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APPENDIX 8-1

GEOTECHNICAL AND PEAT STABILITY ASSESSMENT REPORT

Lackareagh Wind Farm

Geotechnical and Peat Stability Assessment Report

MKO

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1. EXECUTIVE SUMMARY

AFRY Ireland ("AFRY") has been commissioned by MKO on behalf of EDF Renewables Ireland Ltd ('the Applicant') to complete a Geotechnical and Peat Stability Assessment Report as part of an application for planning permission for the proposed Lackareagh Wind Farm in Co. Clare (the 'Proposed Project'). In accordance with the planning guidelines compiled by the Department of the Environment, Heritage and Local Government (Draft DoEHLG 2019 Guidelines,), where peat >0.5m thickness is present on a proposed wind farm development, a peat stability risk assessment is required.

As detailed in Section 1.1.1 of Chapter 1, for the purposes of this EIAR, the various project components are described and assessed under the following references: 'Proposed Project', Proposed Wind Farm', 'Proposed Grid Connection Route' and 'the site'. The objective of this report is to identify the risk of peat slide failure by assessing the geological, geotechnical, and peat-related characteristics of the Proposed Project site.

The Proposed Project site and the surrounding landscape is hilly and undulating, with gradients within the site boundary ranging between 83m OD to 281mOD. The site is predominantly in use as a mixture of forestry and open farmlands.

The slope inclinations at the main infrastructure locations vary between 4.6° (8%) and 15.1° (27%). Trial pits indicate that the subsoil predominantly consists of stiff clay/silt, with soft clay/silt present at two locations. The topsoil at turbine T4, substation and battery storage compound and borrow pit location was observed to be peaty, with depths ranging from 0.2m to 0.4m below ground level.

A site walkover was carried out by AFRY Ireland Limited in January 2024. Peat probing was carried out by MKO between April 2021 and August 2023. Site investigation works were carried out by Causeway Geotech Limited between December 2023 and January 2024 which included boreholes, trial pits, heavy dynamic probes, dynamic cone penetrometers and laboratory testing of soil samples. No peat was identified at the turbine locations T1, T2, T6, T7, the met mast and the associated access roads. While no peat was found at turbine location T5, a peat depth of 0.5m was observed along the spur road leading to T5. The findings of the peat probe survey and the site investigation indicate that the presence of peat on site is minimal and is generally restricted to the topsoil layer, with depths ranging between 0.2m to 0.5m below ground level. However, a localised deeper peat pocket was recorded between chainages T3+350 and T3+400, where peat reached a depth of 1.58m.

Based on the findings from desk study, site walkovers and site investigations, both qualitative and quantitative risk assessments were carried out to evaluate the potential for peat slide failure. The risk assessment methodology was adopted from *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) and *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006).

This methodology defines the risk of peat slide failure as the product of the probability and its adverse consequences, as elaborated in Section 4 and Section 9. The consequence is assessed in terms of the scale of damage inflicted by the geotechnical failure on the surrounding area. The probability is evaluated based on the results of the quantitative and qualitative assessments. In the quantitative analysis, the Factors of Safety (FoS) for undrained and drained conditions are calculated. A FoS of less than 1.0 indicates that a slope is unstable (high risk); a FoS between 1.0 and 1.3 indicates that a slope is stable but not safe (medium risk), and an acceptable FoS for slopes is 1.3 or greater (low risk). The methodology for the qualitative assessment has been adopted from *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) in which risk due to eight principal factors is assessed.

The quantitative analysis for the Proposed Project analysed the turbine locations, access roads and related infrastructure where peat is 0.5m or greater in thickness. The analysis resulted in FoS above the minimum acceptable value of 1.3, and hence LOW probability of peat slide failure. The qualitative assessment returned a LOW to MEDIUM probability at these locations.

In conclusion, the peat stability risk was found to be LOW to MEDIUM at locations with peat depths of 0.5m or greater. However, it is reasonable to assert that risks associated with peaty topsoil can be effectively managed through standard design and construction mitigation measures, ensuring both short-term and long-term stability of the Proposed Project site. Additionally, the report includes recommendations and mitigation measures for construction work in peatlands to maintain an acceptable safety standard throughout the project.

2. STATEMENT OF AUTHORITY

AFRY Ireland (formerly Ionic Consulting) is a leading renewable energy consultancy firm in Ireland, with offices in Dublin and Edinburgh. In July 2022, the business was acquired by AFRY – a Swedish-based international consultancy business who is a European leader in engineering, design, and advisory services across multiple industries, including infrastructure, energy, and construction. Presently, the AFRY Ireland team comprises over 30 staff members with diverse technical and management expertise.

AFRY Ireland is a technology agnostic renewable energy company, offering a comprehensive range of specialist services and technical advice throughout project lifecycles providing technical and project management services to support the development, preconstruction and construction of renewable technologies including solar PV, onshore wind, energy storage and offshore wind, throughout Ireland, the UK, and Europe.

AFRY Ireland has strong corporate credentials and a first-class in-house team, supported by our new colleagues from the wider AFRY family, allowing us to adapt our offering to each geography and the specifics of every project, on a case-by-case basis.

This report has been prepared by Liam Power (AFRY Senior Project Manager) and Manasvi Srivastava (AFRY Civil Engineer, M.E. Structural Engineering, BTech. Civil Engineering). Liam Power is the head of AFRY Ireland Civil Team and has over 25 years construction experience in all aspects of large civil engineering projects, with latter years focusing on project managing large scale renewable projects. Manasvi Srivastava is a Civil Engineer with AFRY Ireland and has over five years of experience in civil, structural, and geotechnical engineering.

3. INTRODUCTION

3.1 Project Background and Description

The Proposed Wind Farm is located 1km north/northeast of the village of Kilbane, Co. Clare. The townlands in which the Proposed Project is located is listed in Table 1-1 in Chapter 1 of this EIAR: Introduction.

The Proposed Project will comprise 7 no. wind turbines, and associated foundations and hardstanding areas, access roads, underground cabling, permanent meteorological mast, temporary construction compound, peat and spoil management, tree felling, site drainage, operational stage signage, battery energy storage system, 38kV onsite substation and battery energy storage system (BESS) and associated underground 38kV cabling connecting to the existing Ardnacrusha 110kV Substation, and all ancillary works and apparatus.

A full description of the Proposed Project is included in Chapter 4 of the EIAR: Description of the Proposed Project.

This report presents the geotechnical and peat stability risk assessment carried out for the Proposed Wind Farm site located within the site boundary as defined in Chapter 4 of this EIAR.

This report has been prepared using information obtained from findings of the site walkovers, preliminary site investigation carried out by Causeway Geotech Limited between December 2023 and January 2024 and supplemented by information available from the Geological Survey Ireland.

The Proposed Grid Connection Route is not examined in further detail in this report as the Geological Survey of Ireland (GSI) mapping indicates minimal presence of peat in these areas. As a result, the risk of peat slides along these routes is deemed to be negligible.

3.2 Purpose

The objective of this report is to present a Geotechnical and Peat Stability Assessment for the Proposed Wind Farm site. This assessment aims to investigate the geological, geotechnical, and peat-related characteristics of the site based on the published geology and data obtained from walkovers and site investigations. It includes an analysis of the ground conditions to evaluate the stability of the peat layers, with a focus on assessing the risk of a peat slide occurrence. The outcome of this peat stability risk assessment is presented in mapping and tabular form, identifying areas assessed as having a ‘high’, ’moderate’, ’low’ or ’negligible’ baseline risk. Furthermore, this report outlines proposed mitigation measures to eliminate or reduce the identified risk levels.

This report presents AFRY’s methodology for Geotechnical and Peat Stability Risk Assessment, the analyses performed, and results obtained. This methodology considers the impacts of imposed infrastructure and considers both quantitative and qualitative assessments, using both desk study and site investigation to gather assessment data.

This report has been developed for the purposes of planning. A detailed site investigation will be carried out prior to construction and further geotechnical assessments undertaken prior to detailed design and construction.

3.1 Overview of Peat Slide Failure

3.1.1 Peat Definition and Classification

The *Developments on Peat and Off-Site Uses of Waste Peat* (SEPA, 2017) defines peat as a sedimentary material, commonly exhibiting a dark brown or black colour, comprised of partially decomposed plant and organic matter that is preserved under anaerobic conditions within waterlogged environments. This classification delineates peat into two primary strata:

- **Acrotelm:** Identified as the upper layer, the acrotelm is characterized by its fibrous structure and the presence of plant roots. Acrotelmic peat is noted for its relatively low moisture content and has some tensile strength.
- **Catotelm:** Identified as the lower layer, the catotelm is highly amorphous and contains a notably higher water content. Catotelmic peat typically demonstrates very low tensile strength and structure of catotelmic peat tends to disrupt completely on excavation and handling.

This classification is based on peat composition, physical characteristics, and strength properties. The *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) categorizes peat according to depth and organic content as follows:

- **Peaty (or organo-mineral) soil**: a soil with a surface organic layer less than 0.5 m deep;
- **Peat:** a soil with a surface organic layer greater than 0.5 m deep which has an organic matter content of more than 60%;
- **Deep Peat**: a peat soil with a surface organic layer greater than 1.0 m deep.

3.1.2 Peat Landslide

A peat landslide is defined as large-scale mass movement of peat deposits, which typically occurs naturally under extreme weather conditions but has been observed to occur in association with construction and other land management practices (Carbon-rich soils, deep peat and priority peatland habitat: Expert views on project level assessment.

The two main classifications of a peat landslide as mentioned in the guidance literature are:

- **Peat Slide**: The term 'peat slide' refers to shallow slab-like failures, often with shear occurring at the peat-substrate interface or within the peat body. These slides involve the breaking up of the peat surface into rafts and blocks, which move downslope mainly through sliding. They resemble translational landslides and typically occur in shallow peat, up to 2m, on moderate slopes of 5 to 15 degrees. Peat slides are the most common type of recorded peat landslides in Scotland, England, and Wales.
- **Bog Burst**: The term 'bog burst' describes highly fluid failures where the peat blanket ruptures due to subsurface creep or swelling, expelling liquefied material through tears on the surface, followed by settling of the overlying mass. These events result in pear-shaped areas of disturbed blanket bog, often with concentric tears and rafts, and little substrate exposure and lacking a clear scar margin. A block and slurry runout zone is typically observed downslope, resembling features associated with peat slides. Bog bursts resemble spreading failures and tend to occur in deep peat, exceeding 1.5 meters, on shallow slopes ranging from 2 to 10 degrees, where deeper peat deposits are common. They are most frequently reported in the Republic of Ireland and Northern Ireland.

3.1.3 Types and Controlling Parameters

Peat landslides are influenced by two main factors: *preparatory factors*, which gradually increase susceptibility to failure without directly causing landslides, and *triggering factors*, which initiate instability and lead to failure. Additionally, certain inherent characteristics (*preconditions*) of peat-covered slopes can predispose them to failure.

Preparatory Factors include the gradual increase in peat mass through vertical accumulation, changes in water content, afforestation activities, reductions in shear strength from creeping and fracturing, loss of vegetation, formation of sub-surface pools or water-filled pipe networks, and afforestation-induced desiccation cracks.

Triggering factors involve both natural triggers and human activities that can initiate peat landslides. Natural triggers include intense rainfall, snow melt, rapid ground accelerations such as earthquakes, fluvial incision reducing support to upslope material, and loading by landslide debris increasing shear stress. Human activity-related triggers include alterations to drainage patterns leading to high pore-water pressures, rapid ground accelerations from blasting or mechanical vibrations, cutting of peat reducing support to upslope material, loading by heavy plant or structures increasing shear stress, and digging and tipping associated with building, engineering, farming, or mining, including subsidence.

The factors that may act as preconditions to slope instability in peatlands include impeded drainage from a peat layer overlying an impervious base, convex slopes or breaks in slope concentrating subsurface flow, proximity to local drainage sources, and connectivity between surface drainage and the peat or impervious interface, facilitating excess pore pressure generation.

3.1.4 Pre-failure Indicators

Ground conditions indicating preparatory or preconditioning factors before failure are often detectable through mapping, remote measurement, or site visits. In many cases, sites experiencing landslides without prior warning could have been identified as susceptible to failure by experienced personnel or through basic monitoring methods.

Certain critical features are indicative of potential failure in peat environments:

- Presence of historical and recent failure scars and debris;
- Presence of features indicative of tension (e.g. cracks);
- Presence of features indicative of compression (e.g. ridges, thrusts, extrusion features);
- Evidence of peat creep (typically associated with tension and compression features);
- Presence of subsurface drainage networks or water bodies;
- Presence of seeps and springs;
- Presence of artificial drains or cuts down to substrate;
- Presence of drying and cracking features;
- The concentration of surface drainage networks;
- Presence of soft clay with organic staining at the peat and (weathered) bedrock interface; and
- Presence of iron pans or similar hardened layers in the upper part of the mineral substrate.

3.1.5 Peat conditions on site

The trial pit results indicate that the depth of topsoil on the site ranges between 0.1m and 0.4m below ground level. Peaty topsoil was discovered at three locations which include turbine location T4, substation and battery storage compound, and borrow pit location. The underlying subsoil layer comprises primarily of firm light brown sandy gravelly SILT and firm orangish brown sandy gravelly silty CLAY, except at two locations where soft sandy gravelly silty CLAY/SILT was encountered. Peat probing conducted on site recorded depths ranging from 0 to 1.58 meters, with an average depth of 0.46m.

The slope inclinations at the main infrastructure locations vary between 4.6° (8%) and 15.1° (27%).

Site walkovers and site investigations did not reveal any evidence of peat failure or bog bursts within the Proposed Wind Farm area.

According to the GSI landslide mapping, no previous landslides have been recorded within the Proposed Wind Farm site. The nearest recorded landslide (Event ID: GSI_LS08-0017 – Slieve Bearnagh 2003 E564524, N677353) occurred in Carrownakilly, Slieve Bearnagh in County Clare. The Proposed Wind Farm site is located approximately 4km to the south of this recorded landslide event on the opposite side of the Slieve Bearnagh mountain. Therefore, it is assumed that the site-specific causes of that previous landslide are deemed to not be pertinent to this site.

4. PEAT STABILITY RISK ASSESSMENT METHODOLOGY

The methodology for the risk assessment is to undertake a broad assessment of the site in such a way that the risk for the whole site can be visually interpreted on a map overlaid on the Proposed Wind Farm layout. Infrastructure overlying any potential high-risk areas can therefore be easily identified and further assessments of these areas can be undertaken to better evaluate the risk. This will allow better quantification of the risk to be made and determine whether any mitigation measures can be installed to reduce the risk to an acceptable level or whether the layout needs to be altered.

Figure 1 shows a workflow diagram showing the general methodology for the PSRA.

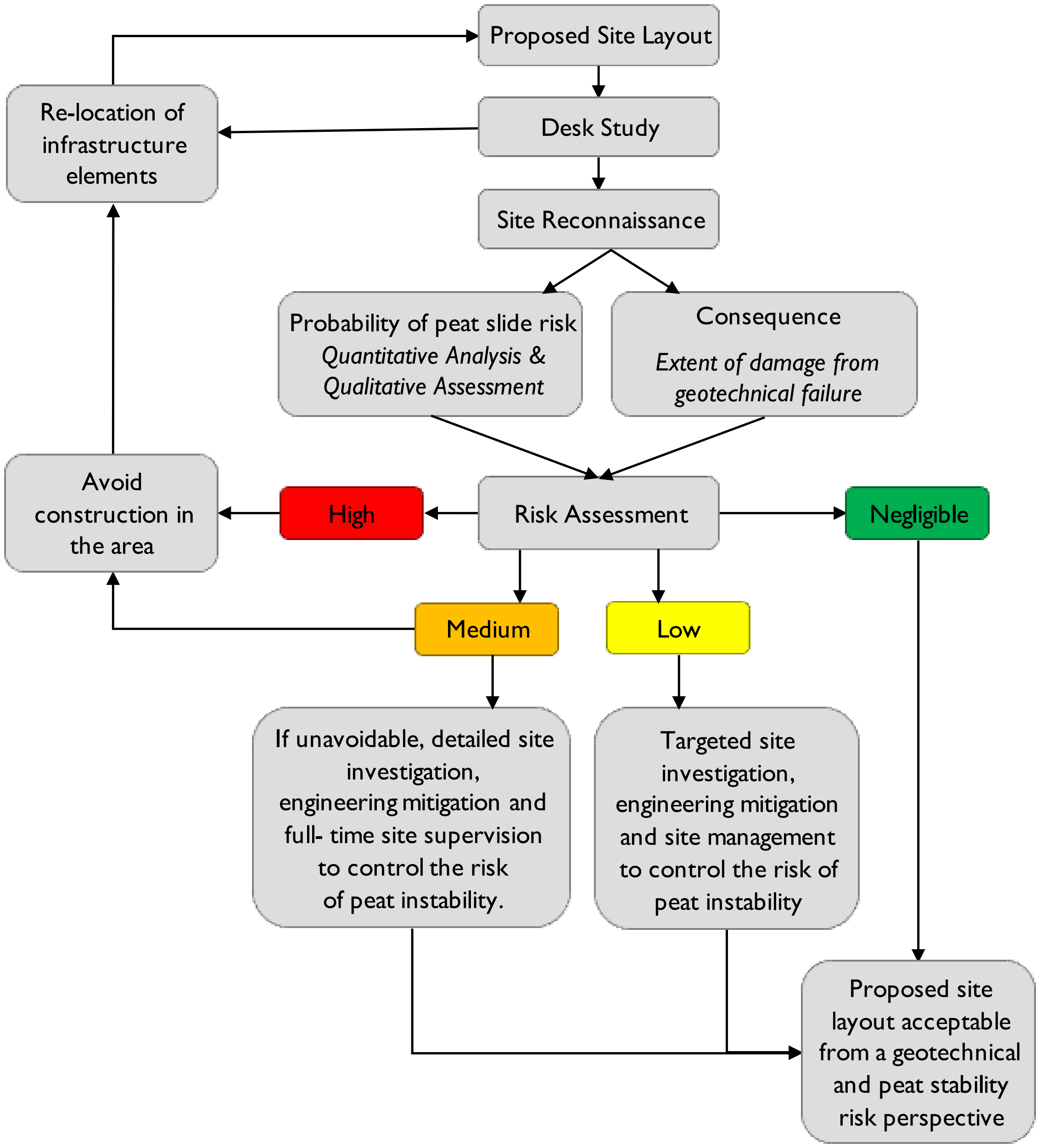


Figure 1: Peat Stability Risk Assessment Methodology

The methodology followed is set out below:

4.1 Desk Study

The desktop study was undertaken to collate, and review published geological information to inform the site investigation. A desk study utilising existing maps, geological data/memoirs of the site is undertaken as an initial step to identify risks and "obstacles". The following data sources were examined during the desk study:

- Aerial/Satellite imagery
- Quaternary sediments
- Bedrock geology
- Geological faults
- Landslide inventory and susceptibility
- Hydrogeology
- Hydrology
- Topography
- Mining and active quarries
- Radon risk

4.2 Preliminary Walkover

A preliminary walkover of the site builds upon information from the desk study identifying areas of significant geotechnical risk and existing geotechnical failures which are immediately identifiable without any level of detailed/penetrative site investigation. These may include existing landslips, areas of peat bog, areas of cracked peat, etc. Other features such as engineered drainage, manmade or natural features are also easily identified and mapped during a site walkover.

A site walkover is also useful to identify where the true site condition or layout differs from existing map-based data of a site or information gathered from other sources.

4.3 Preliminary Fieldworks

Whilst traversing the site on the preliminary walkover it is relatively easy to undertake some fieldworks such as preliminary peat probing. This initial field work allows factual data to be added to existing site layouts/maps. The outcome of Preliminary Walkover/Fieldworks also allow future Site Investigation works to be better focused on areas beyond the reach of Preliminary walkover/fieldworks and away from areas identified as being of low risk.

4.4 Terrain Assessment

A terrain assessment of the site is carried out allowing analysis of slope angles, directions of slope and run off analysis. Assessing slope angles across the site is key in assessing the risk of peat slides.

The assessment of terrain and determination of sliding angles at the site are carried out using Digital Terrain Models (DTMs) obtained from Bluesky, alongside site walkovers.

4.5 Site Investigation

Overall, the peat depth across proposed infrastructure locations ranges from 0m to 0.5m, A localised deeper peat pocket was recorded between chainages T3+350 and T3+400, where peat reached a depth of 1.58m. The depths encountered between chainages T3+350 and T3+400 was an outlier from the data collected at the Proposed Wind Farm site as the peat depths recorded at this location were the deepest peat depths detected on the Proposed Wind Farm site as determined by site investigative works done to date.

Further Site Investigation (SI) is required to better understand the subterranean geological conditions. SI generally includes boreholes, trial pits, dynamic probes, and dynamic cone penetrometers. These works give a better understanding of the soils ability to support loads and also gives a clearer picture of soil depths.

4.6 Risk Assessment Process

This report follows the risk assessment process as detailed in *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) and *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006). The methodology follows the well-established principle that,

RISK = PROBABILITY x CONSEQUENCE

1. Consequence Assessment: Evaluates the potential severity of damage caused by geotechnical failure, considering factors such as displacement scale, infrastructure impact, and environmental consequences.
2. Probability Assessment: Determines the likelihood of peat slide failure through a combination of two separate analyses:
    a. Quantitative approach based on geotechnical data.
    b. Qualitative approach based on best practice guidelines.

By integrating these quantitative and qualitative assessments, the risk assessment process provides a comprehensive understanding of the potential for peat slide failure and informs mitigation strategies to minimize risks.

4.7 Mitigation Measures

Where the risk assessment process has identified infrastructure overlying areas of geotechnical risk, mitigation measures are recommended to reduce the risk level in those areas.

4.8 Summary

The outcome of the risk assessment and other findings are drawn together in a series of conclusions and recommendations at the end of the report.

5. DESKTOP STUDY

5.1 Site Description

The site covers approximately 240 hectares, extending approximately 2.2km from west to east, with varying lengths between 200 meters to 1600 meters. The area is currently accessed through an existing road, The Gap Road L7080, located on the western boundary of the site.

The ground contours obtained from Bluesky reveal a hilly terrain across the site, with elevations ranging between 83m OD and 271m OD.

The aerial imagery indicates that the Proposed Project site is predominantly in use as a mixture of forestry and open farmlands.

Site layout plans for the Proposed Project site are included in Appendix 4-1 of the EIAR: Site Layout Planning Drawings. The coordinates and elevations of turbine bases are given in the table below.

Turbine Location	Turbine Coordinates (ITM)		Elevation (m OD)
	Easting	Northing	
T1	562207	673988	230m
T2	562283	673588	187m
T3	564015	673305	366m
T4	563865	672753	291m
T5	563990	672374	295.m
T6	563315	672290	201m
T7	563402	671881	202m

Table 1: Coordinates and Elevation of Turbine Bases

5.2 Published Geology

The following section is compiled from information provided by the Geological Survey Ireland (GSI) and indicates the conditions across the site.

5.2.1 Quaternary Sediments

GSI Quaternary Sediments mapping indicates that the overburden primarily consists of till derived from Lower Palaeozoic sandstones and shales, bedrock outcrop or subcrop and gravels derived from Lower Palaeozoic and Devonian sandstones. Additionally, a small patch of blanket peat is present in the northeastern part of the site; however, no infrastructure has been proposed in that area.

5.2.2 Bedrock Geology

The GSI Bedrock Geology 100k Map indicates that the site is predominantly underlain by fine to conglomeratic graded greywacke of Broadford Formation, with a band of greywacke sandstone in in the central part of the site.

5.2.3 Geological Faults

Fault lines derived from GSI Bedrock Geology 100k Map indicate multiple geological faults intersecting the Proposed Project site. These faults include one oriented in a west-east direction, two in a northwest-southeast direction, and two running southwest-northeast. Among these, a single southwest-northeast oriented strike fault traverses across the proposed T4 turbine foundation footprint. No faults have been identified at the remaining turbine bases, hardstands, substation and battery storage compound, or the met mast locations.

5.2.4 Landslide Inventory and Susceptibility

Previous landslide records of the Geological Survey Ireland events within the vicinity of the Proposed Project site were examined. No previous landslides have been recorded within the Proposed Project site. The nearest recorded landslide (Event ID: GSI_LS08-0017 - SlieveBearnagh2003 E564524, N677353) occurred in Carrownakilly, Slieve Bearnagh in County Clare. The Proposed Project site is located approximately 4km to the south of this recorded landslide event on the opposite side of the Slieve Bearnagh mountain. Therefore, it is assumed that the site-specific causes of that previous landslide are deemed to not be pertinent to this site.

GSI Landslide Susceptibility mapping indicates that the site is classified as Low to High Susceptibility.

5.2.5 Hydrogeology

1. Aquifer

GSI Groundwater Resources (Aquifer) mapping indicates that the site is underlain by Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones. The site is located within the Tulla-Newmarket-on-Fergus and Lough Graney groundwater bodies. The site entrance and a portion of the access road L7080 Local Road are located within the Broadford Gravels groundwater body.

2. Groundwater Vulnerability

As per the GSI Groundwater Vulnerability mapping, the vulnerability of the aquifer underlying the site ranges from High to Extreme. It is to be noted that the vulnerability of the eastern half of the is classified as Rock at or near Surface or Karst.

3. Subsoil Permeability

As per the GSI Groundwater Subsoil Permeability mapping, the subsoil in the western half of the site is classified as having Moderate to High permeability.

5.2.6 Hydrology

According to the EPA River Waterbody WFD and Stream mapping, multiple streams from the Broadford_010 waterbody traverse the Proposed Project site. These streams include the Kilbane stream, which runs north to south, crossing the road to the met mast before turning southwest, and an unnamed stream and Clooncorry_Beg stream which run from east to west. The Clooncorry_Beg stream intersects the access road to T7. Additionally, there are two other streams in the vicinity of this site, namely Shannaknock and Killeagy, which flow into and converge with the Kilbane stream.

5.2.7 Topography

In order to characterise the slope conditions over the Proposed Wind Farm site, slopes were analysed from a (DTM) derived from Bluesky (2018) orthophoto data. The slopes have been collated in Table 2 below.

Location	Slope of Sliding Plane (%)
T1	19.6
T2	13.0
T3	22.5
T4	20.2
T5	20.2
T6	23.1
T7	27.0
Met Mast	10.3
Substation and BESS Compound	11.4
Temporary Construction Compound	8.0
Storage Area	8.6
Borrow Pit	18.7

Table 2: Summary of Slopes on Site

5.2.8 Mining and Active Quarries

GSI mining mapping indicates that the Proposed Wind Farm site is surrounded by a number of "metallic" and "non-metallic" mineral markers.

There are no active mines or quarries within the Proposed Project site. The nearest quarry, Ballyquinn Pit, is a concrete, sand and gravel fill quarry located approximately 2.7km southwest of T7.

5.2.9 Radon Risk

According to the Environmental Protection Agency's radon risk map, the areas designated for the borrow pit, substation, battery storage compound, temporary construction compound, and storage area fall within a High Radon Area. This classification suggests a higher potential for radon exposure in these specific locations and may require appropriate mitigation measures during project planning and construction.

6. FIELDWORKS

6.1 Preliminary Walkover

A site walkover survey was conducted in January 2024 by AFRY. The walkover survey consisted of a review of the turbine locations, the substation and battery storage compound, the met mast, and the temporary construction compound.

During the walkover, it was observed that turbines T1, T2, T6 and T7, and the met mast are located within open agricultural grasslands and T3 and T4 are located within active commercial forestry. T5, the substation and battery storage compound, the temporary construction compound and the borrow pit are located in an area of forestry that had been recently felled at the time of the site visit.

It was noted that the site is characterized by a steep topography, with most areas covered in sod and some shallow, firm peat overlay. No ponding or soft spots were observed on the site, likely due to the presence of steep slopes which facilitate efficient drainage.

Photos from the site walkover have been included within Appendix A of this report.

6.2 Preliminary Fieldworks

Over 50 peat probes were carried out by MKO between April 2021 and August 2023 in within the Proposed Wind Farm site. The peat probe survey has indicated that the depth of peat across the site is generally shallow (i.e. less than 0.5), with a deeper peat pocket (i.e. 1.58m) identified along the road leading to T3.

There was no peat identified at the turbine locations T1, T2, T6, T7, and associated access roads, as well as at the met mast, the substation and battery storage compound and the borrow pit. While no peat was found at turbine location T5, a peat depth of 0.5m was observed along the spur road leading to T5.

The survey shows that the peat depth at turbine locations T3 and T4 is less than 0.5m, while at the temporary construction compound, it reaches a depth of 0.5m.

Overall, the peat depth across proposed infrastructure locations ranges from 0m to 0.5m, A localised deeper peat pocket was recorded between chainages T3+350 and T3+400, where peat reached a depth of 1.58m.

Results of the peat probe survey are included within Appendix B.

A Peat Depth Map for the Proposed Wind Farm site is shown in Figure 2.

6.3 Further Site Investigation

The initial fieldworks were carried out in July 2022 by Causeway Geotech Limited. During this stage, trial pits were dug at three locations across the site and seven DCP tests were carried along the existing forest road to T7. Shear box testing and laboratory testing on soil and rock samples taken from trial pits were carried out.

Additional investigation works were carried out by Causeway Geotech Limited between December 2023 and January 2024 which included 14no. trial pits, 3no. rotary boreholes, 18no. heavy dynamic probes and 27no. dynamic cone penetrometers. Testing was carried out at turbine bases, hardstands, met mast, substation and battery storage compound, temporary construction compound, borrow pit and access roads. The ground investigation factual report is included within Appendix D.

7. GROUND CONDITIONS

7.1 Superficial Deposits

Teagasc mapping illustrate that the western half of the Proposed Wind Farm site is primarily overlain by deep well drained mineral (mainly acidic) soils. However, specific areas, including turbines T4, T6, and T7, the substation and battery storage compound, temporary construction compound, borrow pit, and storage area locations, are characterized by shallow, well-drained mineral (mainly acidic) soils. Turbines T3 and T5 are located in areas overlain by shallow, rocky, peaty/non-peaty mineral complexes (mainly acidic) soils. This data aligns with the results obtained from the trial pits and peat probe survey, which indicate that the presence of peat on site is minimal and is largely restricted to the topsoil layer.

A Peat Depth Map, as shown in Figure 2, has been developed based on the findings of the peat probing and site investigation. The peat depths at main infrastructure locations and across the access roads are listed in Table 3 and Table 4.

Location	Peat Depths
T1	0.0m
T2	0.0m
T3	0.3m
T4	0.4m
T5	0.0m
T6	0.0m
T7	0.0m
Met Mast	0.0m
Substation and BESS Compound	0.2m - 0.4m
Temporary Construction Compound	0.4m - 0.5m
Storage Area	0.0m
Borrow Pit	0.2m - 0.25m

Table 3: Estimated Peat Depths at Main Infrastructure Locations

Location	Peat Depths
Spur to T1	0.0m
Spur to T2	0.0m
Road to Met Mast	0.0m
Spur to T4	0.0m - 0.4m
T3 - T4	0.3m - 1.58m
Spur to T5	0.0m - 0.5m
Spur to T6	0.0m - 0.1m
T6 - T7	0.3m - 0.6m

Table 4: Estimated Peat Depths across Access Roads

The depth of organic strata each trial pit location is listed in Table 5.

Location	**Trial Pit Coordinates**		**Organic Strata**	**Organic Strata Depth**
	Easting	**Northing**		
T1	562208.01	673986.23	Topsoil	0.2m
T2	562282.26	673586.76	Topsoil	0.2m
T3	564007.76	673278.88	Topsoil	0.35m
T4	563886.6	672683.32	Peaty topsoil	0.4m
T5	563977.48	672336.61	Topsoil	0.2m
T6	563314.91	672289.52	Topsoil	0.2m
T7	563391.33	671880.53	Topsoil	0.1m
Met Mast	562257.48	673271.87	Topsoil	0.2m
Substation and BESS Compound	563610.47	672536.64	Peaty topsoil	0.2m-0.25m
	563650.56	672578.4		
Borrow Pit	563495.49	672475.21	Peaty topsoil	0.2m-0.4m
	563501.42	672514.45		
	563563.63	672495.96		
	563565.3	672543.35		

Table 5: Organic Strata Depth at each Trial Pit Location

The type and thickness of overburden material at each trial pit location is listed in Table 6.

Location	**Trial Pit Coordinates**		**Overburden Material**	**Overburden Thickness (m)**
	Easting	**Northing**		
T1	562208.01	673986.23	firm CLAY	0.6
T2	562282.26	673586.76	firm CLAY	0.2
T3	564007.76	673278.88	firm SILT	0.45
T4	563886.6	672683.32	soft SILT	0.8
T5	563977.48	672336.61	firm SILT	1.3
T6	563314.91	672289.52	firm CLAY	1.1
T7	563391.33	671880.53	firm SILT	0.5
Met Mast	562257.48	673271.87	soft CLAY	0.5
Substation and BESS Compound	563610.47	672536.64	firm SILT	1
	563650.56	672578.4	firm SILT	1.8
Borrow Pit	563495.49	672475.21	firm SILT	1.4
	563501.42	672514.45	firm SILT	0.95
	563563.63	672495.96	firm SILT	1.5
	563565.3	672543.35	firm SILT	1.1

Table 6: Overburden Material at each Trial Pit Location

7.2 Groundwater and Hydrogeology

Groundwater levels at each trial pit location are listed in Table 7.

Location	Groundwater Level m (bgl)
T1	Did not encounter GW
T2	Did not encounter GW
T3	Did not encounter GW
T4	Did not encounter GW
T5	Did not encounter GW
T6	Did not encounter GW
T7	1.8m (seepage)
Met Mast	Did not encounter GW
Substation and BESS Compound	2.2m (moderate flow)
Borrow Pit	0.4m (light seepage); 1.6m (light flow)

Table 7: Groundwater Levels

7.3 Laboratory Testing Results

All geotechnical tests were carried out in accordance with IS EN 1997 (Eurocode 7) and BS 5930. The following geotechnical testing was scheduled by AFRY:

- pH and SO4 Testing

7.3.1 Geochemical Testing

Samples were tested to determine the chemical characteristics of the soil and groundwater, including the level of acidity (pH value).

The results from the chemical analysis are used primarily to determine the concrete exposure classification for chemical attack, which is in turn required to establish an appropriate concrete mix design in accordance with the requirements of IS EN 206-1.

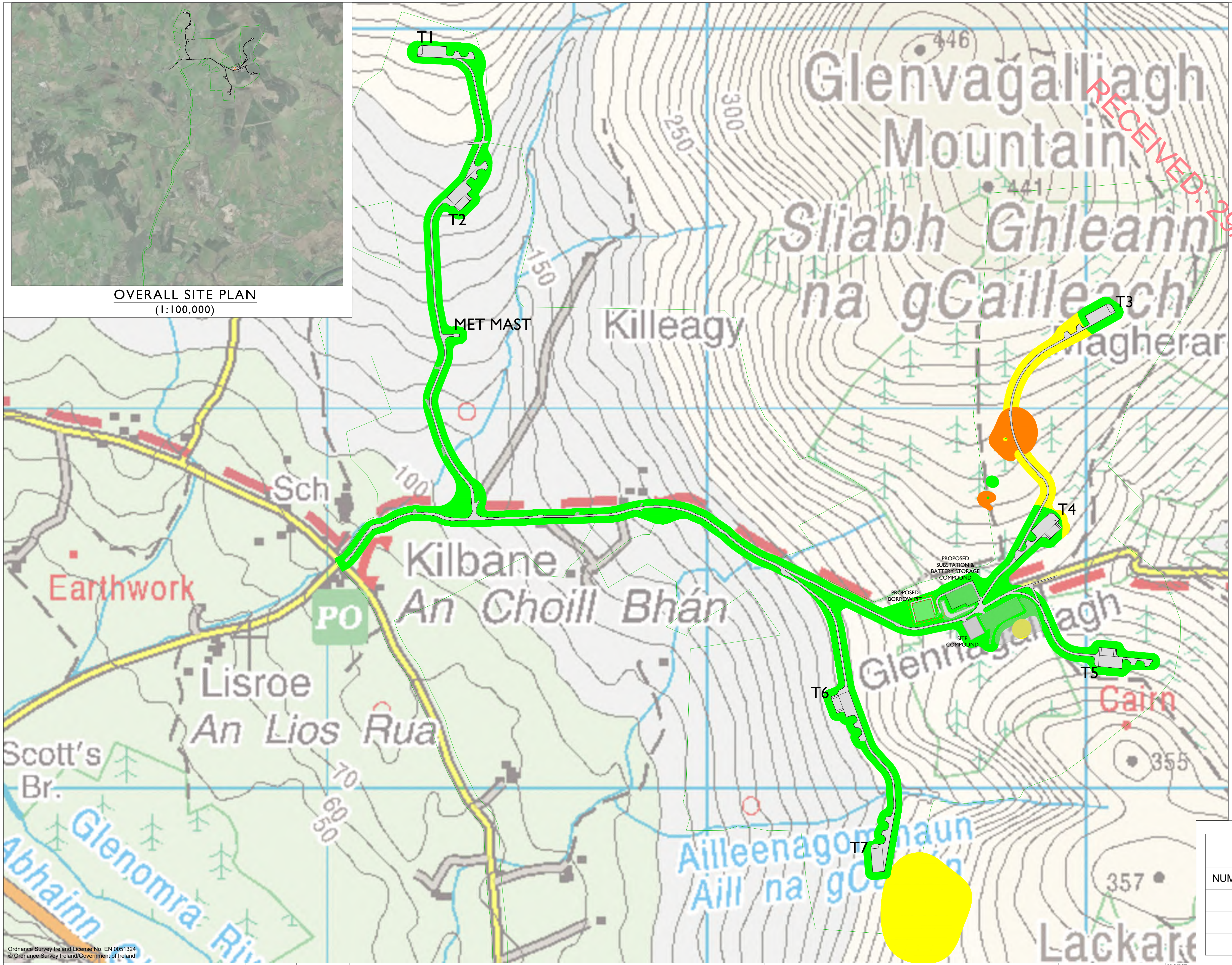
The following data in Table 8 and Table 9 summarise the geochemical testing results conducted on soil samples.

Location	Sample Depth m (bgl)	Moisture Content Ratio (%)
T1	2.5	14
T2	1.0	24
T3	1.7	11
T4	0.6	31
T5	1.7	3.9
T6	2.5	15
T7	2.5	8.6
Substation and BESS Compound	2.0	12.0 - 16.0
Met Mast	1.5	26.0
Borrow Pit	1.1 - 3.0	7.8 - 18.0

Table 8: Summary of Moisture Content Results

Location	Sample Depth BGL m (bgl)	pH (pH Units)	Sulphate Aqueous Extract as SO_4 (2:1) (mg/l)
T1	1.0	7.6	1200
T2	1.6	6.6	80
T3	1.0	6.4	140
T4	3.0	6.2	21
T5	2.0	5.8	30
T6	2.0	6.2	15
T7	1.7	6.3	22
Substation and BESS Compound	N/A	N/A	N/A

Table 9: Summary of Chemical Laboratory Test Results



OVERALL SITE PLAN
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🟩 EIAR SITE BOUNDARY

PEAT DEPTHS

NUMBER	MINIMUM LEVEL	MAXIMUM LEVEL	COLOUR
1	0.0	0.5	🟩
2	0.5	1.0	🟨
3	1.0	1.5	🟧

NOTES

REV	DATE	DRAWN BY	CHECKED BY	DETAILS
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PROJECT

LACKAREAGH WIND FARM
CO. CLARE

TITLE

PEAT DEPTH MAP

REVISION

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CHECKED AND APPROVED: L. POWER
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8. PEAT STABILITY ASSESSMENT

The peat stability assessment is undertaken to evaluate the PROBABILITY or LIKELIHOOD of a peat slide failure, utilizing a combination of quantitative and qualitative analyses detailed within this section.

The turbine delivery route and the Proposed Grid Connection Route have been screened out of this assessment due to the nature of the works involved.

8.1 Methodology

The report follows two methods for analysing peat stability assessment, as follows:

8.1.1 Quantitative Assessment (FoS approach)

The following analysis uses a quantitative approach to determine factors of safety to quantify the risks of peat slides and local rotational failure or engulfment of excavations occurring. This includes assessing the peat for undrained (short-term stability) and drained (long-term stability) conditions:

- The undrained loading condition is relevant in the short-term, specifically during construction and until any pore water pressures induced by construction activities subside.
- The drained loading condition pertains to the long-term scenario. This condition assesses the impact of groundwater level changes due to rainfall on the stability of existing natural peat slopes.

8.1.2 Qualitative Assessment

The qualitative peat stability assessment or the likelihood of peat slip outlines several contributory factors affecting the peat stability which include slope angle, peat depth, peat strength, moisture content, cracking, underground hydrology, surface hydrology, historical peat slips, and weather. This assessment has been covered in further detail in the Section 8.3.

8.1.3 Geotechnical Parameters of Peat

To complete the quantitative (Factor of Safety) analyses, the values of effective cohesion (c') and effective friction angle (ø') are required. However, obtaining these values can be difficult due to the disturbance experienced during peat sampling and the difficulties in interpreting test results caused by the excessive strain induced within the peat. For the purposes of a conservative FoS calculation, these values have been derived as averages from the published literature, as summarized in Table 10.

The values for c' and ø' for drained analysis in this report are as follows:

$$c' = 4\ kPa$$

$$ø' = 25°$$

Reference	Cohesion, c' (kPa)	Friction Angle, ø' (degrees)
Hanrahan et al. (1967)	5 to 7	36 to 43
Rowe and Mylleville (1996)	2.5	28
Landva (1980)	2 to 4	27.1 to 32.5
Landva (1980)	5 to 6	-

Reference	Cohesion, c' (kPa)	Friction Angle, ø' (degrees)
Carling (1986)	6.5	0
Farrell and Hebib (1998)	0	38
Farrell and Hebib (1998)	0.61	31
Rowe, Maclean and Soderman (1984)	3	27
McGreever and Farrel (1988)	6	38
McGreever and Farrel (1988)	6	31
Hungr and Evans (1985)	3.3	-
Madison et al. (1996)	10	23
Dykes and Kirk (2006)	3.2	30.4
Dykes and Kirk (2006)	4	28.8
Warburton et al. (2003)	5	23.9
Warburton et al. (2003)	8.74	21
Entec (2008)	3.8	36.8
Komatsu et al. (2011)	8	34
Zhang and O'Kelly (2014)	0	28.9 to 30.3

Table 10: Effective Cohesion and Friction Angle Values for Peat from Published Literature

8.1.4 Assumptions

The assumptions incorporated in the peat stability analysis are as follows:

1. Peat depths were determined based on the maximum depths recorded in each probe during the walkover surveys.
2. Slope angles for the Proposed Wind Farm site are analysed from the DEM (Bluesky) 1m contours which are assumed to accurately represent slope angles on site.
3. The surface of failure is assumed to be parallel to the ground surface.
4. Undrained shear strength parameters are estimated based on the descriptions in the trial pit logs (e.g. very soft, soft, firm, etc.) and the guidance of BS 5930 (1999) which has traditionally been used to correlate soil consistency observations with undrained shear strength. Due to the inherent disadvantages of this method, conservative assumptions are made.
5. Moisture Content recorded during the laboratory testing of trial pits samples from various locations on site ranged from 3.9% to 31%. Based on these findings, it is reasonable to assume that the soil moisture content at the temporary construction compound, storage area, and along the access road to T3 would exhibit similar characteristics, with an expected moisture content not exceeding 500%. Additionally, the absence of watercourses in close proximity to these locations further supports the assumption.
6. Three surcharging conditions were considered for the stability analysis:
   i. No surcharge load
   ii. Surcharge load of 10 kPa, equivalent to 1m of stockpiled or side-cast peat.

8.2 Quantitative Assessment

The methodology for quantitative peat slide risk assessment is derived from the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006), which includes Infinite Slope

Analysis and Stability of Excavation in peat. In Infinite Slope Analysis, the Factors of Safety (FoS) for undrained and drained conditions are calculated, which helps in assessing the likelihood of a peat slide.

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 purpose of this analysis is to determine the Factor of Safety (FoS) against failure of peat slopes across the site. The analysis was carried out for each section and provides an indication of the stability of peat slopes at each location.

The minimum required FoS for stable slopes is 1.3, as specified in BS6031:1981: Code of Practice for Earthworks (BSI, 1981). Therefore, on the basis of FoS values, the risk can be deemed as "low", "medium" or "high". Table 11 below lists the risk level based on FoS values.

Factor of Safety (FoS)	Risk Level
> 1.3	Low
1.0 – 1.3	Medium
< 1.0	High

Table 11: Risk Level based on Factor of Safety Values

The detailed FoS calculations for both the cases are outlined in this section.

8.2.1 Undrained Condition

Undrained analysis is used to assess the short-term stability of the peat. The formula used to determine the FoS for the undrained condition for a given slope, weight and strength of material (Bromhead, 1986) is as follows:

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

where

FoS= Factor of Safety
C_u= Peak undrained shear strength (kPa)
γ= Bulk Unit Weight of Material (kN/m$^{3)}$
z=Depth to failure plane (Assumed depth of peat) (m)
α= Slope angle (deg)

The results are summarised in Table 12 below:

LOCATION	DATA				ANALYSIS	
	Peat Depth [z (m)]	Peat Strength (kPa)	Angle of Sliding Plane [α (deg)]	Unit Weight Peat [γ (kN/m3)]	No Load FoS	+1m Peat FoS
T3	0.30	10*	12.7	10	15.5	3.6
T4	0.40	10*	11.4	10	12.9	3.7

LOCATION	**DATA**				**ANALYSIS**	
	Peat Depth [z (m)]	Peat Strength (kPa)	Angle of Sliding Plane [α (deg)]	Unit Weight Peat [γ (kN/m3)]	No Load FoS	+1m Peat FoS
T3+350 - T3+400	1.20	10*	6.1	10	7.9	4.3
Substation and BESS Compound	0.40	10*	6.5	10	22.2	6.4
Temporary Construction Compound	0.50	10*	4.6	10	25.0	8.3
Storage Area	0.08	10*	4.9	10	146.9	10.9
Borrow Pit	0.25	10*	10.6	10	22.1	4.4

*Refer to assumption no. 4 in Section 8.1.4

Table 12: Factor of Safety against Sliding for Undrained Condition

The FoS for undrained condition is greater than 1.3 at all locations where peat is present. This indicates that the short-term risk of peat instability is LOW under surcharge loading of +1m peat.

