APPENDIX E-1

Peat Stability Risk Assessment

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Drumnahough Wind Farm

County Donegal

Peat Stability Risk Assessment Report

SSE Renewables/Coillte CGA

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19715	6010	A	Paddy Curran	Eoin Doyle	08th May 2020	Draft
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Executive Summary

Drumnahough Wind Farm DAC engaged Malachy Walsh and Partners (MWP) to complete a peat stability risk assessment as part of the EIAR for the proposed Drumnahough Wind Farm Development in Co. Donegal.

The location of the Drumnahough Wind Farm infrastructure was designed from the outset with a constraints driven approach. This approached placed turbines in areas of low risk for peat slides and also avoided environmentally sensitive areas.

MWP completed extensive walkovers and surveys of the site. MWP also completed 560 peat probes across the site with peat depths ranging from 0.1m to 4.5m. Shear strengths were recorded ranging from 7kPa to 49kPa.

MWP employed high resolution LiDAR data to create an accurate Digital Elevation Model (DEM) of the Site. An iterative design methodology was adopted using a constraints driven approach where ground slope was used as one of the key primary constraint criteria. Slope analysis from the DEM was used to place infrastructure in areas of the site with low ground slope.

MWP completed a two-stage peat stability risk assessment approach. Stage 1 was based on desk study information, site reconnaissance and assessment of contour data. Stage 1 concluded that further quantitative stability risk assessment was required for this site. Stage 2 involved quantitative risk assessment factor of safety analysis (Infinite Slope Stability Analysis), and application of the Peat Slide Hazard Rating System (PHRS) (Nichol, 2006). Both stages were completed for this project. This approach is in line with industry best practice guidance, as published by the Scottish Government PLHRA (2nd Ed 2017).

The findings of the PHRS, carried out as part of the Stage 2 assessment, were that the risk level ranged from **Very Low** (T2, T3, BP1, BP2 & BP3) to **Low-Moderate** (T9, T10, T11, BP4, PMM, Substation). The remainder of the turbines are in **Low** risk areas. The recommended Engineering Response to a finding of a Low Hazard rating is that *Further investigation of the peat slide hazard may be required*. The recommended Engineering Response to a finding of a Low-Moderate is *Peat-slide stabilisation works may be required.* This is typically in the form of a granular berm on the downslope side of the infrastructure to prevent peat movement.

Following on from the PHRS, MWP conducted an Infinite Slope Stability Analysis (ISSA) for the site using the peat probe data and slope data from the LiDAR DEM to calculate the Factor of Safety (FoS) against peat slide for each location probed. The ISSA output was that the majority of the site had a FoS against peat slide in excess of 4 with no infrastructure placed in areas with a FoS less than 2.

MWP completed assessments of the risk presented using the industry best practice guidance of the Scottish Executive and Scottish Government guidelines for Peat Landslide Hazard and Risk Assessments. The outcome of the risk assessment was that landslide presented a **Negligible Level of risk to the Wind Farm Infrastructure**. A further risk assessment for the risk of landslide to surrounding environment found a **Negligible Level of risk.** This is an outcome consistent with an iterative constraints driven approach to wind farm infrastructure design.

Design measures in the form of peat stability monitoring programme during construction has been proposed in order to further mitigate and manage risk.

1 Peat Stability Risk Assessment

1.1 Project Overview

The proposed Drumnahough Wind Farm comprises of 12 No. wind turbines, a meteorological mast, a substation and battery storage area, four borrow pits and their respective associated roads, hardstands, material storage areas, grid connections options and drainage infrastructure. The area of the proposed wind farm is located in a rural upland area of central Donegal on the southern and western slopes of Cronaglack, Crockalogh and Cark, approximately 12.5km south west of Letterkenny and 11km northwest of the twin towns of Ballybofey/Stranorlar.

The site boundary encompasses townlands of Treankeel, Meenadaura, Carrickalangan and Cark. Two options for connection to the national grid are currently being considered. These are 1) connection to the permitted Lenalea substation within the townland of Killymasny and 2) connection to a new proposed substation at the northern end of the windfarm site. The site boundary is presented below in Figure 1-1 and Figure 1-2.

Drumnahough Wind Farm DAC has requested Malachy Walsh and Partners (MWP) to complete the Peat Stability Risk Assessment (PSRA) as part of the Environmental Impact Assessment Report (EIAR) for the project. MWP has extensive experience in completing PSRA's in upland peat areas, having completed PSRA's on over 20 planning applications and the construction of in excess of 30 wind farms located in peatland throughout Ireland.

