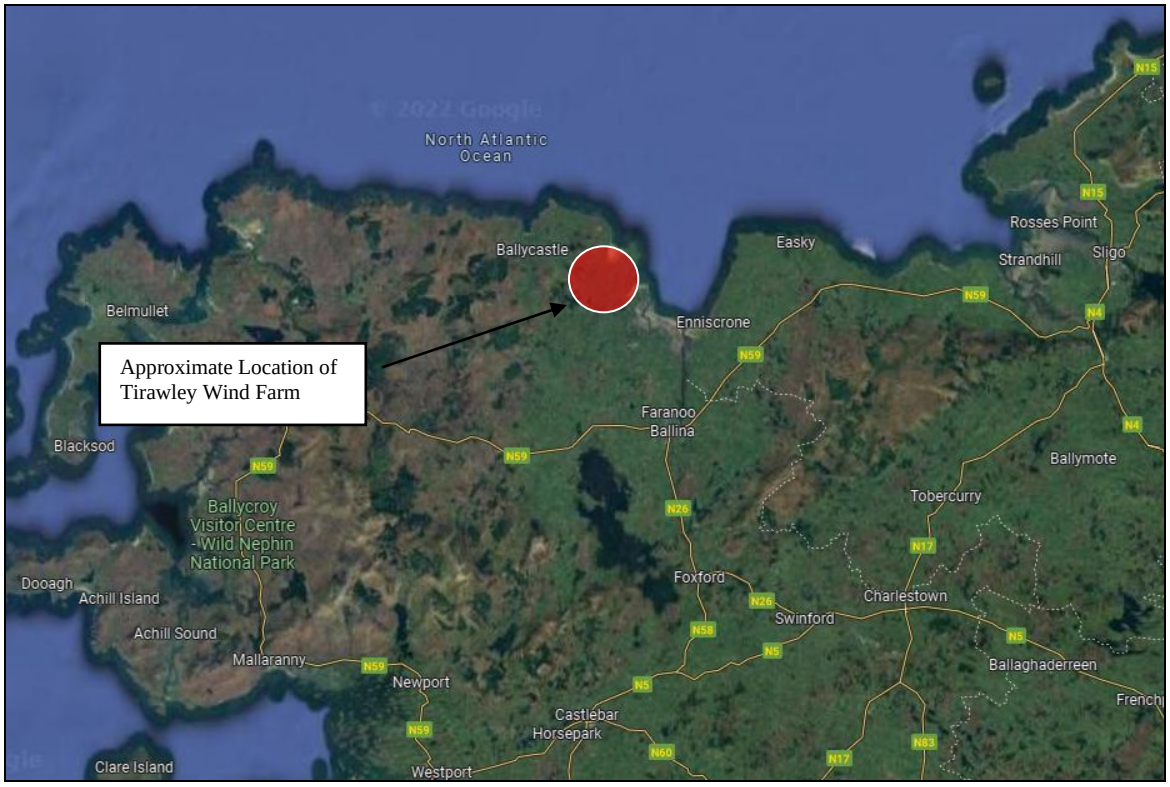
Appendix A	Drawings:- *Site Location Plans* *As-Built Location of Exploratory Holes and In-situ Tests*
Appendix B	Exploratory Trial Hole Logs
Appendix C	In-situ Test Results:- *Probed Peat Thickness Data* *Classed Plot of Peat Thickness*
Appendix D	Laboratory Testing Results Employed for Analysis Purposes
Appendix E	Trial Hole Photographs

Appendix A - Drawings

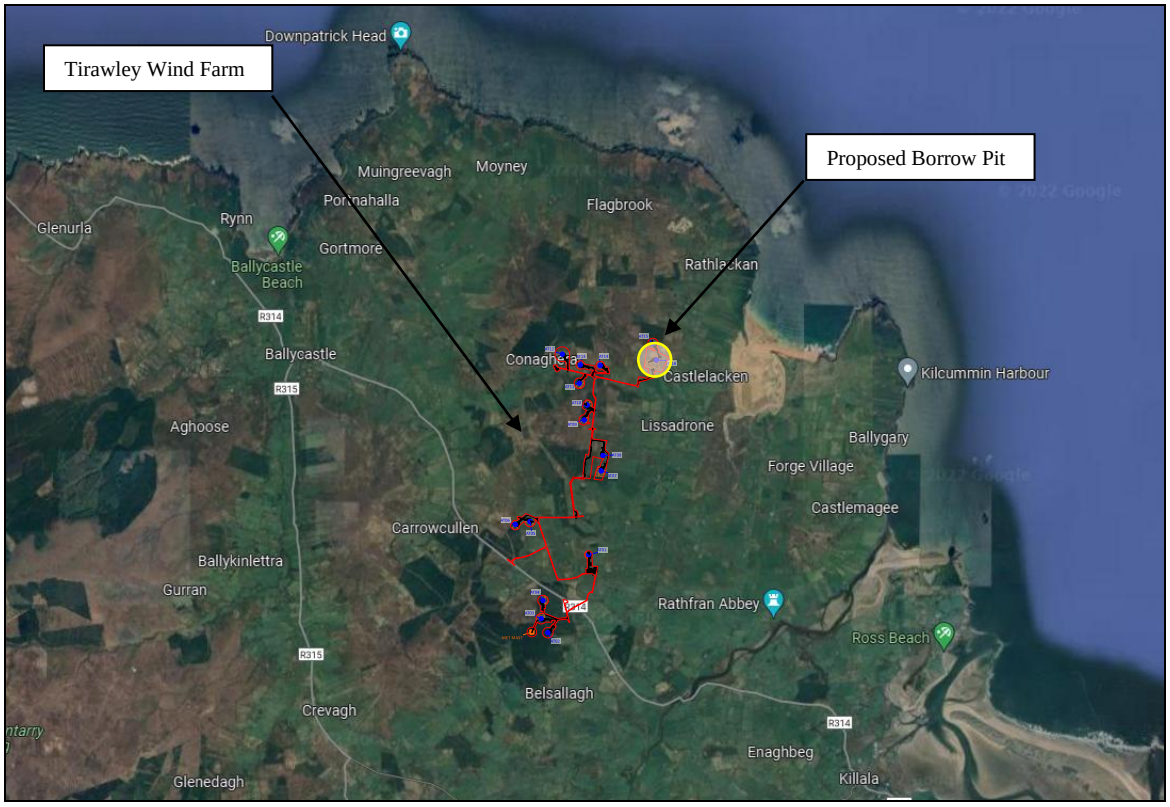
General Site Location Plan – P1 / P2
Site Investigation Layout Plan - P3

EPA Online Environment Viewer – SAC and Natural Heritage Mapping

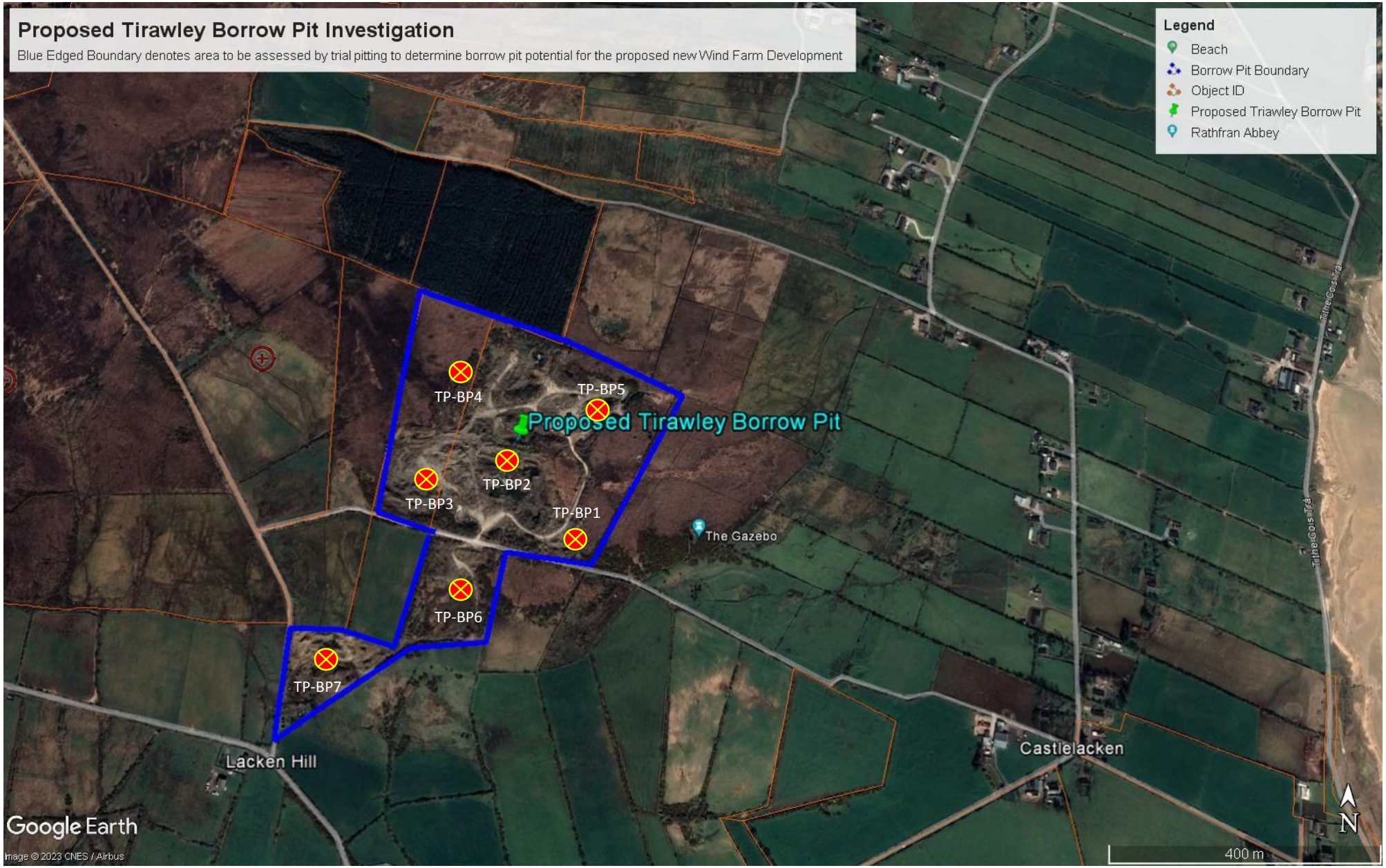
Geological Survey of Ireland Public Viewer Data – Solid and Structural Geology
Geological Survey of Ireland Public Viewer Data – Aggregate Potential
Geological Survey of Ireland Public Viewer Data – Superficial Soils and Landforms
Geological Survey of Ireland Public Viewer Data – Subsoil Permeability
Geological Survey of Ireland Public Viewer Data –Groundwater Aquifer Potential
Geological Survey of Ireland Public Viewer Data – Groundwater Vulnerability
Geological Survey of Ireland Public Viewer Data – Landslide Susceptibility