8.2.2 Drained Condition

Drained analysis is used to assess the long-term stability of the peat. The formula used to determine the FoS for the drained condition for a given slope, weight and strength of material (Bromhead, 1986) is as follows:

$$FoS = \frac{c' + (\gamma z - \gamma_w h_w) Cos^2 \alpha \, Tan\phi'}{\gamma z \, Sin\alpha \, Cos\alpha}$$

where

FoS= Factor of Safety
c'= Effective cohesion (kPa)
γ= Bulk Unit Weight of Material (kN/m$^{3)}$
z= Depth to failure plane (Assumed depth of peat) (m)
h_w= Height of water table
α= Slope angle (deg)

For estimation of FoS in case of drained condition, the unit weight of water (γ_w) and peat (γ) have been taken as 10 kNm^{-3} and 10 kNm^{-3}, respectively. The results are summarised in Table 13 below;

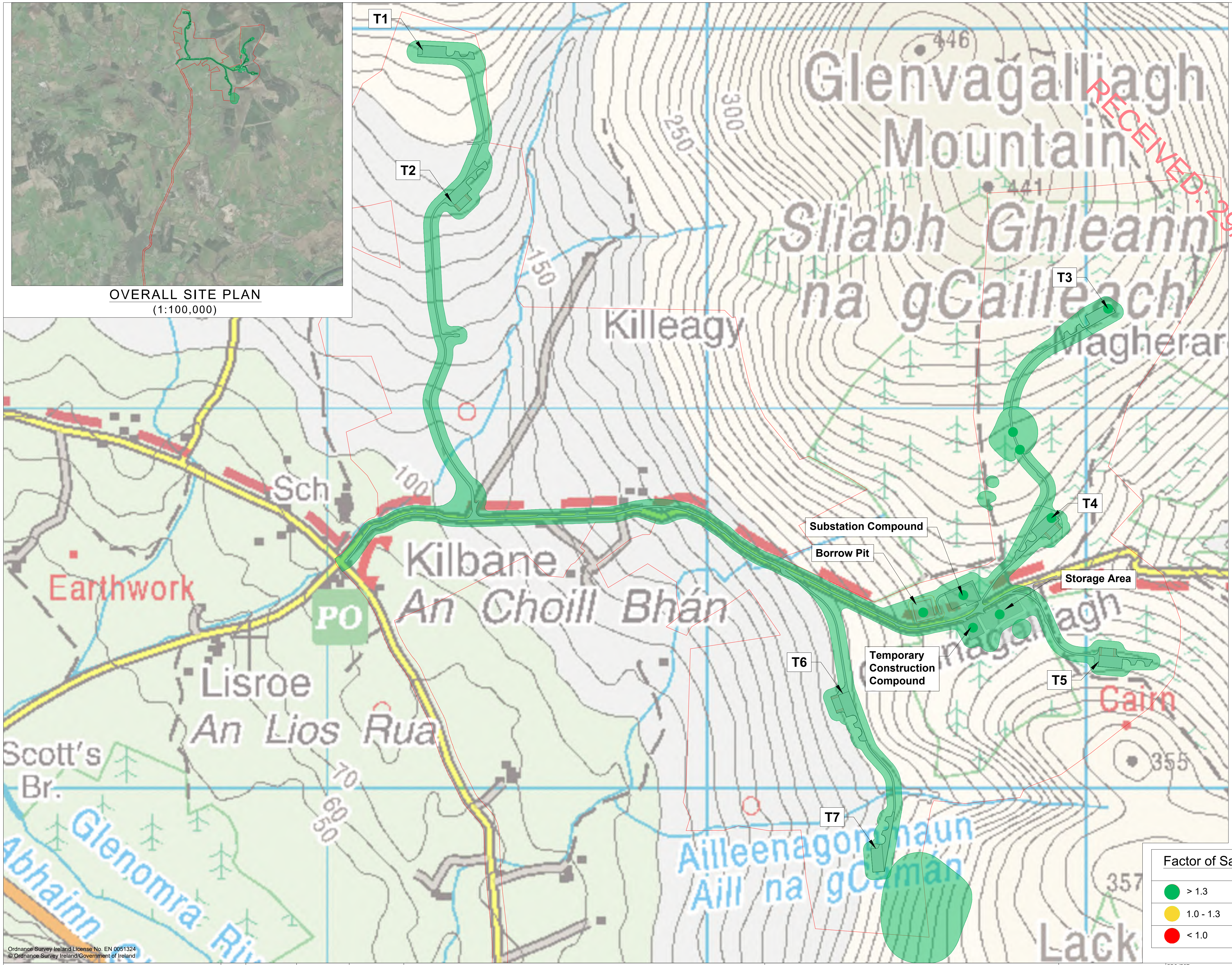
LOCATION	DATA							ANALYSIS	
	Peat Depth [z (m)]	Height of Water Table [h_w (m)]	Effective Cohesion [c' (kPa)]	Friction Angle [ø' (deg)]	Angle of Sliding Plane [α (deg)]	Unit Weight Peat [γ (kN/m3)]	Unit Weight Water [γ_w (kN/m^3)]	No Load FoS	+1m Peat FoS
T3	0.30	0.30	4.0	25.0	12.7	10	10	6.2	1.4
T4	0.40	0.40	4.0	25.0	11.4	10	10	5.2	1.5
T3+350 - T3+400	1.20	1.20	4.0	25.0	6.1	10	10	3.2	1.7
Substation and BESS Compound	0.40	0.40	4.0	25.0	6.5	10	10	8.9	2.5
Temporary Construction Compound	0.50	0.50	4.0	25.0	4.6	10	10	10.0	3.3
Storage Area	0.08	0.08	4.0	25.0	4.9	10	10	58.8	4.4
Borrow Pit	0.25	0.25	4.0	25.0	10.6	10	10	8.8	1.8

Table 13: Factor of Safety against Sliding for Drained Condition

The FoS for drained condition is greater than 1.3 at all locations where peat is present. This indicates that the long-term risk of peat instability is LOW under surcharge loading of +1m peat.

8.2.3 Summary

The FoS obtained from both undrained and drained analyses is greater than 1.3 at all locations where peat depth exceeded 0.5m during peat probing. This indicates that the PROBABILITY or the likelihood of peat slide occurrence within the Proposed Wind Farm site is deemed as LOW. The result of the quantitative analysis for the most critical load case (+1m peat loading) is shown on Figure 3.



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Factor of Safety	Risk Level
● > 1.3	Low
● 1.0 - 1.3	Medium
● < 1.0	High

NOTES

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LACKAREAGH WIND FARM
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PEAT FACTOR OF SAFETY MAP

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8.3 Qualitative Assessment

The qualitative peat slide risk assessment or the likelihood of peat slip is based on the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) that outlines several contributory factors affecting the peat stability. The contributory factors and the methodology for qualitative assessment is described in the following sections.

8.3.1 Controlling Principal Factors

The key parameters which influence the LIKELIHOOD or PROBABILITY of occurrence of a peat slide are:-

- Slope angle
- Peat depth
- Peat strength/ Moisture Content
- Cracking
- Underground Hydrology
- Surface Hydrology
- Historical Peat Slips
- Weather

By focusing on these eight factors it is possible to ensure a consistent site based approach to the likelihood of a geotechnical failure occurring. The qualitative risk assessment process is not necessarily limited to the above eight factors and, potentially, other parameters such as the existing harvesting techniques, water level, pore pressures and especially the nature of the interface between the superficial geology and underlying solid geology may also be significant.

However, some of these factors are variable and transient (resulting from prolonged heavy rainfall) and cannot be determined in a systematic manner and without extensive site investigations and considerable expense. This level of investigation is deemed beyond the scope of a risk assessment unless there are persuasive counter-indications.

The data within these eight principal factors, some of which is not numeric, is used to derive a single representative value for individual areas of the site. The methodology has been adopted from *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) in which the measured value of the principal factors is linked to the likelihood of contributing to a peat slide.

The following tables define the method of assessment, value and the probability of contributing to peat slide for each of the principal factors.

1. Moisture Content

Table 14 of the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) has been adopted to assess the likelihood of peat slips based on mositure content of the soil. The table below shows the probability of contributing to peat slides for different moisture content values.

Moisture Content (%)	Probability
0 - 500	Negligible
500 - 1000	Unlikely
1000 - 1500	Probable
1500 - 2000	Likely

Moisture Content (%)	Probability
2000 - 2500	Very Likely

Table 14: Probability of peat slide occurrence based on moisture content values

2. Peat Depth

Peat depth at the site location was measured using peat probes, trial pits and GPR surveys. Table 15 below shows the probability of contributing to peat slides based on peat depths values.

Peat Depth (m)	Probability
0 - 0.5m	Negligible
0.5m - 1.0m	Unlikely
1.0m - 1.5m	Probable
1.5m - 2.0m	Likely
≥ 2m	Very Likely

Table 15: Probability of peat slide occurrence based on peat depth values

3. Slope Angle

Slope angle at the site location is deciphered from probing, GPR surveys, and LIDAR and can also be measured when peat is excavated. Table 16 below shows the probability of contributing to peat slides based on slope angle values.

Slope Angle (°)	Probability
0 - 3°	Unlikely
4 - 9°	Probable
10 - 15°	Likely
16 - 20°	Very Likely
≥ 20°	High Risk

Table 16: Probability of peat slide occurrence based on slope angle values

4. Cracking

Cracking at the site location can be observed visually. Table 17 below shows the probability of contributing to peat slides based on cracks observed.

Cracking	Probability
No Evidence	Negligible
0 - 5% Road Length	Unlikely
5 - 10% Road Length	Probable
10 - 15% Road Length	Likely
15 - 20% Road Length	Very Likely

Table 17: Probability of peat slide occurrence based on percentage of cracks in the road

5. Underground Hydrology

Underground hydrology is observed visually. Although it is very difficult to evaluate, it can exist in the form of exit/entrances to underground channels. Collapsed ceilings of pipes are quite evident. Table 18 below shows the probability of contributing to peat slides based on underground hydrology of the site location.

Underground Hydrology	Probability
None Evident	Negligible
Few	Unlikely
Frequent	Probable
Many	Likely
Continuous/Significant	Very Likely

Table 18: Probability of peat slide occurrence based on underground hydrology

6. Surface Hydrology

Surface Hydrology is also observed visually. Interpretation may be necessary due to weather conditions at the time of survey. Table 19 below shows the probability of contributing to peat slides based on surface hydrology observed at the site location.

Surface Hydrology	Probability
None Evident	Negligible
Few	Unlikely
Frequent	Probable
Many	Likely
Continuous/Significant	Very Likely

Table 19: Probability of peat slide occurrence based on surface hydrology

7. Historical Peat Slips

Evidence of historical peat slips found using Geological Survey Ireland Spatial Resources Map Viewer. Details on historical peat slips and other geotechnical failures are included in Section 5 and Section 6 of this report. Table 20 below shows the probability of contributing to peat slides based on evidence of previous peat landslide events.

Historical Peat Slips	Probability
No Evidence	Negligible
Little	Unlikely
Frequent	Probable
Many	Likely
Continuous/Significant	Very Likely

Table 20: Probability of peat slide occurrence based on evidence of historical peat slips

8. Weather

This can be evaluated from the weather records of the site area. Table 21 below shows the probability of contributing to peat slides based on weather conditions.

Weather	Probability
Previous Very Dry Period in excess of 5 years	Negligible
Previous Very Dry Period within 4-5 years	Unlikely
Previous Very Dry Period within 3-4 years	Probable
Previous Very Dry Period within 2-3 years	Likely
Previous Very Dry Period within 1-2 years	Very Likely

Table 21: Probability of peat slide occurrence based on weather conditions

8.3.2 Peat Slip Assessment

The likelihood of occurrence of peat slide based on each of the eight contributory factors has been assessed based on the information available and is detailed below in Table 22 through Table 29.

Location	**Moisture Content**		
	Moisture Content	**Probability**	**Probability (%)**
T3	11%	Negligible	10
T4	31%	Negligible	10
T3+350 - T3+400	<500%*	Negligible	10
Substation and BESS Compound	16%	Negligible	10
Temporary Construction Compound	<500%*	Negligible	10
Storage Area	<500%*	Negligible	10
Borrow Pit	18%	Negligible	10

*Refer to assumption no. 5 in Section 8.1.4

Table 22: Probability of occurrence of peat slide based on moisture content values

Location	**Peat Depth (m)**		
	Average Peat Depth (m)	**Probability**	**Probability (%)**
T3	0.3	Negligible	10
T4	0.4	Negligible	10
T3+350 - T3+400	1.2	Probable	40
Substation and BESS Compound	0.4	Negligible	10
Temporary Construction Compound	0.5	Negligible	10
Storage Area	0.1	Negligible	10
Borrow Pit	0.3	Negligible	10

Table 23: Probability of occurrence of peat slide based on peat depth values

Location	**Slope Angle (°)**		
	Recorded Value	**Probability**	**Probability (%)**
T3	12.7	Likely	65
T4	11.4	Likely	65
T3+350 - T3+400	6.1	Probable	40
Substation and BESS Compound	6.5	Probable	40
Temporary Construction Compound	4.6	Probable	40
Storage Area	4.9	Probable	40
Borrow Pit	10.6	Likely	65

Table 24: Probability of occurrence of peat slide based on slope angle values

Location	Cracking		
	Recorded Value	Probability	Probability (%)
T3	No Evidence	Negligible	10
T4	No Evidence	Negligible	10
T3+350 - T3+400	No Evidence	Negligible	10
Substation and BESS Compound	No Evidence	Negligible	10
Temporary Construction Compound	No Evidence	Negligible	10
Storage Area	No Evidence	Negligible	10
Borrow Pit	No Evidence	Negligible	10

Table 25: Probability of occurrence of peat slide based on cracking observed

Location	Underground Hydrology		
	Recorded Value	Probability	Probability (%)
T3	None Evident	Negligible	10
T4	None Evident	Negligible	10
T3+350 - T3+400	None Evident	Negligible	10
Substation and BESS Compound	None Evident	Negligible	10
Temporary Construction Compound	None Evident	Negligible	10
Storage Area	None Evident	Negligible	10
Borrow Pit	None Evident	Negligible	10

Table 26: Probability of occurrence of peat slide based on underground hydrology

Location	Surface Hydrology		
	Recorded Value	Probability	Probability (%)
T3	None Evident	Negligible	10
T4	None Evident	Negligible	10
T3+350 - T3+400	None Evident	Negligible	10
Substation and BESS Compound	None Evident	Negligible	10
Temporary Construction Compound	None Evident	Negligible	10
Storage Area	None Evident	Negligible	10
Borrow Pit	None Evident	Negligible	10

Table 27: Probability of occurrence of peat slide based on surface hydrology

Location	Historical Slips		
	Recorded Value	Probability	Probability (%)
T3	No Evidence	Negligible	10
T4	No Evidence	Negligible	10
T3+350 - T3+400	No Evidence	Negligible	10
Substation and BESS Compound	No Evidence	Negligible	10
Temporary Construction Compound	No Evidence	Negligible	10

Location	Historical Slips		
	Recorded Value	Probability	Probability (%)
Storage Area	No Evidence	Negligible	10
Borrow Pit	No Evidence	Negligible	10

Table 28: Probability of occurrence of peat slide based on historical slips

Location	Weather (Previous Dry Period)		
	Recorded Value	Probability	Probability (%)
T3	1-2 years	Very Likely	90
T4	1-2 years	Very Likely	90
T3+350 - T3+400	1-2 years	Very Likely	90
Substation and BESS Compound	1-2 years	Very Likely	90
Temporary Construction Compound	1-2 years	Very Likely	90
Storage Area	1-2 years	Very Likely	90
Borrow Pit	1-2 years	Very Likely	90

Table 29: Probability of occurrence of peat slide based on weather (previous dry period)

Table 8 of the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) has been adopted to assess the the likelihood of occurrence of a peat slide.

Probability (P) Value	
Very Likely	>75%
Likely	50-75%
Probable	25-50%
Unlikely	10-25%
Negligible	<10%

Table 30: Probability Values for Likelihood of Peat Slip Occurring

In order to maintain consistent results across the varying methods of analysis used in this report, th following approach has been adopted to summarise the above tables:

Probability (P) Value	
High	>75%
Medium	25-75%
Low	10-25%
Negligible	<10%

Table 31: Probability Values for Likelihood of Peat Slip Occurring Developed by AFRY

After taking into account all eight contributory factors, probability has been assessed and is outlined in the table below;

Location	Probability (%)	Probability
T3	27	Medium
T4	27	Medium
T3+350 - T3+400	28	Medium
Substation and BESS Compound	24	Low

Location	Probability (%)	Probability
Temporary Construction Compound	24	Low
Storage Area	24	Low
Borrow Pit	27	Medium

Table 32: Result of Qualitative Risk Assessment

8.3.3 Summary

Based on the above qualitative assessment, the probability/likelihood of peat slide occurrence at the borrow pit, turbine locations T3 and T4, and along the access road to T3 (between chainages T3+350 and T3+400) is deemed as MEDIUM. The substation and battery storage compound, temporary construction compound, and storage area are assessed as having a LOW likelihood of peat slide occurrence. All other areas of the Proposed Wind Farm site have no likelihood of peat slide occurrence.

9. PEAT STABILITY RISK ASSESSMENT

Risk assessment is a screening process at the end of which it may be necessary to undertake more detailed studies or identify the residual risks associated with the development after the implementation of the mitigation measures. The Peat Slide Risk Assessment for the Proposed Wind Farm involved a number of steps identified within this document – please refer to the risk assessment process map which follows.

The Peat Slide Risk Assessment methodology is adopted from *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) and The Geotechnical Risk Assessment methodology devised by AFRY. This methodology utilises the well-defined principal that,

RISK = PROBABILITY x CONSEQUENCE

where PROBABILITY and CONSEQUENCE have been defined as: -

PROBABILITY = Likelihood of a peat landslide occurring

CONSEQUENCE = Severity of a peat landslide

The risk assessment matrix developed by AFRY to represent how risk varies with probability and consequence is displayed below.

		CONSEQUENCE			
		NEGLIGIBLE	LOW	MEDIUM	HIGH
PROBABILITY or LIKELIHOOD	NEGLIGIBLE	Negligible	Negligible	Low	Low
	LOW	Negligible	Low	Medium	Medium
	MEDIUM	Low	Medium	Medium	High
	HIGH	Low	Medium	High	High

Figure 4: Risk Assessment Matrix

It is proposed that site infrastructure identified with a Negligible or Low risk from a landslide (or other geotechnical failure) perspective would not have any further consideration within this report.

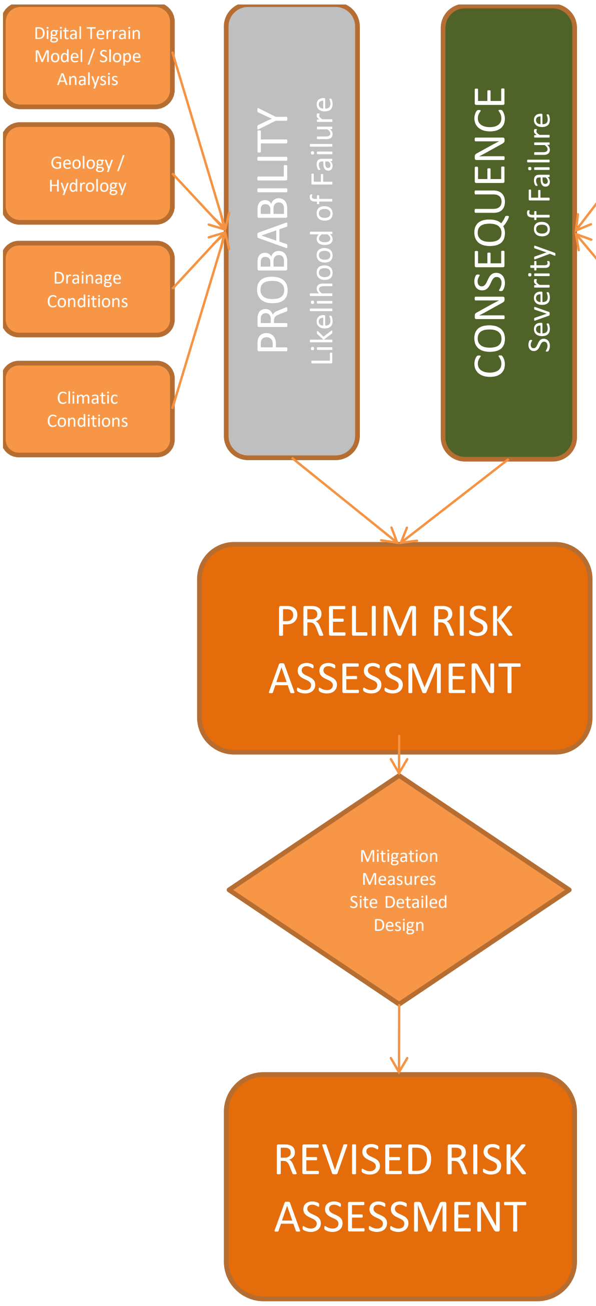


Figure 5: Revised Risk Assessment Process

The following paragraphs describe how PROBABILITY and CONSEQUENCE have been identified and what processes are involved in establishing these values.

9.1 Probability

Based on the quantitative and qualitative risk assessments carried out in Section 8 of this report, the probability of risk is shown in the table below.

SUMMARY OF QUANTITATIVE AND QUALITATIVE RISK ASSESSMENTS		
	Quantitative Risk Assessment	Qualitative Risk Assessment
Location	Infinite Slope Analysis	Peat Slide Risk
T3	LOW	MEDIUM
T4	LOW	MEDIUM
T3+350 - T3+400	LOW	MEDIUM
Substation and BESS Compound	LOW	LOW
Temporary Construction Compound	LOW	LOW
Storage Area	LOW	LOW
Borrow Pit	LOW	MEDIUM

Table 33: Summary of Quantitative and Qualitative Risk Assessments

9.2 Consequence

In this report, the consequence of a geotechnical failure is considered to be the scale of the damage inflicted by the geotechnical failure on the surrounding area. The rising scale of consequence is considered as follows:-

CONSEQUENCE		
	WIND FARM INFRASTRUCTURE	**LOCAL ECOLOGY/ENVIRONMENT**
Negligible	Little or no effect on the wind farm infrastructure. No works are required in the site area.	Little or no effect on local wildlife habitat
Low	A land/peat slide does not directly affect any site infrastructure. The wind farm is not shut down. Works are required to stabilise/reinstate the slide area.	A land/peat slide destroys/affects wildlife habitat within the site boundary.
Medium	A land/peat slide deposits debris over and against site infrastructure without causing structural damage. The wind farm is not shut down. Works are required to stabilise/reinstate the slide area. Works are required to clear areas affected by slide debris.	A land/peat slide destroys/pollutes wildlife habitat within and beyond the site, deposits debris over and against transport links and property without causing structural damage. Works are required to stabilise/reinstate the slide area. Works required to clear areas affected by slide debris.
High	A land/peat slide de-stabilises site foundations / site roads / local pylons / substation. The wind farm is shut down. Works are required to stabilise/reinstate the slide area. Works are required to rebuild roads/buildings/site	A land/peat slide destroys/pollutes wildlife habitat within and beyond the site, damages transport links and damages surrounding property. Works are required to stabilise/reinstate the slide area. Works are required to clear debris, rebuild damaged transport links and buildings.

CONSEQUENCE		
	infrastructure damaged by slide debris	

Analysing the site layout in conjunction with the 1:25,000 OSI map of the area, available aerial photography and gathered site data have allowed AFRY to consider the likely consequence of potential geotechnical failures within the site.

Table 34 below indicates the consequence of a peat slide in the proposed site location.

Location	Consequence
T3	LOW
T4	LOW
T3+350 - T3+400	LOW
Substation and BESS Compound	LOW
Temporary Construction Compound	LOW
Storage Area	LOW
Borrow Pit	LOW

Table 34: Summary of Consequence

9.3 Overall Risk Assessment

Table 35 summarises the probability and consequence of failure and highlights higher risk areas across the site.

LOCATION	PROBABILITY			CONSEQUENCE	SUMMARY
	QUANTITATIVE ASSESSMENT	QUALITATIVE ASSESSMENT	PROBABILITY	CONSEQUENCE	OVERALL RISK
T3	LOW	MEDIUM	MEDIUM	LOW	MEDIUM
T4	LOW	MEDIUM	MEDIUM	LOW	MEDIUM
T3+350 - T3+400	LOW	MEDIUM	MEDIUM	LOW	MEDIUM
Substation and BESS Compound	LOW	LOW	LOW	LOW	LOW
Temporary Construction Compound	LOW	LOW	LOW	LOW	LOW
Storage Area	LOW	LOW	LOW	LOW	LOW
Borrow Pit	LOW	MEDIUM	MEDIUM	LOW	MEDIUM

Table 35: Overall Risk Assessment

9.4 Discussion

While qualitative assessments can provide valuable insights, quantitative analyses offer a more informed and data-driven understanding of risks across various locations. Quantitative analyses better reflect site conditions by examining numerical data, which holds true for the Proposed Project site. Although the site features steep slopes, peat is restricted to the topsoil layer at all infrastructure locations. For the construction of the Proposed Project, it is recommended to remove the topsoil layer; this topsoil layer will be utilised for reinstatement purposes after the construction phase has been completed.

10. MITIGATION MEASURES AND REVISED RISK ASSESSMENT

10.1 Avoidance

If the risk of peat slide failure is assessed to be high, avoidance is suggested as a mitigation measure. This scenario does not apply at the Proposed Wind Farm ..

10.2 Micrositing Infrastructure

No micrositing of infrastructure was necessary for the Proposed Wind Farm due to the level of risk identified onsite.

10.3 Engineered Solution

10.3.1 Installation of Drainage Measures

Installation of targeted drainage measures will isolate areas of susceptible peat from upslope water supply, re-routing surface (flushes/gullies) and subsurface (pipes) drainage around critical areas. Surface water drainage plans have been considered as a useful way of accounting for modified flows created by construction, which in turn may affect peat stability, pollution and wildlife interests. Drainage measures have been carefully planned to minimise any negative impacts, and are included as Appendix 9-1 to Chapter 9 of the EIAR.

10.3.2 Leaving the Peat in Place

This mitigation measure has been adopted from the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006). When dealing with peat depths in excess of 2 metres, it normally becomes more cost effective to leave the peat in place and utilise the strength of the in-situ peat. The most commonly used methods in low volume/low-cost roads are:

- **Placing an embankment over a layer of timber/timber brash as recommended by the Forestry Commission**: This method involves laying a raft of timber directly onto the peat surface and then constructing an embankment on top of the raft. In the short and medium term this provides a reinforcement effect to the base of the embankment, aids stability, and can reduce differential settlements and lateral stresses on the peatland surface.
- **Constructing an embankment using geotextiles and geogrids**: Geotextiles act as a separator and filter and are placed directly onto the peat surface. However, it is the geogrid layers that provide reinforcement to the base of the embankment. Geogrids also aid stability and can reduce differential settlements and lateral stresses on the peatland surface.

Both of the above methods have the benefit of reducing the amount of material required to build the embankment, and a combination of the two methods can be used, involving brash below a geogrid reinforced road. When using geogrids an appropriately sized and graded engineering fill is required to provide the necessary interlocking effect.

In the “Leaving the Peat in Place” construction method, a loading rate is to be determined prior to the construction process and amended during construction. A “loading rate” is the time for materials to be delivered at the embankment head of the road under construction. During construction, the following elements will be monitored:

- Increased rate of sinking or tilting
- Rising of adjacent peat

- Cracking on peat surface
- Rise in water levels

If visual monitoring shows deterioration in the four elements listed above, the time interval between loading will be increased in order to decrease the risk (Figure 6 below).

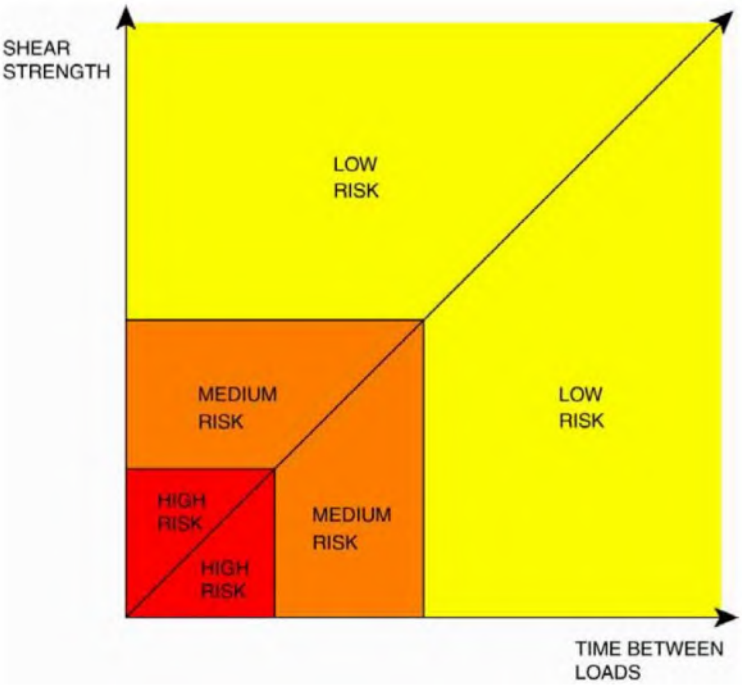


Figure 6: Graph showing relationship between shear strength and time between loads (MacCulloch 2006)

The graph shown in Figure 4 above indicates that reducing the time between deliveries would increase the risk of peat failure. However, increasing the time between the loads allows the pore water pressure to dissipate into the adjoining peat, thus reducing the risk.

In general, if the period of recovery for sinking or tilting, rising of adjacent peat, cracking or rise of water level is too slow due to excessively poor shear strength in the peat, the Excavation and Replacement method (as outlined in the following section) shall be adopted as a mitigation measure.

10.3.3 Excavation and Replacement

In this method the peat is removed, usually side cast, and the mineral sub soil exposed, shaped, and an embankment constructed on it. This method is, in construction terms, almost fail-safe, and is restricted only by the depth of peat. In low-cost roads, the economic depth is approximately 2 metres. The risk is thus moved to the adjacent peat, and to the placement method used for the excavated peat spoil.

In this method of construction, the designer and contractor have several design features to address;

- Shallower excavated faces can be left nearly vertical in the short term. This is an unusual feature of peat, particularly considering the water content. As the peat is excavated, the phreatic surface drops with a consequent reduction in the hydrostatic pressure.

- Localised failures can occur on the edges of the excavation. These may be as a result of encountering peat areas of high water content. Such failures are usually minor but can trigger retrogressive failure.
- The collapse of an excavated face can lead to the siltation, or more significantly damming of a ditch, watercourse or pipe. This could, in turn, trigger a slide event.
- Alteration of water flows will increase the slide risk by increasing the flow or pressure within the pipe system.
- The drainage of the road and the surrounding peatland area must be carefully planned to ensure water flows away from the road.
- The position of the road on a side slope is critical. This is particularly true on convex slopes where the excavation could remove toe support thus triggering a slip.
- The placement of excavated peat requires careful attention. Until the pore water dissipates, the stability of the peat is at its most vulnerable.

10.4 General Mitigation Measures

The following are mitigation measures to be adopted at all locations where peat depths are ≥ 1.0m.

- Upslope cut-off drains will be installed in advance of construction activities to prevent water build up in excavations.
- The sides within excavated peat will be sloped back at an angle of 30 degrees to the horizontal to prevent slippage.
- No excavations shall take place unless fill material is available for filling at the point of excavation. Excavation will be limited to the reach of the excavator sitting on the constructed road surface.
- Any excavations will be immediately backfilled with suitable material when available.
- Excavation for access track to be backfilled as soon as practicable in intact peat. Excavation and filling operations will be co-ordinated to minimise the time an excavation remains unfilled.
- Deposition of excavated material must not occur outside designated areas; temporary stock piling would take place within the development footprint of turbine hardstands before reinstatement and disposal at proposed deposition areas.
- Temporary deposition of excavated soils will only be allowed in areas with peat depth less than 0.5m.
- Excavated spoil will not be deposited on the downslope or upslope edges of adjacent peat.
- Existing drainage patterns in peat will be maintained whenever possible, and any uncontrolled discharges of water onto peat will be prevented.
- Engineered drainage to prevent concentrated flow onto slopes or into excavations. Pumping to be used as required until a permanent solution is in place.
- As per *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) catch wall fences shall be positioned downslope of the suspected or known landslide prone area to slow or halt runout. Similarly, catch ditches may also be

used to slow or halt runout, although it is preferable that they are cut in non-peat material.

- Machinery use on peat surfaces would be minimized, and dependant on site topography the use of vibrating rollers may not be permitted.
- Materials must not be stockpiled, and heavy machinery must not be parked on peat surfaces.
- The use of low ground bearing pressure machines to be used on areas of peat exceeding 1m depth.
- No operatives other than the excavator driver to be allowed in close proximity to open excavations.
- Monitoring posts to be installed in vicinity of risk areas and to be inspected prior to and following works each day by a competent person.
- A qualified geotechnical and/or environmental engineer will conduct regular site visits and assessments to monitor the potential for a peat slide regularly during construction.
- Upon commencement of the reinstatement works, guidance from a suitably qualified environmental professional will be sought to confirm the methodology and programme.
- Exclusion zones delineating the working corridor will be established around all working areas using post and rope fences. No activity will be permitted past this fence.
- The environmental manager or other designated person will conduct induction training and toolbox talks with site staff to explain the risks associated with working on peat, the procedures for reducing the risk of peat slides, and the location of exclusion zones.
- Strict adherence to method statements is required at all times, and any deviation from the agreed work methodology must be approved by a suitably qualified environmental professional or the site geotechnical engineer.
- Particular attention will be paid to conditions during and after heavy rainstorms, especially following extended dry periods when the likelihood of peat movement is higher. The site supervisor would suspend work if either work practices or weather conditions are deemed unsafe.
- After reinstatement is completed, the disposal sites will be re-vegetated using the topsoil, sod or harvested peat.

The above mitigation measures will be implemented in order to reduce the existing risks to acceptable levels.

10.5 Revised Peat Slide Risk Assessment

A LOW risk rating is indicated where the risk can be managed through the mitigation measures indicated. The risk rating at all areas on the site is reduced to LOW provided all mitigation measured are adhered to. Regular checking of peat monitoring posts shall be carried out and if there are any signs of peat instability works in the vicinity will be ceased immediately and a construction method statement will be developed before proceeding further.

11. PRELIMINARY CONSTRUCTION DETAILS

11.1 Turbine Foundations

From a review of the available information associated with the ground conditions present across the site, the following commentary is supplied in relation to the turbine locations. The purpose of the following sections is to define the design approach and present details for the proposed foundations and associated site infrastructure including site roads and hardstands.

Groundwater levels recorded during the trial pit investigation at each turbine location are listed in Table 6 of Section 7. At T7, groundwater was encountered 1.8m below ground level. No groundwater was not encountered at turbine locations T1, T2, T3, T4, T5 and T6, however, it should be noted that only one trial pit was conducted at each of these locations. Given the current information, reinforced concrete Buoyant Gravity foundations are proposed for all turbine locations. However, the possibility of utilizing a non-buoyant foundation solution can be explored during the detailed design stage when a more comprehensive site investigation is completed, which will provide additional insight into the subsurface conditions and inform the most appropriate engineering approach.

Table 36 below presents a summary of the ground conditions encountered during the geotechnical investigation and the likely foundation type. It is to be noted that these are subject to confirmation during the detailed design stage.

Turbine Location	Relevant GI	Geology Encountered	Trial Pit Refusal Depth (m bgl)	Foundation Type
T1	TP-T1-01	Stiff light brown sandy gravelly SILT. Sand is fine to coarse. Gravel is subrounded fine to coarse.	3.2	Gravity Buoyant
T2	TP-T2-01	Stiff light brown sandy gravelly SILT. Sand is fine to coarse. Gravel is subrounded fine to coarse.	1.2	Gravity Buoyant
T3	TP-T3-01	Brownish grey highly weathered GREYWACKE recovered as sandy very angular gravel with high cobble content.	2.3	Gravity Buoyant
T4	TP-T4-01	0.4m - 1.2m: Soft light brownish grey sandy gravelly SILT with low cobble and boulder content. Sand is fine to coarse. Gravel is angular fine to coarse. TP Refusal encountered at 1.2m	1.2	Gravity Buoyant
T5	TP-T5-01	Brownish highly weathered GREYWACKE recovered as slightly sandy very angular	1.9	Gravity Buoyant

Turbine Location	Relevant GI	Geology Encountered	Trial Pit Refusal Depth (m bgl)	Foundation Type
		gravel with high cobble content.		
T6	TP-T6-01	Stiff brown sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is angular fine to coarse.	3.2	Gravity Buoyant
T7	TP-T7-01	Stiff light brown sandy gravelly SILT with low cobble and boulder content. Sand is fine to coarse. Gravel is angular fine to coarse.	3.2	Gravity Buoyant

Table 36 : Summary of Indicative Turbine Foundation Type

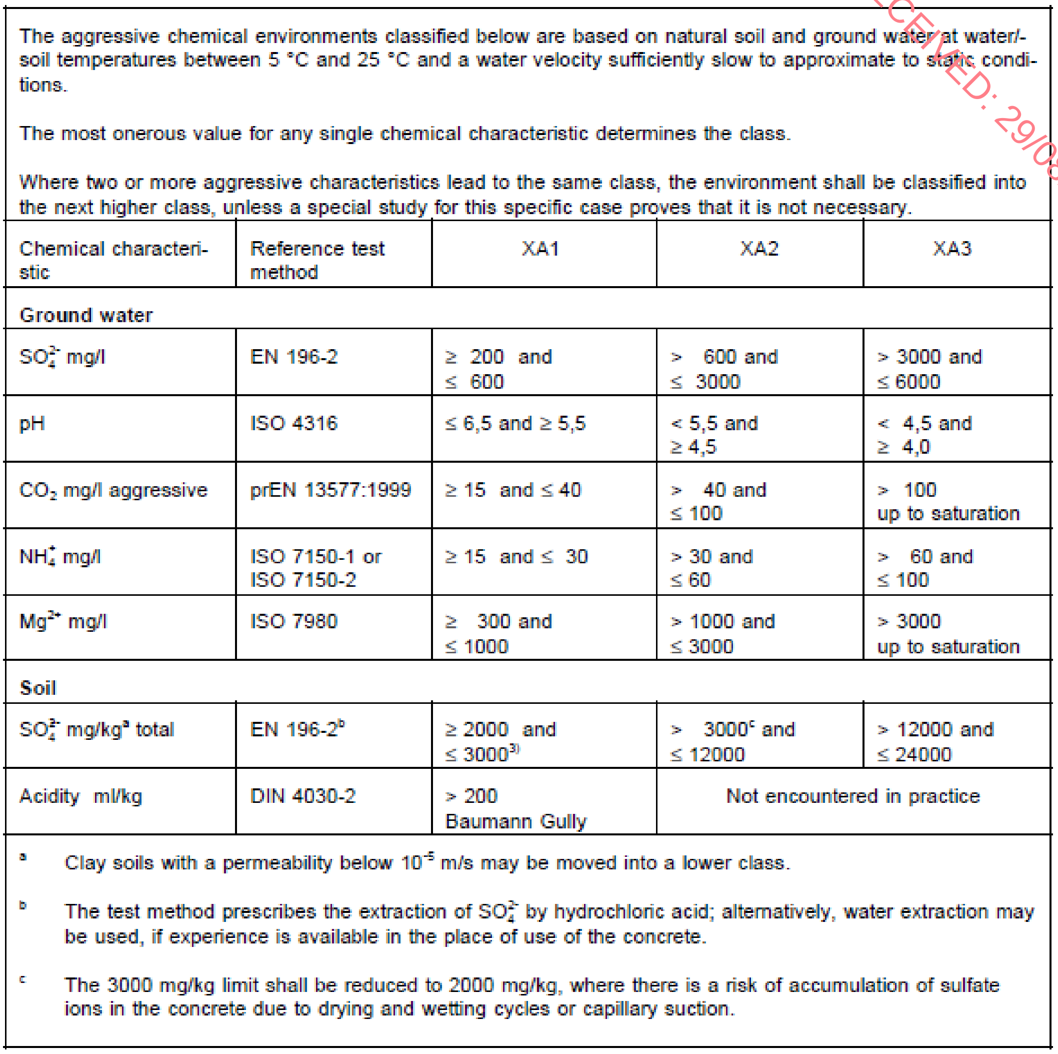
Further ground investigation will be carried out at the detailed design stage at each turbine location in the form of a borehole with in-situ SPT testing at 1m intervals in the overburden and follow-on rotary core through bedrock to confirm the foundation types and formation strata.

For gravity type turbine foundations, where the depth of excavation exceeds the required formation depth for the proposed turbine base, engineered fill (6N or equivalent) shall be used to backfill the excavation to the required formation depth.

11.2 Concrete Specification

Based on the presence of peat at the Proposed Wind Farm site, it is anticipated that XA1 classification will be required at a minimum at this location.

The pH of the samples taken from the trial pits at turbine locations to date averages 6.4, ranging from 5.8 to 7.6 indicating an acidic to neutral environment, as tabulated in Table 9.



The aggressive chemical environments classified below are based on natural soil and ground water at water/-soil temperatures between 5 °C and 25 °C and a water velocity sufficiently slow to approximate to static conditions.

The most onerous value for any single chemical characteristic determines the class.

Where two or more aggressive characteristics lead to the same class, the environment shall be classified into the next higher class, unless a special study for this specific case proves that it is not necessary.

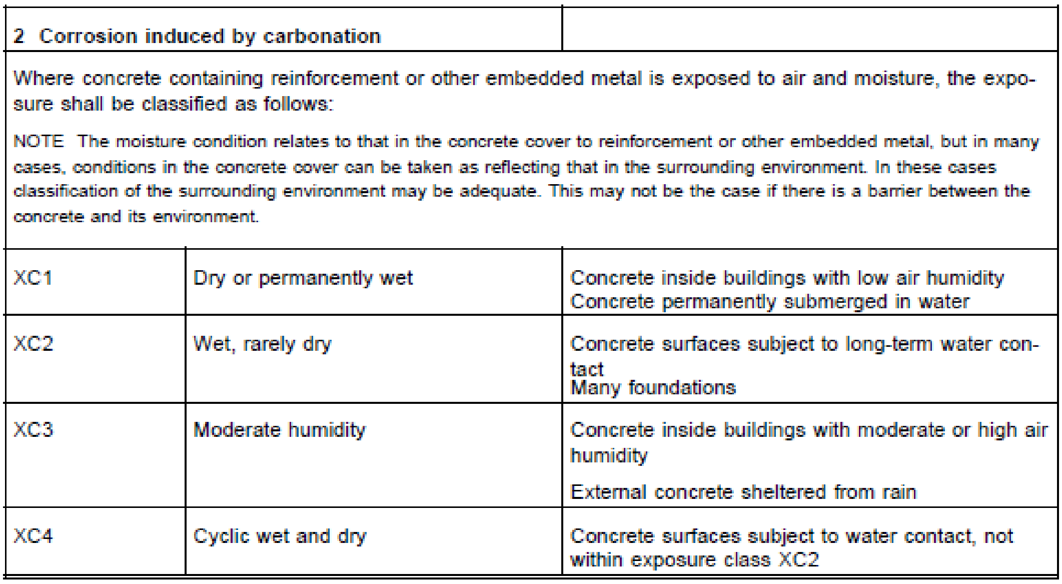
Chemical characteristic	Reference test method	XA1	XA2	XA3
Ground water				
SO_4^{2-} mg/l	EN 196-2	$\geq$ 200 and $\leq$ 600	$>$ 600 and $\leq$ 3000	$>$ 3000 and $\leq$ 6000
pH	ISO 4316	$\leq$ 6,5 and $\geq$ 5,5	$<$ 5,5 and $\geq$ 4,5	$<$ 4,5 and $\geq$ 4,0
CO_2 mg/l aggressive	prEN 13577:1999	$\geq$ 15 and $\leq$ 40	$>$ 40 and $\leq$ 100	$>$ 100 up to saturation
NH_4^+ mg/l	ISO 7150-1 or ISO 7150-2	$\geq$ 15 and $\leq$ 30	$>$ 30 and $\leq$ 60	$>$ 60 and $\leq$ 100
Mg^{2+} mg/l	ISO 7980	$\geq$ 300 and $\leq$ 1000	$>$ 1000 and $\leq$ 3000	$>$ 3000 up to saturation
Soil				
SO_4^{2-} mg/kg[a] total	EN 196-2[b]	$\geq$ 2000 and $\leq$ 3000[3)]	$>$ 3000[c] and $\leq$ 12000	$>$ 12000 and $\leq$ 24000
Acidity ml/kg	DIN 4030-2	$>$ 200 Baumann Gully	Not encountered in practice	

[a] Clay soils with a permeability below 10^{-5} m/s may be moved into a lower class.

[b] The test method prescribes the extraction of SO_4^{2-} by hydrochloric acid; alternatively, water extraction may be used, if experience is available in the place of use of the concrete.

[c] The 3000 mg/kg limit shall be reduced to 2000 mg/kg, where there is a risk of accumulation of sulfate ions in the concrete due to drying and wetting cycles or capillary suction.