The PSRA presented in this report has been carried out within the area of the proposed wind farm infrastructure and grid connection to the proposed new substation within the wind farm site. The grid connection to the permitted 110kv Lenalea substation is along the route of existing public road infrastructure, existing wind farm infrastructure and the permitted Lenalea Wind Farm (DCC Planning Reference 09/50116 and 12/40091) access road, for which a peat stability risk assessment has previously completed as part of the environmental assessment for that scheme. The peat stability risk assessment along this grid connection option has not been repeated in this report. The turbine delivery route is along existing roads and tracks. Only minor localised works to harden soft verges adjacent to the existing roads are required along the turbine delivery route, therefore, the PSRA has not been extended to these areas.

MWP adhere to the latest industry standard when completing PSRAs. The guidance of the Scottish Government publication *"Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, Energy Consents Unit Scottish Government, Second Edition, April 2017"* has been used for this PSRA.

A two-stage process is used in the assessment:

The **Stage 1** assessment uses peat depth and geomorphology to categorise the peat slide risk. This stage of the assessment is used to identify if areas of the site present a stability risk and require further analysis of the risk presented. A desk study is completed which included a review of the Geological Survey of Ireland (GSI) soil, landslide susceptibility and landslide event maps. Topographical information is reviewed, and a site reconnaissance is conducted to "ground truth" the

desk study. The risk areas identified in Stage 1 are then given detailed analysis in a Stage 2 if deemed necessary.

The **Stage 2** assessment is a more detailed assessment of the characteristics of peat land that can give rise to potential peat slides and further assesses the constructability of infrastructure. This assessment assesses peat characteristics (depth, slope angles and shear strength), carries out a quantitative stability analysis (infinite slope calculation), quantifies risk, and maps the risk zones of the site.