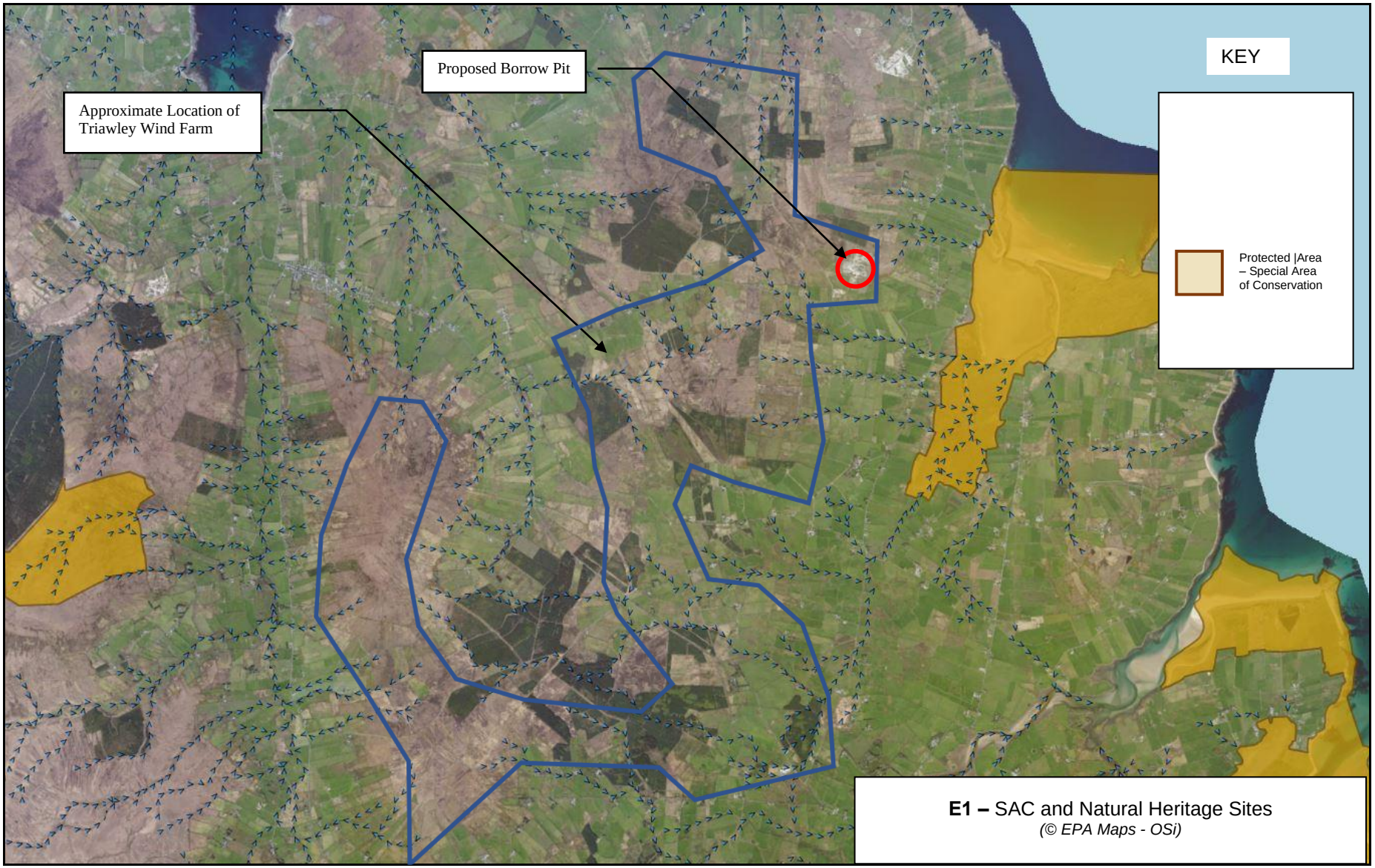


P1 - General Location Plan (Aerial view)
(© google maps 2026)



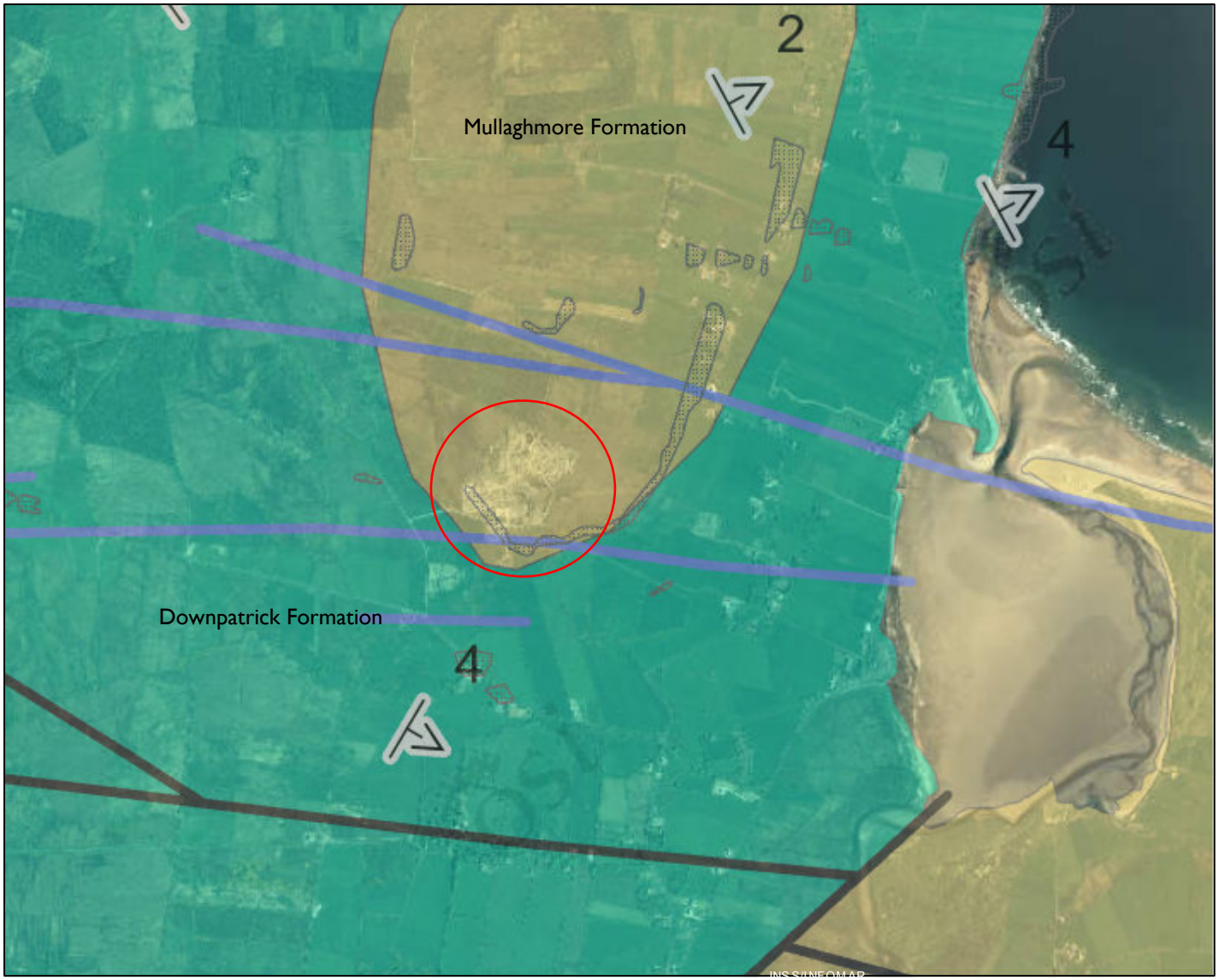
P2 - Local Location Plan (Aerial view)
(© google maps 2026)


Proposed Tirawley Borrow Pit Investigation
Blue Edged Boundary denotes area to be assessed by trial pitting to determine borrow pit potential for the proposed new Wind Farm Development
Legend
Beach
Borrow Pit Boundary
Object ID
Proposed Triawley Borrow Pit
Rathfran Abbey
TP-BP4
TP-BP5
Proposed Tirawley Borrow Pit
TP-BP2
TP-BP3
TP-BP1
The Gazebo
TP-BP6
TP-BP7
Lacken Hill
Castlelacken
Google Earth
Image © 2023 CNES / Airbus
400 m
N



E1 – SAC and Natural Heritage Sites
(© EPA Maps - OSi)

GSI - Solid Geology



Legend

Structural Symbols 100K ITM 2018

- Dip of bedding or main foliation, old GSI data
- First foliation parallel to bedding
- Foliation trend, Thorr and Rosses Granites
- Horizontal Bedding
- Strike and dip of bedding, right way up
- Strike and dip of bedding, way up unknown
- Strike and dip of first foliation
- Strike and dip of overturned bedding
- Strike and dip of second foliation
- Strike and dip of third foliation
- Strike and plunge of first generation fold axis
- Strike and plunge of second generation fold axis
- Strike and plunge of third generation fold axis
- Strike of vertical bedding/foliation
- Strike of vertical first foliation
- <all other values>

- Bedrock Outcrops 100 ITM 2018

Bedrock Linework 100k ITM 2018

- Anticlinal Axis
- Antiformal axis
- Aquifer Boundary
- Area
- Coal seam
- Dyke
- Fault
- Ghost Line
- Goniatite marine band (R1-R4)
- Lithological boundary offshore
- Metadolerite sheet, mainly sills
- Paleogene/ Tertiary Dyke
- Synclinal Axis
- Synformal axis
- Tectonic Slide, barbs on hanging-wall
- Thin stratigraphical unit, diagrammatic
- Thrust, barbs on hanging-wall side
- Tuff band
- Unconformity, dots on younger side
- X-Section

Scale: 1:21,723

Geological Survey Ireland

Creative Commons Attribution 4.0 International license

N W E S

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Map Centre Coordinates (ITM) 517,251 837,518

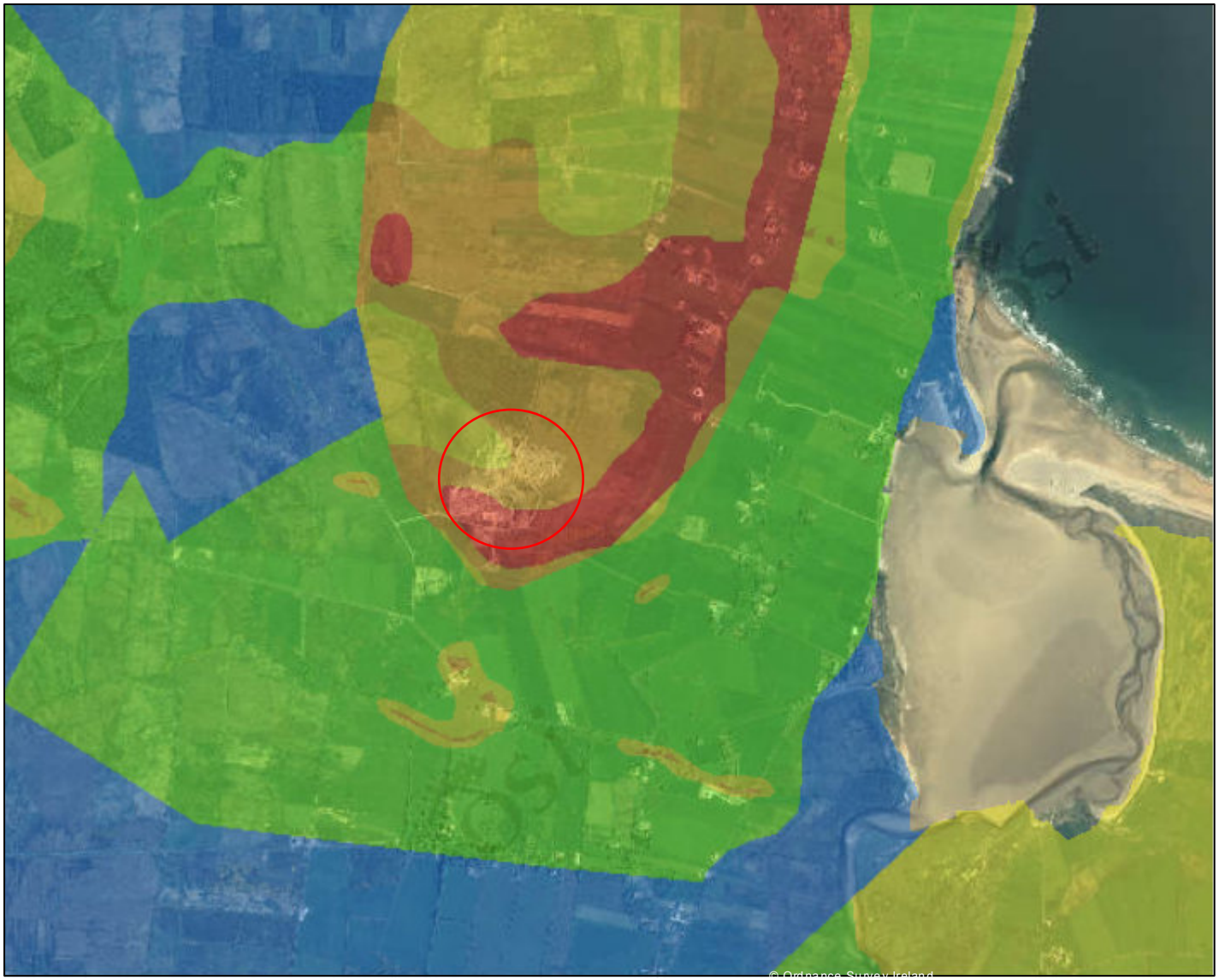
3/27/2023, 4:58:27 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

GSI - Aggregate Potential



Legend

Historic Pits and Quarry Locations

- Pit
- Quarry
- Brickfields
- No Info

Crushed Rock Aggregate Potential

- Very High potential
- High potential
- Moderate potential
- Low potential
- Very Low potential