Table 37: Limiting Values for Exposure Classes for Chemical Attack (I.S. EN 206.1)



2 Corrosion induced by carbonation

Where concrete containing reinforcement or other embedded metal is exposed to air and moisture, the exposure shall be classified as follows:

NOTE The moisture condition relates to that in the concrete cover to reinforcement or other embedded metal, but in many cases, conditions in the concrete cover can be taken as reflecting that in the surrounding environment. In these cases classification of the surrounding environment may be adequate. This may not be the case if there is a barrier between the concrete and its environment.

XC1	Dry or permanently wet	Concrete inside buildings with low air humidity Concrete permanently submerged in water
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact Many foundations
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity External concrete sheltered from rain
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure class XC2

Table 38: Exposure Classes related to Environmental Actions (I.S. EN 206.1)

12. SUMMARY AND RECOMMENDATIONS

No evidence or indications of any previous landslides or past geological failures within the Proposed Wind Farm site was identified during the site walkovers and site investigation. Additionally, the review of published GSI geological data and analysis of aerial/satellite imagery also did not indicate any such failures.

Observations from site walkovers indicate that the topography of the site is hilly. This observation is supported by the terrain assessment of the Bluesky's DTM, which shows the slope angles on site range from 4.6° to 15.1°. The findings of the site investigation data suggest favourable subsoil conditions and shallow peaty topsoil across the site.

When a quantitative assessment for undrained condition was carried out, Factors of Safety (FoS) ranged from 3.6 to 146.9 for 1m peat surcharge. The drained analysis resulted in FoS values between 1.4 to 58.8 for 1m peat surcharge. FoS values higher than 1.3 are deemed to have a negligible probability of instability once mitigation/control measures are implemented.

A qualitative assessment of the peat stability returned a LOW risk at the substation and battery storage compound, temporary construction compound, and storage area. The risk at the borrow pit, turbine locations T3 and T4, and along the access road to T3 (between chainages T3+350 and T3+400) was MEDIUM. This was based on steep slopes and previous periods of dry conditions.

Overall, the peat stability risk was determined to be Low to Medium at all locations where peat depths of 0.5m or greater were observed. It is essential to note, however, that the presence of peat on-site is minimal and largely confined to the topsoil layer. The Peat and Spoil Management Plan, detailed in Appendix 4-2 of the EIAR, proposes the removal of topsoil at all proposed infrastructure locations for reinstatement purposes, with any surplus to be deposited in the borrow pit.

Consequently, it is reasonable to conclude that the risks associated with peaty topsoil can be effectively managed through standard design and construction mitigation measures, ensuring both short-term and long-term stability of the Proposed Wind Farm site. The report also includes recommendations and mitigation measures for construction work in peatlands to ensure that all works adhere to an acceptable standard of safety.

The recommendations and guidelines outlined within Appendix 4-2: Peat and Spoil Management Plan prepared by AFRY will be taken into consideration during the detailed design and construction stage of the wind farm development.

To minimise the risk of construction activity causing potential peat instability it is recommended that the Construction Method Statements for the project take into account, but not be limited to, the recommendations above. This will ensure that best practice guidance regarding the management of peat stability is integrated into the construction phase.

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APPENDIX A – PHOTOS FROM SITE WALKOVER

Photo 1: End of the storage area looking downhill

Photo 2: On storage area platform looking up at T5

Photo 3: Storage area platform

Photo 4: At the storage area looking down the gap road

Photo 5: At the gap road looking up at T5 location

Photo 6: Access road to T5

APPENDIX B – PEAT PROBING DATA

X(ITM)	Y(ITM)	Peat Depth (m)
562322	673188	0.00
563271	671817	0.00
563446	672540	0.20
563447	672519	0.30
563448	672541	0.30
563451	672510	0.20
563454	672548	0.20
563471	672233	0.00
563485	672156	0.20
563500	672562	0.20
563502	672546	0.20
563528	672573	0.40
563556	672091	0.10
563634	672475	0.50
563638	672616	0.30
563655	672490	0.40
563664	672553	0.00
563665	672432	0.50
563687	673002	0.70
563692	672449	0.50
563698	672806	1.54
563699	672897	0.50
563707	672784	1.53
563708	672785	0.40
563709	672846	0.20
563720	672497	0.00
563732	672727	0.30
563745	672963	0.40
563747	672966	1.55
563747	672967	1.56
563747	672694	0.20
563747	672646	0.40
563756	672951	1.57
563762	672944	1.58
563776	672925	0.90
563782	672463	0.60
563820	672752	0.30
563833	672740	0.30
563834	672861	0.60
563855	672481	0.50
563857	672847	0.60
563867	672751	0.40

X(ITM)	Y(ITM)	Peat Depth (m)
563869	672830	0.50
563902	672373	0.30
563915	672800	1.00
563951	672807	0.70
563966	672232	0.20
564014	673300	0.30
564053	672371	0.00
564084	672369	0.00
564087	672370	0.00
564123	672367	0.00

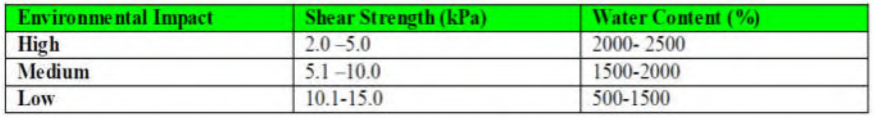
APPENDIX C – PEAT SLIP ASSESSMENT

	Peat Strength (kPa)			Peat Depth (m)			Slope Angle (°)			Cracking		
	Shear Strength	Probability	Probability (%)	Average Peat Depth	Probability	Probability (%)	Recorded Value	Probability	Probability (%)	Recorded Value	Probability	Probability (%)
T3	0-500	Negligible	10	0.30	Negligible	10	12.7	Likely	65	No Evidence	Negligible	10
T4	0-500	Negligible	10	0.40	Negligible	10	11.4	Likely	65	No Evidence	Negligible	10
T3+350 - T3+400	0-500	Negligible	10	1.20	Probable	40	6.1	Probable	40	No Evidence	Negligible	10
Substation and BESS Compound	0-500	Negligible	10	0.40	Negligible	10	6.5	Probable	40	No Evidence	Negligible	10
Temporary Construction Compound	0-500	Negligible	10	0.50	Negligible	10	4.6	Probable	40	No Evidence	Negligible	10
Storage Area	0-500	Negligible	10	0.10	Negligible	10	4.9	Probable	40	No Evidence	Negligible	10
Borrow Pit	0-500	Negligible	10	0.30	Negligible	10	10.6	Likely	65	No Evidence	Negligible	10

* = Derived from Table 6 in *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006)

	Underground Hydrology			Surface Hydrology			Historical Slips			Weather (Previous Dry Period)		
	Recorded Value	Probability	Probability (%)	Recorded Value	Probability	Probability (%)	Recorded Value	Probability	Probability (%)	Recorded Value	Probability	Probability (%)
T3	None Evident	Negligible	10	None Evident	Negligible	10	No Evidence	Negligible	10	1-2 years	Very Likely	90
T4	None Evident	Negligible	10	None Evident	Negligible	10	No Evidence	Negligible	10	1-2 years	Very Likely	90
T3+350 - T3+400	None Evident	Negligible	10	None Evident	Negligible	10	No Evidence	Negligible	10	1-2 years	Very Likely	90
Substation and BESS Compound	None Evident	Negligible	10	None Evident	Negligible	10	No Evidence	Negligible	10	1-2 years	Very Likely	90
Temporary Construction Compound	None Evident	Negligible	10	None Evident	Negligible	10	No Evidence	Negligible	10	1-2 years	Very Likely	90
Storage Area	None Evident	Negligible	10	None Evident	Negligible	10	No Evidence	Negligible	10	1-2 years	Very Likely	90
Borrow Pit	None Evident	Negligible	10	None Evident	Negligible	10	No Evidence	Negligible	10	1-2 years	Very Likely	90

* = Derived from Table 6 in *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006)



Environmental Impact	Shear Strength (kPa)	Water Content (%)
High	2.0 –5.0	2000- 2500
Medium	5.1 –10.0	1500-2000
Low	10.1-15.0	500-1500

Table 6: Range of Shear Strength and Water Content Values

Likelihood		
	Probability (%)	Probability
T3	27	Probable
T4	27	Probable
T3+350 - T3+400	28	Probable
Substation and BESS Compound	24	Unlikely
Temporary Construction Compound	24	Unlikely
Storage Area	24	Unlikely
Borrow Pit	27	Probable

Contributory factor	Method of Assessment	Value/Indicator	Probability of Contributing to Peat Movement	Control Measure Required
Moisture Content	Experience or if available laboratory results.	0-500%	Negligible	No
		500-1000%	unlikely	No
		1000-1500%	probable	Yes
		1500-2000%	Likely	Yes
		2000-2500	Very Likely	Yes
Peat Depth	Measured using peat probes, Ground Radar, Trial Pits	0- 0.5 metre	Negligible	No
		0.5 – 1.0	Unlikely	No
		1.0 – 1.5	Probable	Yes
		1.5 – 2.0	Likely	Yes
		2.0+	Very Likely	Yes
Slope Angle	Indicative from probing, or ground radar, measured when peat excavated.	0-3^0	Unlikely	No
		4-9^0	probable	yes
		10-15^0	Likely	Yes
		16-20^0	Very Likely	Yes
		20^0+	High Risk	Yes
Cracking (Tension and Compression)	Visual. Very Subjective also linked to depth of cracks. It also unlikely that cracking would exceed 20% of road corridor length	No Evidence	Negligible	No
		0-5% Road Length	Unlikely	No
		5-10% Road Length	Probable	Yes
		10-15% Road Lengths	Likely	Yes
		15-20% Road Lengths	Very Likely	Yes
Underground Hydrology (Pipes/Channels)	Visual. Very difficult to evaluate, but evidence may exist in the form of exit/entrances to underground channels. Collapsed ceilings of pipes may be evident	None Evident	Negligible	No
		Few	Unlikely	No
		Frequent	Probable	Yes
		Many	Likely	Yes
		Continuous/Significant	Very Likely	Yes
Surface Hydrology (Gully Channels, Hags and pool, systems, Wet Flushes, Water courses)	Visual. Interpretation may be necessary due to weather conditions at time of survey..	None evident	Negligible	No
		Few	Unlikely	No
		Frequent	Probable	Yes
		Many	Likely	Yes
		Continuous/Significant	Very Likely	Yes
Evidence of Previous Slips	Visual survey .No evidence would be no slips. Significant many small or one large slip	No Evidence	Negligible	No
		Little	Unlikely	No
		Frequent	Probable	Yes
		many	Likely	Yes
		Continuous/Significant	Very Likely	Yes
Weather	This can be evaluated from weather records for the area. With the suggested change in climate this feature may become a significant contributory factor. Research from Ireland has shown that most slides occur during a period of high rainfall following a dry period.	Previous Very Dry Period in excess of 5years.	Negligible	No
		Previous Very Dry Period within 4-5 years.	Unlikely	No
		Previous Very Dry Period within 3-4years.	Probable	Yes
		Previous Very Dry Period within 2-3 years.	Likely	Yes
		Previous Very Dry Period within 1-2 years.	Very Likely	Yes

Table 7: Contributory Factors with Probability Values

Probability (P) Value	
Very Likely	>75%
Likely	50 – 75%
Probable	25-50%
Unlikely	10- 25%
Negligible	<10%

Table 8: Probability Values

APPENDIX D – SI FACTUAL REPORT

Lackareagh Wind Farm – Ground Investigation

Client: MKO

Client's Representative: AFRY

Report No.: 23-1870

Date: March 2024

Status: Final for Issue

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Approved: ISO 9001 • ISO 14001 • OHSAS 18001

CONTENTS

APPENDICES

Document Control Sheet

Report No.:	23-1870
Project Title:	Lackareagh Wind Farm, Co. Clare – Ground Investigation
Client:	MKO
Client's Representative:	AFRY

Revision:	A00	**Status:**	Final for issue	**Issue Date:**	21st March 2024

Prepared by:	**Reviewed by:**	**Approved by:**
Carin Cornwall BSc MSc PhD	Matthew Gilbert MEarthSci FGS	Matthew Graham BEng(Hons) MIEI

The works were conducted in accordance with:

UK Specification for Ground Investigation 2nd Edition, published by ICE Publishing (2012)

British Standards Institute (2015) BS 5930:2015+A1:2020, Code of practice for ground investigations.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

Laboratory testing was conducted in accordance with:

British Standards Institute BS 1377:1990 parts 2, 4, 5, 7 and 9

METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in BS5930:2015+A1:2020, The Code of Practice for Ground Investigation.

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample (thick walled sampler).
UT	Nominal 100mm diameter undisturbed open tube sample (thin walled sampler).
P	Nominal 100mm diameter undisturbed piston sample.
B	Bulk disturbed sample.
LB	Large bulk disturbed sample.
SB	Sonic bulk disturbed sample.
D	Small disturbed sample.
C	Core sub-sample (displayed in the Field Records column on the logs).
L	Liner sample from dynamic sampled borehole.
W	Water sample.
ES / EW	Soil sample for environmental testing / Water sample for environmental testing.
SPT (s)	Standard penetration test using a split spoon sampler (small disturbed sample obtained).
SPT (c)	Standard penetration test using 60 degree solid cone.
(x,x/x,x,x,x)	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length.
(Y for Z/ Y for Z)	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given seating or test length 'Z' (mm).
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm).
HVP / HVR	In situ hand vane test result (HVP) and vane test residual result (HVR). Results presented in kPa.
V VR	Shear vane test (borehole). Shear strength stated in kPa. V: undisturbed vane shear strength VR: remoulded vane shear strength
Soil consistency description	In cohesive soils, where samples are disturbed and there are no suitable laboratory tests, N values may be used to indicate consistency on borehole logs – a median relationship of Nx5=Cu is used (as set out in Stroud & Butler 1975).
dd-mm-yyyy	Date at the end and start of shifts, shown at the relevant borehole depth. Corresponding casing and water depths shown in the adjacent columns.
▽	Water strike: initial depth of strike.
▼	Water strike: depth water rose to.
Abbreviations relating to rock core – reference Clause 36.4.4 of BS 5930: 2015+A1:2020	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.
(xxx/xxx/xxx)	Spacing between discontinuities (minimum/average/maximum) measured in millimetres.

Lackareagh Wind Farm, Co. Clare

1 AUTHORITY

On the instructions of AFRY Consulting Engineers, ("the Client's Representative"), acting on the behalf of MKO ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information for input to the design and construction of a proposed wind farm.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and the laboratory test results.

All information given in this report is based upon the ground conditions encountered during the ground investigation works, and on the results of the laboratory and field tests performed. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those recorded during the investigation. No responsibility can be taken for conditions not encountered through the scope of work commissioned, for example between exploratory hole points, or beneath the termination depths achieved.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to a particular set of instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SCOPE

The extent of the investigation, as instructed by the Client's Representative, included boreholes, trial pits, soil sampling, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted on the proposed site of Lackareagh Wind Farm, located in the townlands of Shannaknock and Killeagy in County Clare. The site includes forestry and farmland. It is bordered by forested land to the east, and fields to the north, south, and west. Kilbane village is located immediately west of the site.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 11th December 2023 and 29th January 2024, comprised:

- three boreholes by rotary drilling
- a standpipe installation in one borehole
- eighteen dynamic probes
- fourteen machine dug trial pits
- indirect CBR tests at twenty-seven locations.

The exploratory holes and in-situ tests were located as instructed by the Client's Representative, and as shown on the exploratory hole location plan in Appendix A.

4.2 Boreholes

Three boreholes (RC-SC-01 – RC-SC-03) were put to their completion by rotary drilling techniques only. The boreholes were completed using a low ground bearing tracked Comacchio 405 drilling rig.

Symmetrix-cased full hole rotary percussive drilling techniques were employed to advance the boreholes to bedrock, after which rotary coring was employed to recover core samples of the bedrock. SPTs were carried out at standard intervals throughout the overburden, with small and bulk disturbed samples obtained where possible through the soil strata.

The core was extracted in up to 1.5m lengths using a metric T2-101 core barrel, which produced core of nominal 84mm diameter, and was placed in triple channel wooden core boxes.

The core was subsequently photographed and examined by a qualified and experienced Engineering Geologist, thus enabling the production of an engineering log in accordance with *BS 5930: 2015+A1:2020: Code of practice for ground investigations*.

Appendix B presents the borehole logs, with core photographs presented in Appendix C.

4.3 Dynamic probes

Eighteen dynamic probes were conducted using the DPSHB method as described in BS EN ISO 22476-3:2005+A1:2011. The method entails a 63.5kg hammer falling 0.75m onto a 50.5mm diameter cone with an apex angle of 90°.

Appendix D provides the dynamic probe logs in the form of plots, against depth, of the number of blows per 100mm penetration.

4.4 Standpipe installations

A groundwater monitoring standpipe was installed in borehole RC-SC-02.

Details of the installations, including the depth range of the response zone, are provided in Appendix B on the individual borehole logs.

4.5 Trial Pits

Fourteen trial pits (TP-MM-01, TP-SC-01 – TP-SC-06, and TP-T1-01 – TP-T7-01) were excavated using a 13t tracked excavator fitted with a 600mm wide bucket, to depths of 1.20-3.40m.

Disturbed (small jar and bulk bag) samples were taken at standard depth intervals and at change of strata.

Any water strikes encountered during excavation were recorded along with any changes in their levels as the excavation proceeded. The stability of the trial pit walls was noted on completion.

Appendix E presents the trial pit logs with photographs of the pits and arising provided in Appendix F.

4.6 Indirect CBR tests (DCP)

An indirect CBR test was conducted at twenty-seven locations (DCP01-DCP27) using a Dynamic Cone Penetrometer (DCP). The equipment was developed in conjunction with the UK Transport Research Laboratory, and is discussed in Highways England CS229 (2020) which refers to the methodology described in TRL Overseas Road Note 18 (1999).

The test results are presented in Appendix G in the form of plots of the variation with depth of the penetration per blow. Straight lines have been fitted to the plots and the CBR for each depth range estimated using the following relationship, which is taken from TRRL Overseas Road Note 8 (1990), *A user's manual for a program to analyse dynamic cone penetrometer data*.

$$\text{Log CBR} = 2.48\text{-}1.057 \text{ Log (mm/blow)}$$

The frequently elevated CBR values are a consequence of the coarse-grained content of the penetrated soils and are often not representative of the soil matrix.

4.7 Surveying

The as-built exploratory hole positions were surveyed following completion of site operations by a Site Engineer from Causeway Geotech. Surveying was carried out using a Trimble R10 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates (Irish Transverse Mercator) and ground elevation (mOD Malin) at each location are recorded on the individual exploratory hole logs. The exploratory hole location plan presented in Appendix A shows these as-built positions.

5 LABORATORY WORK

Upon their receipt in the laboratory, all disturbed samples were carefully examined and accurately described, and their descriptions incorporated into the borehole logs.

5.1 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- **soil chemistry:** pH and water soluble sulphate content

Laboratory testing of soils samples was carried out in accordance with British Standards Institute: *BS 1377, Methods of test for soils for civil engineering purposes; Part 1 (2016), and Parts 2-9 (1990).*

The test results are presented in Appendix H.

5.2 Geotechnical laboratory testing of rock

Laboratory testing of rock sub-samples comprised:

- point load index
- unconfined compressive strength (UCS) tests

Test	Test carried out in accordance with
Point load index	ISRM Suggested Methods (1985) Suggested method for determining point-load strength. Int. J. Rock Mech. Min. Sci. Geomech. Abstr. 22, pp. 53–60
Uniaxial compression strength tests	ISRM Suggested Methods (1981) Suggested method for determining deformability of rock materials in uniaxial compression, Part 2 and

	ISRM (2007) Ulusay R, Hudson JA (eds) The complete ISRM suggested methods for rock characterization, testing and monitoring, 2007

The test results are presented in Appendix H.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise glacial till. These deposits are underlain by greywacke of the Broadford Formation and potentially red conglomerate, sandstone, and mudstone of the Old Red Sandstone.

6.2 Ground types encountered during investigation of the site

A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- **Topsoil:** encountered typically in 200-400mm thickness, occasionally with peat.
- **Glacial Till:** sandy gravelly silty clay, frequently with low cobble content and occasional beds of gravel, typically soft or firm in upper horizons, becoming stiff at depth.
- **Bedrock (Greywacke):** Rockhead was encountered at depths ranging from 2.20-2.50m.

6.3 Groundwater

Details of the individual groundwater strikes, along with any relative changes in levels as works proceeded, are presented on the exploratory hole logs for each location.

Groundwater was encountered as seepage in trial pits TP-SC-01, TP-SC-02, TP-SC-04, TP-SC-06, and TP-T7-01 at 0.40-2.30m.

Groundwater was not noted during drilling at any of the borehole locations. However, it should be noted that the casing used in supporting the borehole walls during drilling may have sealed out any groundwater strikes and the possibility of encountering groundwater during excavation works should not be ruled out.

It should also be noted that any groundwater strikes within bedrock may have been masked by the fluid used as the drilling flush medium.

Seasonal variation in groundwater levels should be factored into design considerations.

7 REFERENCES

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland.

IS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. National Standards Authority of Ireland.

BS 5930: 2015+A1:2020: Code of practice for ground investigations. British Standards Institution.

BS EN ISO 14688-1:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 1 Identification and description.

BS EN ISO 14688-2:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

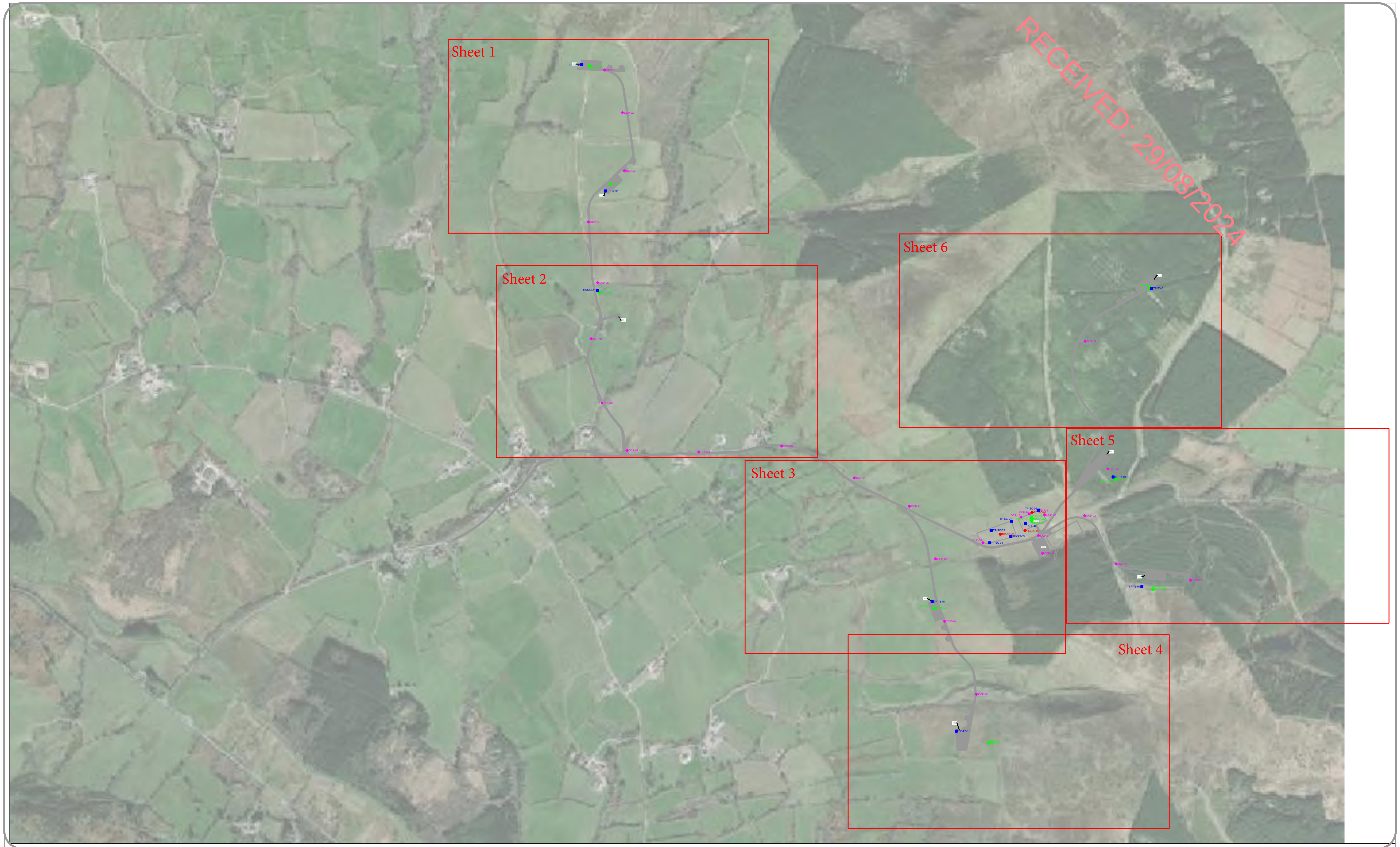
BS EN ISO 14689-1:2018: Geotechnical investigation and testing. Identification and classification of rock. Identification and description.

BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

CAUSEWAY
GEOTECH

APPENDIX A

SITE AND EXPLORATORY HOLE LOCATION PLANS



PROJECT:
Lackareagh Wind Farm, Co.Clare

TITLE:
Exploratory hole layout plan

CLIENT:
MKO

ENGINEER:
AFRY

KEY:
- TP-SC-06
- RC-SC-01
- DCP-20
- DP-SC-02

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 05/02/2024

DRWN: JD

CHCK: MFG

SERIES: 1 of 1

DWG No: 23-1870 EHL-Overview

PROJECT: Lackareagh Wind Farm, Co.Clare	TITLE: Exploratory hole layout plan
CLIENT: MKO	KEY: ▣ TP-SC-06 ⊗ RC-SC-01 ✦ DCP-20 ● DP-SC-02
ENGINEER: AFRY	

CAUSEWAY GEOTECH

SCALE: NTS@A3	DATE: 05/02/2024
DRWN: JD	SERIES: 1 OF 6
CHCK: MFG	DWG No: 23-1870 EHL-01

PROJECT:
Lackareagh Wind Farm, Co.Clare

TITLE:
Exploratory hole layout plan

CLIENT:
MKO

ENGINEER:
AFRY

KEY:
- ▣ TP-SC-06
- ⊗ RC-SC-01
- ✦ DCP-20
- ● DP-SC-02

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 05/02/2024

DRWN: JD

CHCK: MFG

SERIES: 2 OF 6

DWG No: 23-1870 EHL-02

PROJECT:
Lackareagh Wind Farm, Co.Clare

TITLE:
Exploratory hole layout plan

CLIENT:
MKO

ENGINEER:
AFRY

KEY:
- ▣ TP-SC-06
- ⊗ RC-SC-01
- ⌖ DCP-20
- ● DP-SC-02

CAUSEWAY GEOTECH

SCALE:
NTS@A3

DATE:
05/02/2024

DRWN: JD

CHCK: MFG

SERIES:
3 OF 6

DWG No:
23-1870 EHL-03

PROJECT:
Lackareagh Wind Farm, Co.Clare

TITLE:
Exploratory hole layout plan

CLIENT:
MKO

ENGINEER:
AFRY

KEY:
- ▣ TP-SC-06
- ⊗ RC-SC-01
- ◆ DCP-20
- ● DP-SC-02

CAUSEWAY
GEOTECH

SCALE:
NTS@A3

DATE:
05/02/2024

DRWN: JD

CHCK: MFG

SERIES:
4 OF 6

DWG No:
23-1870 EHL-04

PROJECT: Lackareagh Wind Farm, Co.Clare

TITLE: Exploratory hole layout plan

CLIENT: MKO

ENGINEER: AFRY

KEY:
▣ TP-SC-06
⊗ RC-SC-01
✦ DCP-20
● DP-SC-02

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 05/02/2024

DRWN: JD

CHCK: MFG

SERIES: 5 OF 6

DWG No: 23-1870 EHL-05

PROJECT:
Lackareagh Wind Farm, Co.Clare

TITLE:
Exploratory hole layout plan

CLIENT:
MKO

ENGINEER:
AFRY

KEY:
- ▚ TP-SC-06
- ⊗ RC-SC-01
- ⌖ DCP-20
- ● DP-SC-02

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 05/02/2024

DRWN: JD

CHCK: MFG

SERIES: 6 OF 6

DWG No: 23-1870 EHL-06

CAUSEWAY
GEOTECH

APPENDIX B

BOREHOLE LOGS

CAUSEWAY GEOTECH	**Project No.** **23-1870**	**Project Name:** Lackareagh Wind Farm **Client:** MKO **Client's Rep:** AFRY	**Borehole ID** **RC-SC-01**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Rotary Drilling	Comacchio 405	0.00	3.00	563530.12 E
Rotary Coring	Comacchio 405	3.00	5.20	672502.61 N

Final Depth: 5.20 m	**Start Date:** 29/01/2024	**Driller:** TA	Sheet 1 of 1 Scale: 1:40
Elevation: 257.39 mOD	**End Date:** 29/01/2024	**Logger:** TG	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Description	Water	Backfill
								257.08	0.30	Dark brown peaty TOPSOIL.		
								256.88	0.50	Soft brown slightly sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subangular fine to coarse.		
1.20 1.20 - 1.64	D1 SPT(C) 50 (6,7/50 for 285mm) Hammer SN = 1377							254.88	2.50	Stiff brown slightly sandy gravelly CLAY with medium cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse.		
2.50 - 2.80	SPT(C) 50 (7,9/50 for 155mm) Hammer SN = 1377							254.38	3.00	Weathered GREYWACKE (recovered through percussive drilling as grey angular gravel).		
4.00		100	100	90	4					Medium strong massive grey fine grained well cemented GREYWACKE with widely spaced veins of white calcite. Moderately weathered: slightly closer fracture spacing and strong orangish brown discolouration penetrating up to 30mm from joint surfaces. Discontinuities: 1. 0 to 20 degree joints, widely spaced (230/640/1250), planar, smooth with orangish brown staining on joint surfaces. 2. 50 to 70 degree joints, medium spaced (360/550/720), planar, smooth with orangish brown staining on joint surfaces.		
5.20		100	100	100				252.18	5.20			
										End of Borehole at 5.20m		

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Inspection pit hand dug to 1.20m

Casing Details	
To (m)	Diam (mm)

Core Barrel

T2-101

Flush Type

Air Mist

Termination Reason

Terminated at scheduled depth.

Last Updated

21/03/2024

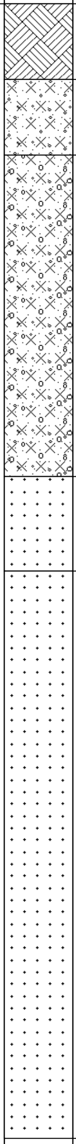
AGS

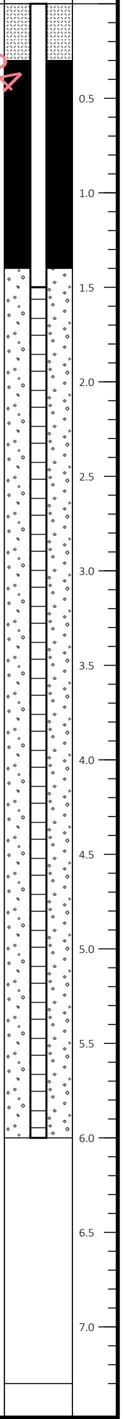
Project No. **23-1870**	**Project Name:** Lackareagh Wind Farm **Client:** MKO **Client's Rep:** AFRY		**Borehole ID** **RC-SC-02**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Rotary Drilling	Comacchio 405	0.00	3.50	563608.35 E
Rotary Coring	Comacchio 405	3.50	6.00	672513.49 N

Final Depth: 6.00 m	**Start Date:** 25/01/2024	**Driller:** TA	Sheet 1 of 1 Scale: 1:40
Elevation: 266.60 mOD	**End Date:** 25/01/2024	**Logger:** TG	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								266.20	0.40		Dark brown peaty TOPSOIL.		
								265.80	0.80		Soft brown slightly sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subangular fine to coarse.		
1.20 1.20 - 1.62	D1 SPT(S) 50 (6,7/50 for 275mm) Hammer SN = 1377					1.20							
2.50 - 2.81	SPT(S) 50 (7,8/50 for 156mm) Hammer SN = 1377					2.50		264.10	2.50		Stiff brown sandy sandy gravelly SILT with medium cobble and boulder content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
								263.60	3.00		Weathered GREYWACKE (recovered through percussive drilling as grey angular gravel).		
		100	65	20	14 >20								
4.50		100	95	80	10								
5.50		100	95	70									
6.00								260.60	6.00		Medium strong (locally strong) massive grey fine grained well cemented GREYWACKE. Highly weathered: reduced strength, much closer fracture spacing and pervasive orangish brown staining up to 40mm from joint surfaces. Discontinuities: 1. 0 to 30 degree joints, closely spaced (50/80/230), planar, smooth with orangish brown staining on joint surfaces. 2. 40 to 65 degree joints, medium spaced (70/220/330), planar, smooth with orangish brown staining on joint surfaces. 3. 2 no. 70 to 90 degree joints at 4.60-4.90m and 5.60-5.85m, planar occasionally undulating, smooth with orangish brown staining on joint surfaces.		
											End of Borehole at 6.00m		





Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Inspection pit hand dug to 1.20m

Casing Details

To (m)	Diam (mm)

Core Barrel

T2-101

Flush Type

Air Mist

Termination Reason

Terminated at scheduled depth.

Last Updated

21/03/2024

CAUSEWAY GEOTECH

Project No.	**Project Name:** Lackareagh Wind Farm		**Borehole ID**
23-1870	**Client:** MKO		**RC-SC-03**
	Client's Rep: AFRY		

Method	**Plant Used**	**Top (m)**	**Base (m)**
Rotary Drilling	Comacchio 405	0.00	2.50
Rotary Coring	Comacchio 405	2.50	5.50

Coordinates
563630.55 E
672571.08 N

Final Depth: 5.50 m	**Start Date:** 24/01/2024	**Driller:** TA	Sheet 1 of 1 Scale: 1:40
Elevation: 275.23 mOD	**End Date:** 24/01/2024	**Logger:** TG	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								274.83	0.40		Dark brown peaty TOPSOIL.		
								274.43	0.80		Soft brown slightly sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subangular fine to coarse.		
1.20 1.20 - 1.64	D1 SPT(C) 50 (3,4/50 for 295mm) Hammer SN = 1377							273.03	2.20		Stiff brown slightly sandy gravelly SILT with high cobble and boulder content. Sand is fine to coarse. Gravel is angular fine to coarse.		
								272.73	2.50		Weathered GREYWACKE (recovered through percussive drilling as grey angular gravel).		
3.50		70	65	20	AZCL >20 8			271.73	3.50		Medium strong massive brownish grey fine-grained well cemented GREYWACKE. Highly weathered: reduced strength, much closer fracture spacing and pervasive orangish brown staining up to 50mm from joint surfaces. Discontinuities: 1. 0 to 30 degree joints, closely spaced (50/80/160), planar, smooth with orangish brown staining on joint surfaces. 2. 40 to 65 degree joints, closely spaced (50/120/200), planar, smooth with orangish brown staining on joint surface		
4.50		100	100	100	2								
5.50		100	100	100				269.73	5.50		Medium strong (locally strong) massive grey fine-grained well cemented GREYWACKE. Slightly weathered: slightly closer fracture spacing and pervasive orangish brown staining up to 10mm from joint surfaces. Discontinuities: 1. 0 to 30 degree joints, medium spaced (140/570/910), planar, smooth with orangish brown staining on joint surfaces. 2. 70 to 90 degree joint at 3.50-3.90m, planar, smooth with orangish brown staining on joint surface.		
											End of Borehole at 5.50m		

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks
Inspection pit hand dug to 1.20m

Casing Details

To (m)	Diam (mm)

Core Barrel
T2-101

Flush Type
Air Mist

Termination Reason
Terminated at scheduled depth.

Last Updated
21/03/2024

AGS

APPENDIX C

CORE PHOTOGRAPHS

Borehole RC-SC-01 (3.00-5.20m)

Borehole RC-SC-02 (3.50-6.00m)

Borehole RC-SC-03 (2.50-5.50m)

APPENDIX D

DYNAMIC PROBE LOGS

CAUSEWAY GEOTECH

Project No.: 23-1870

Project Name: Lackareagh Wind Farm

Probe ID: DP-MM-01

Coordinates: 562262.60 E 673266.76 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 2

Scale: 1:50

Probe Type: DPSH-B

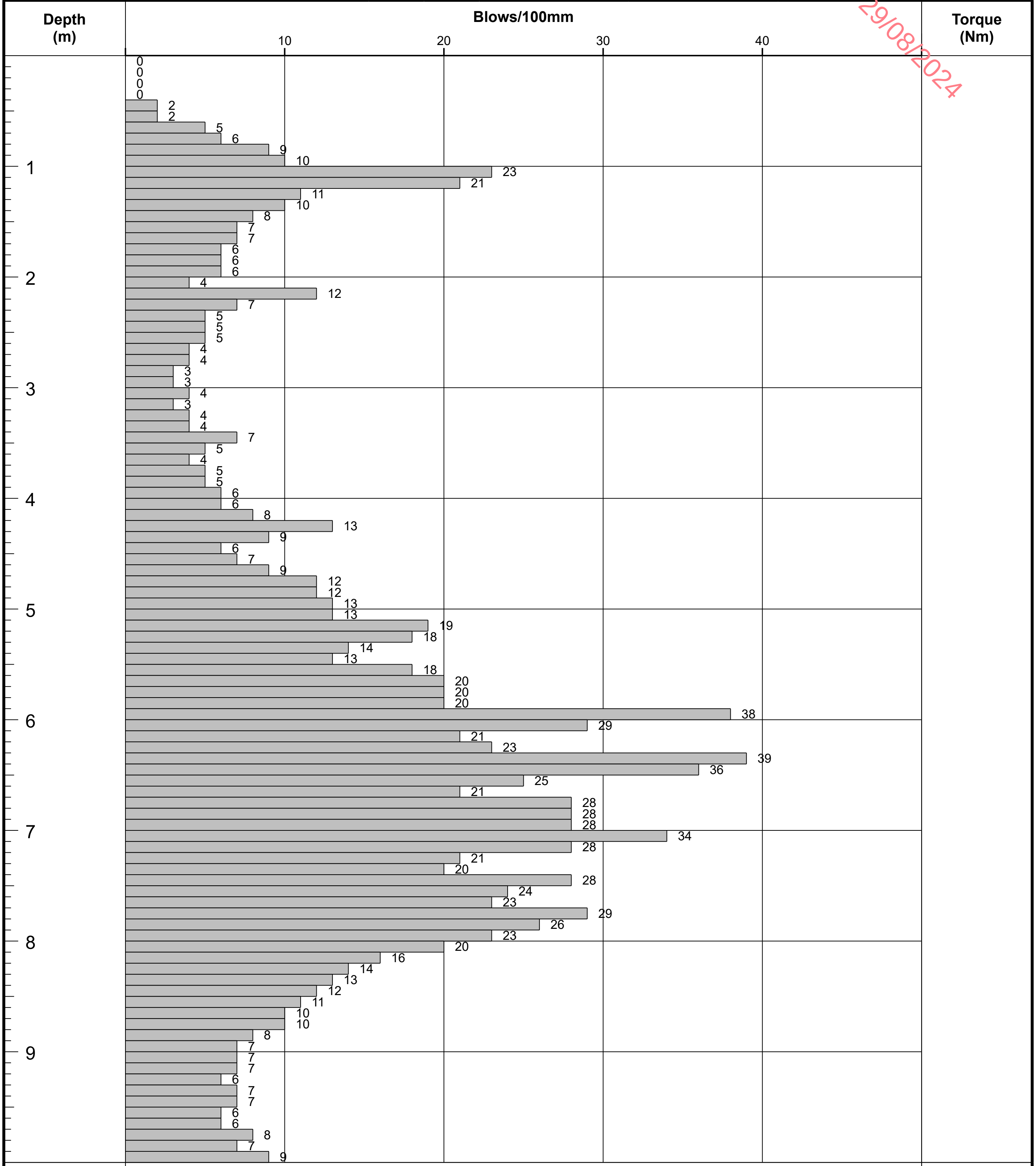
Elevation: 141.85 mOD

Final Depth: 12.00

Date: 28/01/2024

Operator: IC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated on Engineer's instruction

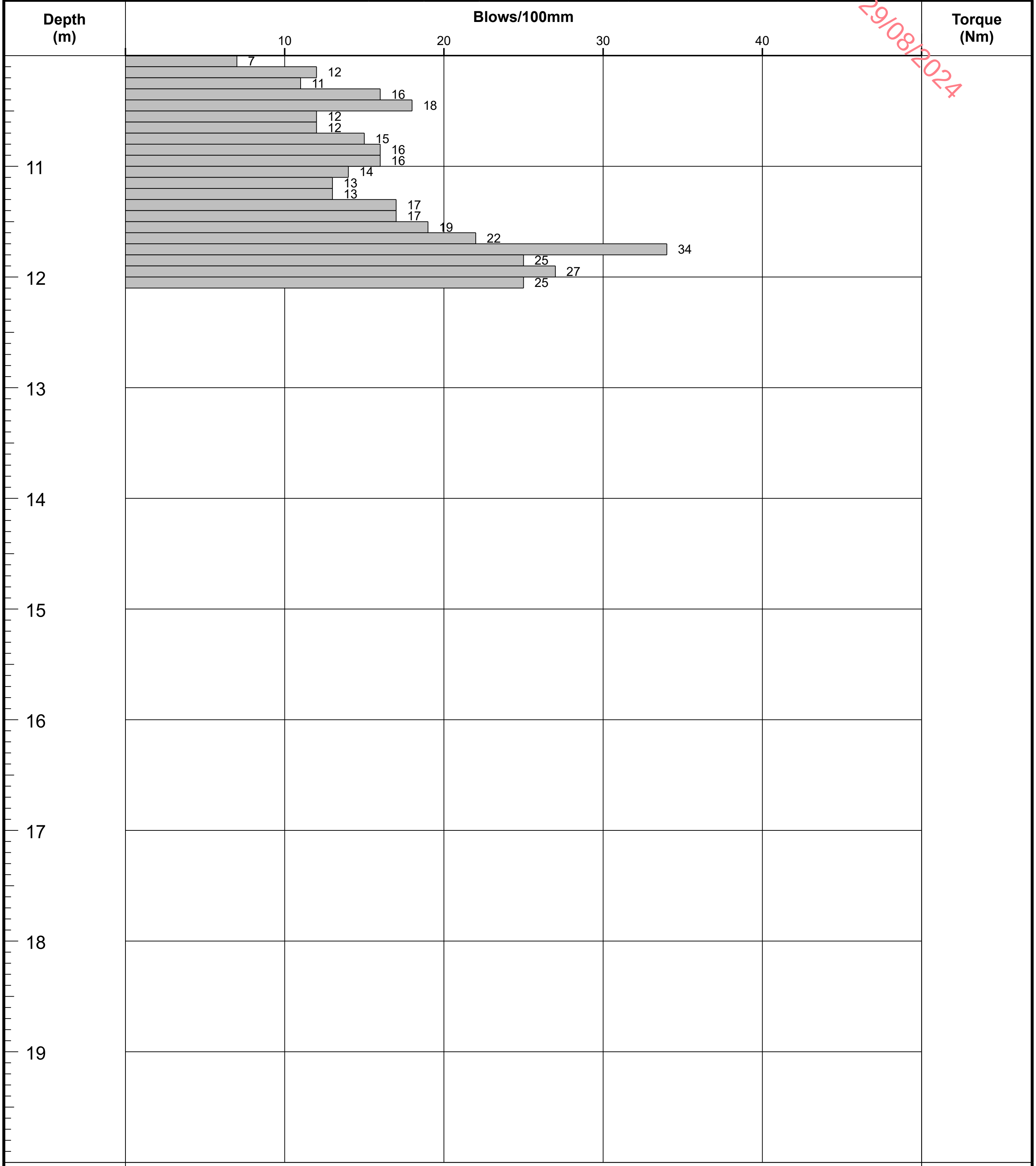
Last Updated

20/03/2024

AGS

CAUSEWAY GEOTECH

	Project No. 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-MM-01**
	Coordinates 562262.60 E 673266.76 N	**Client:** MKO			
Method: Dynamic Probing		**Client's Representative:** AFRY			Sheet 2 of 2 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 141.85 mOD	**Final Depth:** 12.00	**Date:** 28/01/2024	**Operator:** IC	FINAL

