APPENDIX 8.1

TECHNICAL REPORT INCLUDING SITE INVESTIGATION REPORT

VOLUME III

APPENDICES TO ENVIRONMENTAL IMPACT ASSESSMENT REPORT

DECEMBER 2024

Cloonanny Wind Farm, Longford, Co. Longford, Ireland

Soils and Geology Technical Assessment Report

Report No: 2274-24B Rev0

28th August 2024

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

Natural Forces Renewable Energy Ltd
&
Mable Consulting Engineers

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1 SOILS AND GEOLOGY

1.1 Introduction

1.1.1 Background

At the request of Natural Forces Renewable Energy 2 Ltd, Whiteford Geoservices Ltd (WGS) undertook a soils and geology study for the proposed Cloonanny Wind Farm, Longford, County Longford, Ireland.

This Report has been prepared on behalf of Natural Forces Renewable Energy 2 Ltd in respect of a new planning application for Cloonanny Wind Farm, which consists of 2 wind turbines with a blade tip height of 199.9m, one substation, Battery Energy Storage System, new and upgraded access tracks along with other associated infrastructure.

The purpose of this reporting is to determine the hazard relating to soils and geology as a direct result of the construction of the proposed turbines, tracks and other infrastructure, as well as throughout the proposed lifetime of the scheme.

1.1.2 Statement of Authority

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

Commencing work with Kirk McClure Morton (Consulting Engineers) in Belfast since he has been engaged in full-time consultancy for the past 25 years and since 1996 trading as Whiteford Geoservices Ltd. The company and its staff of professional and technical personnel and has completed in excess 2000 contracts for clients within the construction and mineral exploration sectors where they have built up a recognised level of specialist experience, particularly in the field of Wind Energy. Working at home, in Europe and worldwide the company has been involved in more than 130 wind power projects where our services have been sought in relation to foundation design, peat slide risk assessment, geophysics, electrical earthing design and thermal resistivity analysis.

1.1.3 Executive Summary

An assessment of Soils and Geology, together with Peat Stability Hazard screening was undertaken for the installation of 2 No. new wind turbines and associated infrastructure at Cloonanny Wind Farm, in order to identify any potential geo-hazards to the proposed development.

Peat landslide Hazard screening did not record the presence of either PEAT soils or BOGLAND habitat at the Site. The potential for effects from Peat landslide are IMPERCEPTIBLE and were not considered further.

Soils and Geology assessment has indicated the following potential geo-hazards related to Soils and Geology pertinent to the proposed Cloonanny Wind Farm Development. Medium Hazards have the potential to cause Significant Effects.

Medium Hazards

The following Medium hazards can be mitigated to a Low hazard category:

1. *Stability of excavations within weak soils*

2. *The potential of silt to enter the local watercourses at T02 is elevated, particularly as this location is within an area known to have previously flooded.*

3. Structures within the flood zone are particularly vulnerable to damage by both the high groundwater table and erosion by flood waters. For this reason, we recommend a deep foundation, such as a piled solution be employed.

Further, more detailed ground information will be collected ahead of the construction phase in order to assist the selection and design of the appropriate foundations for the scheme.

The following Medium hazards can be mitigated completely are as follows: -

1. “Karst” bedrock is present beneath the site of the wind farm and has the potential to cause foundation failure.

2. The presence of thick superficial CLAY/SILT soils, in excess of 3.5m thick, are present at T1, T2 and the Substation. Although, these soils are suitable for the use of a standard “raft”, “strip” or “pad” foundation for the Substation and transformers and construction of hardstands, access tracks and underground cable trenches, they would be considered marginal for turbine foundations. The action of cyclic loading on cohesive soils such as SILT or CLAY can cause the excessive settlement over the lifetime of the installations.

Further, more detailed ground information will be collected ahead of the construction phase in order to assist the selection and design of the appropriate foundations for the scheme.

MEDIUM hazards are considered to have SIGNIFICANT effects on the proposed Development.

After the application of mitigation these MEDIUM hazards reduce to either LOW or NEGLIGIBLE hazards and are equivalent to NOT SIGNIFICANT or SLIGHT effects on the Development.

A summary of the hazards identified for Cloonanny Wind Farm are detailed in the Table below.

Table A – Summary of Soils and Geology Constraints Identified for Cloonanny Wind Farm

Type of Risk	**Nature of Risk**	**Hazard Description (T1, T2 and Substation)**	**Hazard Rating**	**Recommendation for Mitigation**	**Hazard Rating Post Mitigation**	**Residual Risks**
Geology	Peat Landslide Hazard	This analysis determined that peat stability hazard assessment is not required. Preliminary geotechnical assessment at the turbines finds that PEAT soils are absent. NEGLIGIBLE RISK	🟩	None required	🟩	NEGLIGIBLE RISK
Geology	Excavations and Stability	Cohesive soils with localised moderate flows of groundwater could be present. The stability of superficial soils will deteriorate significantly where acted on by water (either surface inflows or groundwater). For this reason, it would be difficult to excavate below a water table without suitable sidewall support and pumping arrangements. MEDIUM RISK	🟧	A preliminary SI campaign has been undertaken to determine soil conditions and baseline groundwater detail. Further pre-construction SI will be undertaken ahead of construction to further inform design and working practices. Any particular working practices required to reduce risk will be recommended, as mitigation for inclusion in the Construction Environmental Management Plan (CEMP)	🟨	LOW RISK Residual risk of "natural" soil movement occurring during or following extreme rainfall / storm event or seismic activity.
Geology	Land Contamination	No indication of ground contamination was	🟧	A preliminary SI campaign will be undertaken to determine soil	🟨	LOW RISK Residual risk of leaching from any

		observed during the walkover survey. Construction of the wind farm will generate mineral soil spoil which has the potential to contaminate watercourses, where it becomes entrained in surface water flows. Portions of the lands, particularly around T02, are within the flood zone of the Camlin River and particularly sensitive to this issue. MEDIUM RISK	🟧	conditions and baseline groundwater detail. A baseline contamination assessment will be completed prior to construction. Particular working practices required to reduce risk will be employed, as specific mitigation for inclusion in the Construction Environmental Management Plan (CEMP)	🟨	existing contamination present at the Site
Geology	Structural Stability / Foundations (Caused by Soils)	Superficial cohesive soils are particularly thick at the site of T01 and T02. Such soils are more susceptible to consolidation that other types of granular soils and are considered to be MEDIUM RISK, as a formation for emplacement of turbine foundations. The potential for failure or differential settlement is elevated. *(There will be minimal impact at the Substation where different foundations are normally deployed)* Where soils are considered poor, consideration will need to be given to deep foundations (e.g. ground improvement or piling). Shallow clay soils could be less competent than required for other	🟧	A preliminary SI campaign has been undertaken to determine soil conditions and soil competence with respect to turbine / infrastructure foundations. A comprehensive programme of pre-construction SI will be employed to inform selection of the appropriate foundation for each structure and infrastructure element Excavations, where kept open for an extended period of time will be supported or slopes battered back to an appropriate angle. The final design of the wind farm will take into account	🟩	NEGLIGIBLE RISK Residual risk of instability within "fine" soils caused by extreme weather or seismic activity.

		infrastructure too, such as transformer bases and result in changes to the standard foundation deign being required. Soils of low competence also carry a <u>MEDIUM RISK</u> of differential settlement developing within turbine hardstands and access tracks. This can lead to failure or regular maintenance being required.	🟧	the results of the pre-construction SI	🟩	
Geology	Structural Stability (Caused by Rock)	Potential instability due to the presence of dissolution features such as sinkholes, cavities etc. Baseline assessment has determined that the rock formation (Visean Limestones) underlying the site is soluble. Soluble rock formations have the potential to form "karst" features such as cavities, sinkholes etc. Such features are associated with structural stability problems. The presence of this "karst" rock formation means that infrastructure associated with the development is at an elevated risk of stability related issues. At Cloonanny Wind Farm, competent rock has been shown to be greater than 3.5m below existing ground level. In such cases turbine foundations may need deep foundation methods (such as ground improvement, rock anchoring or piling) to transfer loads to a	🟧	Preliminary SI works have been undertaken to determine whether rock is present at shallow depth. Further pre-construction SI works, using a combination of geophysical and geotechnical methods, will be undertaken to map the soil and rock profile below wind farm infrastructure and confirm the competence of all formations. Analysis of the pre-construction SI will allow appropriate foundations to be designed for ground conditions observed.	🟩	<u>NEGLIGIBLE RISK</u> Residual risk of instability / excessive settlement due to presence of small cavities within otherwise massive / intact limestone bedrock, not detected during pre-construction SI.

		deeper or more intact geological stratum. The is currently a MEDIUM RISK associated with this hazard.	🟧		🟩	
Geology	Borrow Pits / Construction Fill	LOW RISK GSI information suggests there is moderate potential at the Site for recovery of crushed aggregate, that would be suitable for construction purposes. Sedimentary limestone rock is generally expected across the site and whilst this formation is often suitable for the production of construction aggregate, it is anticipated to be at such a depth as to be not economically viable to extract. It is anticipated that suitable crushed rock aggregate cannot be "won" at this site. Such aggregate will need be imported to satisfy design requirements.	🟨	Pre-construction SI will be undertaken to confirm whether rock is present close enough to the existing ground surface to be economically recovered. A preliminary analysis of this material would be made at that time to determine the viability of "winning" rock / fill material at the site. Further testing (pre-construction) to determine aggregate potential or suitability as construction fill, will be undertaken to answer these questions.	🟩	NEGLIGIBLE RISK It is unlikely that the aggregate required to construct the wind farm will be "won" on site. The risks pertaining to importation of large quantities of aggregate should be considered. i.e. impacts on project cost, suitability of the local public roads for the axel loads required, potential damage to public roads etc. Given the proximity of suitable aggregate locally, these costs are likely to be minimised.
Geology	Groundwater	The underlying rock formation across the majority of the Site is considered to be a locally important karstified aquifer. Although, no water abstraction boreholes are recorded by GSI within the immediate vicinity of the proposed wind farm, the underlying aquifer, where exposed is considered	🟧	The effect of buoyancy will be considered as an aspect of design for all structures and associated infrastructure. Further detailed pre-construction SI works will be undertaken to map soil and rock profile below each main	🟨	LOW RISK Any drainage installed to assist with the construction of site infrastructure has the potential to degrade over time, if not adequately maintained. This degradation has

		particularly sensitive to contamination. There is a MEDIUM RISK that **surface water runoff** associated with Cloonanny Wind Farm could adversely impact this aquifer. Moderate or strong flows of **groundwater** have the potential to adversely impact both the construction works and the stability of foundations, in respect to up-thrust pressure. Observations of water strikes within exploratory holes indicates low recharge rates and weak flows where groundwater has been observed (Turbine T01 only). A shallow groundwater table can have a significant impact on a wind farm development, affecting construction and structure stability. There is a MEDIUM RISK of adverse impact to the Development as a result.	🟧	element of wind farm infrastructure. The appropriate (buoyant) foundation design, for ground conditions observed, will be selected for each of the other structures and elements of associated infrastructure.	🟨	the potential to affect the performance of the constructed wind farm elements.
Geology	Surface Water	The wind farm is located on flat, low lying lands adjacent to the Camlin River and is, in part (T02), within lands known to have previously flooded. Floodwaters can cause extreme up thrust on structures and other installed infrastructure causing failure to occur. Flowing surface waters can erode foundations and place adverse lateral stresses on these and	🟧	The effect of buoyancy will be considered as an aspect of design for all structures and associated infrastructure. Further detailed pre-construction SI works will be undertaken to map soil and rock profile below each main	🟨	

		other infrastructure elements. There is a MEDIUM RISK of adverse impact to the Development as a result of this hazard, unless appropriate design is applied.	🟧	element of wind farm infrastructure. A deep foundation solution (Piling or other) will be considered for turbine T02, located within the mapped flood zone of the Camlin River. Consideration will be given to raising the infrastructures above the level of the flood waters to reduce the severity of the impact. All other infrastructure will be designed to deal with the impact of flood waters.	🟨	
Geology	Protected Geological Sites	No sites of geological significance are listed within the Site boundary. The closest site is: LD007 Creeve Quarry - *“A long disused quarry with adjacent wooded knoll of exposed rock” 3km to SE.* There is LOW RISK of impact to this protected site from the soils and geology related aspects of Cloonanny Wind Farm.	🟨	Mitigation as required to reduce risk of pollution of watercourses will reduce the risk to the adjacent protected geological site. Refer to Construction Environmental Management Plan (CEMP)	🟩	NEGLIGIBLE RISK
Geology	Protected Sites	No sites of geological significance are listed within the Site boundary. The closest site is: *Carrickglass NHS (Ref 001822 – 850m South East* There is MEDIUM RISK of impact to this protected	🟧	Mitigation as required to reduce risk of pollution of watercourses will reduce the risk to the adjacent protected geological site.	🟨	

		site from the soils and geology related aspects of Cloonanny Wind Farm.		Refer to Construction Environmental Management Plan (CEMP)		

8.1.4 Structure of this report

This report contains the following elements:

1. A Study of the Soils and Geology pertaining to the site and surrounding hinterland.
2. An assessment of the risk of soil instability.

This assessment required a phased approach involving preliminary research, site visits, preliminary testing, follow up site investigations, laboratory testing and a detailed analysis of the findings.

These works are detailed separately under the following two titles and are contained within the Appendix:

- Appendix C: 2274-24A “Cloonanny Wind Farm, Preliminary Ground Investigation”, dated 26th July 2024.

This report contains an analysis of the findings of these reports.

Table 1.1: Summary of Report Connectivity

Cloonanny Wind Farm – Assessment of Peat Stability	
Report No: 2274-24A	Cloonanny Wind Farm, Preliminary Ground Investigation Containing Appendices, A - E
Report No: 2274-24B (This Report)	Cloonanny Wind Farm, Soils and Geology Technical Assessment Report Containing Appendices, A - C

This report contains an amalgamation of the information recorded in the earlier stages of reporting and details the fieldwork undertaken to gather soils and geology data including that required to screen for the risk from peat instability, to the surrounding environment. It also details the analytical process undertaken to apportion risk to the various construction elements; namely construction of the turbine bases and new proposed access tracks.

The field work and interpretative reporting was designed and executed by members of the following project team:

1. John Whiteford BSc (Hons) MEAGE AMIOSH IOSH FGS – Director / Geologist / Geophysicist. (25 years' experience)
2. Mr Ryan Calvert BSc (Hons) Technical Director. (15 years' experience).
3. Mr Armand Tollas BSc (Hons) Environmental Science – Project Engineer. (15 years' experience).
4. Mr Jaime Stothers– Field Engineer. (9 years' experience).

This Soils and Geology study, together with Peat Landslide Hazard Assessment (PLHA) screening is a “stand-alone” document. No data acquired by 3rd parties (at the site) has been used to augment the dataset acquired by Whiteford Geoservices Ltd, which has been used to produce this report.

Although research has been made into conditions external to this wind farm site, no physical survey data has been collected from outside the wind farm planning boundary for the purpose of determining peat, soil or rock stability risk.

Risk to the proposed development lands from natural events originating outside of the development has not been considered.

This assessment solely relates to an assessment of baseline soils and geology, specifically with a view to its interaction with the wind farm Development. Where soil and geology related conditions have the potential to generate negative effects, these have been classified and relevant mitigation recommended. (see Table 1.11 & Table 1.12)

1.1.5 Relevant Legislation

The following is a non-exhaustive list of sources and guidance which may be used and referenced throughout the EIA process:

- Geological Survey of Ireland Datasets Public Viewer www.gsi.ie
- Ordnance Survey of Ireland. www.osi.ie
- OPW. Flood Mapping. www.floodmaps.ie. [Online] EPA. [Cited: 2 March 2021.]
- EPA. Environmental Impact Assessment. www.epa.ie. [Online] EPA. [Cited: 2 March 2021.] http://www.epa.ie/monitoringassessment/assessment/eia/.
- Prepared by the Department of Housing, Planning and Local Government (DPHLG) (2019), Draft Revised Wind Energy Development Guidelines
- Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements – DRAFT September 2015
- EPA (2022) Guidelines on the information to be contained in Environmental Impact Assessment Reports – May 2022 (Supersedes 1997, 2002 and 2017 versions)
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish Wind Energy Association (IWEA) (2012) "Best Practice Guidelines for the Irish Wind Energy Industry".
- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1
- NRA (2010) Project management Guidelines
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- EPA "Consultation with www.catchments.ie/maps/ EPA Catchment Map Viewer" https://www.catchments.ie/maps/
- EPA "Consultation with gis.epa.ie/Envision EPA Map Viewer" http://gis.epa.ie/Envision
- Geological Survey of Ireland "Geological Survey Ireland Spatial Resources".
- The Scottish Executive's "Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments" was published as a final version in December 2006. These guidelines are commonly used in Ireland and have been accepted as authoritative, by the relevant Public Bodies.
- Met Eireann – Historical regional data www.met.ie

- Forestry Commission (2004). "Forests and Water Guidelines". 4th Edition. Forestry Commission, Edinburgh, Scotland.
- Schouten, M. G. C. Ed. (2002) "Conservation and Restoration of Raised Bogs, Geological, Hydrological and Ecological Studies". Duchas, Staatsbosbeheer, GSI, Dublin.
- Scottish Natural Heritage & Forestry Commission Scotland (2010) Floating Roads on Peat
- Scottish Renewables, Scottish Natural Heritage, SEPA, Forestry Commission Scotland & Historic Environment Scotland (2015) Good Practice during Wind Farm Construction.
- Scottish Natural Heritage (2013) A handbook on environmental impact assessment – 4th Edition.
- Scottish Renewables (2012) Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste
- Geological Map of Ireland, 1:750,000 3rd Edition 1962.
- Skinner, B. and Porter, S. (1987) Physical Geology, John Wiley & Sons, Inc.Long, C B and McConnell, B.J. 1999. Geology of South Kerry. GSI, Dublin.
- Close, M. H. 1867. Notes on The General Glaciation of Ireland. Journal of Royal Geological Society Ireland
- Craig, R F. 1997. Soil Mechanics. Sixth Edition. E & FN Spon, London
- Daly, D, And Warren, W. 1994. Mapping of Groundwater Vulnerability to Pollution.
- Geological Survey of Ireland (Dublin) Guidelines.
- Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, published by the Department for Environment, Food and Rural Affairs (DEFRA), London, 2009.

Note: Relevant legislation and reference limits will also be followed and referred to.

1.1.6 Comments from Statutory Consultees

Comments from statutory consultees received in regard to Soils and Geology have been addressed within this report.

1.1.7 Schedule of Works

In April 2024 Whiteford Geoservices Ltd (WGS) personnel initially undertook a desk study of the available information pertaining to the proposed development at Cloonanny Wind Farm. This was then followed up by a site visit undertaken in May 2024, when preliminary scoping and a walkover assessment were carried out. Following analysis, further investigation, laboratory testing and analysis was then carried out, in May and June 2024, when a detailed assessment of topography, geology, drainage and ground stability conditions was also undertaken.

This detailed analysis of baseline conditions was finalised in July 2024.

A complete schedule of the investigative works undertaken at Cloonanny Wind Farm is listed in the table overleaf.

Table 1.2: Schedule of Investigative Works by WGS, at Cloonanny Wind Farm Landholding

Key Dates	Activity	Turbines	Remarks
April 2024	Desk Study Analysis.	T1, T2 and Substation / Control Building	Undertaken by Whiteford Geoservices Ltd. Refer to this Report for findings
May 2024 (14th to17th)	Preliminary Site Investigation consisting of in-situ testing of peat thickness, in-situ shear strength testing. Geophysical surveys.	T1, T2 and Substation / Control Building	
May and June 2024	Intrusive Site Investigation consisting of trial holes and laboratory testing of samples	T1, T2 and Substation / Control Building	
June and July 2024	Reporting	T1, T2 and Substation / Control Building	

1.2 Methodology

1.2.1 Desk Study and Walk Over

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

- Acquire and compile all available maps of the proposed wind farm development.
- Study any geotechnical reporting available within the public domain for the locality (https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx)- *Geological Survey of Ireland – Public Data Viewer Series*
- Study and assess the proposed locations of turbines with regard to available data on site topography and slope gradients (https://ireland.blueskymapshop.com/maps).
- Overlay Geological Survey of Ireland (GSI) online data to determine site bedrock geology and the presence of any major faults or other anomalies.
- Use of Geological Survey of Ireland (GSI) Quaternary mapping to determine soil classification on the site.
- Use of Geological Survey of Ireland (GSI) mapping to determine bedrock aquifer status, groundwater vulnerability, “karst” potential, landslide potential, aggregate potential at the site.
- Review Met Eireann meteorological records pertaining to the site.
- Review of OPW Flood Mapping data to identify current potential for surface water and river flooding at the Site.
- Use desk-based information (including EPA Mapping) to identify preliminary list of potential receptors, either within the site boundary, immediately adjacent to it or in the wider vicinity, where these are at risk of being impacted from peat or soil movement caused by the proposed development.
- Use desk-based research to identify potential site “Preconditions” of slope instability or evidence of “Pre-failure Indicators” within the proposed development and vicinity.

- Visit the site to undertake preliminary scoping works to measure peat depth and other geological information, review the relevance of desk study findings, assess the sensitivity of potential receptors, as well as the applicability of the preconditions and pre-failure indicators previously identified.
- Calculate preliminary soil stability for construction, to identify the factor of safety applicable to the Development, specifically at the main infrastructure; turbine positions and substation control building.

The equipment and materials used during this study consisted of:

- AutoCAD (Graphics);
- Surfer 16 (Graphics);
- Microsoft Excel (Database);
- Microsoft Word (Report);
- PDF (Report);
- Leica and Garmin DGPS Systems;
- Peat probing “depthing” rods;
- “Russian Corer” hand held Gouge Coring Equipment;
- Other sampling equipment

Refer to Report 2274-24A, “Cloonanny Wind Farm, Longford, Co. Longford, Ireland – Preliminary Ground Investigation”, contained here in Appendix C

1.2.2 Site Investigations

WGS conducted preliminary geotechnical and geophysical investigations at the site of the proposed development, between May and June 2024.

These investigation works consisted of:

- Bedrock and sub-soils outcrop logging and characterisation at proposed turbine locations (WGS).
- (Screening for Peat Landslide Hazard): Peat depth probing, undertaken manually by driving a series of “depthing” rods into the ground at turbine positions and across the site development boundary until a significant change in resistance was registered within the sub-soils. The depth at which this increase in resistance was observed was then measured and recorded. (WGS)
- Shear strength of the shallow soils was measured using a hand held shear vane. In-situ assessment of shear strength of soil in its undrained condition is important to determine its current stability. Where peat was present Peat Landslide Hazard Assessment findings have been predicated on the maintenance of the existing ground water regime, using a combination of Hydrological and specific construction techniques aimed at providing a non positive drainage solution. Analysis of recovered peat soils is also undertaken to determine worst-case shear strength, as a comparison. In peat, the process of drying-out peat tends to destroy a portion of the internal fibres and hence reduces tensile strength, measured as shear strength. In mineral soils, this relates to the softening of soils by heavy rainfall. The shear strength of this dried out peat or softened mineral soils is therefore considered as the “worst case” and is important for numerical assessment of slope stability at each individual turbine. Refer to Appendix B. (WGS).
- Gouge coring using a “Russian Corer” to extract intact samples of peat and mineral soils. The Von Post classification method of peat, if present, is also employed to determine the range of organic / peat

characteristics for the sampled Topsoils. This was undertaken for both the Topsoils and Mineral soils at the main wind farm structures. (WGS)

- Assessment of the impact of external factors (such as local hydrology, vegetation etc.) on soil shear strength and hence its tendency towards failure, by shear or rotation, during construction works. (WGS)
- Recording of Irish Transverse Mercator (ITM) Grid coordinates for all investigation locations. (WGS)

1.2.3 Impact Assessment Methodology

From the desk and field data acquired during the initial walkover survey, an initial assessment was made to screen for Peat Landslide Hazard and determine the presence and severity of other soils and geology related hazards.

The following calculations, assessments and constraints, follow on from these preliminary desk top and field-based assessments.

With regard to Soils and Geology, two main aspects have been reviewed; Superficial soils and solid geology and potential contamination of the landscape. The implications of these prevailing conditions were assessed at an early stage (Desk Study and Walkover Survey) and used to drive the rest of the study.

These preliminary assessments indicated the absence of peat soils at the main structures, but confirmed the potential for “Karst” landforms within the soluble Visean Limestones, that underlie the site. This removed the hazard of Peat Landslide from the Soils and Geology baseline, but confirmed the relevance of hazard relating to “Karst” Instability.

The second phase of the Soils and Geology study (Site Investigation) was undertaken to confirm appropriate foundations for the main structures and access track network.

This Site Investigation allowed for a more detailed assessment of soils and geology, as follows:

- Detailed characterisation of the site’s topographical, geological, hydrological and geomorphological regime from the data acquired.
- Detailed consideration of ground stability issues as a result of the proposed development, its specific design and method of construction.
- Assessment of the collected baseline data acquired to update the preliminary assessment of impacts on the soils, geology and hydrological aspects of the environment.
- Laboratory analysis of soils samples to determine specific stability characteristics for the native soils and rock formations.
- Where impacts are identified, consider measures that would mitigate or reduce the identified impact.
- Consider that the development will be most at risk of peat movement during the construction phase. Whether a failure occurs during the operational life of the wind farm or not, the likelihood of it occurring will be demonstrated from the factors applied
- Present and report these findings in a clear and logical format that complies with general EIAR reporting requirements.

1.2.4 *Characteristics of the Development*

The proposed development comprises 2 no. wind turbines, 2 no. turbine hardstands, substation, BESS, site compound and new access tracks along with associated infrastructure.

The natural superficial soils that mantle the proposed development site consist predominantly of topsoils, underlain by till (mineral soils) consisting of, sandy, gravelly, silts or clays. GSI mapping indicates the presence of isolated pockets of cut over raised peat bog in the region.

Analysis of the trial hole investigations, undertaken during previous investigations, indicates that peat is absent within the construction footprint, and that topsoils are underlain by a natural sequence of till soils, consisting of clayey, sands, gravels and boulders.

The following sections provide a summary of the findings of the SI campaign, a summary of existing site topography, as well as a summary of the main elements of the proposed development.

- <u>Whiteford Geoservices Ltd – 8 to 10 May 2024 (SI Fieldwork – Stage 1 Walkover)</u>
  Peat Landslide Hazard screening; shear strength was recorded at the turbine centres (according to the proposed layout at that time), with peat found to be absent at the main infrastructure and subsoil shear strength to vary from 42 to 90 kPa at the main structures within the development.
- <u>Whiteford Geoservices Ltd – 29 to 30 May 2024 (SI Fieldwork – Stage 2 Intrusive Works)</u>
  Topsoil thickness recorded in the trial holes was found to vary from 0.25m to 0.80m.
  No intact bedrock (Limestone pertaining to the Visean Limestones Formation) was encountered during the intrusive investigations at T01, T02 and the Substation. All exploratory holes were terminated at between 3.50m to 3.70m depth within predominantly stiff SILT/CLAY.
  Groundwater was generally only encountered within exploratory holes at T02 during the relatively transient fieldwork period.

The following record of Peat depths, below existing ground level, was recorded during this most recent study of soils and geology:

- Range across entire landholding = 0m
- Range across infrastructure footprint = 0m
- Median across entire landholding = 0m
- Mean across entire landholding = 0m

While ground slope ranges are generally low (less than 3 degrees to the horizontal at the turbines and substation BESS compounds) slopes of up to 4 degrees are present within the entire construction footprint.

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

- Construction Zone **c. 14.33 ha** (Red-line or “Planning application” boundary)
- Peat is absent across the entire surveyed landholding. Screening peat depth = **0m**.
- **2 No.** wind turbines
- Construction of reinforced concrete base foundations for **2 No.** wind turbines. (Typically, circular with a foundation diameter of c.**27.2m**, Turbine base area = **581m^2**

- Construction of crane hardstanding areas located beside each turbine to facilitate erection by mobile cranes and blade lay-down. (Area of c.**7,985m^2**)
- Construction of a 38kV electrical substation control building and switchyard; **c. 360m^2**.
- Battery Energy Storage facility (BESS)
- Construction of Met Mast and associated compound; **c. 600m^2**.
- Construction of approximately **8600m** of new site access tracks and **828m** of upgraded existing track having a minimum finished width of c.**5.0m,** of which **all** will consist of traditionally constructed. In addition, there will be a requirement for turning areas and lay-bys extending to **1083m^2**
- The terrain within the construction footprint is sloping with gradients generally between 0 – 4 degrees to the horizontal.
- Ground surface elevation (within "wind farm planning boundary") ranging from 44m to 55m above sea level (Malin Head OD).

1.3 Introduction

An initial investigation of the existing land, soils and geology characteristics of the study area was conducted by undertaking a desk study, consultation with relevant authorities and Site-based fieldwork surveys.

The study area is defined as the region within which changes to the soils and geology environment associated with The Project could reasonably impact sensitive receptors. All of potential effects of The Project have a limited zone of influence and for these the study area has been limited to 1km from the Site boundary. However, there is also the potential for the zone of influence to be greatly extended, for instance soil contamination by watercourses. In such a case effects can potentially impact receptors downstream, in excess of 1km from the Site. For this reason, sensitive receptors within 5km have been included in the study area

All data collected has been interpreted to establish the baseline conditions within the study area and the significance of potential adverse effects have been assessed. These elements are discussed in detail in the following sections.

1.3.1 Site Description

The Proposed Development Site is located within the townlands of Corragarrow, Derryharrow and Cloonanny Glebe, approximately 3km north east of Longford, Co. Longford.

Ground surface elevations vary between approximately 45m to 60m above Ordnance Datum (Malin Head).

The land usage across the number of land holdings which make up the Site, consists of agricultural grazing land for cattle and small areas of forestry.

1.3.2 Turbine Component Delivery Route / Haul Route

The Turbine Delivery Route from Belview Port, Waterford will be via motorways and the national, regional and local roads network to the wind farm entrance off the L50462. Refer to **Chapter 2, Section 2.3.10** for details.

Both permanent and temporary works will be required at a number of locations along the Turbine Delivery Route. Refer to **Chapter 2, Section 2.3.5.2.**

Permanent New Access Road will be constructed off the L50462 local road for a distance of 0.8km as far as Turbine T2. This road will have a width of 5m and take the form of an excavated and stone fill road with a clause 804 crushed aggregate capping.

It is also proposed to upgrade the L50462 from the junction of the L5046 for a distance of circa 1km to the new permanent access road. This upgrade comprises the temporary widening of the road from 3m to 5m. Following Turbine delivery, the temporary widening will be grubbed up and the area will be reinstated.

1.3.3 Grid Route

The 20kV substation at Cloonanny will connect via underground circuits to one of two potential grid connection points, 1) the existing Richmond 110kV Substation, or b) the existing Glebe 38kV

Substation, from where it will connect by existing connection to the National Grid. For further details please refer to **Chapter 2, Section 2.3.11**.

1.3.4 Land Usage

1.3.4.1 Current

The land usage varies across the land holdings which make up the Cloonanny Wind Farm development with the predominant usage agricultural; as mainly pastureland for livestock. In addition, there are areas of concentrated drainage at Turbines T01 and T02, where the lands within the river floodplain have been drained.

There are no residential dwellings within the site, however there are some uninhabited or agricultural buildings located within the red-line boundary. The closest habited buildings being more than 800m from the nearest proposed Cloonanny turbine.

1.3.4.2 Historic

A review of historical mapping, courtesy of GSI, suggests that the site of Cloonanny Wind Farm has not changed significantly in land use from that recorded on the 1st Edition 6" TE Mapping. The same mapping indicates the original course of the Camlin River, along the southern boundary of the wind farm, has been straightened, although the overall course remains similar.

1.3.4.3 Services & Utilities

No overhead utilities were recorded within the proposed Wind Farm construction footprint, except for at the entrance off the L5046 public road, where overhead telecom cables have been observed.

Although, no evidence of underground utilities was recorded, underground services are anticipated to be present within the carriageway and verge adjacent to the site boundary and site entrance. Refer to Material Assets Built Services Chapter for further details.

1.3.5 Bedrock Geology

According to the GSI online database, the entirety of the proposed development area for Cloonanny Wind Farm site is immediately underlain by the Visean Limestones Formation which consists of undifferentiated dark grey limestone rock.

Also present just outside the development area south of the Site, is the Argillaceous Limestones Formation which consists of dark limestone and shale.

One fault, trending along part of the Camlin River in an approximately south east – north west direction, separate the Visean Limestone Formation from the Argillaceous Limestones Formation. Fault zones are often associated with highly fractured and deeply weathered bedrock and / or the channelling of groundwater flow.
Such conditions can have significance for foundation design of structures such as wind turbines, and will be fully investigated prior to the construction phase.

Internationally, faults can often be associated with an increased hazard of ground movement. That notwithstanding, Ireland is located within a region of extremely low tectonic activity and well removed from regions of significant seismic activity. Risk of this type of seismic movement is considered to be slight.

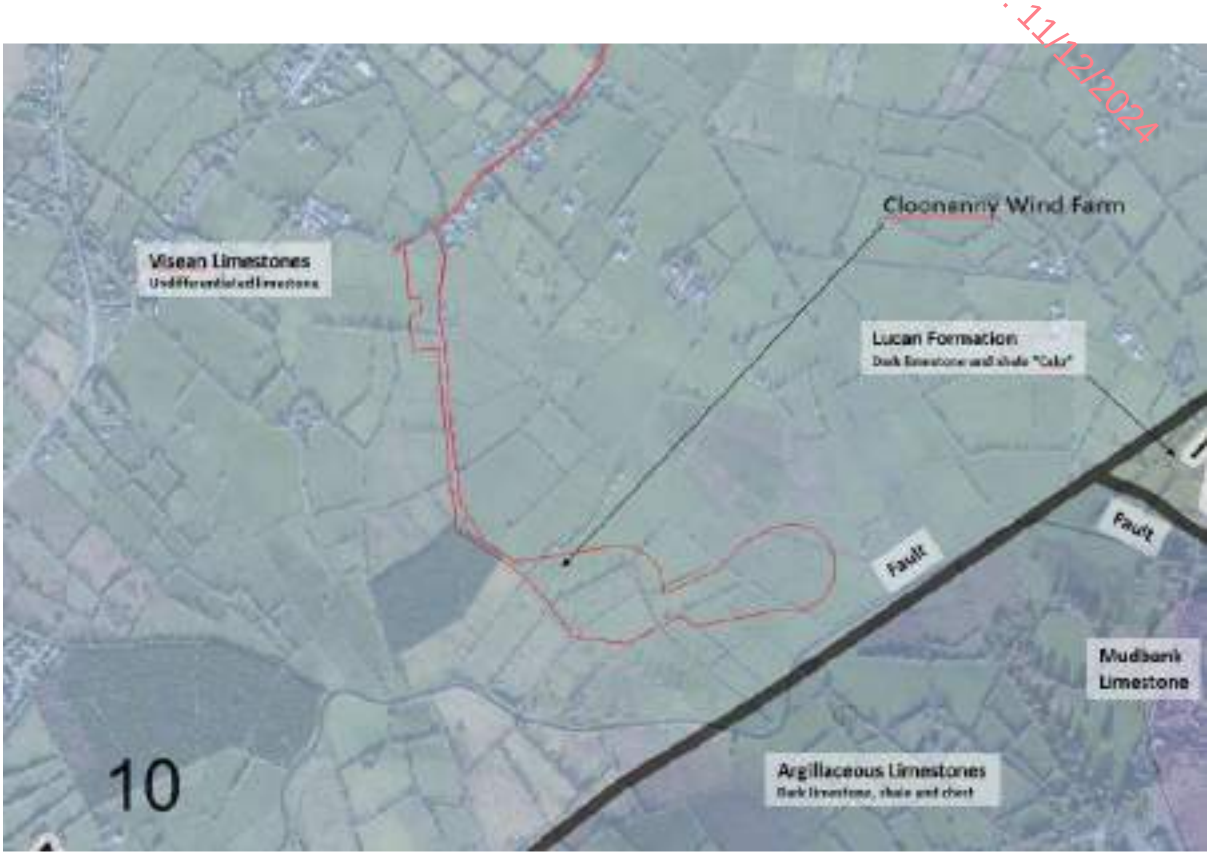

Figure 1.1 *– Bedrock Solid Geology (Reproduced courtesy of GSI Datasets Public Viewer)*

1.3.5.1 Palaeo Karst Features

Karst topography is defined as “*An assemblage of topographic forms resulting from dissolution of the bedrock and consisting primarily of closely spaced sinkholes*.” Karst topography can form in regions of exceptionally soluble rocks, including Limestone.
Soluble rocks generally mean those containing limestone, chalk or evaporite deposits such as gypsum that contain carbonates which are particular susceptible to dissolution under the action of rainfall.

The presence of such features has, in some cases, resulted in structural instability.

The walkover survey did not identify any specific landforms / features consistent with a “karst” landscape at Cloonanny Wind Farm. Additionally, the ground investigations undertaken in 2024 did not record the presence of limestone, chalk or other obviously soluble rock. However, the underlying rock formation is known to contain soluble limestone and is this particular rock formation is also known to be associated with “karst” features at other sites where it outcrops closer to the surface.

Karst landforms and other forms of instability associated with the rock formation are consequently considered to be a risk to development at the Site. Mitigation will be employed to reduce this risk to an acceptable level.

1.3.6 Soils and Subsoils

A study was made of available geological information. This study indicated that the following natural drift geology is present across the site of Cloonanny Wind Farm.

- Topsoil
- Boulder Clay (Till / Mineral Soils)
- Alluvium

Superficial soils present within the wind farm consist of thick till soils overlying often limestone rock at T01, T02 and the Substation. The rock formation was not observed.

Alluvium and raised bog are also indicated by GSI within the site where it is associated with minor watercourses. Alluvial and peat soils have the potential to impact construction at T02.

Following the site visit the presence of peat soils was ruled out as a potential hazard.

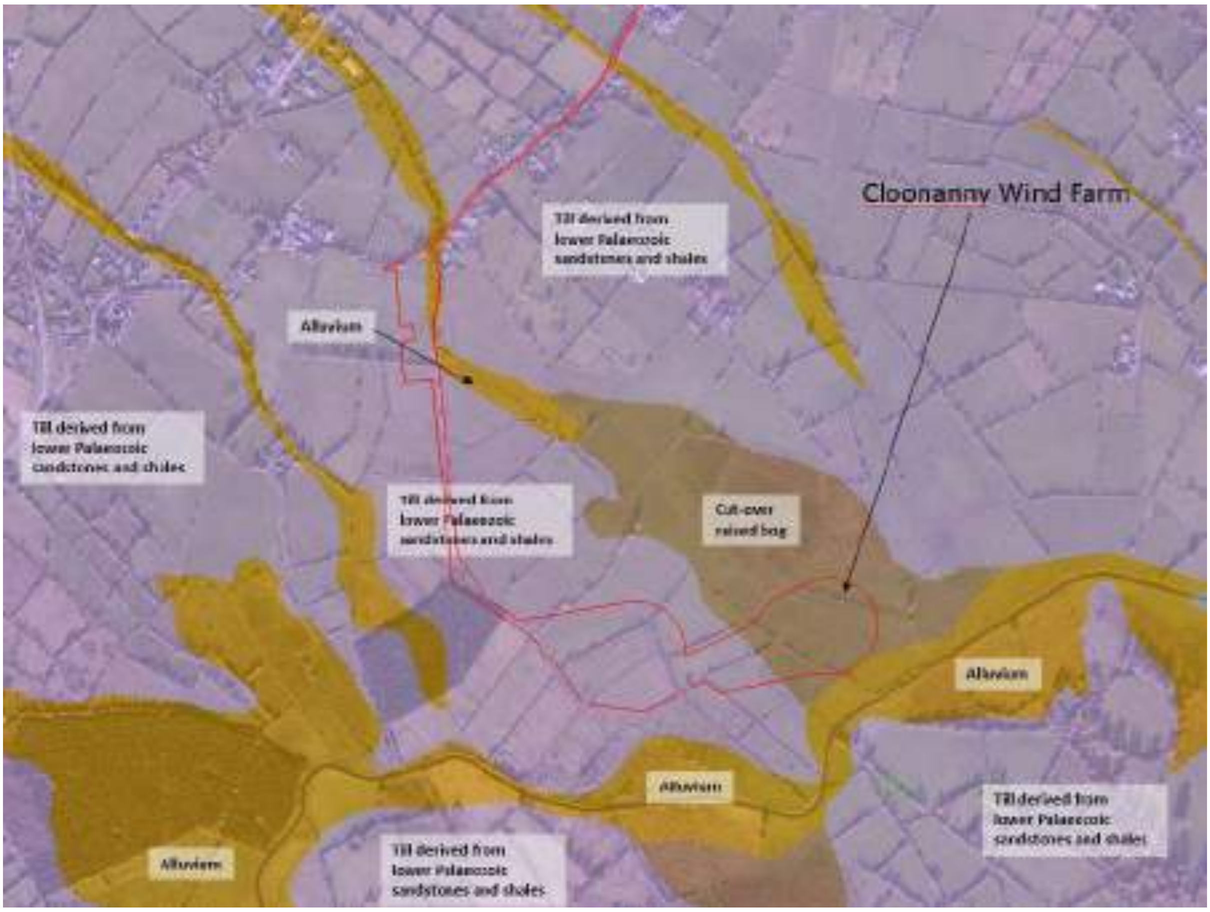

Figure 1.2 *– Superficial Geology. Reproduced courtesy of GSI Datasets Public Viewer*

The following table shows the range of peat / topsoil thickness encountered within the area around each of the proposed main structures.

Peat is absent at all structures and thus further detailed peat landslide hazard assessment was not required.

1.3.6.1 Peat

Analysis of GSI online mapping and other records do not record any landslide events within 5km of the site boundary. Three landslide events; 2no relating to GSI_LS13-0002, Tomisky 2009, Longford and 1no relating to GSI_LS03-0007, Newtownforbes 1883, Longford are recorded within a 5km radius. Both events record a low level of impact.

Peat depth screening undertaken at Turbines T01, T02 and the Substation / BESS for Cloonanny Wind Farm site recorded an absence in PEAT soils within the Development footprint. Specific assessment for Peat Landslide Hazard is not required due to its absence. Peat Landslide Hazard screening was undertaken at the main structures, within the redline boundary shown above. The results of these peat thickness measurements are given in **Table 1.3** below.

Table 1.3: Peat Depth Distribution by Category

Peat Depth Category	Number of Survey Points
A – Rock/Very Shallow Peat/Topsoil (0.0-0.5m)	18
B - Shallow (0.5-1.5m)	0
C - Moderately Deep (1.5-2.5m)	0
D - Deep (2.5-4.0m)	0
E - Extremely Deep (>4m)	0
Total	**9**

No peat was recorded during these assessments and all organic soils encountered were classified as Topsoil.

1.3.6.2 Mineral Soils

Trial hole excavations undertaken during the site investigations were completed at each of the 2 no. proposed wind turbine locations and at the substation / battery energy storage facility.

The results of these peat thickness measurements are given in **Table 1.4** below.