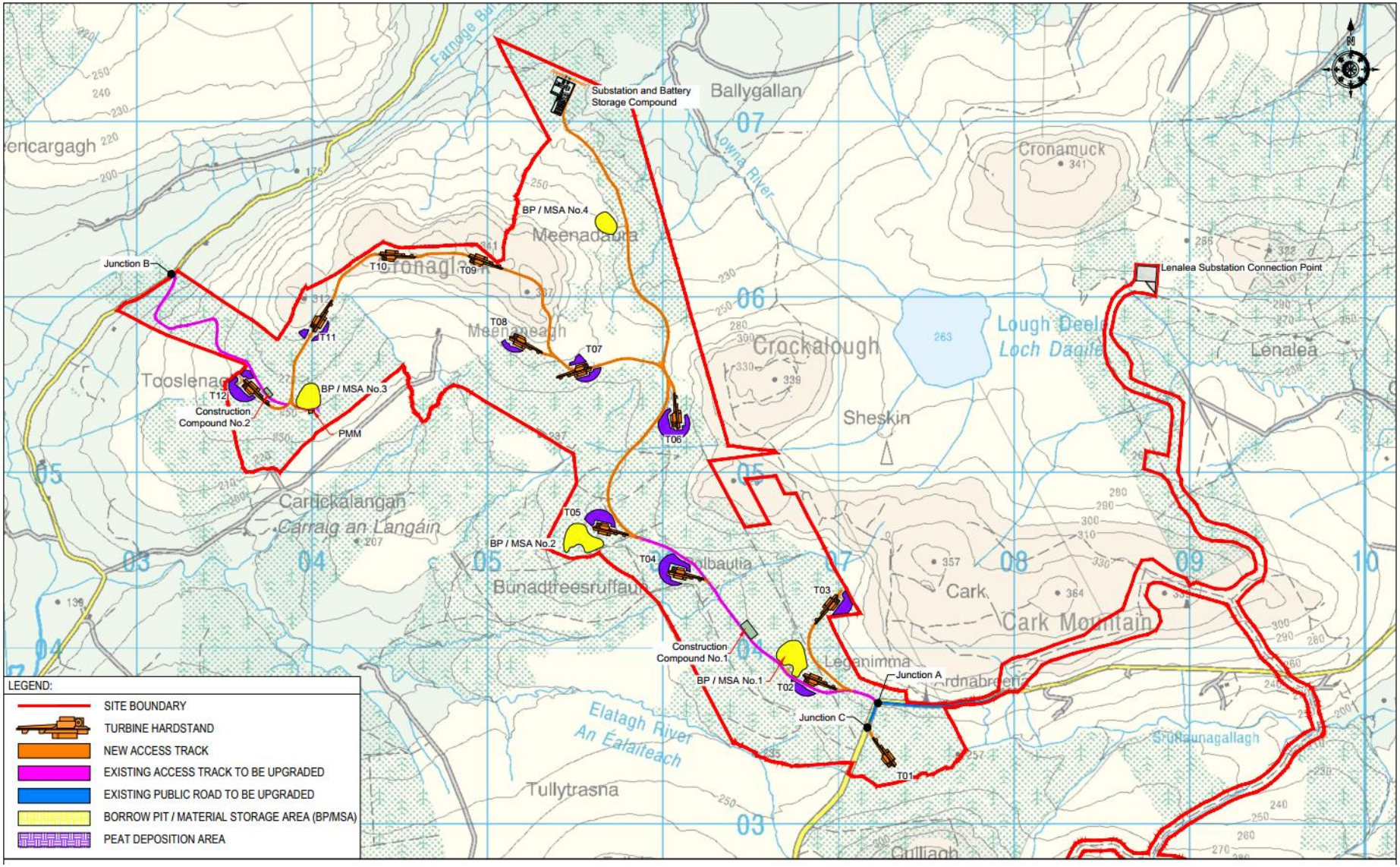

Figure 1-1 –Site Layout on OS Mapping

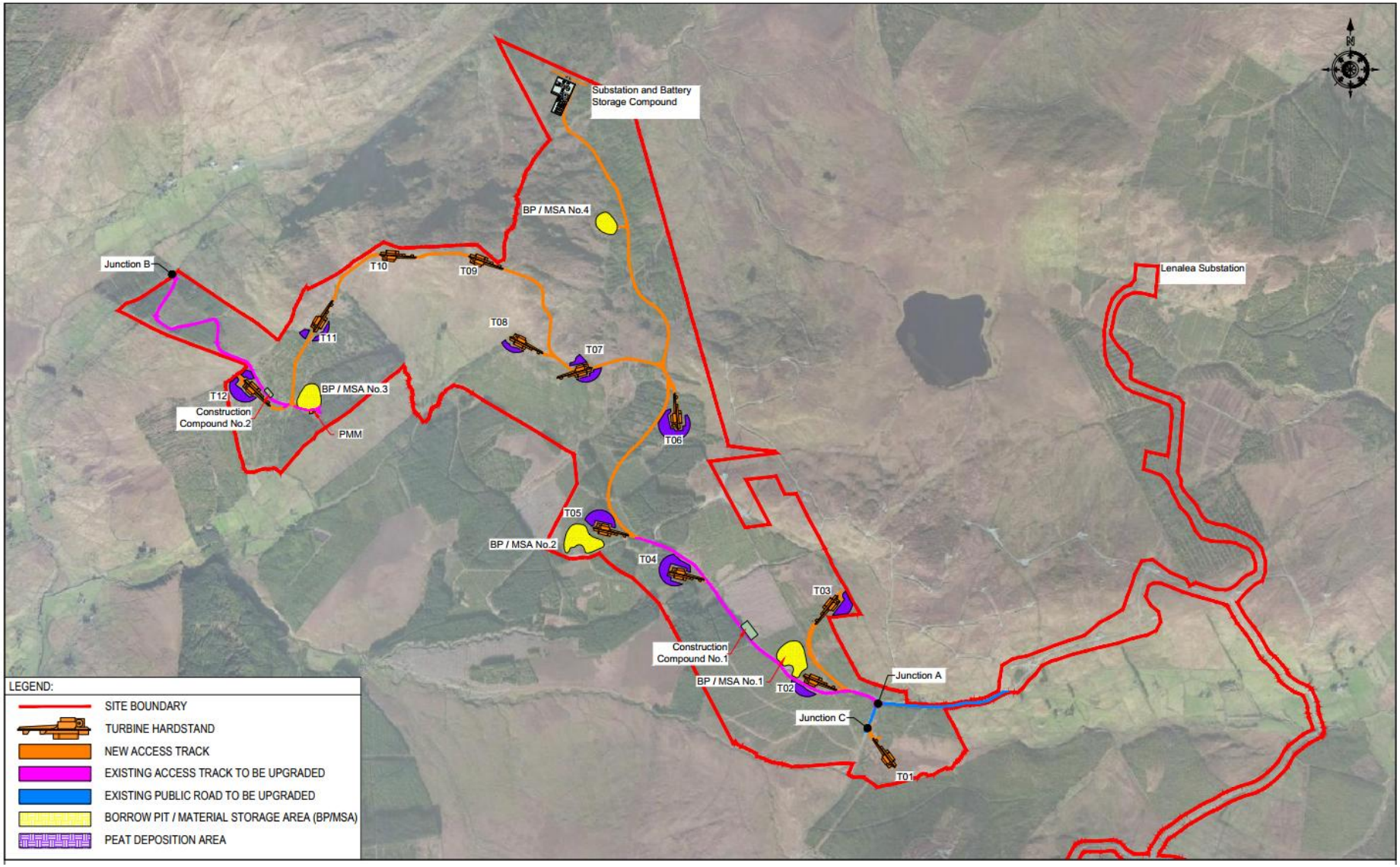

Figure 1-2 - Site Layout on Aerial Photographic Background

Figure 1-3 – Typical photographs of upland areas within the study area

2 Stage 1 - Desk Study and Site Reconnaissance

The desk study for the Peat Stability Risk Assessment consisted of the following main elements:

- Review of existing site information including:
  - Study of Aerial photography from the Geological Survey Ireland (GSI), Ordnance Survey Ireland (OSI) and publicly available ortho rectified aerial imagery.
  - Examination of Geological records from the GSI (Soil and Teagasc Maps)
- Review of site reconnaissance data

2.1 Landslide Susceptibility - Geological Survey Ireland Dataset

The GSI dataset includes landslide susceptibility mapping. The susceptibility mapping for the Drumnahough site is illustrated in Figure 2-1

From Figure 2-1 it can be seen that the full range of susceptibility ratings (Low through to High) are present within the site.

No landslide events are shown in the GSI dataset of recorded landslides. The nearest recorded landslide is approximately 13km south-west of the Drumnahough site. Refer Figure 2-2.