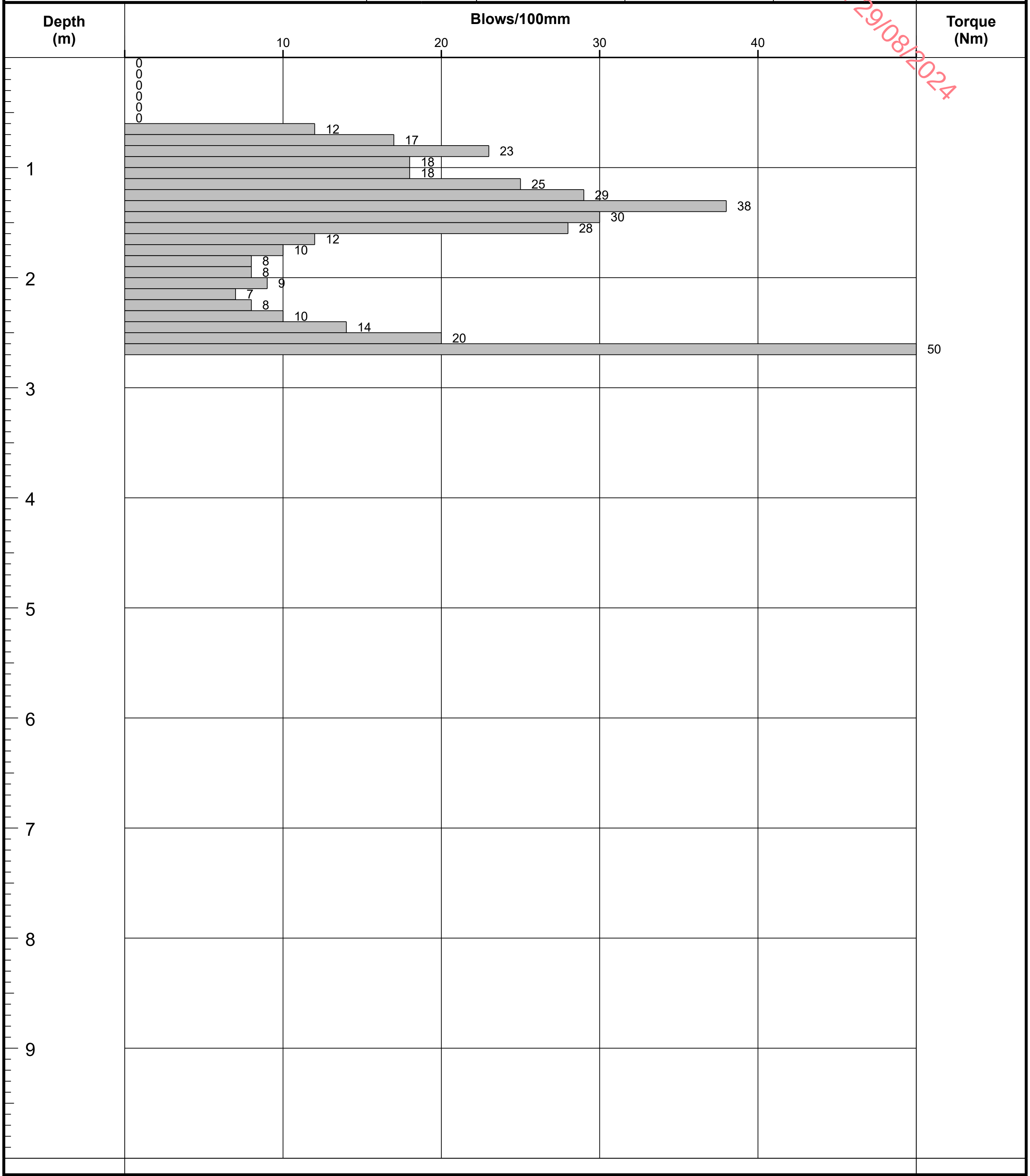


Fall Height: 750 mm	**Remarks**
Hammer Mass: 63.5 kg	
Cone Diameter: 50.5 mm	**Termination Reason** Terminated on Engineer's instruction

Last Updated
20/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-SC-01**
	Coordinates 563628.39 E 672544.07 N	**Client:** MKO			
Method: Dynamic Probing		**Client's Representative:** AFRY			Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 272.00 mOD	**Final Depth:** 2.60	**Date:** 28/01/2024	**Operator:** IC	FINAL



Fall Height: 750 mm	**Remarks**
Hammer Mass: 63.5 kg	
Cone Diameter: 50.5 mm	**Termination Reason** Terminated on refusal

Last Updated
20/03/2024

AGS

CAUSEWAY GEOTECH

Project No.
23-1870

Project Name:
Lackareagh Wind Farm

Probe ID
DP-SC-01A

Coordinates
563629.88 E
672544.79 N

Client:
MKO

Method:
Dynamic Probing

Client's Representative:
AFRY

Sheet 1 of 1
Scale: 1:50

Probe Type:
DPSH-B

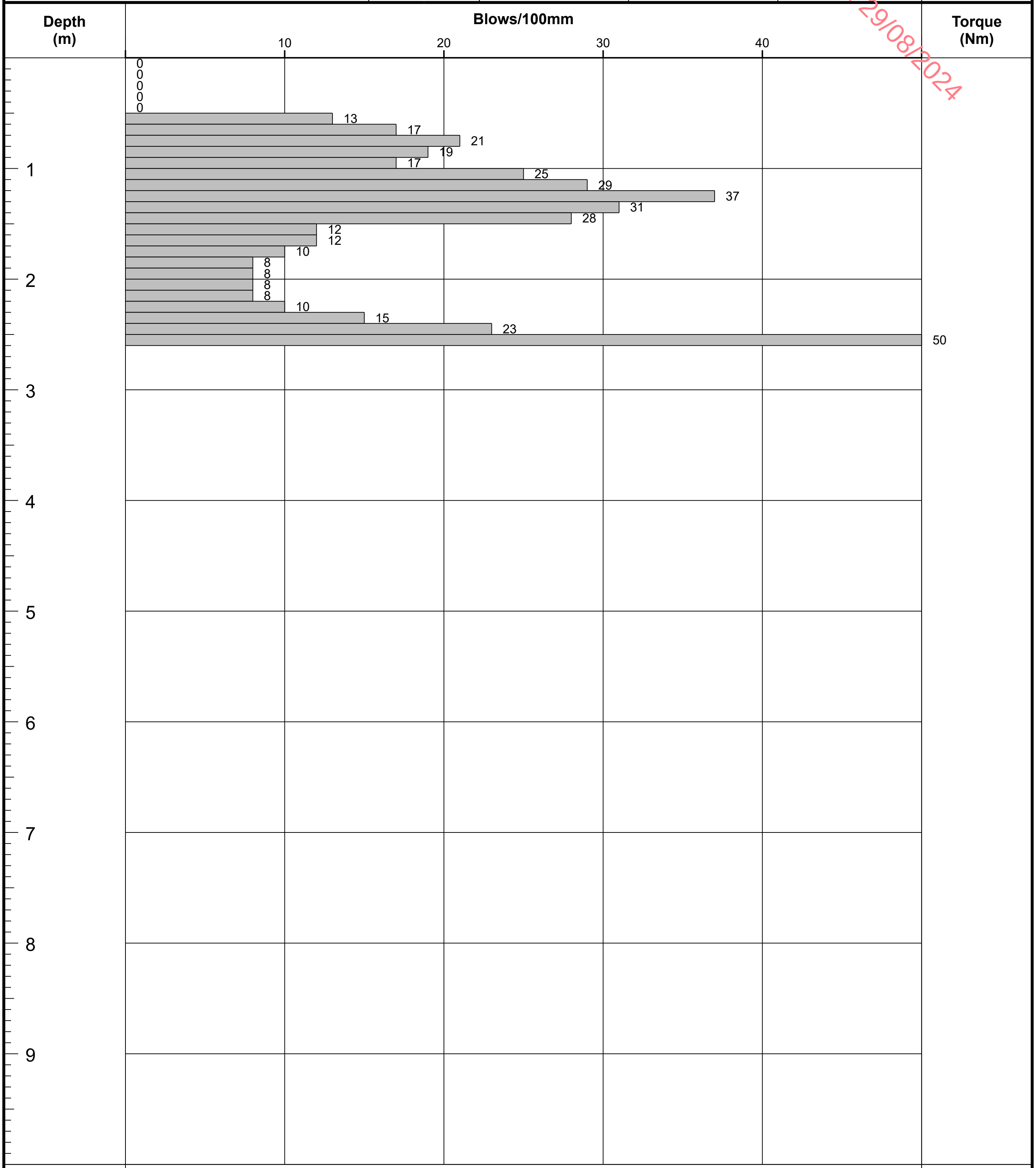
Elevation
272.00 mOD

Final Depth:
2.50

Date:
28/01/2024

Operator:
IC

FINAL



Fall Height: 750 mm	**Remarks**
Hammer Mass: 63.5 kg	
Cone Diameter: 50.5 mm	**Termination Reason** Terminated on refusal

Last Updated
20/03/2024

AGS

Project No.
23-1870

Project Name:
Lackareagh Wind Farm

Probe ID
DP-SC-02

Coordinates
563628.36 E
672553.01 N

Client:
MKO

Method:
Dynamic Probing

Client's Representative:
AFRY

Sheet 1 of 1
Scale: 1:50

Probe Type:
DPSH-B

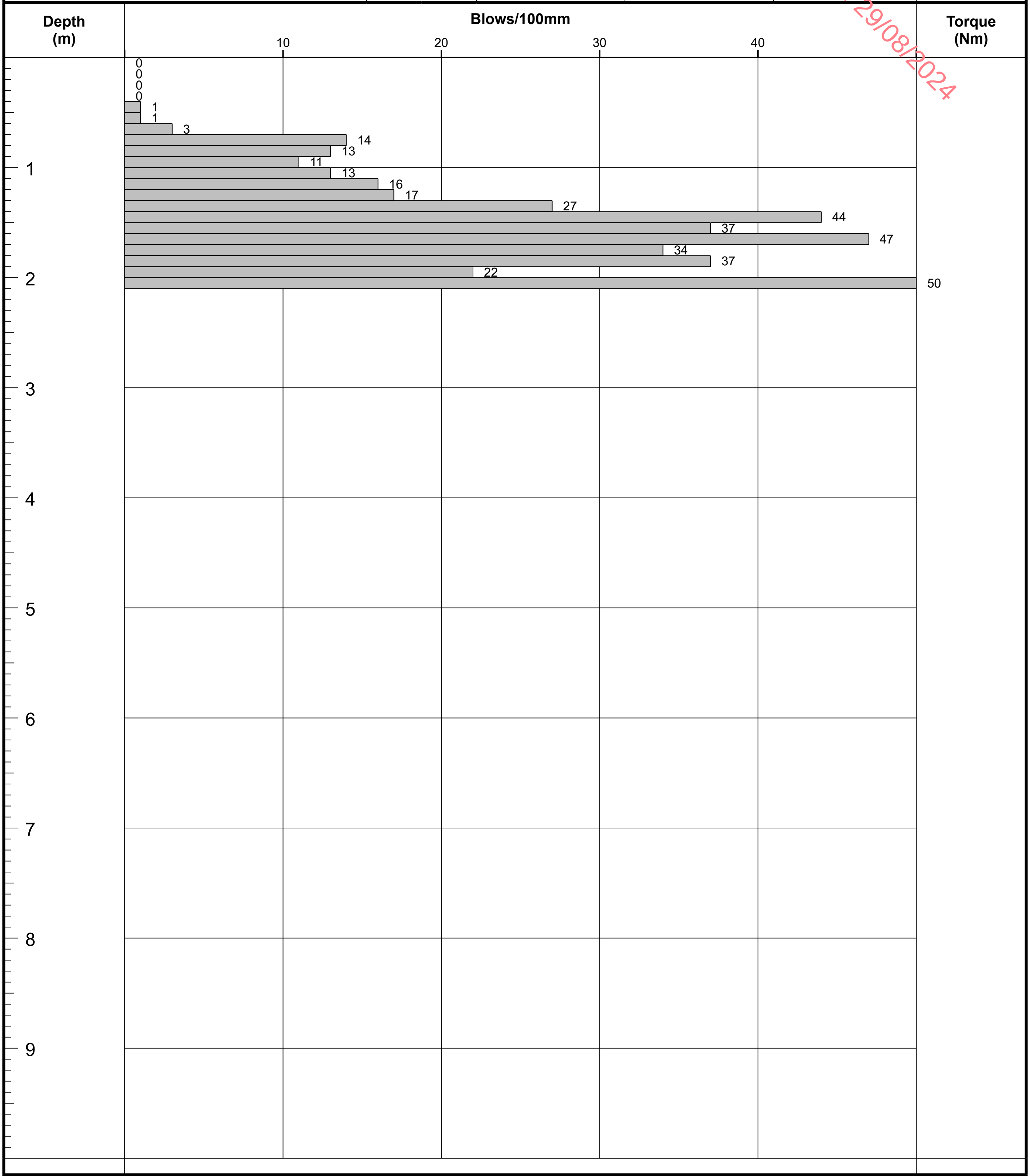
Elevation
272.76 mOD

Final Depth:
2.00

Date:
28/01/2024

Operator:
IC

FINAL



Fall Height:
750 mm

Hammer Mass:
63.5 kg

Cone Diameter:
50.5 mm

Remarks

Termination Reason
Terminated on refusal

Last Updated
20/03/2024

CAUSEWAY GEOTECH

Project No.
23-1870

Project Name:
Lackareagh Wind Farm

Probe ID
DP-SC-02A

Coordinates
563629.85 E
672553.73 N

Client:
MKO

Method:
Dynamic Probing

Client's Representative:
AFRY

Sheet 1 of 1
Scale: 1:50

Probe Type:
DPSH-B

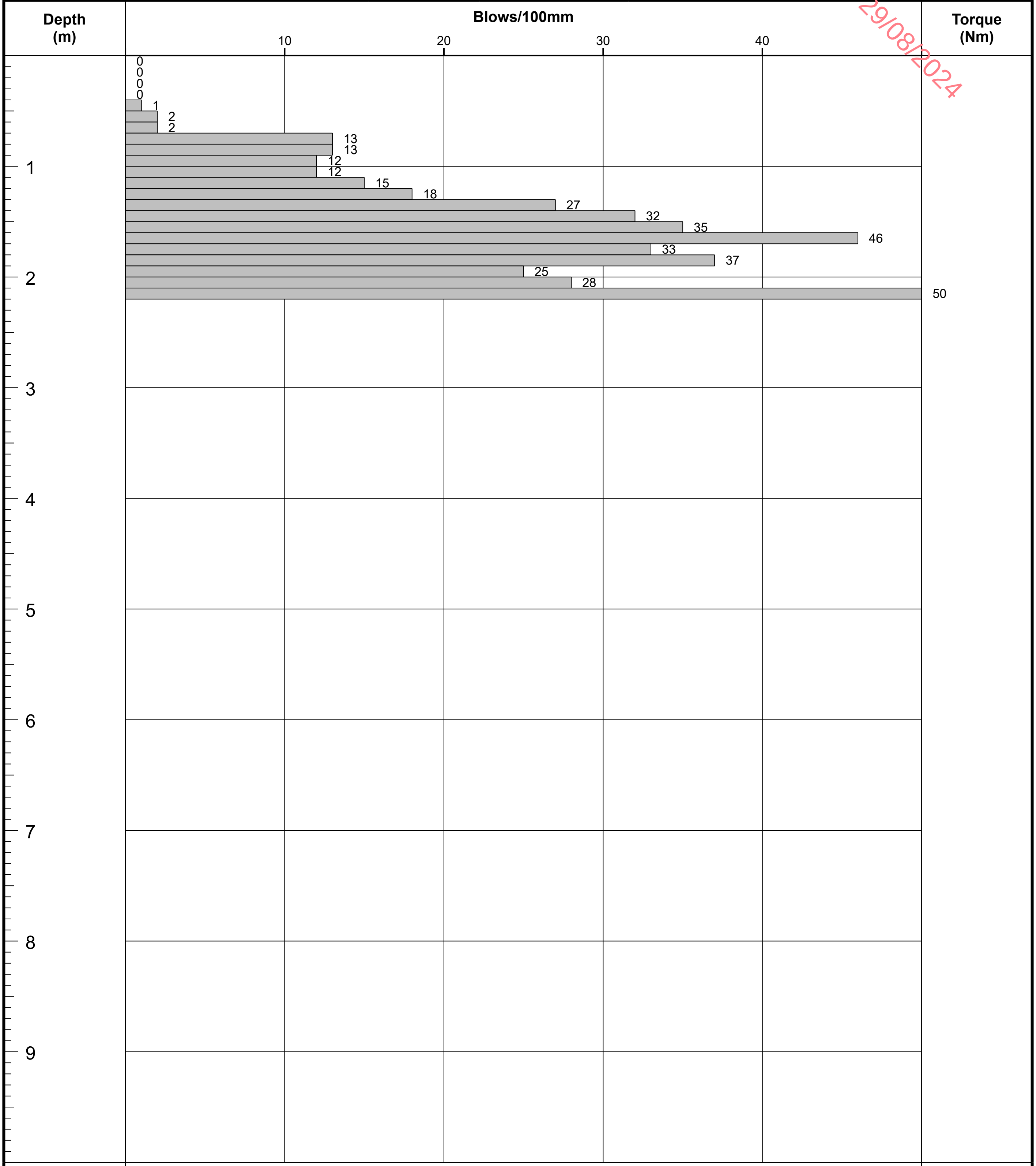
Elevation
272.76 mOD

Final Depth:
2.10

Date:
28/01/2024

Operator:
IC

FINAL



Fall Height:
750 mm

Hammer Mass:
63.5 kg

Cone Diameter:
50.5 mm

Remarks

Termination Reason
Terminated on refusal

Last Updated
20/03/2024

AGS

CAUSEWAY GEOTECH

Project No.: 23-1870

Project Name: Lackareagh Wind Farm

Probe ID: DP-T1-01

Coordinates: 562233.07 E 673982.35 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:50

Probe Type: DPSH-B

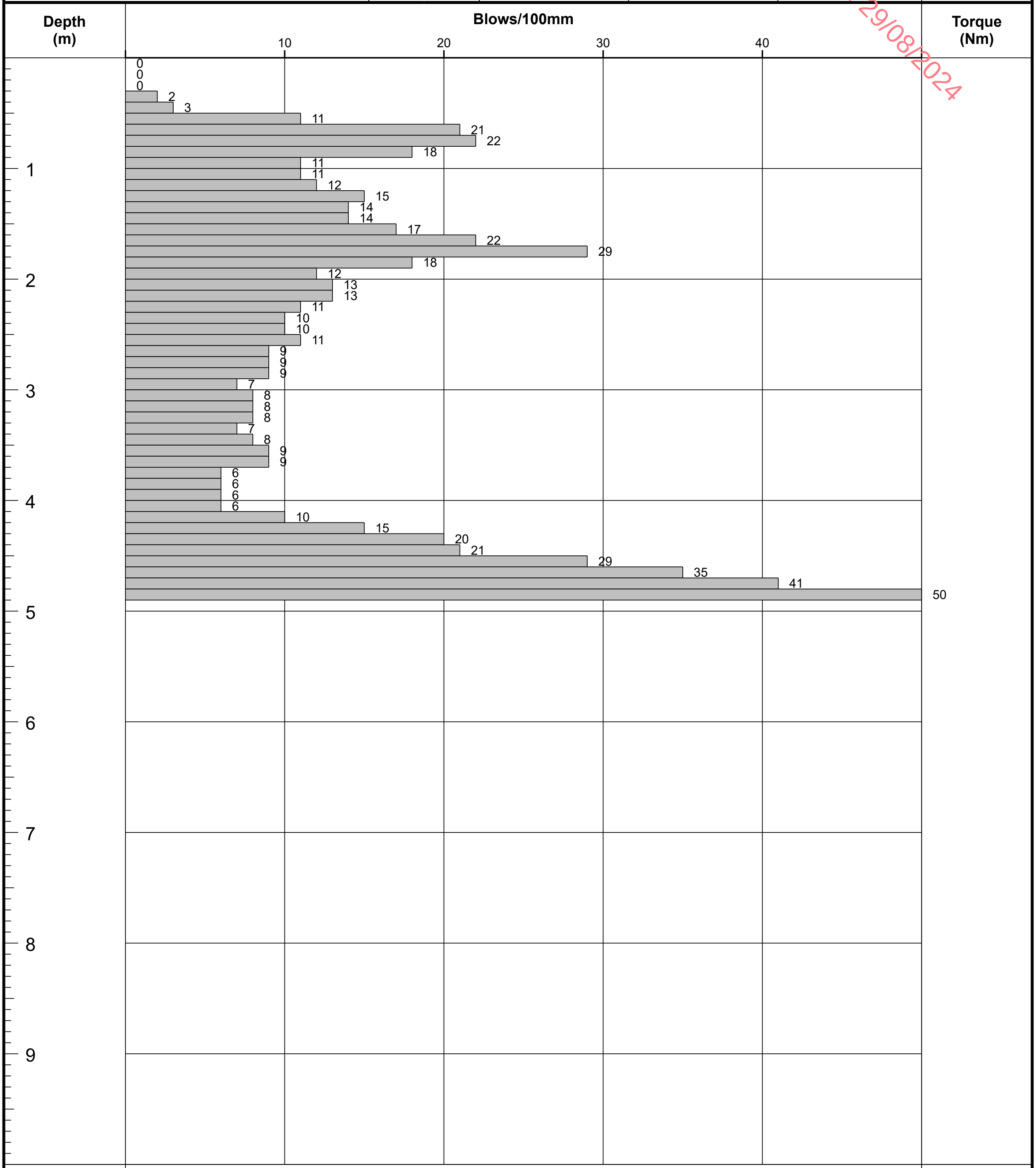
Elevation: 236.57 mOD

Final Depth: 4.80

Date: 28/01/2024

Operator: IC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

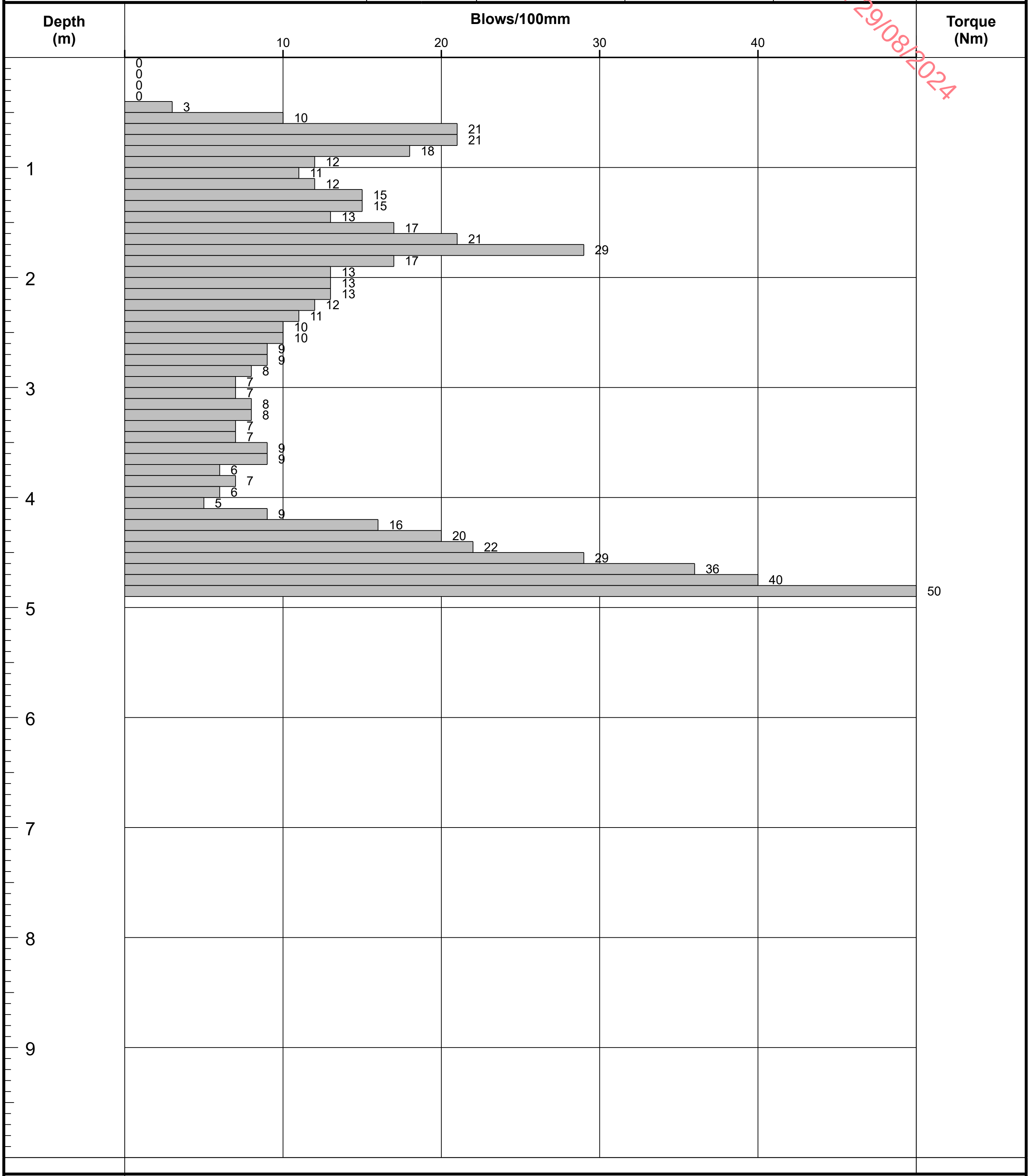
Terminated on refusal

Last Updated

20/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-T1-01A**
	Coordinates 562232.19 E 673980.73 N	**Client:** MKO			
Method: Dynamic Probing		**Client's Representative:** AFRY			Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 236.56 mOD	**Final Depth:** 4.80	**Date:** 28/01/2024	**Operator:** IC	FINAL



Fall Height: 750 mm	**Remarks**
Hammer Mass: 63.5 kg	
Cone Diameter: 50.5 mm	**Termination Reason** Terminated on refusal

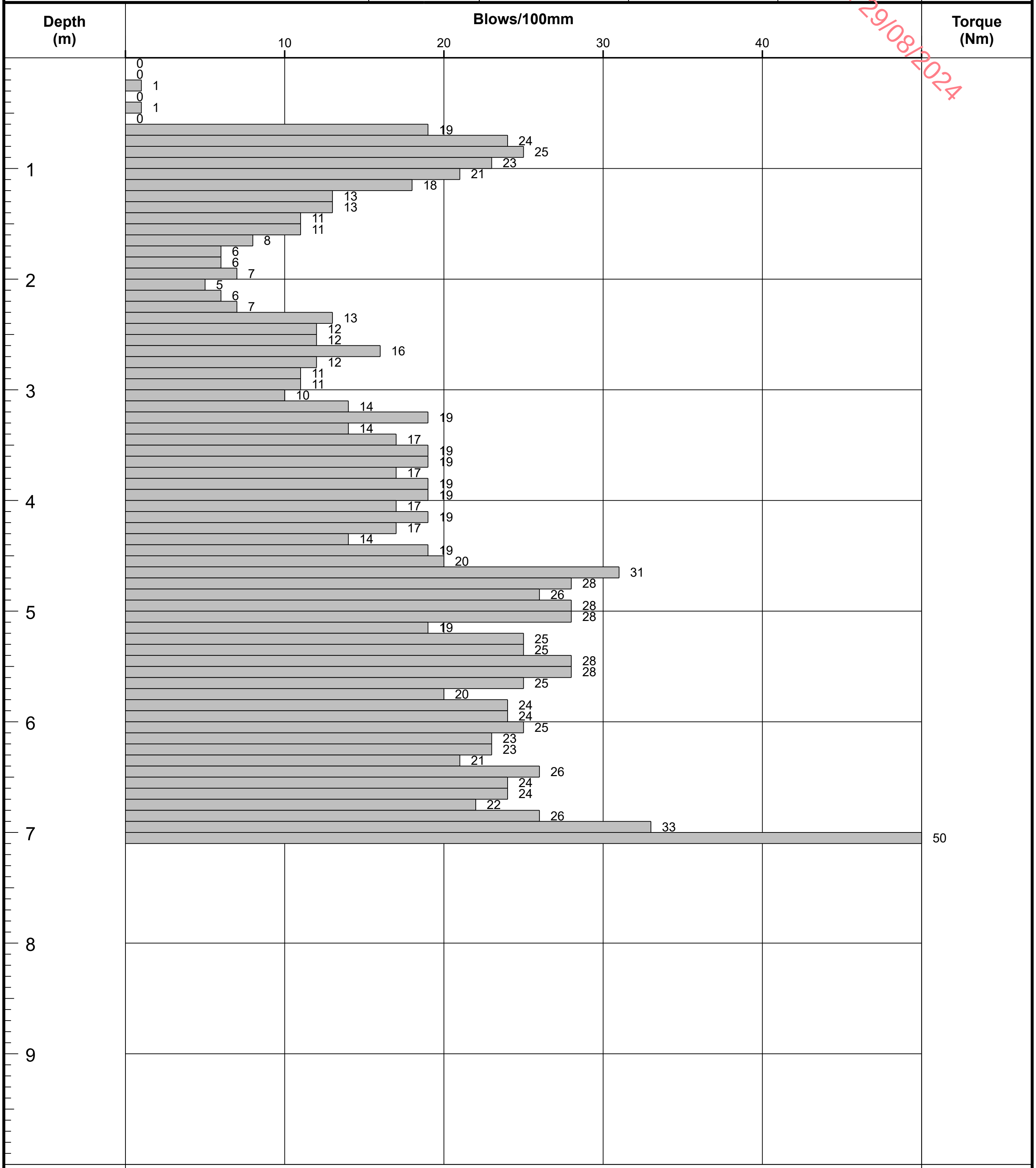
Last Updated
20/03/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-T2-01**
Coordinates 562298.89 E 673609.00 N	**Client:** MKO			
Method: Dynamic Probing	**Client's Representative:** AFRY			Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 189.87 mOD	**Final Depth:** 7.00	**Date:** 28/01/2024	**Operator:** IC
				FINAL

RECEIVED: 29/08/2024



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated on refusal

Last Updated

20/03/2024

AGS

CAUSEWAY GEOTECH

Project No.: 23-1870

Project Name: Lackareagh Wind Farm

Probe ID: DP-T3-01

Coordinates: 564002.85 E
673280.78 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:50

Probe Type: DPSH-B

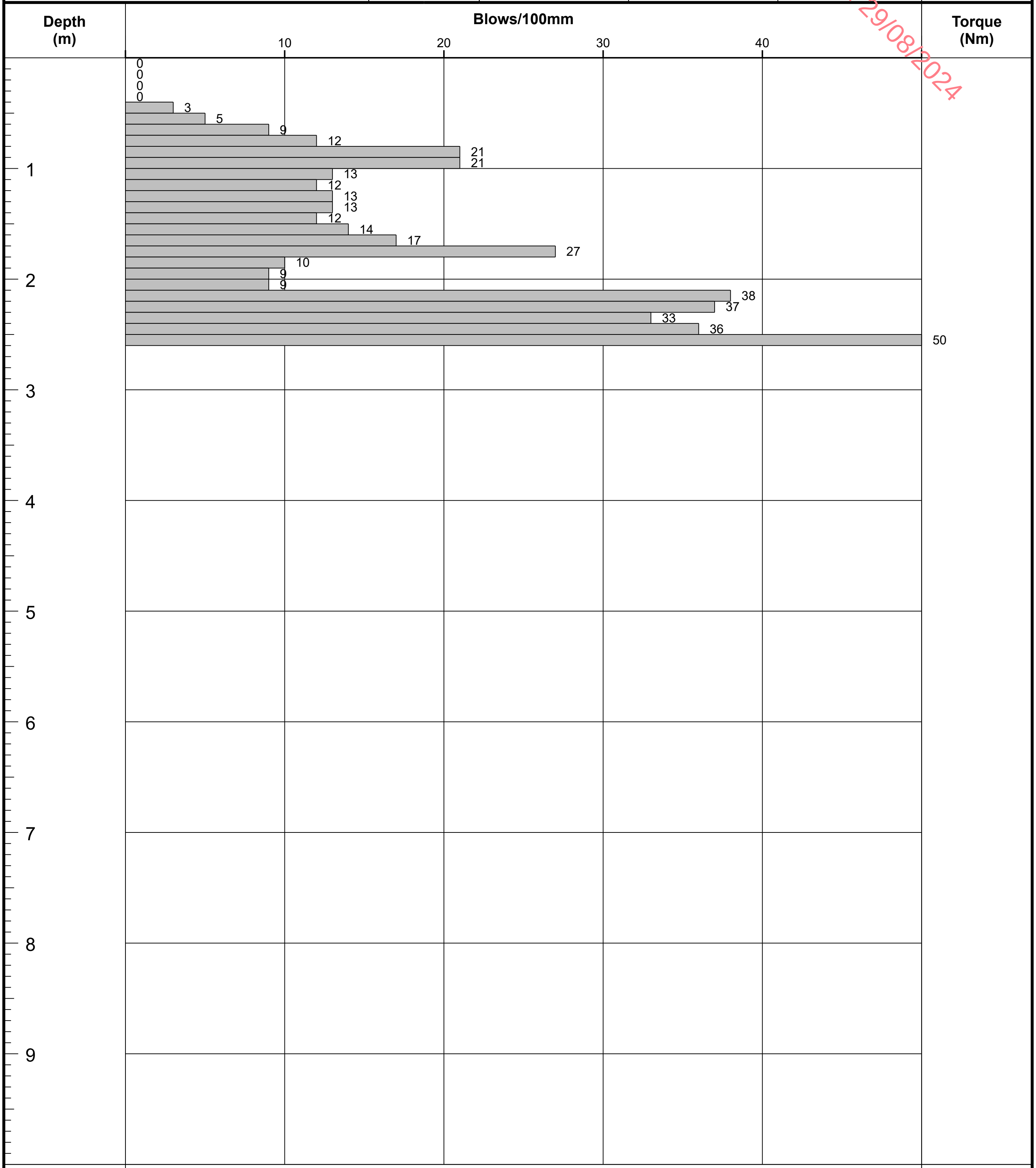
Elevation: 365.74 mOD

Final Depth: 2.50

Date: 28/01/2024

Operator: IC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

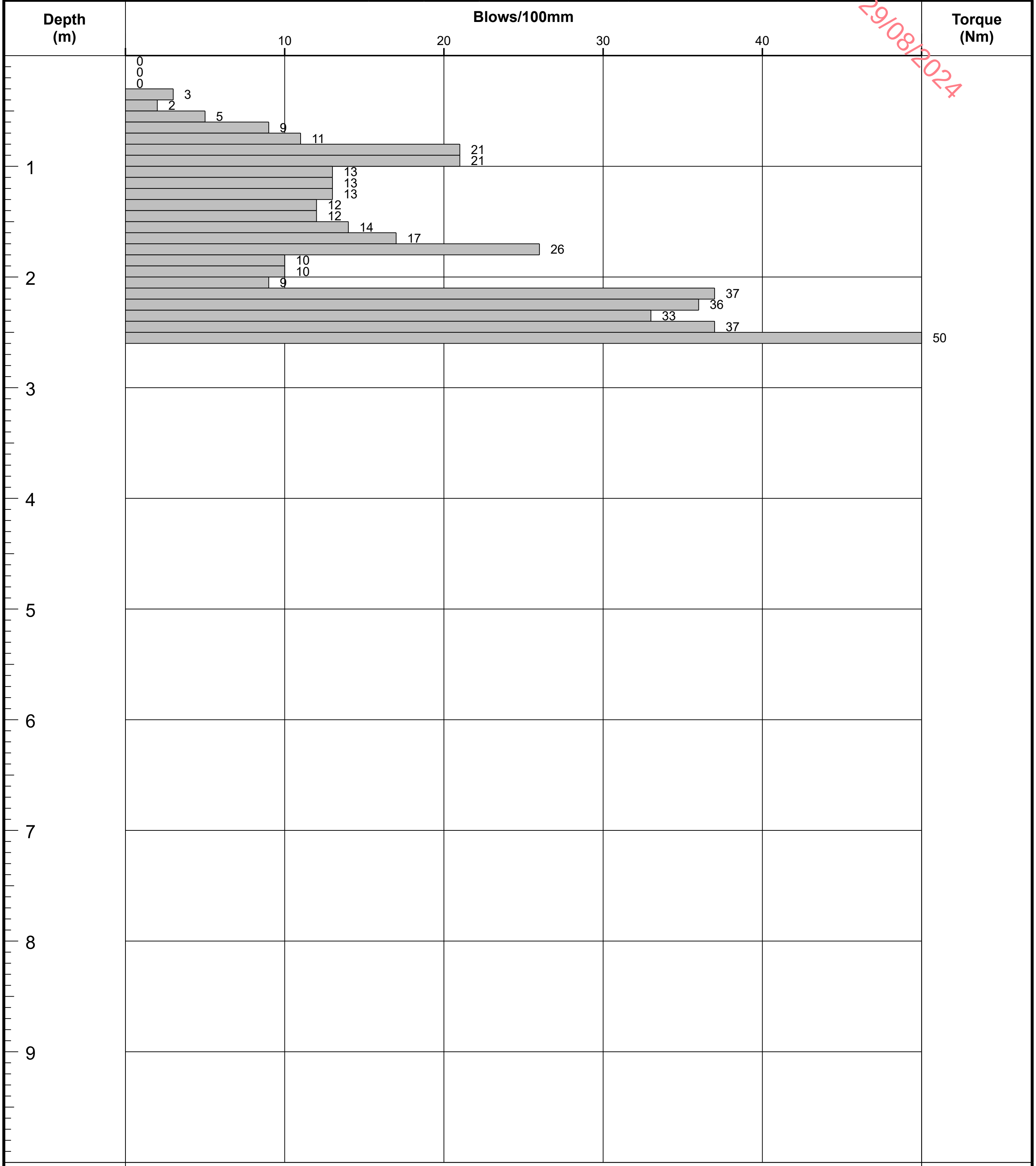
Terminated on refusal

Last Updated

20/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm		**Probe ID** **DP-T3-01A**
	Coordinates 564001.91 E 673281.35 N	**Client:** MKO		
Method: Dynamic Probing		**Client's Representative:** AFRY		Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 365.74 mOD	**Final Depth:** 2.50	**Date:** 28/01/2024	**Operator:** IC
				FINAL



Fall Height: 750 mm	**Remarks**
Hammer Mass: 63.5 kg	
Cone Diameter: 50.5 mm	**Termination Reason** Terminated on refusal

Last Updated
20/03/2024

CAUSEWAY GEOTECH

Project No. 23-1870

Project Name: Lackareagh Wind Farm

Probe ID **DP-T4-01**

Coordinates 563892.93 E 672675.11 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:50

Probe Type: DPSH-B

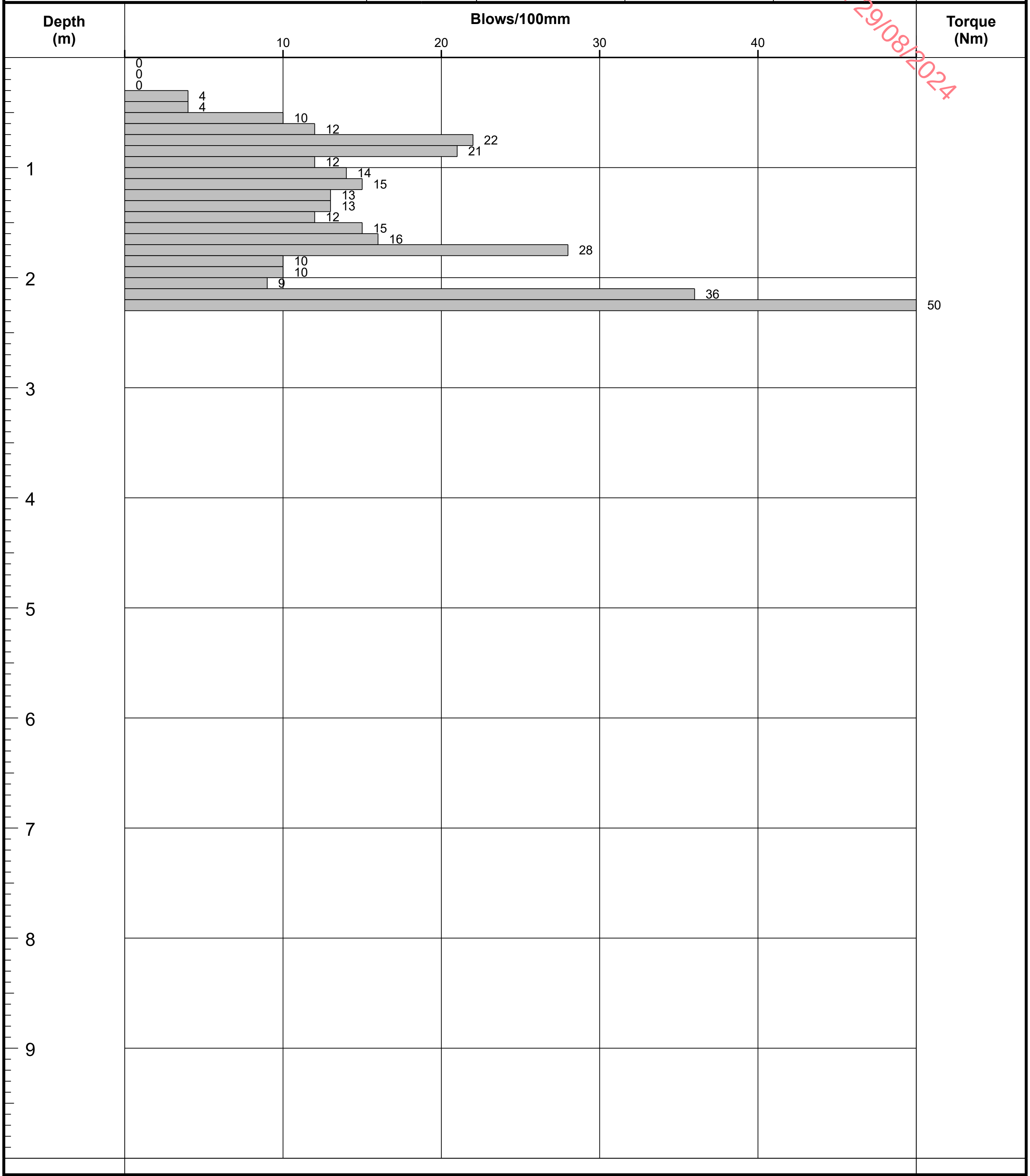
Elevation 276.92 mOD

Final Depth: 2.20

Date: 28/01/2024

Operator: IC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated on refusal

Last Updated 20/03/2024

AGS

Project No. 23-1870

Project Name: Lackareagh Wind Farm

Probe ID DP-T4-01A

Coordinates 563892.42 E 672674.58 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:50