Table 1.4 – Summary of Ground Conditions Encountered at the Main Wind Farm Infrastructure

Turbine / Infrastructure	Stratum Encountered	Depth to Stratum (m)	Remarks	Foundation Recommendation
T01	TOPSOIL	0.00		

Turbine / Infrastructure	Stratum Encountered	Depth to Stratum (m)	Remarks	Foundation Recommendation
	Firm sandy gravelly CLAY/SILT	0.20		Gravity Base foundation in stiff SILT / CLAY at 3.50m depth
	Stiff sandy gravelly CLAY/SILT with low cobble and boulder content	1.60 – 2.00	No rock encountered. Hole terminated at 3.50m	
T02	TOPSOIL	0.00		Deep foundation (Piled or other), where suitable rock formation is >3.50m b.g.l. and turbine lies within a flood zone.
	Medium dense SAND	0.70 – 0.80		
	Stiff sandy gravelly CLAY/SILT	3.30 – 3.40	No rock encountered. Hole terminated at 3.70m	
Substation and BESS	TOPSOIL	0.00		Raft foundation within firm SILT/CLAY at 1.50m depth.
	Firm sandy gravelly CLAY/SILT	0.30	-	
	Stiff sandy gravelly CLAY/SILT with low cobble and boulder content	1.60 – 2.60	No rock encountered. Hole terminated at 3.50m	

These figures for soil thickness, obtained from the site investigation, have been employed for the purpose of calculating spoil quantities anticipated during excavation activities.

Table 1.5 – Details of Estimated Soil Excavation at Turbine / Structural Locations

Element	Ave. topsoil depth (m)	Area of excavation for footprint at gravity base (m^2)	Area of hardstands/ temporary hardstands (m^2)	Vol. of topsoil spoil at bases (m^3)	Vol. of topsoil spoil at hardstand /set down (m^3)	Total Vol. of excavated topsoil (m^3)	Total Vol. excavated mineral soil (m^3)
Turbines, Hardstands and Temporary Hardstands	0.20 – 0.80	1414	12,235	706	5,489	6,195	7,903
Control Building / Substation and BESS Compounds	0.30	1,145				344	484
Track, turning heads and widening	0.43	17,404				7,542	5,511
Met Mast Foundation and Hardstand	0.30	425				128	310

Internal Cabling	0.43				211	228
Grid Connection	0.15				390	1950
Temporary Compound	0.30				630	315
Total est. Vols. Of Spoil Generated					**15,440**	**16,701**

Refer to drawing **2274-24-D1** for screening plot depicting discrete peat depth in the vicinity of each of the turbine positions.

Drawings **2274-24-D2** and **2274-24-D3** display the variation in ground surface as contoured plots of surface elevation and ground slope gradient respectively. All plots are provided as overlays on top of the proposed wind farm layout.

Drawing **2274-24-SD1** identifies the optimal location for containment of topsoil and mineral spoil generated during construction activities.

1.3.7 Ground Stability

A preliminary analysis of Blueskies topographic data was undertaken to identify the variation in gradient applicable to the existing slopes within the vicinity of the proposed wind farm development.

Ground stability is divided into two main types – Soil and Rock stability; the former being further sub-divided into Peat or Topsoils and Mineral Soils.

1.3.7.1 Ground Stability – Peat Soils

Both Evans and Warburton (2007) and Boylan et al. (2008) found from their analysis of recorded failures in blanket bog, that these were often recorded for slopes of typically 4 – 8 degrees to the horizontal. In such cases the mechanism of failure is by predominantly "bog burst" where the cause is a build-up of excessive hydrostatic pressure in the peat mass as a whole.

In this case the peat failure was often internal and not due to a detaching of the peat soils from the underlying mineral substrate. This probably causes internal rupturing and detachment to occur below the failure point, coupled with lubrication of the basal plane by water. It is unlikely that the peat – mineral soil friction will have been exceeded in the case of "bog-burst".

Friction at the base of the peat is nonetheless important and thus it is important to consider the existing slope gradient as a potential trigger and a precondition for peat instability.
No significant thickness of peat was recorded within the Cloonanny Wind Farm site and therefore the potential stability hazard has not been considered further.

1.3.7.2 Ground Stability – Subsoils / Mineral Soils

For the purpose of this report the term Mineral Soils relates to all other cohesive and granular natural soils. These soils are significantly more stable than peat / organic soils, with specific properties dependant on a combination of their relative density, particle distribution and shear strength properties.

Landslides within mineral soils are generally by rotational failure and greatly influenced by weather conditions, in particular how this affects the groundwater table and how the resulting surface water erodes the soil substrate.

In light of the reasons given above, this report advocates a banded factor-based approach to apportioning risk for peat and mineral soil failure. The following bands are used for this purpose.

Table 1.6 – Risk Factor Assignment – Existing Slope Gradient

Existing Slope Angle (Measured at Surface of Peat, Angle to Horizontal)	Relative Risk	Remarks
0 - ≤3	Negligible influence	Peat & organic soils only
3 - 5	Low	Peat & organic soils only
5 - ≤ 10	Medium (Peat) / Low (Mineral Soil)	Peat & organic soils only
10 - ≤ 22.5	High Peat) / Medium (Mineral Soil)	Potential for Unsupported granular soil failure
> 22.5	Very High (Peat) / High (Mineral Soil)	Unsupported granular soil failure. Potential failure in poor quality rock formations

1.3.6.3 Rock Stability

Rock formations are normally significantly more stable than soil formations, where these repose at shallow angles. Where rock faces are present in the vicinity of wind farm infrastructure, particularly slope gradients in excess of 45 degrees to the horizontal, the risk of rock instability needs to be considered.

In the case of Cloonanny Wind Farm none of the construction activities are expected to be exposed to stability risk from rock faces.

The potential hazard associated with rock faces has not been considered further.

1.3.8 Site Visit Assessment of Ground Conditions

The following is an appraisal of ground conditions at each of the locations where turbine bases and other infrastructure are being considered, for the proposed Cloonanny Wind Farm development.

Point 1 - Turbine T01

Nature of Assessment	Observations
Position (ITM)	615037, 77906
Peat / Topsoil Thickness	Peat 0m / Topsoil 0.20m
Superficial Soils	Firm, to stiff sandy, gravelly CLAY/SILT with a low cobble and boulder content
Solid Geology	>3.50m b.g.l. – Visean Limestones – not encountered

Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	None identified
Topography	Up to 2 degrees to horizontal.
Sensitive Receptors	< 300m from River Camlin; <200m from other designated watercourse. Within area of land drains
Utilities: Underground or overhead	None evident in vicinity
Any other observations	Extensive man-made drainage evident in the vicinity

Point 2 - Turbine T02

Nature of Assessment	Observations
Position (ITM)	615470, 777952
Peat / Topsoil Thickness	Peat 0m / Topsoil 0.70m to 0.80m
Superficial Soils	Medium dense SAND overlying firm to stiff sandy, gravelly CLAY/SILT.
Solid Geology	>3.70m b.g.l. – Visean Limestones – not encountered
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	None identified
Topography	Up to 1 degree to horizontal.
Sensitive Receptors	< 200m from River Camlin; coincident with other designated watercourse. Within area of land drains.
Utilities: Underground or overhead	None evident in vicinity
Any other observations	Extensive man-made drainage evident in the vicinity

Point 3 – Control Building

Nature of Assessment	Observations
Position (ITM)	614549, 778553
Peat / Topsoil Thickness	Peat 0m / Topsoil 0.30m
Superficial Soils	Firm, to stiff sandy, gravelly CLAY/SILT with a low cobble and boulder content
Solid Geology	>3.50m b.g.l. – Visean Limestones – not encountered
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	None identified
Topography	Up to 1 degree to horizontal.
Sensitive Receptors	< 400m from River Camlin; <30m from other designated watercourse.
Utilities: Underground or overhead	None evident in vicinity
Any other observations	Extensive man-made drainage evident in the vicinity

1.3.9 Existing Mining Activities and Potential Aggregate Resources

Review of the GSI online mapping data indicates that there is one active quarry / pit in close proximity of the proposed site.

Details for the closest active quarry are as follows:

1. Rhyne Quarries (Limestone): > 4km north west of Turbine T02 at Cloonanny Wind Farm

There are several other active aggregate extraction sites and historic mineral occurrences / workings within 10km radius of the site. None of these activities are considered to have more than a slight impact on the proposed development. There are no historic quarry / pits located within the Site.

Mineral prospecting boreholes have been undertaken within the local area, but no active mineral extraction is recorded. No records of shafts or adits are recorded within 10km of the site.

According to GSI the Site lies within an area predominantly classified as of Moderate Potential for Crushed Rock Aggregate, with very small pockets of high and very high potential along sections of the Camlin River where there is also Moderate Potential for Granular Aggregate. This same database also indicates that overburden for the majority of the Site is in excess of 10m thick with pockets of 5 – 10m thick overburden in the vicinity of turbine T02.

1.3.10 Existing Services / Utilities

The walkover survey did not yield any further information regarding the position of additional underground utilities within the site. Overhead telecom cables and potentially underground pipe and cable services are present at the site entrance, along the edge of the minor public road.

1.3.11 Sites of Geological Heritage

The Geological Survey of Ireland (GSI) also maintains a database for known Geological Heritage Sites in Ireland. This database was accessed on 22nd October 2024 and review of its published contents has determined that the following audited Geological Heritage Sites are present tin the vicinity.

Table 1.7A: Audited Geological Site at Creeve Quarry

Site Code	LD007
Site Name	Creeve (3 km South East)
IGH Theme 1	IGH8
IGH Theme 2	
County	Longford
Description	A long disused quarry with adjacent wooded knoll of exposed rock
Designation	CGS
Geological	A good representative exposure of the Lower Carboniferous rocks in Longford
Report	
Coordinates (IG)	218353, 276290
Coordinates (ITM)	618300.245, 776307.746

Table 1.7B: Audited Geological Site at Killoe Quarry

Site Code	LD011
Site Name	Killoe Quarry (4.5km North East)
IGH Theme 1	IGH8
County	Longford
Description	A large working quarry in the Lucan Formation, of Viséan (Lower Carboniferous) age
Designation	CGS
Geological	A good representative site for the Lower Carboniferous limestone rocks in Longford
Report	
Coordinates (IG)	219708, 279845
Coordinates (ITM)	619654.812, 779861.860

Table 1.7C: Audited Geological Site at Glen Lodge Stream (8.5km North East)

Site Code	**LD009**
Site Name	Glen Lodge Stream (6.5km North West)
IGH Theme 1	IGH2, 4
County	Longford
Description	Streambank exposures in a deep glen or gorge
Designation	CGS. Recommended for NHA
Geological	Site is unique in Ireland as the sole exposure of late Silurian sedimentary rocks in Longford-Down
Report	
Coordinates (IG)	222845, 282972
Coordinates (ITM)	622791.478, 782988.731

Table 1.7D: Audited Geological Site at Drumlish Quarry

Site Code	**LD008**
Site Name	Drumlish Quarry (9.5km North East)
IGH Theme 1	IGH8
County	Longford

Description	An intermittently active quarry into greywacke of the Coronea Formation, of Ordovician age
Designation	CGS.
Geological	A good representative site for rocks not well exposed despite being relatively resistant to erosion within the Iapetus Suture zone
Report	
Coordinates (IG)	219420, 287244
Coordinates (ITM)	619366.926, 787259.292

Table 1.7E: Audited Geological Site at Lough Rinn Drumlins

Site Code	**LM022**
Site Name	Lough Rinn Drumlins (11.5km North)
IGH Theme 1	IGH7
County	Leitrim
Description	This site forms part of a small, discrete field of drumlins, south and southeast of Mohill Village.
Designation	CGS.
Geological	Being set among an extensive field of drumlinised ribbed moraines, this small field of drumlins is unusual in that it comprises a small number of discrete, spindle-shaped drumlins, sittingon their own within the wider ribbed moraine landscape.
Report	
Coordinates (IG)	
Coordinates (ITM)	

Table 1.7F: Audited Geological Site at Mid Roscommon Ribbed Moraines

Site Code	**RO022**
Site Name	Mid Roscommon Ribbed Moraines (17.5km North West)
IGH Theme 1	IGH7
County	Roscommon
Description	This field of ribbed moraine forms part of a small, discrete field northwest of Slieve Bawn
Designation	CGS.
Geological	This field of ribbed moraines form the perfect 'ribbed' topography

Report	
Coordinates (IG)	188269, 281685
Coordinates (ITM)	588222.859, 781701.684

1.3.12 Landslide Susceptibility

The GSI maintains a Landslide Susceptibility Map for Ireland. GSI landslide susceptibility mapping also indicates that the site has a low susceptibility with respect to landslide risk within the red-line boundary.

The Geological Survey of Ireland (GSI) records show that 4 no. landslides are recorded within 5km of the Site, with the closest landslide event being “Rhine1809”, which occurred in 1808, approximately 2.5km to east of the Site.

1.3.13 Peat Landslide Hazard Assessment

Although GSI mapping had indicated, as desk study stage, there to be an area of “cut-over” peat bog in the vicinity of turbine T02, no observations of peat soils, either at T02 of elsewhere within the red-line boundary were recorded at SI stage.

Preliminary screening has determined that peat landslide hazard is negligible due to the Site’s virtually flat topography and absence of significant peat within the construction zone.

1.3.14 Sites of Designated Importance

The following designated sites are sensitive environmental receptors within the Study Area which have been assessed for potential effects arising from The Project.

The following seven areas lie close to the Site are designated protected areas according to the Government of Ireland’s EPA Map Viewer (accessed on 22nd October 2024):

- Carrickglass NHS (Ref 001822 – 850m South East
- Royal Canal Proposed NHA (Ref 002103 – 3.4km South West)
- Section of the Camlin River designated as Nutrient Sensitive, according to the Urban Waste Water Directive (Ref 1994 – 3.6km South West)
- Lough Forbes Complex SAC / NHA (Ref IE0001818 – Habitats – 4.7km West)
- Ballykelly Fisherstown Bog SPA (Ref: IE0004101 – Birds – 4.7km West)
- Derrymore Bog Proposed NHA (Ref: 000447 – 4.9km South)
- Brown Bog Proposed SAC / NHA (Refs: IE0002346 & 00042) – 5km South West)

1.3.15 Soil Contamination

No soil or groundwater contamination was observed within the Proposed Development site, nor on the grid connection route. No evidence of soil contamination was noted during walkover surveys or the site investigation. As agricultural and forestry equipment is used across much of the Site it is possible that minor fuel spills and leaks have occurred locally in the past.

The EPA records the following four licenced industrial consents within 5km of the Site.

- P0855; Kiernan Structural Steel Limited, Killyreher, Carrigglas, Longford. (1km East)
  Active license no: P0855-01
  IPC, IPPC Facility & IPPC Boundary designations apply

- P0226; Barbour Threads, Templemichael Road, Longford. (2km South)
  Active license no: P0226-01
  IEL & IPPC Facility designations apply

- P0327; Glennon Brothers Timber Limited, The Sawmills, Kilnasavogue, Longford. (3km South East)
  Active license no: P0327-01
  IEL, IPPC Facility & IPPC Boundary designations apply

- P0351; Gem Manufacturing Company Limited, Catrongeeragh, Longford. (5km South West)
  Active license no: P0327-01
  IPC, & IPPC Facility designations apply

1.3.16 Site Investigations – Summary of Findings

Table 1.8 presents a summary of the findings of the Soils and Geology Baseline together with preliminary design recommendations.

Table 1.8: Summary of Site Investigation Findings and Recommendations

Element Ref:	Element Assessed at Site Investigation Stage	Summary Soil Description
1A	Typical Soil Overburden (Wind Farm)	A. Topsoil overlying firm to stiff, grey mottled orange, sandy, gravelly SILT / CLAY with a medium cobble and low boulder content.. (T01 & substation / BESS) B. Topsoil overlying medium dense, grey, very silty SAND and firm SILT (T02 only)
1B	Typical Soil Overburden and Bedrock (Grid Connection)	MADE GROUND consisting of bituminous road surfacing and road base granular aggregate, overly mainly GLACIAL TILL mineral soils for all three route options.. Isolated pockets of ALLUVIUM and PEAT are also present in the vicinity of the Camlin River affecting soute options 2 and 3.. The bedrock geology mapped along the Grid Connection route consists of solely Visean Limestones (Dark limeston, shale and chert) for route options 1 and 3. Along route option 3 bedrock geology consists of Visean Limestone, the Ballysteen Formation (dark muddy limestone and shale) and the Meath Formation (Limestone cand calcareous sandstone), Although the majority of the circuits will be laid within the superficial soils, some limited bedrock excavation is anticipated.
2	Typical Overburden Thickness (m)	T01 = >10m

Element Ref:	Element Assessed at Site Investigation Stage	Summary Soil Description
		T02 = 8 to 10m SUBSTATION and BESS = > 10m
2	Rock Type (Wind Farm)	VISEAN LIMESTONES. Rock was not encountered within the trial holes excavated during the Site Investigation campaign. Geophysical Electrical Resistivity Imaging (ERT) surveys did identify rock at 8 – 10m depth at T02, but did not identify rock at T01. Geophysical data suggests that overburden is antcicipated to be >10m thick at T01 and the Substation.
4	Rock Competence (Wind Farm)	Unconfirmed at this time. Further SI will be undertaken at construction stage to confirm this aspect. Geophysical data at T02 indicates that the rock will be WEAK to MEDIUM STRONG LIMESTONE (i.e. 5 - 50 MPa)
5	Typical Depth to Non Rippable Rock	T01 = > 10m T02 = 8 - 10m SUBSTATION and BESS = > 10m
6	Anticipated Wind Turbine Foundation Type	T01 = Gravity Base within stiff MINERAL SOILS T02 = Ground Improvement and Gravity Base / Piled Foundation within stiff MINERAL SOILS SUBSTATION = Raft, strip or pad foundations within the stiff MINERAL SOILS
7	Slope Stability	T01 : FoS > 1.1 (Acceptable) T02 : FoS > 1.1 (Acceptable) SUBSTATION and BESS: FoS > 1.1 (Acceptable)
8	Karst Features	Although the underlying rock formation is soluble and therefore has potential to develop Karst dissolution features, no “karst” features such as sinkholes, caves, cavities, voids or subterranean watercourses were located during the site investigation campaign.

Element Ref:	Element Assessed at Site Investigation Stage	Summary Soil Description
		GSI does not records any karst features within the Site. The potential impact to the Development is Significant, but will be mitigated by undertaking a detailed pre-construction ground investigation. This investigation will contain supplementary holes intended to map the competence of the rock formation over the footprint of the main infrastructure.
9	Groundwater Observations	**T01** – No groundwater recorded during SI. Soils are weakly permeable only. Location expected to be in hydraulic continuity with Camlin River and at this location subject to slow recharge. Mobile ground water table anticipated. **T02** – Weak flows of groundwater recorded at 2.80 – 3.30m depth during SI. Soils are moderately permeable. Location expected to be in hydraulic continuity with Camlin River and at this location subject to moderate rate of recharge. Mobile ground water table anticipated. **Substation / BESS** – No groundwater recorded during SI. Soils are weakly permeable only. Location expected to be in hydraulic continuity with Camlin River and at this location subject to slow recharge. Mobile ground water table anticipated.
10	Protected Geological Sites	The following sites of geological significance are present in the local vicinity: - RO022: Mid Roscommon Ribbed Moraines, IG7 LD004: Drumlish Quarry, IG4 LD011: Killoe Quarry, IG8 LD007: Creeve Quarry, IG8 All these sites are sufficiently far enough from the proposed development for any potential impact / effect caused by its construction and operation to be imperceptible.
11	Landslide Hazard	GSI mapping indicates landslide potential at the Site to be low. Preliminary SI indicates that peat soils are absent at the main infrastructure and the natural mineral soils are not considered sensitive. Maximum slope gradients at the site are less than 5 degrees to the horizontal. Risk is confirmed to be low.

Element Ref:	Element Assessed at Site Investigation Stage	Summary Soil Description
12	GSI – Crushed Rock Aggregate Potential	According to Geological Survey Ireland, the Aggregate Potential for the Borrow Pit site can be summarised as follows: - Moderate – Majority of development area, including T01, T02 and the Substation and majority of access track network. High – Portions of Turbine T02 However, the author's own opinion is that the significant thickness of overburden likely to need removed to exposed the underlying limestone rock formation would make quarrying operations uneconomical. Further borehole SI would be required to intercept the rock formation and test the competence of the crushed rock.
13	Predicted Performance as a construction aggregate	**Marginal.** It is anticipated that negligible rock spoil will be generated during construction works. Spoil will consist of either SILT/CLAY or SAND/GRAVEL mineral soils. The former is likely to be variable in terms of their suitability and likely to be subject to degradation by wet weather conditions. The latter are anticipated to perform well as a construction fill material and less susceptible to weather conditions.
14	Predicted Performance as a construction aggregate	**It is not possible to predict with any certainty the quality of crushed rock aggregate that could be derived from the site**. Further SI is required to gain the necessary additional information to determine rock aggregate performance. The following is known and positive; a) this limestone rock formation generally produces an acceptable quality of crushed aggregate b) b) there are limestone rock quarries within 5km of the site. The following is known and negative; a) at this site **b)** GSI records indicate a moderate to high potential for crushed rock aggregate at this site.

1.3.17 Other Potential Sensitive Receptors

Analysis of desk study resources and follow up walkover surveys have identified the following receptors with the potential to be susceptible to peat instability generated by activity related to the proposed wind farm construction and / or operation.

Table 1.9 – Analysis of Other Sensitive Receptors Applicable to the Site

Receptor	Minimum distance to Site	Exposure Factor Assigned (Using Factor Based Probabilistic Analysis)	Remarks
Peatlands / Bog	4.5km	1	Closest significant bog is located approx. 4.5km to the south west.
Agricultural Lands	0m (within site)	1	-
Minor Utilities	0m (within site)	2	Utilities near Substation and T2
Designated Minor Watercourses / Water Bodies	0m (within site)	2	Camlin 26 River, Derryharrow Stream and IE_SH_26C010800 Waterbody
Designated Major Watercourses / Water Bodies	< 0.3km	3	Camlin 26 River
Undesignated Watercourses / Drainage	0m (within site)	1	e.g. ditches and man-made watercourses, around T01, T02 and close to Substation
Minor Public Roads	0m (adjacent to Site Entrance)	3	
Moderately to highly trafficked Public Road	< 1km	4	R198
Dwellings	c.70m from Site Boundary.	4	Closest dwelling to Site Boundary. Minimum distance to dwelling from a wind turbine is > 800m.
Commercial Property	0m (at Site Entrance)	3	Various. Closest is adjacent to Site Entrance. Minimum distance from a wind turbine is > 650m.
Significant Utilities (Overhead) / Underground	>1km	3	
Population centre / Urban area	c. 3km to west	5	Longford, population 10,592 (2022)

1.3.15 Potential Preconditions Identified within the immediate vicinity of the proposed development

Analysis of desk study resources and follow up walkover survey have identified the following static or inherited factors that could potentially act as preconditions to slope instability in peatlands.

Table 1.10 – Risk Analysis of Preconditions Applicable to the Site

Precondition	**Minimum distance to Development (m)**	**Remarks**
Concentrated drainage network / presence of standing water / area of flush / springs, or rises	0m (drained lands adjacent to Camlin River at turbines T01 and T02.)	
Significant slopes	N/A	
Significant peat thickness	Not applicable – no peat at infrastructure	No peat encountered at Site
Very highly decomposed Peat	Not applicable – no peat at infrastructure	No peat encountered at Site
Very weak Peat or underlying mineral soils	Not applicable – no peat at infrastructure	No peat encountered at Site
Potential sonic vibration or ground accelerations	No sources of sonic energy (e.g. blasting etc.) within 3km of the site	Potential impact to site from existing quarry operations is imperceptible.

1.3.16 Pre-Failure Indicators within the immediate vicinity of the proposed development

Pre-failure indicators are physical landforms that are "tell-tale" signs of stress within the peatland environment.

The following pre-failure indicators have been considered for the proposed development at Cloonanny Wind Farm:

- Historical evidence of previous movement
- Tension or compression features
- Soil creep
- Cracking / desiccation
- Other[1]

The following pre-failure indicators are present within the immediate vicinity of the proposed development:

Table 1.11 – Analysis of Pre-Failure Indicators Applicable to the Site

Pre-Failure Indicator	**Minimum distance to Structures / Infrastructure (m)**	**Remarks**
Historic peat cutting	0m	Large central portion of the Site has been "cut-over". No peat remains.
Evidence of cracking or movement within the rock formation	N/A	None evident

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[1] The Scottish Guidance notes other potential pre failure indicators such as artificial drainage, concentrated drainage networks, seeps, springs, soft clays and iron pans. The author considers these to be preconditions and not pre failure indicators.

Evidence historical peat slide	c. 5km	GSI has identified 3no historical peat landslides within 5km of the proposed wind farm
Evidence of tension cracking or compression features	N/A	None
Evidence of soil creep	N/A	No soil creep observed within proposed construction zone
Cracking / desiccation	N/A	None evident within proposed construction zone

1.4 Mineral Soils Stability, Peat Stability Hazard Assessment and Rock Slope Stability Assessment

1.4.1 Cumulative Risk

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

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

With respect to soil stability both Infinite Slope Analysis (Bromhead 1986) and Rotation Failure in Slopes (Bishop 1955) have been employed to assess the potential risk of soil slope stability at the site of the main infrastructure.

In the case of rock slope stability Bishop 1955 is employed for analysis. Any risk in respect to rock stability has been ruled out as an issue for Cloonanny Wind Farm.

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

1.4.1.1 Preparatory Factors

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

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

- Afforestation of peat areas, reducing water held in the peat body, and increasing potential for formation

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

1.4.1.2 Preconditions

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

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

1.4.1.3 Triggers

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

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

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

Triggers associated with human activities include:

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

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

1.4.1.4 Pre-failure Indicators

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

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

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

Assessment of the risk of peat or mineral soils instability requires the assessment of the effect of these cumulative risk factors. In the case of ***triggers,*** we assume the "worst-case" external environmental impact attributable over a period equivalent to twice the "normal lifespan[2]" and assume that the trigger will be one of those highlighted in bold italic text above, most likely cumulative and loading / weather related. We caveat certain potential triggers such as "blasting", "earthquake", "rapid ground accelerations", "alteration to natural drainage", "*loading of peat mass*", "*digging or dumping*" by the following respective practices:

- Review of historic seismicity, in the context that the British Isles is generally considered very low risk in this respect (Peat and mineral soils).

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[2] 70 years

- Determining whether quarry blasting occurs in the vicinity of the infrastructure, the closest extent to which blasted slopes will encroach on wind farm infrastructure, monitoring of a series of blast activities at the closest wind turbine structures to assess air blast overpressure and peak ground movement. *(This hazard is absent at Cloonanny Wind Farm)*
- The drainage that is recommended is as a default "*non-positive*" primarily so that surface water will not develop significant momentum (Peat and mineral soil environments).
- A competent contractor will undertake the works and understand the risks associated with construction of peatlands and will be capable of maintaining ground stability within all soil types at all times.
- If ground conditions are particularly sensitive, we advocate risk mitigation by suggesting the use of low-pressure plant, at least until construction works are complete. All mitigation measures are included within the CEMP, and will be transposed into task specific construction method statements. We assume our advice will be followed.

A mixture of desktop research, visual assessment, topographic analysis and in-situ testing forms the basis of the screening process used to establish whether Peat Landslide Hazard is a consideration for the Development.
This screening assessment was undertaken in line with the guidance contained in "*Peat Slide Hazard and Risk Assessment Best Practice Guide for Proposed Electricity General Developments*" 2nd Edition, produced by The Scottish Executive & Halcrow Group Ltd (Apr 2017).

Following an initial scoping assessment of the above factors / indicators, a coarse assessment of the hazard ranking for Peat Stability was completed and deployed to assist in the determining the need to consider the site for further, detailed, Peat Landslide Hazard Risk Assessment. This preliminary analysis determined that peat or organic soils in excess of 0.50m thick are not present at the Site. Peat Landslide Hazard is classified as NEGLIGIBLE and no further, more detailed analysis in this respect is required.

1.4.2 Analytical Assessment

The following assessment uses an analytical approach to determine factors of safety to quantify the risks of soil and rock movement and local rotational failure or engulfment of excavations occurring.

1.4.2.1 Soil Slopes

The application of Infinite Slope Stability Analysis be employed to gauge the stability of mineral soils on slopes and for the determination of the relevant Factor of Safety (FoS). As an additional observation, the Stability of Excavations within mineral soils at the site of approved turbine excavations has also been considered. Refer to Appendix B - "Analytical Assessment" for detailed analysis in respect to the above. Results of these analyses are presented in the tables provided following.

Table 1.12A - Analytical assessment of Infinite Slope Stability of Soils

LOCATION	Max Slope (°)	z (m)	Undrained Condition		Dry Condition	
			Cu[3] (kPa)	Factor of Safety Sliding	Cu (kPa)	Factor of Safety Sliding[4]
T01	2.0	3.5	82	**29.21**	10	**3.56**
T02	1.0	3.5	67	**47.70**	10	**7.12**
Substation / Compound	1.0	1.6	52	**80.98**	10	**15.57**

Table 1.12B – Analytical assessment of Rotation Slope Stability of Soils

LOCATION	Cu (kPa)	Maximum Face Height Considered (m)	Factor of Safety Rotational Failure
T01	82	3.5	>1.10
T02	67	3.5	
Substation / Compound	52	1.6	

1.4.2.2 Rock Slopes

Not required. Rock slope instability is not a significant hazard at Cloonanny Wind Farm.

1.4.3 Slope Stability Risk at Main Structures

The following table details the calculation of hazard in relation to soil and soil slope stability at both the proposed wind turbines and the substation.

Table 1.13 – Preliminary Hazard Ranking for each turbine location prior to implementation of Mitigation Measures

Turbine Location	Slope Stability (Soil / Rock) Pre-Mitigation[5]		
	Likelihood	Impact	HAZARD RANKING
T01	2	2	**4**
T02	3	3	**9**
Substation	2	2	**4**

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[3] Minimum in-situ test values used

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

[5] Refer to Tables A1 and B1

Likelihood Rating	Likelihood
1	Highly Unlikely
2	Unlikely
3	Likely
4	Very likely
5	Frequent

Impact Rating	Impact of Risk
1	Low
2	Minor
3	Serious
4	Major
5	Catastrophic

Hazard Ranking	Category
1 to 6	Low
7 to 11	Medium
12 to 25	High

Construction mitigation, where applied in full, will further reduce the risk of soil movement during both the construction and operation phases of the Development.

1.4.4 Recommendations

Construction mitigation, where applied in full, will further reduce the risk of soil movement during both the construction and operation phases of the Development. The following detailed mitigation measures have been provided for inclusion in the CEMP.

1.4.4.1 Construction Mitigation of Risk

General Constraints and Anecdotal Evidence

Analysis of the historic conditions following soil movement indicates that the following main factors generally trigger slope failures:

1. Excessive quantities of spoil loaded onto sensitive topsoil, organic soils or sensitive mineral soils covered sloping ground. (In such cases the gradient of the slope should be no more than an average of 5 degrees to the horizontal). Topsoils and organic soils should always be removed prior to such actions and retained for re-use as landscaping a material.
2. The angle of repose of the cut face of excavations is all too often found to be too high, sometimes 70 – 80 degrees to the horizontal. Battering back the sides of an excavation to approx. 60 degrees in clay soils and 30 degrees in granular soils helps to reduce the potential for slippage, which will significantly reduce the potential for soil movement.
3. Surface water flows will compromise most granular or cohesive soils at any slope angle and care should be taken to stop the development of such flows during construction.
4. The consequences of soil movements can be identified as Damage to Machinery, Damage or Loss of Access Track, Damage to Site Drainage, Site Works Damaged, Death or Injury to Personnel or Degradation to the Environment.
5. An emergency plan is to be prepared, and will be enacted should soil movement occur.

1.4.4.2 Prevention of Landslide

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

1. Excavated spoil will not be deposited on the down slope or up slope edges of the adjacent topsoil. This spoil will instead be deposited on the two flanks either side of the excavation (where gradient is least) and spread in such a way as to limit the surcharge pressure on sensitive topsoils.
2. The hardstanding areas surrounding the turbine bases will be designed in a manner such that crane loadings can be transferred directly onto the competent strata underlying any sensitive mineral soils. In order to facilitate these works it will be necessary to undertake limited excavations. To ensure effective sidewall support during these operations the contractor will adopt an approved engineering solution (such as sheet piling or other bracing method) to maintain sidewall stability at all times.
3. Movement can often occur during or following severe rainstorm events, particularly when following a prolonged dry spell. Extra vigilance will be maintained at such times, during construction.
4. All slopes are to be regularly checked for development of tension cracks indicative of slope movement.
5. Method statements will be followed at all times. Where modification is required this will be agreed by the supervising engineer.
6. Slopes will not be undercut or excavations left unsupported for periods in excess of 24 hours. Excavations are to be backfilled as soon as practicable. Excavation and filling operations shall be coordinated to minimise the time an excavation remains opened.
7. Pore water pressure within excavations should be kept low at all times by draining deliberate or intentional sumps at regular intervals. This is to prevent ponding of water within excavations which can in turn increase hydraulic heads locally and potentially lead to instability.
8. The potential for Soil Movement will be monitored regularly during the construction works, by means of regular site visits and assessments, by a suitably qualified and experienced professional.
9. Only experienced and competent contractors will be appointed to carry out the construction works.
10. Low ground bearing pressure machinery shall be used for transport of construction materials in sensitive areas, where ground conditions dictate its requirement.
11. Construction at less sensitive areas will be completed first to allow suitable construction practices to be established before works commence in the more difficult areas.
12. Site staff will also undergo induction training to learn about the risks associated with working on “upland environments” and procedures aimed at reducing soil movement.
13. Sufficient time should be allowed to carry out the works in a safe and timely manner.

1.4.4.3 Spoil Disposal

Spoil will invariably be generated during excavations for foundations at turbines and along new access roads. Minimisation of the production of this spoil will be treated as a high priority, but it is nevertheless expected that there will be in the region of **32,141m^3** of topsoils and till / rock spoil excavated during site works.

Analysis of topsoil thicknesses indicates a range of 0.0m to > 0.80m across the site, average topsoil thickness of 0.45m within the construction zone and an average peat thickness of 0m for the entire site.

Assuming average topsoil depth prevails across the construction footprint, the volume of topsoil (or semi-organic soils) extracted is estimated to be approximately **15,440m^3**.

Assuming an average depth to competent bearing stratum of 0.75m for access tracks, 0.30m to 1.00m for hardstandings and 5.00m for turbine foundations, the volume of mineral soil / till / rippable weathered rock to be extracted is estimated to be approximately **16,701m^3**.
Spoil types will be treated separately. Till soils and topsoils / organic soils will be separated during excavation and these two types of spoil will be disposed of generally as follows:

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

B *Topsoils / Organic Soils will be stored separately, protected from the environment to maintain their integrity and used to reinstate the minerals soil surfaces following completion of construction works. No topsoil will be disposed of as part of the Development.*

1. Mineral soil spoil disposal will take place at various locations within the wind farm land holding where low surface gradients combine with minimal peat depth and sufficient distance from sensitive receptors. These proposed spoil deposition areas are detail in the Spoil Management planned, containing within the Construction and Environmental Management Plan.

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

3. Preparation of the Spoil Disposal site will involve the removal of the topsoil which will be transferred to a specific location to be stockpiled and maintained for re-use during restoration operations.

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

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

6. Spoil Disposal Sites used will have a regular weekly assessment, made by the construction manager or other suitably qualified individual, to ensure that stability and good condition is maintained.

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

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

Table 1.14 – Hazard – Risk Reducing factors

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

The reduction in risk due to the above measures is discussed below, and the Hazard Rankings have been updated for each location; refer to Table 1.13 for pre-mitigation Hazard Ranking.

1.4.4.5 Post-Mitigation

Implementation of the mitigation measures contained within the previous section (Table 1.14 – Hazard – Risk Reducing Factors) allows the optimal level of risk to be attained at each turbine of the proposed Cloonanny Wind Farm development site.

Table 1.15 – Hazard Ranking for each turbine location following Mitigation Measures

Turbine Location	Slope Stability (Soil / Rock) Pre-Mitigation[6]			Risk Reduction Factors[7]						Slope Stability (Soil / Roc) Post-Mitigation		
	Likelihood	Impact	HAZARD RANKING	A (-0.25)	B (-0.25)	C (-0. 5)	D (-0.5)	E (-0.25)	F (-0.5)	Hazard	Exposure	HAZARD RANKING
T1	2	2	**4**	Y					Y	0.25	4	**1**
T2	3	3	**9**	Y					Y	1.25	4	**5**
Substation	2	2	**4**	Y					Y	0.25	4	**1**

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[6] Refer to Tables 11.1A-D

[7] Refer to Table 1.13 for explanation of the Risk Reduction Factors (A – F)

Hazard Ranking	Category
1 to 6	Low
7 to 11	Medium
12 to 25	High

1.5 Do Nothing Effect

The "Do Nothing Effect" is the effect on the Site should the proposed wind farm not be constructed. In this case, it is envisaged that the current land use would remain as it is now, with continued intensive grazing for cattle and other livestock. Given the nature of the land, being generally pastureland, minor forestry and rough grazing, it is unlikely that any substantial changes in this use will occur in the near future.

Other Do Nothing Effects are detailed in Table 1.16, below.

Table 1.16: Do Nothing Effect

Item	Assessed Element	Assessed Baseline Condition	Anticipated Do Nothing Effect
1	Water Regime – Response to Storm events	Combination of mobile groundwater, low lying setting and close proximity to a water course at site of wind farm infrastructure and portions of access track. Storm events have in the past given rise to the flooding, where the local water course breaks its banks and floods the low-lying lands adjacent lands.	Do Nothing Potential Effect: Negative, direct, moderate / potentially significant, site-wide / potentially regional, conforms to baseline, likely, short term.
2	Water Regime – Erosion, alteration and compaction	Current slopes within the Site are of very low gradient and of limited susceptibility to movement within the direct influence of surface water. Parts of the Site are susceptible to flooding, particularly in the vicinity of turbine T01. This will have a detrimental impact on the soils in terms of quality and composition	Do Nothing Potential Effect: Negative, direct, significant, site-wide / local, conforms to baseline, likely, short term to medium term.
3	General Soil Stability	Peat Stability Assessment indicated negligible hazard of peat landslide. Extant mineral soils reside on low gradient slopes at the site of all significant excavations and ancillary infrastructure and are at very low risk with respect to instability.	Do Nothing Potential Effect: Negative, direct, not significant, site-wide, conforms to baseline, unlikely, short term.
4	Land Contamination	Negligible contamination of nature soils and groundwater was encountered at The Site. Potential for activities to cause contamination remains.	Do Nothing Potential Effect: Negative, direct, moderate, site-wide, conforms to baseline, unlikely, long term.

1.6 Potential Impacts of The Development

1.6.1 Construction Phase

The Proposed Development is characterised by the construction of infrastructure necessary to complete the wind farm as described in **section 4 of the Construction and Environmental Management Plan.**

The EIA also assesses the Works required along the proposed turbine delivery haul route.

The direct and indirect effects of the construction activities, and their expected duration are assessed further in the following sections. The effect on use of land and on natural resources required to carry out the works which relate to soils and geology is also assessed.

The Construction Phase activities that will give rise to effects on soils and geology are listed below: -

- Turbine Construction
- Substation and Battery Energy Storage Site (BESS) Construction
- Crane hard stand and temporary blade lay down hard stand construction
- Temporary construction compound
- Installation of internal cabling
- Installation of grid connection cabling
- Construction of Ste Tracks
- Upgrade Turbine Delivery / Haul Route

These activities will have the following potential effects:

1.6.1.1 Land and Land Use

32,141m3 of topsoil, subsoil and bedrock removal will occur during construction excavations and is an unavoidable consequence of the Proposed Development. This will result in an adverse effect to land capability for agriculture, causing a loss of moderately productive agricultural lands and a small area of forestry.

Removal of the soil (both organic topsoil and mineral soils) and bedrock is considered to be a permanent effect as it would not normally be reversed, although some reinstatement of the agricultural capability is possible after decommissioning.

Table 1.17: Effect Summary – Land and Land Use

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Loss / Change of Land Use	Direct	Negative	Slight	Site	Contrast to baseline	Likely	Permanent

1.6.1.2 Earthworks Activities

Subsoil and bedrock removal will occur during construction excavations and is an unavoidable consequence of the Proposed Development. The operation of removing soils and bedrock increases the potential for contaminating soil movements to occur. Processes such as soil instability, poor spoil handling, compaction and subsidence brought about by earthworks activities, can cause a release of silt into the environment, which can adversely affect local sensitive receptors, such as watercourses and their associated flora and fauna.

1.6.1.2.1 Soil and Bedrock Excavations

Excavations will be required for most aspects of the Proposed Development including for turbines, turbine hardstand areas, substation and BESS, Site access tracks, haul route, Site compound, cable trenches and grid connection route. Estimates of excavation volumes are presented in **Table 4-3 Excavation Volumes** in the **CEMP.**

The superficial soil material encountered at each turbine and infrastructure location during construction, is considered to be, in the main, a combination of Topsoil and Glacial Till (mineral soils). A portion of this material should also be suitable for re-use as construction fill for Site Access Track construction and as “ballast” placement above the turbine foundations.

Significant bedrock excavations are not anticipated. Bedrock was not encountered during the site investigations within the exploratory holes, but was located by the geophysical surveys at depths in excess of 5m below existing ground level.

The use of heavy breakers or blasting will not be required to remove rock at the Site.

Site Access Tracks will be needed to accommodate the construction works and to provide access to the turbine locations for the whole life cycle of the wind farm. The tracks will be constructed using unbound crushed aggregates and incorporate drainage to maintain the performance of the pavement during wet weather. This road pavement will be constructed within the firm glacial till soils, following removal of the overlying topsoil, weak organic soils and soft glacial tills.

The potential effects here are considered to be **significant**, **permanent** and **negative**.

1.6.1.2.2 Haul Route

Haul Routes will use the existing public roads, between Belview Port, Waterford City and the Site, to facilitate the turbine haul route, but will require some temporary alterations. These alterations include temporary widening of sections to the L5046 and L50462 as well as temporary junction accommodation works to the site entrances on the L5046 and the L50462. Refer to **section 4.8** of the **CEMP** for details.

As part of the development, it is proposed to upgrade and temporarily widen the L50462 from the junction of the L5046 for a distance of circa 1km to the main Site Entrance. Following Turbine delivery, the temporary widening will be grubbed up and the area will be reinstated.

Also, as part of the development it is proposed to construct a temporary Access Road to the west of the L5046/ L50462 junction for abnormal load deliveries. Except for abnormal loads, this road will not be used for construction traffic, a removable barrier will be constructed across the entrance points to the road to prevent unauthorised use.

Generally, the effects associated with this will be the same as for the Site access track construction (compaction and settlement where new road surface is laid), but on a very minor scale and reversible. The effects are considered to be **not significant**, **temporary** and **negative**.

1.6.1.2.3 Site Cable Trenches

Cable trenches throughout the Site will be 0.325m wide and excavated to a depth of 0.95m. Topsoil and glacial till soils will be stored separately during construction and any excess remaining after reinstatement will be stored permanently on site. Refer to section **4.7.9** of the **CEMP** for further details.

Imported granular fill will be used to surround the cables, however the majority of the excavated soils will be used for backfill with only minor amounts being removed and used elsewhere for berm landscaping. The effects associated with excavations for cable trenches are considered to be **not significant, permanent and negative.**

1.6.1.2.4 Grid Connection Cable

Grid connection trenches will be excavated along one of the proposed grid connection routes; to Richmond 110kv substation, Longford 38kV substation or the Glebe 38kV substation from where it will connect to the national grid. Refer to **section 4.9 and Appendix B – Grid Connection** of the **CEMP** for further details.