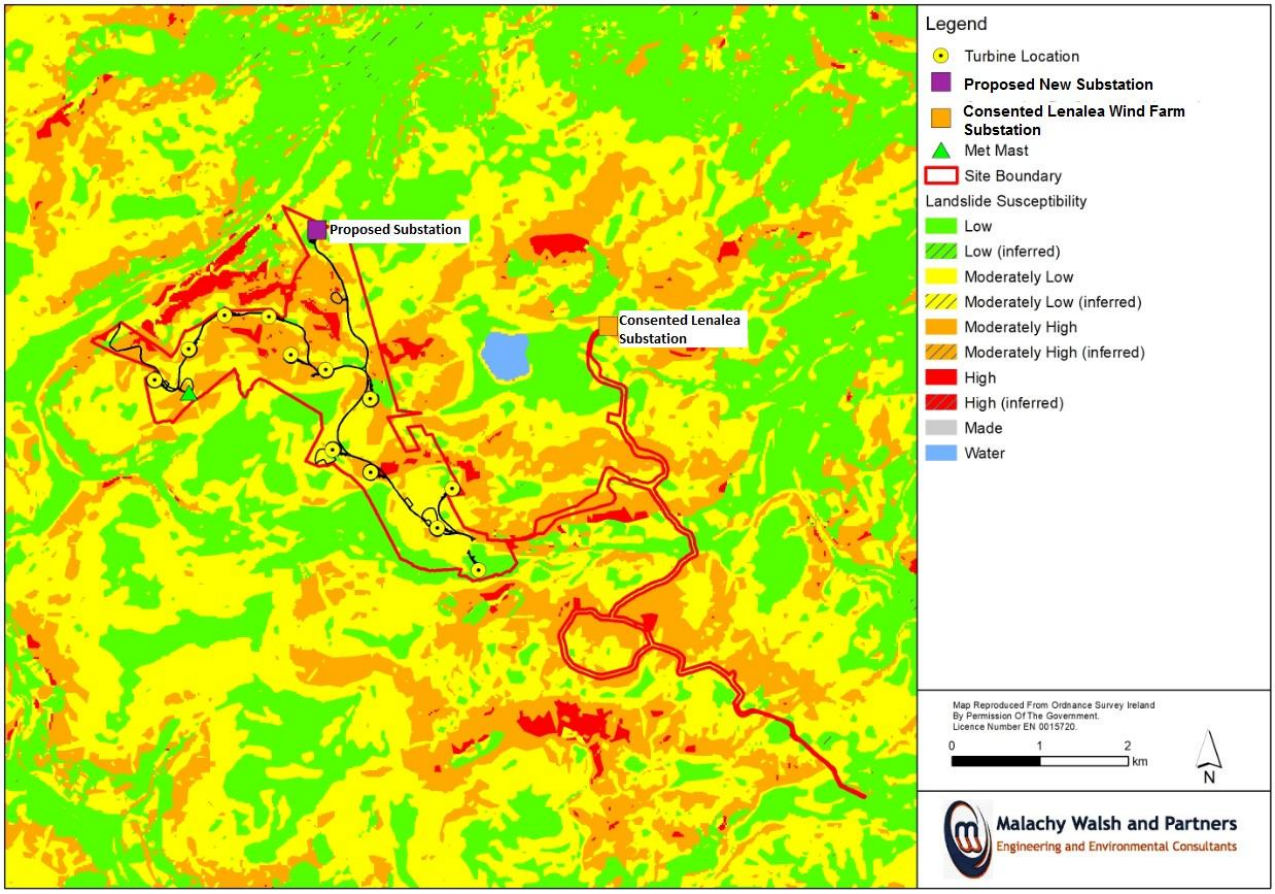

Figure 2-1 – GSI Landslide Susceptability Mapping

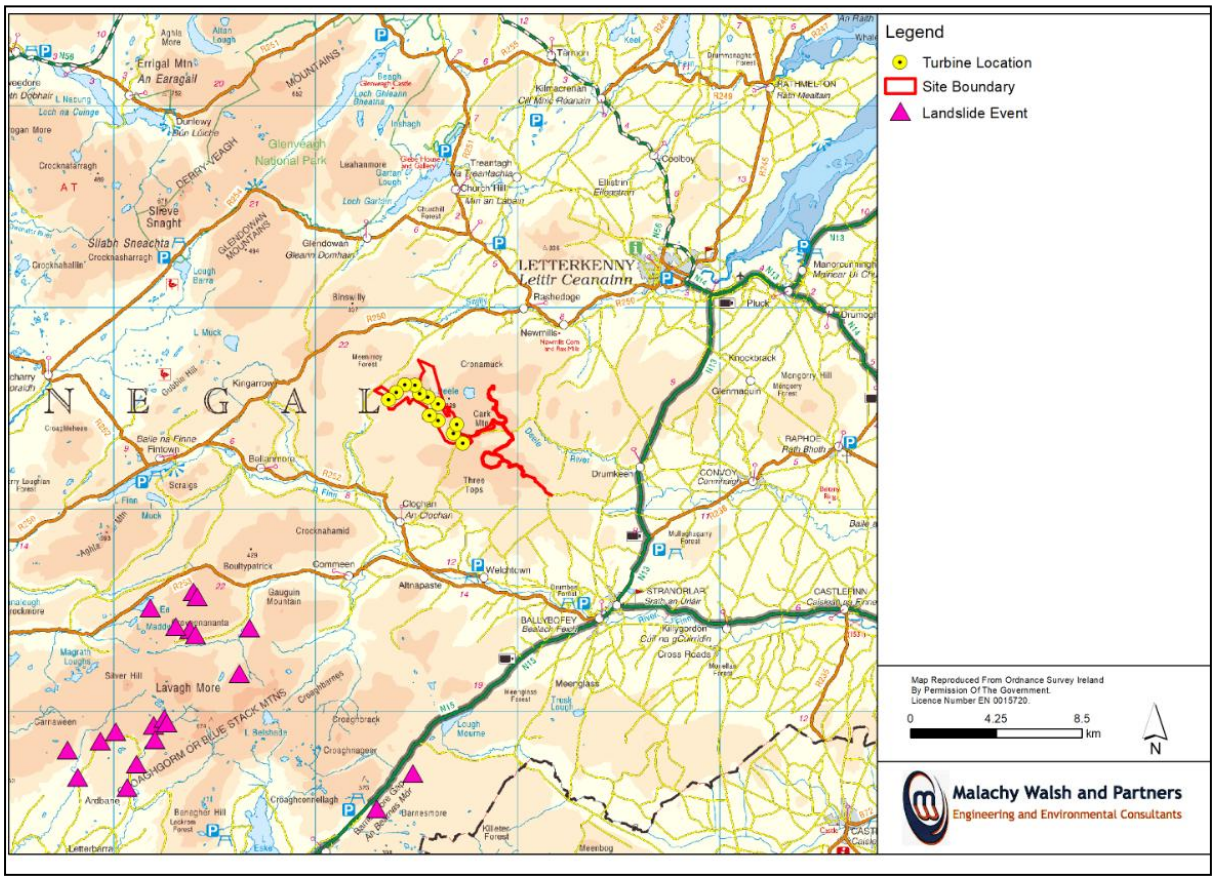

Figure 2-2 – GSI Recorded Landslide Events

2.2 Soil Maps - Geological Survey Ireland Dataset

The predominant soil type present at this site is "*Blanket Peat*" according to the Teagasc/ EPA Soil Maps available on the Geological Survey of Ireland online mapping system, refer to Figure 2-3. Areas of "*Peaty Podzols*" are present in the northern half of the site. Pockets of "*Surface water Gleys/ Ground water Gleys Acidic*" are present to