Probe Type: DPSH-B

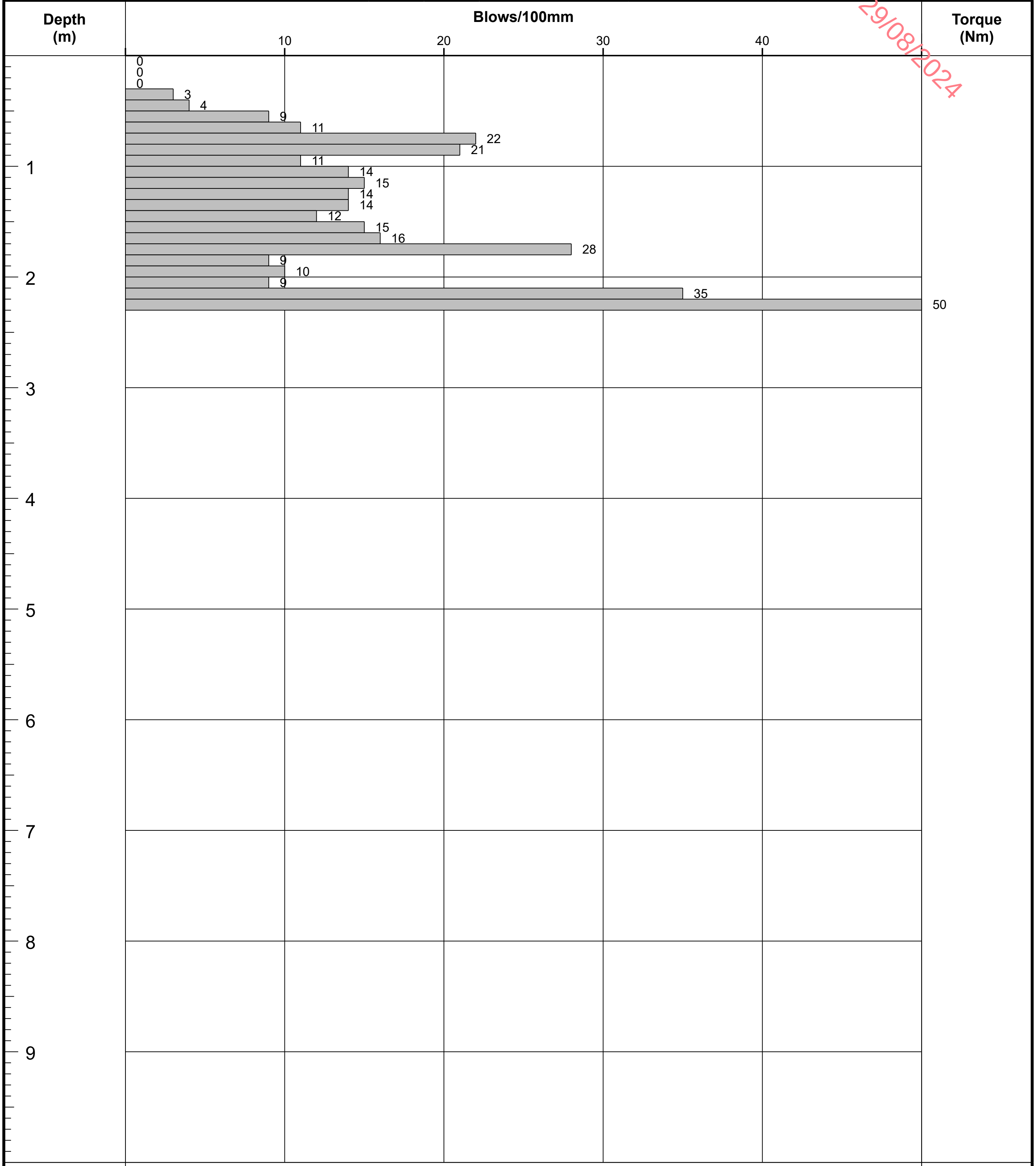
Elevation 276.93 mOD

Final Depth: 2.20

Date: 28/01/2024

Operator: IC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated on refusal

Last Updated 20/03/2024

AGS

Project No.
23-1870

Project Name:
Lackareagh Wind Farm

Probe ID
DP-T5-01

Coordinates
564012.30 E
672328.75 N

Client:
MKO

Client's Representative:
AFRY

Sheet 1 of 1
Scale: 1:50

Method:
Dynamic Probing

Probe Type:
DPSH-B

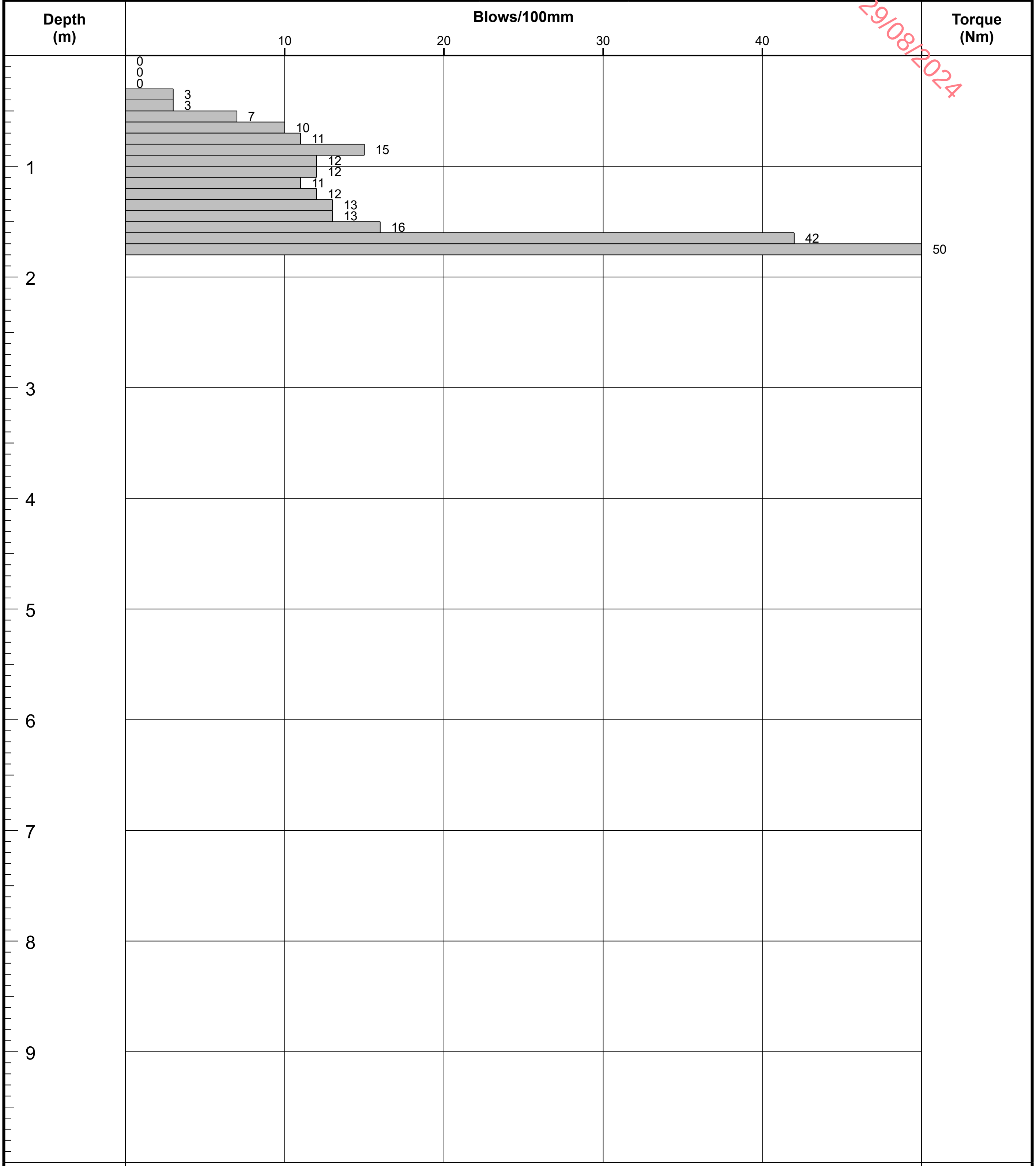
Elevation
300.02 mOD

Final Depth:
1.70

Date:
28/01/2024

Operator:
IC

FINAL



Fall Height:
750 mm

Hammer Mass:
63.5 kg

Cone Diameter:
50.5 mm

Remarks

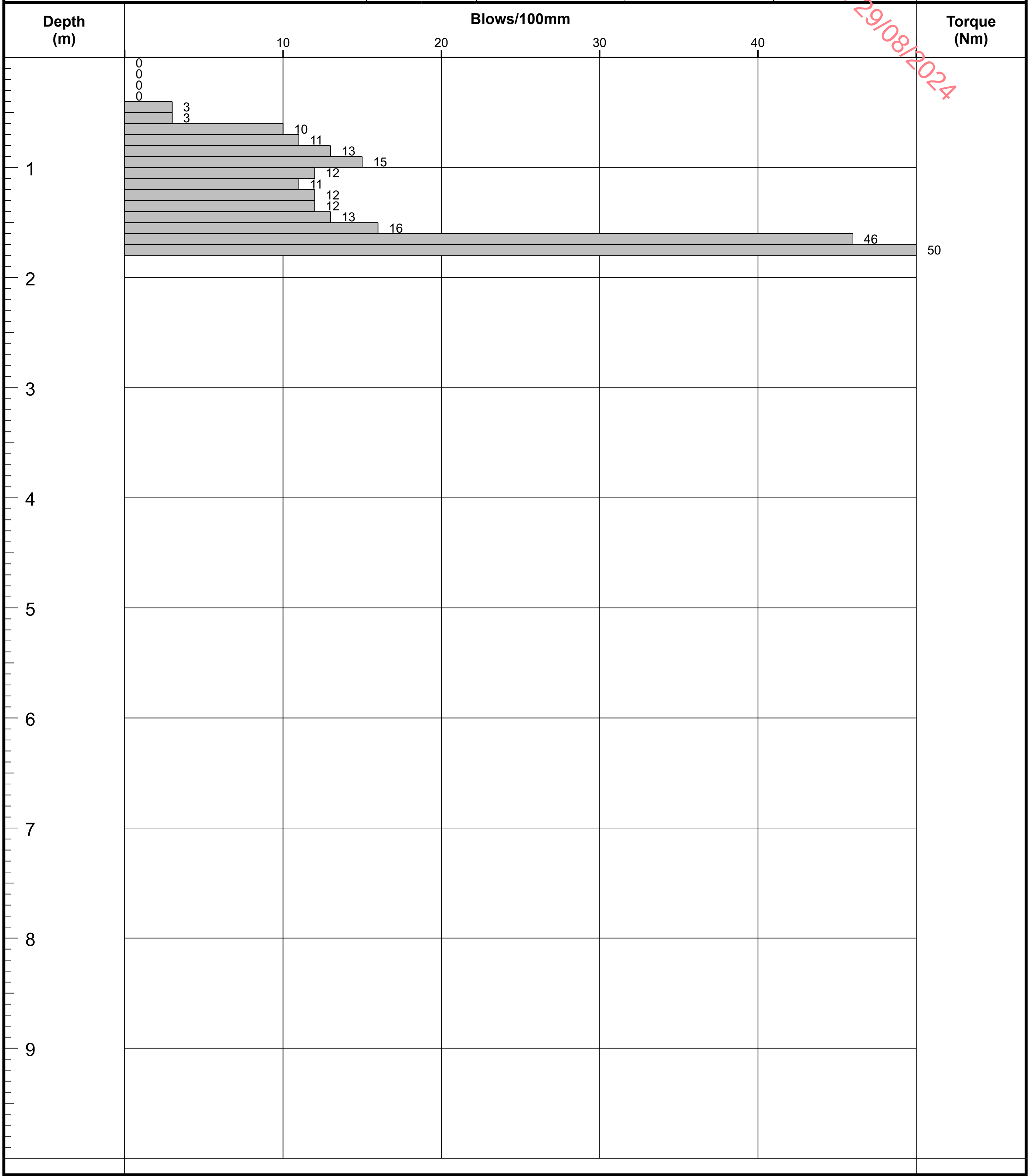
Termination Reason
Terminated on refusal

Last Updated
20/03/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-T5-01A**
Coordinates 564012.53 E 672329.04 N	**Client:** MKO			
	Client's Representative: AFRY			Sheet 1 of 1 Scale: 1:50
Method: Dynamic Probing				
Probe Type: DPSH-B	**Elevation** 300.04 mOD	**Final Depth:** 1.70	**Date:** 28/01/2024	**Operator:** IC
				FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated on refusal

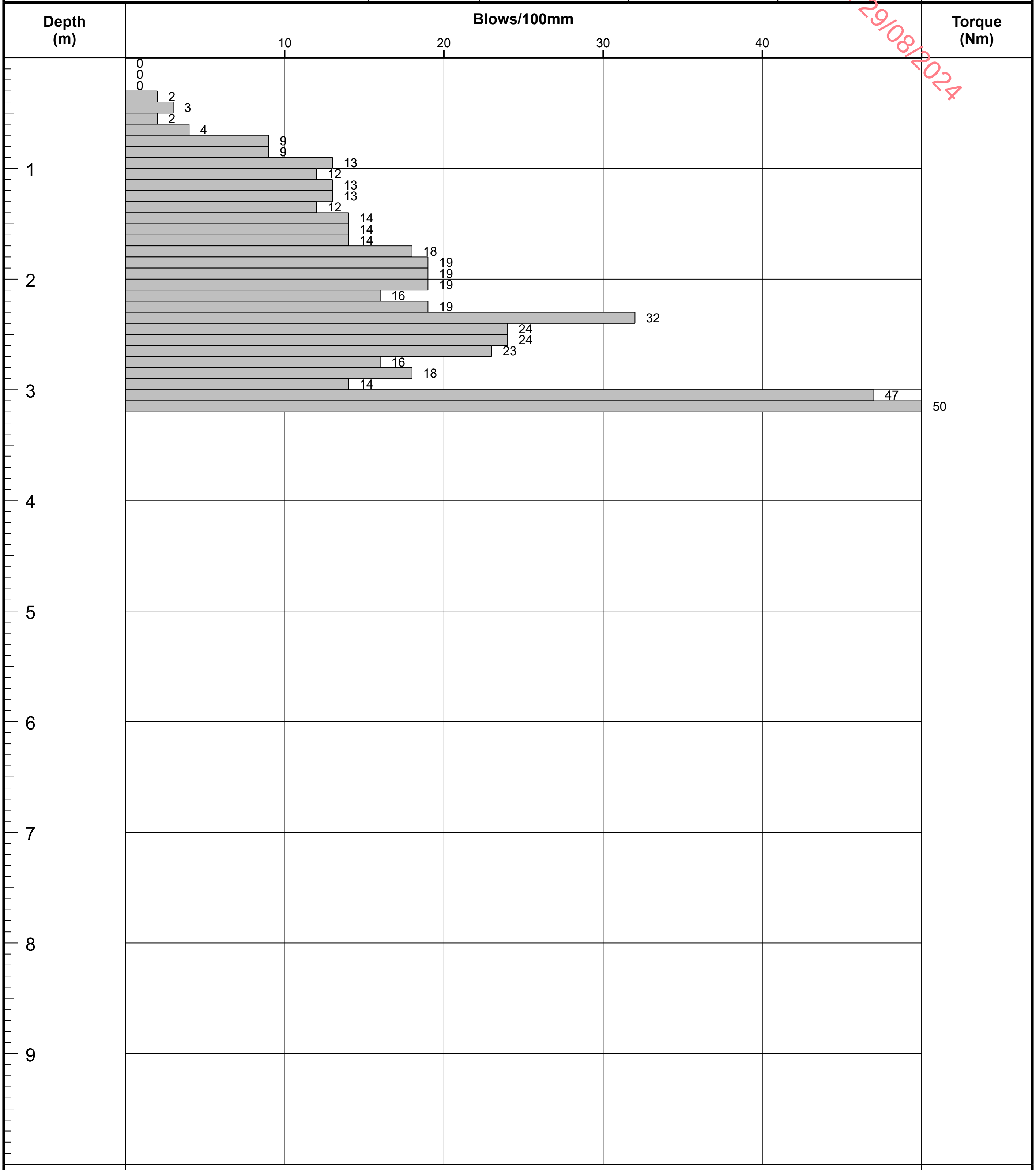
Last Updated

20/03/2024

AGS

CAUSEWAY GEOTECH

	Project No. 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-T6-01**
	Coordinates 563321.11 E 672267.96 N	**Client:** MKO			
Method: Dynamic Probing		**Client's Representative:** AFRY			Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 203.16 mOD	**Final Depth:** 3.10	**Date:** 28/01/2024	**Operator:** IC	FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

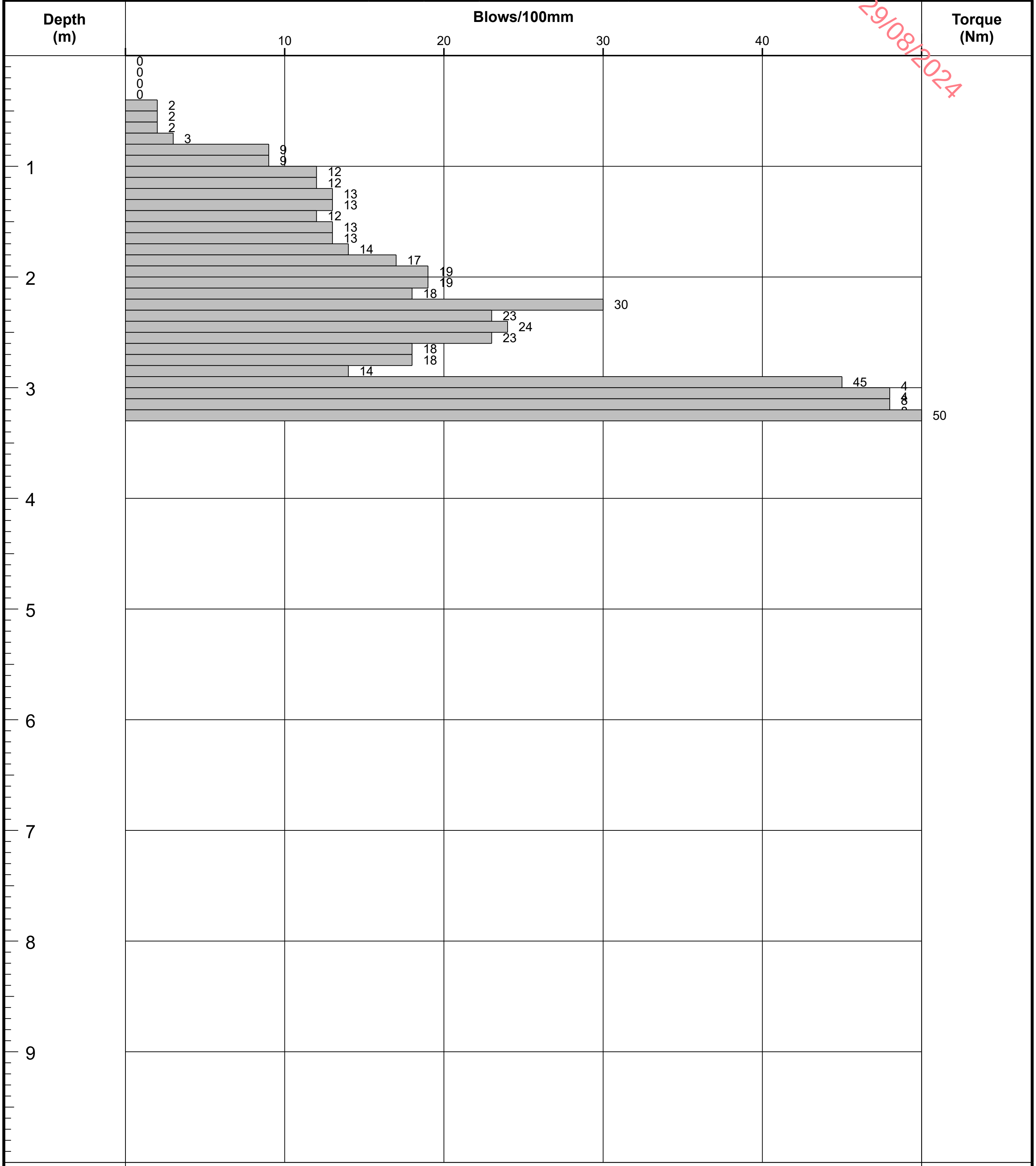
Terminated on refusal

Last Updated

20/03/2024

AGS

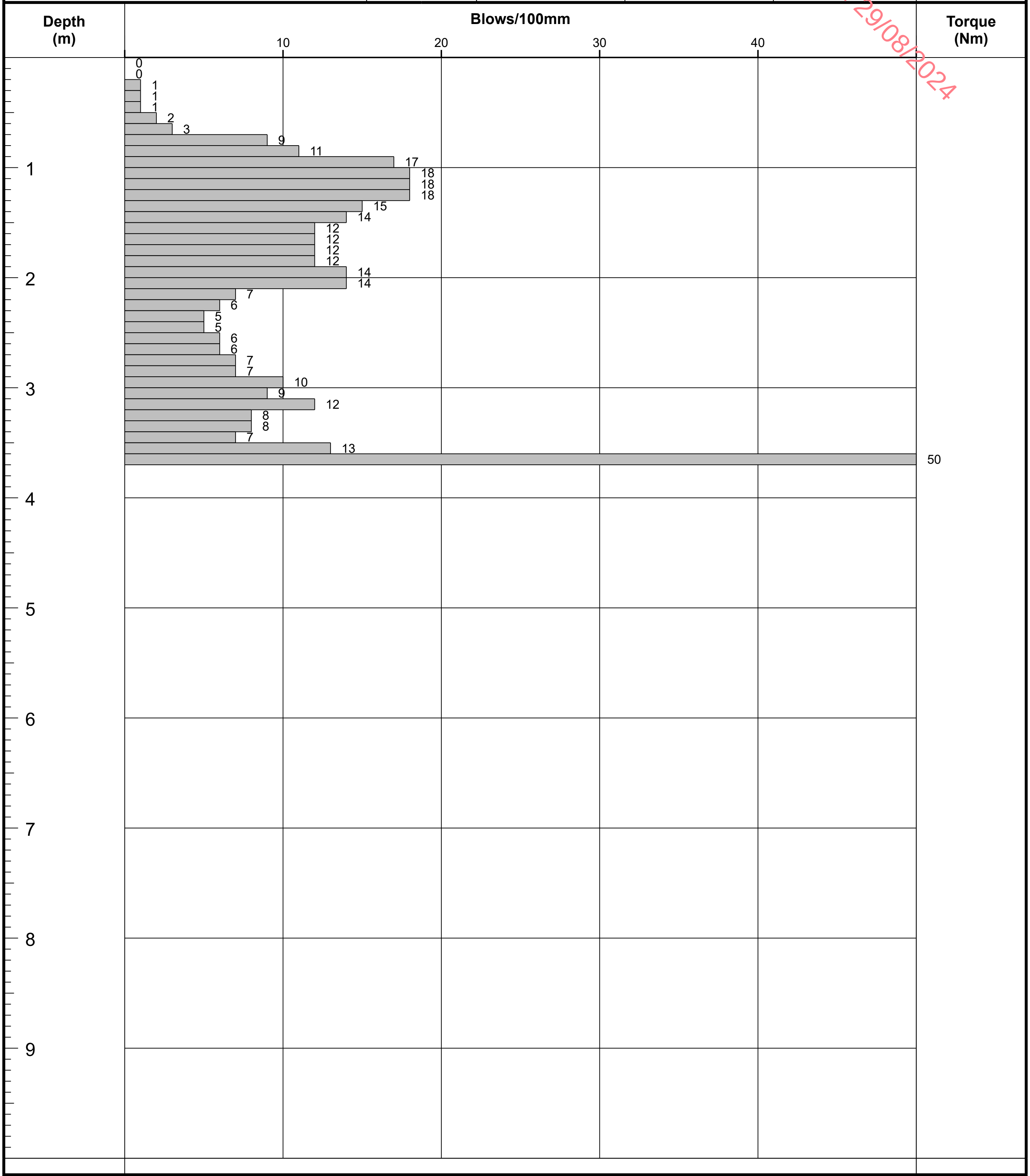
CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-T6-01A**
	Coordinates 563321.75 E 672268.67 N	**Client:** MKO			
Method: Dynamic Probing		**Client's Representative:** AFRY			Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 203.15 mOD	**Final Depth:** 3.20	**Date:** 28/01/2024	**Operator:** IC	FINAL



Fall Height: 750 mm	**Remarks**	
Hammer Mass: 63.5 kg		
Cone Diameter: 50.5 mm	**Termination Reason** Terminated on refusal	**Last Updated** 20/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm			**Probe ID** **DP-T7-01**
	Coordinates 563493.13 E 671842.74 N	**Client:** MKO			
Method: Dynamic Probing		**Client's Representative:** AFRY			Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 202.54 mOD	**Final Depth:** 3.60	**Date:** 28/01/2024	**Operator:** IC	FINAL



Fall Height: 750 mm	**Remarks**	
Hammer Mass: 63.5 kg		
Cone Diameter: 50.5 mm	**Termination Reason** Terminated on refusal	**Last Updated** 20/03/2024

AGS

Project No.: 23-1870

Project Name: Lackareagh Wind Farm

Probe ID: DP-T7-01A

Coordinates: 563493.57 E 671843.18 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:50

Probe Type: DPSH-B

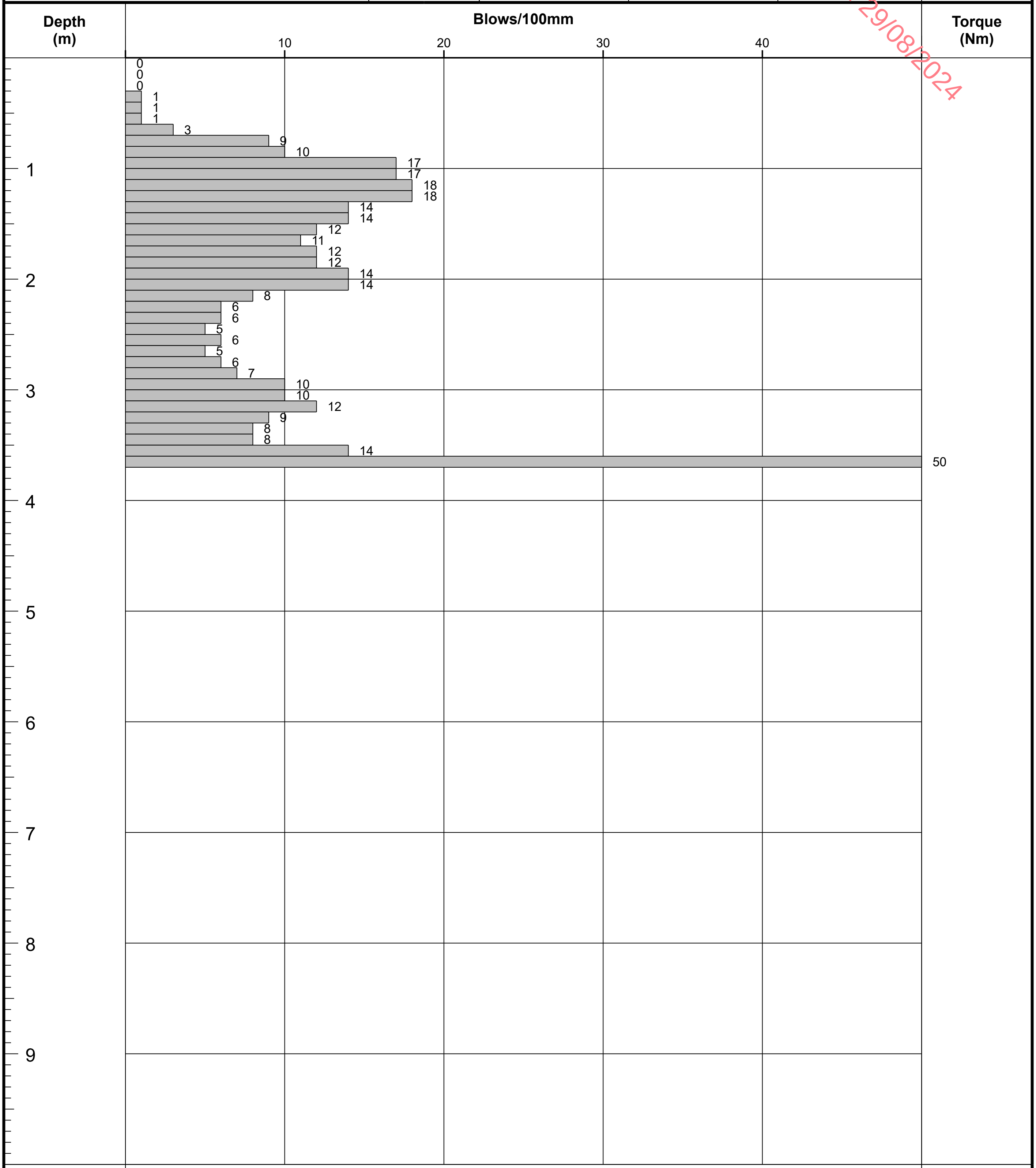
Elevation: 202.55 mOD

Final Depth: 3.60

Date: 28/01/2024

Operator: IC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated on refusal

Last Updated

20/03/2024

AGS

CAUSEWAY
GEOTECH

APPENDIX E

TRIAL PIT LOGS

	Project No. 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID**
	Coordinates 562257.48 E 673271.87 N	**Client:** MKO	**TP-MM-01**
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 141.94 mOD	**Date:** 12/12/2023 **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	TOPSOIL	
			141.74	0.20		Soft orangish brown sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
0.50 0.50	B1 D2						
			141.24	0.70		Firm light brown slightly sandy gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is angular fine to coarse.	
1.50 1.50	B3 D4						
			140.34	1.60		End of trial pit at 1.60m	

Water Strikes	
Struck at (m)	Remarks

Depth: 1.60
Width: 1.40
Length: 2.90

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID**
	Coordinates 563495.49 E 672475.21 N	**Client:** MKO	**TP-SC-01**
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 247.68 mOD	**Date:** 24/01/2024 — **Logger:** JAC	FINAL

RECEIVED: 29/08/2024

Depth (m)	**Sample / Tests**	**Field Records**	**Level (mOD)**	**Depth (m)**	**Legend**	**Description**	**Water**
						TOPSOIL	
			247.48	0.20		Firm light brown slightly sandy very gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
1.00 1.00	B1 D2						
		Light flow at 1.60m	246.08	1.60		End of trial pit at 1.60m	▼

Water Strikes	
Struck at (m)	Remarks
1.60	Light flow at 1.60m

Depth: 1.60
Width: 1.50
Length: 3.60

Remarks:

Stability: Stable

Termination Reason: Terminated on virtual refusal

Last Updated: 21/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID**
	Coordinates 563501.42 E 672514.45 N	**Client:** MKO	**TP-SC-02**
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 253.79 mOD	**Date:** 24/01/2024 **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	Peaty TOPSOIL	
			253.54	0.25	▨	Firm light brown sandy gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
1.00 1.00	B1 D2						
			252.59	1.20	▨	Brown sandy slightly silty angular fine to coarse GRAVEL with low cobble content. Sand is fine to coarse.	
1.60 1.60	B3 D4						
		Seepage at 2.30m	251.49	2.30		End of trial pit at 2.30m	▼

Water Strikes	
Struck at (m)	Remarks
2.30	Seepage at 2.30m

Depth: 2.30

Width: 1.70

Length: 4.10

Remarks:

Stability:
Stable

Termination Reason
Terminated on virtual refusal

Last Updated
21/03/2024

AGS

Project No.: 23-1870

Project Name: Lackareagh Wind Farm

Trial Pit ID: TP-SC-03

Coordinates: 563563.63 E 672495.96 N

Client: MKO

Method: Trial Pitting

Client's Representative: AFRY

Sheet 1 of 1
Scale: 1:25

Plant: 13t Tracked Excavator

Elevation: 260.92 mOD

Date: 26/01/2024

Logger: JAC

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	Peaty TOPSOIL	
			260.72	0.20	▨	Firm light brown slightly sandy gravelly SILT with low cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
1.00 1.00	B1 D2						
			259.22	1.70		End of trial pit at 1.70m	

Water Strikes

Struck at (m)	Remarks

Depth: 1.70
Width: 1.60
Length: 4.00

Remarks:
No groundwater encountered

Stability:
Unstable

Termination Reason
Terminated on virtual refusal

Last Updated
21/03/2024

CAUSEWAY GEOTECH

Method: Trial Pitting	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm		**Trial Pit ID** **TP-SC-04**
	Coordinates 563565.30 E 672543.35 N	**Client:** MKO		
		Client's Representative: AFRY		Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 265.07 mOD	**Date:** 24/01/2024	**Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	Peaty TOPSOIL	
			264.87	0.20	▨	Firm light brown sandy gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular to angular fine to coarse.	
		Light seepage at 0.40					▼
1.00 1.00	B1 D2						
			263.77	1.30	▨	Light brown sandy clayey angular fine to coarse GRAVEL with medium cobble content. Sand is fine to coarse.	
2.00 2.00	B3 D4						
3.00 3.00	B5 D6						
		Light seepage at 3.40m	261.67	3.40		End of trial pit at 3.40m	▼

Water Strikes

Struck at (m)	Remarks
3.40	Light seepage at 3.40m
0.40	Light seepage at 0.40

Depth: 3.40
Width: 1.60
Length: 4.20

Stability:
Stable

Remarks:

Termination Reason
Terminated on virtual refusal

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH

Method: Trial Pitting	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID**
Plant: 13t Tracked Excavator	**Coordinates** 563610.47 E 672536.64 N	**Client:** MKO	**TP-SC-05**
		Client's Representative: AFRY	Sheet 1 of 1 Scale: 1:25
	Elevation 268.99 mOD	**Date:** 24/01/2024 · **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			268.79	0.20		Peaty TOPSOIL	
1.00 1.00	B1 D2		267.79	1.20		Firm light brown slightly sandy very gravelly SILT with medium cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
2.00 2.00	B3 D4		266.29	2.70		Stiff light brown sandy gravelly CLAY with medium cobble and boulder content. Sand is fine to coarse. Gravel is angular fine to coarse.	
						End of trial pit at 2.70m	

Water Strikes

Struck at (m)	Remarks

Depth: 2.70
Width: 1.50
Length: 4.30

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated on virtual refusal

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1870

Project Name: Lackareagh Wind Farm

Trial Pit ID

TP-SC-06

Coordinates 563650.56 E 672578.40 N

Client: MKO

Method: Trial Pitting

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:25

Plant: 13t Tracked Excavator

Elevation 276.88 mOD

Date: 24/01/2024

Logger: JAC

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	Peaty TOPSOIL	
			276.48	0.40	▨	Firm light brown slightly sandy very gravelly SILT with medium cobble and medium boulder content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
1.00	B1						
1.00	D2						
			275.68	1.20	▨	Light brown sandy clayey subangular to subrounded fine to coarse GRAVEL with medium cobble and boulder content. Sand is fine to coarse.	
2.00	B3						
2.00	D4						
		Moderate flow at 2.20m	274.68	2.20		End of trial pit at 2.20m	▼

Water Strikes

Struck at (m)	Remarks
2.20	Moderate flow at 2.20m

Depth: 2.20
Width: 1.60
Length: 4.20

Remarks:

Stability: Unstable

Termination Reason Terminated on virtual refusal

Last Updated 21/03/2024

CAUSEWAY GEOTECH

	Project No. 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID**
	Coordinates 562208.01 E 673986.23 N	**Client:** MKO	**TP-T1-01**
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 235.17 mOD	**Date:** 12/12/2023 — **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	TOPSOIL	
			234.97	0.20	▨	Firm orangish brown sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
0.50 0.50	B1 D2						
			234.37	0.80	▨	Stiff light brown slightly sandy gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is angular fine to coarse.	
1.50 1.50	B3 D4						
2.50 2.50	B5 D6						
			231.97	3.20		End of trial pit at 3.20m	

Water Strikes	
Struck at (m)	Remarks

Depth: 3.20

Width: 1.40

Length: 3.60

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID** **TP-T2-01**
	Coordinates 562282.26 E 673586.76 N	**Client:** MKO	
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 187.10 mOD	**Date:** 13/12/2023 **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	TOPSOIL	
			186.90	0.20	▨	Firm orangish brown sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
0.40	D2		186.70	0.40	▨	Stiff light brown sandy gravelly SILT. Sand is fine to coarse. Gravel is subrounded fine to coarse.	
0.50	B1						
1.00 1.00	B3 D4						
			185.90	1.20		End of trial pit at 1.20m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes	
Struck at (m)	Remarks

Depth: 1.20
Width: 1.40
Length: 3.30

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID** **TP-T3-01**
	Coordinates 564007.76 E 673278.88 N	**Client:** MKO	
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 364.65 mOD	**Date:** 11/12/2023 · **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			364.30	0.35		TOPSOIL with roots and rootlets	
0.70 0.70	B1 D2		363.85	0.80		Orangish brown sandy silty angular fine to coarse GRAVEL with low cobble and boulder content. Sand is fine to coarse.	
1.70 1.70	B3 D4		362.35	2.30		Brownish sandy angular fine to coarse GRAVEL of greywacke with high cobble content. Sand is fine to coarse. Cobbles are angular of greywacke. (Possible weathered bedrock)	
						End of trial pit at 2.30m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes			
Struck at (m)	Remarks	**Depth:** 2.30 **Width:** 2.00 **Length:** 4.20	**Remarks:** No groundwater encountered
		Stability: Unstable	**Termination Reason** Terminated at refusal on boulders / possible bedrock. · **Last Updated** 21/03/2024

AGS

CAUSEWAY GEOTECH

	Project No. 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID** **TP-T4-01**
	Coordinates 563886.60 E 672683.32 N	**Client:** MKO	
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 276.38 mOD	**Date:** 11/12/2023 — **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			275.98	0.40	▨	Brown peaty TOPSOIL with roots and rootlets	
0.60 0.60	B1 D2		275.18	1.20	▨	Soft light brownish grey sandy gravelly SILT with low cobble and boulder content. Sand is fine to coarse. Gravel is angular fine to coarse.	
						End of trial pit at 1.20m	

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Water Strikes			
Struck at (m)	Remarks	**Depth:** 1.20 **Width:** 1.10 **Length:** 3.80	**Remarks:** No groundwater encountered
		Stability: Unstable	**Termination Reason** Terminated at refusal on boulders / possible bedrock.

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1870	**Project Name:** Lackareagh Wind Farm		**Trial Pit ID** **TP-T5-01**
Coordinates 563977.48 E 672336.61 N	**Client:** MKO		
Method: Trial Pitting	**Client's Representative:** AFRY		Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 301.59 mOD	**Date:** 24/01/2024	**Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	TOPSOIL	
			301.39	0.20	▨	Firm orangish brown slightly sandy very gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
1.00 1.00	B1 D2						
			300.09	1.50	▨	Brown slightly sandy angular fine to coarse GRAVEL of greywacke with high cobble content. Sand is fine to coarse. Cobbles are angular of greywacke. (Possible weathered bedrock)	
1.70	B3						
			299.69	1.90		End of trial pit at 1.90m	

0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

Water Strikes

Struck at (m)	Remarks

Depth: 1.90
Width: 1.50
Length: 3.40

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated on virtual refusal

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1870	**Project Name:** Lackareagh Wind Farm		**Trial Pit ID** **TP-T6-01**
Coordinates 563314.91 E 672289.52 N	**Client:** MKO		
Method: Trial Pitting	**Client's Representative:** AFRY		Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 203.45 mOD	**Date:** 12/12/2023	**Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Description	Water
					TOPSOIL	
			203.25	0.20	Firm orangish brown slightly sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subrounded fine to coarse.	
0.50 0.50	B1 D2					
			202.15	1.30	Stiff brown sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is angular fine to coarse.	
1.50 1.50	B3 D4					
2.50 2.50	B5 D6					
			200.25	3.20	End of trial pit at 3.20m	

Water Strikes	
Struck at (m)	Remarks

Depth: 3.20
Width: 1.40
Length: 3.40

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
21/03/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1870	**Project Name:** Lackareagh Wind Farm	**Trial Pit ID**
	Coordinates 563391.33 E 671880.53 N	**Client:** MKO	**TP-T7-01**
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 204.79 mOD	**Date:** 13/12/2023 **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
			204.69	0.10		TOPSOIL	
0.50 0.50	B1 D2		204.19	0.60		Firm orangish brown sandy gravelly SILT with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.	
1.50 1.50	B3 D4	Seepage at 1.80m	202.99	1.80		Light brown sandy silty angular fine to coarse GRAVEL with low cobble and boulder content. Sand is fine to coarse.	▼
2.50 2.50	B5 D6		201.59	3.20		Stiff light brown slightly sandy very gravelly silty CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is angular fine to coarse.	
						End of trial pit at 3.20m	

Water Strikes

Struck at (m)	Remarks
1.80	Seepage at 1.80m

Depth: 3.20
Width: 1.40
Length: 3.50

Remarks:

Stability: Unstable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
21/03/2024

AGS

CAUSEWAY
GEOTECH

APPENDIX F

TRIAL PIT PHOTOGRAPHS

Trial Pit TP-MM-01

Trial Pit TP-MM-01

Trial Pit TP-MM-01

Trial Pit TP-MM-01

Trial Pit TP-SC-01

Trial Pit TP-SC-01

Trial Pit TP-SC-01

Trial Pit TP-SC-02

Trial Pit TP-SC-02

Trial Pit TP-SC-02

Trial Pit TP-SC-03

Trial Pit TP-SC-03

Trial Pit TP-SC-03

Trial Pit TP-SC-04

Trial Pit TP-SC-04

Trial Pit TP-SC-04

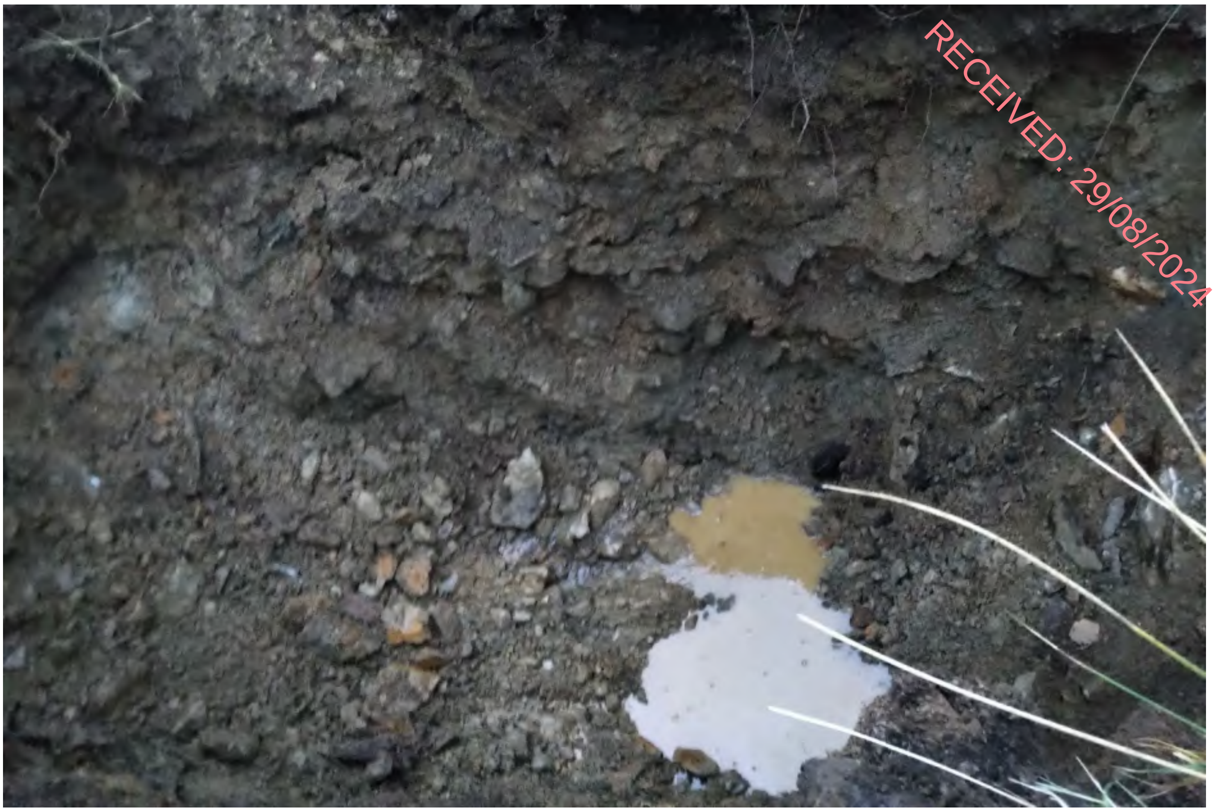
Trial Pit TP-SC-05

Trial Pit TP-SC-05

Trial Pit TP-SC-05

Trial Pit TP-SC-05

Trial Pit TP-SC-06



Trial Pit TP-SC-06

Trial Pit TP-SC-06

Trial Pit TP-T1-01

Trial Pit TP-T1-01

Trial Pit TP-T1-01

Trial Pit TP-T1-01

Trial Pit TP-T2-01

Trial Pit TP-T2-01

Trial Pit TP-T2-01

Trial Pit TP-T3-01

Trial Pit TP-T3-01

Trial Pit TP-T3-01

Trial Pit TP-T3-01

Trial Pit TP-T4-01

Trial Pit TP-T4-01

Trial Pit TP-T4-01

Trial Pit TP-T4-01

Trial Pit TP-T5-01

Trial Pit TP-T5-01

Trial Pit TP-T5-01

Trial Pit TP-T5-01

Trial Pit TP-T6-01

Trial Pit TP-T6-01

Trial Pit TP-T6-01

Trial Pit TP-T6-01

Trial Pit TP-T7-01

Trial Pit TP-T7-01

Trial Pit TP-T7-01

Trial Pit TP-T7-01

APPENDIX G

INDIRECT IN-SITU CBR TEST RESULTS

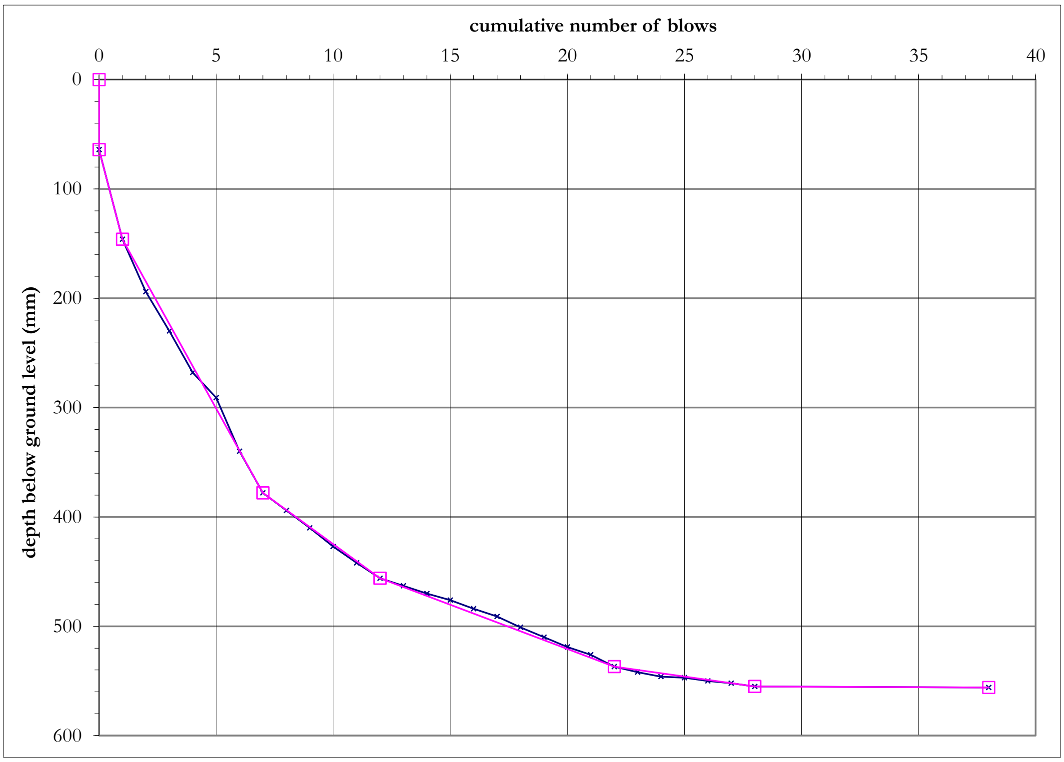
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP01	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Rain

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 64	N/A	N/A
64 146	82	2.9
146 378	39	6.3
378 456	16	17
456 537	8.1	33
537 555	3	95
555 556	0.1	>100

CBR Range	Min: 2.9 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		December 2023

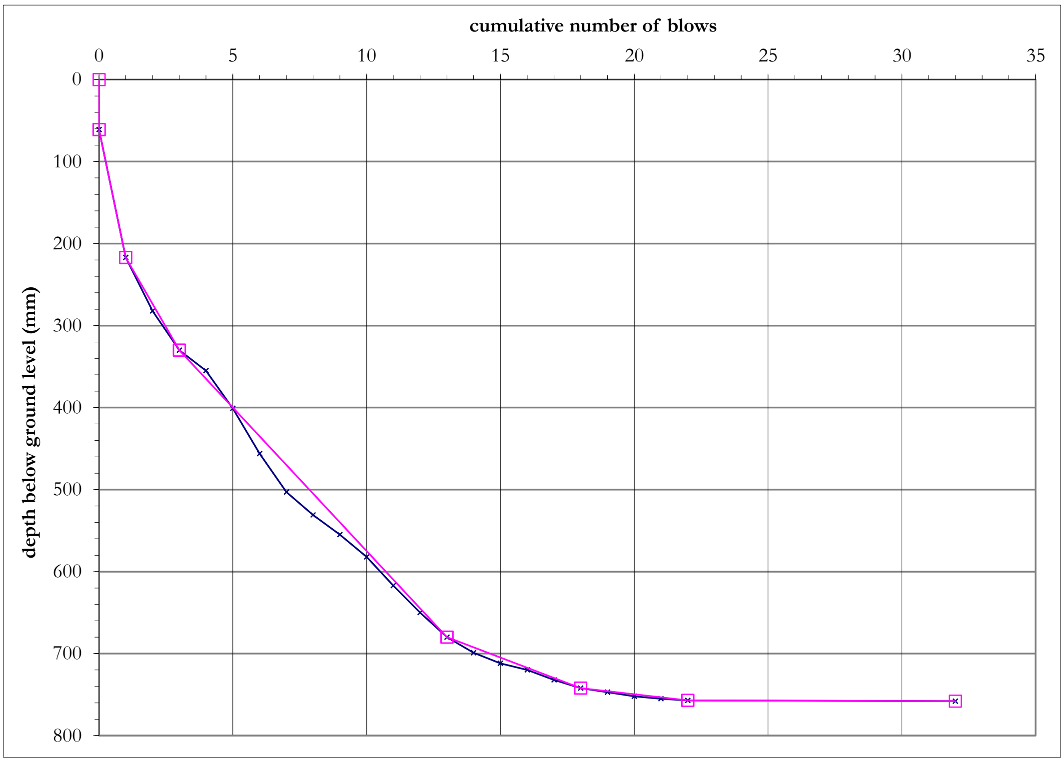
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP02	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Rain