The trenches will be predominantly within roads and verges, of 0.325m in width and to a proposed depth of 0.95m, depending on confirmatory investigations. Excavation of road aggregates, topsoil, topsoil, glacial till and bedrock will be required.

The following gives a summary of each route.

Option 1 - Connection to Existing Richmond 110kV Substation

This connection option consists of connecting the Wind Farm to the national electricity grid via circa 8km of underground 20kV electrical cabling connecting to Richmond 110kV Substation in the townland of Ballykenny, County Longford. The majority of the grid connection will be constructed in public roads.

This connection option also involves crossing of the Camlin River and an Iarnród Éireann Irish Rail line. It is proposed to directional drill these sections of the grid route works. See **Section 4.9.11 of the CEMP**, for details on directional drilling. The remaining sections will be installed in ducts which will be laid in excavated trenches.

Cable trenching along the public road will be carried out in the road verge or in the grassed area on the side of the road where possible. This will depend on the space available in the verge and offset requirements from the existing services. Where there is insufficient space at the edge of the road or in the grassed area to the edge of the road, the cable will be installed in the roadway.

Option 2 – Connection to Existing Longford 38kV Substation

This connection option has been reviewed by the applicant and has been deemed not feasible.

4.9.3 Option 3 – Connection to Existing Glebe 38kV Substation

This connection option consists of connecting the Wind Farm to the national electricity grid via circa 5.9km of underground 20kV electrical cabling connecting to Glebe 38kV Substation in the townland of Lisnamuck, County Longford.

This connection option involves crossing of the Camlin River. It is proposed to directional drill this section of the grid route works. The remaining sections will be installed in ducts which will be laid in excavated trenches.

Cable trenching along the public road will be carried out in the road verge or in the grassed area on the side of the road where possible. This will depend on the space available in the verge and offset requirements from the existing services. Where there is insufficient space at the edge of the road or in the grassed area to the edge of the road, the cable will be installed in the roadway.

The trenches will be backfilled using imported granular material. The excavated material will be disposed of offsite as inert landfill or recycled for use elsewhere. The effects associated with excavations for cable trenches are considered to be **not significant, permanent and negative**.

1.6.1.2.5 Temporary Construction Compound

One temporary construction compound will be employed. The compound, located to the western side of the access track near the Site entrance, is to be the construction phase operations compound.

Construction works will involve the topsoil stripping and levelling of the subsoils within compound footprint and laying of road base materials for the siting of modular offices, stores, parking and material storage.

The potential effects here are considered to be **slight, temporary and negative.**

1.6.1.2.6 Storage and Stockpiles / Spoil Management

It is expected that the majority of spoil generated on Site will be either topsoil, small amounts of organic soils, glacial till or rock. This spoil will be re-used, where possible, as fill around infrastructure and to construct stockpiles / bunds along the edge of site tracks, at the substation and around the edges of the construction compound. Surplus spoil will be disposed to permanent spoil storage separated for topsoil and glacial till / rock materials.

Removal of soil and rock during construction produces spoil that lacks the competence and stability it had before removal. Such spoil represents a hazard to the wider environment where it can be either a potential contaminant, causing siltation of watercourses, or a landslide hazard where earthworks are not managed appropriately.

The handling, management and re-use of excavated spoil material is of importance during the construction phase of the project.

Excavated spoil material will arise from all infrastructure elements of the windfarm (foundations, tracks, hardstands, cabling, grid connection etc.).

Estimated total volumes of material to be excavated are presented in **Table 4-3** of the **CEMP**.

Within the spoil management process there is potential for a moderate negative effect on soil due to erosion of inappropriately handled excavated materials. However, any effects from the handling of excavated materials will be managed through good site practice, as per NRA Guidelines. A robust sediment and erosion plan, greatly reduces the risk of erosion or sediment release to surface waters.

Organic matter loss can occur when wet peat or organic soils are excavated and allowed to dry in the open air. Such material is a major source of carbon and the loss of organic matter leads to an emission source of carbon dioxide (CO2) and nitrogen dioxide (NO2). A Carbon Calculator can be found in Chapter 18: Air Quality and Climate, which addresses the effect of loss of carbon to the atmosphere through the drying out of organic soils excavated as part of the Proposed Development.

Excavated soil and bedrock will be re-used for the construction of Site Access Tracks. No excavated soils will be taken offsite.

Any residual soils that cannot be re-used will be stored at the designated spoil repository. Refer to **Spoil Management Plan, CEMP.**

Table 4-3, CEMP, also provides a breakdown for the amount of spoil retained in stockpiles, re-used and permanently stored.

This process of spoil management will have a **moderate, permanent and negative effect** on the geology and soils.

A general summary of significance for all the individual pre-mitigation effects, associated with subsoil and bedrock removal is presented in **Table 1.18.**

Table 1.18: Effect Summary – Excavation Activities

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Earthworks Activities – Soil Excavations	Direct	Negative	Significant	Site / Regional	Contrast to baseline	Likely	Permanent
Earthworks Activities - Site Haul Route	Direct	Negative	Moderate	Site	Conforms to baseline	Likely	Temporary
Earthworks Activities – Site Cable Trenches	Direct	Negative	Not significant	Site	Contrast to baseline	Likely	Permanent
Earthworks Activities – Grid Connection Cable	Direct	Negative	Not significant	Regional	Conforms to baseline	Likely	Permanent
Earthworks Activities – Temporary Construction Compound	Direct	Negative	Slight	Site	Contrast to baseline	Likely	Temporary
Earthworks Activities – Storage and Stockpiles / Spoil Management	Direct	Negative	Moderate	Site	Contrast to baseline	Likely	Permanent

1.6.1.3 Vehicular Movement

1.6.1.3.1 Overview

Vehicle movement will occur primarily during the construction phase of the wind farm. Construction vehicles will include cranes, excavators, dumper trucks, concrete trucks, private cars (construction personnel).

This process of vehicle movement will have a **significant, negative and permanent effect** on the geology and soils.

1.6.1.3.2 Compaction, Erosion and Degradation

Compaction, erosion and degradation of soils will occur during construction. In general, compacted soils will be excavated during the construction process, and access to soils away from hardstanding areas will be prevented. Ongoing compaction of soils will occur in areas of road construction on alluvial soils, where the effect, under adverse weather conditions, is potentially significant.

Erosion and degradation of exposed soils will also occur during construction where subsoils are stripped of topsoil and exposed to the action of weathering. In general, this will be restricted to the construction footprint for the duration of the construction period only.

These compaction, erosion and degradation effects are also considered to be **significant, permanent and negative**.

1.6.1.3.3 Haul Route and Site Tracks

There will be no material changes to the existing public roads with the exception of temporary widening between the Site entrance and the L50462, where new load bearing surface will be laid alongside the existing public road. This will result in new compaction of the underlying, currently uncompacted, soils, although this will be slight in significance.

Construction of new temporary Access Road to the west of the L5046/ L50462 junction for abnormal load deliveries will also result in compaction of currently uncompacted soils. This effect is considered to be **moderate, permanent** and **negative**.

The effects of compaction associated with heavy vehicle movements along the haul route is considered to be **moderate, temporary** and **negative**.

Vehicle movement along the Site Access Tracks will also result in a compaction of the underlying soils. The effects associated with vehicle movements on the geology and soils along the Site Access Tracks is considered to be **moderate, permanent** and **negative.**

A summary of the pre-mitigation effects associated with vehicle movement is given in **Table 1.19.** overleaf.

Table 1.19: Effect Summary – Vehicular Movement

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Vehicle Movement - Compaction, erosion and degradation of soils arising from vehicular movement	Direct	Negative	Significant	Localised	Contrast to baseline	Likely	Long term / Permanent *(Temporary in the case of widened road grubbed out on completion of construction)*
Vehicle Movement - Subsidence and settlement of newly established and upgraded Site tracks	Direct	Negative	Moderate	Localised	Contrast to baseline.	Likely	Permanent *(Temporary in the case of widened road grubbed out on completion of construction)*

1.6.1.4 Peat Landslide Hazard, Ground Stability and Failure

Ground instability or failure refers to a significant mass movement of a body of soil or rock that would have an adverse effect on the Proposed Development and the surrounding environment.

Peat Landslide Hazard has been screened out as a potential impact on soils and geology as this was not recorded within the footprint of the windfarm infrastructure.

A significant amount of Site Investigation data has been acquired across the Wind Farm site and this data provides confidence on the depth of topsoil, subsoil and subsoil type. Subsoils are logged as mineral soil glacial till deposits comprising sandy, gravelly SILT/CLAY with cobbles and boulders and silty, SAND / sandy SILT.

These subsoils are generally not associated with ground instability or a risk of landslides where the ground slopes are low as they are at the Proposed Development. The overall landslide susceptibility is assessed to be low within the footprint of the Proposed development.

Where the water level is high (e.g. within the flood zone surrounding T02), excavations within the granular soils will quickly become unstable if progressed below the water table. In such cases direct support will be required to maintain stability.

An iterative design involving multiple stages of ground investigations, followed by turbine and infrastructure re-design has been completed in order to avoid the worst of the existing ground conditions.

Site investigations did not record the presence of karst features, below the subsoils which can impact the stability of infrastructure. Given that the underlying rock formation Visean Limestones is known to be soluble, this hazard remains. Construction stage investigations will collect further geotechnical data to inform the appropriate design of foundations in this respect.

The subsurface conditions underlying the different Grid Connection route options have also been assessed. Local ground conditions along the route consist of made ground (bituminous macadam surfacing and granular aggregate road base) overlying glacial till deposits of varying consistency. A short section of the route between the Site and Richmond 110kV substation is underlain by peat and alluvial soils, where it crosses the Camlin River. The consequent effect this will have on stability will has been considered.

Small amounts of hard strata excavation will be required to install the circuits at the scheduled for all routes.

The potential effects associated with ground stability are contained in table 1.20, below

Table 1.20: Effect Summary – Peat Landslide Hazard, Ground Stability and Failure

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Ground Stability and Failure - Stability issues and slope failure (Localised displacement)	Direct or Indirect / Secondary	Negative	Moderate	Localised / Potentially Regional	Contrast to baseline	Likely	Long term / Permanent
Ground Stability and Failure - Stability issues and slope failure (Landslide)	Indirect / Secondary	Negative	Significant	Localised / Potentially Regional	Contrast to baseline	Unlikely	Permanent

1.6.1.5 Soil and Groundwater Contamination

Four industrial processes with active pollution control licences are present within 5km of the Site. However, there are no records of contamination emanating from these facilities nor was any evidence of contamination observed at the Site during the Site Investigation campaign.

These sites also represent a cumulative risk with respect to the development.

Accidental spillage of fuels and other chemicals during construction works is the main pollution risk.

The production of waste materials during construction will be minimised by good site practices and adherence to the waste management section of the CEMP. Refer to the **Construction Environmental Management Plan (CEMP), EMP4 – Fuel, Oil and Chemical Management & EMP15 – Waste Management Plan**.

The following sections present a breakdown of all the possible effects associated with the use of construction plant during the construction process.

1.6.1.5.1 Hydrocarbons

Wherever there are vehicles and plant in use, there is the potential for a direct hydro-carbon release which may contaminate the soil and subsoil. A spill also has the potential to indirectly pollute water, if the soil and subsoil act as a pathway from any source of pollution.

The accumulation of small amounts of fuels and lubricants during routine plant use can also be a significant pollution risk. Hydrocarbons have a high toxicity to humans, flora and fauna including fish and if released is persistent in the environment. Large spills or leaks have the potential to result in significant effects (i.e. contamination of soil, subsoils and pollution of underlying aquifers) on the geological and water environment.

Any spill of fuel or oil would potentially present a **significant, long-term, negative** effect on the soil and geological environment.

1.6.1.5.2 Wastewater and Sanitation

Wastewater / sewerage from the Temporary Construction Compound with be placed in a holding tank, which will be emptied periodically.

Chemicals will be used to reduce odours. The waste will be taken to a local wastewater sanitation plant for treatment. Wastewater or sewerage leakage may occur but will be small, localised and short-term.

The effects associated with wastewater and sewerage is considered to be **moderate, temporary** and **negative**.

Table 1.21: Effect Summary – Soil and Groundwater Contamination

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Soil and Groundwater Contamination - Hydrocarbons	Direct or Indirect / Secondary	Negative	Significant	Localised / Potentially Regional	Contrast to baseline	Unlikely	Long term / Permanent
Soil and Groundwater Contamination – Wastewater and Sanitation	Direct or Indirect / Secondary	Negative	Moderate	Localised / Potentially Regional	Conforms to baseline	Likely	Temporary

1.6.1.6 Sites of Geological Heritage

There are a number of geological heritage sites mapped proximal to the Proposed Development. These are located as follows: -

- LD007 Creeve Quarry (3 km South East)
- LD011 Killoe Quarry (4.5km North East)
- LD009 Glen Lodge Stream (6.5km North West)

- LD008 Drumlish Quarry (9.5km North East)
- LM022 Lough Rinn Drumlins (11.5km North)
- RO022 Mid Roscommon Ribbed Moraines (17.5km North West)

All of these geological heritage sites have been screened out for potential impacts on soils and geology, as they are located too distant from the Proposed Development for any direct or indirect impact on soils and geology to occur.

Table 1.22: Effect Summary – Sites of Geological Heritage

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Degradation of Quality of Sites of Geological Heritage caused by emissions / pollution from the Proposed Development	Direct / Indirect	Negative	Imperceptible	Regional	Contrast to baseline	Unlikely	Long term / Permanent

1.6.1.7 Sites of Designated Importance

There are a number of sites of designated importance mapped proximal to the Proposed Development. These are located as follows: -

- Carrickglass NHA (Ref 001822 – 850m South East
- Royal Canal Proposed NHA (Ref 002103 – 3.4km South West)
- Section of the Camlin River designated as Nutrient Sensitive, according to the Urban Waste Water Directive (Ref 1994 – 3.6km South West)
- Lough Forbes Complex SAC / NHA (Ref IE0001818 – Habitats – 4.7km West)
- Ballykelly Fisherstown Bog SPA (Ref: IE0004101 – Birds – 4.7km West)
- Derrymore Bog Proposed NHA (Ref: 000447 – 4.9km South)
- Brown Bog Proposed SAC / NHA (Refs: IE0002346 & 00042) – 5km South West)

All of these designated sites, with the exception of the Carrickglass NHA have been screened out for potential impacts on soils and geology, as they are located too distant from the Proposed Development for any direct or indirect impact on soils and geology to occur.

The following Table details the Pre-Mitigation Potential Effects for the closest of these sites, Carrickglass NHA, where the potential effect is greatest

Table 1.23: Effect Summary – Sites of Designated Significance

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Degradation of Quality of Sites of Sites of Designated Importance caused by emissions / pollution from the Proposed Development	Direct / Indirect	Negative	SIgnificant	Local / Regional	Contrast to baseline	Unlikely	Long term / Permanent

1.6.1.8 Turbine Delivery Route / Haul Route

Refer to Section 1.6.1.2.2 for details regarding enabling works to be undertaken. This section looks at effects caused to the existing soils and geology by increased traffic and axle loading on the route and relates to excessive compaction, settlement and subsidence.

The effects associated with soils and geology in respect to the turbine delivery route / haul route are given in **table 1.24**, below.

Table 1.24: Effect Summary – Turbine Delivery Route

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Turbine Delivery Route	Direct	Negative	Moderate	Localised / Regional	Conforms to baseline	Likely	Long term / Permanent

1.6.1.9 Waste Materials

1.6.1.9.1 Construction Spoil

All construction materials will be stored in secure areas. Any hazardous materials will be correctly stored within properly bunded areas in accordance with good Site practice as described in the IWEA and Scottish Best Practice Guidelines and in accordance with the CEMP.

The effects associated with the use of construction materials are considered to be **moderate, permanent** and **negative**.

1.6.1.9.2 General Waste

All construction and operation waste materials will be correctly sorted, recycled or disposed of practice as described in the IWEA and Scottish Best Practice Guidelines and in accordance with the CEMP. A policy of Reduce, Reuse and Recycle will apply.

The effects associated with waste materials is considered to be **slight, permanent** and **negative**.

In summary, the Proposed Development has the potential to give rise to the following pre-mitigation soil contamination effects, shown in **Table 1.25** below:

Table 1.25: Effect Summary – Waste Materials

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Waste Materials – Construction Spoil	Direct	Negative	Moderate	Localised*	Contrast to baseline	Likely	Long term / Permanent
Waste Materials – General Waste	Direct	Negative	Slight	Localised*	Contrast to baseline	Unlikely	Temporary

1.6.2 Health Effects

Potential health effects arise mainly through the potential for soil, rock and groundwater contamination. The Proposed Development is not a recognised source of pollution and so the potential for effects during the operational phase are negligible.

Hydrocarbons will be used on site during construction; however, the volumes will be small in the context of the overall scale of The Site and will be handled in accordance with best practice mitigation measures.

The potential residual impacts to human health associated with soil, hydrocarbon or groundwater contamination are long term, permanent and negative.

1.6.3 Operational Phase Potential Effects

The direct and indirect effects of the operational phase of The Project is assessed in the following sections.

1.6.3.1 Land and Land Use

No further effect on land use is envisaged during the operational phase of the development.

1.6.3.2 Earthwork Activities

Subsoils and bedrock removal during the operational phase can be further categorised as Excavations and laying / upgrading of Haul Route and Site Tracks.

1.6.3.2.1 Soil and Bedrock Excavations

No significant new excavations will be undertaken during the operational phase of The Project, although minor works will be undertaken. Any excavation works carried out, during the operational phase, will be limited to that associated with maintenance of the infrastructure and will be both minor and constrained within the original construction footprint.

The effects are considered to be **not significant**, **temporary** and **negative**.

1.6.3.2.2 Haul Route

The Site Track network and sections of the haul route will still be employed during the operational phase of The Project. However, this usage will be significantly less than during construction and on an ad hoc basis depending on maintenance or operational requirements.

The effects are considered to be **slight**, **permanent** and **negative**.

1.6.3.2.3 Storage and Stockpiles / Spoil Management

Only minor spoil management works associated with ad hoc maintenance will be undertaken during the operational phase of The Project.

These effects are considered to be **not significant, permanent and negative.**

1.6.3.3 Vehicular Movement

Only limited vehicle movement will occur during the operational phase of The Project. These vehicles will include cranes, excavators, dumper trucks, concrete trucks, private cars (operational personnel).

As with during construction, compaction of soils will occur during the operational phase, but to a very limited extent. Compaction of soils will continue below the road base, as the sub soils continue to consolidate.

The effects associated with vehicular movement are considered to be **slight, permanent and negative.**

1.6.3.4 Peat Landslide Hazard, Ground Stability and Failure

No additional effect on land use is envisaged during the operational phase of the development.

The ongoing potential for ground instability or failure will be **slight, permanent and negative.**

1.6.3.5 Soil and Groundwater Contamination

Use of waste materials during the operational phase of The Project will be minimised by established site practices and waste management.

As for the construction phase, wherever there are vehicles and plant in use, there is the potential for a direct hydro-carbon release which may contaminate the soil and subsoil. A spill has the potential to indirectly pollute water, if the soil and subsoil act as a pathway from any source of pollution.

Any spill of fuel or oil would potentially present a **significant, long-term, negative** effect on the soil and geological environment.

During the operational phase wastewater/sewerage from the Substation Building Compound with be placed in a holding tank, which will be emptied periodically. Chemicals will be used to reduce odours. The waste will be taken to a local wastewater sanitation plant for treatment. Wastewater or sewerage leakage may occur but will be small, localised and short-term.

The effects associated with wastewater and sewerage is considered to be **slight, temporary and negative**.

1.6.3.6 Sites of Geological Heritage

No further effect on Geological Heritage is envisaged during the operational phase of the development.

1.6.3.7 Sites of Designated Importance

No further effect on Geological Heritage is envisaged during the operational phase of the development.

1.6.3.8 Waste Materials

1.6.3.8.1 Operational Waste

All materials required for the operation of the Wind Farm will be stored in secure areas. Any hazardous materials will be correctly stored within properly bunded areas in accordance with good Site practice as described in the IWEA and Scottish Best Practice Guidelines and in accordance with the Standard Operating Procedure. The effects associated with the operational materials is considered to be **slight, permanent** and **negative**.

1.6.3.8.2 General Waste

All operational waste materials will be correctly sorted, recycled or disposed of, as described in the IWEA and Scottish Best Practice Guidelines, and in accordance with the Standard Operating Procedure. A policy of Reduce, Reuse and Recycle will apply. The effects associated with waste materials is considered to be **slight, permanent** and **negative**.

The Proposed Development has the potential to give rise to the following effects during the operational phase. Refer to **Table 1.26** below:

Table 1.26: Effects Summary – Operational Phase

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Land and Land Use	Direct	Negative	Imperceptible	Localised	Contrast to baseline	Likely	Long term / Permanent
Earthworks Activities	Direct	Negative	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
Vehicle Movement	Direct	Negative	Slight	Localised*	Contrast to baseline	Unlikely	Long term / Permanent
Peat Landslide Hazard, Ground Stability and Failure	Direct	Negative	Slight	Localised*	Contrast to baseline	Unlikely	Permanent
Soil and Groundwater Contamination	Direct	Negative	Significant	Localised / Potentially Regional	Contrast to baseline	Unlikely	Long term / Permanent
Operational Materials	Direct	Negative	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
General Waste	Direct	Negative	Slight	Localised	Contrast to baseline	Likely	Permanent

1.6.4 Decommissioning of the Wind Farm

In general, the potential effects associated with decommissioning will be similar to those associated with construction, but of reduced magnitude because extensive excavation and wet concrete handling will not be required. The potential environmental effect of soil storage and stockpiling and contamination by fuel leaks will remain during the decommissioning period.

Refer to **Table 1.27** for Decommissioning Phase Effects.

Table 1.27: Effects Summary –Decommissioning Phase

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Land and Land Use	Direct	Positive	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
Earthworks Activities	Direct	Negative	Moderate	Localised*	Contrast to baseline	Likely	Long term / Permanent
Vehicle Movement	Direct	Negative	Moderate	Localised*	Contrast to baseline	Unlikely	Long term / Permanent
Peat Landslide Hazard, Ground Stability and Failure	Direct	Negative	Moderate	Localised*	Contrast to baseline	Unlikely	Permanent
Soil and Groundwater Contamination	Direct	Negative	Significant	Localised	Contrast to baseline	Unlikely	Long term / Permanent
Turbine Delivery Route	Direct	Negative	Moderate	Localised / Potentially Regional*	Conforms to baseline	Likely	Temporary
Decommissioning Spoil	Direct	Positive	Moderate	Localised*	Contrast to baseline	Likely	Long term / Permanent
General Waste	Direct	Negative	Slight	Localised	Contrast to baseline	Unlikely	Permanent

1.6.5 Cumulative Effects

Cumulative effects of the Proposed Development with other developments in the region, as discussed in "**Cumulative Assessment, Cloonanny Windfarm" Sept 2024**, relate to the indirect effects that may arise due to the use of public roads as haul routes to bring construction materials to Site and the cumulative effect on the use of natural resources.

The following activities are present within the local area and give rise to cumulative effects.

These activities are as follows: -

Planning Applications

1. Solar Farm at Ballykenny, Co Longford, located c. 6km west of the proposed development (Planning Application - Permission Granted)
2. Solar Farm at Cleggil Co Longford, located c. 4.5km west of the proposed development (Planning Application - Permission Granted)
3. Bloomfield Park SHD at Bracklin Road, Edgeworthstown, Road Co Longford, located ca. 11km south east of the proposed residential development of 100 homes (Planning Application – Permission Granted)
4. An application for a single wind turbine in Lissanore, Co Longford, ca. 14 km southeast of the subject site, currently under appeal
5. An amendment application for 2 Turbines at Roxborough, Co Roscommon, c. 27km west of the site has been refused by the Planning Authority in 2024
6. An application for the Derryadd Windfarm (c. 12km southeast of the site) has been granted by ABP in 2020. The decision has subsequently been quashed by Order of the High Court in 2022. However, it is understood that the applicant is currently in the progress to prepare a new application at this site
7. Lissanore, Co Longford. Permission for the construction of one 4.2MW wind turbine. Permission Granted 2024.
8. Roxborough, Co Roscommon. Permission refused for 2 no. 4.9MW wind turbines

Operational Activities

1. Sliabh Bawn Wind Farm at Strokestown, Co Roscommon. 20nr 3.2MW turbines (Operational)
2. Quarry at Rhine, Killoe, Co Longford, located c. 4.5km north west of the proposed development (Operational – New Planning Application in Progress)

Rhine Quarry and Sliabh Bawn Wind Farm have been assessed to be potential cumulative effects to the Proposed Development with respect to Vehicle Movement. As such, there will be a **moderate, negative and temporary** cumulative effect, caused mainly by increased vehicle traffic, during the construction and decommissioning phases of the project. During the Operational phase there will be a s**light, negative and long-term** cumulative effect**.**

During the construction of the proposed project there will be the requirement for the importation of engineered fill from source quarries. Should these coincide with demand for imported aggregate for maintenance works at the existing Sliabh Bawn Wind Farm or construction of any of the projects currently in planning, there would a cumulative impact in terms of demands placed on local quarries for aggregate.

As such, it is considered there will be a **moderate, negative** and **temporary** cumulative effect, caused by this issue, during the construction and decommissioning phases of the project.

During the operational phase this effect will reduce to a **slight, negative** and **long-term** cumulative effect.

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1.7 Mitigation Measures and Residual Effects

This chapter outlines the main mitigation measures which will be applied to the Development in order to reduce the effects of the effects outlined previously.

1.7.1 Design Phase

With regard to the proposed project, design and best practice has been and will be implemented as follows:

The primary mitigation measure employed has been the design of the wind farm in terms of locating the turbines, access roads, material storage areas and other site infrastructure on agricultural lands and minor forestry, where the soils are extensively worked and drained, so as to be remote from residential and sensitive commercial properties.

In order to reduce the impacts on soils and geology infrastructure has also been positioned within areas where organic soils are absent and slope gradients are low. Infrastructure has also been moved away from designated watercourses and other sensitive features.

Extensive work has already been undertaken at the preliminary design stage to apply risk avoidance by design and include the following:

- Extensive peat probing to screen for the presence of peat or other organic soil deposits across the site and layout takes this into account for the purpose of placement of wind farm infrastructure. No significant wind farm infrastructure will be constructed within 100m of peat bog of thickness greater than 0.50m.
- Excavation of trial pit and undertaking of geophysical surveys to establish overburden and bedrock characteristics at the main structures.
- Relocation and micro-siting of turbines, hardstandings, access roads and other infrastructure based on the site assessments and geotechnical assessments in order to reduce ground risk associated with the proposed project.
- Works have been designed and checked by geotechnical engineers, who are suitably qualified and experienced in excavation and earthworks design and construction methodologies.

The following additional works will also be implemented:

- Any excavation and construction related works will be subject to a design risk assessment at detailed design stage to determine risk levels for the construction, operation and maintenance and decommissioning of the works. Identified impacts will be minimised by the application of principles of avoidance, prevention and protection. Information on residual impacts will be recorded and relayed to appropriate parties
- Detailed method statements for each element of the works will be prepared by the Contractor prior to any element of the work being carried out.
- Given that the works comprise a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works.

- The Contract will require programming of the works such that earthworks are not scheduled during severe weather conditions.

1.7.2 Construction Phase

The following sections outline appropriate mitigation measures to avoid or reduce the potential effect of the Proposed development during the construction phase.

1.7.2.1 Construction and Environmental Management Plan

A **Construction Environmental Management Plan (CEMP)** has been prepared for The Project. This **CEMP** defines the work practices, environmental management procedures and management responsibilities relating to the construction phase of the proposed project.

The CEMP also sets out the key environmental management measures associated with the construction, operation and decommissioning of the proposed wind farm, to ensure that during these phases of the development, the environment is protected, and any potential impacts are minimised.

The final CEMP will be developed further at the construction stage, on the appointment of the main contractor to the project to address the requirements of any relevant planning conditions, including any additional mitigation measures that are conditioned and shall be submitted to the planning authority.

Reference to relevant sections of the CEMP with respect to the mitigation of potential effects to Soils and Geology from the proposed project are outlined in the following sections.

1.7.2.2 Land and Land Use

No mitigation is proposed.

1.7.2.3 Earthworks Activities

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

Ground conditions vary across the site with varying depths of soil cover. At the proposed turbine bases, excavation required is anticipated to be up to 5.00m to a suitable bearing stratum for emplacement of turbine foundations.

The project will be constructed in a phased manner in order to reduce the potential effects of The Project on the Soils and Geology. Phased construction reduces the amount of open, exposed excavations at any one time.

Given that the works comprises a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be deployed on site to supervise the works.

Details of the proposed methodology and mitigation measures are summarised below and are also outlined in the CEMP.

One of the primary mitigation measures employed at the preliminary design stage was the minimisation of volumes of excavated overburden deposits to be exported off site. All excavated overburden will be retained on-site.

This will include:

- Use of suitable site won material (selected overburden / granular and cohesive mineral soils) as general fill in the construction of access tracks, hardstands and in reinstatement around turbine foundations.

- Surplus overburden will be re-used on site in the form of landscaping and for reinstatement purposes at the existing on-site borrow pit.

- Residual surplus overburden will also be stored at a permanent spoil repository. Refer to **the Spoil Management Plan** (CEMP) for details.

Surplus overburden deposits excavated during the course of the works will be temporarily stored in designated areas adjacent to the construction phase excavations prior to reuse.

Some temporary stockpiles (not exceeding 2m in height) of material will be necessary adjacent to the excavation areas prior to reinstatement. No surplus/waste soil or rock will be removed from the proposed project site.

Temporary stockpiles will be shaped and sealed to prevent the ingress of water from rainfall.

To mitigate against the compaction of soil at the site, prior to the commencement of any earthworks, the work corridor will be demarcated, and machinery will stay within this corridor so that soils outside the work area are not damaged.

Excavations will then be carried out from access tracks as they are constructed in order to reduce the compaction of soft or otherwise sensitive ground.

1.7.2.4 Vehicular Movements

Vehicular movements will be restricted to the footprint of the Proposed Development, particularly with respect to the newly constructed Site Access Tracks. This ensures that machinery must be kept on tracks and will not move onto areas that are not permitted.

Vehicular traffic on Site will be minimised through the re-use of excavated material on Site which will reduce the need to source material from external quarries.

As discussed previously, excavation volumes have been reduced during the design phase by avoiding areas of sensitive or soft soils and by avoiding excessive cut and fill during construction. This will result in reduced excavation volumes and therefore reduced Site traffic.

Best practice as described in the IWEA and Scottish Best Practice Guidelines will be applied during construction which will minimise double handling, again reducing the Site traffic.

All works will be managed and carried out in accordance with the Construction Environmental Management Plan, which will be updated by the civil engineering contractor and agreed prior to any Site works commencing.

1.7.2.5 Soil Contamination

Careful design of the wind farm has reduced the amount of Site traffic required on Site by reducing access tracks lengths, excavation volumes and double handling. Similarly, good Site practice and a robust CEMP will also result in less traffic and a lower potential for fuel spills and leakages.

The CEMP (refer to **EMP1, EMP3, EMP4 and EMP5**) requires the checking of assets (plant, vehicles, fuel bowsers) on a regular basis during the construction phase of the Proposed Development. The purpose of this management control is to ensure that the measures in place are operating effectively, prevent accidental leakages, and identify potential breaches in the protective retention and attenuation network during earthworks operations.

Fuel management procedures (**EMP4 – Fuel, Oil and Chemical Management**) will include the following elements:

- Mobile bowsers, tanks and drums will be stored in secure, impermeable storage area, away from drains and open water;
- Fuel containers will be stored within a secondary containment system e.g. bund for static tanks or a drip tray for mobile stores;
- Ancillary equipment such as hoses, pipes will be contained within the bund;
- Taps, nozzles or valves will be fitted with a lock system;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- Only designated trained operators will be authorised to refuel plant on Site.

The emergency response plan, as detailed in the **EMP 11 – Emergency Response Plan**, has been developed in order to deal with any emergency accidents or spills. In particular an emergency spill kit with oil boom and absorbers will be kept on Site in the event of an accidental spill. All Site operatives will be trained in its use. In addition, all vehicles will also contain emergency spill kits.

1.7.2.6 Ground Stability and Failure

As discussed previously, careful design of the wind farm has reduced the amount of construction required in areas of sensitive or soft soils, high slopes and other areas of potential ground instability.

With regard to slope stability issues, detailed design and construction phase best practice will be implemented as follows:

- The works will be supervised by a suitably qualified and experienced geotechnical engineer or engineering geologist, and hydrologist or drainage engineer.

- Drainage infrastructure will be put in place in advance of excavations. Drains will divert surface water and groundwater away from excavations into the existing and proposed surface drainage network. Uncontrolled, direct and concentrated discharges of water onto the ground surface will be avoided.

- Loading or stockpiling of materials on the surface of soft ground will be avoided. Loading or stockpiling on other deposits will not be undertaken without first establishing the adequacy of the ground to support loads by an appropriately qualified geotechnical engineer experienced in construction within upland conditions. No stockpiling of material shall take place on slopes greater than 5 degrees to the horizontal. The height of temporary stockpiles will not exceed 2m.

- Turbines located in areas adjacent to peat deposits will incorporate drainage measures such that surface water will be drained away from the peat and will not be allowed to collect adjacent to the peat mass.

- Excavation will be carried out from access roads or hardstanding areas to avoid tracking of construction plant across areas of soft ground/peat.

- An assessment of the stability at proposed infrastructure locations has been carried out as part of this EIAR based on worst case conditions. A further assessment will be undertaken at detailed design stage.

- Blasting of rock will not be permitted.

- Excavations which could have the potential to undermine the up-slope component of an existing slope will be sufficiently supported to resist lateral slippage and careful attention will be given to the existing drainage.

- Earthworks will not be commenced when heavy or sustained rainfall is forecast. A rainfall gauge will be installed on site to provide a record of rainfall intensity. An inspection of site stability and drainage by the Geotechnical Engineer will be carried out on site when a daily rainfall of over 25mm is recorded on site, works will only recommence after heavy rain with the prior approval of the Geotechnical Engineer following inspection.

The Construction Environmental Management Plan (**EMP 11 – Emergency Response Plan)** includes an emergency response to be applied in the unexpected event of a landslide or ground instability. In particular, catch fences and other physical barriers (i.e. concrete blocks) will be on Site and available in sufficient quantities to be used in the event of ground instability.

1.7.2.7 Material and Waste Management

All materials used on Site and wastes generated on Site will be reduced by good Site practice and attention to the CEMP (**EMP15 – Waste Management Plan)**. A policy of reduce, re-use and recycle will apply.

All waste will be segregated and re-used where possible or removed from Site for recycling. Any waste which is not recyclable or compostable will be properly disposed to landfill.

Whenever possible, excavated spoil materials will be re-used close to the area of excavation. The careful design which has been achieved will result in minimal excess soil and rock.

1.7.2.8 Construction Phase Residual Effects

The residual effects after implementation of all mitigation measures for the construction phase of the Proposed Development are presented in **Table 1.28**.

Table 1.28: Construction Phase Residual Effect Summary

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Loss / Change of Land Use	Direct	Negative	Slight	Site	Contrast to baseline	Likely	Permanent
Earthworks Activities – Soil Excavations	Direct	Negative	Slight	Site	Contrast to baseline	Likely	Permanent
Earthworks Activities - Site Haul Route	Direct	Negative	Not significant	Site	Contrast to baseline	Likely	Temporary
Earthworks Activities – Site Cable Trenches	Direct	Negative	Not significant	Site	Contrast to baseline	Likely	Permanent
Earthworks Activities – Grid Connection Cable	Direct	Negative	Not significant	Regional	Contrast to baseline	Likely	Permanent
Earthworks Activities – Temporary Construction Compound	Direct	Negative	Slight	Site	Contrast to baseline	Likely	Temporary
Earthworks Activities – Storage and Stockpiles / Spoil Management	Direct	Negative	Slight	Site	Contrast to baseline	Likely	Permanent
Vehicle Movement - Compaction, erosion and degradation of soils arising from vehicular movement	Direct	Negative	Slight	Localised	Contrast to baseline	Likely	Long term / Permanent
Vehicle Movement - Subsidence and settlement of newly established and upgraded Site tracks	Direct	Negative	Slight	Localised	Contrast to baseline.	Likely	Permanent
Ground Stability and Failure - Stability issues and slope failure arising from vehicular movement (Localised displacement)	Direct or Indirect / Secondary	Negative	Slight	Localised / Potentially Regional	Contrast to baseline	Likely	Long term / Permanent
Ground Stability and Failure - Stability issues and slope failure arising from vehicular movement (Landslide)	Indirect / Secondary	Negative	Slight	Localised / Potentially Regional	Contrast to baseline	Unlikely	Permanent
Soil and Groundwater Contamination - Hydrocarbons	Direct or Indirect / Secondary	Negative	Slight	Localised / Potentially Regional	Contrast to baseline	Unlikely	Long term / Permanent
Soil and Groundwater Contamination – Wastewater and Sanitation	Direct or Indirect / Secondary	Negative	Slight	Localised / Potentially Regional	Contrast to baseline	Unlikely	Long term / Permanent

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Quarry Blasting – Structural Integrity	Direct	Negative	Slight	Localised	Conforms to baseline	Likely	Long term / Permanent
Quarry Blasting – Site Users Health and Safety	Direct or Indirect / Secondary	Negative	Moderate	Localised	Conforms to baseline	Likely	Temporary
Degradation of Quality of Sites of Geological Heritage caused by emissions / pollution from the Proposed Development	Direct / Indirect	Negative	Imperceptible	Regional	Contrast to baseline	Unlikely	Long term / Permanent
Degradation of Quality of Sites of Sites of Designated Importance caused by emissions / pollution from the Proposed Development	Direct / Indirect	Negative	Imperceptible	Regional	Contrast to baseline	Unlikely	Long term / Permanent
Turbine Delivery Route	Direct	Negative	Not significant	Localised / Regional	Conforms to baseline	Likely	Long term / Permanent
Waste Materials – Construction Spoil	Direct	Negative	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
Waste Materials – General Waste	Direct	Negative	Slight	Localised	Contrast to baseline	Unlikely	Temporary

1.7.3 Operational Phase

It is not envisaged that the operation of The Project will result in significant impacts on the Soils and Geology regime within the study area, as there will be no further disturbance of overburden postconstruction.

The main potential impact during the operation phase would be the risk to groundwater from contamination from spills. Storage tanks, used to store fuel for the various items of machinery, will be self-contained and double-walled. Refuelling of maintenance vehicles will be carried out from these tanks or from delivery vehicles at designated refuelling areas. Specific mitigation measures relating to the management of hydrocarbons are as follows:

- Fuels, lubricants and hydraulic fluids for equipment used on the site will be carefully handled to avoid spillage.

- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained, and the contaminated soil removed from the site and properly disposed of;

- Waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for recycling and

- Appropriate spill control equipment, such as oil soakage pads, will be kept within the refuelling areas and in each item of plant to deal with any accidental spillage.

All wastes from the substation, battery storage and ancillary facilities will be removed by the appropriate contractor. The operational team will carry out maintenance works (to Site Access Tracks, Substation, Battery Energy Storage and Turbines) and will put in place control measures to mitigate the risk of hydrocarbon or oil spills during the operational phase of the windfarm. Any vehicles utilised during the operational phase will be maintained on a weekly basis and checked daily to ensure any damage or leakages are corrected.

Due to the reduced magnitude of the effects, no additional mitigation measures are required for the maintenance and operation of the wind farm, over and above those incorporated into the design of the substation transformers and batteries, which will be bunded to protect soils against accidental leakages of oils and battery fluids.

These potential effects are limited by the size of the fuel tank of vehicles used on the Site. Additional potential effects will occur in the event that a turbine needs replacement. The effects associated with this will be similar to those involved for vehicles movements during construction but much reduced.

There are no other effects relating to soils and geology during the operational phase of the Proposed Development.

1.7.3.1 Operational Phase Residual Effects

The potential effects on the soil and geological environment during the operational phase of the work will be mitigated through good Site practice as described in the IWEA and Scottish Best Practice Guidelines; vehicular movements, hydrocarbon controls, sustainable use of natural resources, human health etc. as discussed previously.

Overall, the residual effects from these aspects will have a **not significant, permanent, negative** effect on the Site.

The residual effects after implementation of all mitigation measures for the operational phase of the Proposed Development are presented in **Table 1.29**.

Table 1.29: Operational Phase Residual Effect Summary

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Land and Land Use	Direct	Negative	Not Significant	Localised*	Contrast to baseline	Likely	Long term / Permanent
Earthworks Activities	Direct	Negative	Not Significant	Localised*	Contrast to baseline	Likely	Long term / Permanent
Vehicle Movement	Direct	Negative	Slight	Localised*	Contrast to baseline	Unlikely	Long term / Permanent
Ground Stability and Failure	Direct	Negative	Slight	Localised*	Contrast to baseline	Unlikely	Permanent
Soil and Groundwater Contamination	Direct	Negative	Not significant	Localised	Contrast to baseline	Likely	Long term / Permanent
Turbine Delivery Route	Direct	Negative	Not significant	Localised / Potentially Regional*	Conforms to baseline	Likely	Long Term
Operational Materials	Direct	Negative	Not significant	Localised*	Contrast to baseline	Likely	Long term / Permanent
General Waste	Direct	Negative	Not significant	Localised	Contrast to baseline	Likely	Permanent

1.7.4 Decommissioning and Restoration Phases

Following the permitted lifespan of the wind farm, decommissioning of the infrastructure will occur or the Site may be repowered with more modern turbines, subject to a separate planning application. **Refer to Decommissioning and Reinstatement Plan, June 2024 for details.**

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant.

Access Tracks

In terms of the access tracks, the stone imported to the site for use in their construction be removed from site and recycled for use as road base material in line with best environmental practices. The subsoil, if present, shall be aerated and a layer of topsoil material gained during the construction of the project will be spread over the excavated area and this will either be encouraged to regenerate from the seed-bank within the topsoil or reseeded with an appropriate seed mix of local native species and land use.

The area will be profiled to match the existing contours and to prevent ponding of rainwater. The developer will monitor the re-growth of vegetation and if necessary appropriate actions will be taken to ensure full re-growth.

An alternative option that may be explored with the consent of the Planning Authority at the time of decommissioning is to leave the roads on site if the land use at time of decommissioning would benefit from doing so. The option is commonly favourable among farmers as it gives access to areas that would not normally be accessible. This option reduces the amount of excavation works required and minimizes the disruption to the surrounding area during decommissioning.

Turbines and Hardstands

Following removal of the turbines, turbine bases and hardstand materials, the overburden shall be spread over the area of both the turbine foundation and hardstand. Any additional subsoil removed and stored during the construction of the bases shall be returned to the area and the original contours restored.

The alternative to complete removal of the turbine foundation is partial removal of the turbine foundation. The turbine foundation is made up of two sections/parts, the lower base and the upper base. With partial removal of the turbine foundation the upper base is removed to a depth of approximately 0.7 meters below ground level and the lower part of the base is left in place. The remaining foundation will be covered by soil and re-sodded with the same vegetation as exists in the surrounding area. This option reduces the amount of excavation works required and minimises the disruption to the surrounding area

Substation and BESS

The internal cables will be pulled back through the ducting and wound onto cable reels and removed from site for re-use elsewhere or recycled as appropriate. The ducting will be left in situ.