Scale: 1:21,723

Geological Survey Ireland

PSI Licence

N W E S

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km



Map Centre Coordinates (ITM) 517,296 837,530

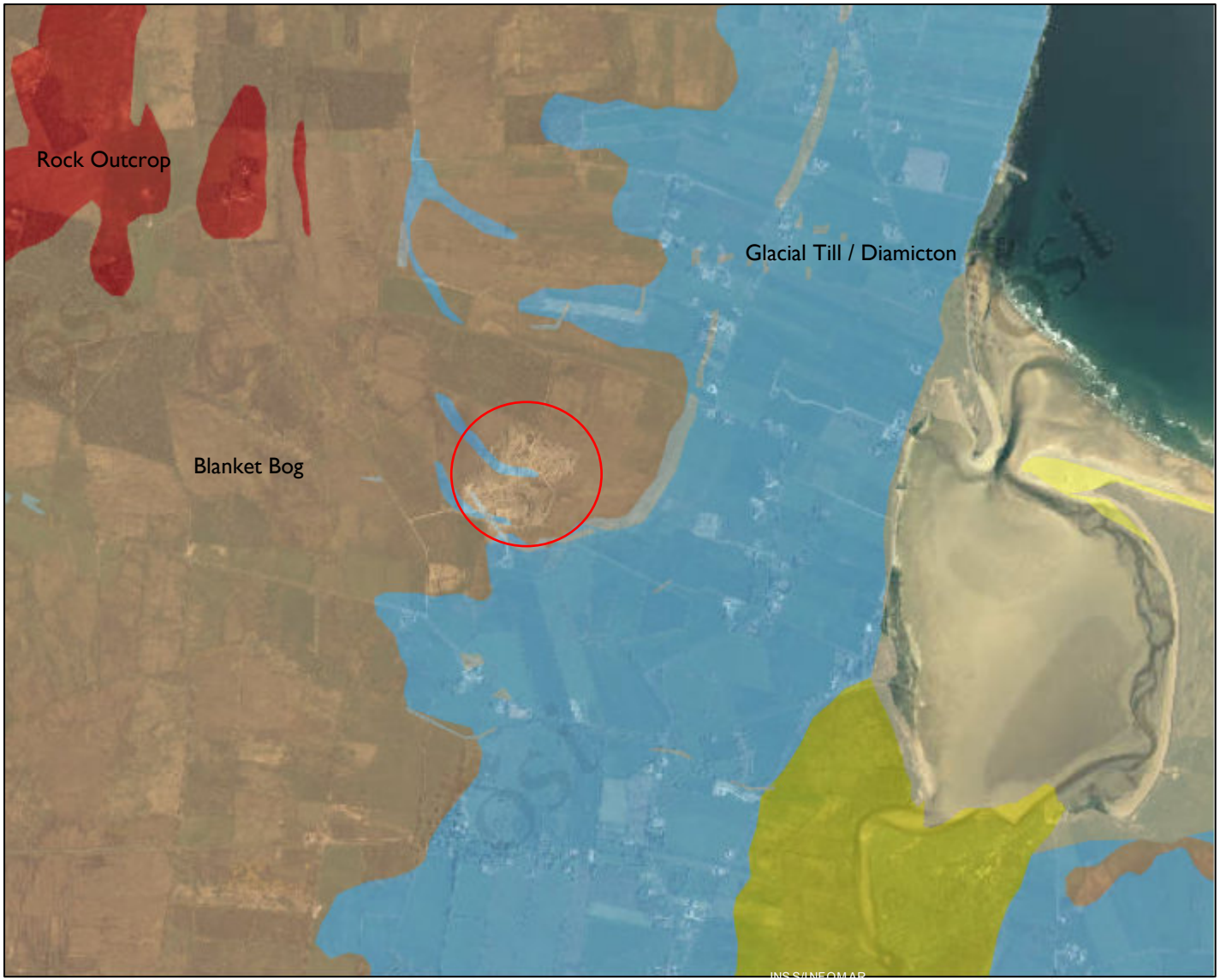
3/27/2023, 5:09:34 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

GSI - Superficial Soils Geology



Scale: 1:21,723

Geological Survey Ireland

Creative Commons Attribution 4.0 International license

N W E S

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Map Centre Coordinates (ITM) 517,251 837,518

3/27/2023, 5:00:19 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Legend

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

GSI - Subsoil Permeability



Legend

IE GSI Subsoil Permeability 40k Ireland (ROI) ITM

- High
- Moderate
- Low
- Water
- Not mapped

Scale: 1:21,723

Geological Survey Ireland

Creative Commons Attribution 4.0 International license

N W E S

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km



Map Centre Coordinates (ITM) 517,251 837,518

3/27/2023, 5:02:05 PM

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

GSI - Groundwater Resources



Legend

IE GSI Bedrock Aquifers 100k Ireland (ROI) ITM

- Rkc - Regionally Important Aquifer - Karstified (conduit)
- Rkd - Regionally Important Aquifer - Karstified (diffuse)
- Rk - Regionally Important Aquifer - Karstified
- Rf - Regionally Important Aquifer - Fissured bedrock
- Rf/Rk - Regionally Important Aquifer - Fissured bedrock/Regionally Important Aquifer - Karstified
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Lk - Locally Important Aquifer - Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- Lake
- Unclassified

Scale: 1:21,723

Geological Survey Ireland

Creative Commons Attribution 4.0 International license

N W E S

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Map Centre Coordinates (ITM) 517,251 837,518

3/27/2023, 5:03:35 PM

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

GSI - Groundwater Vulnerability



Legend

Groundwater Vulnerability

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low
- Water

Scale: 1:21,723

Geological Survey Ireland

Creative Commons Attribution 4.0 International license

N W E S

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km



Map Centre Coordinates (ITM) 517,251 837,518

3/27/2023, 5:05:05 PM

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

GSI - Landslide Susceptibility Map



Legend

- Landslide Locations Ireland ITM
- Landslide Extents Ireland ITM

Landslides Susceptibility Classification

- Unclassified
- Low
- Low (inferred)
- Moderately Low
- Moderately Low (inferred)
- Moderately High
- Moderately High (inferred)
- High
- High (inferred)
- Made
- Water

Scale: 1:21,723

Geological Survey Ireland

CC-BY 4.0

N W E S

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Map Centre Coordinates (ITM) 517,261 837,545

3/27/2023, 5:12:04 PM

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Copyright holders.
This map is a user generated static output from an Internet mapping site and is for general reference only.
Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Ordnance Survey Ireland Licence No. EN 0047216
© Ordnance Survey Ireland/Government of Ireland
© Geological Survey Ireland/Government of Ireland

Appendix B – Exploratory Trial Hole Logs

Engineering Trial Pit Logs (6nr)

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E116913.66 N337309.43
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-06	TP	108.95m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30	108.65		Soft, brown, sandy TOPSOIL
					1.20	107.75		Firm, slightly gravelly, very sandy SILT/CLAY
		1.50			1.90	107.05		Extremely weak to very weak, dark grey, distinctly weathered SANDSTONE
					2.00	106.95		Medium strong, grey, partially weathered SANDSTONE
								End of Pit at 2.000m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	2.00	Arisings

Remarks

No groundwater encountered.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E117111.28 N337632.29
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-05	TP	112.17m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
	▼	2.50			2.50	109.67		Probable MADE GROUND; Dense, grey, clayey SAND and GRAVEL with a high cobble and boulder content [QUARRY FILL]
					3.00	109.17		Probable MADE GROUND; Dense, COBBLES and BOULDERS [QUARRY FILL]
								End of Pit at 3.000m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides unstable upon completion	None		0.00	3.00	Arisings

Remarks

Groundwater encountered 2.3m b.g.l (Weak flow).

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E116956.11 N337653.82
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-04	TP	118.89m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Probable MADE GROUND; Dense, grey, clayey SAND and GRAVEL with a high boulder and cobble content [QUARRY FILL]
		2.00						
	▼				2.30	116.59		Medium strong, grey, partially weathered SANDSTONE
					2.40	116.49		End of Pit at 2.400m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides unstable upon completion	None		0.00	2.40	Arisings

Remarks

Groundwater encountered 2.4m b.g.l (Seepage).

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E116847.08 N337492.86
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-03	TP	114.72m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	114.52		Medium strong to strong, light grey, partially weathered SANDSTONE
								End of Pit at 0.200m

1
2
3
4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	0.20	Arisings

Remarks

No groundwater encountered.

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E117039.63 N337538.80
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-02	TP	115.74m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.60	115.14		Soft, dark brown PEAT
					1.20	114.54		Firm, grey, sandy SILT
		1.50			2.80	112.94		Extremely weak to very weak, dark grey, destructured SHALE
		3.00			3.20	112.54		Weak, dark grey, partially weathered SANDSTONE
					3.30	112.44		Moderately weak, dark grey, partially weathered SANDSTONE
								End of Pit at 3.300m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	3.20	Arisings

Remarks

Groundwater encountered 1.2m b.g.l (Seepage).

AGS

whiteford
explore the possibilities

Address: 2 Main Street, Straid, Ballyclare
BT39 9NE, UK
Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Tirawley WF - Proposed Borrow Pit Site	Project No: 2165-22	Client: Constant Energy Ltd	Date: 23/02/2022
		Contractor: Whiteford Geoservices Ltd	Co-ords: E117098.57 N337458.40
Location: Carrowmore Lacken, Co. Mayo, Ireland		Sub Contractor: Carty Plant Hire	Equipment: Komatsu PW118MR

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-01	TP	114.14m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30	113.84		Soft, dark brown PEAT
					0.70	113.44		Firm, grey, sandy SILT
		0.80			0.80	113.34		Very weak to weak, dark grey, partially weathered SHALE
					0.90	113.24		Medium strong, grey, unweathered SANDSTONE
								End of Pit at 0.900m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	1.50	Sides stable upon completion	None		0.00	0.80	Arisings

Remarks

No groundwater encountered.

AGS

Appendix C – Laboratory Testing

Moisture Content Tests (3nr)

Bulk Density (3nr)

Dry Density (3nr)

Chemical Aggressiveness to Concrete (1nr)

Point Load Tests (4nr)

Laboratory Results

Location: Tirawley Wind Farm Proposed Borrow Pit

Job No: 2165-22B

Client: Constant Energy Ltd

Sample no:	Depth (m)	Bulk Density kg/m3	Dry Density kg/m3
TP-02	1.50	2173	1669
TP-04	2.00	2322	1856
TP-05	2.50	2357	1526

Operator	Checked	Approved
LJ	JMCN	JW

BS1377-Part2 (1990) Section 2

Chemical Content Results

Location: Tirawley Wind Farm Proposed Borrow Pit

Job No: 2165-22B
Client: Constant Energy Ltd

Sample ID:	Depth (m)	Sulphate (mg/l)	Chloride (mg/l)	Sulphide (mg/l)	pH
TP01	3.00	128	180	0.26	6.35

Operator	Checked	Approved
LJ	JWJM	WGS

BS1377-Part2 (1990) Section 2

Point Load Testing

Location: Tirawley Wind Farm Proposed Borrow Pit

Project No: 2165-22

Sample no:	*Postion*	*Sample Depth (m)*	*Diameter (mm) "D"*	*Max Load (kN) "P"*	*Point Load Strength (Mpa) "I_s"*	*Size Correction Factor (F)*	*Corrected Point Load Strength (MPa) "$I_{s(50)}$"*
TP01	IL	0.03	0	3.407	0.86	1.00	0.86
TP03	IL	0.03	0	19.11	4.81	1.00	4.81
TP05	IL	0.04	0	15.88	4.00	1.00	4.00
TP06	IL	0.02	0	14.68	3.70	1.00	3.70

Operator	Checked	Approved
LJ	JMCN	JW

ASTM D5731-08

Appendix D – Trial Hole Photography

Trail Hole Photographs (20nr)



TP 01



TP 01



TP 02



TP 02



TP 02



TP 02



TP 03



TP 04



TP 04



TP 04



TP 04



TP 05



TP 05



TP 05



TP 05



TP 05



TP 06



TP 06



TP 06



TP 06

APPENDIX G

Peat Slide Risk Assessment –	46 x A4
"Preventative Action: A Guide for Workers"	







Peat Slide Risk

Preventative Action

A Guide For Workers

WHITEFORD
GEOSERVICES

22nd September 2009

John Whiteford

Whiteford Geoservices Ltd

Straid House, 2 Main Street,

Straid, BALLLYCLARE BT39 9NE

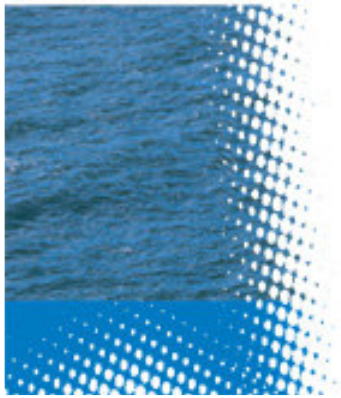
Tel: 0044 (0)28 9334 9351
Fax: 0044 (0)28 9334 9352

Email: john@whitefordgeoservices.com

WHITEFORD
GEOSERVICES







[A] Introduction - What Is Peat?

[B] Why Is Peat So Unstable?

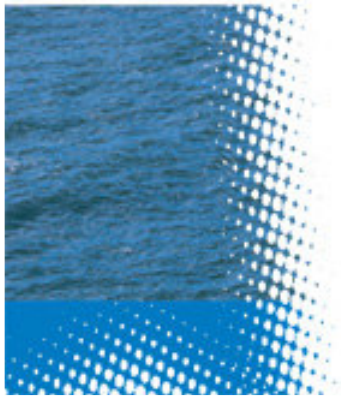
[C] Whiteford *Geoservices*

How Can We Help?