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 61	N/A	N/A
61 217	156	1.5
217 330	57	4.2
330 680	35	7
680 742	12	21
742 757	3.8	75
757 758	0.1	>100

CBR Range	Min: 1.5 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director	Dam O'Mahony	December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

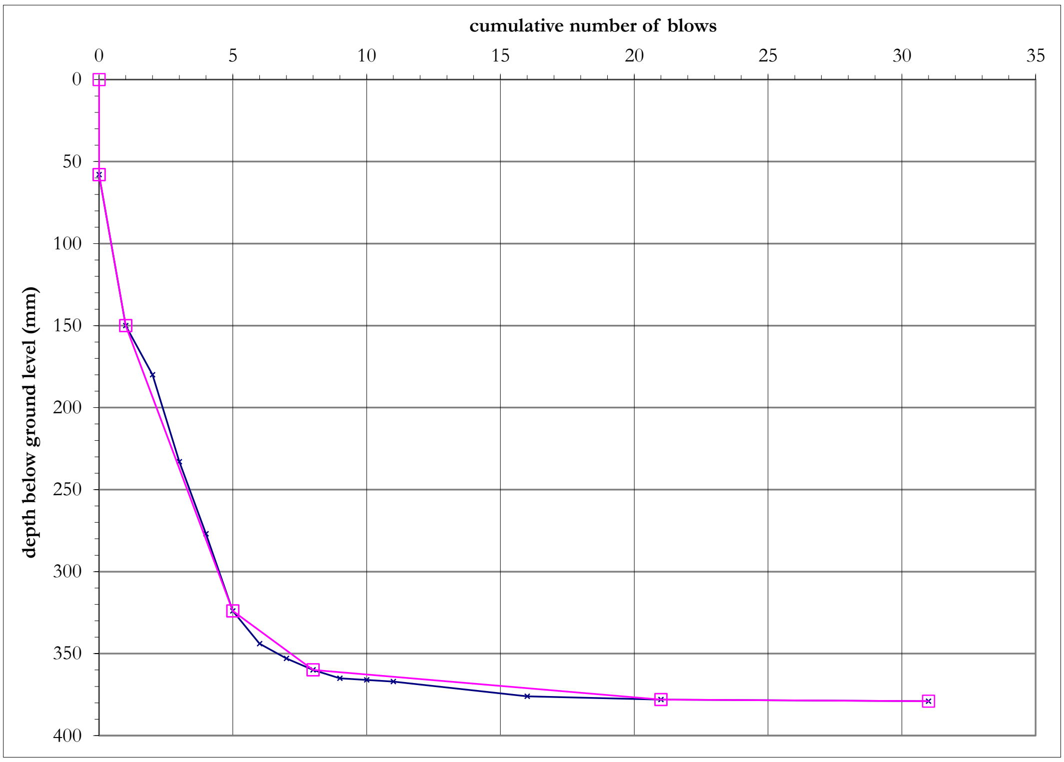
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP03	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Rain

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	**Description of surface material at test depth**
N/A	TOPSOIL



top / base of layer (mm)	**mm/ blow**	**CBR (%)**
0 58	N/A	N/A
58 150	92	2.5
150 324	44	5.6
324 360	12	22
360 378	1.4	>100
378 379	0.1	>100

CBR Range	Min: 2.5 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		December 2023

UKAS TESTING 10122

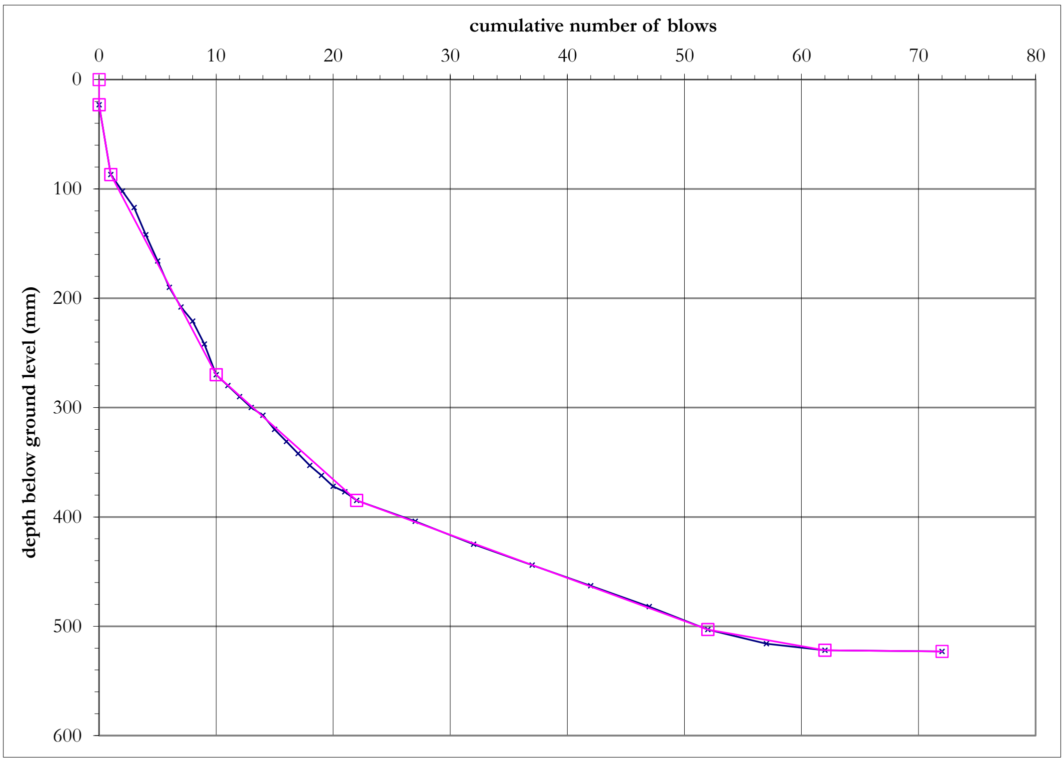
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP04	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 23	N/A	N/A
23 87	64	3.7
87 270	20	13
270 385	9.6	28
385 503	3.9	71
503 522	1.9	>100
522 523	0.1	>100

CBR Range	Min: 3.7 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	D O'Mahony	December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

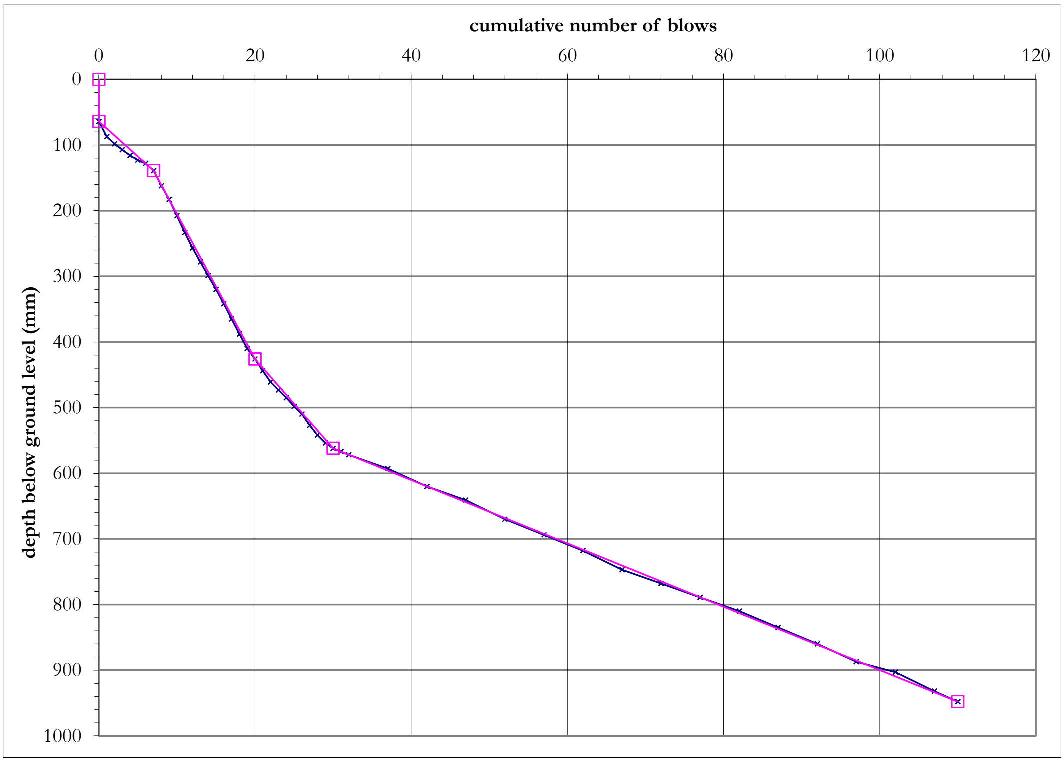
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP05	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	**Description of surface material at test depth**
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 64	N/A	N/A
64 139	11	25
139 426	22	11
426 562	14	19
562 948	4.8	57

CBR Range	Min: 11 Max: 57	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None

Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director		December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

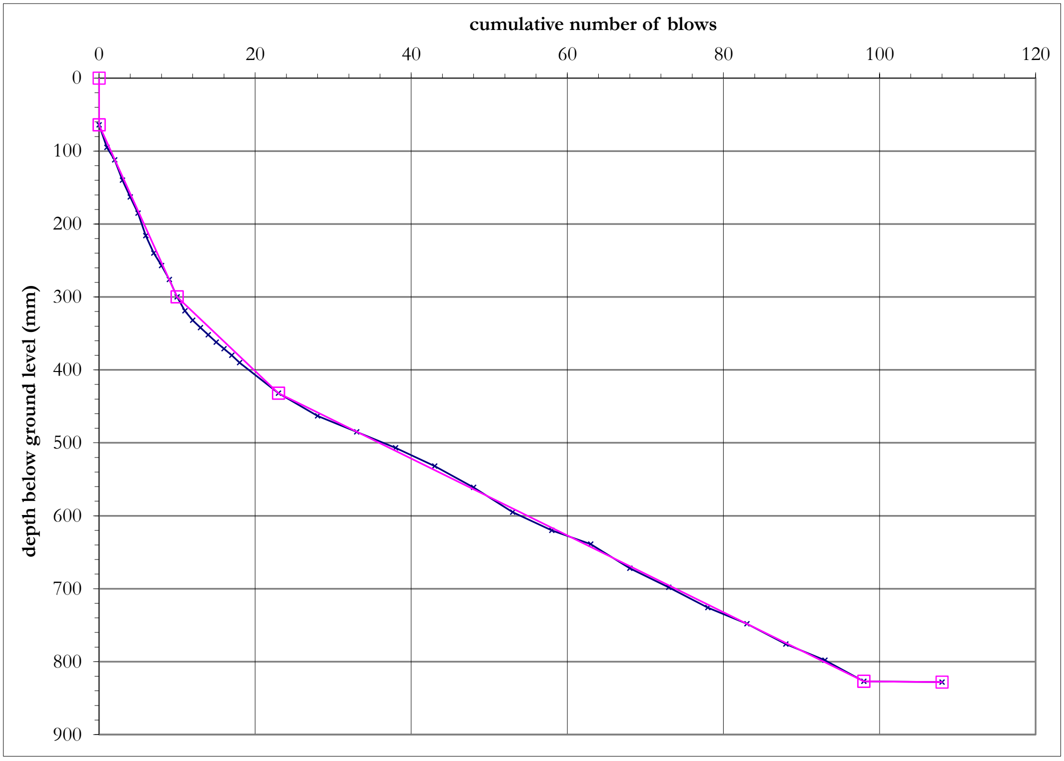
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP06	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	**Description of surface material at test depth**
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 64	N/A	N/A
64 300	24	11
300 432	10	26
432 827	5.3	52
827 828	0.1	>100

CBR Range	Min: 11 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

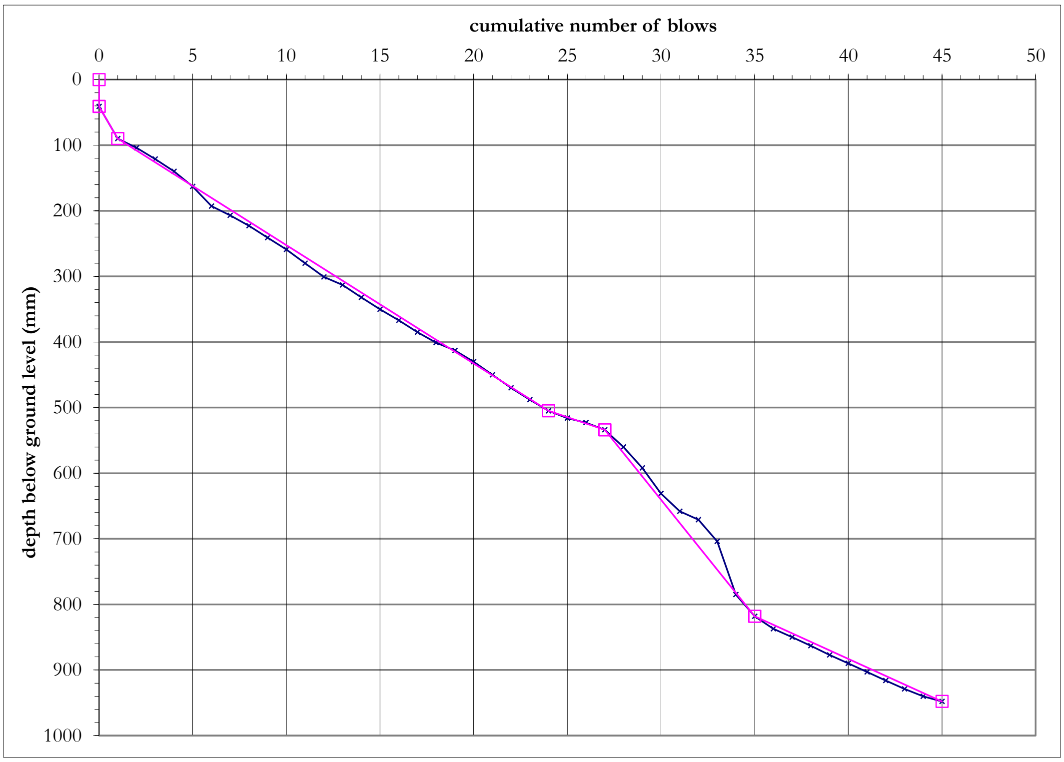
CAUSEWAY GEOTECH

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP07	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	**Description of surface material at test depth**
N/A	GRAVEL



top / base of layer (mm)	mm/ blow	CBR (%)
0 41	N/A	N/A
41 90	49	4.9
90 505	18	14
505 534	9.7	27
534 818	36	6.9
818 948	13	20

CBR Range	Min: 4.9 Max: 27	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	December 2023

UKAS TESTING 10122

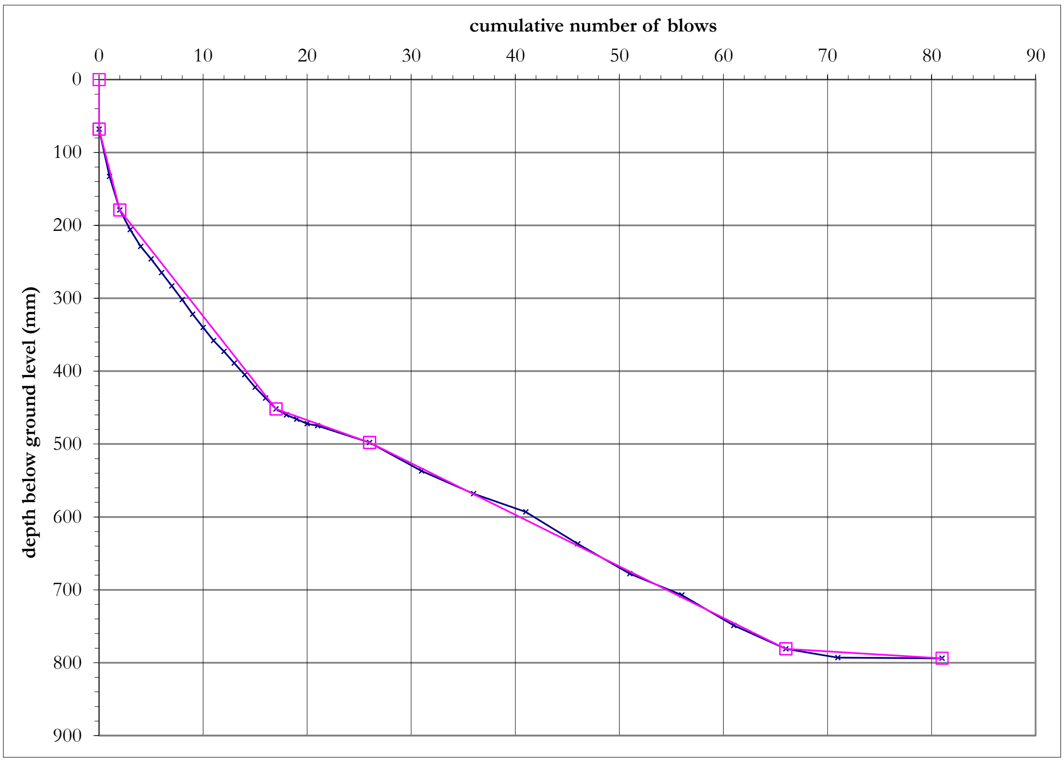
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP08	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 68	N/A	N/A
68 179	56	4.3
179 452	18	14
452 498	5.1	54
498 781	7.1	38
781 794	0.9	>100

CBR Range	Min: 4.3 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director	Dan O'Mahony	December 2023

UKAS TESTING 10122

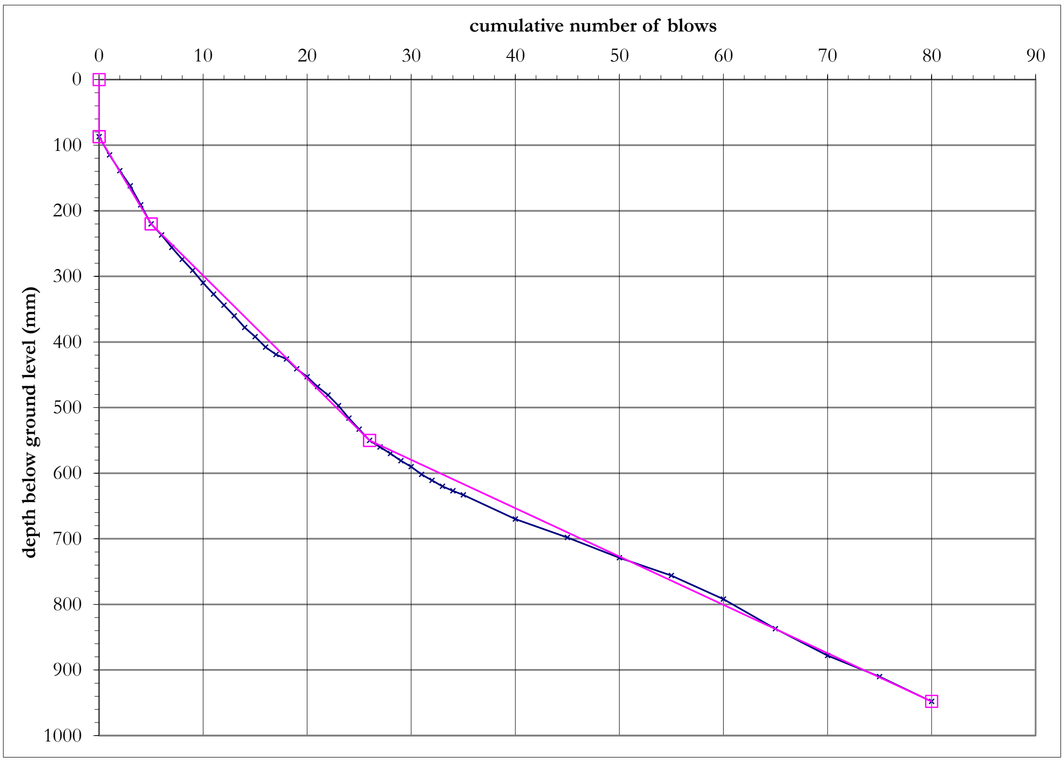
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP09	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 87	N/A	N/A
87 220	27	9.4
220 550	16	16
550 948	7.4	37

CBR Range	Min: 9.4 Max: 37	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		December 2023

UKAS TESTING 10122

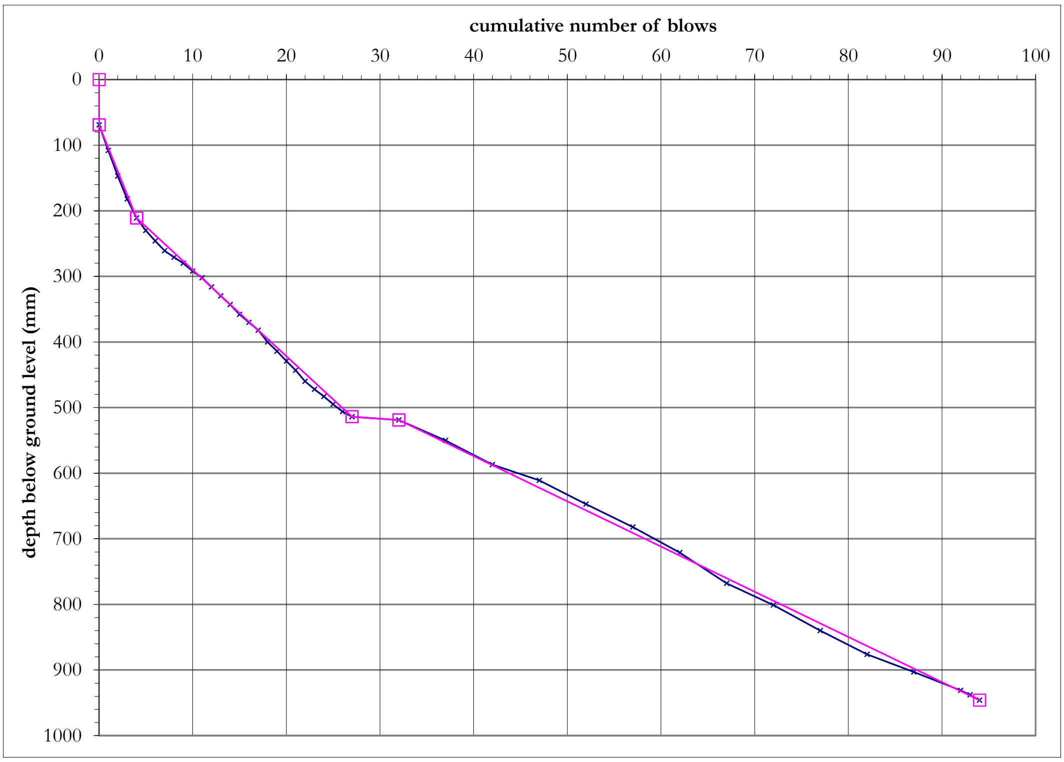
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP10	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 69	N/A	N/A
69 211	36	6.9
211 514	13	20
514 519	1	>100
519 946	6.9	39

CBR Range	Min: 6.9 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	December 2023

10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

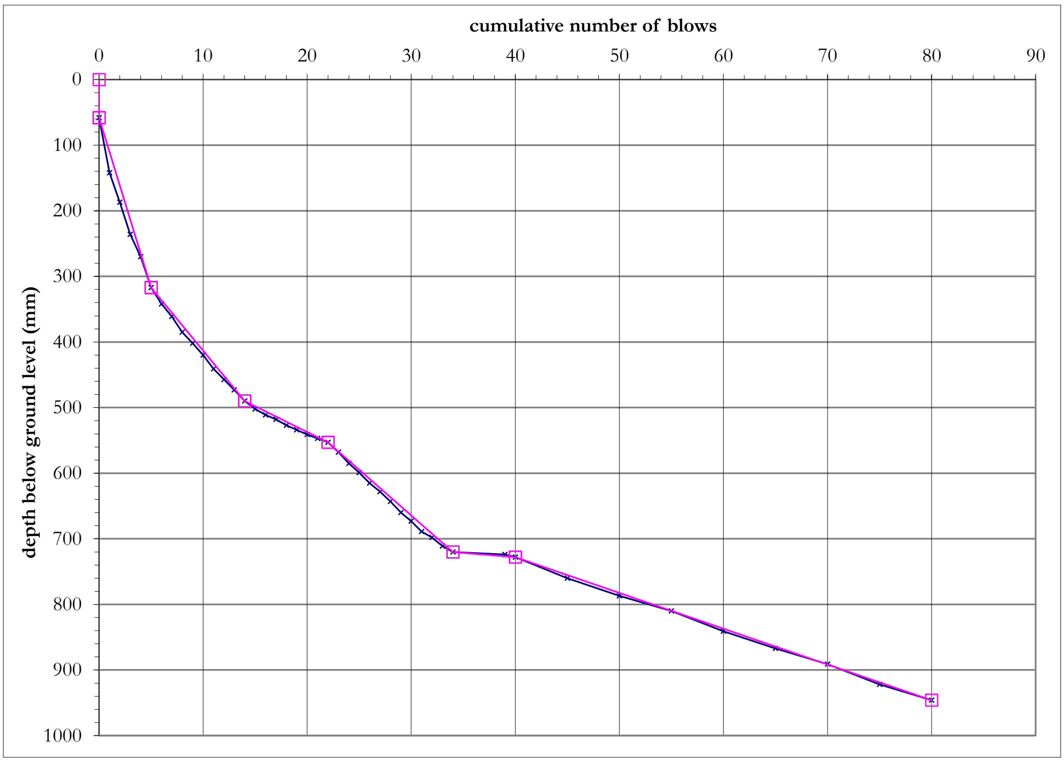
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP11	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 58	N/A	N/A
58 317	52	4.7
317 490	19	13
490 553	7.9	34
553 720	14	19
720 728	1.3	>100
728 946	5.5	50

CBR Range	Min: 4.7 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		December 2023

UKAS TESTING 10122

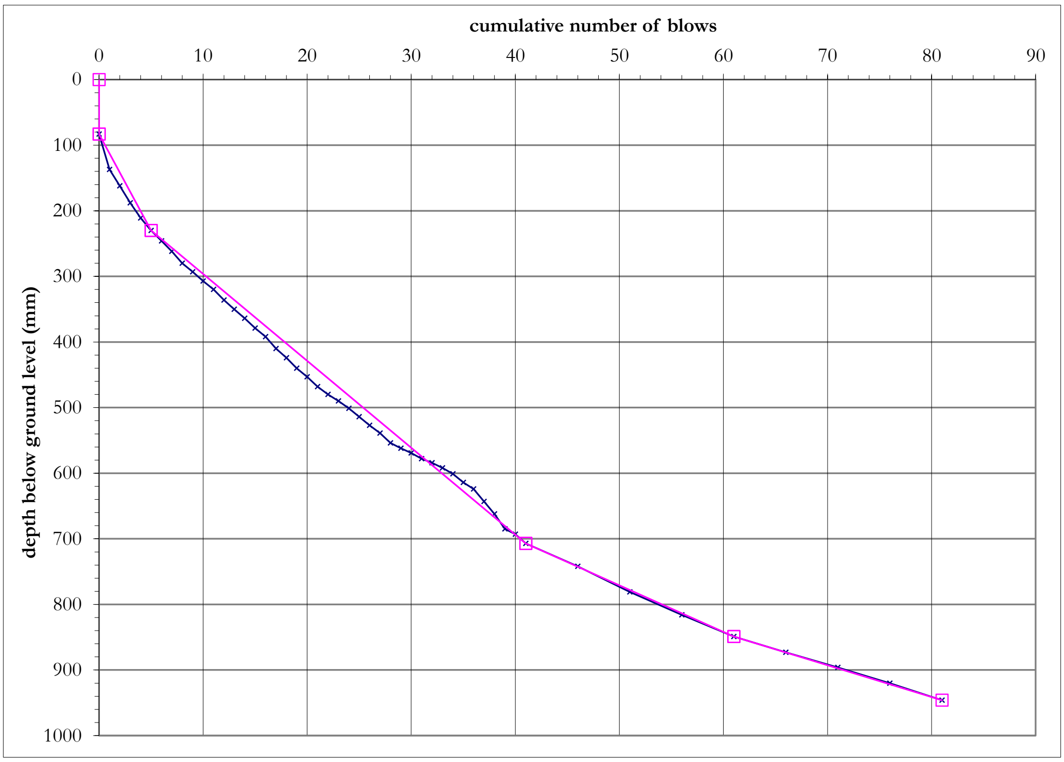
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP12	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 83	N/A	N/A
83 230	29	8.5
230 707	13	20
707 849	7.1	38
849 946	4.9	57

CBR Range	Min: 8.5 Max: 57	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director	D O'Mahony	December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

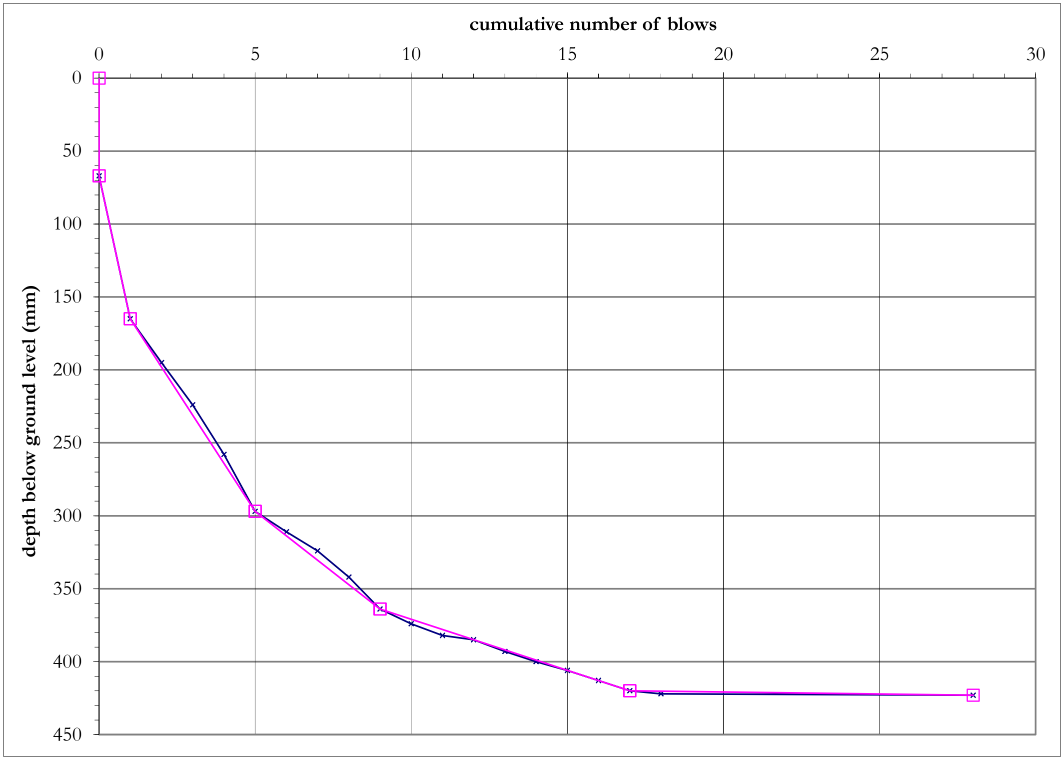
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP13	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	**Description of surface material at test depth**
N/A	GRAVEL



top / base of layer (mm)	mm/ blow	CBR (%)
0 67	N/A	N/A
67 165	98	2.4
165 297	33	7.5
297 364	17	15
364 420	7	39
420 423	0.3	>100

CBR Range	Min: 2.4 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	December 2023

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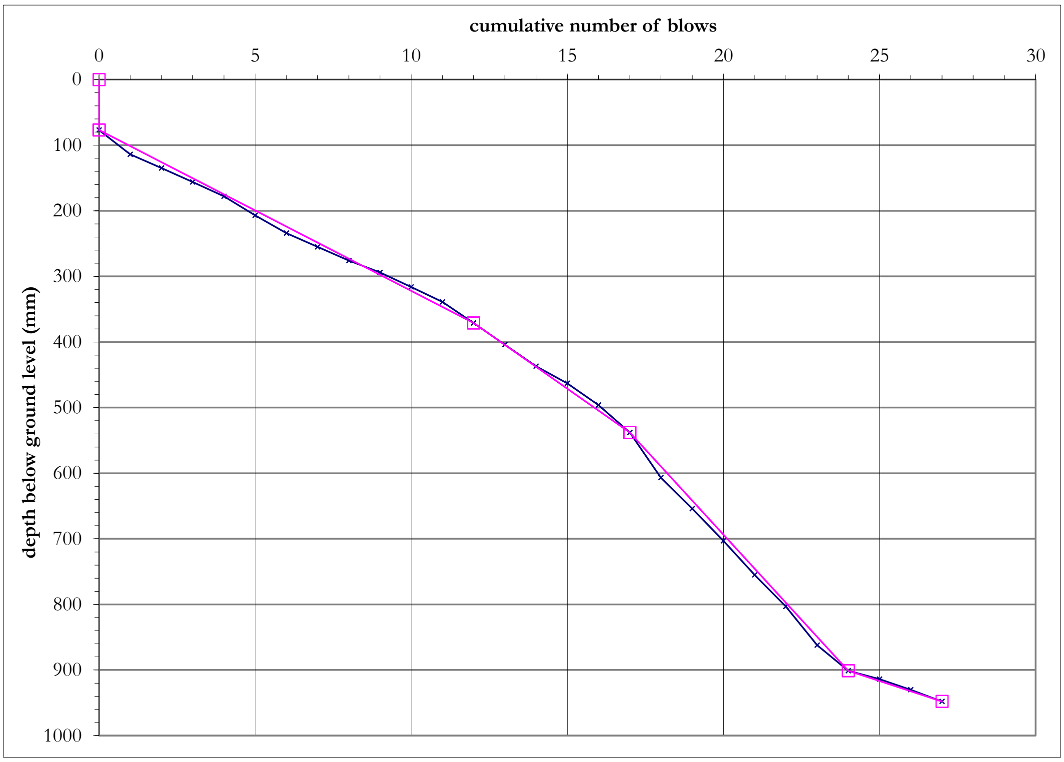
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP14	**Date Tested**	12/12/2023
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	GRAVEL



top / base of layer (mm)	mm/ blow	CBR (%)
0 77	N/A	N/A
77 371	25	10
371 538	33	7.4
538 901	52	4.6
901 948	16	16

CBR Range	Min: 4.6 Max: 16	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director	D O'Mahony	December 2023

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

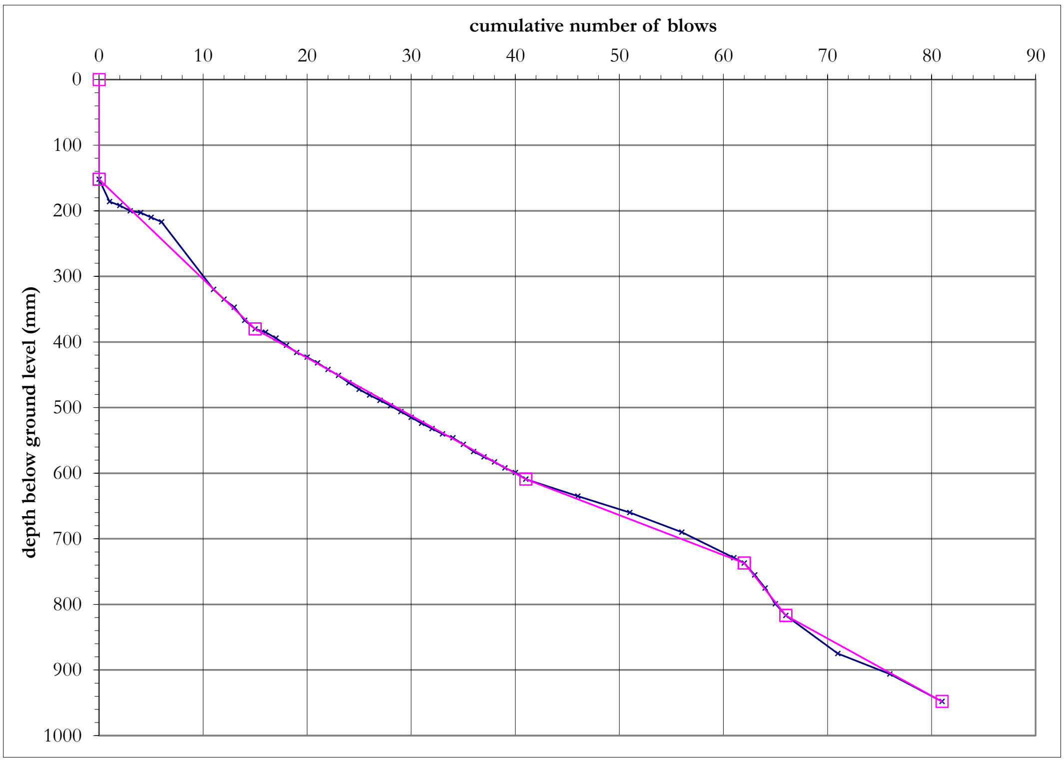
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP15	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 152	N/A	N/A
152 380	15	17
380 609	8.8	30
609 737	6.1	45
737 817	20	13
817 948	8.7	31

CBR Range	Min: 13 Max: 45	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director		December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

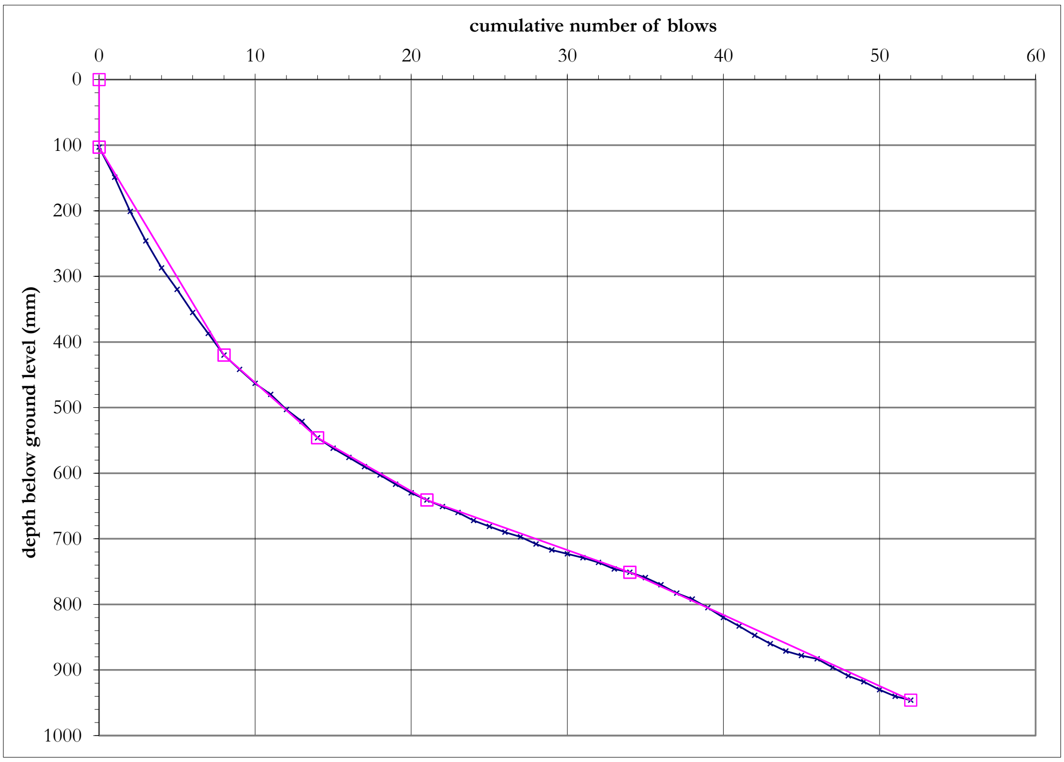
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP16	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 103	N/A	N/A
103 420	40	6.2
420 546	21	12
546 641	14	19
641 751	8.5	32
751 946	11	24

CBR Range	Min: 6.2 Max: 32	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	D O'Mahony	December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

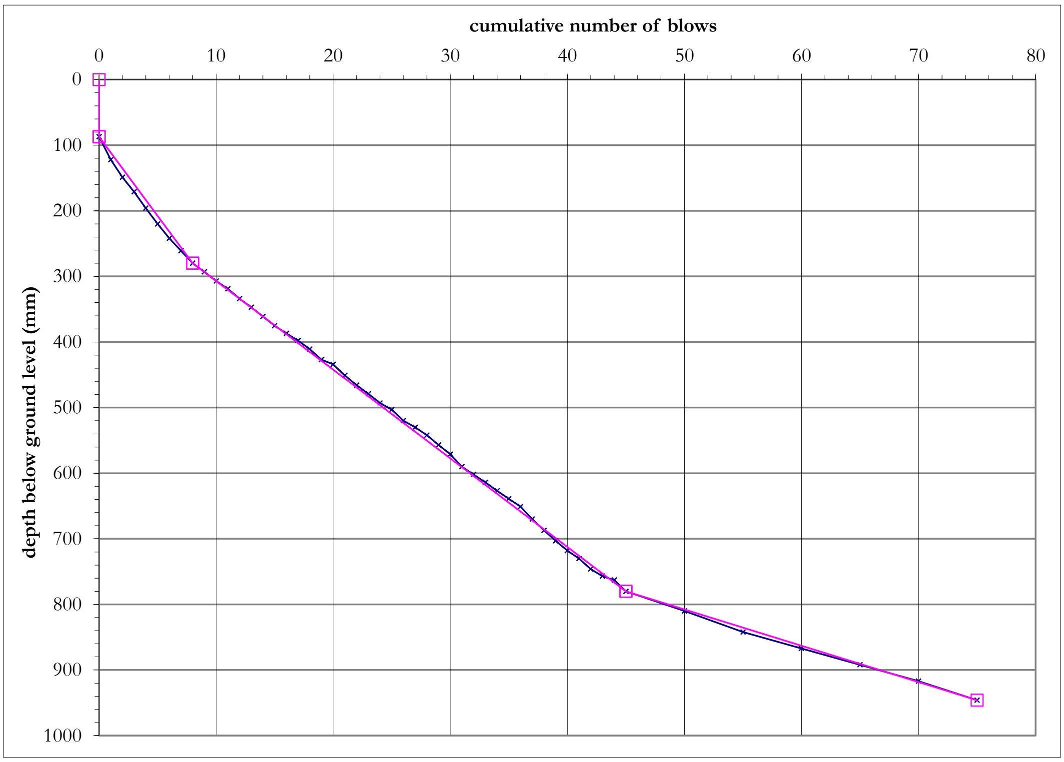
Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY
GEOTECH

Test Number	DCP17	**Date Tested**	13/12/2023
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 87	N/A	N/A
87 280	24	10
280 780	14	19
780 946	5.5	50

CBR Range	Min: 10 Max: 50	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	December 2023

UKAS
TESTING
10122

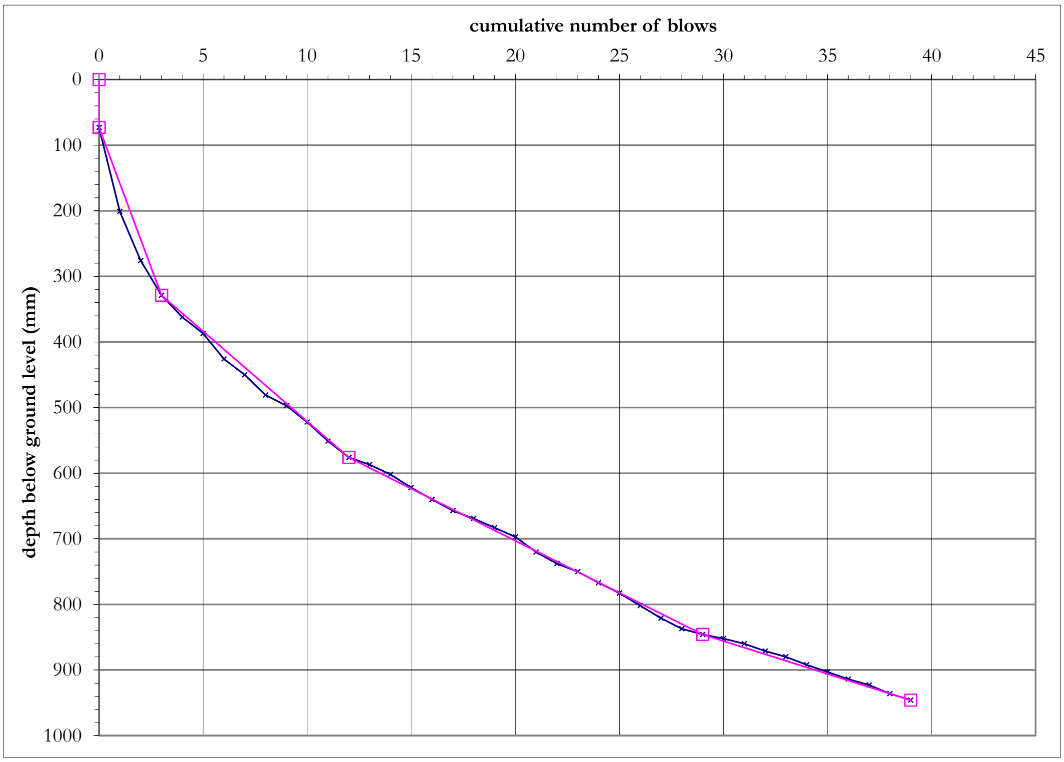
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP18	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 73	N/A	N/A
73 329	85	2.7
329 576	27	9.1
576 846	16	16
846 946	10	26