The modular substations and BESS units will be dismantled and removed from site. The area will then be reinstated and revegetated.

Grid connection infrastructure including substations and ancillary electrical equipment shall form part of the national grid and will be left in situ. Removal of this infrastructure would result in considerable disruption to the local environment in terms of increased sedimentation, erosion, dust, noise, traffic and an increased possibility of contamination of the local water table.

However, if removal is deemed to be required by the respective local authority all infrastructure will be removed with mitigation measures similar to those during construction being employed.

General

Areas of excess soil and rock will be reused in order to match the surrounding land as near as possible. Drainage and slopes will be restored as close to the original ground as possible.

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures outlined above.

1.7.4.1 Decommissioning Phase Residual Effects

The residual effects associated with decommissioning includes waste generation, hydrocarbon leakage and erosion of soil and rock. In general, effects will be similar to those at construction, but of a greatly reduced magnitude.

On completion of reinstatement works, it is expected that the wind farm will be returned as close to its present condition as possible. In particular, areas where local drainage has been altered will be reinstated.

Refer to **Table 1.30** for Decommissioning Phase Residual Effects.

Table 1.30: Decommissioning Phase Residual Effect Summary

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Land and Land Use	Direct	Positive	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
Earthworks Activities	Direct	Neutral	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
Vehicle Movement	Direct	Negative	Slight	Localised*	Contrast to baseline	Unlikely	Long term / Permanent
Peat Landslide Hazard, Ground Stability and Failure	Direct	Negative	Slight	Localised*	Contrast to baseline	Unlikely	Permanent
Soil and Groundwater Contamination	Direct	Negative	Slight	Localised	Contrast to baseline	Likely	Long term / Permanent

Effect Description	Type	Quality	Significance	Extent	Context	Probability	Duration / Frequency
Turbine Delivery Route	Direct	Negative	Slight	Localised / Potentially Regional*	Conforms to baseline	Likely	Temporary
Decommissioning Spoil	Direct	Positive	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
General Waste	Direct	Positive	Slight	Localised	Contrast to baseline	Likely	Permanent

1.9 Monitoring

All drainage systems will be properly maintained at regular intervals.

Excavations, slopes, disposal sites and roads will be inspected regularly for signs of movement and where possible, early warning systems should be established.

Regular analysis of watercourses will be undertaken.
All activity on site and at boundaries will be monitored and a register kept.

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

1.10 Conclusion

The proposed wind farm presents a low risk to soils and geology related aspects of the existing environment following successful adherence to the mitigation measures contained within this report. This will allow for the optimal level of risk to be attained during the construction and operation of Cloonanny Wind Farm, with respect to soils and geology.

The hazard of peat landslide is avoided due to the minimal quantities of organic soils present.

Standard methods of excavation and construction, such as excavation of topsoil so that the site access road base can be founded directly onto the underlying mineral soils, remains the optimal approach. The need for "floated road" construction, for access tracks, is not envisaged at Cloonanny Wind Farm. Construction of the wind farm infrastructure is considered to have **significant, negative and permanent** effect on the baseline.

Related to excavation activities is the potential for significant effect on close by Protected Areas and Sites of Designated Importance. There is potential for contamination, in the form of hydrocarbons, chemicals or spoil to propagate via watercourses and detrimentally impact the Carrickglass NHA. Construction of the wind farm infrastructure is considered to have **significant, negative** and **permanent** effect on the baseline.

Baseline surveys indicate that a portion of the wind farm infrastructure lies within the floodplain of the Camlin River. This means that the location around turbine T02, the associated access track and other wind farm infrastructure will be potentially subject to seasonal river flooding. Floodwater has the potential to cause high levels of up-thrust on, and to cause erosion to, foundations, road bases, hardstands, transformers, installed cable trenches etc. This action can disturb or destabilise structures unless designed to deal with such scenarios. Similarly, baseline surveys have also indicated that soluble rocks, typical of a "karst" environment, are potentially present below the site, although these soluble rocks do not outcrop within the site boundary. The presence of a "karst" environment elevates a risk to the ground stability of structures placed on it. Thus, the potential ground stability / failure related impact from both these scenarios, is considered to be **significant, negative and permanent**.

In order to mitigate this risk, further detailed ground investigations will be undertaken prior to construction of the turbines, hardstands and other sensitive infrastructure. This is required to ensure that the competence of the underlying subsurface is more fully understood and that foundation design is appropriate. Similarly, supplementary ground investigation will be undertaken prior to construction to ensure the appropriate design solution is employed for all structures and other infrastructure affected.

Construction and operation of the wind farm will result in an elevated risk of contamination to the local environment resulting from silt from spoil generating activities entering watercourses, and / or contaminants such as oils and other chemicals used in the construction and operation entering the subsurface or water courses. The potential impact this will cause is considered to be **significant, negative and long terms**.

Baseline contamination at the Site is imperceptible with only limited exposure to contamination from agricultural land use. Construction of the wind farm infrastructure has the potential to introduce hydrocarbon and other forms of contamination into the soils and as such this will potentially have a **significant, negative and permanent** effect on the baseline in this context.

All other potential effects, relating to soils and geology, are considered to be at most **negative, slight and of at least long-term duration**.

The application of the mitigation measures as recommended will ensure that the development will suffer no significant impact from; nor have no significant negative effect to; the soils, geology or surface water conditions in the vicinity of the proposed Cloonanny Wind Farm site.

The following table summarises the findings of the soils and geology assessments at Cloonanny Wind Farm:

Table 1.31 – Summary of Soils and Geology Constraints Identified for Cloonanny Wind Farm

Type of Risk	Nature of Risk	Hazard Description (T1, T2 and Substation)	Hazard Rating	Recommendation for Mitigation	Hazard Rating Post Mitigation	Residual Risks
Geology	Peat Landslide Hazard	This analysis determined that peat stability hazard assessment is not required. Preliminary geotechnical assessment at the turbines finds that PEAT soils are absent. NEGLIGIBLE RISK	🟩	None required	🟩	NEGLIGIBLE RISK
Geology	Excavations and Stability	Cohesive soils with localised moderate flows of groundwater could be present. The stability of superficial soils will deteriorate significantly where acted on by water (either surface inflows or groundwater). For this reason, it would be difficult to excavate below a water table without suitable sidewall support and pumping arrangements. MEDIUM RISK	🟧	A preliminary SI campaign has been undertaken to determine soil conditions and baseline groundwater detail. Further pre-construction SI will be undertaken ahead of construction to further inform design and working practices. Any particular working practices required to reduce risk will be recommended, as mitigation for inclusion in the Construction Environmental Management Plan (CEMP)	🟨	LOW RISK Residual risk of "natural" soil movement occurring during or following extreme rainfall / storm event or seismic activity.

Geology	Land Contamination	No indication of ground contamination was observed during the walkover survey. Construction of the wind farm will generate mineral soil spoil which has the potential to contaminate watercourses, where it becomes entrained in surface water flows. Portions of the lands, particularly around T02, are within the flood zone of the Camlin River and particularly sensitive to this issue. <u>MEDIUM RISK</u>	🟧	A preliminary SI campaign will be undertaken to determine soil conditions and baseline groundwater detail. A baseline contamination assessment will be completed prior to construction. Particular working practices required to reduce risk will be employed, as specific mitigation for inclusion in the Construction Environmental Management Plan (CEMP)	🟨	<u>LOW RISK</u> Residual risk of leaching from any existing contamination present at the Site
Geology	Structural Stability / Foundations (Caused by Soils)	Superficial cohesive soils are particularly thick at the site of T01 and T02. Such soils are more susceptible to consolidation that other types of granular soils and are considered to be <u>MEDIUM RISK</u>, as a formation for emplacement of turbine foundations. The potential for failure or differential settlement is elevated. *(There will be minimal impact at the Substation where different foundations are normally deployed)* Where soils are considered poor, consideration will need to be given to deep	🟧	A preliminary SI campaign has been undertaken to determine soil conditions and soil competence with respect to turbine / infrastructure foundations. A comprehensive programme of pre-construction SI will be employed to inform selection of the appropriate foundation for each structure and infrastructure element Excavations, where kept open for an extended period of time will be supported or slopes	🟩	<u>NEGLIGIBLE RISK</u> Residual risk of instability within "fine" soils caused by extreme weather or seismic activity.

		foundations (e.g. ground improvement or piling). Shallow clay soils could be less competent than required for other infrastructure too, such as transformer bases and result in changes to the standard foundation deign being required. Soils of low competence also carry a <u>MEDIUM RISK</u> of differential settlement developing within turbine hardstands and access tracks. This can lead to failure or regular maintenance being required.	🟧	battered back to an appropriate angle. The final design of the wind farm will take into account the results of the pre-construction SI	🟩	
Geology	Structural Stability (Caused by Rock)	Potential instability due to the presence of dissolution features such as sinkholes, cavities etc. Baseline assessment has determined that the rock formation (Visean Limestones) underlying the site is soluble. Soluble rock formations have the potential to form "karst" features such as cavities, sinkholes etc. Such features are associated with structural stability problems. The presence of this "karst" rock formation means that infrastructure associated with the development is at an elevated risk of stability related issues. At Cloonanny Wind Farm, competent rock has been shown to be greater than 3.5m below existing ground level. In such	🟧	Preliminary SI works have been undertaken to determine whether rock is present at shallow depth. Further pre-construction SI works, using a combination of geophysical and geotechnical methods, will be undertaken to map the soil and rock profile below wind farm infrastructure and confirm the competence of all formations. Analysis of the pre-construction SI will allow appropriate foundations to be designed for ground conditions observed.	🟩	<u>NEGLIGIBLE RISK</u> Residual risk of instability / excessive settlement due to presence of small cavities within otherwise massive / intact limestone bedrock, not detected during pre-construction SI.

		cases turbine foundations may need deep foundation methods (such as ground improvement, rock anchoring or piling) to transfer loads to a deeper or more intact geological stratum. The is currently a MEDIUM RISK associated with this hazard.	🟧		🟩	
Geology	Borrow Pits / Construction Fill	LOW RISK GSI information suggests there is moderate potential at the Site for recovery of crushed aggregate, that would be suitable for construction purposes. Sedimentary limestone rock is generally expected across the site and whilst this formation is often suitable for the production of construction aggregate, it is anticipated to be at such a depth as to be not economically viable to extract. It is anticipated that suitable crushed rock aggregate cannot be "won" at this site. Such aggregate will need be imported to satisfy design requirements.	🟨	Pre-construction SI will be undertaken to confirm whether rock is present close enough to the existing ground surface to be economically recovered. A preliminary analysis of this material would be made at that time to determine the viability of "winning" rock / fill material at the site. Further testing (pre-construction) to determine aggregate potential or suitability as construction fill, will be undertaken to answer these questions.	🟩	NEGLIGIBLE RISK It is unlikely that the aggregate required to construct the wind farm will be "won" on site. The risks pertaining to importation of large quantities of aggregate should be considered. i.e. impacts on project cost, suitability of the local public roads for the axel loads required, potential damage to public roads etc. Given the proximity of suitable aggregate locally, these costs are likely to be minimised.
Geology	Groundwater	The underlying rock formation across the majority of the Site is considered to be a locally important karstified aquifer. Although, no water abstraction boreholes are recorded by GSI within the	🟧	The effect of buoyancy will be considered as an aspect of design for all structures and associated infrastructure.	🟨	LOW RISK Any drainage installed to assist with the construction of site infrastructure

		immediate vicinity of the proposed wind farm, the underlying aquifer, where exposed is considered particularly sensitive to contamination. There is a MEDIUM RISK that **surface water runoff** associated with Cloonanny Wind Farm could adversely impact this aquifer. Moderate or strong flows of **groundwater** have the potential to adversely impact both the construction works and the stability of foundations, in respect to up-thrust pressure. Observations of water strikes within exploratory holes indicates low recharge rates and weak flows where groundwater has been observed (Turbine T01 only). A shallow groundwater table can have a significant impact on a wind farm development, affecting construction and structure stability. There is a MEDIUM RISK of adverse impact to the Development as a result.	🟧	Further detailed pre-construction SI works will be undertaken to map soil and rock profile below each main element of wind farm infrastructure. The appropriate (buoyant) foundation design, for ground conditions observed, will be selected for each of the other structures and elements of associated infrastructure.	🟨	has the potential to degrade over time, if not adequately maintained. This degradation has the potential to affect the performance of the constructed wind farm elements.
Geology	Surface Water	The wind farm is located on flat, low lying lands adjacent to the Camlin River and is, in part (T02), within lands known to have previously flooded. Floodwaters can cause extreme up thrust on structures and other installed infrastructure causing failure to occur.	🟧	The effect of buoyancy will be considered as an aspect of design for all structures and associated infrastructure. Further detailed pre-construction SI works will be undertaken to map	🟨	

		Flowing surface waters can erode foundations and place adverse lateral stresses on these and other infrastructure elements. There is a MEDIUM RISK of adverse impact to the Development as a result of this hazard, unless appropriate design is applied.	🟧	soil and rock profile below each main element of wind farm infrastructure. A deep foundation solution (Piling or other) will be considered for turbine T02, located within the mapped flood zone of the Camlin River. Consideration will be given to raising the infrastructures above the level of the flood waters to reduce the severity of the impact. All other infrastructure will be designed to deal with the impact of flood waters.	🟨	
Geology	Protected Geological Sites	No sites of geological significance are listed within the Site boundary. The closest site is: LD007 Creeve Quarry - *"A long disused quarry with adjacent wooded knoll of exposed rock" 3km to SE.* There is LOW RISK of impact to this protected site from the soils and geology related aspects of Cloonanny Wind Farm.	🟨	Mitigation as required to reduce risk of pollution of watercourses will reduce the risk to the adjacent protected geological site. Refer to Construction Environmental Management Plan (CEMP)	🟩	NEGLIGIBLE RISK
Geology	Protected Sites	No sites of geological significance are listed within the Site boundary. The closest site is: *Carrickglass NHS (Ref 001822 – 850m South East*	🟧	Mitigation as required to reduce risk of pollution of watercourses will reduce the risk to the adjacent	🟨	

		There is MEDIUM RISK of impact to this protected site from the soils and geology related aspects of Cloonanny Wind Farm.	🟧	protected geological site. Refer to Construction Environmental Management Plan (CEMP)	🟨	

1.11 References

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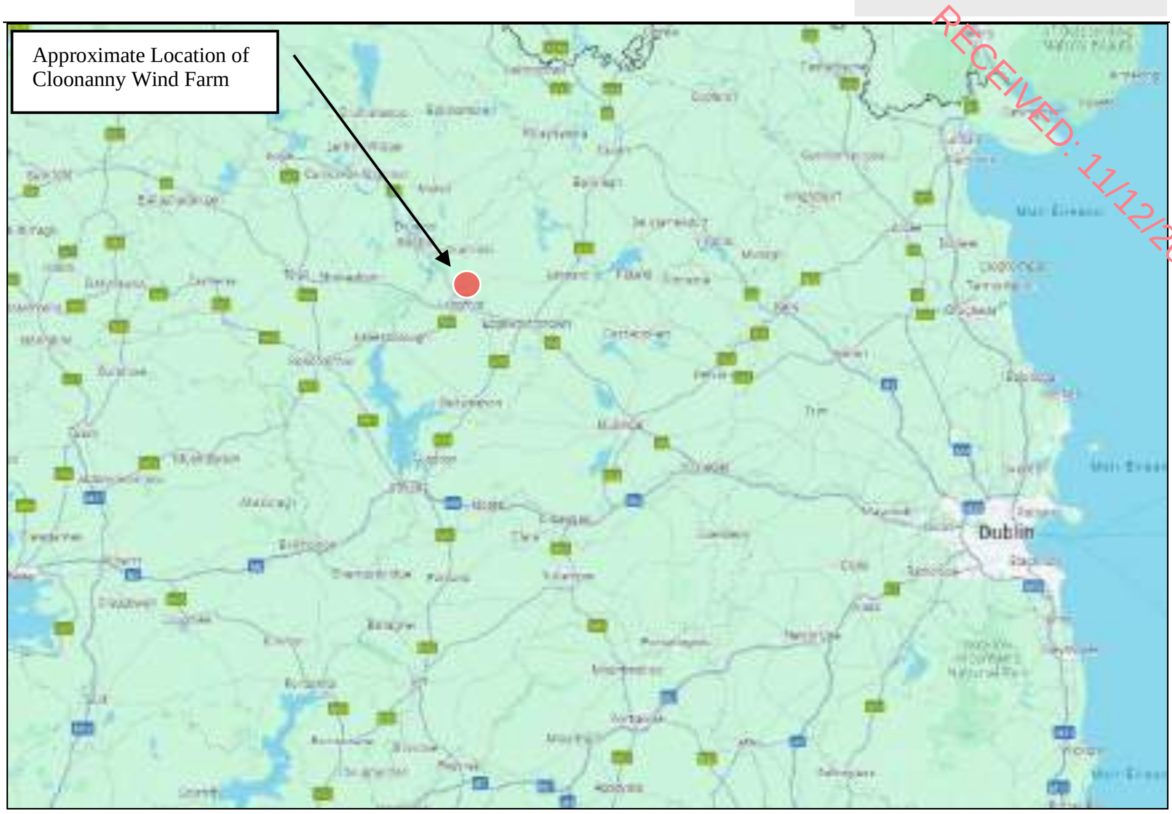
DRAWINGS

General Site Location Plan Solid Geology **Figures P1 & P2**	1 x A4
Wind Farm Layout Plan and Study Areas **Figure 8.0**	1 x A3
Solid Geology **Figure 8.1**	1 x A3
Superficial Geology **Figure 8.2**	1 x A3
Groundwater Features, Karst, Springs and Abstraction **Figure 8.3**	1 x A3
Landslide Susceptibility and Recorded Events **Figure 8.4**	1 x A3
Minerals and Active Quarrying **Figure 8.5**	1 x A3
Geological Audited and Unaudited Sites **Figure 8.6**	1 x A3
Groundwater Vulnerability **Figure 8.7**	1 x A3
Crushed Aggregate Potential **Figure 8.8**	1 x A3
EPA – Closest Protected Sites, Sites of Designated Importance & Existing Waste Licensing **Figure 8.9**	1 x A3
Location of Exploratory Trial Holes **Figure L1**	1 x A3
Classed Plot of Peat Thickness Overlaid On Background Plot *(Peat Landslide Hazard Screening)* **Figure D1**	1 x A3
Contoured Plot of Ground Surface Elevation Overlaid on Background Plot **Figure D2**	1 x A3
Contoured Plot of Ground Slope Gradient Overlaid on Background Plot **Figure D3**	1 x A3
Spoil Disposal Areas (Proposed) Overlaid on Background Mapping **Figure SD1**	1 x A3



P1 - General Location Plan (Aerial view)
(© Google Maps 2024)

P2 - Local Location Plan (Aerial view)
(© Google Earth 2024)

2274-24 Cloonanny Wind Farm, Co. Longford
Google Earth SI Layout Plan

Walkover Survey Study Areas & Preliminary Trial Holes at Proposed Turbines and Borrow Pits

Notes:

1. GSI Copyright Google Earth
2. Where indicated all elevation relate to Main Head Datum
3. Background Mapping Source: OSI Digital Globe.

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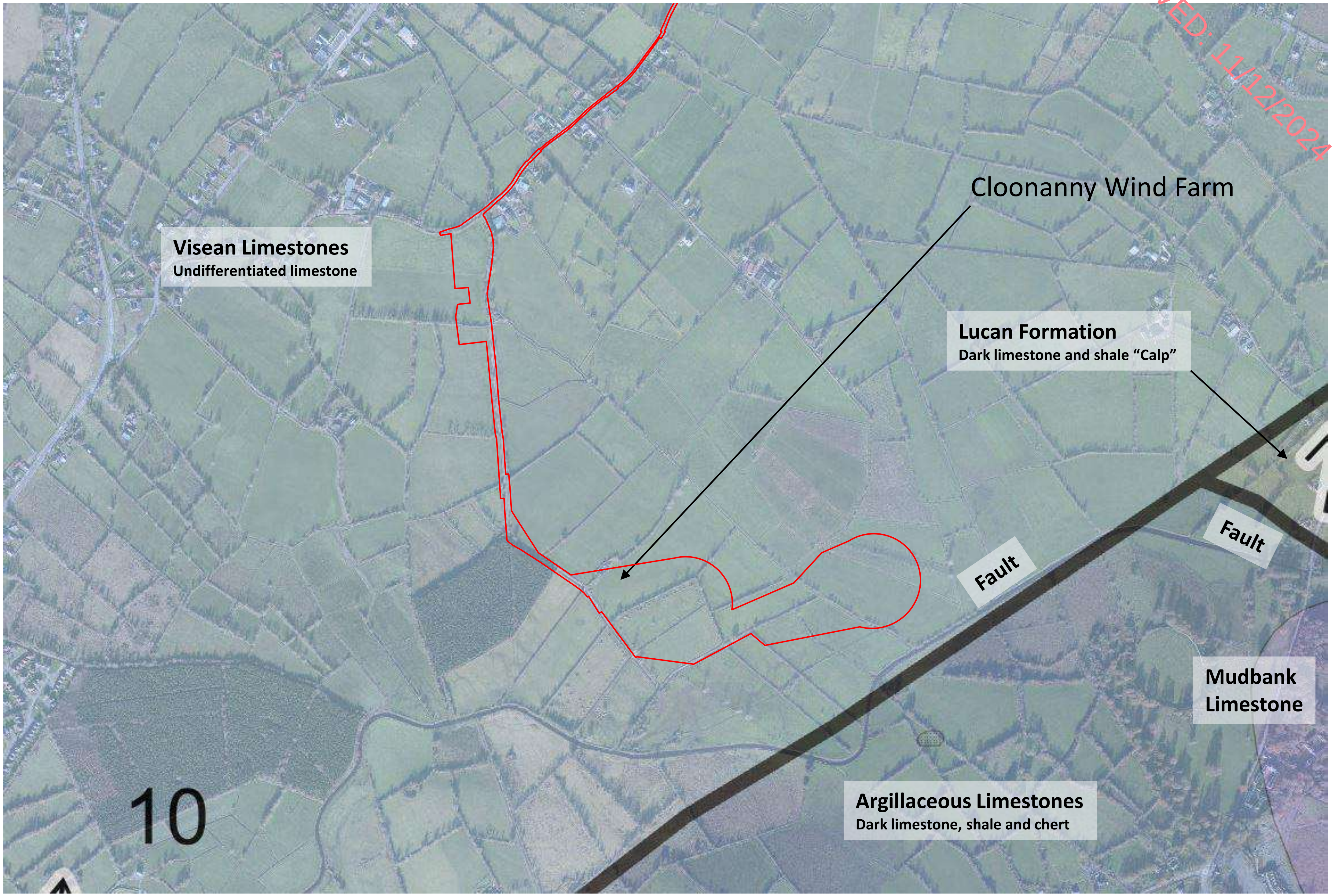
Wind Farm Layout Plan and Study Areas

	Edition	Sheet
Cloonanny Wind Farm **Soils and Geology Assessment**	1	

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Solid Geology



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Solid Geology

Cloonanny Wind Farm **Soils and Geology Assessment**	Edition 1	Sheet

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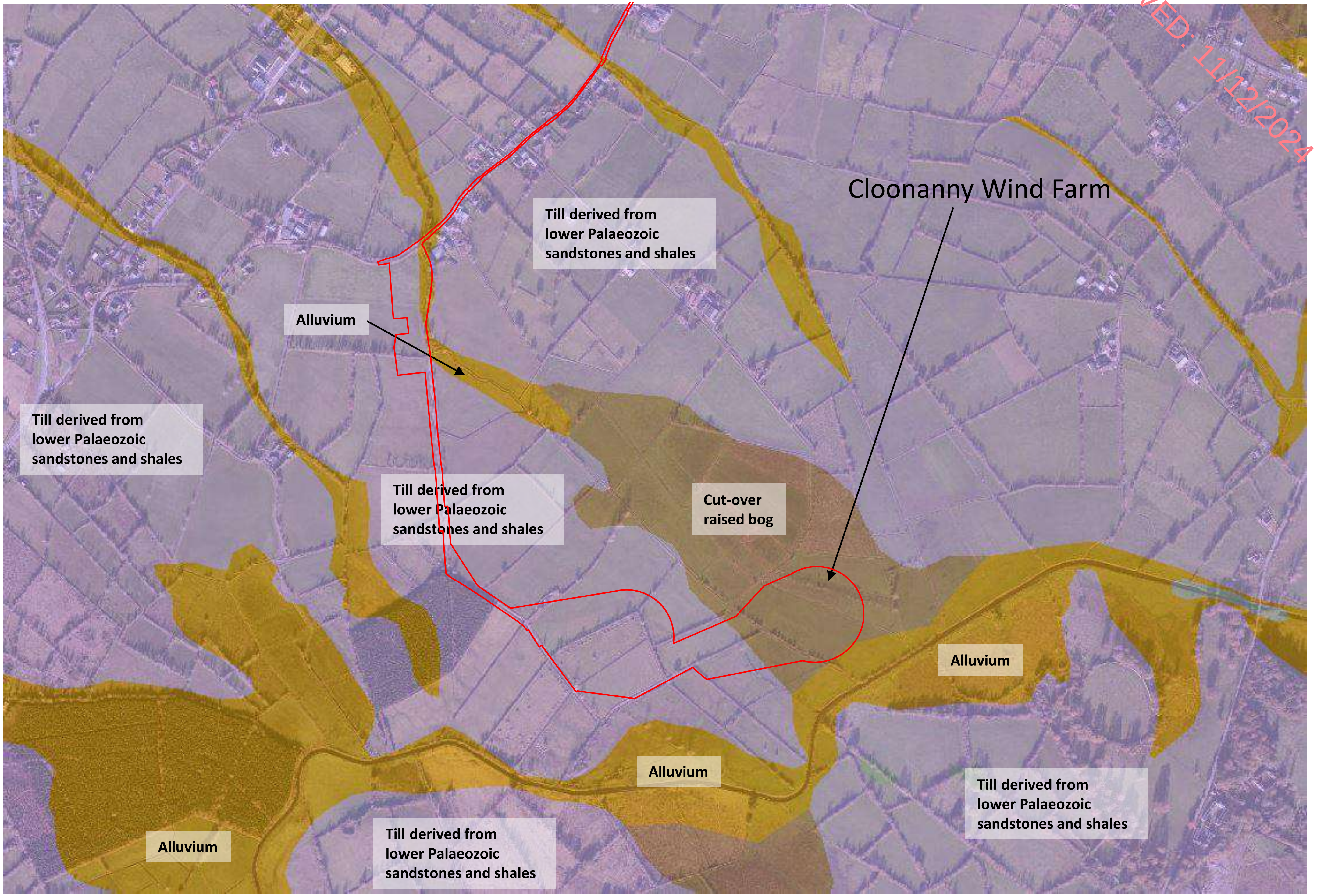
Soils and Geology Constraints

GSI – Superficial Soils



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Superficial Soils

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Soils and Geology Assessment

Edition 1

Sheet

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Wind Farm Red-Line Boundary

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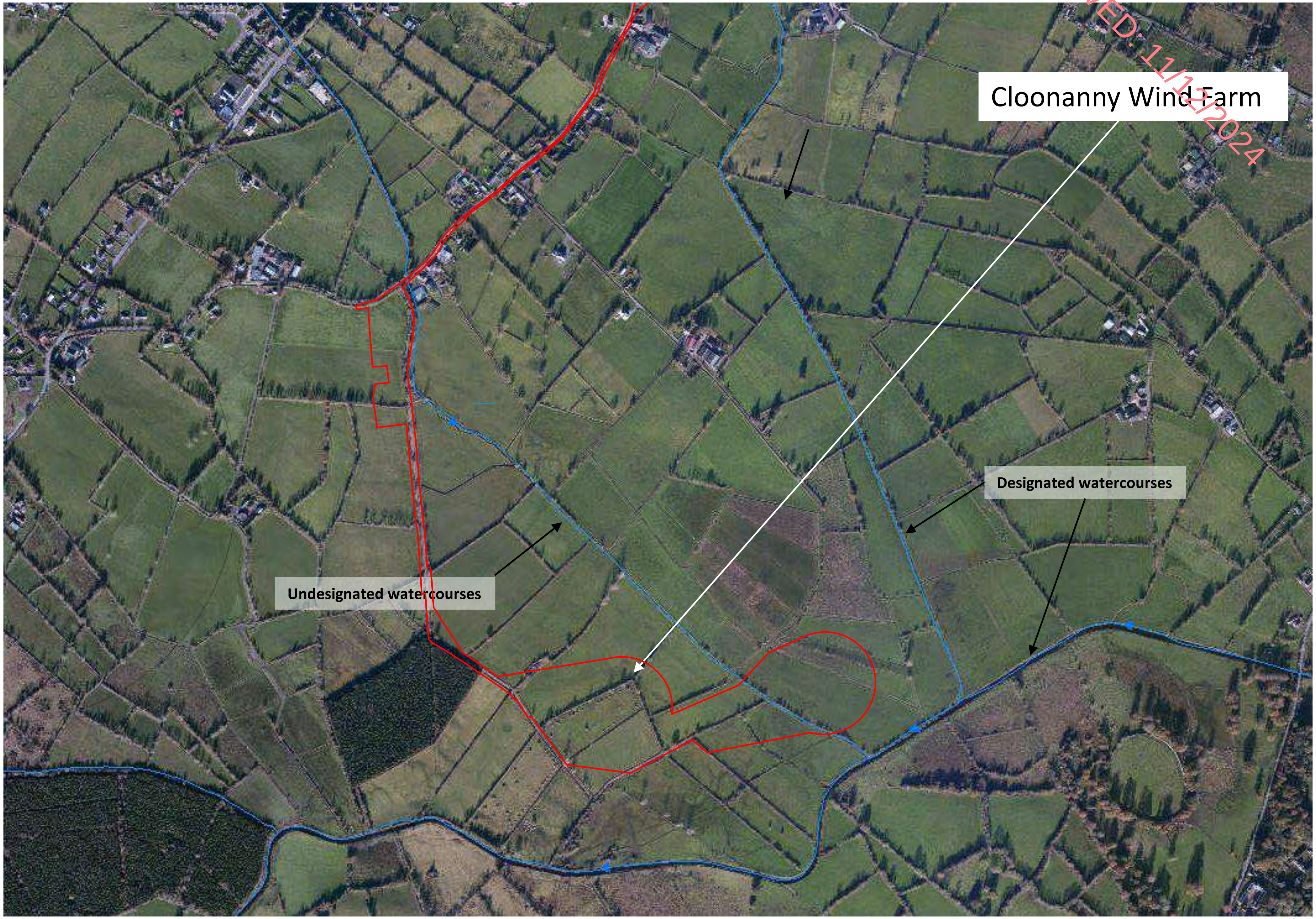
Whiteford Geoservices Ltd Straid House 2 Main Street, Straid, BALLYCLARE, Co. Antrim, UK BT39 9 NE		**Wind Farm Layout Plan Red-Line Boundary**			
		Cloonanny Wind Farm **Soils and Geology Assessment**		Edition 1	Sheet

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Groundwater Features, Karst Features, Springs and Abstraction Points



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Geological Survey of Ireland Online Mapping Database
Groundwater Features, Karst, Springs and Abstraction

Cloonanny Wind Farm
Soils and Geology Assessment

Edition	Sheet
1	

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Soils and Geology Constraints

GSI – Landslide Susceptibility and Recorded Events

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Landslide Susceptibility and Recorded Events

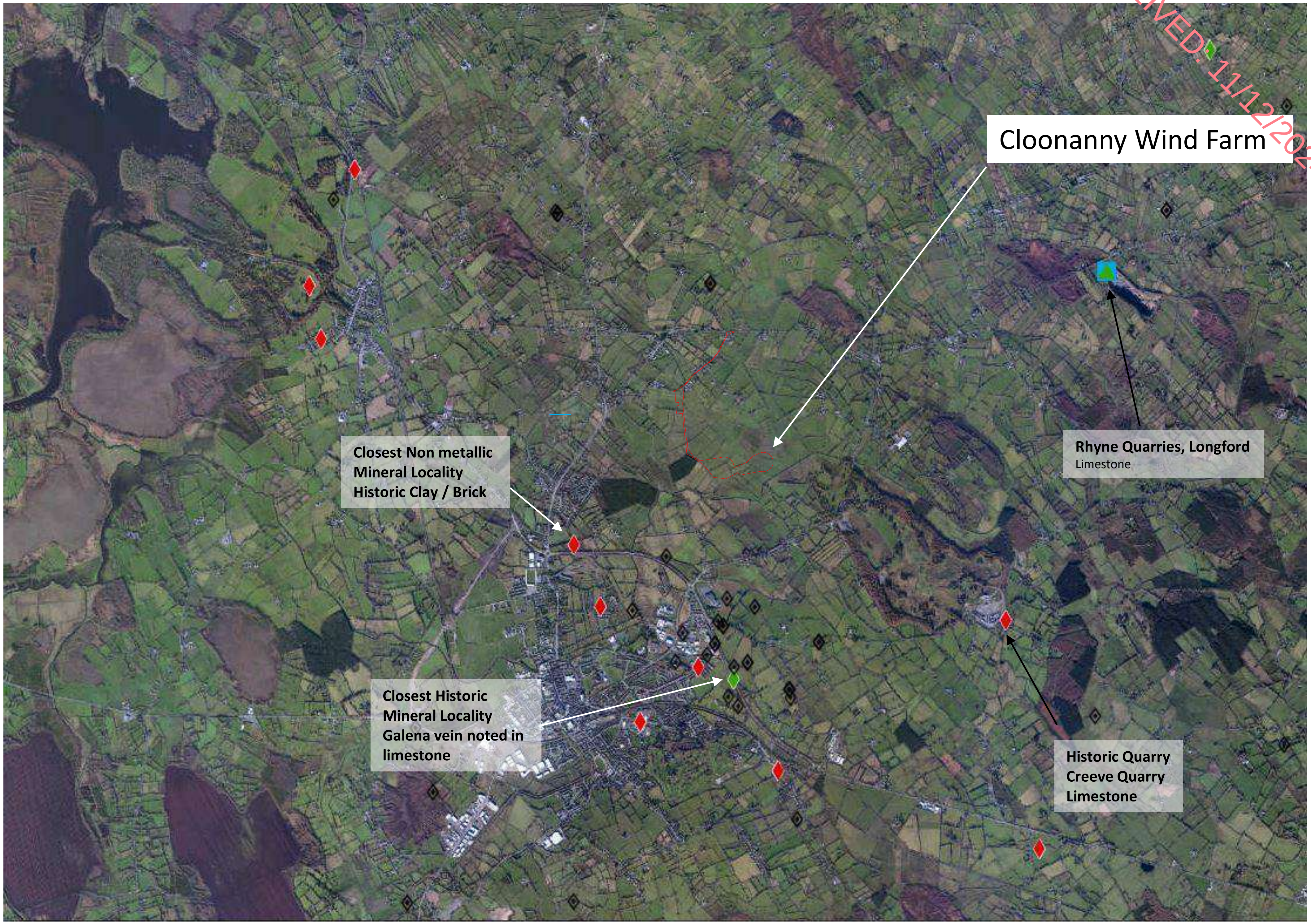
Cloonanny Wind Farm
Soils and Geology Assessment

Edition 1

Sheet

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Minerals and Active Quarrying



Key

- ◆ Mineral Exploration Boreholes
- 🟥 Non-metallic Mineral Quarrying Activity
- 🟩 Historic Metallic Mineral Activity
- ● Sand & Gravel Pits
- 🟦 Active Aggregate Quarries

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Minerals and Active Quarrying

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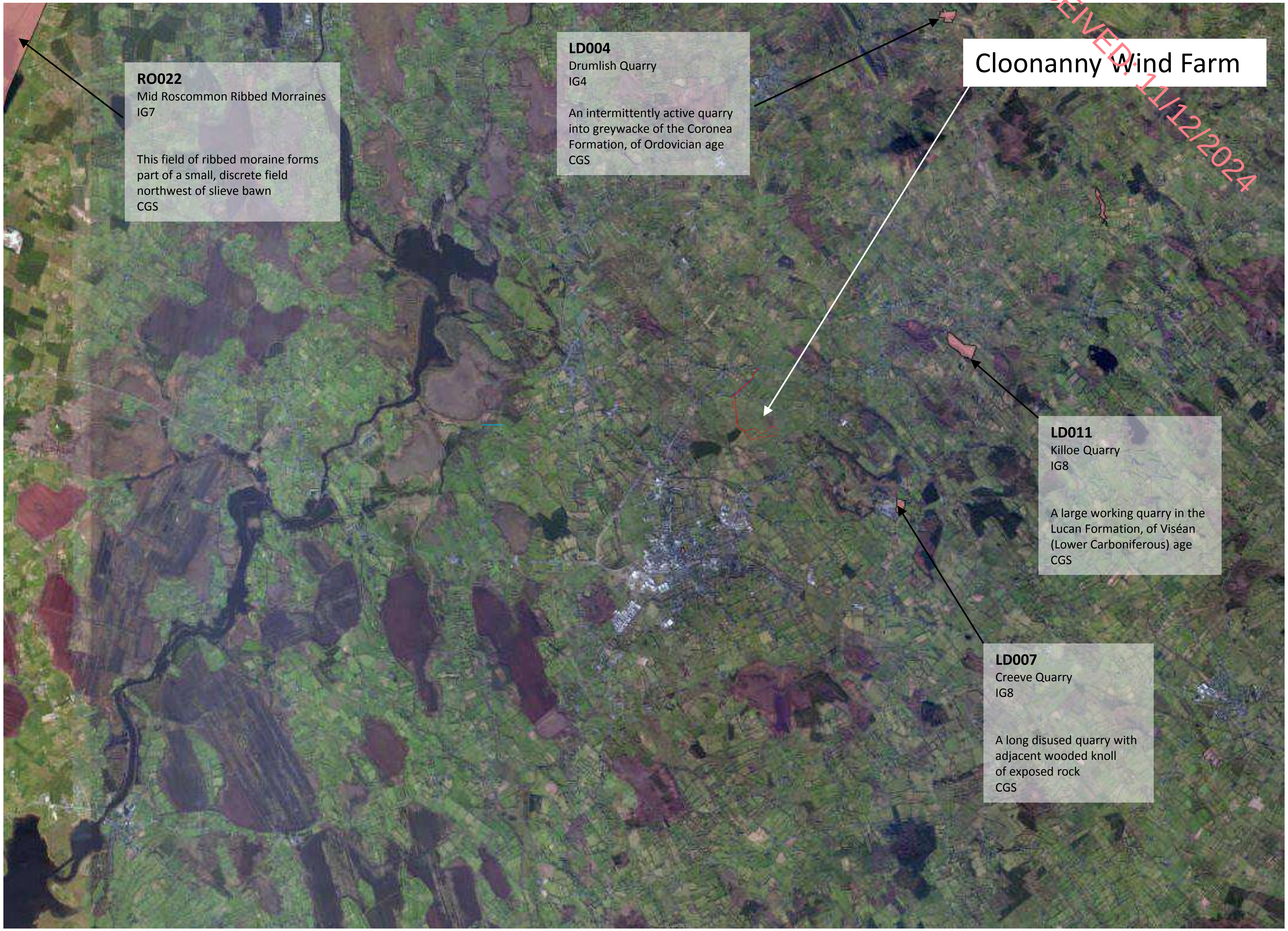
Soils and Geology Constraints

GSI – Closest Geological Audited and Unaudited Sites



RO022
Mid Roscommon Ribbed Morraines
IG7

This field of ribbed moraine forms part of a small, discrete field northwest of slieve bawn
CGS

LD004
Drumlish Quarry
IG4

An intermittently active quarry into greywacke of the Coronea Formation, of Ordovician age
CGS

LD011
Killoe Quarry
IG8

A large working quarry in the Lucan Formation, of Viséan (Lower Carboniferous) age
CGS

LD007
Creeve Quarry
IG8

A long disused quarry with adjacent wooded knoll of exposed rock
CGS

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Geological Audited and Unaudited Sites

3

Cloonanny Wind Farm
Soils and Geology Assessment

Edition	Sheet
1	

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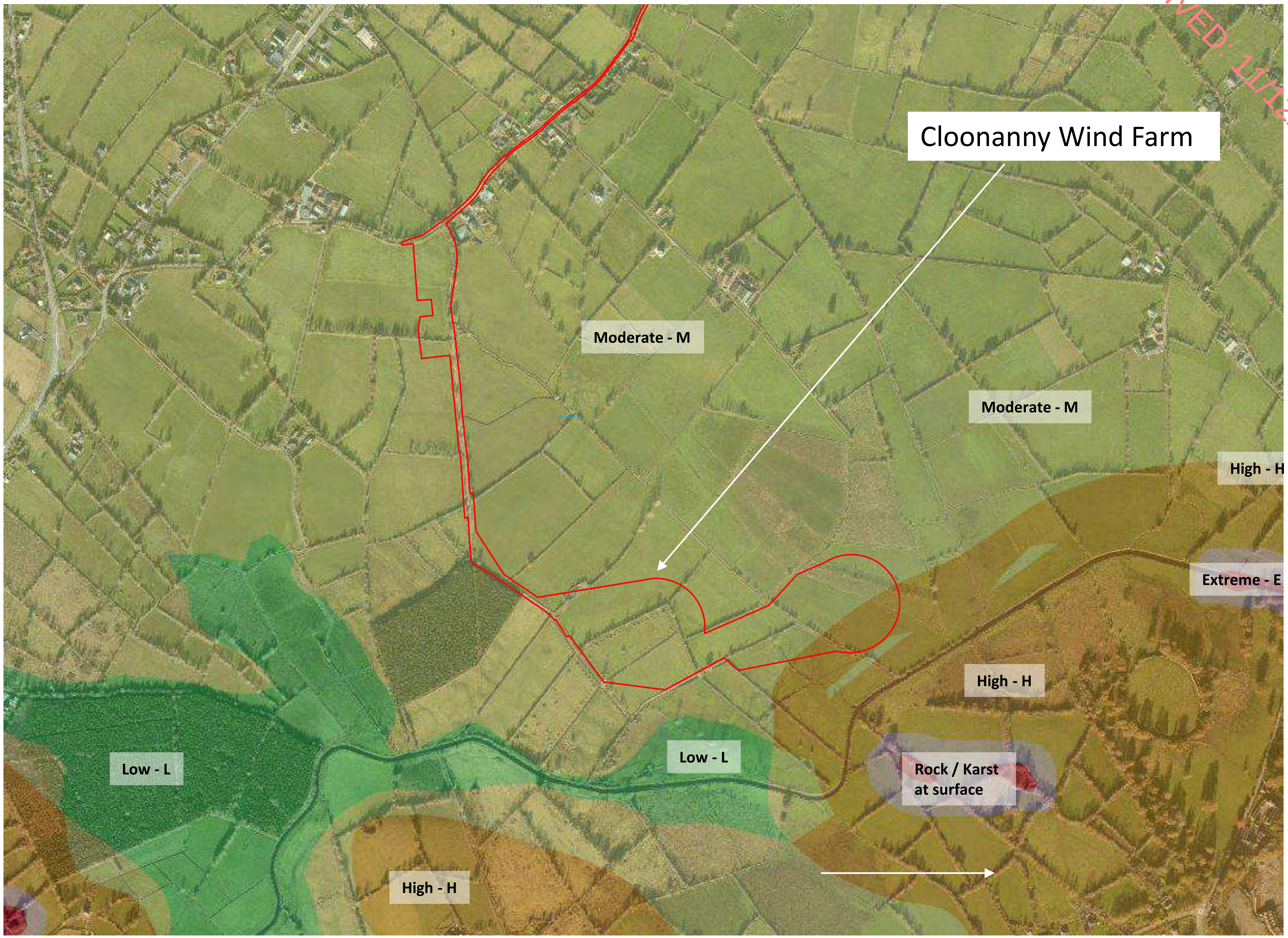
Soils and Geology Constraints