WHITEFORD
GEOSERVICES







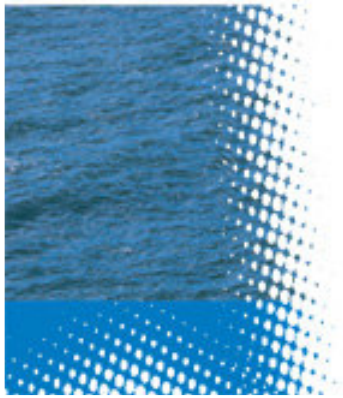
[A] Introduction - What Is Peat?

1. Where Does Peat Come From?
2. What Is Peat Composed Of?
3. Is There A High Potential For Instability In Peat?
4. Do I Have A Baseline Peat Site? – Should I Be Worried?

WHITEFORD
GEOSERVICES







A1 Where Does Peat Come From?

- Organic soil derived from plant remains; shrubs, herbaceous vegetation and degradable parts of trees
- Deposited over extended period of time in temperate latitudes
- Prevalent only in regions of high rainfall





A1 Where Does Peat Come From?

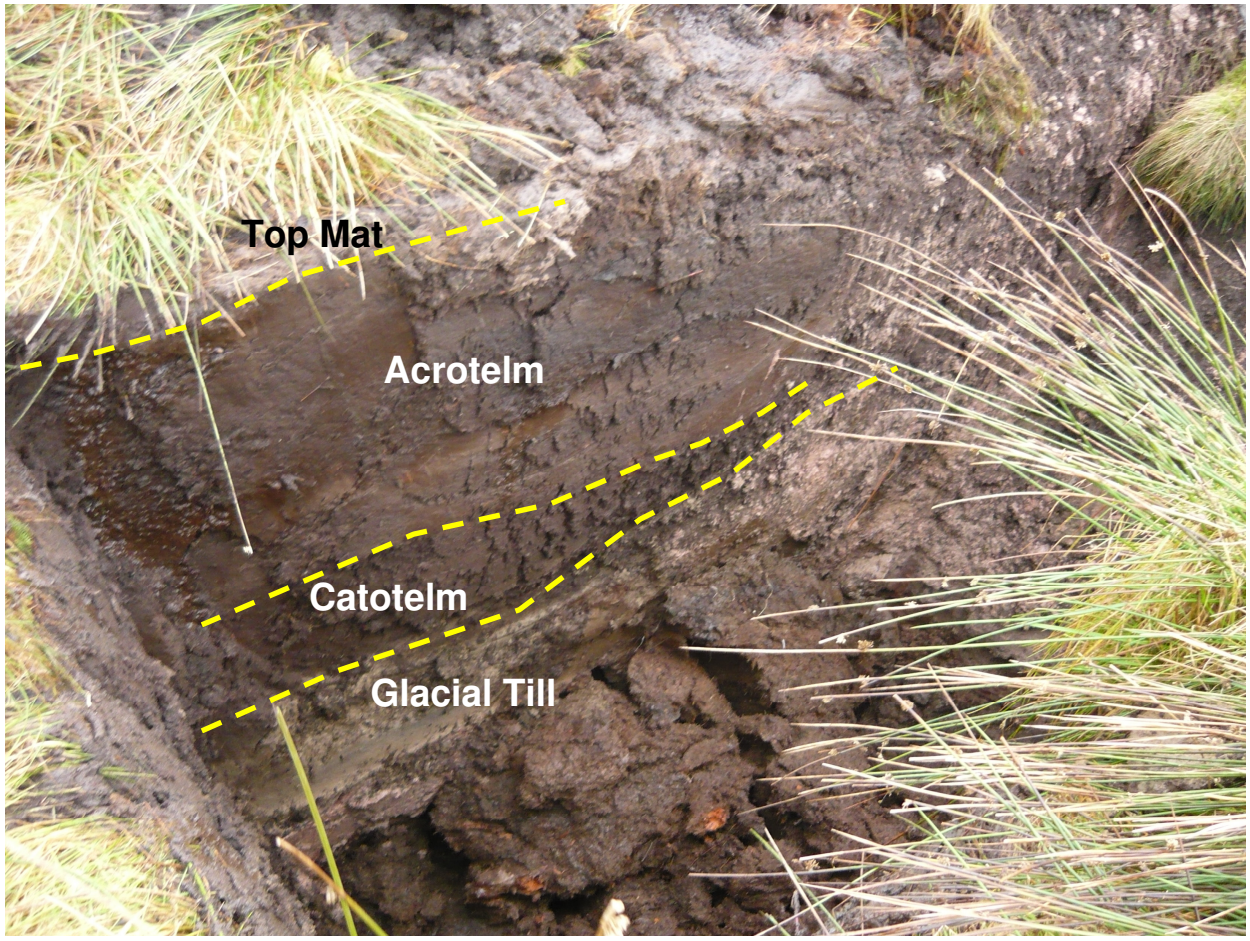
- Often moves as a mass to cover large tracts of uplands areas
- Can form naturally up to 4m in thickness, but can migrate / flow to thicknesses well in excess of this figure.
- Extensively mined / extracted for use as fuel source, particularly in the nineteenth and early part of the twentieth centuries



WHITEFORD
GEOSERVICES



A2 What Is Peat Composed Of?





A2 What Is Peat Composed Of?

Contains generally three distinct parts

TOP MAT

- Living vegetation
- Herbaceous Plants, grasses, moss and lichens
- Moderate shear strength

ACROTELM

- Decomposing peat; highly fibrous
- Periodically saturated; high permeability
- Moderately to low shear strength, 0.2 – 1.3m thick

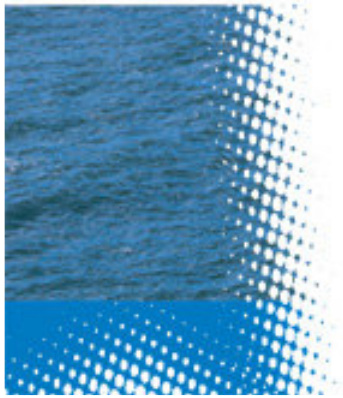
CATOTELM

- Completely decomposed peat; pseudo-amorphous to amorphous
- Permanently saturated; low permeability
- Very low shear strength; occurs below 1.3m depth

WHITEFORD
GEOSERVICES







A3 Is There A High Potential For Instability In Peat?

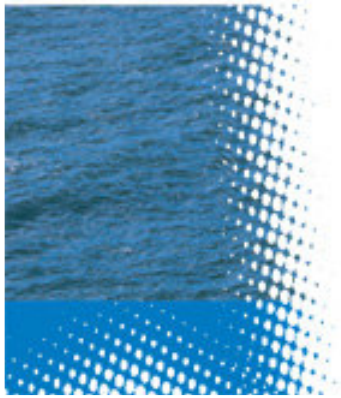
- **YES**
- ***WHY?***
- **PEAT IS HIGHLY SENSITIVE TO A HOST OF FACTORS:-**

1. *Changes in slope*
2. *Changes in drainage patterns*
3. *Dewatering / desiccation*
4. *Loading*
5. *Cutting*
6. *Variations in rainfall*
7. *Vibration / Seismic / Sonic Activity*
8. *Propagation of local impacts*

WHITEFORD
GEOSERVICES







A4 Do I Have A "Baseline Peat" Site?

What is a "Baseline Peat" site?

- One where peat is present to such a level that it represents a peatland habitat and as such is highly sensitive to environmental change.

Simple Test

- A site should be designated "Baseline Peat" if the average peat thickness is 0.5m or more.

Should I Be Worried?

- ***No***

Concerned?

- ***Probably***

Informed?

- ***MOST DEFINITELY!***

WHITEFORD
GEOSERVICES



A4 To Be Informed Is To Be Prepared

Main Issues With Peat Sites

- Slope Failure; Peat Slide or Bog Burst
- Sensitive Hydrology
- Flora and Fauna
- Contamination Of Water Courses



Information You Should Have

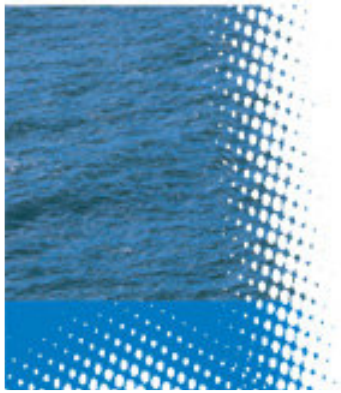
- Desk Study
- Walk Over Assessments
- Peat Probings / Gouge Sampling / Vane Testing



WHITEFORD
GEOSERVICES







[B] You Should Always Ask The Following Questions About Your Construction Site?

1. Can The Risk Of Peat Slide / Bog Burst Be Averted On My Site During Construction?
2. Why Is Peat So Unstable?
3. What Triggers a Peat Slide / Bog Burst?
4. How Can I Measure Risk At My Site?
5. **What Can I Do To Prevent Peat Slide / Bog Burst?**

B1 Can Bog Burst / Peat Slide Be Averted?

- YES (Potentially, although some sites are unsuitable)
- Mitigation can always be applied to reduce the risk of slope failure from occurring
- However – it can ***never*** be completely ruled out



Bog Burst – Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

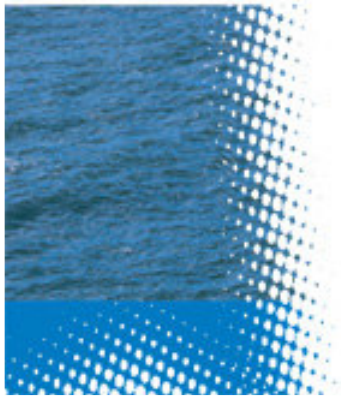


Peat Slide – Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES







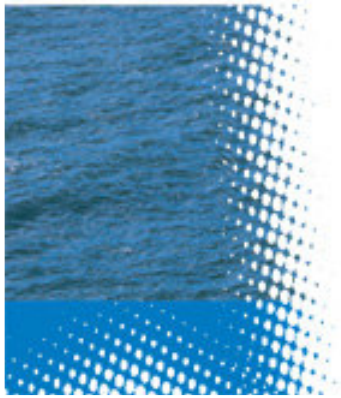
B2 Why Is Peat So Unstable?

- Exists in **Equilibrium of tension and compression** in the Top Mat and Acrotelm
- Any tear / cutting within the surface Mat / Shallow Acrotelm **compromises this shear strength**
- **Catotelm** is highly unstable and only **weakly permeable**
- Water flowing into the acrotelm from above can only flow into the catotelm, but not through it.
- Pore water pressure builds up steadily within the catotelm – water cannot escape – **high hydrostatic pressure**
- Incisions / Cuts into the base of the peat (catotelm layer) can cause a **rapid dewatering** of peat – BOG BURST
- In shallower peat – mechanism is PEAT SLIDE

WHITEFORD
GEOSERVICES







B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Steep Slopes



WHITEFORD
GEOSERVICES



B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

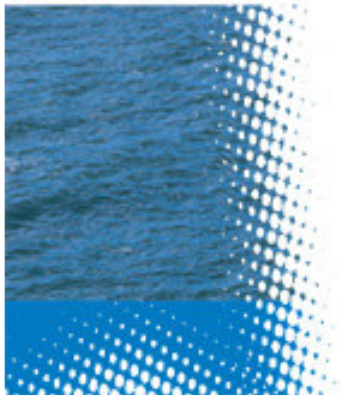
Deep Peat



WHITEFORD
GEOSERVICES







B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

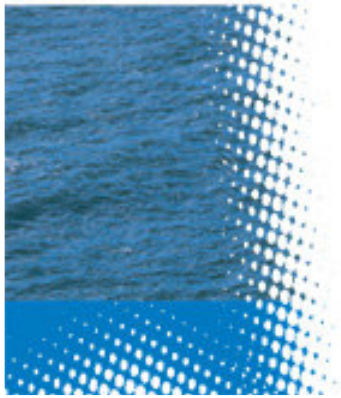
Active Peat Instability



WHITEFORD
GEOSERVICES







B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

- Incipient Peat Instability
- *Tension Cracks*
- *Peat Creep / Diamond Tears*
- *Peat Pipes*



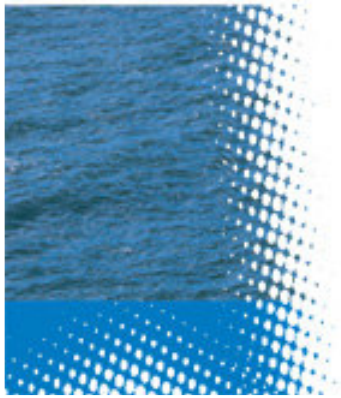
Tension Cracks – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES







B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Incipient Peat Instability

- *Peat Creep / Diamond Tears*



Diamond Tears – Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES

B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Incipient Peat Instability

- *Peat Pipes*

Peat Pipes – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006

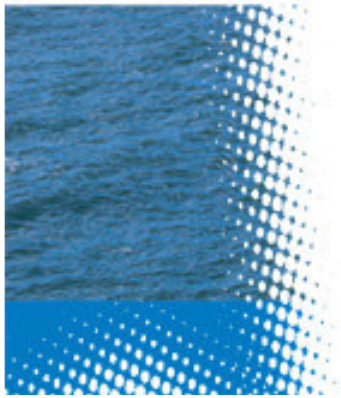




WHITEFORD
GEOSERVICES







B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Relic Peat Instability

- *Landforms*

Peat Thrusts – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006





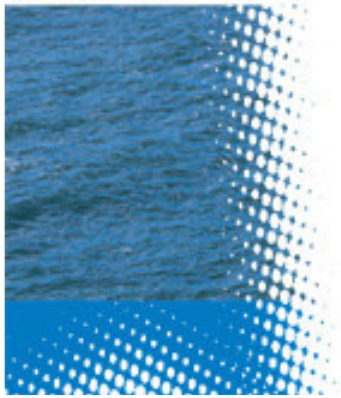
Peat Ridges – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES







B3 What Triggers A Peat Slide / Bog Burst?