CBR Range	Min: 2.7 Max: 26	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	D O'Mahony	February 2024

UKAS TESTING 10122

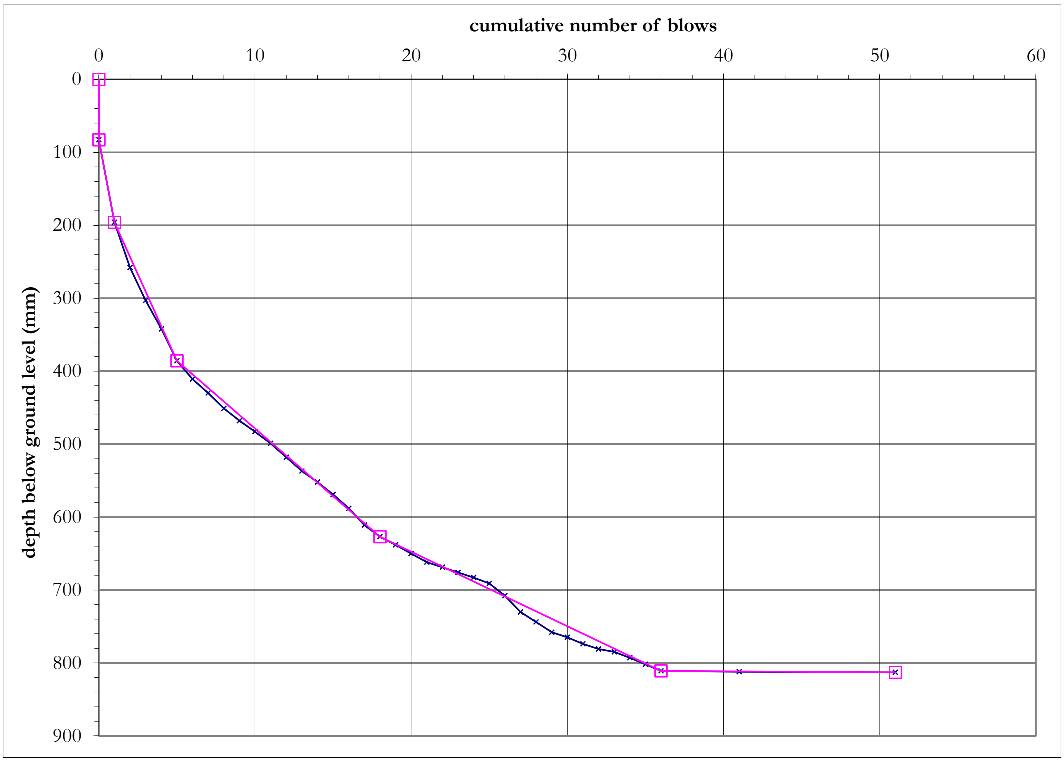
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP19	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	**Description of surface material at test depth**
N/A	TOPSOIL



top / base of layer (mm)	**mm/ blow**	**CBR (%)**
0 83	N/A	N/A
83 196	113	2
196 386	48	5.1
386 627	19	14
627 811	10	26
811 813	0.1	>100

CBR Range	Min: 2 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		February 2024

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

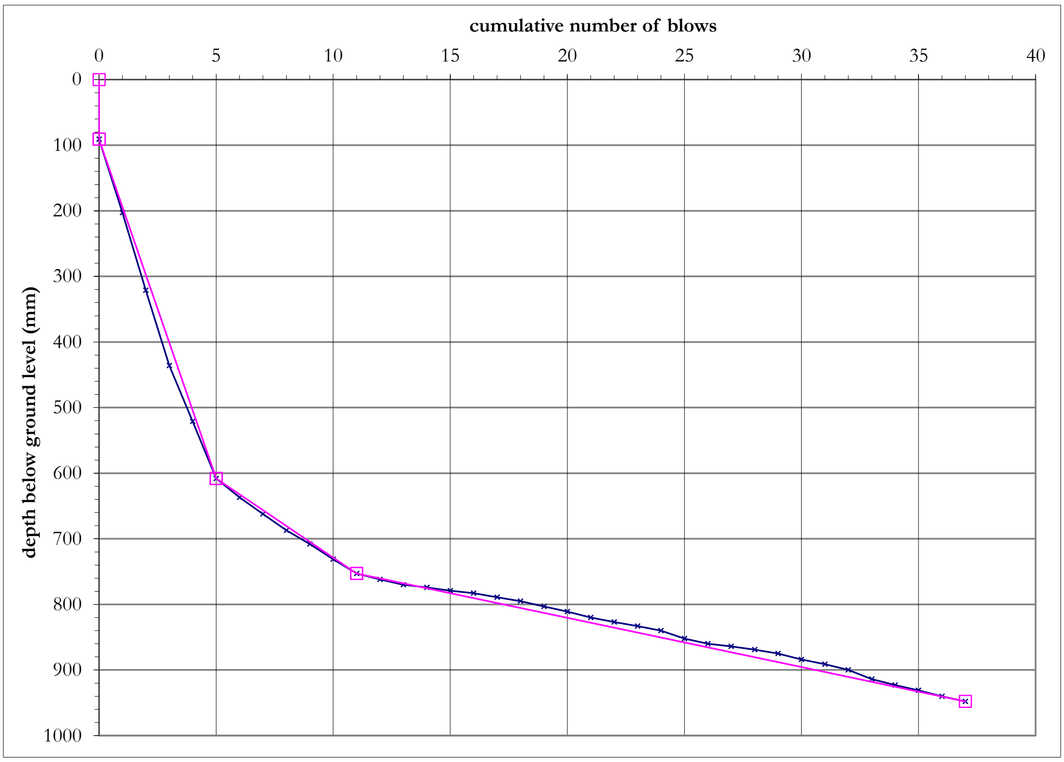
Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

CAUSEWAY GEOTECH

Test Number	DCP20	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Dry

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 91	N/A	N/A
91 608	103	2.2
608 753	24	10
753 948	7.5	36

CBR Range	Min: 2.2 Max: 36	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		February 2024

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

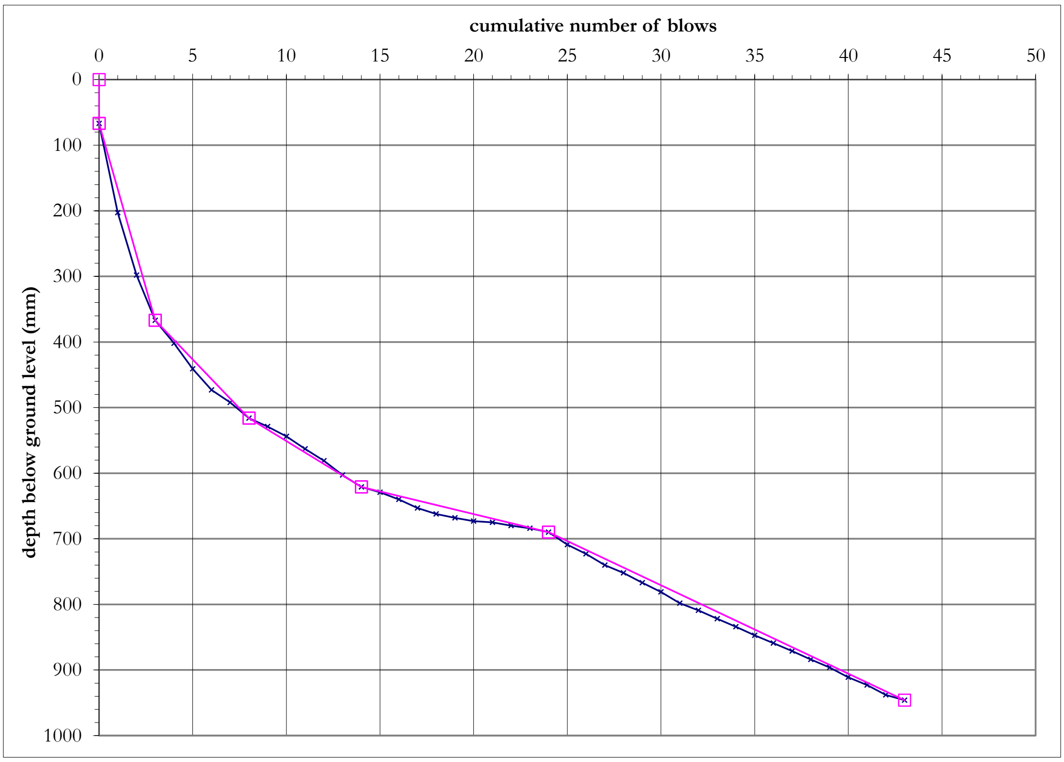
CAUSEWAY GEOTECH

Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP21	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 67	N/A	N/A
67 367	100	2.3
367 516	30	8.4
516 621	18	15
621 690	6.9	39
690 946	13	19

CBR Range	Min: 2.3 Max: 39	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		February 2024

UKAS TESTING 10122

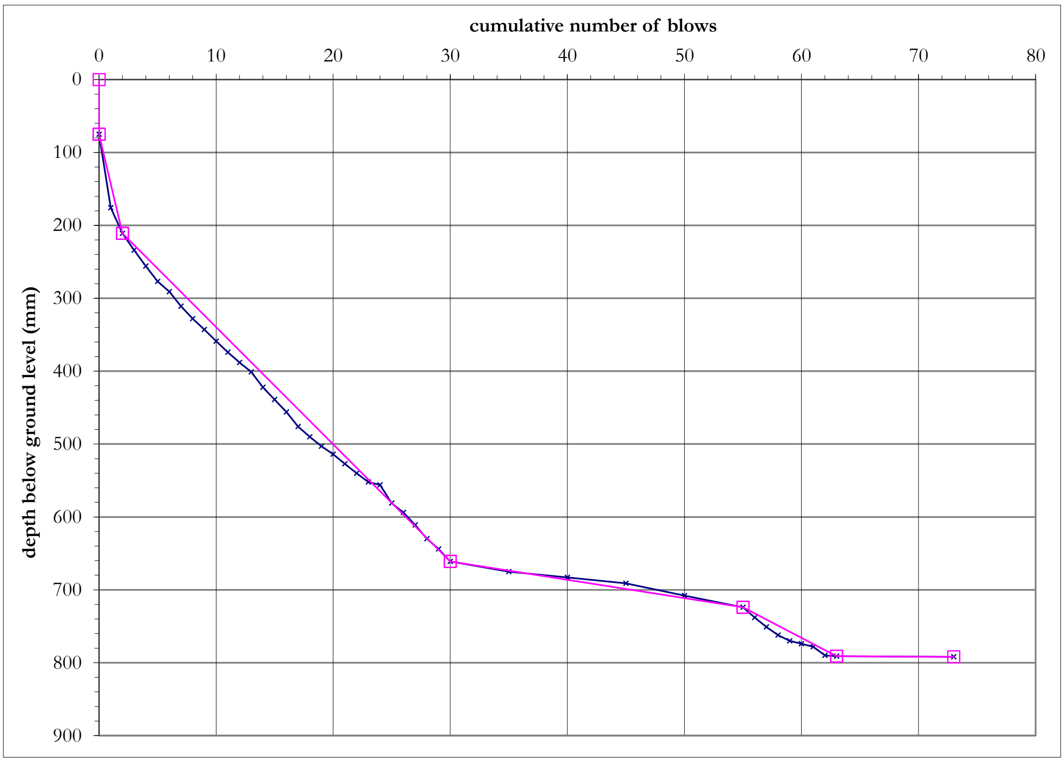
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP22	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 75	N/A	N/A
75 211	68	3.5
211 661	16	16
661 724	2.5	>100
724 791	8.4	32
791 792	0.1	>100

CBR Range	Min: 3.5 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment		
Darren O'Mahony Director		February 2024

UKAS TESTING 10122

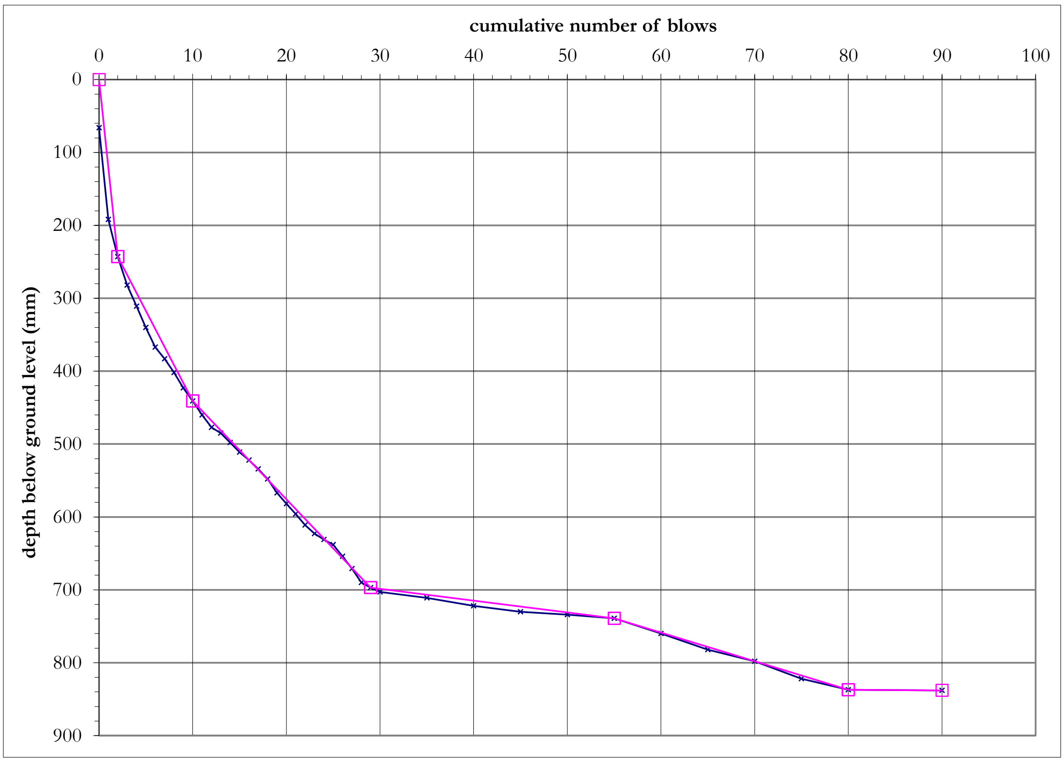
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP23	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 243	N/A	N/A
243 441	25	10
441 697	13	19
697 739	1.6	>100
739 837	3.9	71
837 838	0.1	>100

CBR Range	Min: 10 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	D O'Mahony	February 2024

UKAS TESTING 10122

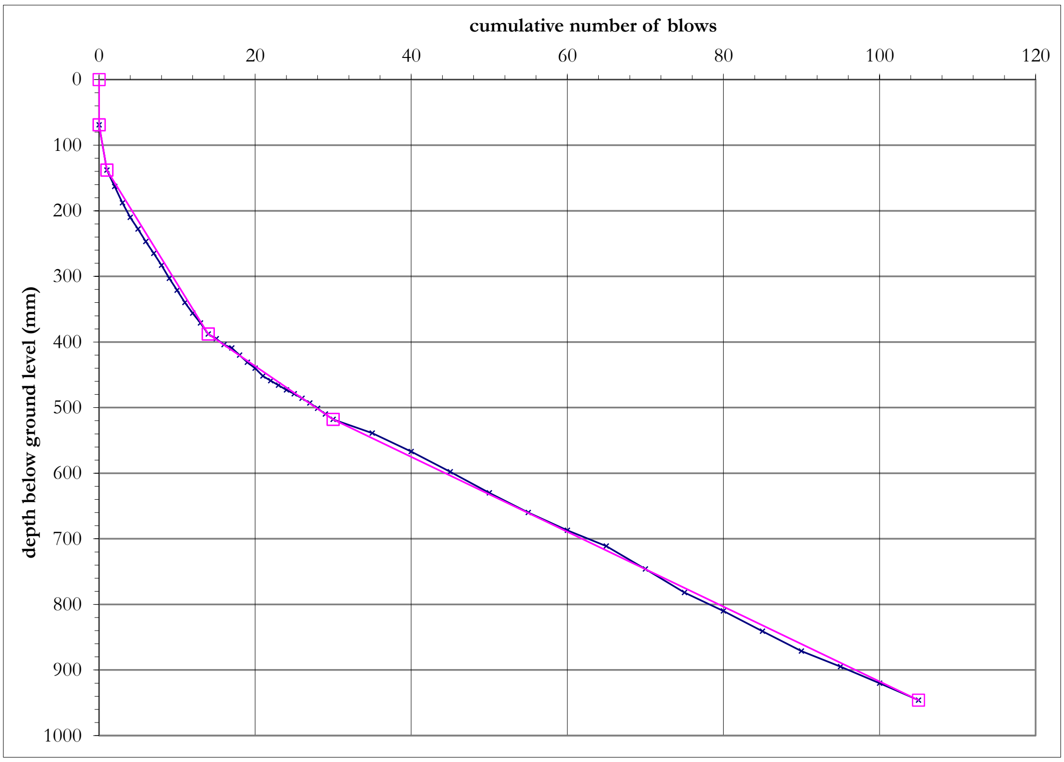
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP24	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	**Description of surface material at test depth**
N/A	TOPSOIL



top / base of layer (mm)	**mm/ blow**	**CBR (%)**
0 69	N/A	N/A
69 138	69	3.4
138 388	19	13
388 518	8.1	33
518 946	5.7	48

CBR Range	Min: 3.4 Max: 48	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	D O'Mahony	February 2024

UKAS TESTING 10122

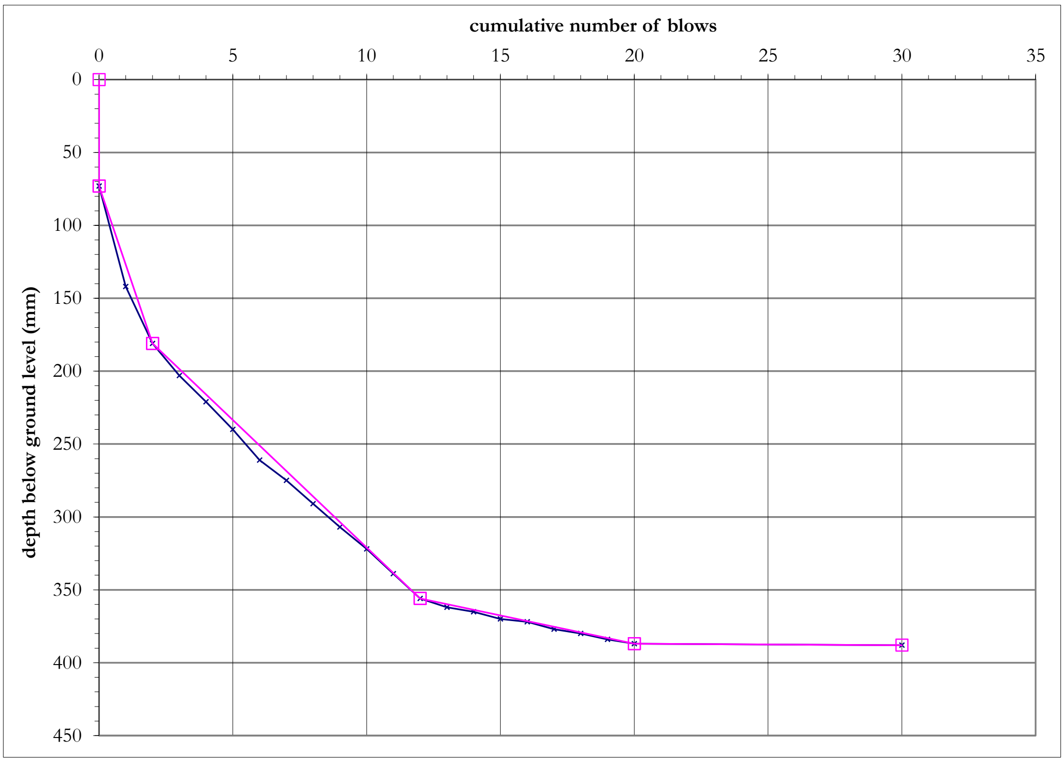
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1890
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP25	**Date Tested**	25/01/2024
Depth bgl (m)	0.00	**Weather**	Showers

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 73	N/A	N/A
73 181	54	4.5
181 356	18	15
356 387	3.9	72
387 388	0.1	>100

CBR Range	Min: 4.5 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	February 2024

10122

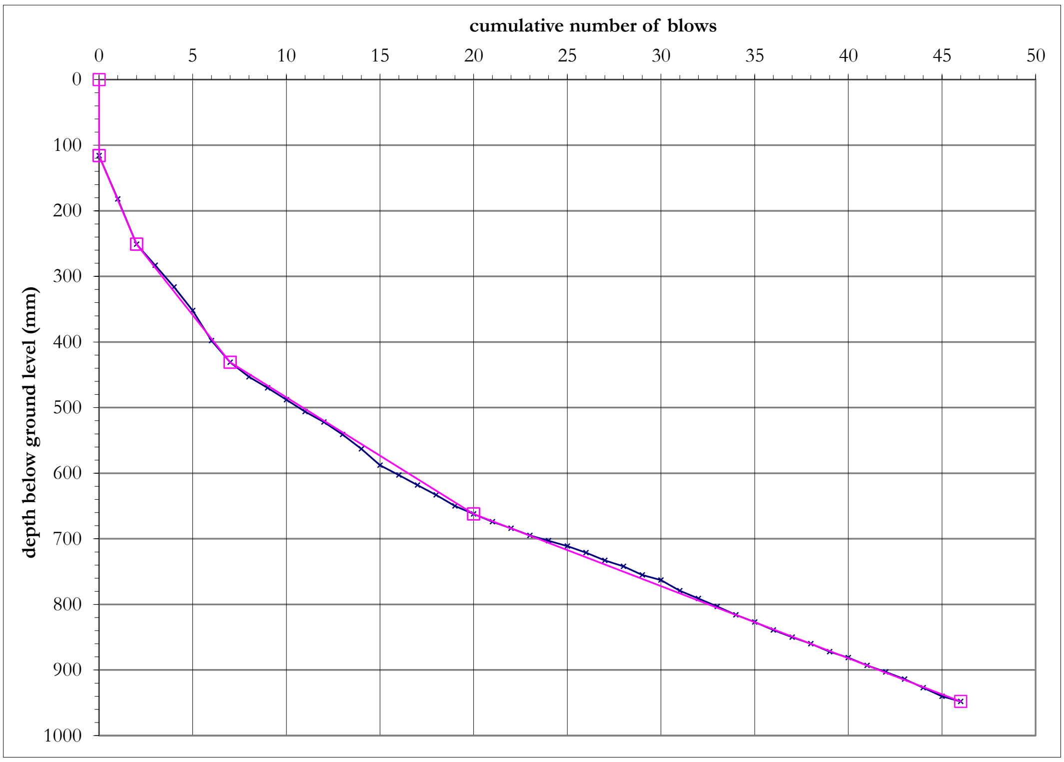
Dynamic Cone Penetrometer (DCP) test results and estimated CBR

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP26	**Date Tested**	11/12/2023
Depth bgl (m)	0.00	**Weather**	Rain

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 116	N/A	N/A
116 251	68	3.5
251 431	36	6.8
431 662	18	14
662 948	11	24

CBR Range	Min: 3.5 Max: 24	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	December 2023

UKAS TESTING 10122

Dynamic Cone Penetrometer (DCP) test results and estimated CBR

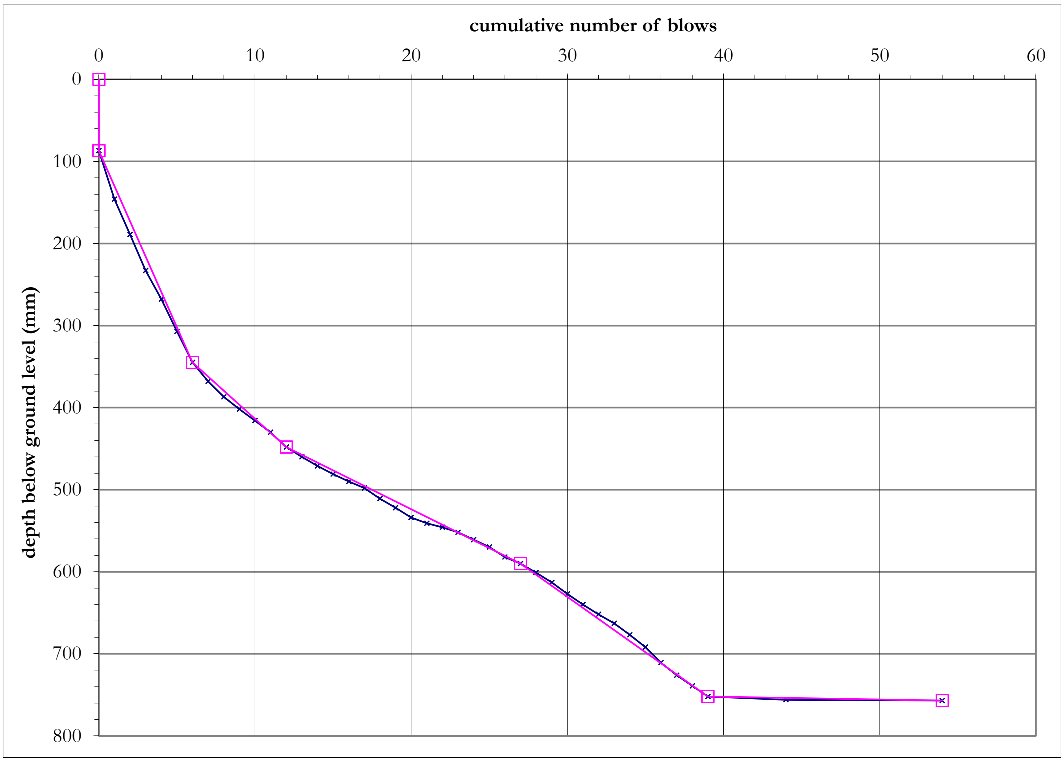
CAUSEWAY GEOTECH

Project Number	23-1870
Project Name	Lackareagh Wind Farm, Co Clare
Site Location	Lackareagh, Co Clare

Test Number	DCP27	**Date Tested**	11/12/2023
Depth bgl (m)	0.00	**Weather**	Rain

Test conducted in accordance with Documented In-House Technical Procedure IMS TP7-4 and DMRB CS 229 Rev 0
CBR calculated using the TRRL CBR DCP relationship: log10(CBR) = 2.48 - 1.057 x log10(mm/blow) in accordance with DMRB CS 229 Rev 0

Surface preparation	Description of surface material at test depth
N/A	TOPSOIL



top / base of layer (mm)	mm/ blow	CBR (%)
0 87	N/A	N/A
87 345	43	5.7
345 448	17	15
448 590	9.5	28
590 752	14	19
752 757	0.3	>100

CBR Range	Min: 5.7 Max: >100	The self-weight penetration at the start of the test (shown above) has not been included in the minimum and maximum values shown to the left. The selection of layers is based on visual interpretation of the data. The insitu DCP reading (mm/blow) and CBR values are valid at the time of testing; variation in moisture content or other factors may affect the insitu value. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report should not be reproduced except in full without the written approval of the laboratory.

Deviation(s) from standard procedure	None
Observations and comments	

Approved Name and Appointment

Darren O'Mahony Director	December 2023

UKAS TESTING 10122

CAUSEWAY
GEOTECH

APPENDIX H

GEOTECHNICAL LABORATORY TEST RESULTS

CAUSEWAY
GEOTECH

HEAD OFFICE
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Stephenstown Industrial Estate
Balbriggan, Co Dublin, Ireland, K32 VR66
ROI: +353 (0)1 526 7465
Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS LABORATORY TEST REPORT

12 March 2024

Project Name:	Lackareagh Wind Farm
Project No.:	23-1870
Client:	MKO
Engineer:	Albert Fry

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the Contents page(s). This testing was performed between 15/02/2024 and 12/03/2024.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Lackareagh Wind Farm

Report Reference: Schedule 1

The table below details the tests carried out, the specifications used, and the number of tests included in this report. Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests.

The results contained in this report relate to the sample(s) as received. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. This report shall not be reproduced other than in full, without the prior written approval of the laboratory.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Water Content of Soil	BS 1377-2: 1990: Cl 3.2	14
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	11
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	12
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	5
ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	5
ROCK	Uniaxial Compressive Strength (UCS)*	ISRM Suggested Methods -Rock Characterization Testing and Monitoring, Ed. E T Brown - 1981	2

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	**Type of test/Properties measured/Range of measurement**	**Standard specifications**	**No. of results included in the report**
SOIL – Subcontracted to Derwentside Environmental Testing Services Limited *(UKAS 2139)*	pH Value of Soil		14
SOIL – Subcontracted to Derwentside Environmental Testing Services Limited *(UKAS 2139)*	Sulphate Content water extract		14

CAUSEWAY GEOTECH

Summary of Classification Test Results

Project No.	Project Name
23-1870	Lackareagh Wind Farm

Hole No.	Sample				Specimen Description	Density		w	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		bulk	dry	%	%	%	%	%	Mg/m3	
						Mg/m3								
TP-MM-01	4	1.50		D	Brown sandy slightly gravelly clayey SILT.			26	74	40 -1pt	29	11		MI
TP-SC-01	2	1.00		D	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			9.9	32	31 -1pt	22	9		CL
TP-SC-02	4	1.60		D	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			11						
TP-SC-03	1	1.00		B	Brown sandy slightly gravelly clayey SILT.			18	38	38 -1pt	28	10		MI
TP-SC-04	6	3.00		D	Brown sandy slightly gravelly silty CLAY.			7.8	27	34 -1pt	23	11		CL
TP-SC-05	3	2.00		B	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			16	37	32 -1pt	21	11		CL
TP-SC-06	4	2.00		D	Brown slightly sandy slightly silty subangular fine to coarse GRAVEL.			12	25	40 -1pt	28	12		MI
TP-T1-01	6	2.50		D	Brown sandy gravelly silty CLAY.			14	49	27 -1pt	18	9		CL
TP-T2-01	4	1.00		D	Brown sandy slightly gravelly clayey SILT.			24	52	40 -1pt	29	11		MI
TP-T3-01	4	1.70		D	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			11						
TP-T4-01	2	0.60		D	Brown sandy slightly gravelly clayey SILT.			31	42	71 -1pt	49	22		MV
TP-T5-01	3	1.70		B	Brown gravelly slightly clayey fine to coarse SAND.			3.9						

All tests performed in accordance with BS1377:1990 unless specified otherwise

LAB 01R Version 6

Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

Date Printed

03/12/2024 00:00

Approved By

Stephen Watson

UKAS TESTING

10122

Summary of Classification Test Results

Project No.
23-1870

Project Name
Lackareagh Wind Farm

Hole No.	Sample				Specimen Description	Density		*w*	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		bulk	dry							
						Mg/m3		%	%	%	%	%	Mg/m3	
TP-T6-01	6	2.50		D	Brown sandy gravelly silty CLAY.			15	40	30 -1pt	22	8		CL
TP-T7-01	6	2.50		D	Brown sandy gravelly silty CLAY.			8.6	29	35 -1pt	24	11		CL/CI/ML/MI

All tests performed in accordance with BS1377:1990 unless specified otherwise

LAB 01R Version 6

Key

Density test

Linear measurement unless :

wd - water displacement

wi - immersion in water

Liquid Limit

4pt cone unless :

cas - Casagrande method

1pt - single point test

Particle density

sp - small pyknometer

gj - gas jar

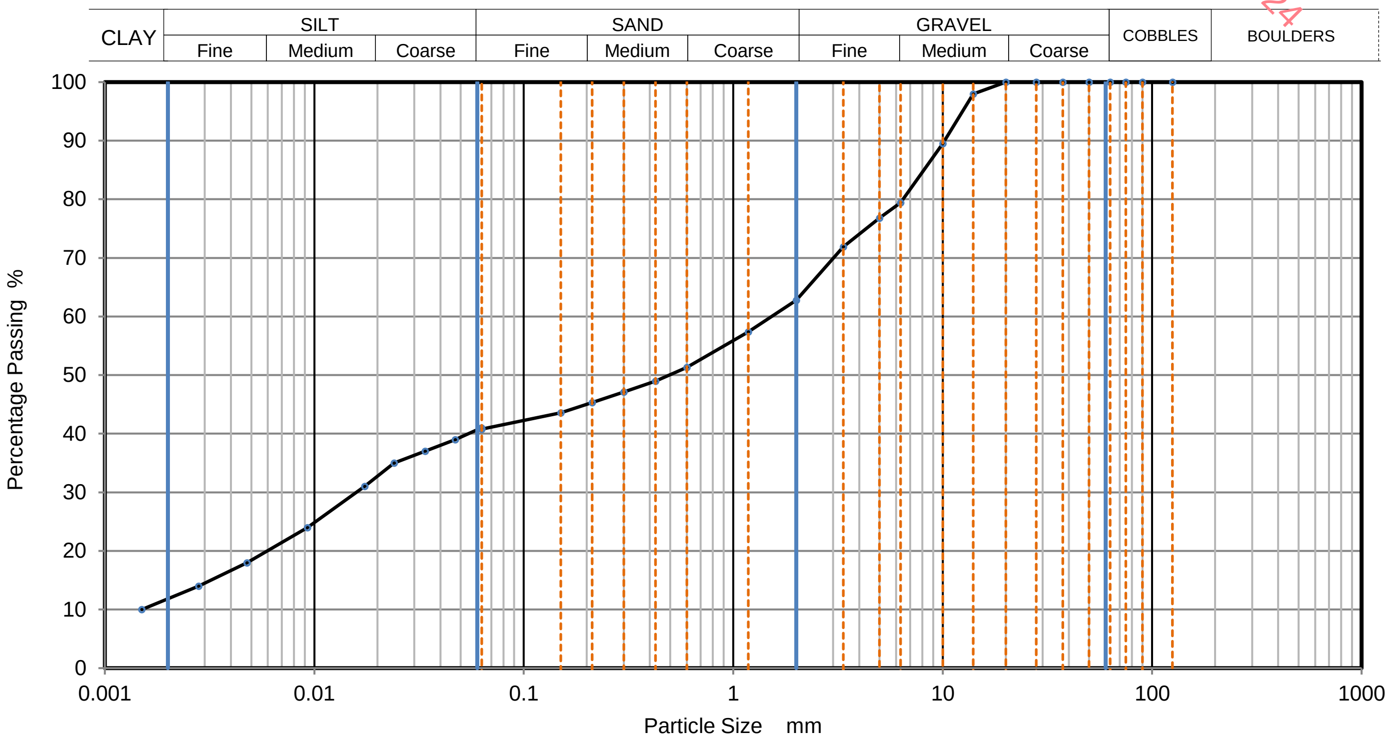
Date Printed
03/12/2024 00:00

Approved By
Stephen Watson

10122

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1870**
				Borehole/Pit No.	TP-MM-01
Site Name	Lackareagh Wind Farm			Sample No.	3
Specimen Description	Brown sandy slightly gravelly clayey SILT.			Sample Depth (m) Top	1.50
				Base	
Specimen Reference	2	Specimen Depth	1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus202402153



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06289	41
90	100	0.04710	39
75	100	0.03379	37
63	100	0.02406	35
50	100	0.01737	31
37.5	100	0.00926	24
28	100	0.00477	18
20	100	0.00281	14
14	98	0.00150	10
10	90		
6.3	79		
5	77		
3.35	72		
2	63		
1.18	57		
0.6	51	Particle density	(assumed)
0.425	49	2.65	Mg/m3
0.3	47		
0.212	45		
0.15	44		
0.063	41		

Dry Mass of sample, g	508

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	37.2
Sand	22.0
Silt	29.4
Clay	11.4

Grading Analysis		
D100	mm	
D60	mm	1.52
D30	mm	0.0154
D10	mm	0.00162
Uniformity Coefficient		940
Curvature Coefficient		0.097

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

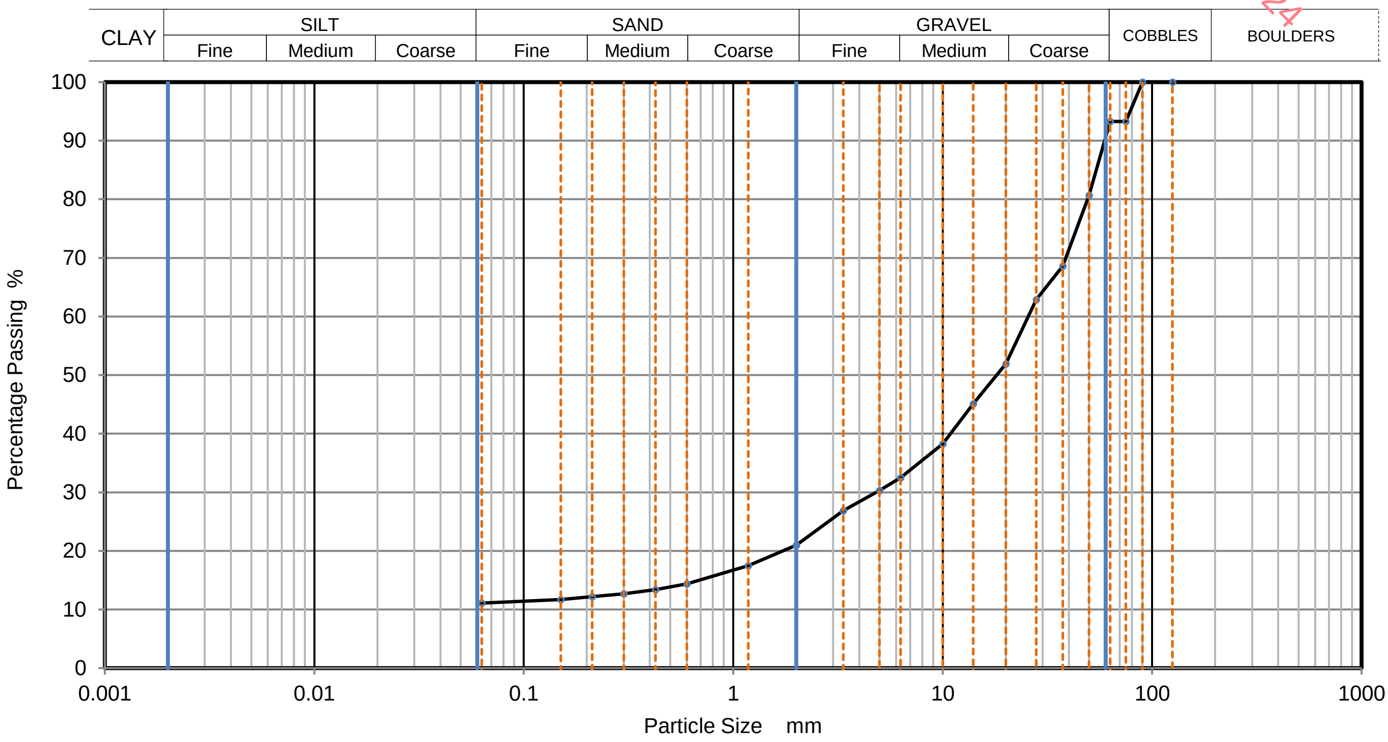
Approved
Stephen Watson

LAB 05R - Version 6

10122

PARTICLE SIZE DISTRIBUTION

Job Ref	23-1870			
Borehole/Pit No.	TP-SC-01			
Site Name	Lackareagh Wind Farm	Sample No.	1	
Specimen Description	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.	Sample Depth (m)	Top	1.00
			Base	
Specimen Reference	2	Specimen Depth	1 m	
Sample Type	B			
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2024021521	



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	93		
63	93		
50	81		
37.5	69		
28	63		
20	52		
14	45		
10	38		
6.3	33		
5	30		
3.35	27		
2	21		
1.18	18		
0.6	14		
0.425	13		
0.3	13		
0.212	12		
0.15	12		
0.063	11		

Dry Mass of sample, g	12050

Sample Proportions	% dry mass
Cobbles	6.7
Gravel	72.3
Sand	10.0
Fines <0.063mm	11.0

Grading Analysis	
D100 mm	
D60 mm	25.6
D30 mm	4.83
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

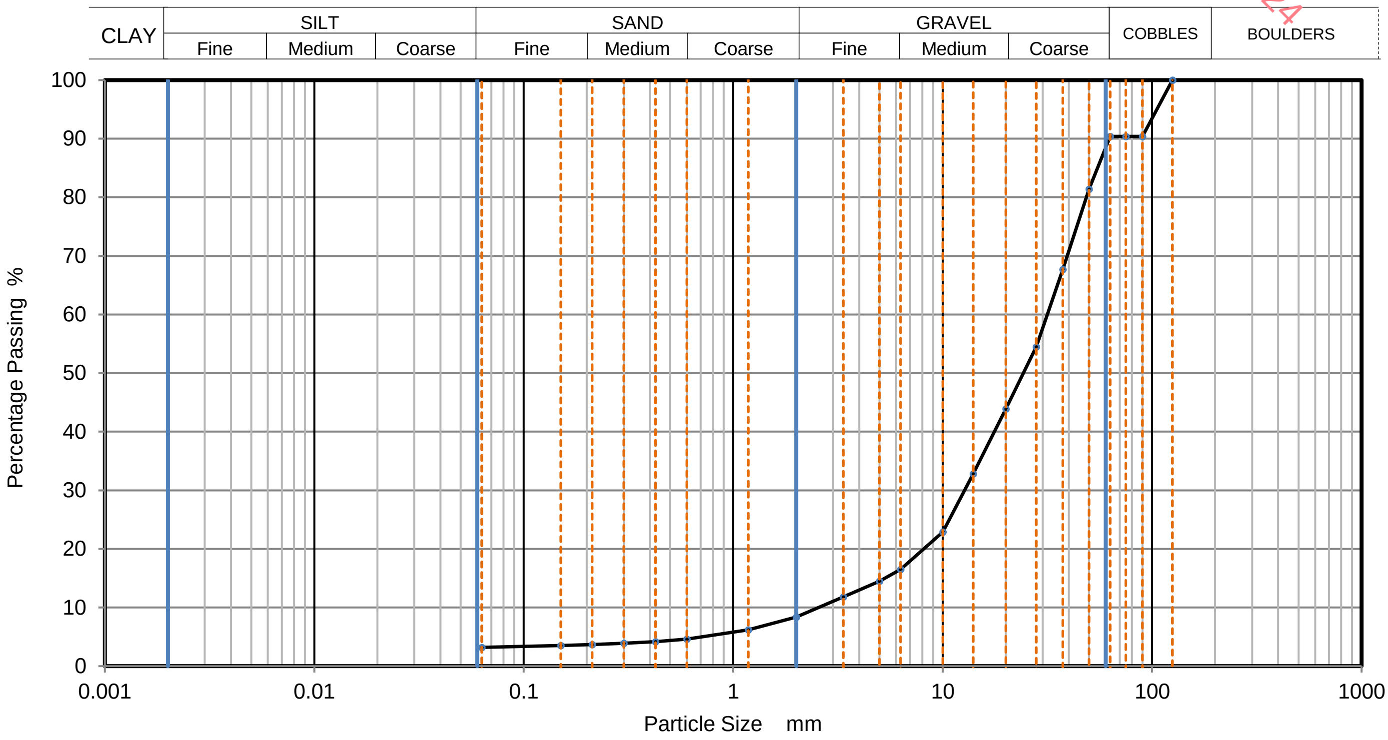
Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

10122

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1870**
				Borehole/Pit No.	TP-SC-02
Site Name	Lackareagh Wind Farm			Sample No.	3
Specimen Description	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			Sample Depth (m) Top	1.60
				Base	
Specimen Reference	2	Specimen Depth	1.6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2024021523



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	90		
75	90		
63	90		
50	81		
37.5	68		
28	55		
20	44		
14	33		
10	23		
6.3	17		
5	15		
3.35	12		
2	8		
1.18	6		
0.6	5		
0.425	4		
0.3	4		
0.212	4		
0.15	4		
0.063	3		

Dry Mass of sample, g	12826

Sample Proportions	% dry mass
Cobbles	9.6
Gravel	82.0
Sand	5.2
Fines <0.063mm	3.0

Grading Analysis		
D100	mm	125
D60	mm	31.6
D30	mm	12.7
D10	mm	2.55
Uniformity Coefficient		12
Curvature Coefficient		2

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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Stephen Watson