GSI – Groundwater Vulnerability



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Groundwater Vulnerability

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Soils and Geology Assessment

Edition	Sheet
1	

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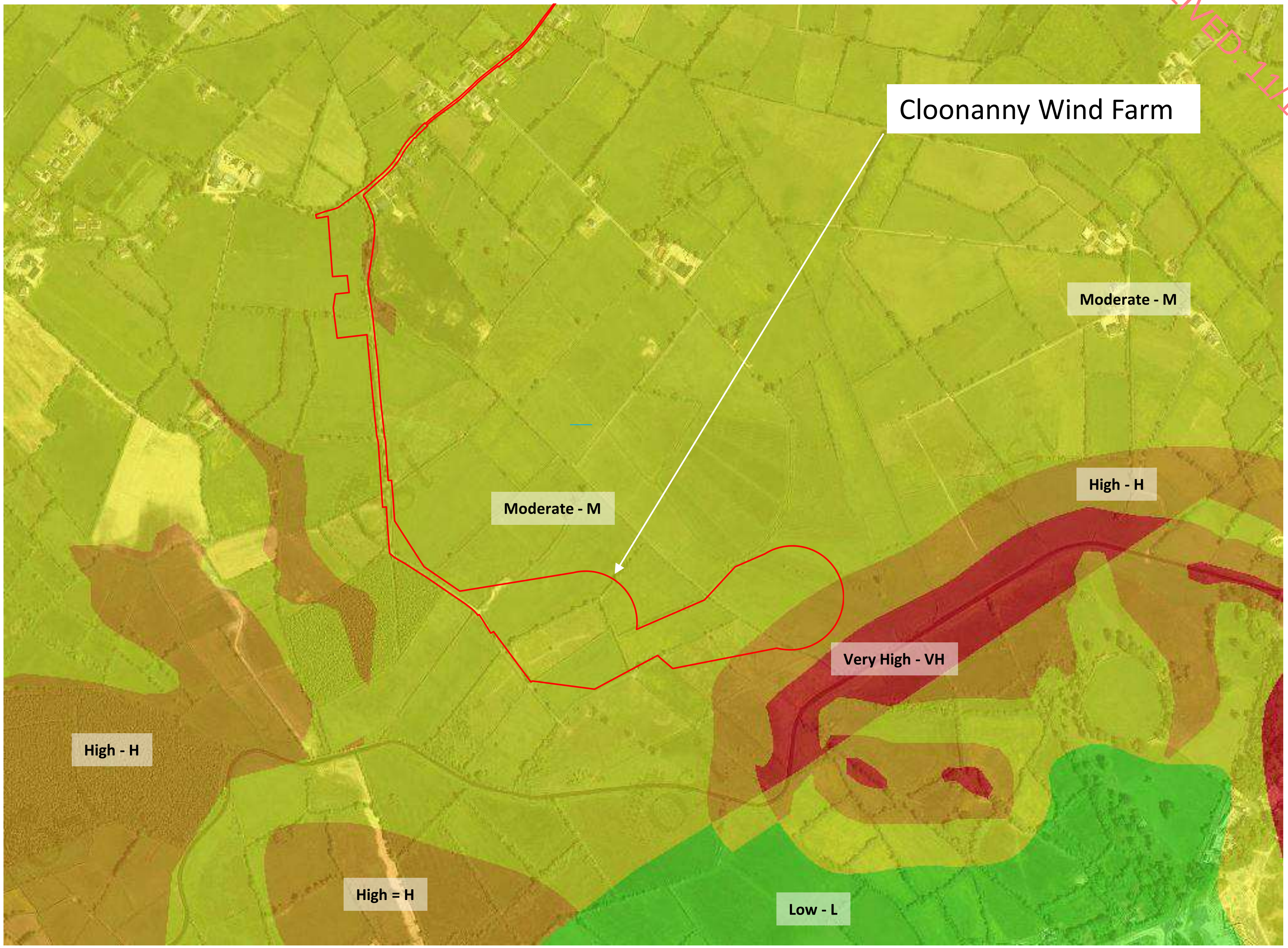
Soils and Geology Constraints

GSI –



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Crushed Aggregate Potential

Cloonanny Wind Farm
Soils and Geology Assessment

Edition	Sheet
1	

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

EPA – Closest Protected Sites, Sites of Designated Importance & Existing Waste Licensing

Key

🟦	IPC / IEL License
▱	IPPC License Boundary

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EPA Mapping Database
Protected Sites and Sites & Waste Licensing

Cloonanny Wind Farm
Soils and Geology Assessment

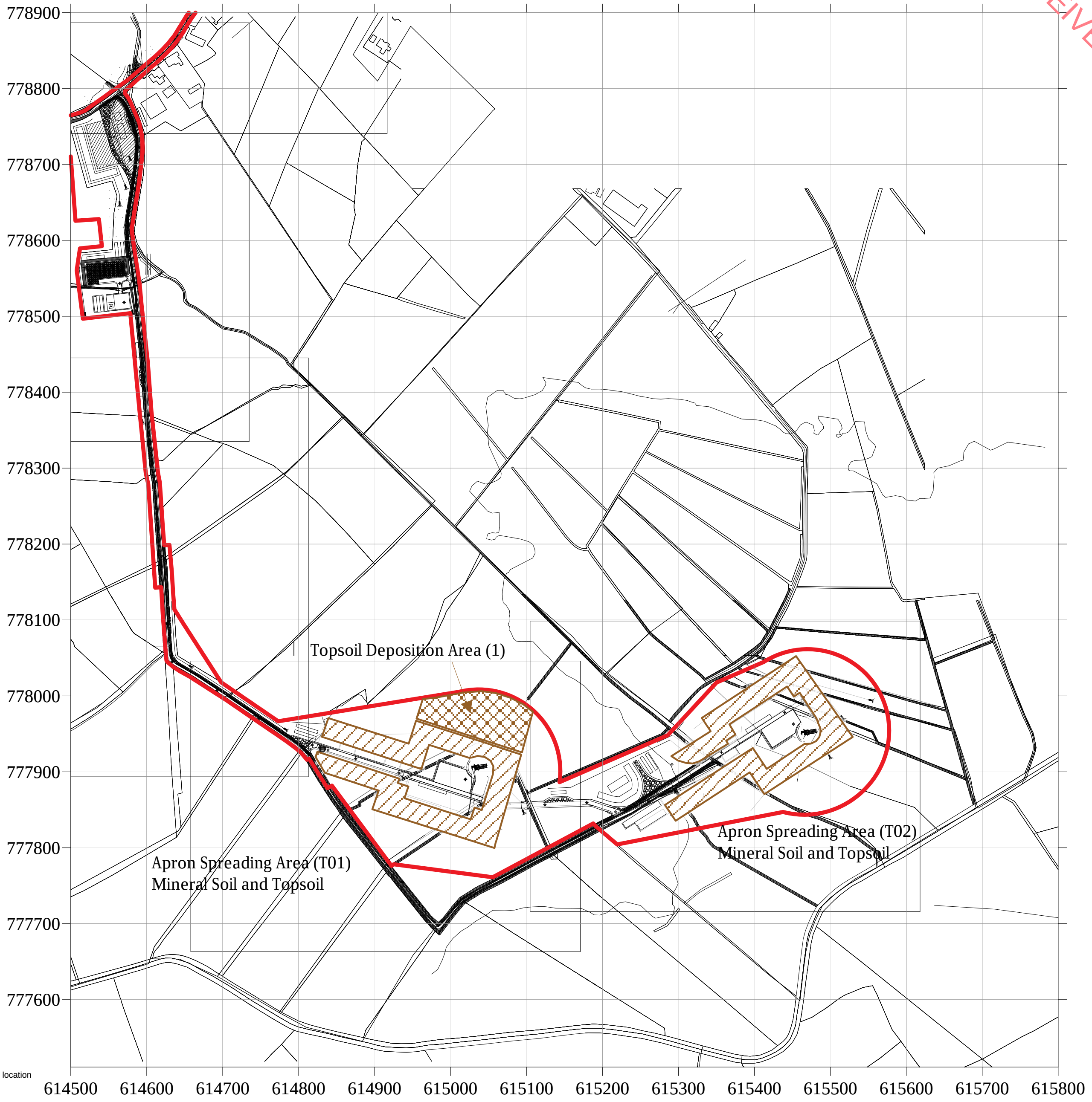
Edition	Sheet
1	

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: Dated 17-05-2024

Spoil Disposal / Deposition Plan

30th August 2024



N
W E
S

KEY

- ╱ Proposed Spoil Storage Berms along site tracks (Topsoil)
- ▨ Proposed Spoil Storage around hardstands (Topsoil & Mineral Soils)
- ▦ Proposed Topsoil Deposition Area (Long-term)
- — Land Drains
- — Red Line Boundary

Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

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JW	JW	JM 04/12/2024	2274-24 SD1	04/12/2024	1 : 6,000

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Cloonanny Wind Farm -
Soils and Geology Assessment

Proposed Spoil Deposition

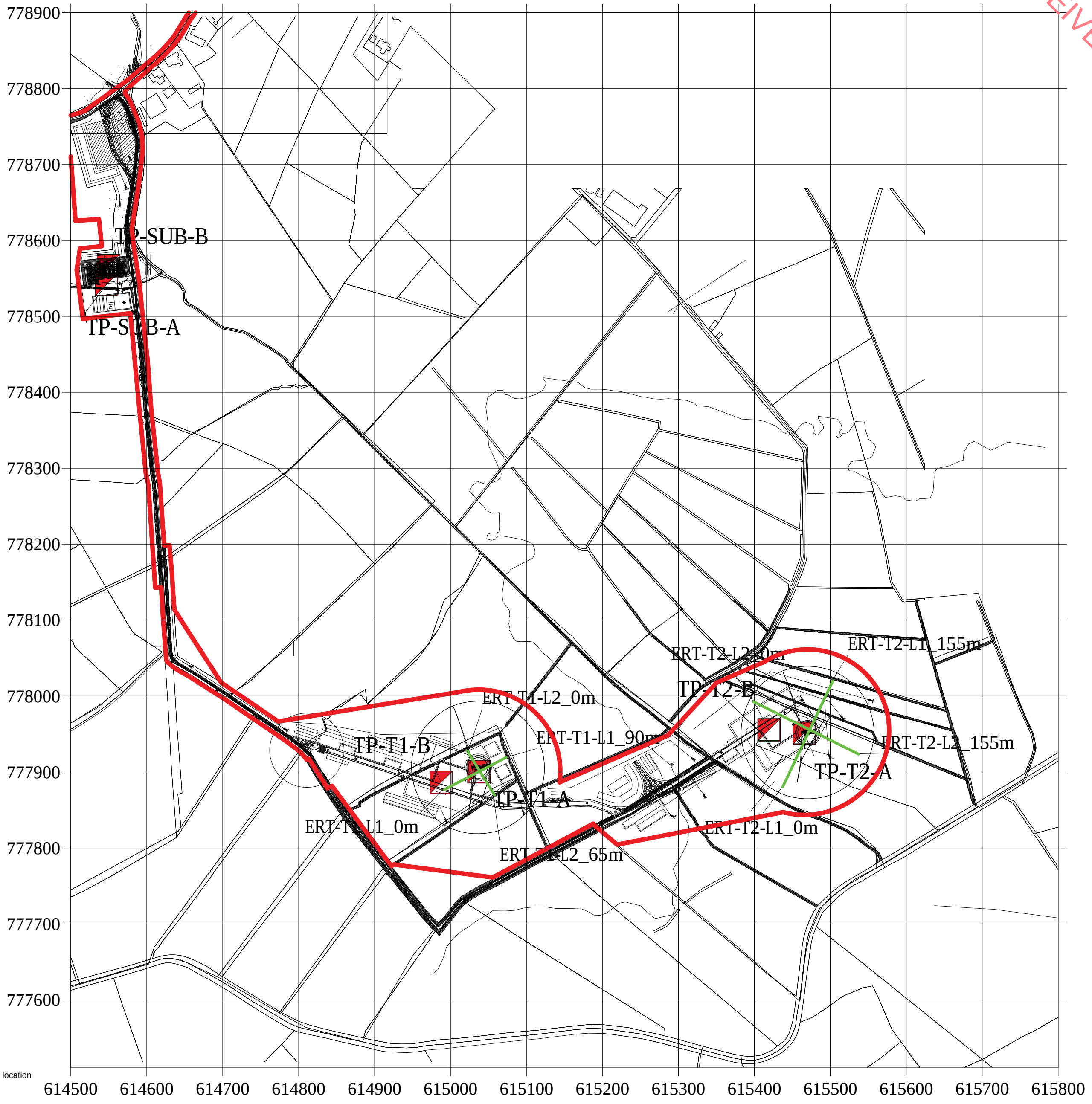
Edition	Sheet
1	A3

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

As-Built SI Layout Plan

22nd October 2024



KEY

🟥	Trial Hole
╱	Profile for Slope Stability Assessment
—	Red Line Boundary

Notes:

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

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Cloonanny Wind Farm -
As Built SI Layout Plan

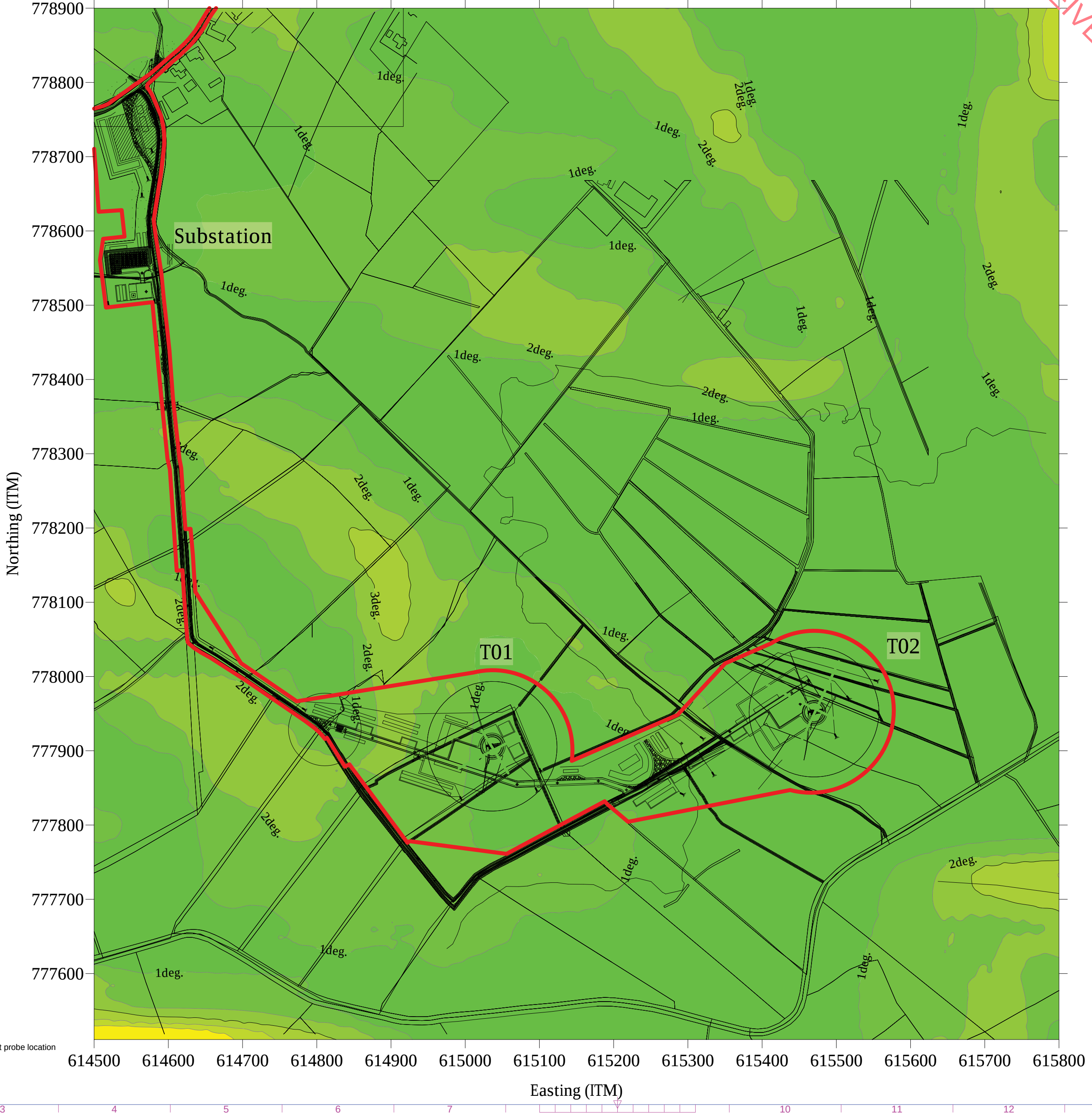
	Edition	Sheet
Location of Exploratory Holes	3	A3

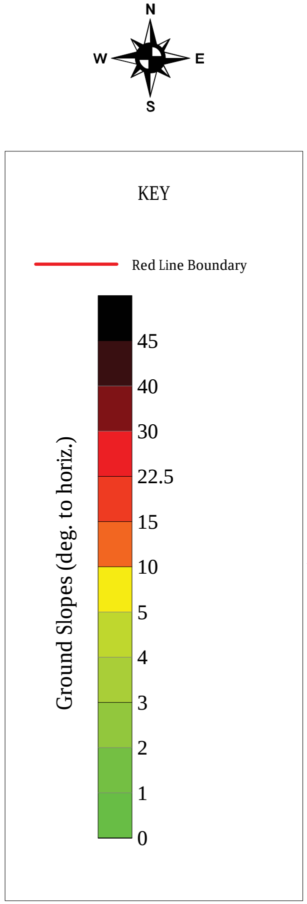
2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

Contour Plot of Ground Slopes

22nd October 2024





Notes:

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2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
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Contoured Plot of Ground Slopes

Cloonanny Wind Farm

Edition 3

Sheet A3

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

Contour Plot of Ground Elevations

22nd October 2024

Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

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Contoured Plot of Ground Elevations

Cloonanny Wind Farm

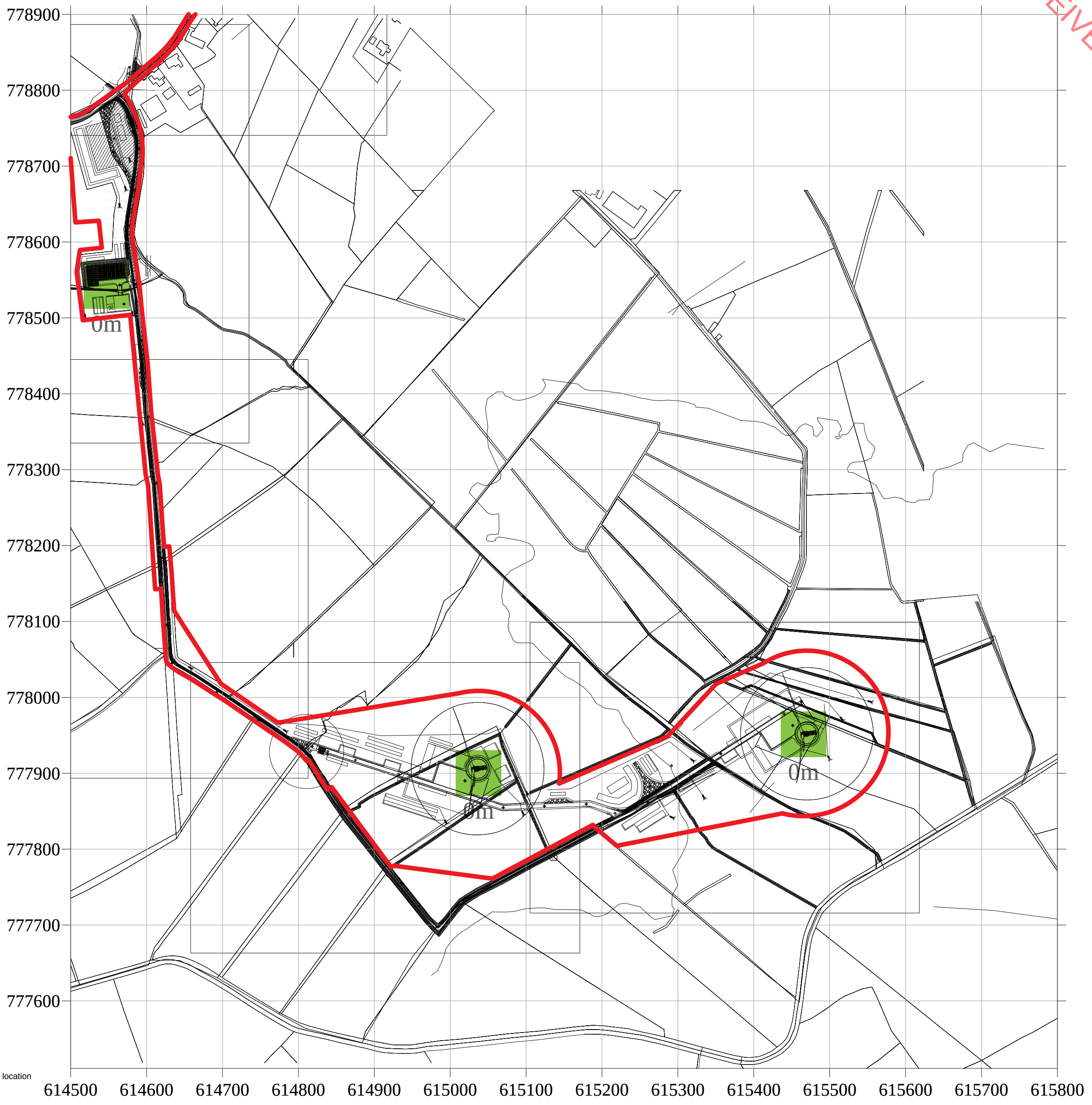
Edition	Sheet
3	A3

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

Classed Plot of Peat Depth

22nd October 2024



KEY

🟥	Red Line Boundary

Peat Depth (m)

🟩	0 to 0.5
🟨	0.5 to 1
🟧	1 to 2
🟥	2 to 3
🟫	3 to 4
⬛	4 to 5

Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
JW	JW	JM 04/12/2024	2274-24 D1	04/12/2024	1 : 6,000

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Cloonanny Wind Farm - Classed Plot of Peat Depth

	Edition	Sheet
Classed Plot of Peat Depth	3	A3

APPENDIX A

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

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

Guidance Notes: Controlled Circulation Only Confidential

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

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

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

1. Peat Thickness
2. Topography (i.e steepness of ground in the vicinity of the construction zone)
3. Drainage Issues
4. Historic, Active or Incipient Peat Landforms
5. Sonic / Seismic Activity (e.g. Quarrying, blasting etc.)
6. Degradation of Peat (i.e. Von Post classification)
7. Rate of Annual Precipitation recorded by Met Eirrean in 2023
8. Shear Strength of Peat (i.e Vane test data)
9. Peat Landslide History (GSI records / significant events)

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

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

HAZARD = +2 +1 +1 = 4

The table below illustrates the Factors associated with the Key Indicators for the proposed development at Cloonanny Wind Farm.

Item	Key Indicator	Numerical HAZARD Factor
1	Peat Thickness. (0.5 – 1.0m)	+0.5
2	Peat Thickness (1.0 – 2.0m)	+1
3	Peat Thickness. (> 2.0m < 3.0m)	+2
4	Peat Thickness (> 3.0m)	+3
5	Topography. Slopes of < 3º to horizontal	0
6	Topography. Slopes of 3º to 5º to horizontal	+1
7	Topography. Slopes of > 5º < 10º to horizontal	+2
8	Topography. Slopes of > 10º < 22.5º to horizontal	+3
9	Topography. Slopes of > 22.5º to horizontal	+4
10	Drainage Issues: Areas of forestry either already felled or due to be felled to facilitate construction	+1
11	Drainage Issues: Water table at or near the surface; standing water / ephemeral lakes within construction zone	+0.5
12	Drainage Issues: Concentrated drainage network evident in vicinity	+0.5
13	Relic Peat Landforms present in vicinity of construction zone (1). Eroded peat hags, tension cracks, peat banks (0 – 1.5m height) present within	+1

	construction zone	
14	Relic Peat Landforms present in vicinity of construction zone (2). Peat substrate cut for peat harvesting, pipe pipes, “bog holes”, peat detachment evident	+2
15	Sonic / Seismic Activity. (Quarrying / Piling within 500m, blasting within 500m, earthquake risk etc.)	+1
16	Von Post Classification Of Peat Degradation = >H8 at base	+1
17	Von Post Classification Of Peat Degradation = <H3 at base	- 0.5
18	Vane Test Classification Of Shear Strength = < 5 at 1.5m depth (Variants exist)	+3
19	Vane Test Classification Of Shear Strength = >60 at 1.5m depth	-0.5
20	Annual Precipitation: Low (<1100mm)	0
21	Annual Precipitation: Moderate (>1100mm <1250mm)	+0.25
22	Annual Precipitation: High (>1250mm <1300mm)	+0.5
23	Annual Precipitation: Very High (<1350mm)	+0.75
24	Peat Landslide History (5km radius): None recorded	0
25	Peat Landslide History (5km radius): < 5 recorded	+0.25
26	Peat Landslide History (5km radius): <10 recorded	+0.5
27	Peat Landslide History (5km radius): Major incident recorded	+1

Table X1 – Numerical Calculation of Risk Parameters

APPENDIX B

Analytical Analysis	4 x A4

Analytical Analysis

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

For this purpose Infinite Slope Stability Analysis has been employed to gauge the stability of peat on slopes and determination of the relevant Factor of Safety (FoS).

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

The minimum required FoS for stable slopes is 1.3, as specified in BS 6031:1981: Code of Practice for Earthworks (BSI, 1981). Where undrained parameters are used a FoS of 1.5 may be preferable.

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

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

where

FoS = Factor of Safety

C_u = Undrained Shear Strength (kPa)

γ = Bulk Unit Weight of Saturated Material (kN/m^3) (Use 23kN/m3)

m = Height of water table as a fraction of soil depth (m)

γ_w = Unit Weight of Water (kN/m^3)

ϕ = Angle of internal friction (deg)

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

α = Slope angle (deg)

However, the inclusion of the modification for water table fluctuation has the effect of increasing the factor of safety when the water level rises. Ultimately the soil slope is most vulnerable when water is present and the density of the soil material is at its highest.

For this purpose the basic form of the equation has been employed and the most conservative value of density for the mineral clay soils, (approximately 23kN/m^3 at the main structures), has been considered.

Infinite Slope Analysis

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

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

Where,

FoS = Factor of Safety

C_u = Undrained Shear Strength (kPa)

γ = Bulk Unit Weight of Material (kN/m^3) – assumed, for saturated clay/silt, to be at 23kN/m^3

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

α = Slope angle (deg)

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

The results are summarised in the table below:

LOCATION	Max Slope (°)	z (m)	Undrained Condition		Extreme Conditions	
			Cu (kPa)	Factor of Safety Sliding	Cu (kPa)	Factor of Safety Sliding
T01	2.0	3.5	82	**29.21**	10	**3.56**
T02	1.0	3.5	67	**47.70**	10	**7.12**
Substation / Control Building	1.0	1.6	52	**80.98**	10	**15.57**

Table 4 – Analytical Assessment of Infinite Slope Stability

Stability of Excavations in Natural Mineral Soils

As an additional observation it is useful to consider the stability of excavations within the natural mineral soils at the site of proposed cuttings and / or excavations. The following formula allows a determination of the maximum height of a vertical slope that should be considered when excavating in the natural soils[1].

a) <u>Maximum height of vertical excavated faces:</u>

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

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

Where

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

Taking the most conservative approach, assuming a zero angle of internal friction (φ=0°), and the lowest shear strength (estimated for the proposed turbine location during extreme conditions) of 10kPa with a materials partial safety factors of 1.3 applied to it, the **<u>safe vertical height would be 1.34m</u>**.

---

[1] This assumes removal of topsoil prior to commencement of excavations.

This estimate of safe vertical height is taken into consideration in the risk assessment, construction method statements and mitigation measures.

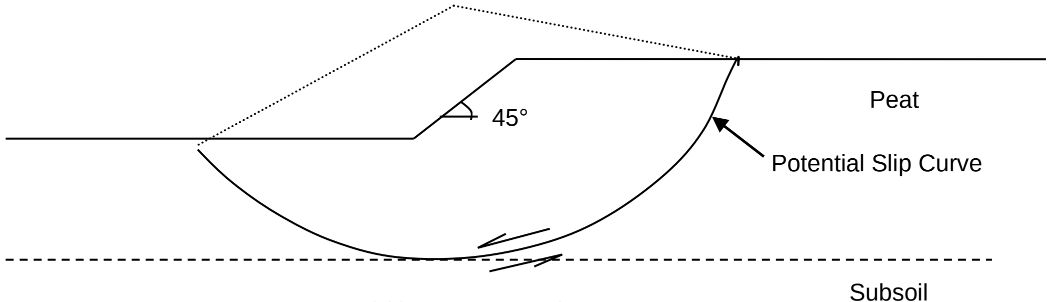
Based on the above analysis, it is likely that the cut faces of natural soils (assuming topsoil has been removed), with height is in excess of this figure, will require support (or terracing) at certain locations, either by battering back to 45° for shallower faces or use of sidewall support / plating in the case of deep excavations for hard-standings. The excavation of soils will therefore have to be carefully managed in order to mitigate against local face or slope failure.

b) Rotational failure of battered back slopes:

Assessment of the potential stability of the face of a battered back excavation enables the engineer to determine the level of risk appropriate to excavations.

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

The theory is based on the short-term stability of excavations and involves dividing the soil mass into vertical slices and determining the overall horizontal and moment equilibrium about a potential slip curve tangential to the base of the peat (see diagram below) by equating the active and resisting forces along that curve. A Factor of Safety is therefore determined for both horizontal equilibrium and moment equilibrium. The lower of these values is tabulated in Table 5.



Stability of Excavations

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

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

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

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

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

For 45 degree cut faces, within the maximum peat depth encountered at the proposed development site, the following rotational stability FoS has been calculated. See Table 5 overleaf.

ID	Cu (kPa)	Max Face Height Considered[2]	Factor of Safety Rotational Failure
T01	82	3.5	>1.10
T02	67	3.5	
Substation / Control Building	52	1.6	

Table 5 – Analytical Assessment of Stability of Excavations

Undrained factors of safety are in excess of 1.10. By battering back of the soil faces to slopes of 45° will render the risk of soil instability to be LOW for the natural soil strengths and slopes encountered at the proposed Cloonanny Wind Farm site (assuming surface water flows are kept to a minimum).

---

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

APPENDIX C

SI Report 2274-24A, “Cloonanny Wind Farm, Longford, Co. Longford, Ireland - Preliminary Ground Investigation”.	77 x A4

Cloonanny Wind Farm, Longford, Co. Longford, Ireland

Preliminary Ground Investigation

Report No: 2274-24A Rev0

26th July 2024

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

Natural Forces Renewable Energy Ltd
&
Mable Consulting Engineers

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Cloonanny Wind Farm, Co. Longford

[SOILS AND GEOLOGY STUDY – PRELIMINARY GROUND INVESTIGATION]

Document Control

SIGN OFF		
Name (Role)	Signature	Date
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0.0	24 July 2024	First Draft for Mable Consulting Engineers & Natural Forces Renewable Energy Ltd review	JW	JW	JM

CONTENTS

1 INTRODUCTION

This report should be read in conjunction with the Cloonanny Wind Farm – "Soils and Geology Technical Assessment Report", Report 2274-24.

In May 2024 Whiteford Geoservices Ltd was commissioned by Mable Consulting Engineers to undertake investigation works at Cloonanny Wind Farm near Longford, County Longford, Ireland, on behalf of their client Natural Forces Renewable Energy Ltd.

This preliminary investigation was required to obtain information for the civil design of access tracks and other infrastructure; primarily with respect to the assessment of soils and geology in relation to an application for planning permission: -

A total of 2nr new wind turbine generators, substation, associated infrastructure and turbine hardstands, as well as new site access tracks.

The results of this site investigation have been employed to determine the nature of, and condition of, the soils and geology underlying the proposed major wind farm infrastructure.

Prior to carrying out these investigation works a desktop study and walkover survey had been undertaken for the site to provide a broad understanding of the prevailing ground conditions along with a screening assessment for the hazard of peat instability. As part of the walkover survey, preliminary peat / organic soil thickness was recorded and Peat Landslide Hazard screening undertaken.

This analysis determined that peat / sensitive organic soils are either not present within the zone likely to be affected by wind farm construction works or of sufficient depth to cause peat instability.

The site investigation works, detailed within this report, consist of the following elements;

The scope of these works was as follows: -

Ref	SI Component	Remarks
A	Peat probing	In-situ assessment of peat thickness at wind turbine generators and substation. (7nr).
B	Trial pitting to determine the underlying soil type, its thickness overlying rock and the relative competence of each stratum.	A total of 6nr Trial pit exploratory holes to assess ground conditions. Each trial pit was excavated to a maximum depth of 3.5 – 4.0m depending on specific ground conditions. These exploratory holes were undertaken at the following locations: 1. T1 2. T2 3. SUBSTATION

C	Geophysical Surveys at T01 and T02	To identify bedrock and potential geohazards
D	Laboratory testing of soils	To determine preliminary geotechnical parameters for foundation design

Table 1 – Scope of SI Works

The investigation was performed in accordance with the relevant standards (see References) and data presented within the relevant appendix to this report.

This report presents the factual records of the investigations undertaken.

2 SITE AND GEOLOGY

2.1 The Site

Cloonanny Wind Farm is situated approximately 2.8km north of Longford, County Longford where it lies on agricultural lands between the R193 and the Camlin River.

Ground surface elevations within the Site vary between approximately 44m to 61m above Ordnance Datum (Malin Head).

The land usage across the number of land holdings which make up the Cloonanny Wind Farm development area consists of agricultural grazing land for cattle and pockets of coniferous forestry.

The closest active quarrying operation to the site, is Rhyne Rock (Limestone) Quarry, at Rhine, Killoe, Co. Longford approximately 4.5km north west of the Site.

2.2 Published Geology

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

- Visean Undifferentiated Limestone
- Till (derived from Lower Palaeozoic and Carboniferous sandstones and shales)
- Alluvium (associated with a watercourse to the eastern edge of the Site)
- Cutover Raised Bog (isolated discrete locations in the west of the Site)

2.2.1 Solid Geology

According to the GSI online database, the majority of the proposed development area for Cloonanny Wind Farm site is immediately underlain by the Visean Undifferentiated Limestone Formation which consists of Interbedded limestone with subordinate sandstone and argillaceous beds.

Also present just outside the development area, at the southern edge of the Site, south of the Camlin River, the bedrock geology is recorded to be Argillaceous Limestones consisting of dark limestone, shale and chert.

The boundary between these two rock types coincides with a fault that trends in a south west to north east direction along a portion of the Camlin River that forms the southern Site boundary. Bedrock adjacent to fault zones have the potential to have caused highly fractured and deeply weathered, where this can have the effect of channelling groundwater flow.

Such conditions can have significance for foundation design of structures such as wind turbines at T01 and T02. This will be fully investigated prior to the construction phase during the main pre-construction ground investigation.

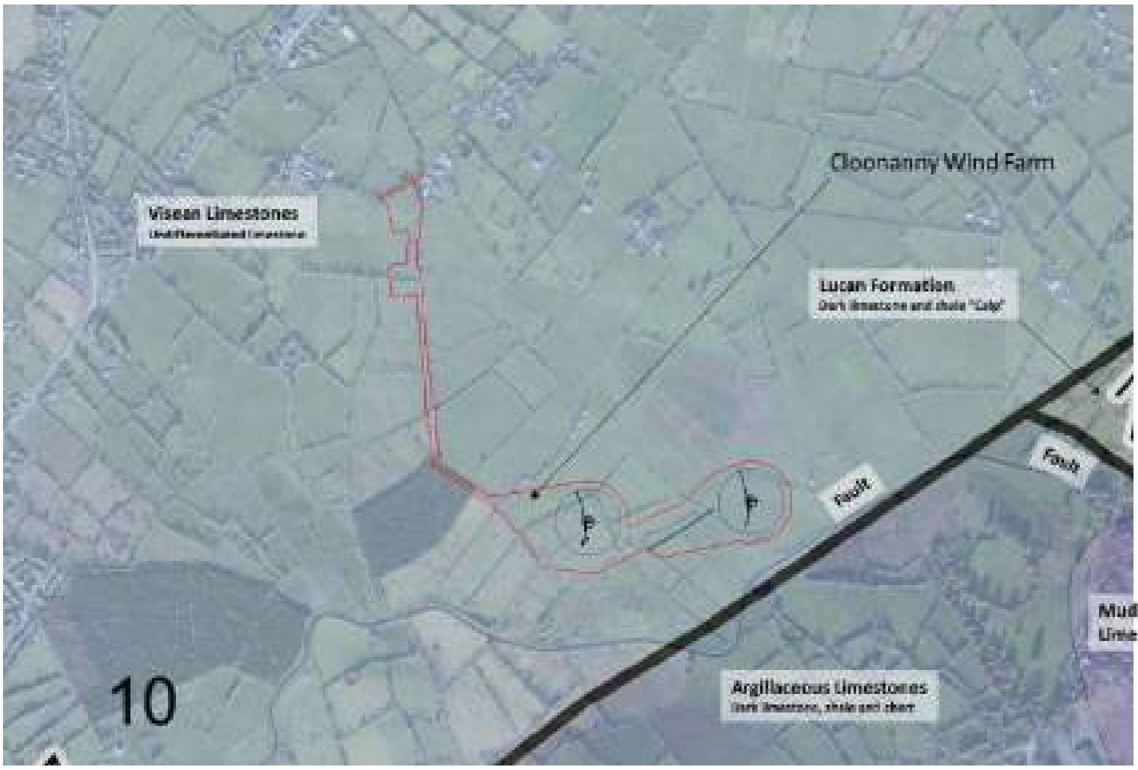

Figure 1 – Bedrock Solid Geology
Reproduced courtesy of GSI Datasets Public Viewer

Internationally, faults can often be associated with an increased hazard of ground movement. That notwithstanding, Ireland is currently located within a region of extremely low tectonic activity and well removed from regions of significant seismic activity.

The most significant event recorded in Ireland by the British Geological Survey was a low energy seismic event that occurred on 7th April 2019 more than 100km from the wind farm site. Details held for the largest and closest recorded events are contained within the table below.

yyyy-mm-dd	hh:mm:ss.ss	Lat	Lon	Depth	ML	Nsta	RMS	Intensity	Locality
27/07/1970	02:45:13.1	53.5	-5	5	2.7			.	ANGLESEY
16/09/1982	03:31:00.0	53.4	-5.8		0.5			2	W OF CANNICH

24/09/1982	16:28:26.1	53.31	-5.67	2.3	1.4				CELTIC SEA
16/10/1982	03:31:00.0	53.4	-5.8		0.5				KISH BASIN
24/10/1982	16:28:27.0	53.38	-5.75		1.5				KISH BASIN
11/09/1983	21:46:29.0	53.41	-6.93		0.8			3	ENFIELD
19/12/1989	21:50:07.3	53.54	-4.93	9.5	0.1				IRISH SEA
15/05/1990	20:14:11.1	53.041	-5.441	11.1	1.4	17	0.4		IRISH SEA
28/04/1992	21:34:05.6	52.931	-6.177	11	1.3	12	0.2	2	WICKLOW
10/11/2004	23:35:15.2	53.175	-5.241	7.5	2.1	17	0.3		IRISH SEA
14/12/2005	03:30:25.4	53.005	-5.644	8.8	2.8	19	0.4	3	IRISH SEA
01/12/2012	10:24:16.0	53.13	-5.253	9.6	1.1	7	0.2		IRISH SEA
21/12/2013	10:37:37.7	53.15	-5.385	12.2	1	5	0.3		IRISH SEA
07/09/2015	12:15:53.3	54.521	-5.986	3.3	0.8	3	0.4		DRUMBEG
19/09/2015	20:08:28.6	53.944	-5.037	5	0.5	8	0.4		IRISH SEA
10/03/2017	05:06:26.7	53.046	-5.509	8.9	0.7	6	0.3		IRISH SEA
18/05/2017	23:04:14.6	53.042	-5.43	13.9	0.9	8	0.3		IRISH SEA
17/11/2019	14:56:09.2	53.537	-5.441	7.5	0.7	6	0.2		IRISH SEA
15/12/2019	21:19:52.9	53.636	-4.931	7.5	2.1	21	0.4		IRISH SEA
20/12/2019	09:53:44.2	53.634	-4.932	6.5	1.1	10	0.4		IRISH SEA
13/02/2020	19:13:03.3	53.017	-5.561	10.4	1	5	0.1		IRISH SEA
06/06/2020	14:19:36.0	53.636	-4.925	5.6	1	7	0.4		IRISH SEA
17/09/2020	17:31:42.2	53.585	-6.13	17.8	1.1	10	0.2		SKERRIES
17/05/2022	23:00:56.9	53.04	-5.451	6.7	1.1	6	0.4		IRISH SEA

Table 2 – Schedule of Selected Historic Earthquakes of Significance

Reproduced courtesy of BGS Earthquake Database

🟨	Nearest largest seismic event
🟧	Largest recorded seismic event (within 100km)

In light of the above an assessment has been made with regard to seismic activity. This has determined that any ground movement recorded can be expected to be negligible with respect to the development proposed; where Peak Ground Accelerations can be expected to be in the order of 0.02g[1].

2.2.2 Superficial Geology

GSI records the superficial soils present within the wind farm to be thick glacial till soils (Substation and turbine T01) generally >10m thick, with thinner sequences, 5m – 10m are present in the vicinity of turbine T02. overlying limestone rock.

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[1] Source: British Geological Survey – Search of Earthquake Database centred on Cloonanny Wind Farm – search radius of 100km; time period 1st Jan 1000 to 23/12/2022.

GSI also record Raised Cut-over Peat Bog in the vicinity of turbine T02, although walkover inspection has observed an absence of peat at this location.

Alluvium is present at the eastern edge of the site where it is associated with the Camlin River, Derryharrow and another un-named watercourse near the site entrance.

These alluvial soils could have the potential to impact design of foundations at T02.