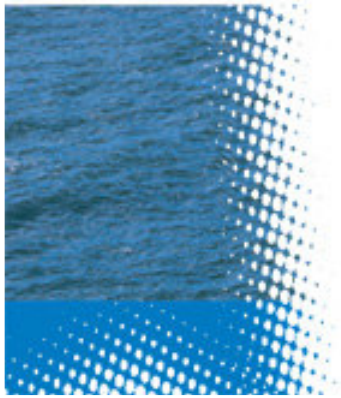
Triggering Incidents

- *Periods Of Rapid / Excessive Rainfall*
- *Changes In Hydrology (e.g. blocking drains etc.)*
- *Excessive Dewatering Of Peat (e.g. highly positive drainage)*
- *Loading Of Peat (e.g. disposal of more than 0.5m of spoil on peat >1.5m thick)*
- *Unloading Of Peat (e.g. cuttings in excess of 1.5m deep)*
- *Excessive Vibrations / Seismic / Sonic Activity (e.g. blasting, rock breaking)*

WHITEFORD
GEOSERVICES







B4 Typical Data That Will Be Available For Your Construction Site?

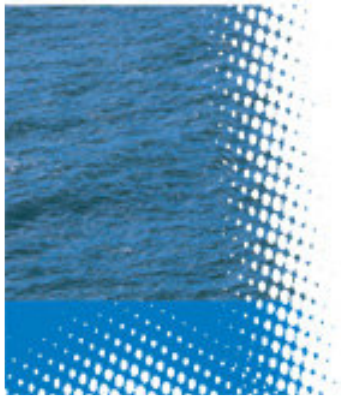
Ground Investigation

- *Desk Study (e.g. Geological maps, mines / water wells etc.)*
- *Walk Over Assessments (Sinkholes, land slides etc.)*
- *Analysis Of Topographic Data (Slope magnitude / direction)*
- *Measurement Of Peat Thickness (Direct probing)*
- *Measurement Of Peat Strength (Vane test)*
- *Analysis Of Peat Competence (Peat coring – Von post)*

WHITEFORD
GEOSERVICES







B4 How Can I Measure Risk At My Site?

Typical Topographic Data

Ardmore Wind Farm

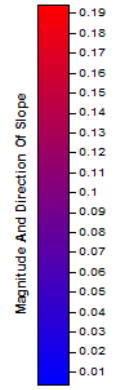
Slope Magnitude & Direction

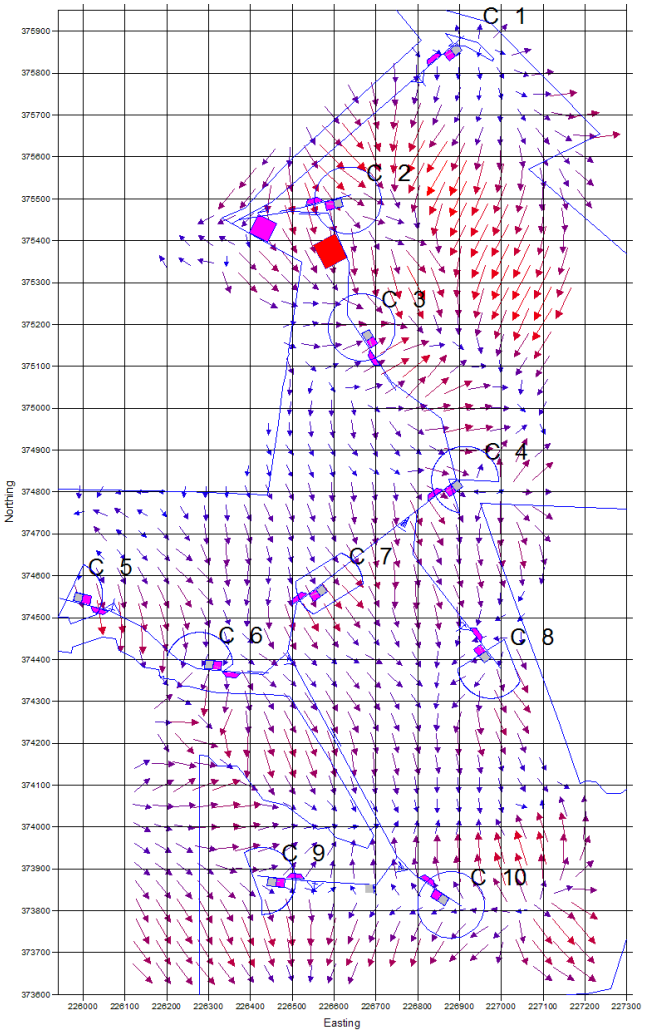
Vector Magnitude & Direction Plot

6th November 2008

NOTES:

1. Gridding carried out using a Kriging Function
2. Grid spacing of 50m applied to produce smoothed contours from collected data
3. Maximum peat depth encountered was 4.6m at E=227647, N=378666





WHITEFORD
GEOSERVICES

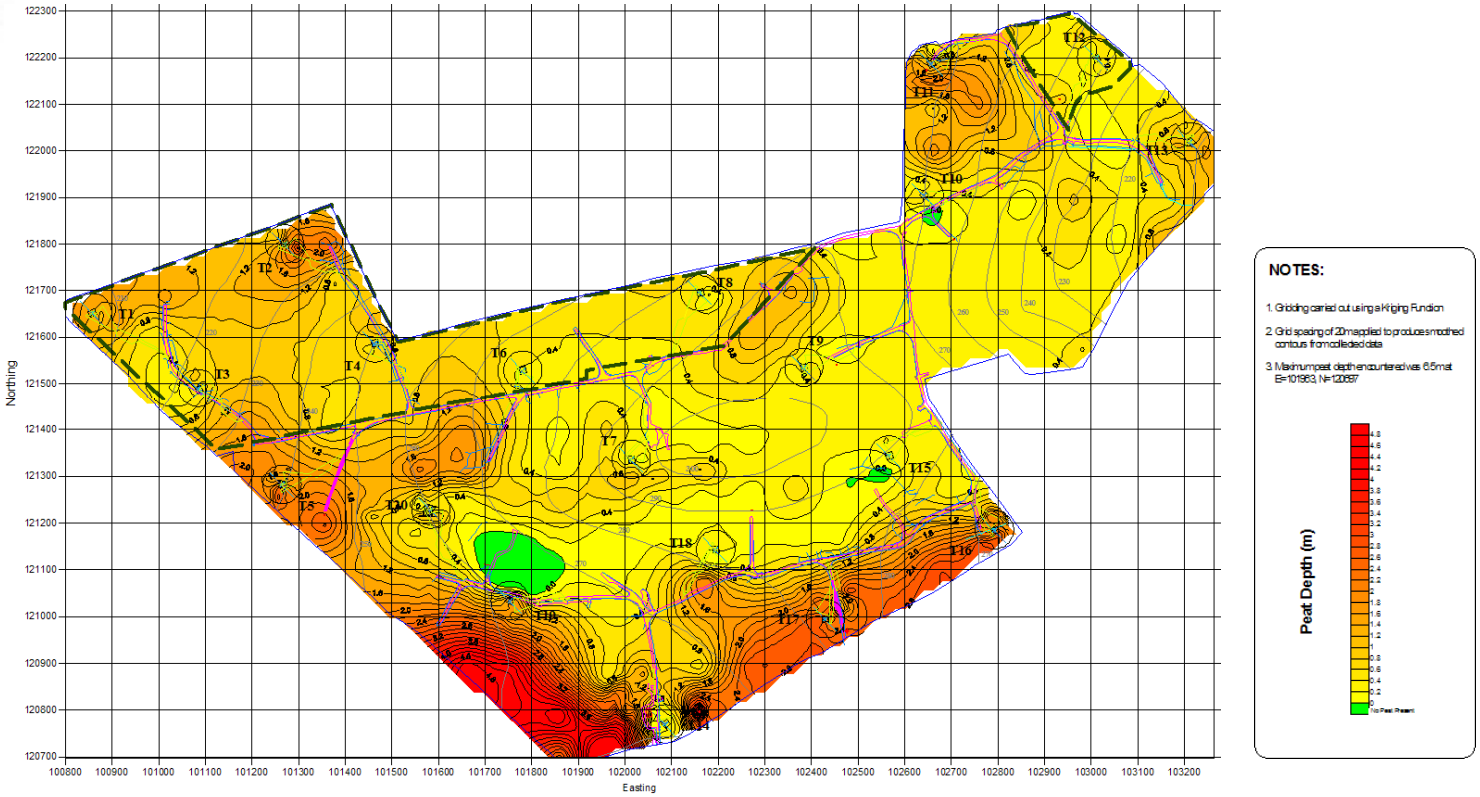
B4 How Can I Measure Risk At My Site?

Typical Peat Thickness Data



Lisnamoyle Wind Farm
Peat Probing Survey

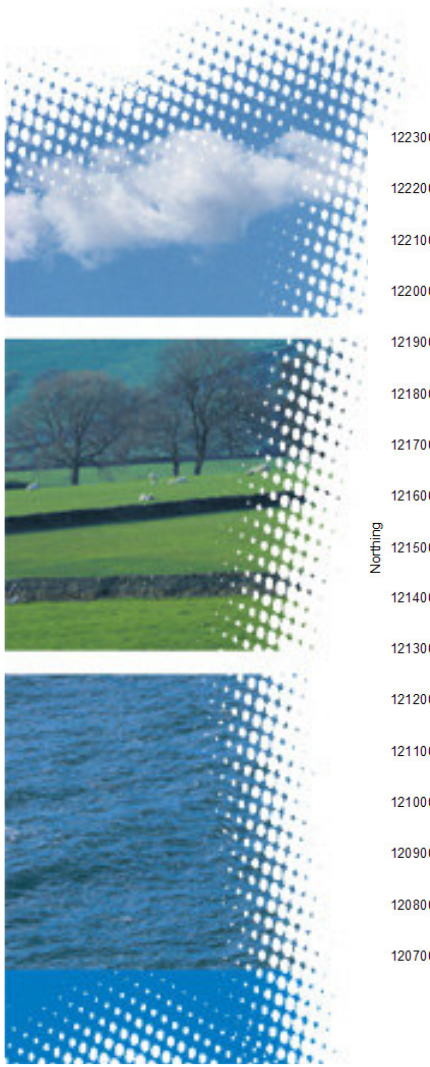
Contoured Peat Thickness (m)
20th December 2008