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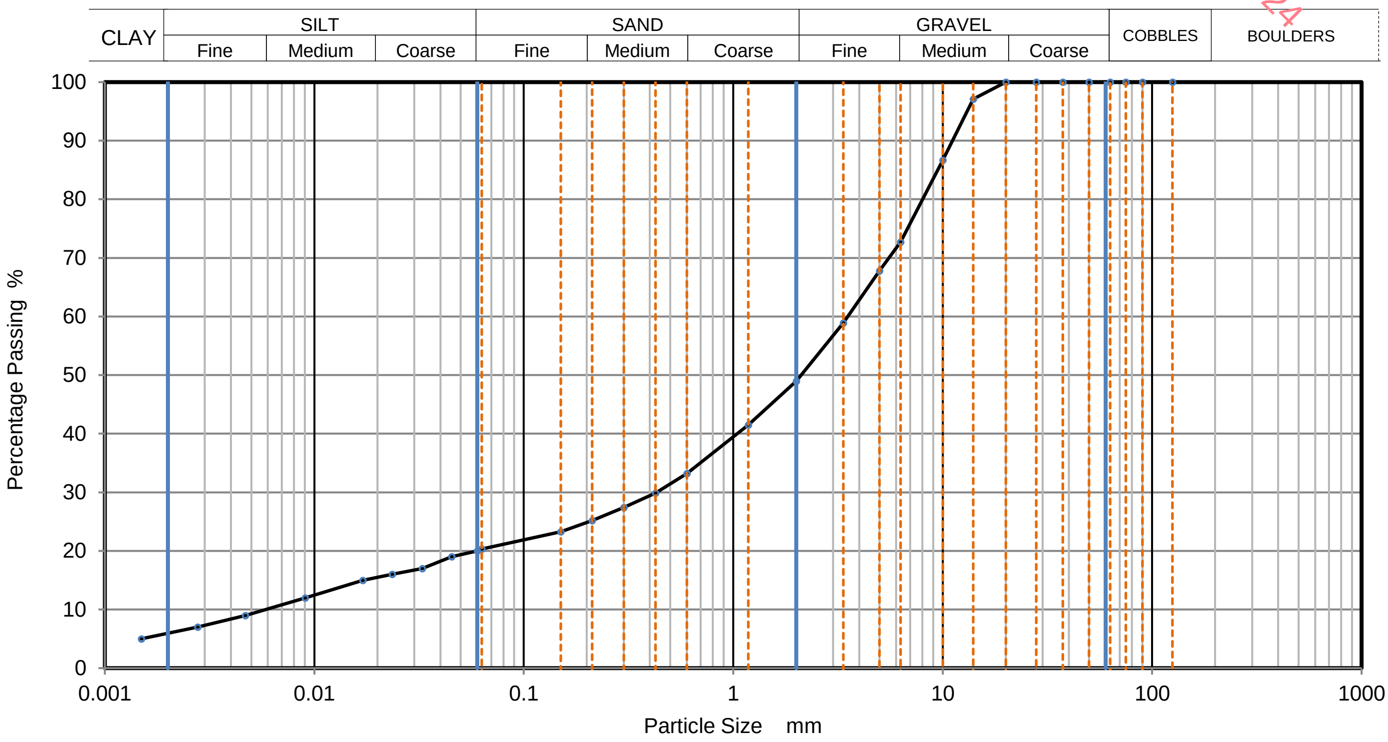
UKAS TESTING 10122

PARTICLE SIZE DISTRIBUTION

Job Ref	**23-1870**				
Borehole/Pit No.	TP-SC-03				
Site Name	Lackareagh Wind Farm			Sample No.	1
Specimen Description	Brown sandy slightly gravelly clayey SILT.			Sample Depth (m) Top	1.00
				Sample Depth (m) Base	
Specimen Reference	4	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2024021525



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06003	20
90	100	0.04536	19
75	100	0.03282	17
63	100	0.02355	16
50	100	0.01701	15
37.5	100	0.00903	12
28	100	0.00469	9
20	100	0.00277	7
14	97	0.00149	5
10	87		
6.3	73		
5	68		
3.35	59		
2	49		
1.18	42		
0.6	33	Particle density	(assumed)
0.425	30	2.65	Mg/m3
0.3	27		
0.212	25		
0.15	23		
0.063	20		

Dry Mass of sample, g	349

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	51.0
Sand	28.7
Silt	14.7
Clay	5.6

Grading Analysis		
D100	mm	
D60	mm	3.52
D30	mm	0.431
D10	mm	0.00567
Uniformity Coefficient		620
Curvature Coefficient		9.3

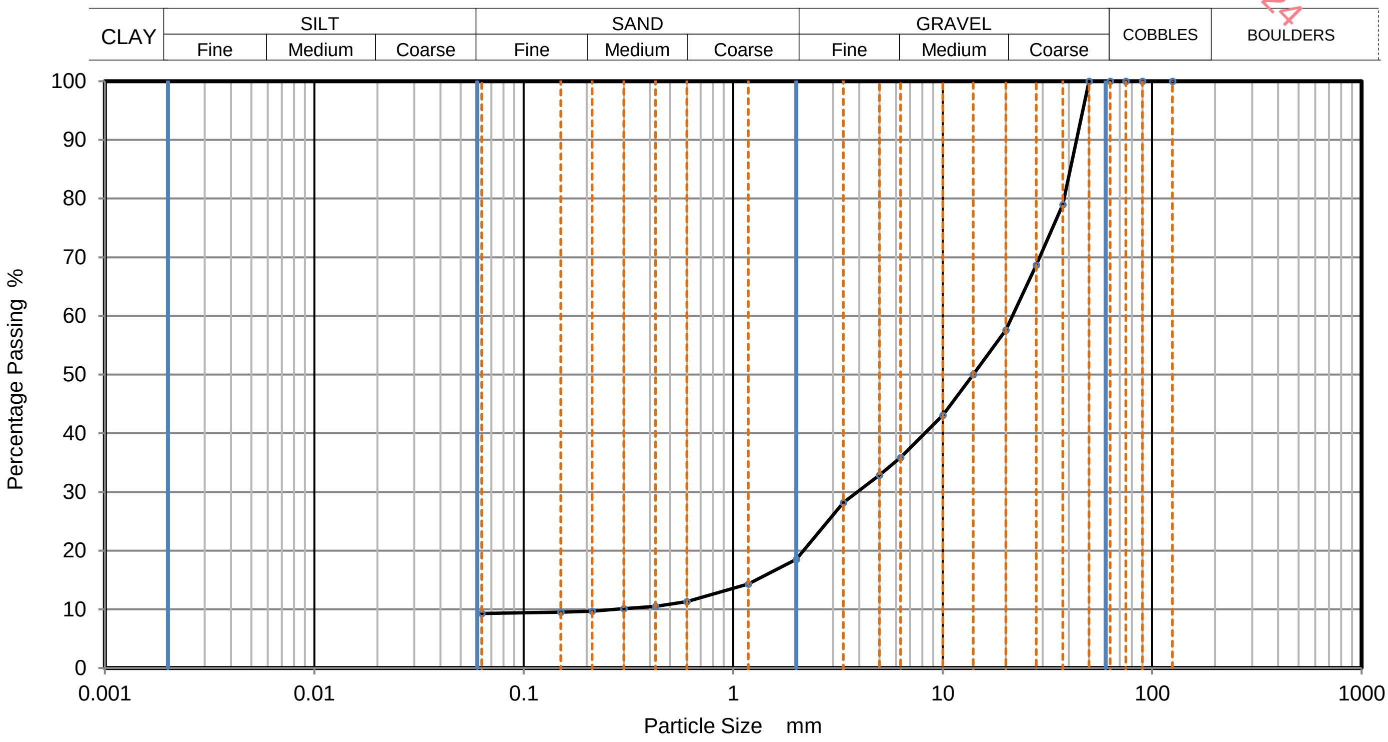
Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref		**23-1870**
				Borehole/Pit No.		TP-SC-04
Site Name	Lackareagh Wind Farm			Sample No.		3
Specimen Description	Brown gravelly slightly clayey fine to coarse SAND.			Sample Depth (m)	Top	2.00
					Base	
Specimen Reference	2	Specimen Depth	2 m	Sample Type		B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID		Caus2024021527



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	79		
28	69		
20	58		
14	50		
10	43		
6.3	36		
5	33		
3.35	28		
2	19		
1.18	14		
0.6	11		
0.425	11		
0.3	10		
0.212	10		
0.15	10		
0.063	9		

Dry Mass of sample, g	2964

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	81.5
Sand	9.2
Fines <0.063mm	9.0

Grading Analysis		
D100	mm	
D60	mm	21.5
D30	mm	3.9
D10	mm	0.275
Uniformity Coefficient		78
Curvature Coefficient		2.6

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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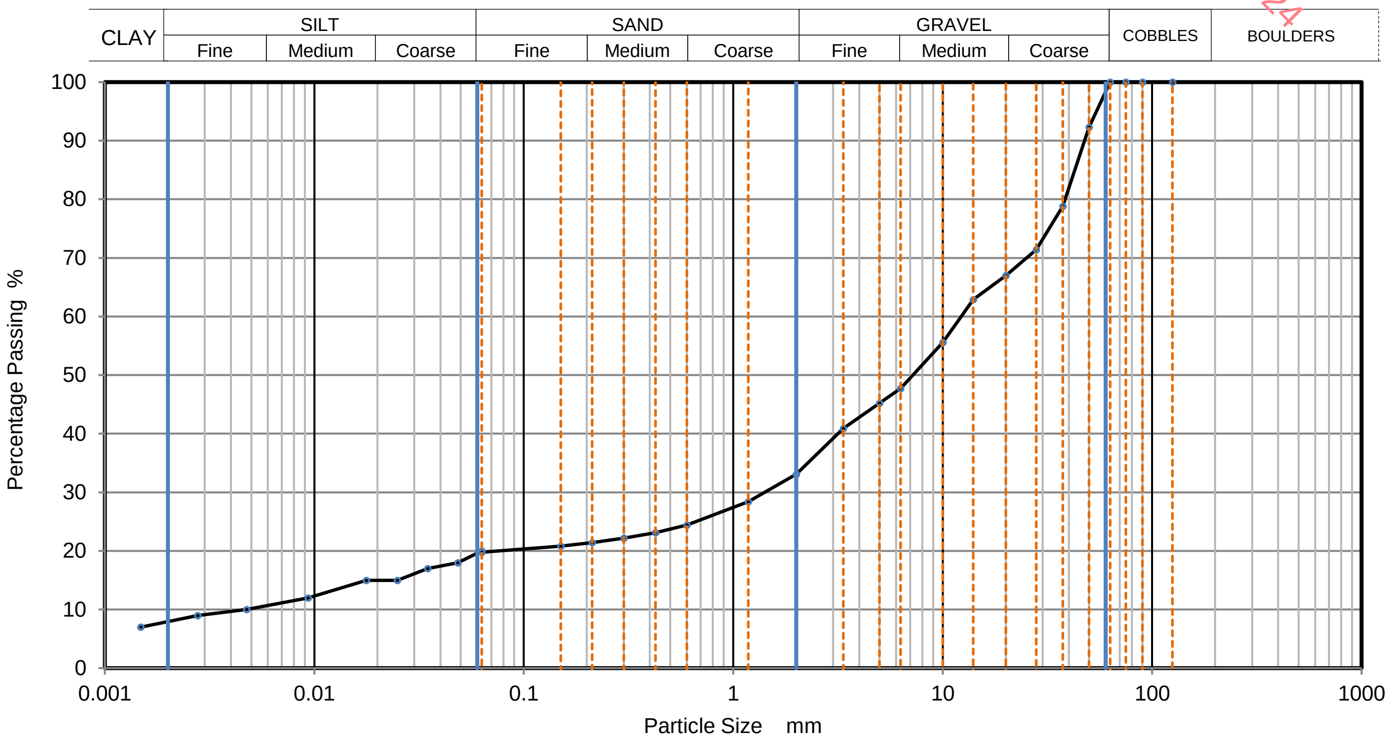
Stephen Watson

UKAS TESTING
10122

CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1870**
				Borehole/Pit No.	TP-SC-05
Site Name	Lackareagh Wind Farm			Sample No.	1
Specimen Description	Brown sandy gravelly silty CLAY.			Sample Depth (m) Top	1.00
				Base	
Specimen Reference	2	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2024021529



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	20
90	100	0.04846	18
75	100	0.03473	17
63	100	0.02489	15
50	92	0.01771	15
37.5	79	0.00932	12
28	71	0.00475	10
20	67	0.00277	9
14	63	0.00148	7
10	56		
6.3	48		
5	45		
3.35	41		
2	33		
1.18	28		
0.6	24	Particle density	(assumed)
0.425	23	2.65	Mg/m3
0.3	22		
0.212	21		
0.15	21		
0.063	20		

Dry Mass of sample, g	6401

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	66.9
Sand	13.3
Silt	12.2
Clay	7.6

Grading Analysis		
D100	mm	
D60	mm	12.3
D30	mm	1.41
D10	mm	0.0043
Uniformity Coefficient		2900
Curvature Coefficient		38

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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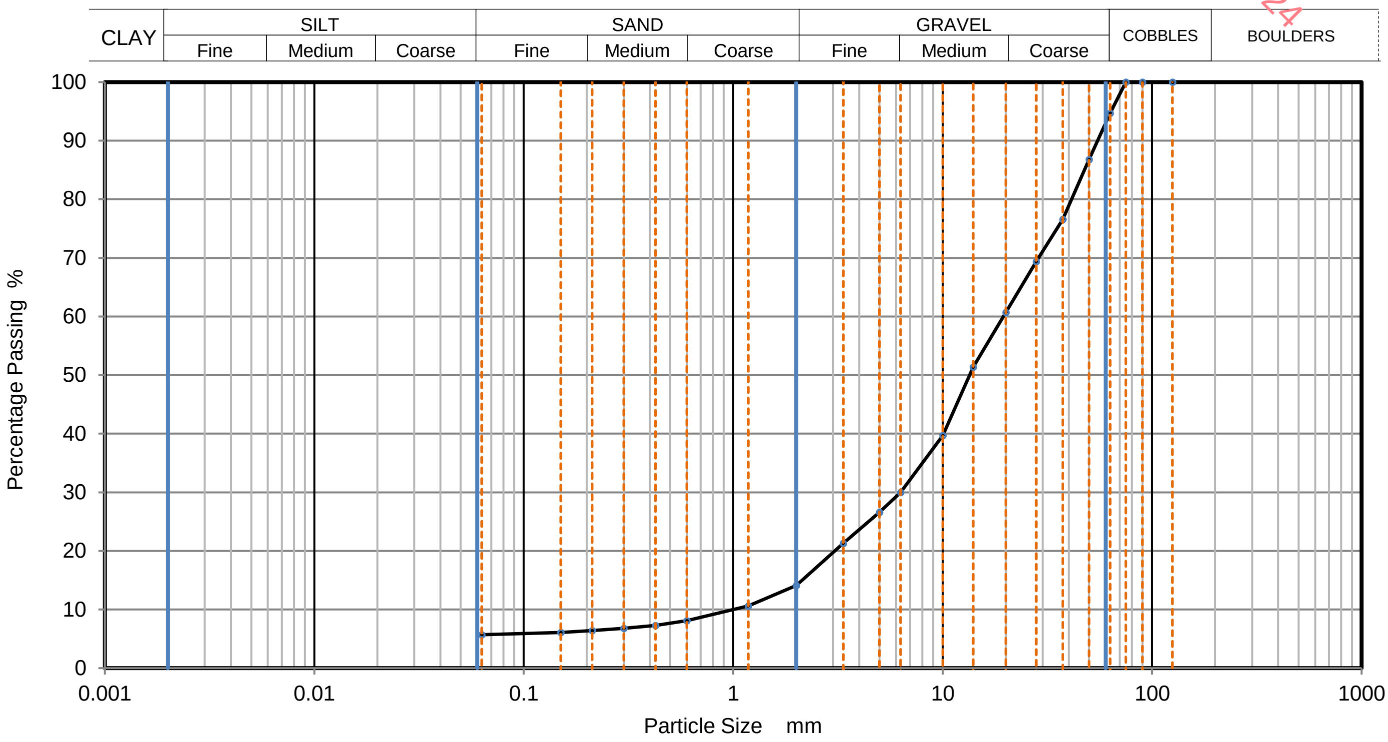
Stephen Watson

UKAS TESTING
10122

PARTICLE SIZE DISTRIBUTION

Job Ref	23-1870				
Borehole/Pit No.	TP-SC-06				
Site Name	Lackareagh Wind Farm			Sample No.	3
Specimen Description	Brown slightly sandy slightly silty subangular fine to coarse GRAVEL.			Sample Depth (m) Top	2.00
				Base	
Specimen Reference	2	Specimen Depth	2 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2024021532



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	95		
50	87		
37.5	77		
28	69		
20	61		
14	51		
10	40		
6.3	30		
5	27		
3.35	21		
2	14		
1.18	11		
0.6	8		
0.425	7		
0.3	7		
0.212	6		
0.15	6		
0.063	6		

Dry Mass of sample, g	10220

Sample Proportions	% dry mass
Cobbles	5.3
Gravel	80.6
Sand	8.4
Fines <0.063mm	6.0

Grading Analysis	
D100 mm	
D60 mm	19.5
D30 mm	6.3
D10 mm	0.996
Uniformity Coefficient	20
Curvature Coefficient	2.1

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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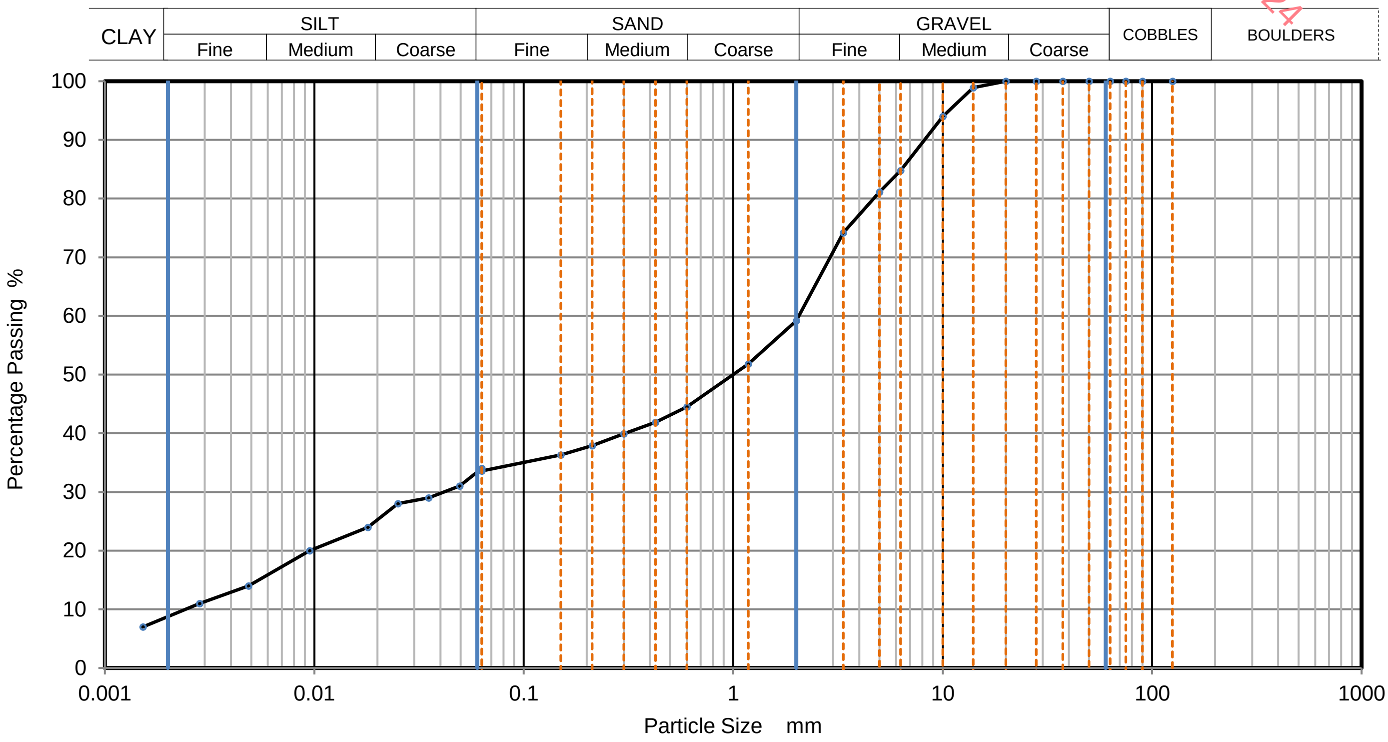
Stephen Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1870**
				Borehole/Pit No.	TP-T1-01
Site Name	Lackareagh Wind Farm			Sample No.	3
Specimen Description	Brown sandy gravelly silty CLAY.			Sample Depth (m) Top	1.50
				Base	
Specimen Reference	2	Specimen Depth	1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus202402155



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	34
90	100	0.04945	31
75	100	0.03519	29
63	100	0.02505	28
50	100	0.01805	24
37.5	100	0.00949	20
28	100	0.00486	14
20	100	0.00284	11
14	99	0.00152	7
10	94		
6.3	85		
5	81		
3.35	74		
2	59		
1.18	52		
0.6	45	Particle density	(assumed)
0.425	42	2.65	Mg/m3
0.3	40		
0.212	38		
0.15	36		
0.063	34		

Dry Mass of sample, g	507

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	40.8
Sand	25.7
Silt	24.6
Clay	8.9

Grading Analysis		
D100	mm	
D60	mm	2.05
D30	mm	0.0407
D10	mm	0.00237
Uniformity Coefficient		870
Curvature Coefficient		0.34

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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Stephen Watson

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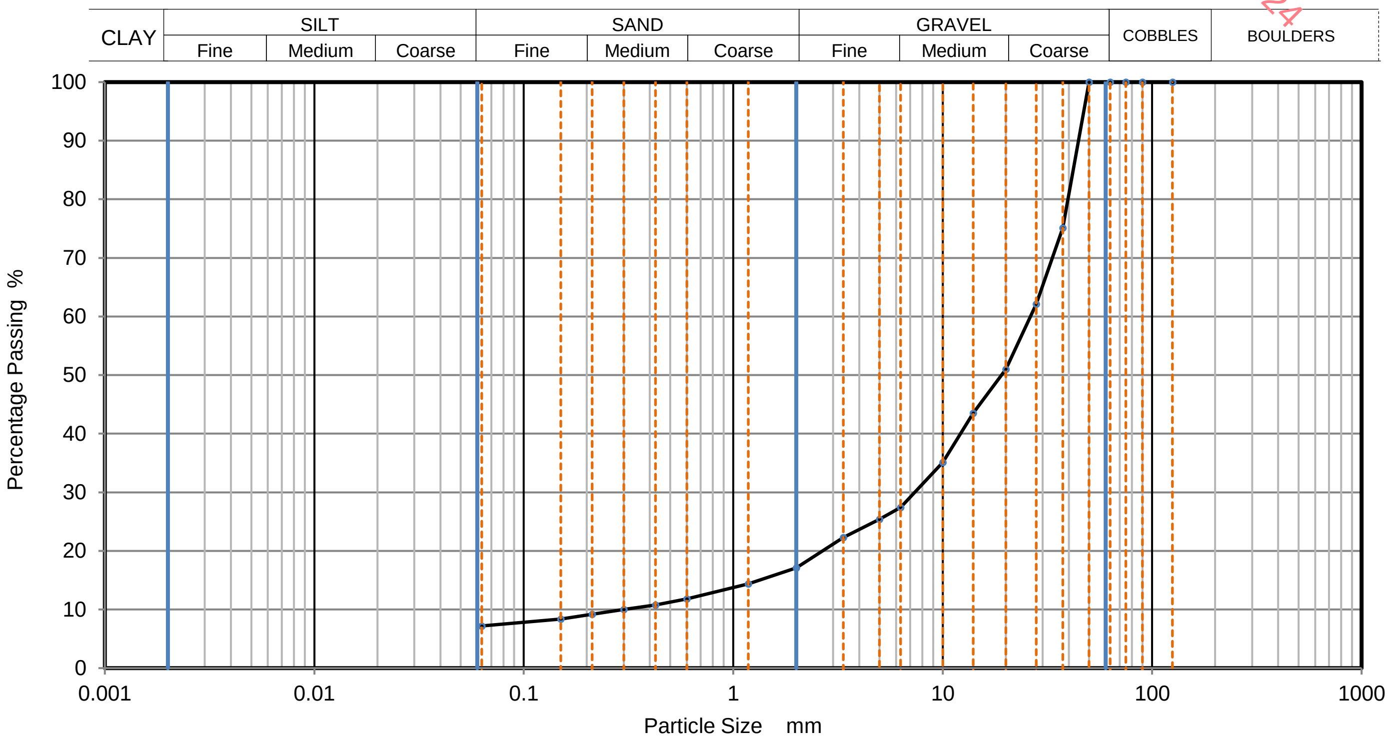
PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1870**
				Borehole/Pit No.	TP-T3-01
Site Name	Lackareagh Wind Farm			Sample No.	1
Specimen Description	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			Sample Depth (m) Top	0.70
				Base	
Specimen Reference	2	Specimen Depth	0.7 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2024021510



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	75		
28	62		
20	51		
14	44		
10	35		
6.3	27		
5	25		
3.35	22		
2	17		
1.18	14		
0.6	12		
0.425	11		
0.3	10		
0.212	9		
0.15	8		
0.063	7		

Dry Mass of sample, g	3288

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	82.9
Sand	9.9
Fines <0.063mm	7.0

Grading Analysis	
D100 mm	
D60 mm	26.3
D30 mm	7.37
D10 mm	0.306
Uniformity Coefficient	86
Curvature Coefficient	6.7

Remarks

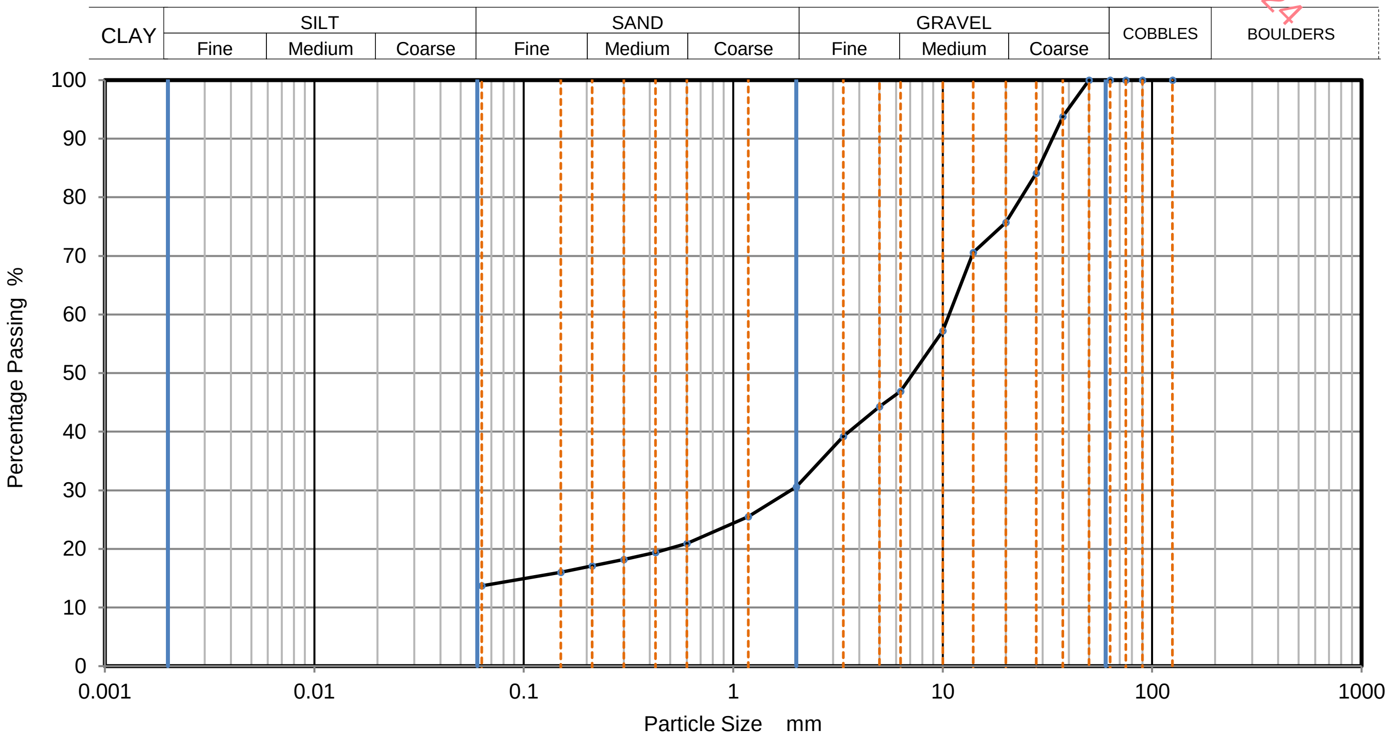
Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

UKAS TESTING
10122

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1870**
				Borehole/Pit No.	TP-T5-01
Site Name	Lackareagh Wind Farm			Sample No.	1
Specimen Description	Brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			Sample Depth (m) Top	1.00
				Base	
Specimen Reference	2	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2024021534



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	94		
28	84		
20	76		
14	71		
10	57		
6.3	47		
5	44		
3.35	39		
2	31		
1.18	26		
0.6	21		
0.425	19		
0.3	18		
0.212	17		
0.15	16		
0.063	14		

Dry Mass of sample, g	2698

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	69.4
Sand	17.0
Fines <0.063mm	14.0

Grading Analysis		
D100	mm	
D60	mm	10.7
D30	mm	1.88
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

10122

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Stephen Watson

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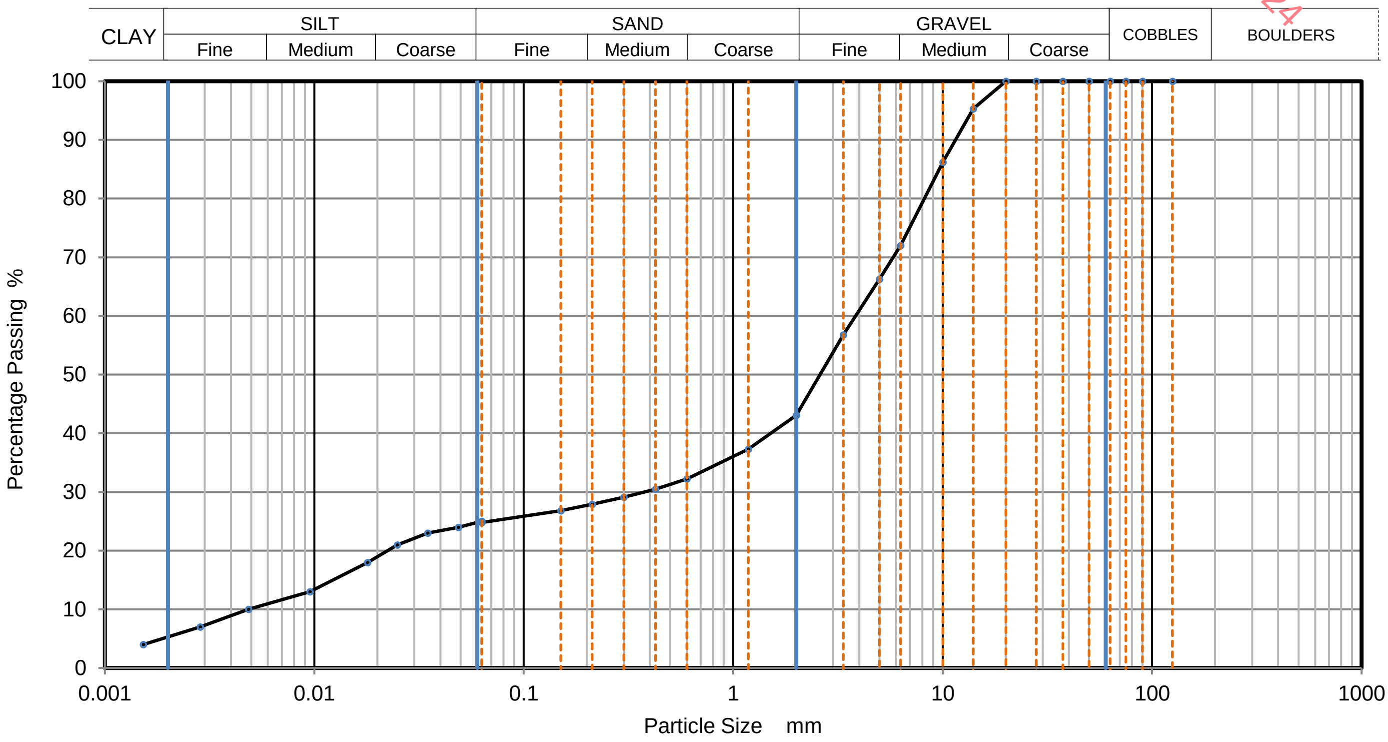
PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1870**
				Borehole/Pit No.	TP-T6-01
Site Name	Lackareagh Wind Farm			Sample No.	1
Specimen Description	Brown sandy slightly gravelly silty CLAY.			Sample Depth (m) Top	0.50
				Base	
Specimen Reference	2	Specimen Depth	0.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2024021515



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	25
90	100	0.04879	24
75	100	0.03473	23
63	100	0.02489	21
50	100	0.01794	18
37.5	100	0.00955	13
28	100	0.00486	10
20	100	0.00285	7
14	95	0.00153	4
10	86		
6.3	72		
5	66		
3.35	57		
2	43		
1.18	37		
0.6	32	Particle density	(assumed)
0.425	31	2.65	Mg/m3
0.3	29		
0.212	28		
0.15	27		
0.063	25		

Dry Mass of sample, g	501

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	56.9
Sand	18.3
Silt	19.5
Clay	5.3

Grading Analysis		
D100	mm	
D60	mm	3.84
D30	mm	0.377
D10	mm	0.00495
Uniformity Coefficient		780
Curvature Coefficient		7.5

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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Stephen Watson

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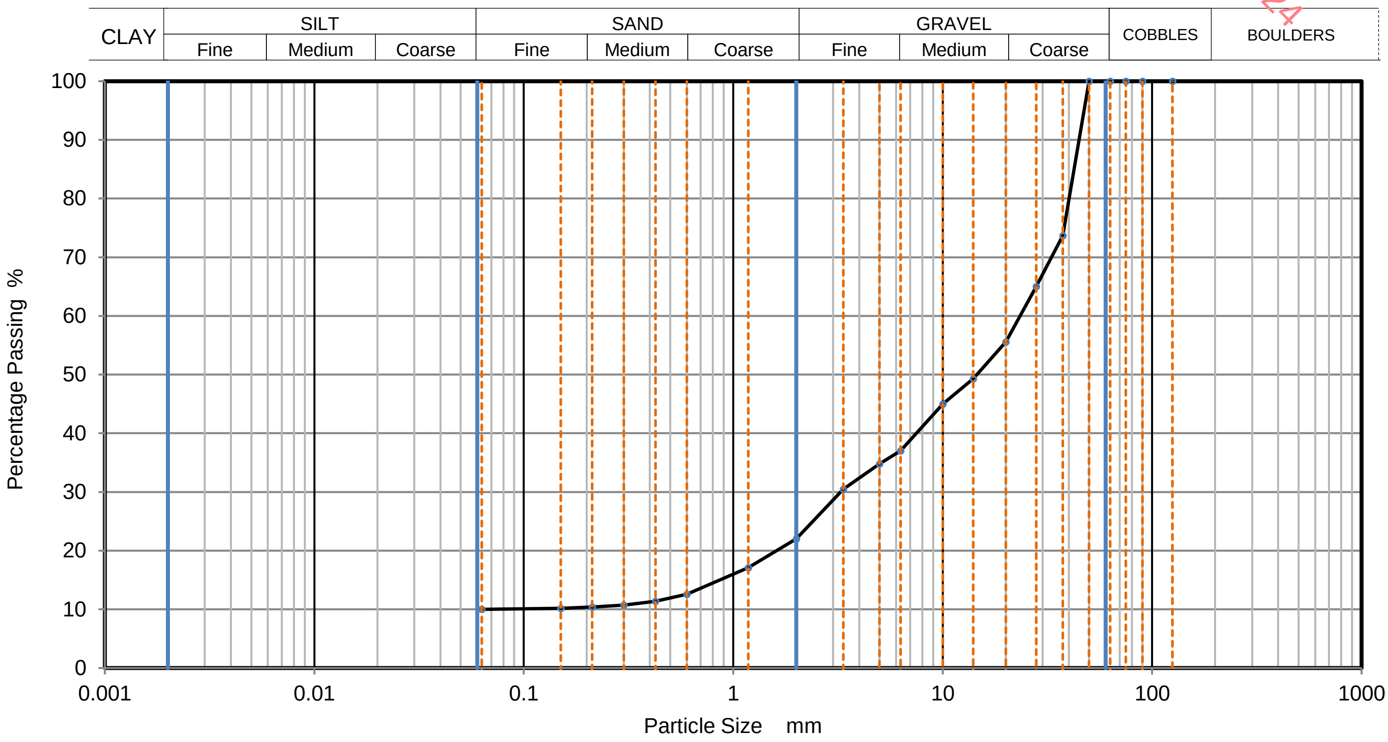
UKAS TESTING

10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref		**23-1870**
				Borehole/Pit No.		TP-T7-01
Site Name	Lackareagh Wind Farm			Sample No.		3
Specimen Description	Brown gravelly clayey fine to coarse SAND.			Sample Depth (m)	Top	1.50
					Base	
Specimen Reference	2	Specimen Depth	1.5 m	Sample Type		B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID		Caus2024021518



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	74		
28	65		
20	56		
14	49		
10	45		
6.3	37		
5	35		
3.35	31		
2	22		
1.18	17		
0.6	13		
0.425	11		
0.3	11		
0.212	10		
0.15	10		
0.063	10		

Dry Mass of sample, g	3367

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	78.0
Sand	12.0
Fines <0.063mm	10.0

Grading Analysis	
D100 mm	
D60 mm	23.4
D30 mm	3.25
D10 mm	0.0668
Uniformity Coefficient	350
Curvature Coefficient	6.7

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

UKAS TESTING 10122

Approved
Stephen Watson

LAB 05R - Version 6

Point Load Strength Index Tests
Summary of Results

Project No.

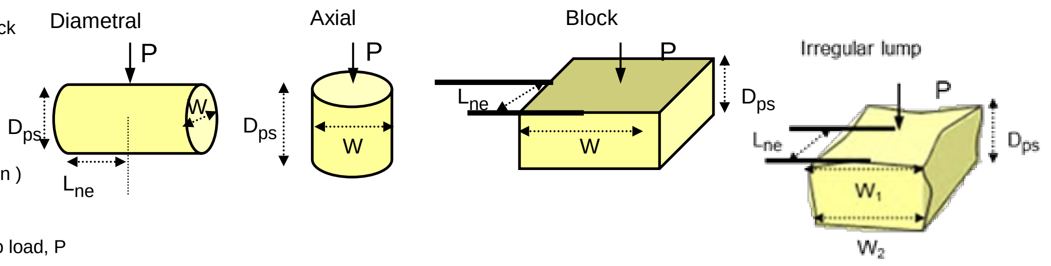
23-1870

Project Name

Lackareagh Wind Farm

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
RC-SC-01	5.00	1	C	2	5.00	GREYWACKE	D	U	YES	62.0	83.4	83.4	81.0	7.3	82.2	1.1	1.4	
RC-SC-02	3.70	1	C	2	3.70	GREYWACKE	A	U	YES		83.5	110.0	104.0	10.5	105.2	0.9	1.3	
RC-SC-02	4.70	2	C	2	4.70	GREYWACKE	D	U	YES	54.7	83.5	83.5	81.0	19.0	82.2	2.8	3.5	
RC-SC-02	4.80	2	C	2	4.80	GREYWACKE	A	U	YES		83.4	63.5	64.0	11.1	82.4	1.6	2.0	
RC-SC-03	3.10	1	C	2	3.10	GREYWACKE	D	U	YES	80.3	83.3	83.3	81.0	7.0	82.1	1.0	1.3	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 1985, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

LAB 17R - Version 5

Date Printed

03/04/2024 00:00

Approved By

Stephen Watson

10122

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Project No.
23-1870

Project Name
Lackareagh Wind Farm

Hole No.	Sample				Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3			Remarks
	Ref	Top	Base	Type		Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Mode of failure	UCS MPa	
RC-SC-01	2	4.10	4.40	C	GREYWACKE	83.3	238.0	2.9	2.69	0.6	as received	S	38.2	
RC-SC-03	2	4.00	4.50	C	GREYWACKE	83.6	237.5	2.8	2.71	0.1	as received	F	77.5	

Notes

1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

above notes apply unless annotated otherwise in the remarks

Mode of failure :

S - Single shear	MS - multiple shear
AC - Axial cleavage	F - Fragmented

Test Specification
International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Date Printed
03/04/2024 00:00

Approved By
Stephen Watson

Table
1

sheet
1

DETS

Certificate of Analysis

Certificate Number	24-04533	*Issued:*	07-Mar-24

Client Causeway Geotech
8 Drumahiskey Road
Ballymoney
County Antrim
BT53 7QL

Our Reference	24-04533
Client Reference	23-1870
Order No	(not supplied)
Contract Title	LACKAREAGH WIND FARM, CO CLARE
Description	7 Soil samples.
Date Received	04-Mar-24
Date Started	04-Mar-24
Date Completed	07-Mar-24
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

ilac-MRA

UKAS
TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 24-04533
Client Ref 23-1870
Contract Title LACKAREAGH WIND FARM, CO CLARE

			Lab No	2307271	2307272	2307273	2307274	2307275	2307276	2307277
			.Sample ID	TP-SC-01	TP-SC-02	TP-SC-03	TP-SC-04	TP-SC-05	TP-SC-06	TP-T5-01
			Depth	1.00	1.60	1.00	3.00	2.00	2.00	1.70
			Other ID							
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	01/03/2024	01/03/2024	01/03/2024	01/03/2024	01/03/2024	01/03/2024	01/03/2024
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Inorganics										
pH	DETSC 2008#		pH	7.6	6.6	6.4	6.2	5.8	6.2	6.3
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l	1200	80	140	21	30	15	22

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 24-04533
Client Ref 23-1870
Contract LACKAREAGH WIND FARM, CO CLARE

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2307271	TP-SC-01 1.00 SOIL	01/03/24	PT 500ml		
2307272	TP-SC-02 1.60 SOIL	01/03/24	PT 500ml		
2307273	TP-SC-03 1.00 SOIL	01/03/24	PT 500ml		
2307274	TP-SC-04 3.00 SOIL	01/03/24	PT 500ml		
2307275	TP-SC-05 2.00 SOIL	01/03/24	PT 500ml		
2307276	TP-SC-06 2.00 SOIL	01/03/24	PT 500ml		
2307277	TP-T5-01 1.70 SOIL	01/03/24	PT 500ml		

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

CAUSEWAY
GEOTECH

APPENDIX I

SPT HAMMER ENERGY MEASUREMENT REPORT

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Southern Testing
Unit 11
Charlwoods Road
East Grinstead
West Sussex
RH19 2HU

SPT Hammer Ref: 1377.
Test Date: 18/02/2023
Report Date: 20/02/2023
File Name: 1377..spt
Test Operator: RWS

Instrumented Rod Data

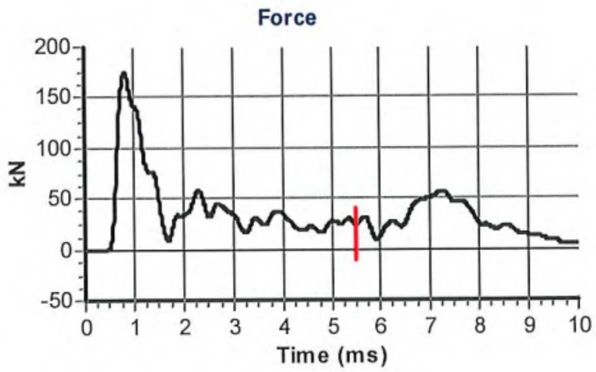
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.7
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	64786
Accelerometer No.2:	64789

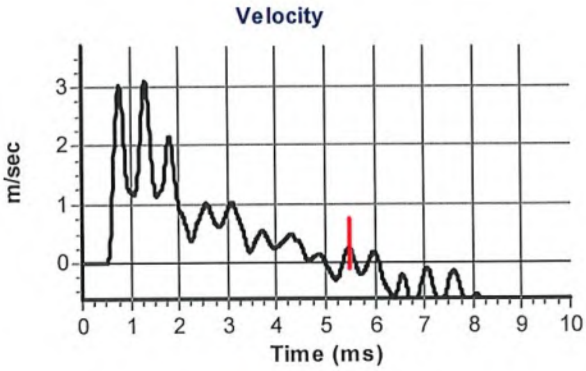
SPT Hammer Information

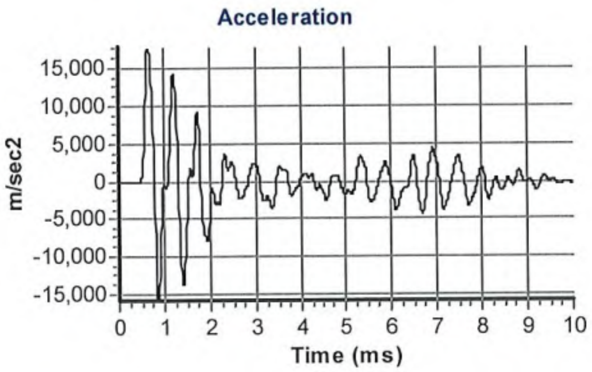
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

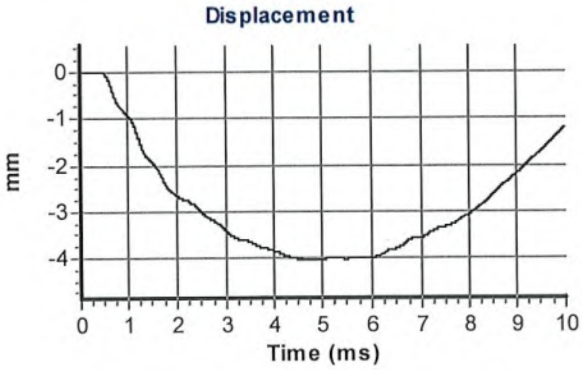
Comments / Location

CAUSEWAY









Calculations

Area of Rod A (mm2):	996
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	292

Energy Ratio E_r (%): **62**

Signed: Bob Stewart
Title: Technician

The recommended calibration interval is 12 months