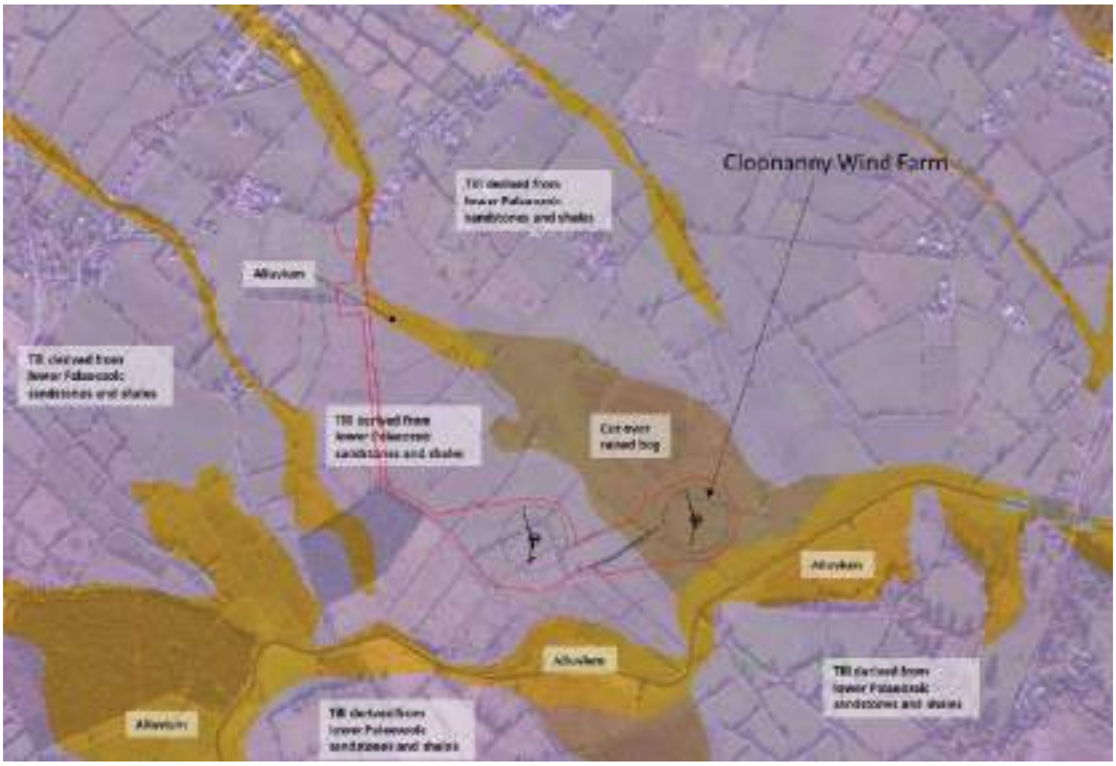

Figure 2 – Superficial Geology
Reproduced courtesy of GSI Datasets Public Viewer

3 FIELDWORK

3.1 General

All fieldwork was carried out in general accordance with BS 5930:2015+A1:2020 and other related standards.

Please refer to Appendix A for the location of all geotechnical investigations undertaken.

3.2 Exploratory Holes

The exploratory holes are detailed within the following table.

METHOD	QUANTITY	MAXIMUM DEPTH (m)	EQUIPMENT
Trial Pit	6 Nr.	3.70	Trial pits were carried out with the use of a 13T Tracked Excavator

Table 3 – Schedule of Exploratory Holes

Refer to Appendix B for engineering logs of trial holes

3.3 In-situ Testing

The in-situ testing works carried out are detailed within the following table.

TYPE	QUANTITY	MAX. DEPTH (M)	EQUIPMENT
Peat Probing	3[2]	None present within Site	Rigid “depthing rods”
In-Situ Shear Strength	3	3.00	At centre of T01, T02 and Substation
Von Post (Decomposition Assessment)	3	None present within Site	At centre of T01, T02 and Substation

Table 4 – Schedule of In-Situ Tests

Refer to Appendix B for details

3.4 Geophysical Surveys

The geophysical survey involved the following non-destructive testing techniques.

---

[2] Peat probing was undertaken at the centre-point for each wind turbine generator and at the Substation

METHOD	LOCATION	MAXIMUM DEPTH PENETRATION (m)	EQUIPMENT
2D Electrical Resistivity Tomography	2 Nr. profile at “wind turbine generators T02, T04 and T06.	approx. 15m	Campus Tigre Electrical Resistivity Imaging System.
2D Electromagnetic Conductivity Surveying	2nr grids of geophysical data was collected at the site of proposed infrastructure at T01 and T02	Approx. 5m	Geofyzika CMD4 Ground Conductivity Meter

Table 4 – GPR and Geophysical Methods Deployed

2D Electrical Resistivity

A Campus Tigre Electrical Resistivity System employing a 32 electrode Wenner Array was used to conduct the geophysical 2D resistivity survey, with the intention of analysing the sub-surface to a depth of approximately 15m below existing ground level.

Field quality-controlled data processing was carried out using Imager Pro 2006.

Two electrodes input a controlled electrical current into the ground, where the lines of current flow adapt to the sub-surface resistivity pattern. In this way the potential difference between the equipotential surfaces can be measured, where they meet the ground surface, using a second pair of electrodes. Comparison of the input current to the measured potential difference enables the resistance to be calculated.

Imager Pro 2006, a Windows acquisition program allows real time colour pseudo-sections to be generated on the laptop computer used to collect and store data in the field. Such real time presentation offers instant confirmation of data quality.

Res2DinV software was applied to the field data to provide the modelled sections which were then interpreted, in terms of resistivity, by an experienced Geologist.

Refer to Appendix C for the annotated 2D Electrical Resistivity profiles collected.

Electromagnetic Conductivity

A digital CMD-4 electromagnetic conductivity meter was employed to record quadrature data (Conductivity) within the region surrounding the wind turbine generators, where the stability of existing strata has the potential to impact the stability of new structures.
Refer to SI Layout Plan, L1, contained in the Appendix.

Positions were recorded, in real-time, using a differential GPS integrated with the CMD-4 surveying unit.

Data processing was carried out using Golden Software Surfer 16 and the information was analysed for anomalies that may indicate changes in the sub-surface.

3.5 Topographical Survey

A topographical survey of exploratory hole locations was undertaken post-completion of all associated investigation works and is detailed in the table below.

EQUIPMENT	COORDINATE SYSTEM
Leica RTK / GNSS DGPS System	Irish Transverse Mercator (ITM) / Malin Hean (Ordnance Datum)

Table 5 – Topographic Surveying

4 LABORATORY TESTING

4.1 Geotechnical Testing

Following detailed analysis soils laboratory testing was undertaken on samples collected from the site.

This testing was scheduled and carried out in accordance with BS 1377 (1990) and other standards by Whiteford Geoservices Ltd.

A schedule of this testing is summarised in the table below and the results are presented within Appendix C.

TYPE	QUANTITY	REMARKS
Bulk Density	3	BS1377:1990 Part 2
Natural Moisture Content	7	BS1377:1990 Part 2
Partial size Distribution	3	BS1377:1990 Part 2
Sulphate Content of Water Extract	3	BS 1377- Part 3 (2018)
Chloride Content of Water Extract	3	BS 1377- Part 3 (2018)
Sulphide Content of Water Extract	3	BS 1377- Part 3 (2018)
Organic Matter Content	3	BS 1377- Part 3 (2018)
pH	3	BS 1377- Part 3 (2018)

Table 6 – Schedule of Laboratory Test of Recovered Samples

5 SURVEY RESULTS

5.1 Introduction

The investigation has provided geophysical information on the sub-surface conditions within the zones identified on the Geophysical Layout Plans in Appendix A.

Refer to Appendix C for annotated findings for the 2D Electrical Resistivity Surveys.

5.2 Soil Stratigraphy at Turbines

The following Table details the findings of preliminary exploratory holes undertaken at proposed Wind Turbine positions. Refer to Appendix B for individual engineering logs of exploratory holes

TURBINE NO.	TOPSOIL THICKNESS (M)	DEPTH TO COMPETENT MINERAL SOIL (M)	SOIL TYPE	WEAK ROCK DEPTH (M)
T01	0.20	0.50	Firm, grey mottled orange, sandy, gravelly SILT / CLAY with a medium cobble and low boulder content.	>3.60 (Est. > 10m)
T02	0.70 – 0.80	1.00	Medium dense, grey, very silty SAND.	>3.70 (Est. 5 – 10m)
SUB	0.30	0.60	Firm, grey mottled orange, sandy, gravelly SILT / CLAY with low cobble and boulder content.	>3.50 (Est. >10m).

Table 7 – Summary of Stratigraphy at Main Infrastructure

In light of the findings from the preliminary trial hole works the following schedule of foundations is recommended for the main infrastructure

TURBINE NO.	TURBINE / BUIDLING	HARDSTAND / TRANSFORMER BASE	ACCESS TRACKS
T01	Gravity Base Foundation in stiff SILT / CLAY (c. 3.50m – 5.00m depth)	Place at 1.00m depth within competent mineral soils	Remove all soft or very weak soils and commence road construction within firm CLAY/SILT or loose SAND soils
T02	Gravity Base Foundation in medium dense SAND (c. 3.50m – 5.00m depth)	1.00 m depth within competent mineral soils	
SUB	Raft Footing for Building on rock (c. 1.60m depth)	1.20 m depth within competent mineral soils	

Table 8 – Recommendations for Infrastructure Foundations

5.2 Geophysical Survey

5.2.1 2D Electrical Resistivity Survey (Turbines T01 and T02)

a. Profiles at Turbine T01, indicates a thin layer of organic soils overlying approximately 16m of low resistivity material, probably sandy gravelly SILT/CLAY containing potentially very large boulders. There is a weak indication of a higher resistor, i.e. limestone rock at approximately 16m depth, although this is poorly defined.

b. Profiles at Turbine T02, indicates a thin layer of topsoils overlying approximately 6 – 6.5m of low resistivity material, probably silty SAND. There is also a strong indication of a higher resistor, i.e. limestone rock at approximately 7m depth. There is no indication of lateral variability in the rock formation that would suggest “karst” features, e.g. cavities, sinkholes etc.

5.2.2 Conductivity Surveys (Turbine T01 and T02)

a. Surveys at T01 indicate very little variation in ground conductivity and indicates that the thick glacial till soils vary little across the construction footprint. It is unlikely that this method has penetrated deep enough to give us any useful information in respect to the underlying limestone rock formation.

b. Surveys at T02 record obvious variation in the Conductivity data within the construction footprint. This is believed to relate to a potential variation in the soil type present, i.e. the relative distribution of granular soils to cohesive soils. It is unlikely that this method has penetrated deep enough to give us any useful information in respect to the underlying limestone rock formation.

6 SUMMARY OF SITE INVESTIGATION FINDINGS

The following table summarises the main additional findings from the Site Investigation campaign in respect to Soils and Geology.

REF.	ITEM	DETAIL
1	Typical Soil Overburden	A. 0.20 – 0.30m of topsoil overlying a very thick sequence of firm to stiff sandy gravelly CLAY / SILT containing cobbles and boulders. Geophysical surveys predict limestone bedrock to be in excess of 10m depth. (T01 and the Substation). B. 0.70 – 0.80m of topsoil overlying thick sequence of potentially alternating silty SAND and stiff sandy gravelly CLAY / SILT soils containing cobbles and boulders. Geophysical surveys predict limestone bedrock to be at 6 - 7m depth. (T02 only).
2	Typical Overburden[3] Thickness (m)	T01 = 10 - 20m T02 = 5 - 10m SUBSTATION = 10 - 20m
3	Rock Type	Not sampled on site but expected to be dark grey LIMESTONE. The potential for “karst” dissolution features to be present is high.
4	Potential for Dissolution Features / “Karst” Landforms to be present	Limestone rock underlies the site and is known to be karstified in other areas. Where “karst” dissolution features develop in limestone rock they have the potential to induce instability in structures placed on top of them. The potential impact to the Development is Significant, but will be mitigated by undertaking a detailed pre-construction ground investigation. This investigation will contain supplementary holes intended to map the competence of the rock formation over the footprint of the main infrastructure.
5	Rock Competence	Currently unknown as rock formation was not exposed during preliminary SI works. This limestone formation is expected to be initially highly weathered to the point of disintegration, where the material resembles dense, often very large cobbles and boulders in a matrix of mineral soil. Where intact, the rock formation competence is expected to be WEAK or better.
6	Typical Depth to Non Rippable Rock[4]	T01 = est. 16m T02 = est. 7m SUBSTATION = >10m

---

[3] Extremely weak rock is considered to be overburden, as are soils. Weak rock is not considered to be overburden and is anticipated to be the limit of straightforward conventional excavation.

[4] Using 13T tracked excavator

REF.	ITEM	DETAIL
7	Anticipated Wind Turbine Foundation Type	WTG01 = Gravity Base at 3.5m – 5m depth within stiff mineral soils potentially with associated ground improvement, or Piled and socketed into the limestone bedrock. WTG02 = Gravity Base at 3.5 – 5m depth within stiff mineral soils potentially with associated ground improvement, or Piled and socketed into the limestone bedrock. SUBSTATION = Raft, strip or pad foundations within competent mineral soils, Est > 1.2m depth
8	Groundwater Regime	T01 – No groundwater recorded during SI. Soils are weakly permeable only. Location expected to be in hydraulic continuity with Camlin River and at this location subject to slow recharge. Mobile ground water table anticipated. T02 – Weak flows of groundwater recorded at 2.80 – 3.30m depth during SI. Soils are moderately permeable. Location expected to be in hydraulic continuity with Camlin River and at this location subject to moderate rate of recharge. Mobile ground water table anticipated. Substation – No groundwater recorded during SI. Soils are weakly permeable only. Location expected to be in hydraulic continuity with Camlin River and at this location subject to slow recharge. Mobile ground water table anticipated.
9	Protected Geological Sites	The following sites of geological significance are present in the local vicinity: - RO022: Mid Roscommon Ribbed Moraines, IG7 LD004: Drumlish Quarry, IG4 LD011: Killoe Quarry, IG8 LD007: Creeve Quarry, IG8 All these sites are sufficiently far enough from the proposed development for any potential impact / effect caused by its construction and operation to be imperceptible.
10	Landslide Hazard	GSI mapping indicates landslide potential at the Site to be low. Preliminary SI indicates that peat soils are absent at the main infrastructure and the natural mineral soils are not considered sensitive. Maximum slope gradients at the site are less than 5 degrees to the horizontal. Risk is confirmed to be low.
11	GSI – Crushed Rock Aggregate Potential	According to Geological Survey Ireland, the Aggregate Potential for the Borrow Pit site can be summarised as follows: - Moderate – Majority of development area, including T01, T02 and the Substation and majority of access track network. High – Portions of Turbine T02 However, the author's own opinion is that the significant thickness of overburden likely to need removed to exposed the underlying limestone rock formation would make quarrying operations uneconomical. Further borehole SI would be required to intercept the rock formation and test the competence of the crushed rock.

REF.	ITEM	DETAIL
12	Predicted Performance as a construction fill material	It is anticipated that negligible rock spoil will be generated during construction works. Spoil will consist of either SILT/CLAY or SAND/GRAVEL mineral soils. The former are likely to be variable in terms of their suitability and likely to be subject to degradation by wet weather conditions. The latter are anticipated to perform well as a construction fill material and less susceptible to weather conditions.
13	Predicted Performance as a construction aggregate	**It is not possible to predict with any certainty the quality of crushed rock aggregate that could be derived from the site**. Further SI is required to gain the necessary additional information to determine rock aggregate performance. The following is known and positive; a) this limestone rock formation generally produces an acceptable quality of crushed aggregate b) b) there are limestone rock quarries within 5km of the site. The following is known and negative; a) at this site b) GSI records indicate a moderate to high potential for crushed rock aggregate at this site.

Table 7 - Summary of Findings

7 REFERENCES

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24. ASTM C215-08: Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Frequencies of Concrete Specimens
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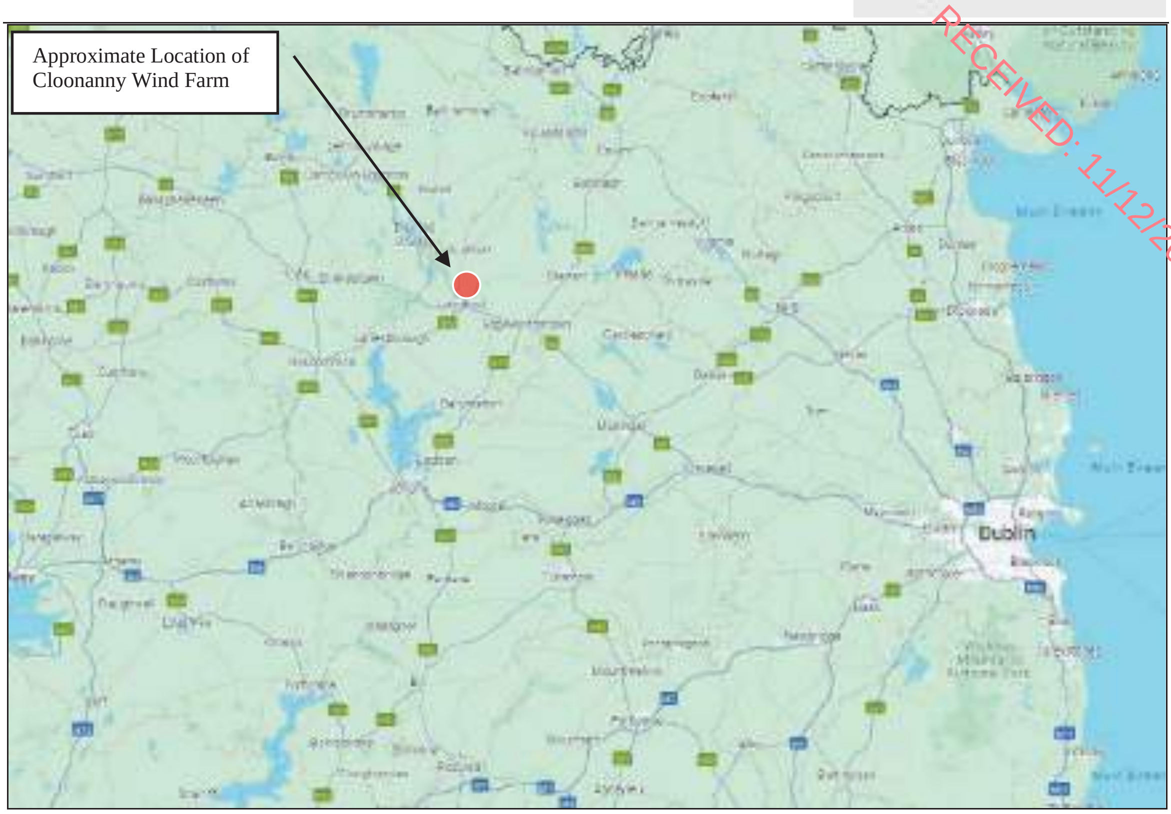
APPENDICES

Appendix A	DRAWINGS
Appendix B	RESULTS OF PEAT LANDSLIDE HAZARD SCREENING PRELIMINARY TRIIAL HOLE INVESTIGATION ENGINEERING LOGS
Appendix C	INTERPRETED GEOPHYSICAL SURVEY DATA
Appendix D	SOILS LABORATORY TESTING
Appendix E	PHOTOGRAPHIC RECORD

APPENDIX A

DRAWINGS

General Site Location Plan Solid Geology **Figures P1 & P2**	1 x A4
Walkover Study Areas **Figure A1**	1 x A3
Solid Geology **Figure A2**	1 x A3
Superficial Geology **Figure A3**	1 x A3
Groundwater Features, Karst, Springs and Abstraction **Figure A4**	1 x A3
Landslide Susceptibility and Recorded Events **Figure A5**	1 x A3
Minerals and Active Quarrying **Figure A6**	1 x A3
Geological Audited and Unaudited Sites **Figure A7**	1 x A3
Groundwater Vulnerability **Figure A8**	1 x A3
Crushed Aggregate Potential **Figure A9**	1 x A3
Site Layout Plan and Location of Exploratory Trial Holes and In-situ Tests **Figure L1**	1 x A3
Classed Plot of Peat Thickness Overlaid On Background Plot *(Peat Landslide Hazard Screening)* **Figure D1**	1 x A3
Contoured Plot of Ground Surface Elevation Overlaid on Background Plot **Figure D2**	1 x A3
Contoured Plot of Ground Slope Gradient Overlaid on Background Plot **Figure D3**	1 x A3



P1 - General Location Plan (Aerial view)
(© Google Maps 2024)

P2 - Local Location Plan (Aerial view)
(© Google Earth 2024)

2274-24 Cloonanny Wind Farm, Co. Longford
Google Earth SI Layout Plan

Walkover Survey Study Areas & Preliminary Trial Holes at Proposed Turbines and Borrow Pits

Notes:

1. GSI Copyright Google Earth
2. Where indicated all elevation relate to Main Head Datum
3. Background Mapping Source: OSI Digital Globe.

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J.W.	J.M.	J.W. 24/06/2024	Figure 8.0	24/06/2024	NTS

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Wind Farm Layout Plan and Study Areas

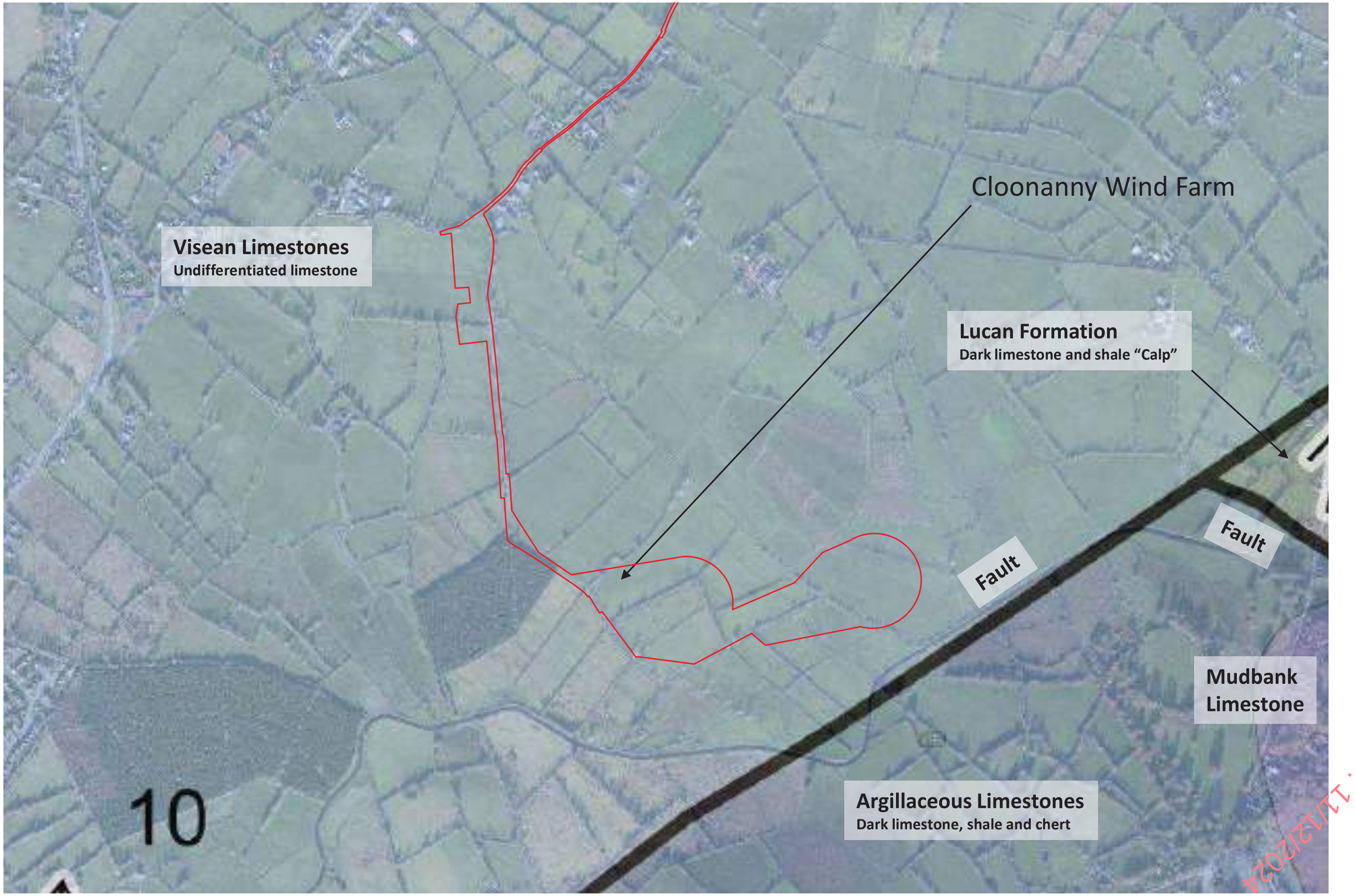
Cloonanny Wind Farm
Soils and Geology Assessment

Edition 1

Sheet

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Solid Geology



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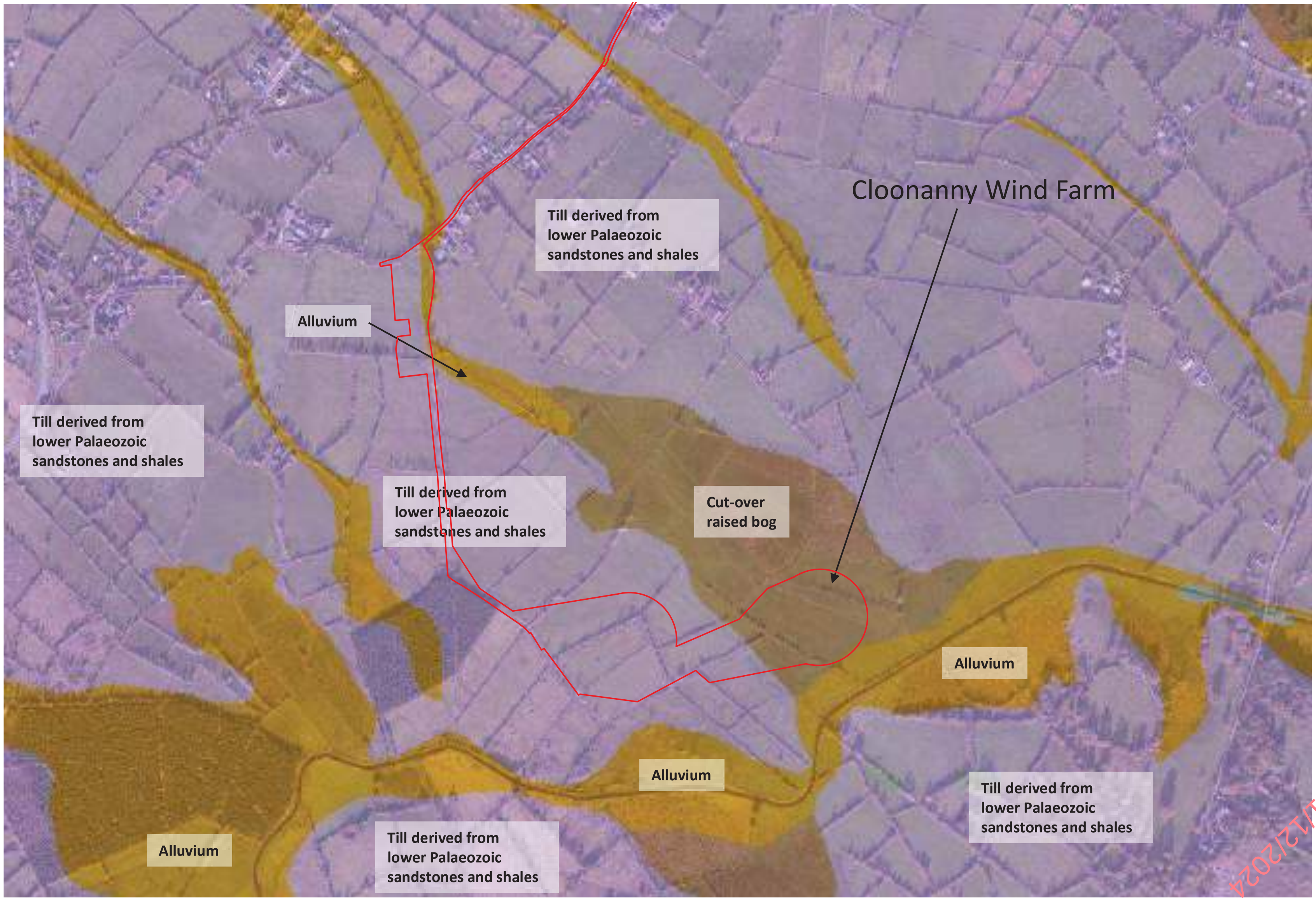
	Cloonanny Wind Farm **Soils and Geology Assessment**			Edition 1	Sheet

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Superficial Soils



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Superficial Soils

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Soils and Geology Assessment

Edition
1

Sheet

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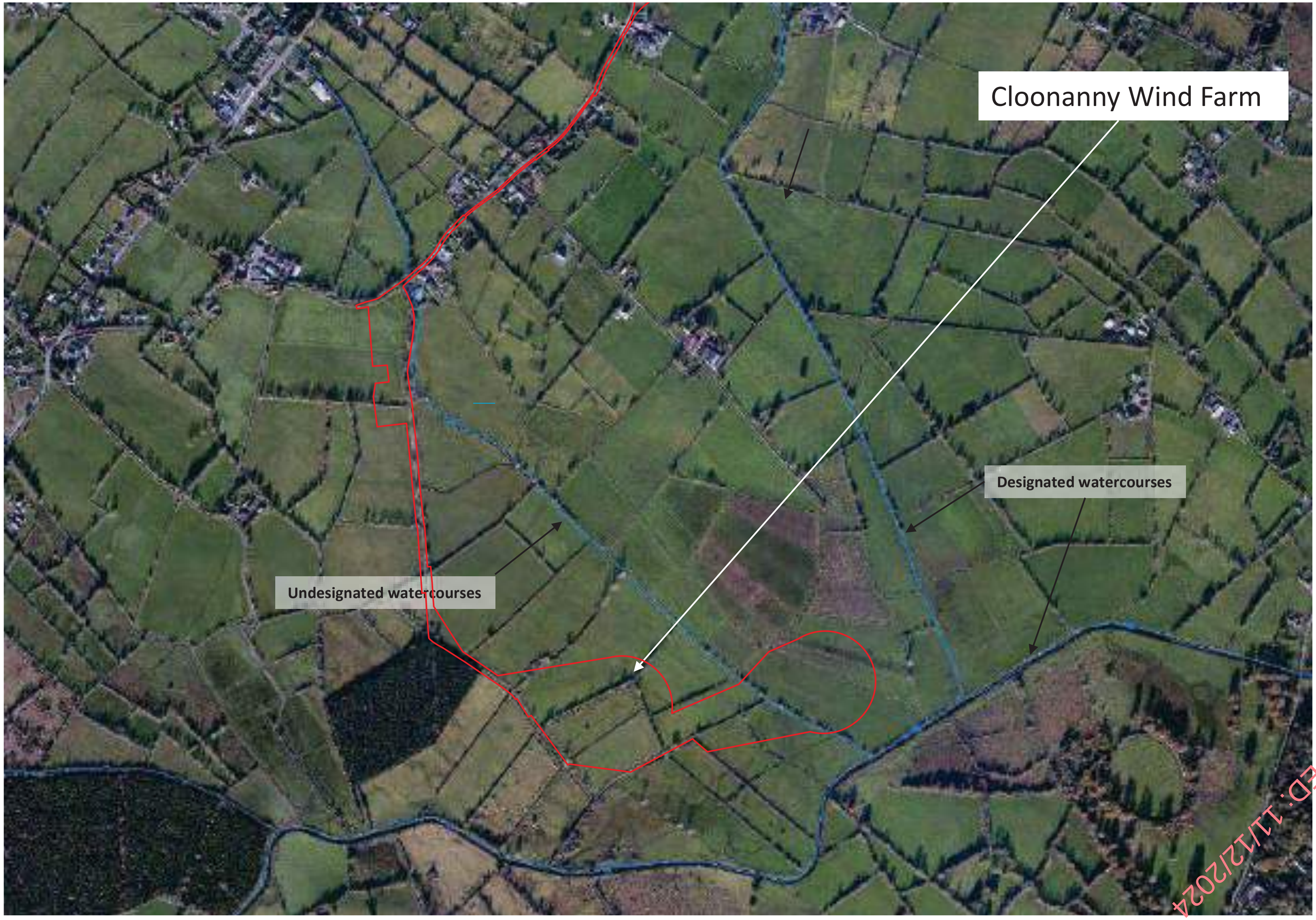
Soils and Geology Constraints

GSI – Groundwater Features, Karst Features, Springs and Abstraction Points



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Geological Survey of Ireland Online Mapping Database
Groundwater Features, Karst, Springs and Abstraction

Cloonanny Wind Farm
Soils and Geology Assessment

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Soils and Geology Constraints

GSI – Landslide Susceptibility and Recorded Events

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Landslide Susceptibility and Recorded Events

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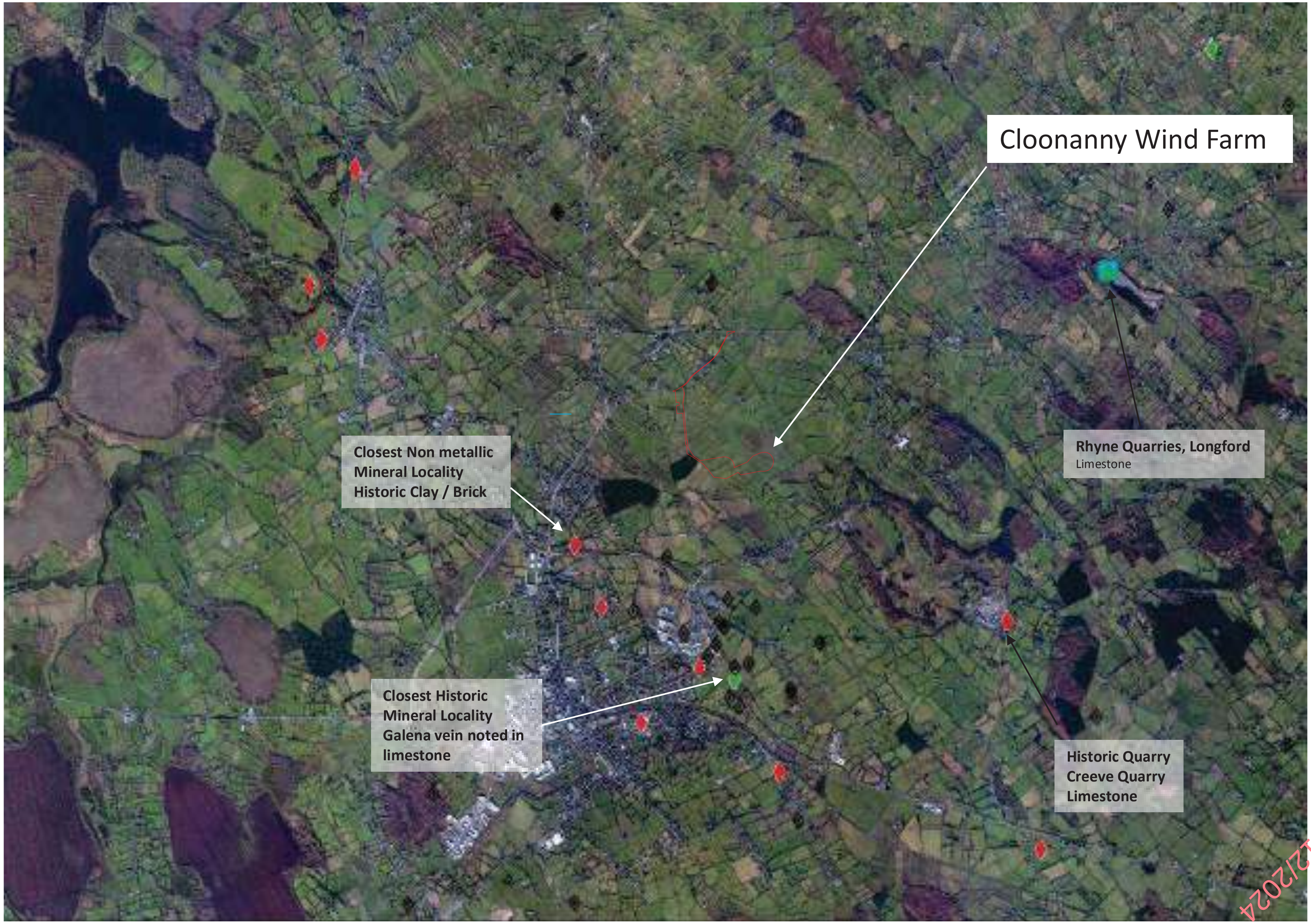
Soils and Geology Constraints

GSI – Minerals and Active Quarrying



Key

- ◆ **Mineral Exploration Boreholes**
- ◆ **Non-metallic Mineral Quarrying Activity**
- ◆ **Historic Metallic Mineral Activity**
- ● **Sand & Gravel Pits**
- ■ **Active Aggregate Quarries**

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Minerals and Active Quarrying

	Edition	Sheet
Cloonanny Wind Farm **Soils and Geology Assessment**	1	

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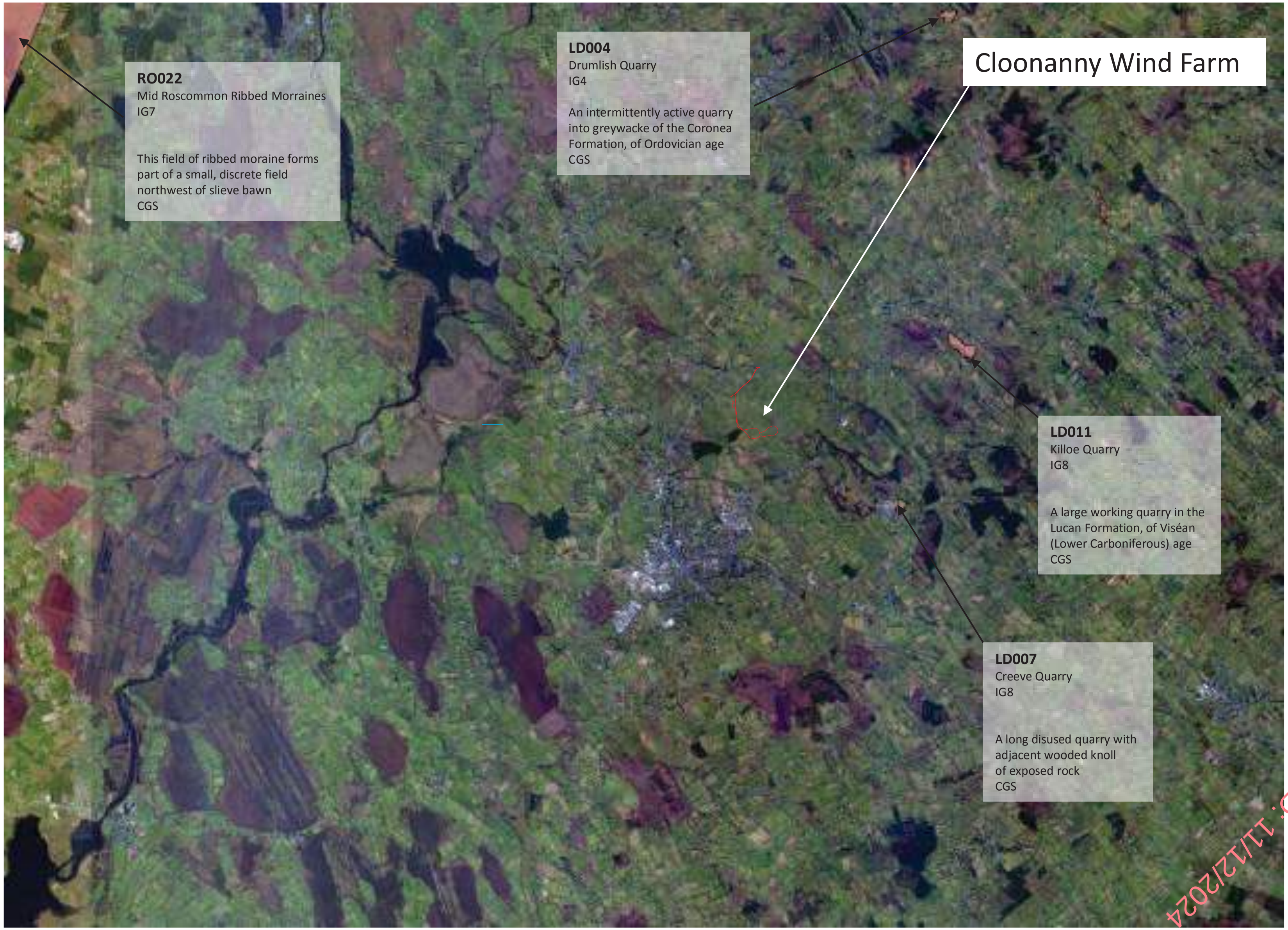
Soils and Geology Constraints

GSI – Closest Geological Audited and Unaudited Sites



Cloonanny Wind Farm

RO022
Mid Roscommon Ribbed Morraines
IG7

This field of ribbed moraine forms part of a small, discrete field northwest of slieve bawn
CGS

LD004
Drumlish Quarry
IG4

An intermittently active quarry into greywacke of the Coronea Formation, of Ordovician age
CGS

LD011
Killoe Quarry
IG8

A large working quarry in the Lucan Formation, of Viséan (Lower Carboniferous) age
CGS

LD007
Creeve Quarry
IG8

A long disused quarry with adjacent wooded knoll of exposed rock
CGS

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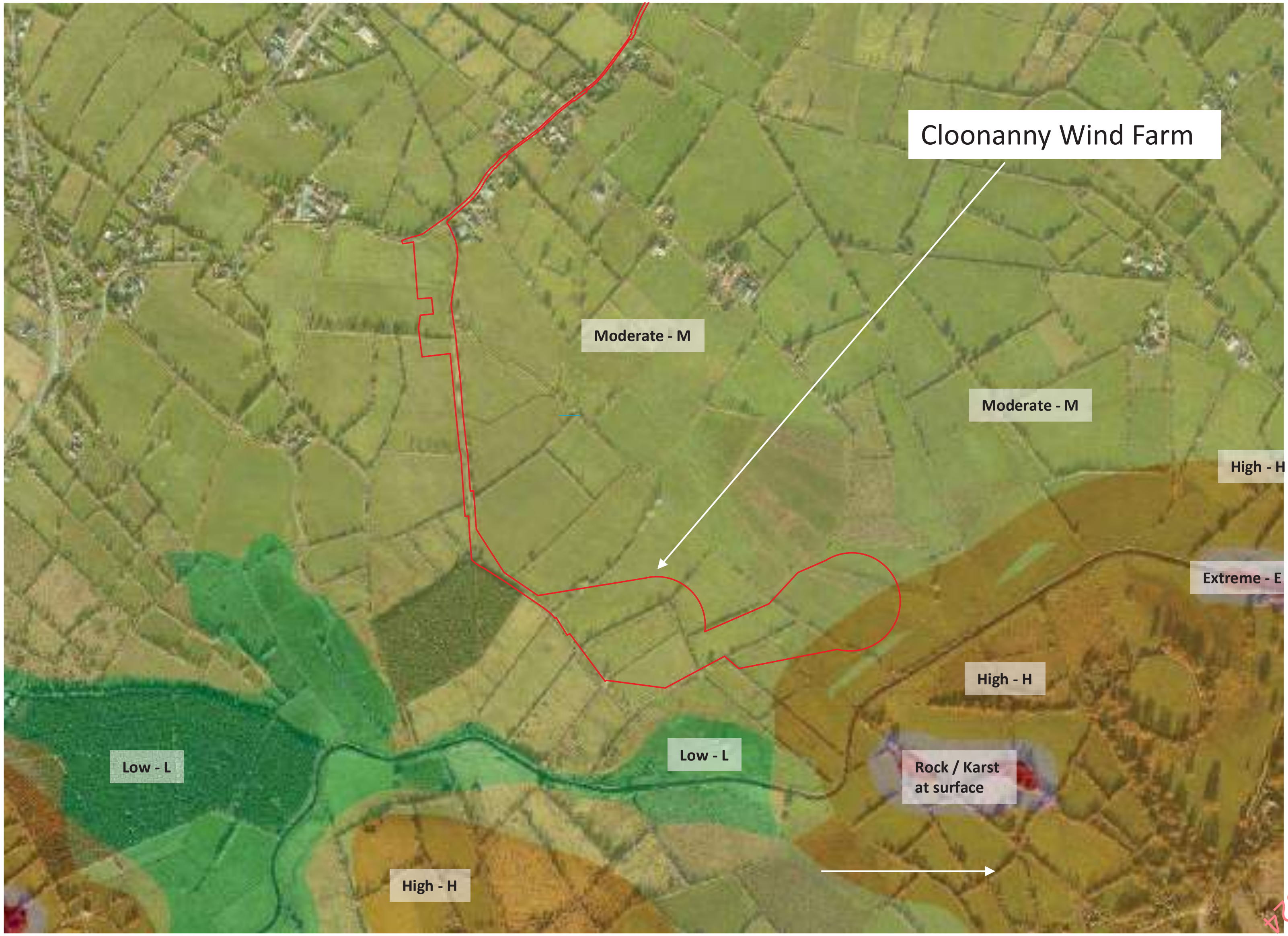
Geological Survey of Ireland Online mapping Database Geological Audited and Unaudited Sites		
Cloonanny Wind Farm Soils and Geology Assessment	Edition 1	Sheet