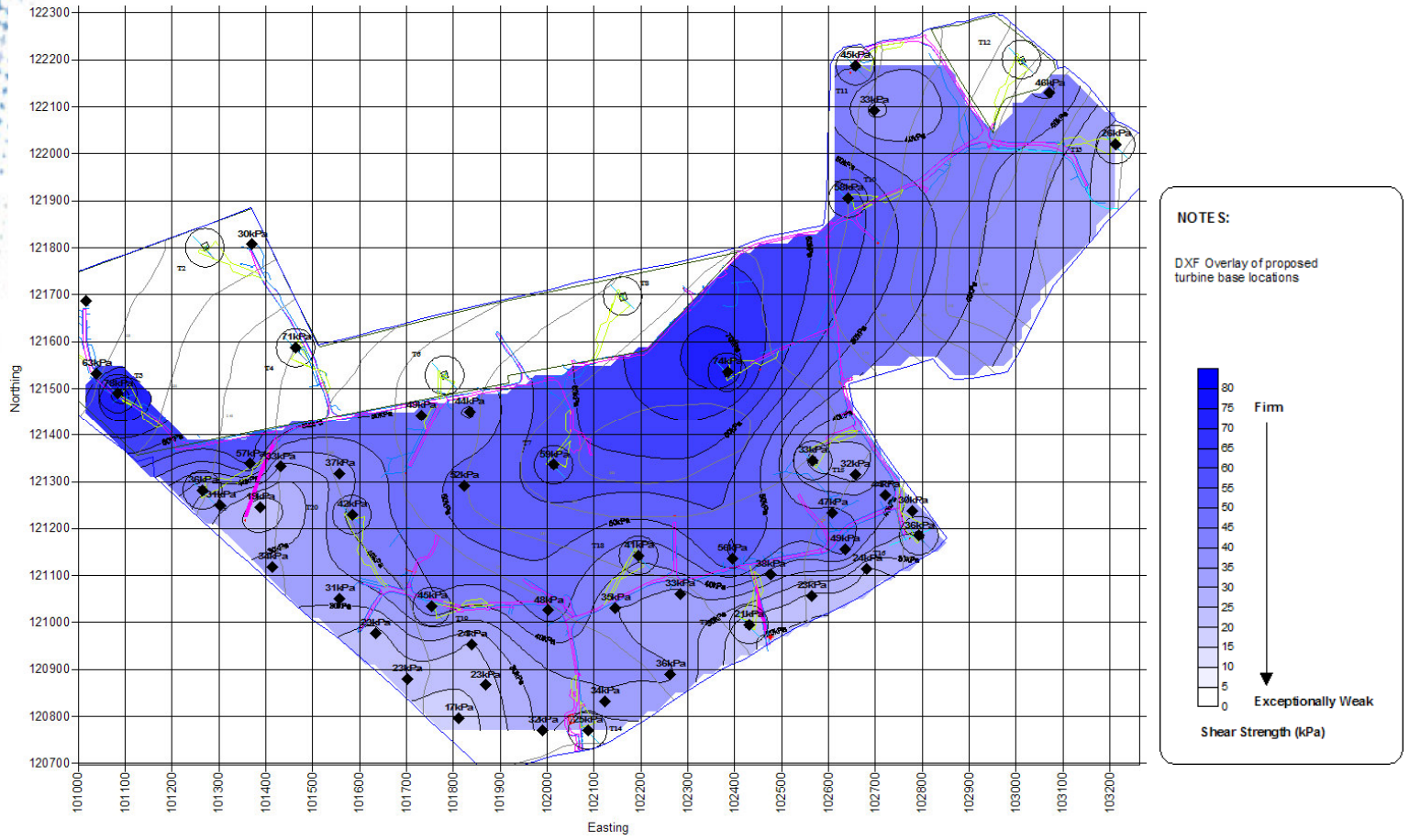


WHITEFORD
GEOSERVICES

B4 How Can I Measure Risk At My Site?

Typical Analysis Of Peat Strength





WHITEFORD
GEOSERVICES

B4 How Can I Measure Risk At My Site?

Typical Analysis Of Peat Competence – Von Post







Von Post Humification Scale - Lisnamoyle Wind Farm

Client : Lisnamoyle Wind Farm Ltd
Location : Virginia, Co. Cavan
Date : 12-13 November 2008

Turbine Locations

ID	Geographic Coordinates		Peat Characteristics													Peat Thickness (m)	Underlying Soil Type
	Easting	Northing	0.3 m	0.6 m	0.9 m	1.2 m	1.5 m	1.8 m	2.1 m	2.4 m	2.7 m	3 m	3.3 m	3.6 m	3.9 m	4 m	
T3	101085	121489	H4														0.27	Silty SAND & GRAVEL
T4	101464	121587	H4	H5													0.45	Sandy, gravelly SILT
T5	101265	121282	H4	H5	H5	H6	H6	H7	H8								2	Silty SAND & GRAVEL
T7	102014	121336	H4														0.25	Sandy, gravelly SILT
T9	102385	121535	n/a														n/a	Sandy SILT
T10	102642	121905	n/a														n/a	Sandy, gravelly SILT
T11	102657	122187	H3	H3	H4												0.9	Sandy, gravelly SILT
T12A	103071	122129	n/a														n/a	SILT
T13	103212	122020	H3	H4													0.6	Sandy, gravelly SILT
T14	102087	120771	H4	H4	H4	H5											1.05	Sandy, gravelly SILT
T15	102566	121345	H3	H3													0.5	Sandy, gravelly SILT
T16	102793	121185	H3	H3	H3	H4	H5	H5	H6								2.05	Sandy CLAY
T17	102430	120996	H3	H4	H4	H4	H5	H5	H6	H6	H7	H7	H7				3.1	Sandy, gravelly SILT
T18	102195	121143	n/a														n/a	SILT
T19	101754	121034	H3	H3	H4	H4											1.2	Silty SAND & GRAVEL
T20	101584	121230	H3	H4	H5												0.95	Sandy, gravelly SILT

Peat Characteristics

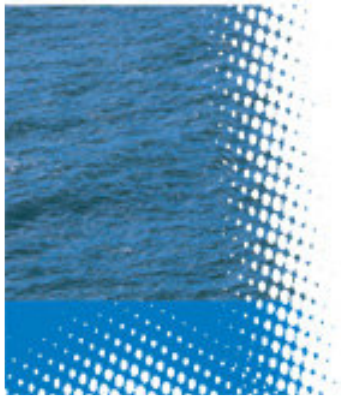
Note :
Green refers to new location (original location inaccessible due to very thick forest).

H1 - Completely undecomposed peat; only clear water can be squeezed from peat.
H2 - Almost undecomposed; mud free peat; water squeezed from peat is almost clear.
H3 - Very little decomposition; very slightly muddy peat; water squeezed from peat is muddy
H4 - Poorly decomposed; somewhat muddy peat; water squeezed from peat is muddy; residue is muddy but shows structure of peat.
H5 - Somewhat decomposed; muddy growth structure discernible but distinct; some peat passes through fingers when squeezed; compressed residue is muddy.
H6 - Somewhat decompsed; muddy; growth structure indistinct; less than one-third of peat passes through fingers when squeezed; residue very muddy.
H7 - Well decomposed; very muddy; growth structure indistinct; about one-half of peat passes through fingers when squeezed; exuded liquid has a "pudding-like" consistency.
H8 - Well decomposed; growth structure very indistinct; about two-thirds of peat passes through fingers when squeezed; residue consists mainly of roots and resistant fibers.
H9 - Almost completely decomposed; peat is mud-like; almost no growth structure can be seen; almost all of peat passes through the fingers when squeezed.
H10 - Completely decomposed; no discernible growth structure; entire peat mass passes through the fingers when squeezed.

WHITEFORD
GEOSERVICES







B4 How Can I Measure Risk At My Site?

Calculation Of Risk

- ***Quantitative Risk Assessment***
- ***Degree Of Risk = Likelihood x Effect***
- ***Hazard Ranking = Hazard x Exposure***

Success Depends On Correct Assessment Of HAZARD and EXPOSURE

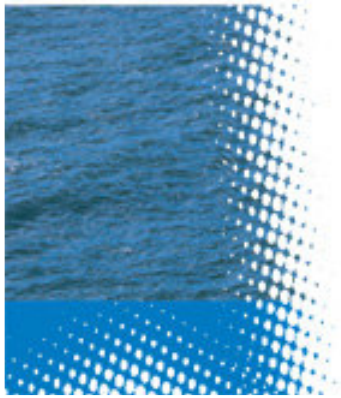
Your Consultant Will Have Carried This Out Already – Using The Following Data

(Refer to Annex for details)

WHITEFORD
GEOSERVICES







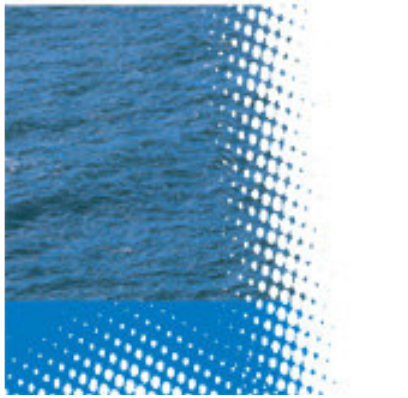
B4 Typical HAZARDS

- *Peat Depth In Excess Of 1.5m (i.e Cutting into the CATOTELM)*
- *Level Peat Overlying Sloping Natural Soils / Rock*
- *Presence Of Particularly Weak Peat*
- *Cuttings in excess of 1.5m*
- *Placement Of "Floating" Roads On Any Thickness Of Peat*
- *Drainage (Positive Drainage Causes Settlement / Negative Drainage Causes Flooding)*
- *Surface Loading Of Peat (Spoil Disposal > 0.5m Thick)*
- *Presence Of Recent, Incipient and Relic Peat Instability*

WHITEFORD
GEOSERVICES







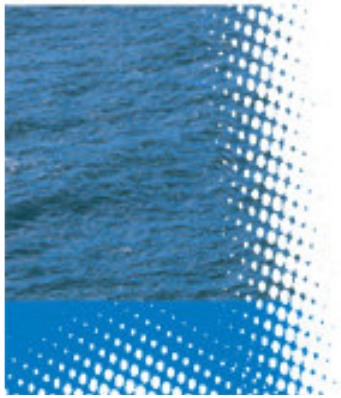
B4 Typical EXPOSURE

- *An Event Likely To Cause Degradation Of Habitat*
- *- Visual Scars*
- *- Blockage Of Site Drainage*
- *- Disruption To Site Construction Works*
- *- Contamination Of Water Courses*
- *- Damage To Construction Infrastructure / Public Infrastructure*
- *- Injury / Death – Wildlife And Farm Animals*
- *- Injury / Death – Workers / General Public*

WHITEFORD
GEOSERVICES







B5 Calculating the Hazard Ranking For Your Site

Typical Breakdown Of Dominant Risk Factors

(External Example – Looking At Effect Of Risk)

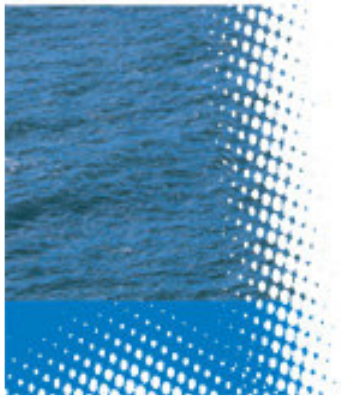
Peat Depth (m)	Risk Factor	Slope Angle	Risk Factor	Risk	Risk Factor
> 4.1m	7	12-13˚	7	High	13-14
3.6-4.1m	6	10-11˚	6	Medium/High	11-12
3.1-3.5m	5	7-9°	5	Medium	9-10
2.4-3.0m	4	5-6°	4	Low/Medium	7-8
1.8-2.3m	3	4-5°	3	Low	5-6
1.1-1.7m	2	3-4°	2	Highly Unlikely	3-4
<1m	1	<3°	1	Negligible	1-2

Alfred McAlpine, 2005

WHITEFORD
GEOSERVICES







B5 Calculating the Hazard Ranking For Your Site

Typical Assessment Scale Used

Scale	Likelihood	Probability of occurrence
5	Almost certain	> 1 in 3
4	Probable	1 in 10 - 1 in 3
3	Likely	1 in 10^2 - 1 in 10
2	Unlikely	1 in 10^7 - 1 in 10^2
1	Negligible	< 1 in 10^7

Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

Scale	*Exposure*	*Impact as % of total project cost or time*
5	Extremely high impact	> 100% of project
4	Very high impact	10% - 100%
3	High impact	4% - 10%
2	Low impact	1% - 4%
1	Very low impact	< 1% of project

Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES



B5 Calculating the Hazard Ranking For Your Site

Hazard Ranking for each hazard zone		*Action suggested for each hazard zone*
17 - 25	Serious	Avoid project development at these locations
11 - 16	Substantial	Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to significant or less
5 - 10	Significant	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations
1-4	Insignificant	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES



B5 Calculating the Hazard Ranking For Your Site

Typical Analysis (External Example)

Influences and Factors	Description	Scoring
Construction Elements	Turbine 24, associated hardstanding and access tracks are likely to be constructed on glacial tills and possibly weathered rock.	
Peat Depth:	0.5 to 1.5m; For scoring purposes peat depths are considered up to 2 m to reflect a conservative scenario.	1.5
Topography:	Mostly moderately sloping (6 to 15°) with negligible changes in grade.	1.5
Evidence of Instability:	No signs of instability observed.	1.0
Surface Hydrology:	Predominantly well-drained.	0.5
Scale:	Peat depths of up to 2m on rolling terrain.	2.25
Exposure:	Potential to impact on Afton Water / Afton Reservoir	2.0