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Groundwater Vulnerability



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Groundwater Vulnerability

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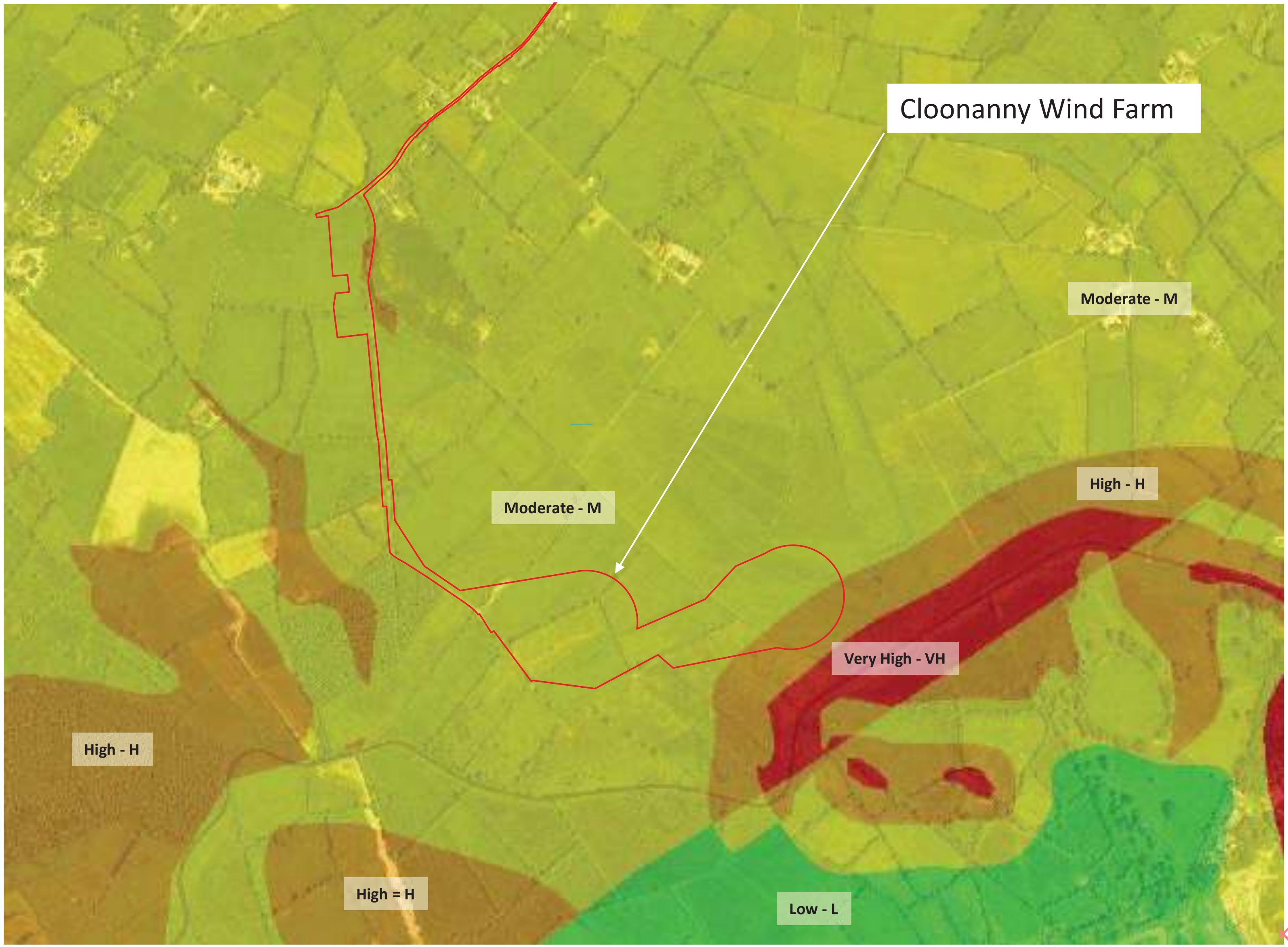
Soils and Geology Assessment

Edition 1

Sheet

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI –



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Crushed Aggregate Potential

Cloonanny Wind Farm
Soils and Geology Assessment

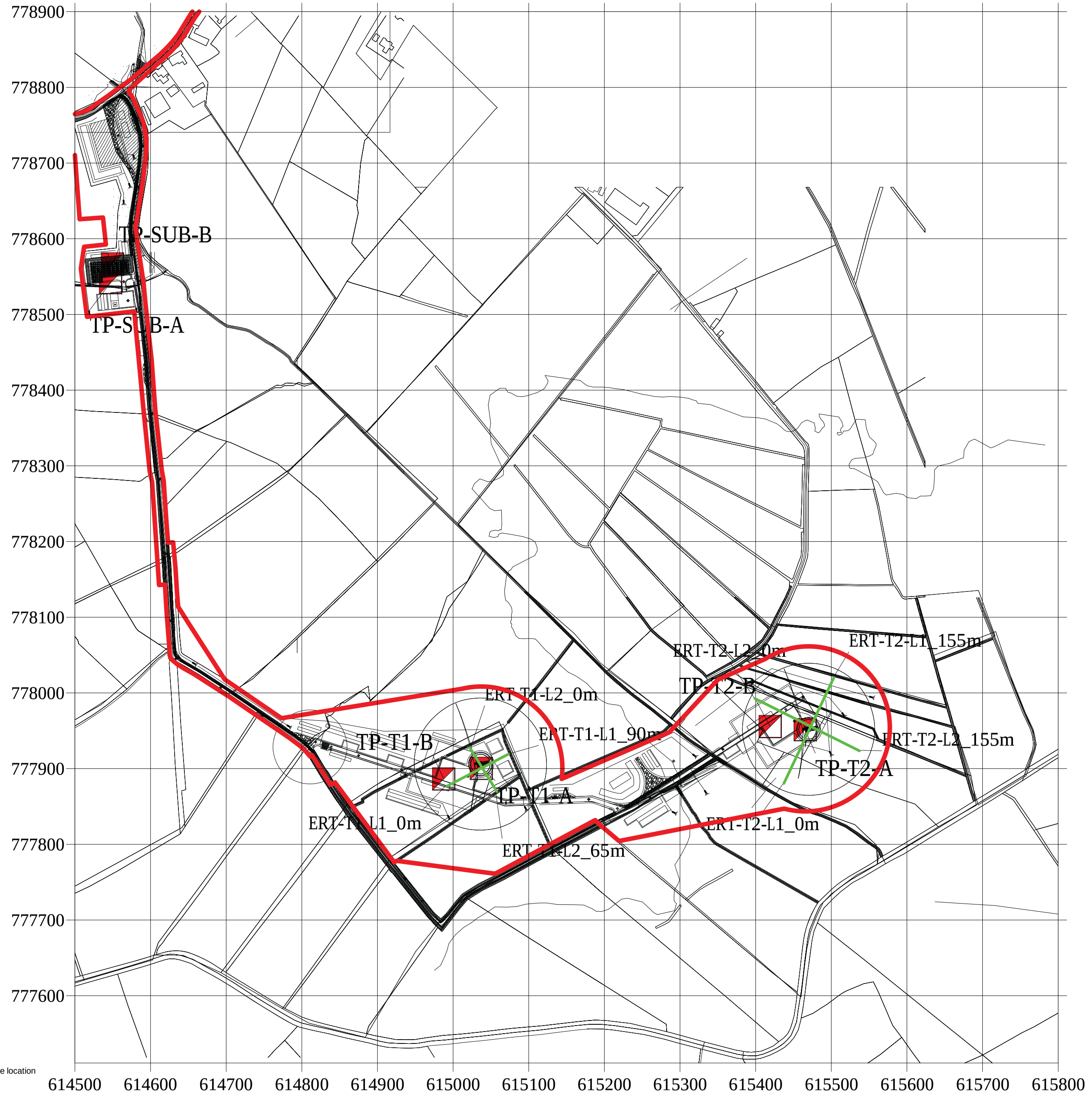
Edition	Sheet
1	

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

As-Built SI Layout Plan

22nd October 2024



KEY

🟥 Trial Hole

Profile for Slope Stability Assessment

Red Line Boundary

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Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

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JW	JW	JM 04/12/2024	2274-24 L1	04/12/2024	1 : 6,000

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Cloonanny Wind Farm -
As Built SI Layout Plan

Location of Exploratory Holes

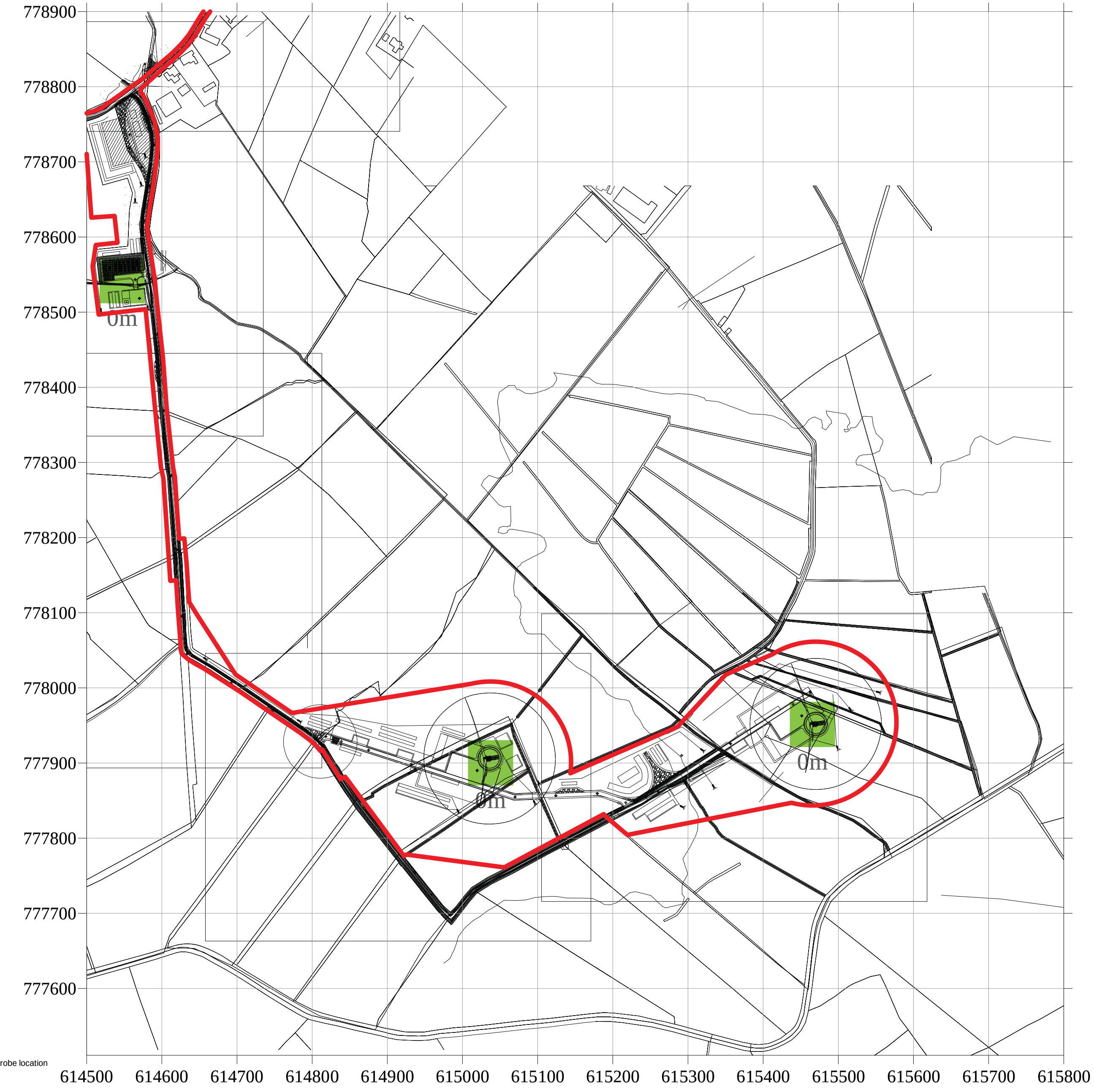
Edition	Sheet
3	A3

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

Classed Plot of Peat Depth

22nd October 2024



KEY

Red Line Boundary

Peat Depth (m)

🟩	0 to 0.5
🟨	0.5 to 1
🟧	1 to 2
🟥	2 to 3
🟫	3 to 4
⬛	4 to 5

Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

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Cloonanny Wind Farm - Classed Plot of Peat Depth

Classed Plot of Peat Depth

Edition 3

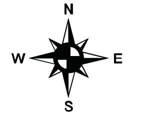
Sheet A3

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

Contour Plot of Ground Elevations

22nd October 2024



KEY

Red Line Boundary

Ground Elevation (m.O.D.)

▨	60.5
▨	59.75
▨	59
▨	58.25
▨	57.5
▨	56.75
▨	56
▨	55.25
▨	54.5
▨	53.75
▨	53
▨	52.25
▨	51.5
▨	50.75
▨	50
▨	49.25
▨	48.5
▨	47.75
▨	47
▨	46.25
▨	45.5
▨	44.75
▨	44

Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

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JW	JW	JM 04/12/2024	2274-24 D2	04/12/2024	1 : 6,000

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Contoured Plot of Ground Elevations

Cloonanny Wind Farm

Edition 3

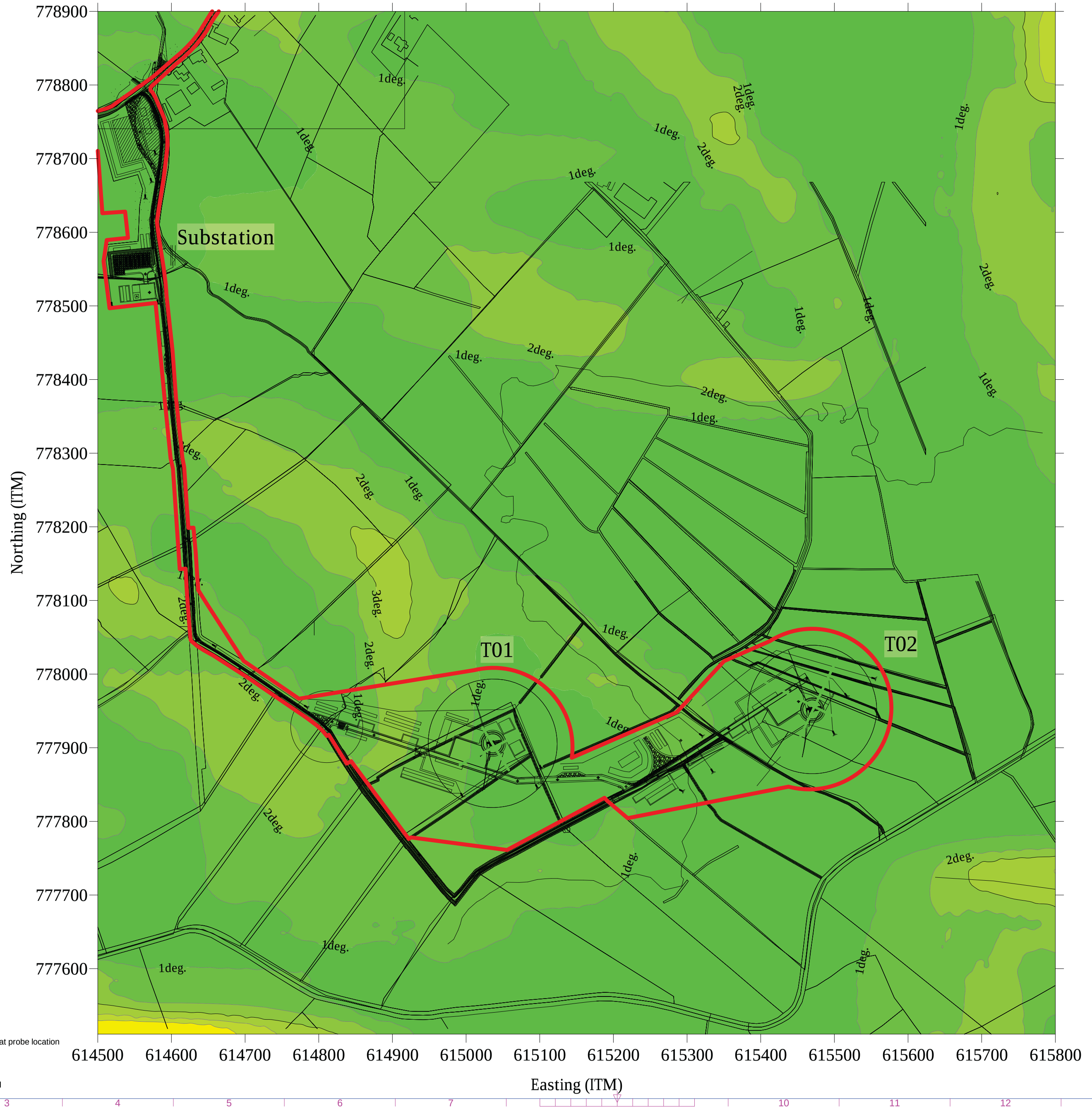
Sheet A3

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P8-Site Layout

Contour Plot of Ground Slopes

22nd October 2024



N
W E
S

KEY

Red Line Boundary

Ground Slopes (deg. to horiz.)

- ⬛ 45
- 🟥 40
- 🟥 30
- 🟥 22.5
- 🟧 15
- 🟨 10
- 🟩 5
- 🟩 4
- 🟩 3
- 🟩 2
- 🟩 1
- 🟩 0

Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

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Contoured Plot of Ground Slopes

Cloonanny Wind Farm

Edition	Sheet
3	A3

APPENDIX B

IN-SITU TEST RESULTS AND LOGS OF EXPLORATORY HOLES

Plot of Peat Thickness at Turbine Locations *(PLH screening)*	1 x A3
Trial Pit Logs	6 x A4

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Tel: (028) 9334 9351
Email: Info@whitefordgeoservices.com
Website: www.whitefordgeoservices.com

Trial Pit Log

Project Name: Cloonanny Wind Farm	Project No: 2274-24	Client:	Date: 31/05/2024
		Contractor:	Co-ords: E614547.24 N778541.99
Location:		Sub Contractor: SBPH	Equipment: Zaxis 130LCN

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-SUB-A	TP	48.50m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	**Sample and In Situ Testing**			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
▨					0.30	48.20	▨	Soft, brown, sandy TOPSOIL
▨		1.00	B		1.60	46.90	▨	Firm, grey mottled orange, sandy, gravelly SILT/CLAY with a low cobble and boulder content
▨		3.00	B		3.50	45.00	▨	Stiff, dark grey, sandy, gravelly SILT/CLAY with a low cobble and boulder content
								End of Pit at 3.500m

Dimensions		**Trench Comments**			**Backfill Details**		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	0.90	Sides unstable upon completion	None		0.00	3.50	Arisings

Remarks

No groundwater encountered.

AGS

whiteford
explore the possibilities

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

Trial Pit Log

Project Name: Cloonanny Wind Farm	Project No: 2274-24	Client:	Date: 31/05/2024
		Contractor:	Co-ords: E614549.76 N778566.69
Location:		Sub Contractor: SBPH	Equipment: Zaxis 130LCN

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-SUB-B	TP	48.61m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
▨							▨	Soft, brown, sandy TOPSOIL
▨					0.30	48.31	▨	Firm, grey mottled orange, sandy, gravelly SILT/CLAY with a low cobble and boulder content
▨		1.00	B				▨	
▨					2.60	46.01	▨	Stiff, dark grey, sandy, gravelly SILT/CLAY with a low cobble and boulder content
▨		3.00	B				▨	
					3.50	45.11		End of Pit at 3.500m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	0.90	Sides unstable upon completion	None		0.00	3.50	Arisings

Remarks

No groundwater encountered.

AGS

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explore the possibilities

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

Trial Pit Log

Project Name: Cloonanny Wind Farm	Project No: 2274-24	Client:	Date: 31/05/2024
		Contractor:	Co-ords: E615037.36 N777900.32
Location:		Sub Contractor: SBPH	Equipment: Zaxis 130LCN

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-T01-A	TP	48.49m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
▨					0.20	48.29	▨	Soft, brown, sandy TOPSOIL
▨		1.00	B		1.60	46.89	▨	Firm, grey mottled orange, sandy, gravelly SILT/CLAY with a medium cobble and low boulder content
▨		3.00	B		3.50	44.99	▨	Stiff, dark grey, sandy, gravelly SILT/CLAY with a medium cobble and low boulder content
								End of Pit at 3.500m

Depth scale: 1, 2, 3, 4

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	0.90	Sides unstable upon completion	None		0.00	3.50	Arisings

Remarks

No groundwater encountered.

AGS

whiteford
explore the possibilities

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

Trial Pit Log

Project Name: Cloonanny Wind Farm	Project No: 2274-24	Client:	Date: 31/05/2024
		Contractor:	Co-ords: E614987.64 N777886.34
Location:		Sub Contractor: SBPH	Equipment: Zaxis 130LCN

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-T01-B	TP	48.51m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
							▨	Soft, brown, sandy TOPSOIL
					0.20	48.31	▨	Firm, grey mottled orange, sandy, gravelly SILT/CLAY with a medium cobble and low boulder content
		1.00	B					
					2.00	46.51	▨	Stiff, dark grey, sandy, gravelly SILT/CLAY with a medium cobble and low boulder content
		3.00	B					
					3.60	44.91		End of Pit at 3.600m

Dimensions		**Trench Comments**			**Backfill Details**		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	0.90	Sides unstable upon completion	None		0.00	3.60	Arisings

Remarks

No groundwater encountered.

AGS

whiteford
explore the possibilities

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

Trial Pit Log

Project Name: Cloonanny Wind Farm	Project No: 2274-24	Client:	Date: 31/05/2024
		Contractor:	Co-ords: E615465.59 N777951.44
Location:		Sub Contractor: SBPH	Equipment: Zaxis 130LCN

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-T02-A	TP	43.98m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
							▨	Soft, dark brown, sandy, organic TOPSOIL
		0.50	B					
					0.80	43.18	⁙	Medium dense, grey, very silty SAND
		1.50	B					
	▼							
					3.40	40.58	⁙	Firm becoming stiff, grey, slighty gravelly, sandy SILT
		3.50	B					
					3.70	40.28		End of Pit at 3.700m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	0.90	Sides unstable upon completion	None		0.00	3.70	Arisings

Remarks

Groundwater encountered 2.80m b.g.l. (Weak Flow)

AGS

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

Trial Pit Log

Project Name: Cloonanny Wind Farm	Project No: 2274-24	Client:	Date: 31/05/2024
		Contractor:	Co-ords: E615419.30 N777955.56
Location:		Sub Contractor: SBPH	Equipment: Zaxis 130LCN

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP-T02-B	TP	43.92m AoD	J.Stothers	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.50	B					Soft, dark brown, sandy, organic TOPSOIL
					0.70	43.22		Medium dense, grey, very silty SAND
		1.50	B					
	▼				3.30	40.62		Firm becoming stiff, grey, slighty gravelly, sandy SILT
		3.50	B		3.50	40.42		End of Pit at 3.500m

Dimensions		Trench Comments			Backfill Details		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Top	Base	Description
3.50	0.90	Sides unstable upon completion	None		0.00	3.50	Arisings

Remarks

Groundwater encountered 3.30m b.g.l. (Weak Flow)

APPENDIX C

INTERPRETED GEOPHYSICAL SURVEY DATA

Annotated Electrical Resistivity Tomography (ERT) Profiles:

T1 – ERT Profiles	1 x A3
T2 – ERT Profiles	1 x A3

Annotated Electromagnetic Conductivity Survey:

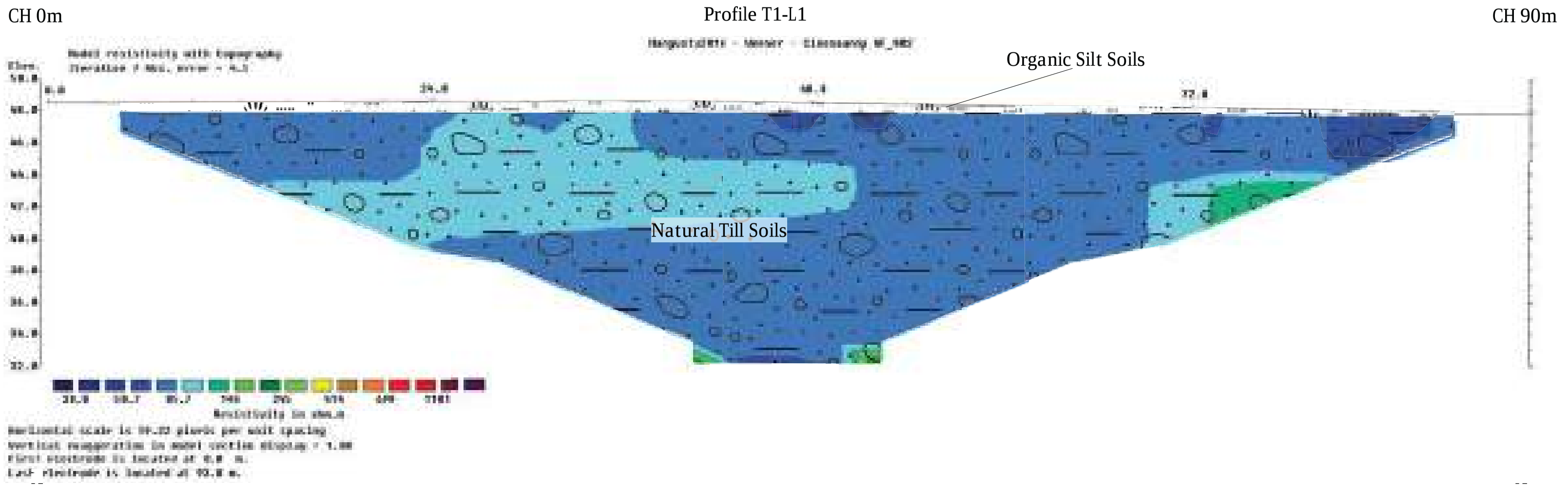
T1 and T2 – 2D Annotated Contour Plot	1 x A3

2274-24 Cloonany Wind Farm, Roscommon, Co. Roscommon
Turbines T1 and T2

Electrical Resistivity Tomography (ERT) Surveys

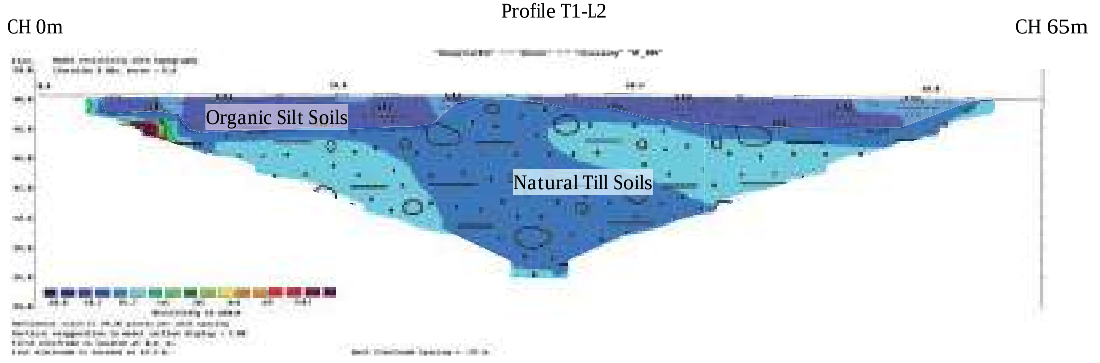
Interpretated Resistivity Imaging Profile L1 at Turbine T1

24 June 2024



Interpretated Resistivity Imaging Profile L2 at Turbine T1

24 June 2024



Key To Sections

Each Profile indicates variation in the elctrical restivity of the Subsurface with depth.

Natural Soils (generally 10 - 500Wm)
Greywacke Rock (generally >500Wm)

▨	Organic Soils (PEAT and sandy, organic SILT / CLAYS)
▨	Natural Soils (Sandy, gravelly CLAYS with cobbles and boulders)
▨	Weathered Rock (Probably decomposed limestone rock or large boulders within residual soil matrix)
▨	Limestone Rock

RECEIVED: 11/12/2024

B

B'

Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. Positions, where detailed, relate to the IG coordinate system.
3. Please refer to Drawing 2217-23-A for position of each ERT Profile.

Draft

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.W.	J.W.	J.M. - 25/06/2024	2274/24 - ERT- T1	25/06/2024	As Shown

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

Interpreted Electrical Resistivity Data
Profiles T1-L1 and T1-L2

Cloonany Wind Farm SI

Edition: 0
Sheet: A3

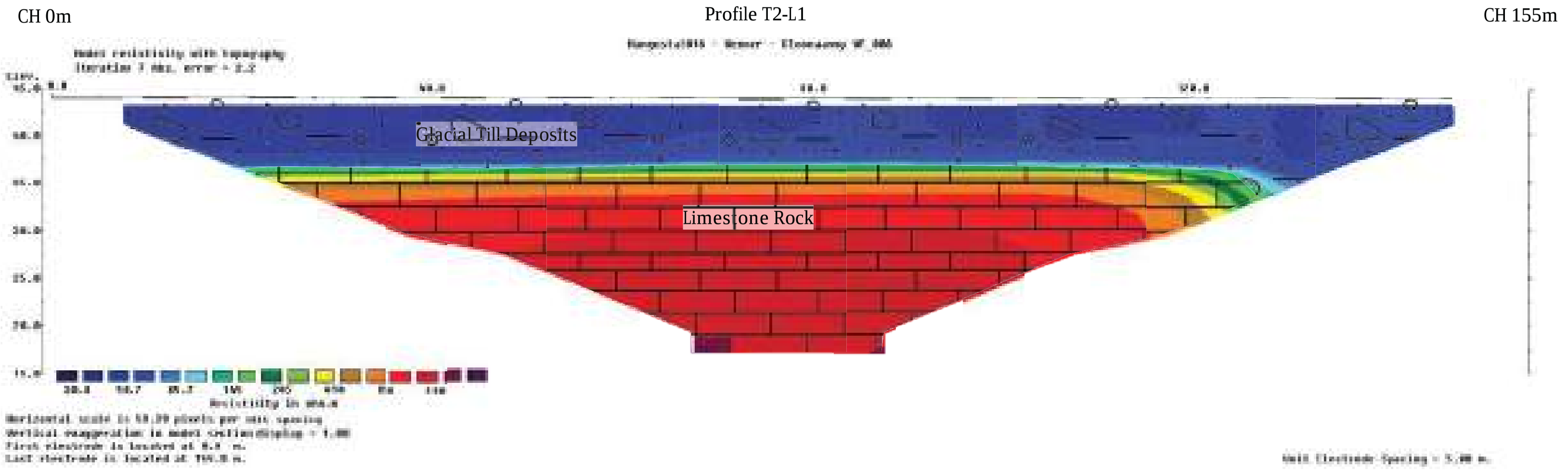
2274-24 Cloonany Wind Farm, Roscommon, Co. Roscommon
Turbines T1 and T2

whiteford

Electrical Resistivity Tomography (ERT) Surveys

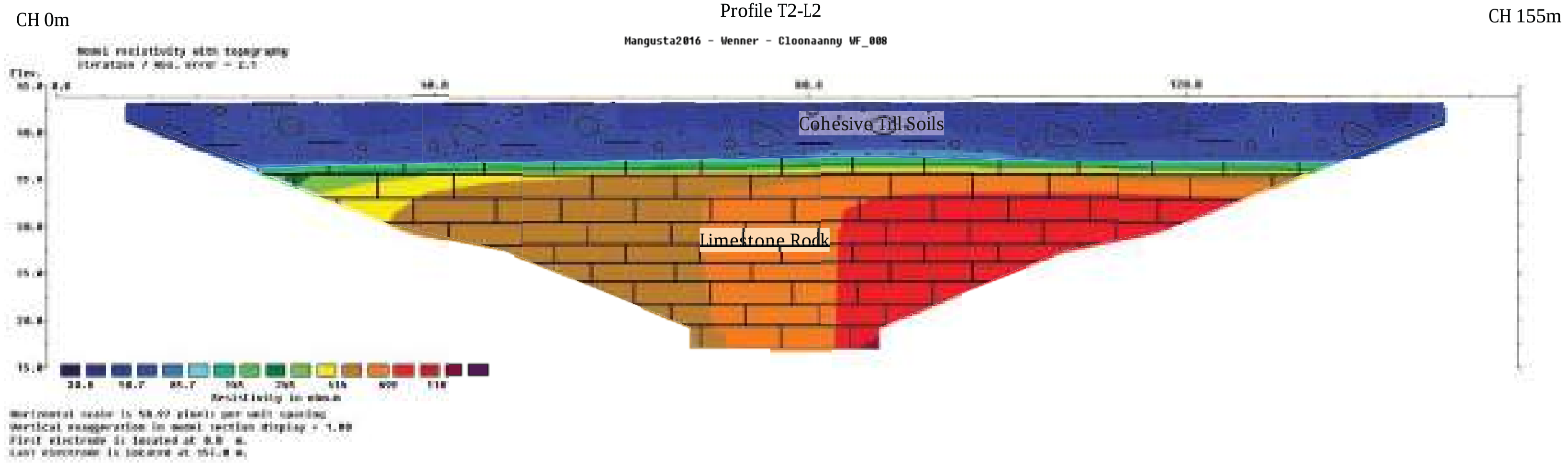
Interpretated Resistivity Imaging Profile L1 at Turbine T2

24 June 2024



Interpretated Resistivity Imaging Profile L2 at Turbine T2

24 June 2024



D

D'

Key To Sections

Each Profile indicates variation in the elctrical restivity of the Subsurface with depth.

Natural Soils (generally 10 - 500Wm)
Greywacke Rock (generally >500Wm)

⁙	Organic Soils (PEAT and sandy, organic SILT / CLAYS)
○	Natural Soils (Sandy, gravelly CLAYS with cobbles and boulders)
▩	Weathered Rock (Probably decomposed limestone rock or large boulders within residual soil matrix)
▦	Limestone Rock

Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. Positions, where detailed, relate to the IG coordinate system.
3. Please refer to Drawing 2217-23-A for position of each ERT Profile.

Draft

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.W.	J.W.	J.M. - 25/06/2024	2274/24 - ERT- T2	25/06/2024	As Shown

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

Interpreted Electrical Resistivity Data
Profiles T2-L1 and T2-L2

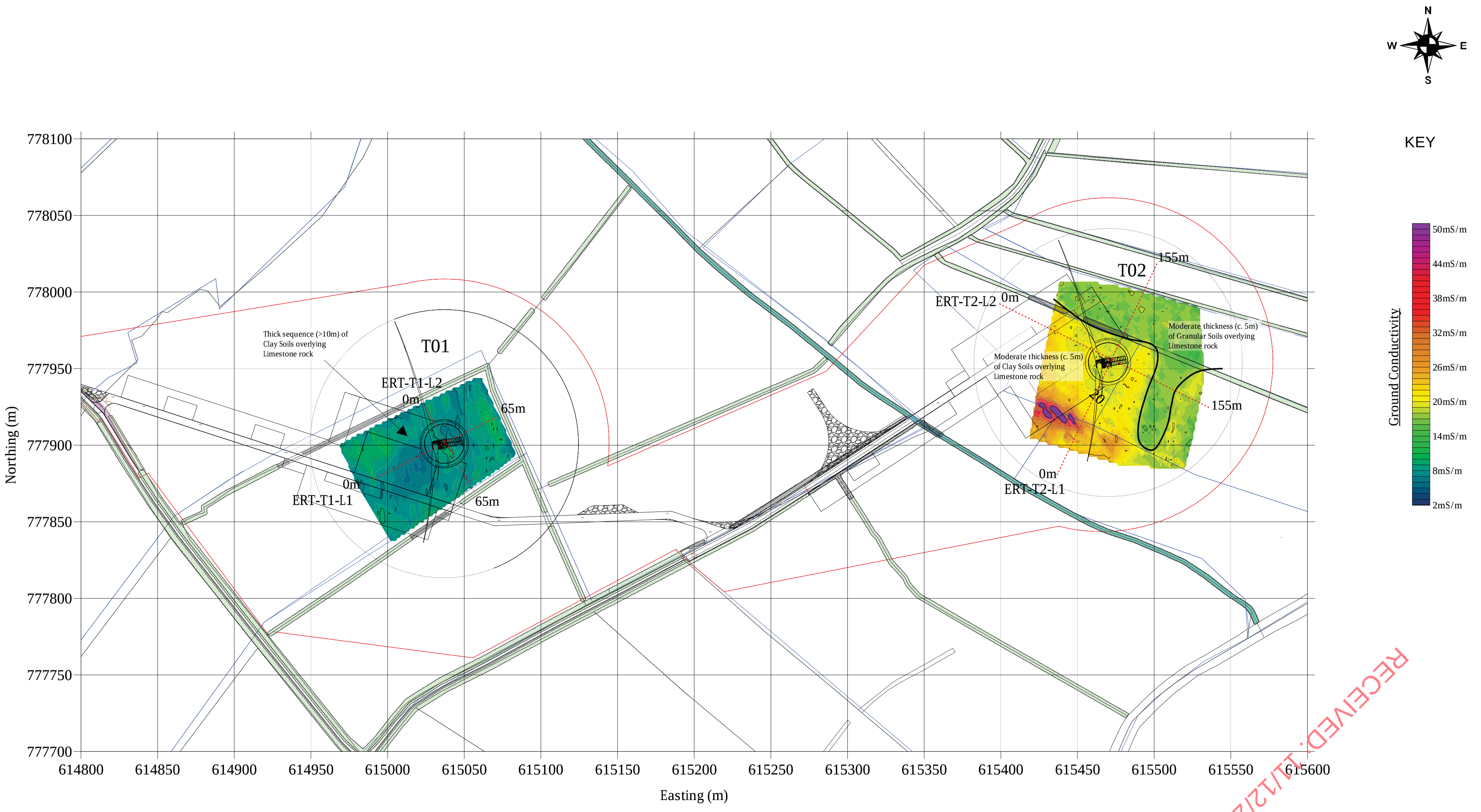
	Edition	Sheet
Cloonany Wind Farm SI	0	A3

2274-24 Cloonanny Wind Farm - Soils and Geology Assessment

Turbine Layout: 22729-100 Series-P4

Electromagnetic Survey - Conductivity Data

20th June 2024



Notes:

1. Depths on Classed plot maps are only representative of peat depth at probe location
2. All depths are relative to ground level existing at the time of the survey / investigation.
3. All positions relate to the Irish National Grid coordinate system.
4. Any elevations are provided relative to Ordnance Datum Malin Head

Designed by JS	Checked by JW	Approved by - date JM 28/06/2024	Drawing No. 2274-24 EM1	Date 28/06/2024	Scale 1 : 6,000

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

Cloonanny Wind Farm - Electromagnetic Survey

Conductivity Data

Edition 1

Sheet A3

APPENDIX D

LABORATORY TESTING RESULTS

Partial Size Distribution	3 x A4
Moisture Content and Bulk Density	1 x A4
pH, Sulphate Content, Chloride Content & Sulphide Content of groundwater extract; Organic Matter Content	8 x A4

Moisture Content & Bulk Density

Location: **Cloonanny Wind Farm**

Client: **Natural Forces Renewable Energy Ltd**

Job No: **2274-24**

Hole ID	*Depth*	*Moisture Content %*	*Shear Strength (kPa)*	*Bulk Density (kg/m^3)*
TP-T01-A	3.00	8	82	2295
TP-T02-B	1.50	14	67	1905
TP-SUB-B	1.00	11	52	2055

Operator	Checked	Approved
Dr Sivakumar QUB	JMCN	JW

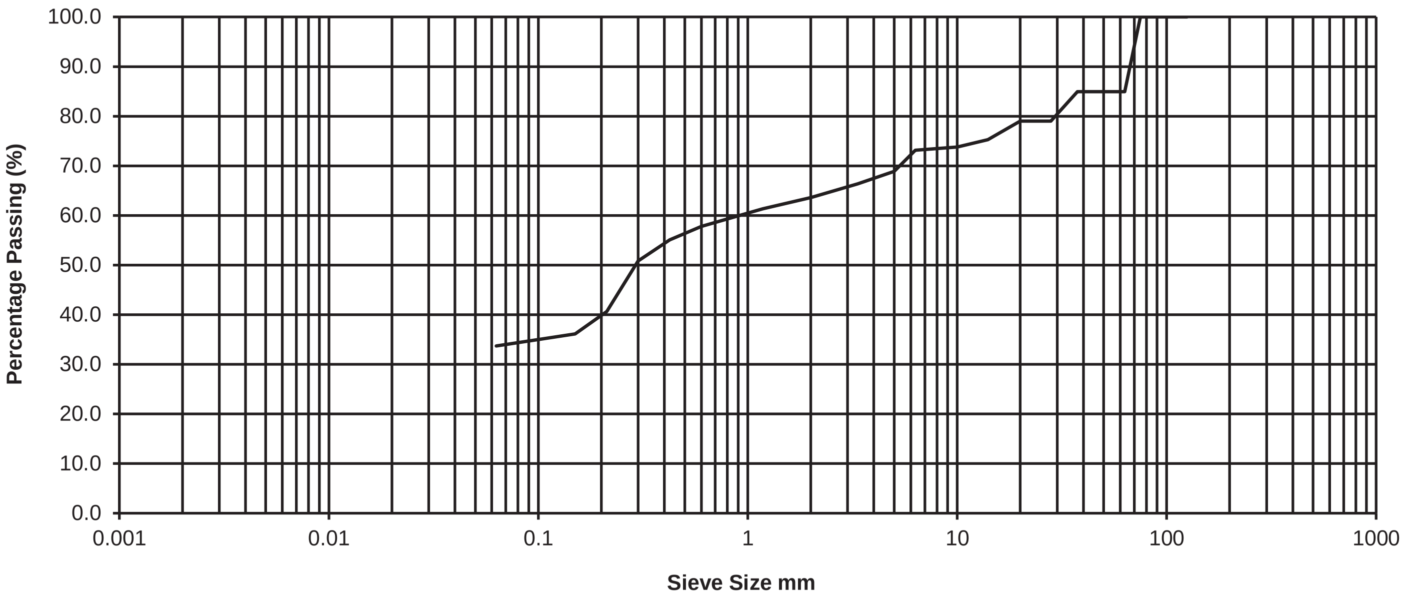
Test Method: BS 1377 : 1990: Part 2

VINI Geotechnical Testing

Determination of Particle Size Distribution

BS 1377 : 1990 : Part 2 : Clauses 9.2 & 9.5

Sieve Size mm	% Passing
125.000	100.0
75.000	100.0
63.000	84.9
50.000	84.9
37.500	84.9
28.000	79.0
20.000	79.0
14.000	75.3
10.000	73.8
6.300	73.1
5.000	68.9
3.350	66.4
2.000	63.6
1.180	61.4
0.600	57.8
0.425	55.1
0.300	50.8
0.212	40.6
0.150	36.1
0.063	33.7