Sensitivity Score = 1.125

Consequence Score = 4.50

Mott MacDonald, 2008

Risk Score = 5.06, Low

WHITEFORD
GEOSERVICES



B5 Calculating the Hazard Ranking For Your Site

Typical Risk Classification System Compared To Scottish Executive Guide

Risk Scoring	Risk Category	*Equivalent Hazard Ranking (S.E. Guide)*
> 90	Very High	*Serious*
40 - 90	High	*Substantial*
8 - 40	Medium	*Significant*
0.5 - 8	Low	*Insignificant*
0 - 0.5	Very Low	
0	Negligible (i.e. no significant depths of peat deposits present)	*Negligible*

Mott MacDonald, 2008

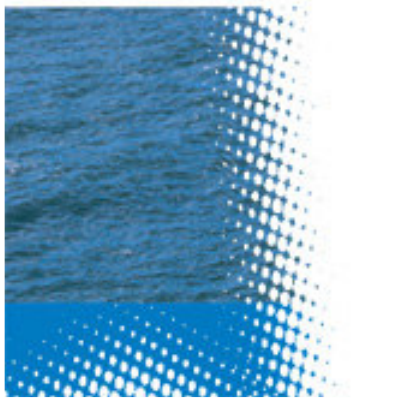
WHITEFORD
GEOSERVICES

B5 Calculating the Hazard Ranking For Your Site

Typical Risk Assessment Data (External Example)







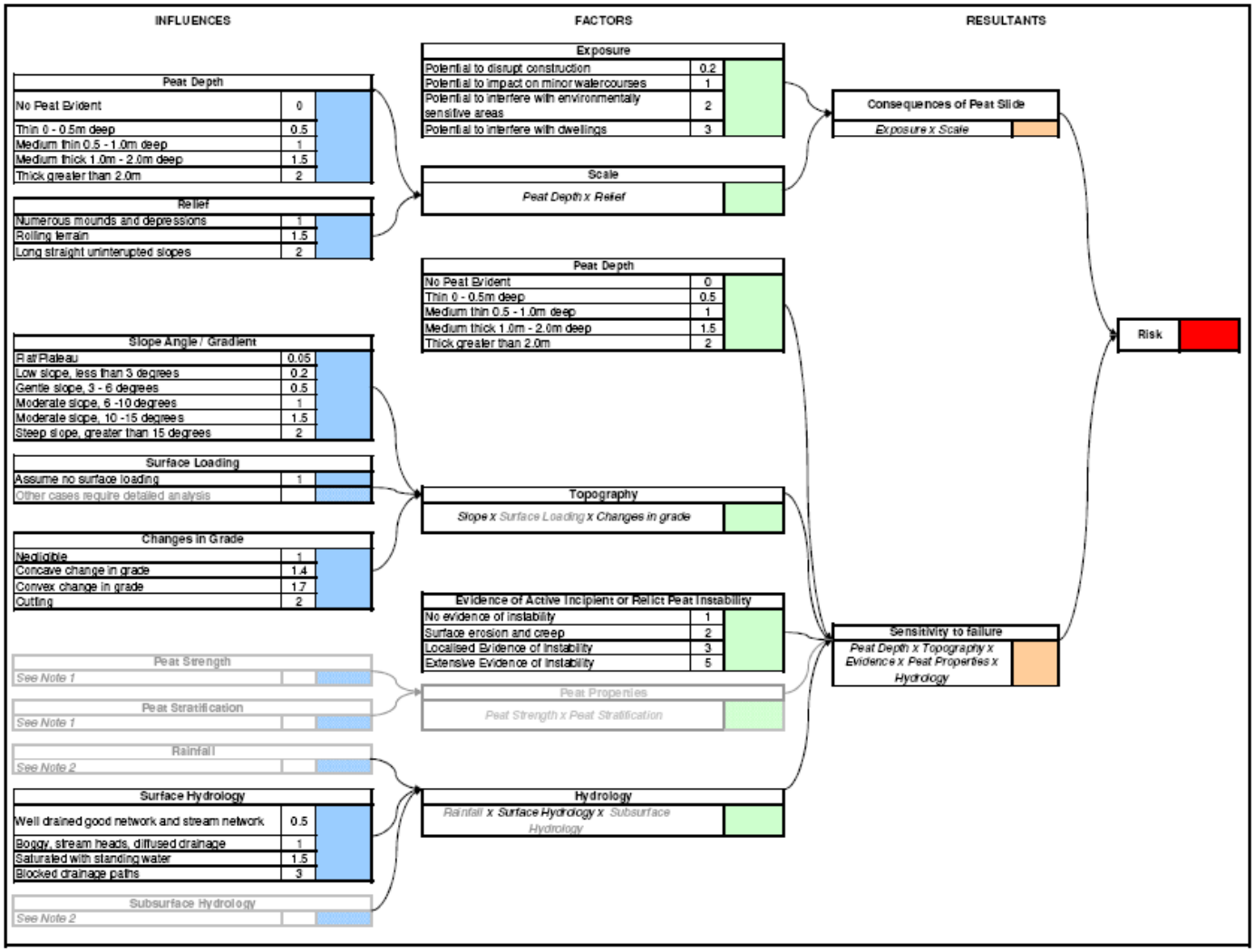
Area	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Exposure	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Peat Depth	1.0	0.5	1.5	1.5	1.0	1.5	1.0	1.0	1.5	1.0	1.0	1.0	1.0	1.5
Relief	1.5	2.0	1.0	1.0	1.5	1.0	1.5	1.0	1.5	2.0	1.5	2.0	1.5	1.5
Scale *(Assumed Peat Depth x Relief)*	1.50	1.00	1.50	1.50	1.50	1.50	1.50	1.00	2.25	2.00	1.50	2.00	1.50	2.25
Consequence	**3.00**	**2.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**2.00**	**4.50**	**4.00**	**3.00**	**4.00**	**3.00**	**4.50**
Area	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Peat Depth	1.0	0.5	1.5	1.5	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5
Slope Angle / Gradient	1.00	1.50	1.50	1.00	1.00	1.00	1.50	1.00	1.00	2.00	1.50	2.00	1.00	1.50
Surface Loading	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Changes in Grade	1.0	1.0	1.7	1.4	1.0	1.0	1.0	1.7	1.0	1.0	1.7	1.0	1.0	1.0
Topography *(Slope Gradient x Surface Loading x Changes in Grade)*	1.00	1.50	2.55	1.40	1.00	1.00	1.50	1.70	1.00	2.00	2.55	2.00	1.00	1.50
Evidence	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Drainage	1.0	0.5	0.5	0.5	1.0	1.0	0.5	0.5	1.0	0.5	0.5	0.5	1.0	0.5
Surface Hydrology *(=Drainage)*	1.0	0.5	0.5	0.5	1.0	1.0	0.5	0.5	1.0	0.5	0.5	0.5	1.0	0.5
Sensitivity	**1.00**	**0.375**	**1.913**	**1.05**	**1.00**	**1.50**	**0.75**	**0.85**	**1.00**	**1.00**	**1.275**	**1.00**	**1.00**	**1.125**
Area	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Risk Rating Score *(Consequence x Likelihood)*	**3.00**	**0.75**	**5.74**	**3.15**	**3.00**	**4.50**	**2.25**	**1.70**	**4.50**	**4.00**	**3.83**	**4.00**	**3.00**	**5.06**
Qualitative Risk Assigned	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**

Mott MacDonald, 2008

WHITEFORD
GEOSERVICES



B5 Calculating the Hazard Ranking For Your Site

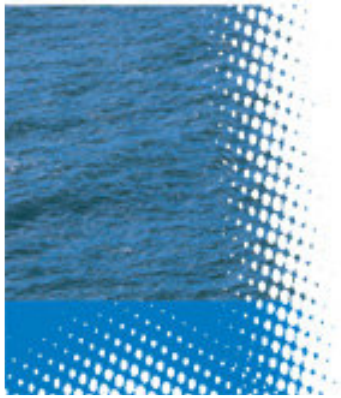


Mott MacDonald, 2008

WHITEFORD
GEOSERVICES







B5 What If Risk Is Calculated To Be…….

INSIGNIFICANT

The Standard Mitigation in the following section will be applicable.

SIGNIFICANT OR SUBSTANTIAL

Is It Possible To Mitigate To An Insignificant Level?

If YES proceed with specific peat slide mitigation in addition to the above.

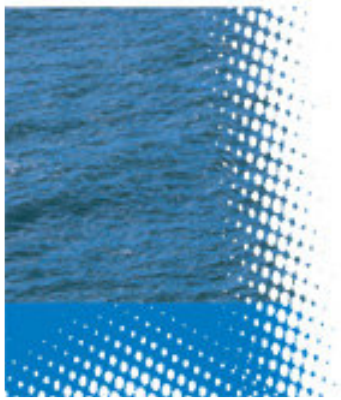
If NO consider specific peat slide mitigation as well as long term monitoring

SERIOUS

It is unlikely that Serious Levels Of Peat Slide Risk Can Be Mitigated Against In The Current Climate







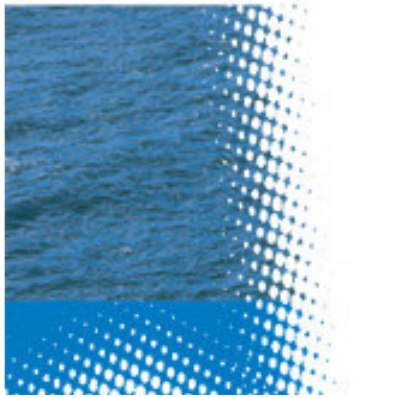
B5 Standard Mitigations And Actions

1. Works should always be **supervised by qualified and experienced site staff.**
2. Refer to your detailed Construction Works Plan.
3. Areas of sensitive peat should be clearly mapped and marked out on site. If possible the area should be taped off.
4. **Peat Instability Register.** A file should be created to record observations on peat stability. This will take the form of a daily inspection sheet, signed off by a suitably qualified person. Typical observations are visual observation of slopes, floated road sections, movement detection systems etc. The system is designed to be transferable.
5. **Movement detection systems**. Lightweight canes can be set in lines within sensitive areas to visually determine peat movement.
6. **Effective emergency plan** for dealing with peat slide events.

WHITEFORD
GEOSERVICES







B5 Mitigations

7. **Immediate Stabilisation.** Stockpiles of crushed rock should be kept on site, for rapid mobilisation to stabilise slopes or stop flow reaching sensitive receptors.

8. **Defined peat storage / disposal sites**. These should be planned carefully, drainage specifically designed and clearly defined in terms of disposal thickness.

9. In general peat should not be loaded in excess of 0.5m adjacent to excavations unless location specific risk assessment carried out.

10. Drainage Systems must be maintained regularly (Weekly or better)

11. **Catch Wall Fences / Catch Ditches** have been shown to be useful when dealing with stopping small slide before they gather momentum

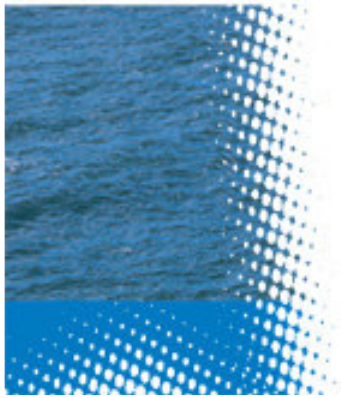
12. Frequent independent assessment of work practice should be undertaken

13. Regular **analysis of water courses** should be undertaken for indications of sediment infiltration – possible precursor to a peat slide

WHITEFORD
GEOSERVICES







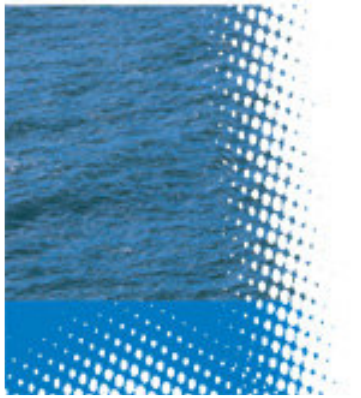
B5 Mitigations

14. Prior to placement of loads on **bases** / **crane pads etc. these should be tested** to ensure that overloading does not occur – potentially triggering a peat slide