Percentage Particle Size

Clay	Fine Medium Coarse	Fine Medium Coarse	Fine Medium Coarse	Cobbles	Boulder
	Silt	Sand	Gravel		
0.0	33.7	29.9	21.3	15.1	0.0

Sample Description Gravelly silty SAND and Cobbles

Project Cloonanny WF

Operator	SS	Checked	VS	Approved	VS	Date sample tested	27/06/2024

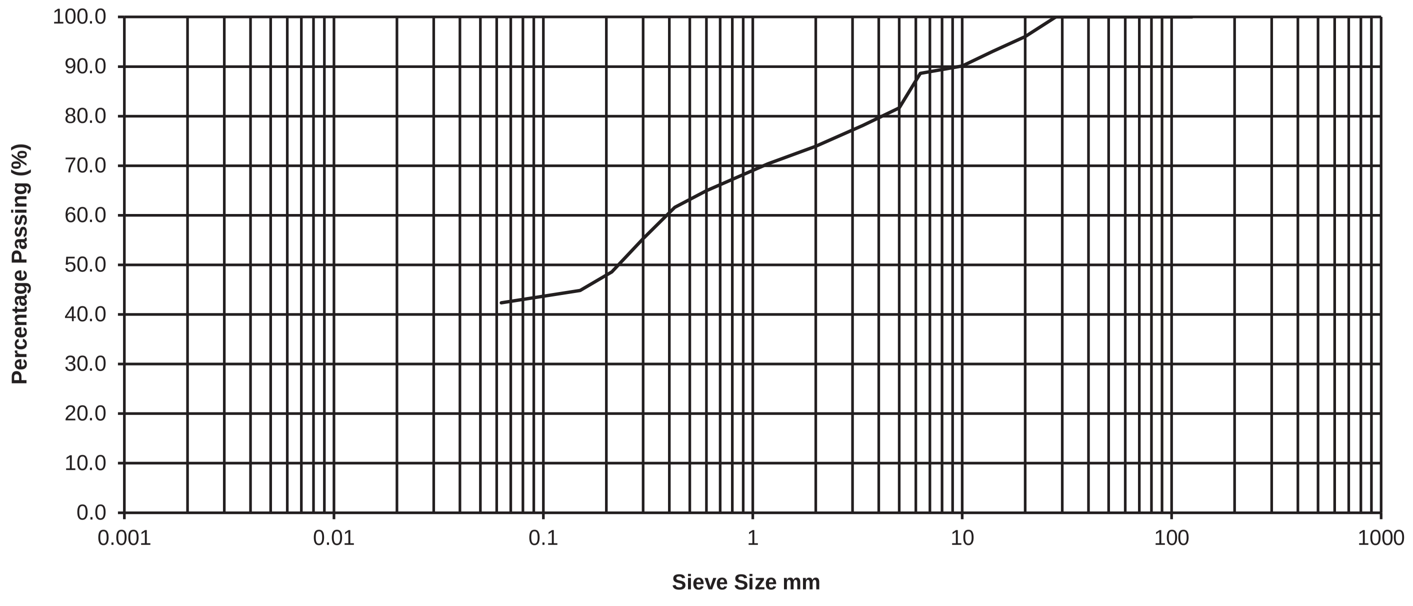
Project No. 2274-24
BH/TP No. TP-SUB-B
Sample No.
Depth 1.0m

VINI Geotechnical Testing

Determination of Particle Size Distribution

BS 1377 : 1990 : Part 2 : Clauses 9.2 & 9.5

Sieve Size mm	% Passing
125.000	100.0
75.000	100.0
63.000	100.0
50.000	100.0
37.500	100.0
28.000	100.0
20.000	96.1
14.000	93.1
10.000	90.1
6.300	88.6
5.000	81.6
3.350	78.1
2.000	73.9
1.180	70.4
0.600	65.0
0.425	61.6
0.300	55.3
0.212	48.6
0.150	44.8
0.063	42.3



Percentage Particle Size

Clay	Fine Medium Coarse	Fine Medium Coarse	Fine Medium Coarse	Cobbles	Boulder
	Silt	Sand	Gravel		
	42.3	31.6	26.1	0.0	0.0

Sample Description Gravelly sandy SILT

Project Cloonanny WF

Project No. 2274-24
BH/TP No. TP-T01-A
Sample No.
Depth 3.0m

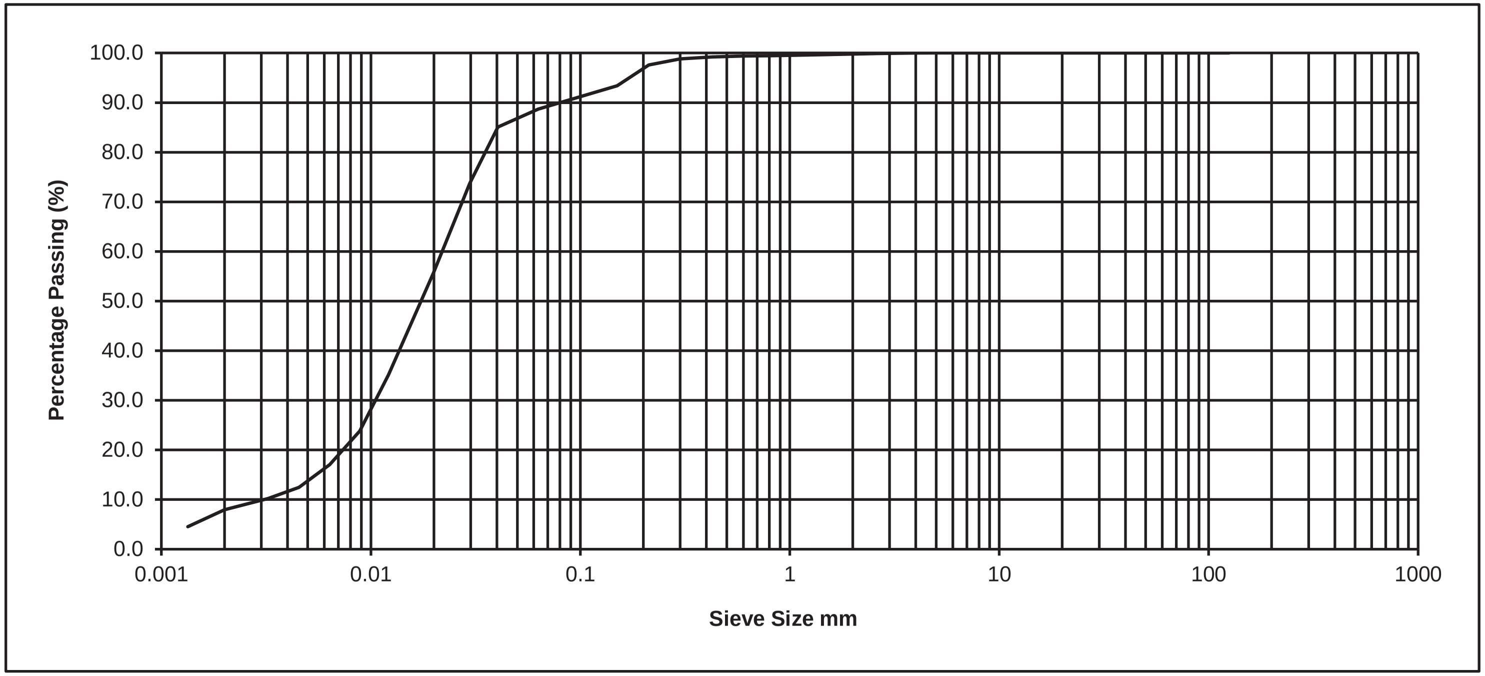
Operator	SS	Checked	VS	Approved	VS	Date sample tested	27/06/2024

VINI Geotechnical Testing

Sieve	%
Size mm	Passing
125.000	100.0
75.000	100.0
63.000	100.0
50.000	100.0
37.500	100.0
28.000	100.0
20.000	100.0
14.000	100.0
10.000	100.0
6.300	100.0
5.000	100.0
3.350	100.0
2.000	99.8
1.180	99.6
0.600	99.4
0.425	99.2
0.300	98.8
0.212	97.6
0.150	93.4
0.063	88.7
0.040	85.1
0.030	73.7
0.020	55.6
0.012	35.2
0.009	23.8
0.006	17.0
0.005	12.5
0.003	10.2
0.002	7.9
0.001	4.5

Determination of Particle Size Distribution

BS 1377 : 1990 : Part 2 : Clauses 9.2 & 9.5



Percentage Particle Size

Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulder
		Silt			Sand			Gravel			
7.9		80.8			11.1			0.2		0.0	0.0

Sample Description Sandy SILT

Project Cloonanny WF

Operator	SS	Checked	VS	Approved	VS	Date sample tested	27/06/2024

Project No. 2274-24

BH/TP No. TP-T02-B

Sample No.

Depth 1.5m

Element Materials Technology
Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

P: +44 (0) 1244 833780
F: +44 (0) 1244 833781

W: www.element.com

Whiteford Geoservices
Straid House
Straid
Ballyclare
United Kingdom
BT39 9EU

Attention :	Joy McNeill
Date :	5th July, 2024
Your reference :	2273-24
Our reference :	Test Report 24/10674 Batch 1
Location :	Cloonanny WF
Date samples received :	21st June, 2024
Status :	Final Report
Issue :	202407050929

Three samples were received for analysis on 21st June, 2024 of which three were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

The greenhouse gas emissions generated (in Carbon – Co2e) to obtain the results in this report are estimated as:

Scope 1&2 emissions - 4.778 kg of CO2

Scope 1&2&3 emissions - 11.293 kg of CO2

Authorised By:

Bruce Leslie
Project Manager

Client Name: Whiteford Geoservices
Reference: 2273-24
Location: Cloonanny WF
Contact: Joy McNeill
EMT Job No: 24/10674

Report : **Solid**

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

EMT Sample No.	1	2	3								LOD/LOR	Units	Method No.
Sample ID	TP-T01A	TP-T02B	TP-SUB B										
Depth	3.00	1.50	1.00										
COC No / misc													
Containers	T	T	T										
Sample Date	<>	<>	<>										
Sample Type	Soil	Soil	Soil										
Batch Number	1	1	1										
Date of Receipt	21/06/2024	21/06/2024	21/06/2024										
Natural Moisture Content	11.9	29.2	17.5								<0.1	%	PM4/PM0
Chloride #	6	7	8								<2	mg/kg	TM38/PM20
Sulphate as SO4 (2:1 Ext) #	0.0177	0.0803	0.0059								<0.0015	g/l	TM38/PM20
Organic Matter	0.5	1.8	0.3								<0.2	%	TM21/PM24
Sulphide	<10	<10	<10								<10	mg/kg	TM107/PM45
pH #	8.77	7.70	7.81								<0.01	pH units	TM73/PM11

Notification of Deviating Samples

Client Name: Whiteford Geoservices
Reference: 2273-24
Location: Cloonanny WF
Contact: Joy McNeill

Matrix : Solid

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
24/10674	1	TP-T01A	3.00	1	All analyses	No sampling date given
24/10674	1	TP-T02B	1.50	2	All analyses	No sampling date given
24/10674	1	TP-SUB B	1.00	3	All analyses	No sampling date given

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating. Only analyses which are accredited are recorded as deviating if set criteria are not met.

It is a requirement under ISO 17025 that we inform clients if samples are deviating i.e. outside what is expected. A deviating sample indicates that the sample 'may' be compromised but not necessarily will be compromised. The result is still accredited and our analytical reports will still show accreditation on the relevant analytes.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 24/10674

SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 35°C ±5°C.

Where Mineral Oil is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil is quoted, this refers to Total Aliphatics C10-C40.

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a requirement of our Accreditation Body for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.
Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

Age of Diesel

The age of release estimation is based on the nC17/pristane ratio only as prescribed by Christensen and Larsen (1993) and Kaplan, Galperin, Alimi et al., (1996).
Age estimation should be treated with caution as it can be influenced by site specific factors of which the laboratory are not aware.

Tentatively Identified Compounds (TICs)

Where Tentatively Identified Compounds (TICs) are reported, up to 10 Tentatively Identified Compounds will be listed where there is found to be a greater than 80% match with the NIST library. The reported concentration is determined semi-quantitively, with a matrix specific limit of detection. Note, other compounds may be present but are not reported.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above quantitative calibration range. The result should be considered the minimum value and is indicative only. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics mathematically subtracted
#2	EU_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 24/10674

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil.	PM24	Preparation of Soil and Marine Sediment Samples for Total Organic Carbon.			AD	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013l	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AD	Yes
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM107	Determination of Sulphide/Thiocyanate by Skalar Continuous Flow Analyser	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide, Sulphide and Thiocyanate analysis.			AR	Yes

APPENDIX E

PHOTOGRAPHIC RECORD

Photographic Plates

Site Visit 1 (16 May 2024)	6 x A4
Site Visit 2 (31 May 2024)	12 x A4

Plate 1—T01 (Vicinity)

Plate 2—T01 (Vicinity)

Plate 3—T01 (Vicinity)

Plate 4—T01 (Vicinity)

Plate 5—T02 (Vicinity)

Plate 6—T02 (Vicinity)

Plate 7—T02 (Vicinity)

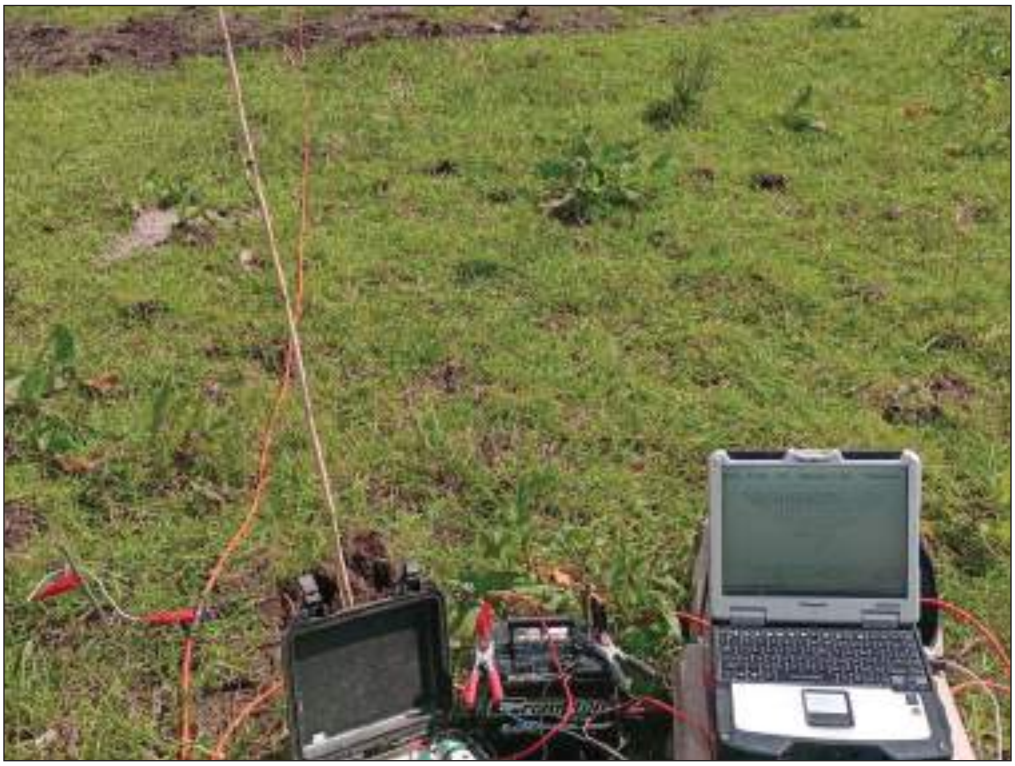


Plate 8—T02 (Geophysical Survey in progress)

Plate 9—Substation (Vicinity)

Plate 10—Substation (Vicinity)

Plate 11—Substation (Vicinity)

Plate 12—Substation (Vicinity)

Plate 1—TP-T01A

Plate 2—TP-T01A

Plate 3—TP-T01A

Plate 4—TP-T01A

Plate 5—TP-T01B

Plate 6—TP-T01B

Plate 7—TP-T01B

Plate 8—TP-T01B

Plate 9—TP-T02A

Plate 10—TP-T02A

Plate 11—TP-T02A

Plate 12—TP-T02A

Plate 13—TP-T02B

Plate 14—TP-T02B

Plate 15—TP-T02B

Plate 16—TP-T02B

Plate 17—TP-SUB-A

Plate 18—TP-SUB-A

Plate 19—TP-SUB-A

Plate 20—TP-SUB-A

Plate 21—TP-SUB-B

Plate 22—TP-SUB-B

Plate 23—TP-SUB-B

Plate 24—TP-SUB-B

APPENDIX 8.2

SOILS AND GEOLOGY CONSTRAINTS MAPPING

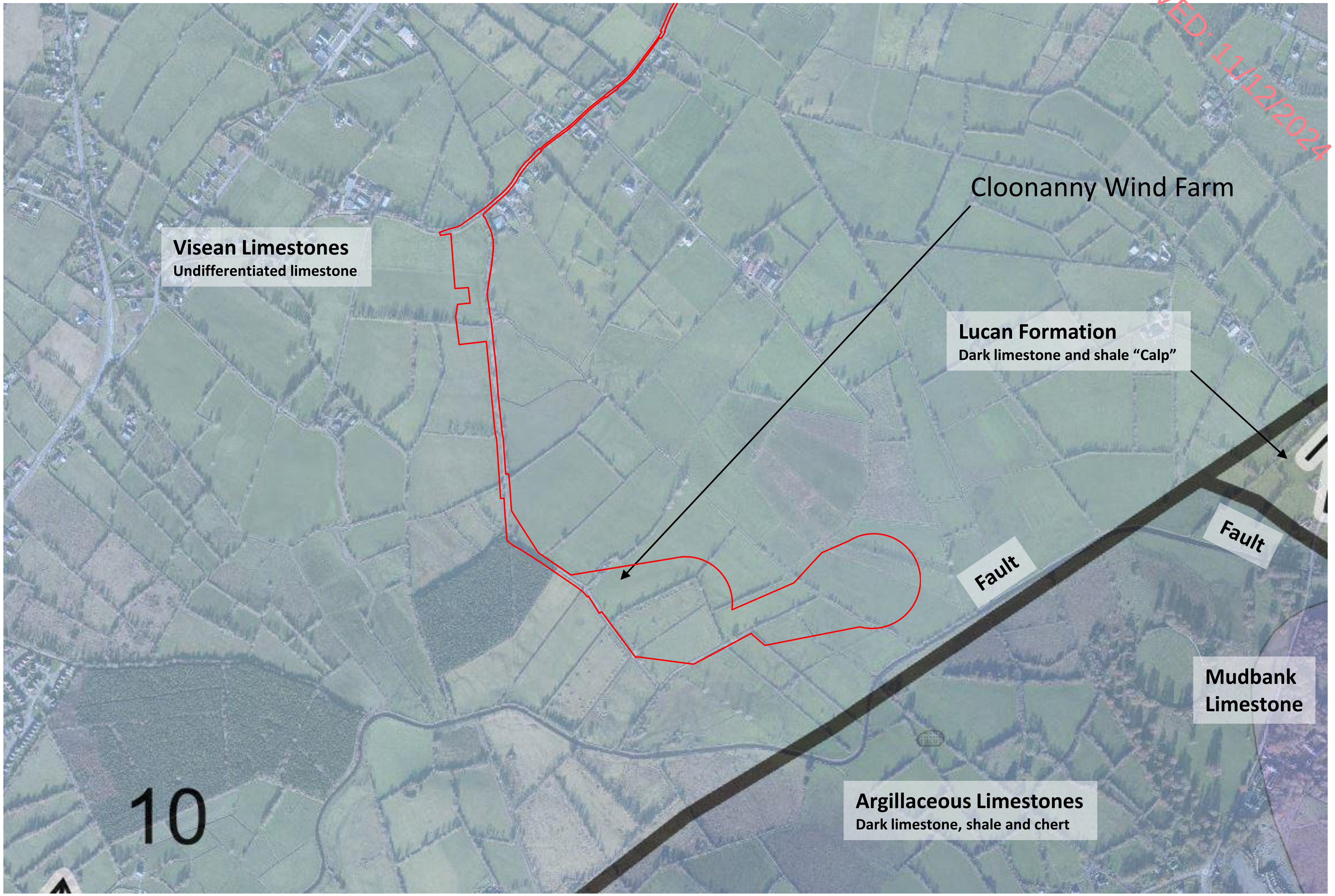
VOLUME III

APPENDICES TO ENVIRONMENTAL IMPACT ASSESSMENT REPORT

DECEMBER 2024

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Solid Geology



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3. Background Mapping Source: OSI Digital Globe.

Designed by J.W.	Checked by J.M.	Approved by - date J.W. 24/06/2024	Drawing No. Figure 8.1	Date 24/06/2024	Scale NTS

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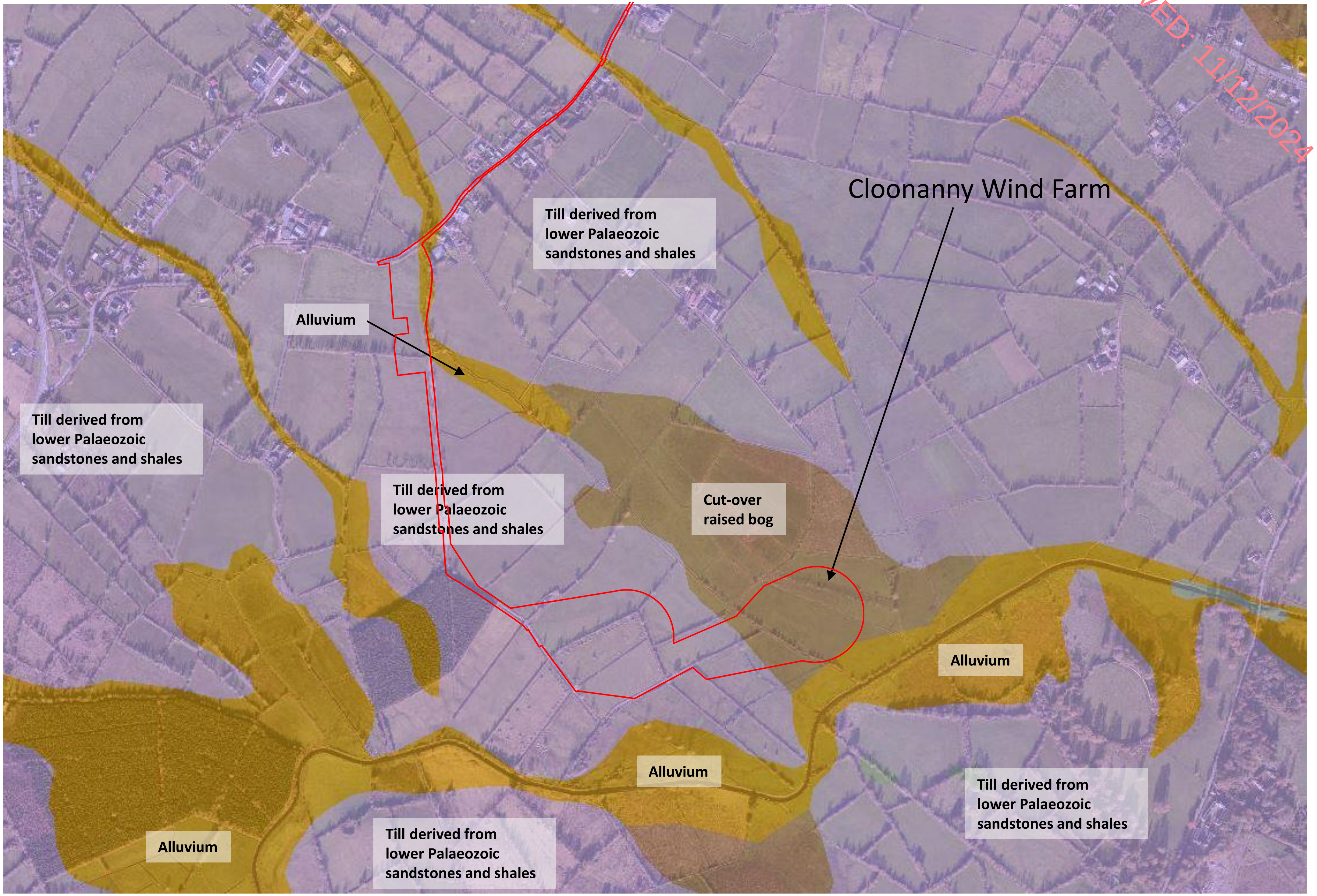
Geological Survey of Ireland Online Mapping Database
Solid Geology

Cloonanny Wind Farm **Soils and Geology Assessment**	Edition 1	Sheet

2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

GSI – Superficial Soils



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Superficial Soils

Cloonanny Wind Farm
Soils and Geology Assessment

Edition 1

Sheet

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Wind Farm Red-Line Boundary

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Wind Farm Layout Plan Red-Line Boundary

Cloonanny Wind Farm
Soils and Geology Assessment

Edition 1

Sheet

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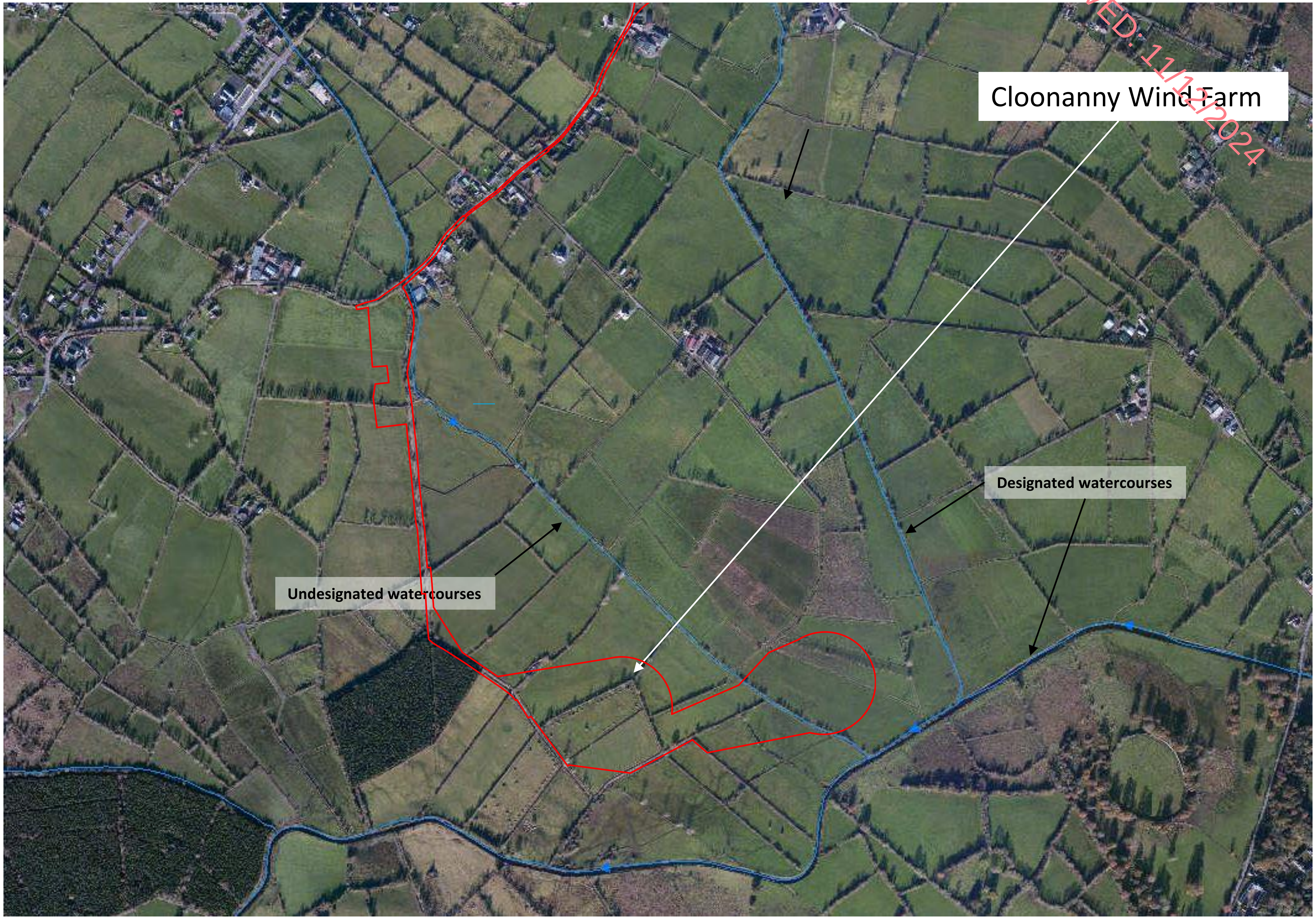
Soils and Geology Constraints

GSI – Groundwater Features, Karst Features, Springs and Abstraction Points



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Geological Survey of Ireland Online Mapping Database
Groundwater Features, Karst, Springs and Abstraction

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Soils and Geology Assessment

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Soils and Geology Constraints

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GSI – Landslide Susceptibility and Recorded Events

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Landslide Susceptibility and Recorded Events

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Soils and Geology Assessment

Edition 1

Sheet

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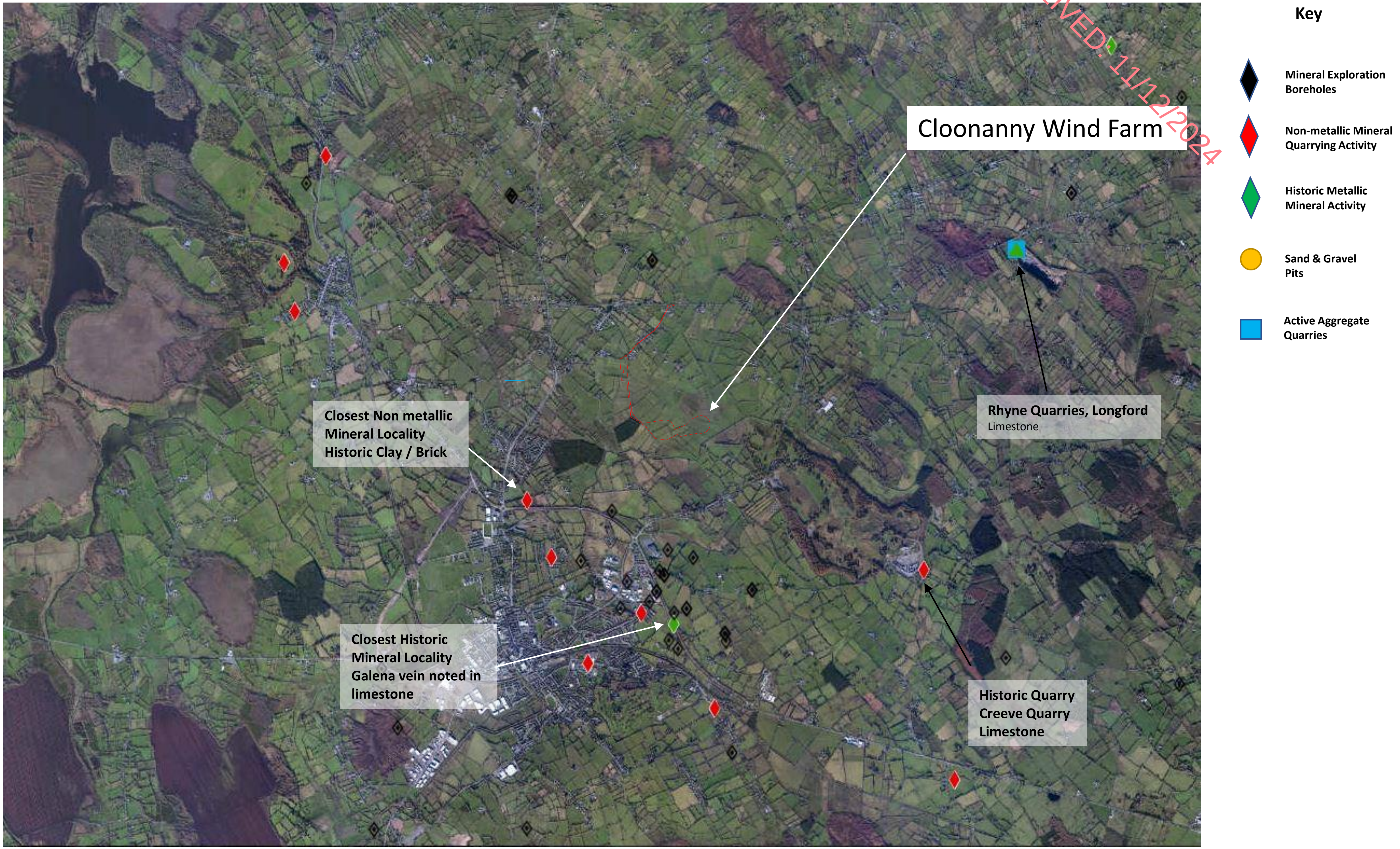
Soils and Geology Constraints

GSI – Minerals and Active Quarrying



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Minerals and Active Quarrying

	Edition	Sheet
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2273-24 Cloonanny Wind Farm, Co. Longford
Soils and Geology Constraints

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GSI – Closest Geological Audited and Unaudited Sites

Cloonanny Wind Farm

RO022
Mid Roscommon Ribbed Morraines
IG7

This field of ribbed moraine forms part of a small, discrete field northwest of slieve bawn
CGS

LD004
Drumlish Quarry
IG4

An intermittently active quarry into greywacke of the Coronea Formation, of Ordovician age
CGS

LD011
Killoe Quarry
IG8

A large working quarry in the Lucan Formation, of Viséan (Lower Carboniferous) age
CGS

LD007
Creeve Quarry
IG8

A long disused quarry with adjacent wooded knoll of exposed rock
CGS

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Geological Audited and Unaudited Sites

Cloonanny Wind Farm
Soils and Geology Assessment

Edition 1

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3

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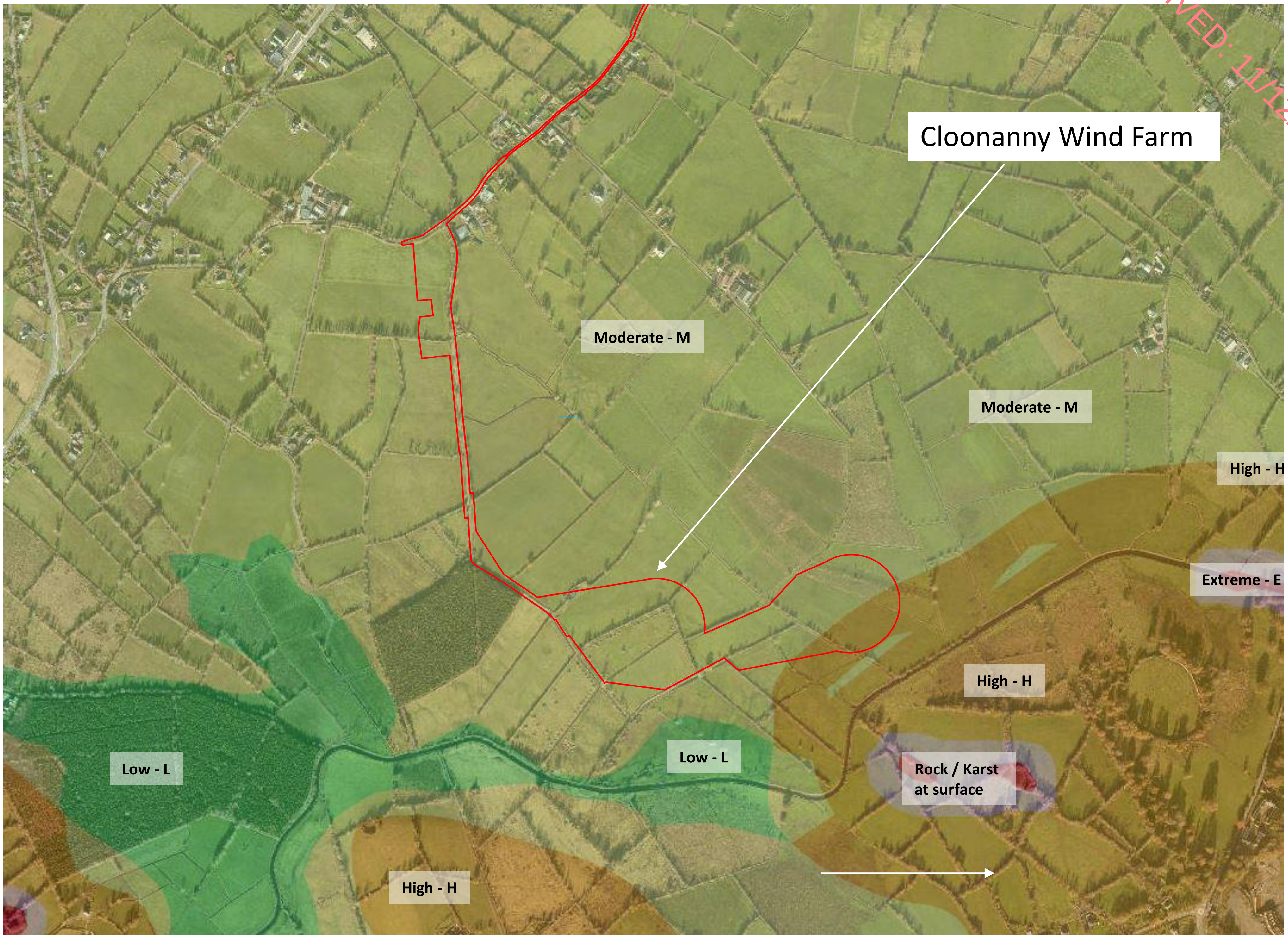
Soils and Geology Constraints

GSI – Groundwater Vulnerability



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Groundwater Vulnerability

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Soils and Geology Assessment

Edition 1

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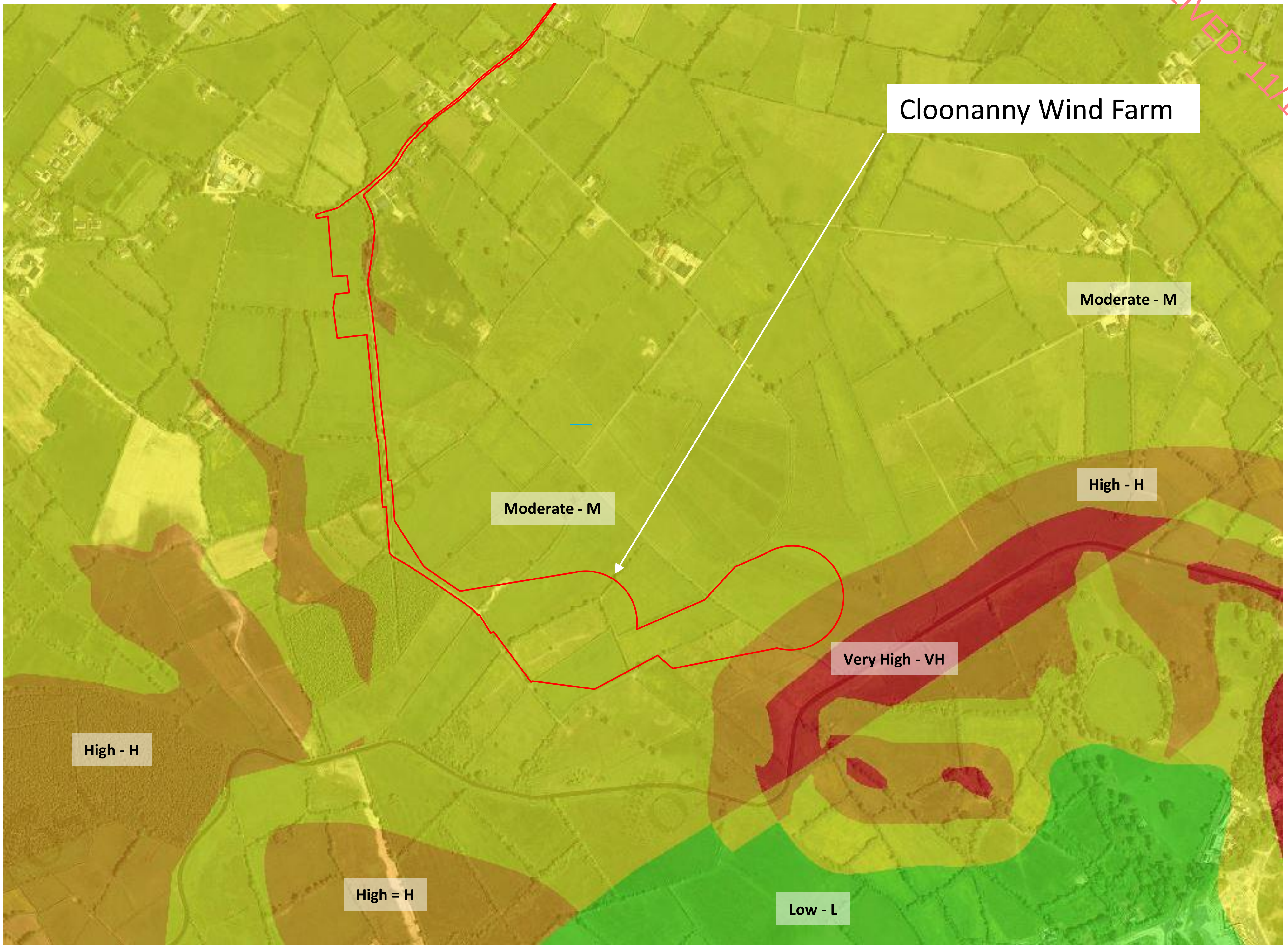
Soils and Geology Constraints

GSI –



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Crushed Aggregate Potential

Cloonanny Wind Farm
Soils and Geology Assessment

Edition 1

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Soils and Geology Constraints

EPA – Closest Protected Sites, Sites of Designated Importance & Existing Waste Licensing

Key

- 🟦 IPC / IEL License
- ▱ IPPC License Boundary

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EPA Mapping Database
Protected Sites and Sites & Waste Licensing

Cloonanny Wind Farm
Soils and Geology Assessment

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