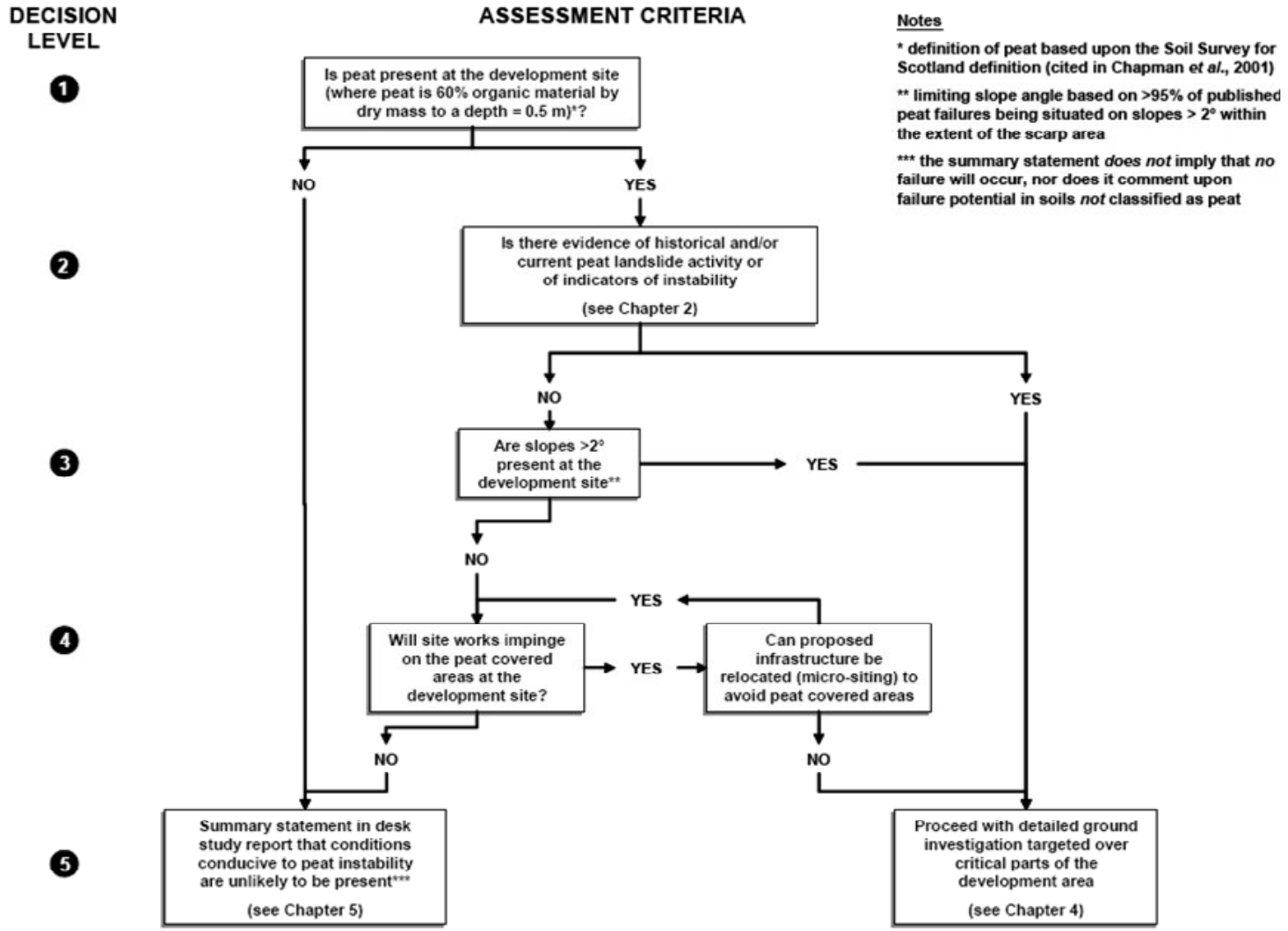
WHITEFORD
GEOSERVICES







Typical Assessment Procedure That Will Have Been Undertaken At Your Site



Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES



ANNEX Additional Reference Documents

John Whiteford (Managing Director)

Whiteford ***Geoservices Ltd***

Straid House, 2 Main Street,

Straid, BALLLYCLARE BT39 9NE

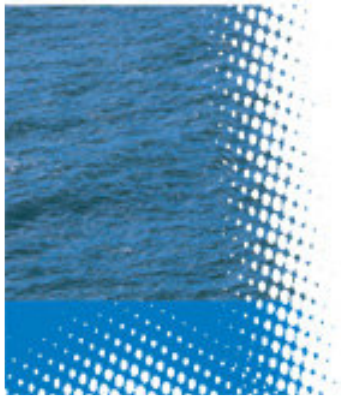
Tel: 0044 (0)28 9334 9351
Fax: 0044 (0)28 9334 9352

Email: john@whitefordgeoservices.com

WHITEFORD
GEOSERVICES







D1 Data Sources

Aaby, B and Berglund, B.E. (1986) Characterisation of peat and lake deposits – Handbook of Holocene Palaeoecology And Palaeohydrology, edited by B.E. Berglund; John Wiley & Sons, Chichester and New York, pp 231 – 246

AGEC (2004) Reports On Derrybrien Windfarm, Final Report On Landslide of October 2003 / Final Report on Post – Landslide Site Appraisal. Unpublished Report for ESBI.

Bell, F.G. (1999) The Engineering Properties Of Soils And Rocks. Blackwell.

Bowes, D.R. (1960) A Bog Burst In The Isle Of Lewis. Scottish Geographical Magazine, 76, pp21 – 23.

Boylan, N., Jennings, P. And Long, M. (2008) Peat Slope Failure In Ireland. Quarterly Journal Of Engineering Geology And Hydrogeology, Vol 41, pp 93 – 108.

Bromhead, E.N. (1992) The Stability Of Slopes. Spon Press.

Brunsden, D and Jones, D.K.C. (1972) The Morphology Of Degraded Landslide Slopes In South West Dorset. Quarterly Journal Of Engineering Geology, 5, pp205 – 222

Carling, P.A. (1986) Peat Slides In Teesdale And Weardale, North Pennines, July 1983. Earth Processes And Landforms, 11, pp193 – 207.

Clayton, C.R.I (2001) Managing Geotechnical Risk. Thomas Telford Ltd.

Craig, R.F. (1997) Soil Mechanics, Sixth Ed. London, Spon Press.

Department Of The Environment (1996) Landslide Investigation And Management In Great Britain: A Guide For Planners And Developers. London, HMSO.

Dykes, A.P. And Kirk, K.J. (2006) Slope Instability And Mass Movements In Peat deposits. Peatland Evolution And Records Of Environmental And Climatic Change. Elsevier, Amsterdam.

Dykes, A.P. And Warburton, J. (2006) Mass Movements In Peat : A Formal Classification Scheme. Geomorphology.

Halcrow Group Ltd (2003), Shetland A970 Channerwick Peat Slides – Interpretative Report, Report No. R5917. Shetland Islands Council.

Hemmingway, J.E. And Sledge, W.A. (1941 – 46) A Bog Burst Near Danby In Cleveland. Proceedings Of The Leeds Philosophical And Literature Society, Science 4, pp276 – 288.

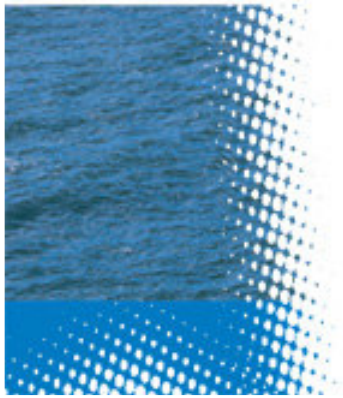
Hobbs, N.B. (1986) Mire Morphology And The Properties And Behaviour Of Some British And Foreign Peats. Quarterly Journal Of Engineering Geology, 19, pp7 – 80.

Lee, E.M. And Jones, D.K.C. (2004) Landslide Risk Assessment. Thomas Telford, London.

WHITEFORD
GEOSERVICES







D1 Data Sources

Long, M. (2005) Review Of Peat Strength, Peat Characterisation And Constitutive Modelling Of Peat With Reference To Landslides. Studia Geotechnica et Mechanica, Vol. xxvii, no. 3 – 4.

The Scottish Government Publications, Peat Landslide Hazard And Risk Assessments : Best Practice Guide For Proposed Electricity Generation developments, December 21 2006

Tobin (2003) Report On The Landslides At Dooncarton, Barnachuille And Pollathamais, County Mayo. Mayo County Council.

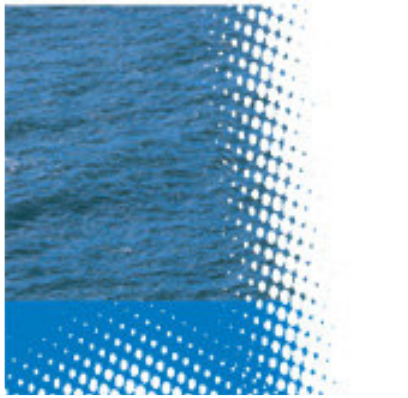
Tomlinson, R.W. (1981) The erosion Of Peat In Uplands Of Northern Ireland, Irish Geography, 14, pp51 – 64.

Warbuton, J., Higgit, D And Mills, A.J. (2004) Anatomy Of A Pennine Peat Slide, Northern England. Earth Surface Processes and Landforms, 28, pp 457 – 473.

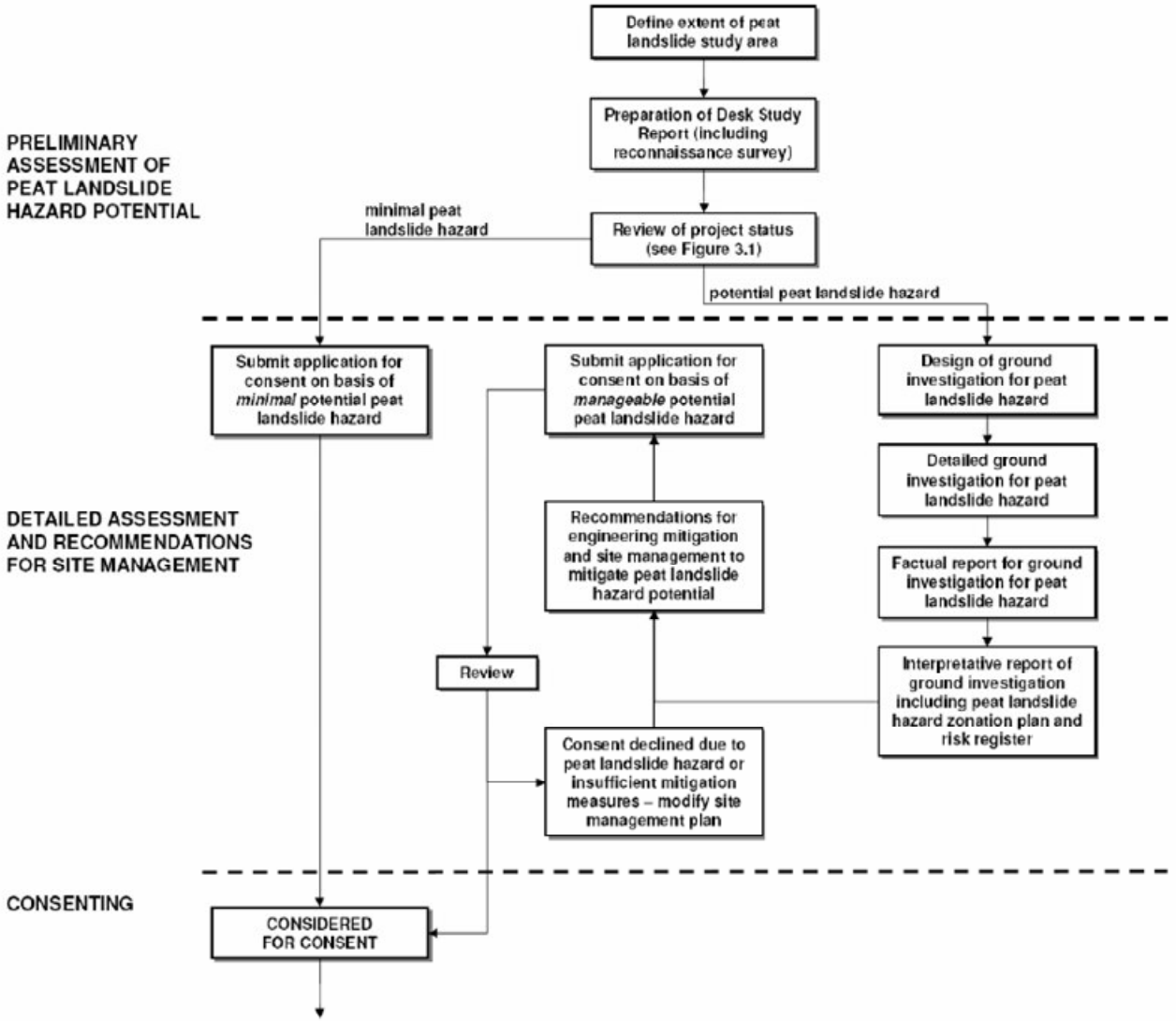
WHITEFORD
GEOSERVICES







Peat Risk Assessment – Typical Stages That Should Have Been Undertaken Prior To Commencement Of Construction



Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

WHITEFORD
GEOSERVICES



For Additional Guidance And Support Please Contact Us At:-

Whiteford *Geoservices Ltd*

Straid House, 2 Main Street,

Straid, BALLLYCLARE BT39 9NE

Tel: 0044 (0)28 9334 9351
Fax: 0044 (0)28 9334 9352

Email: john@whitefordgeoservices.com