the north and south of the site. The characteristics of the *Blanket Peat* soil type based on data from Teagasc are a high level of organic matter and very high moisture content.

The Quaternary Sediments at the site shown on the Geological Survey of Ireland online mapping system include "*Blanket Peat*" for the majority of the site with local concentrations of "*Bedrock at surface*" and "*Metamorphic Till*" present mainly in the northern half of the site. Refer Figure 2-4 for further information.

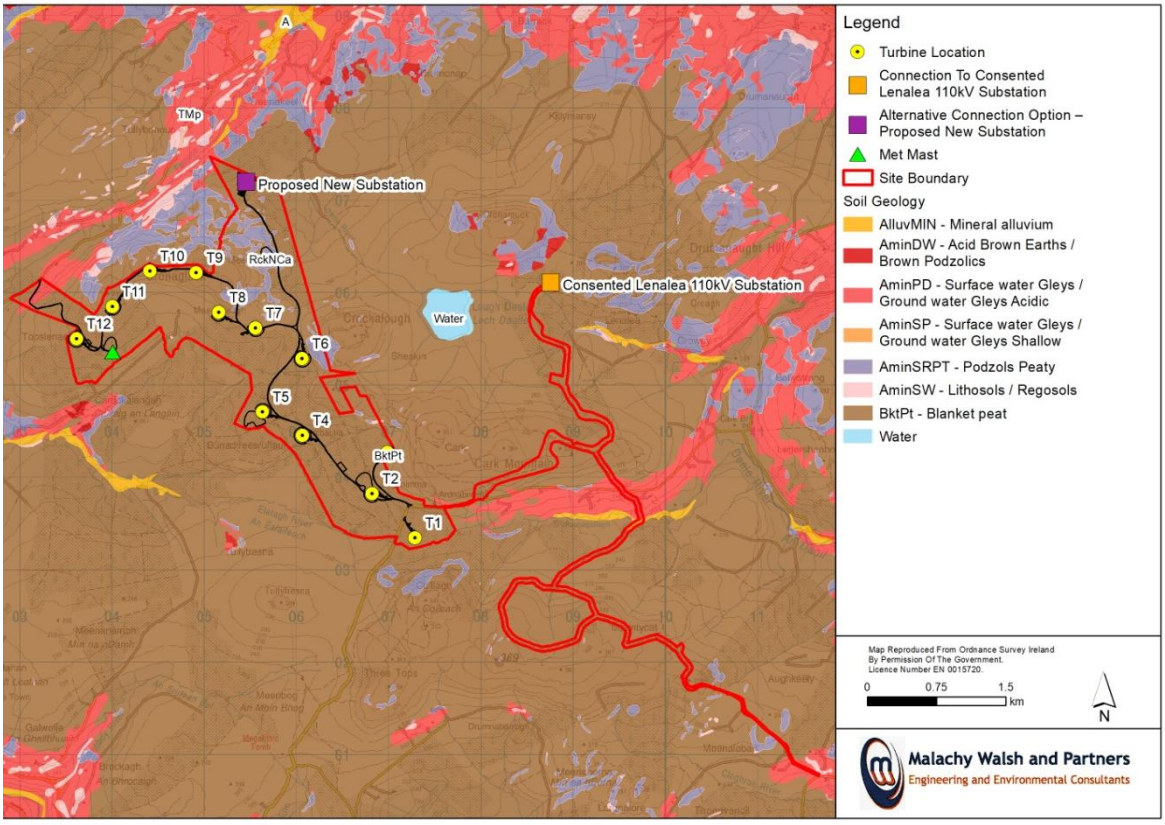

Figure 2-3: Soil Descriptions

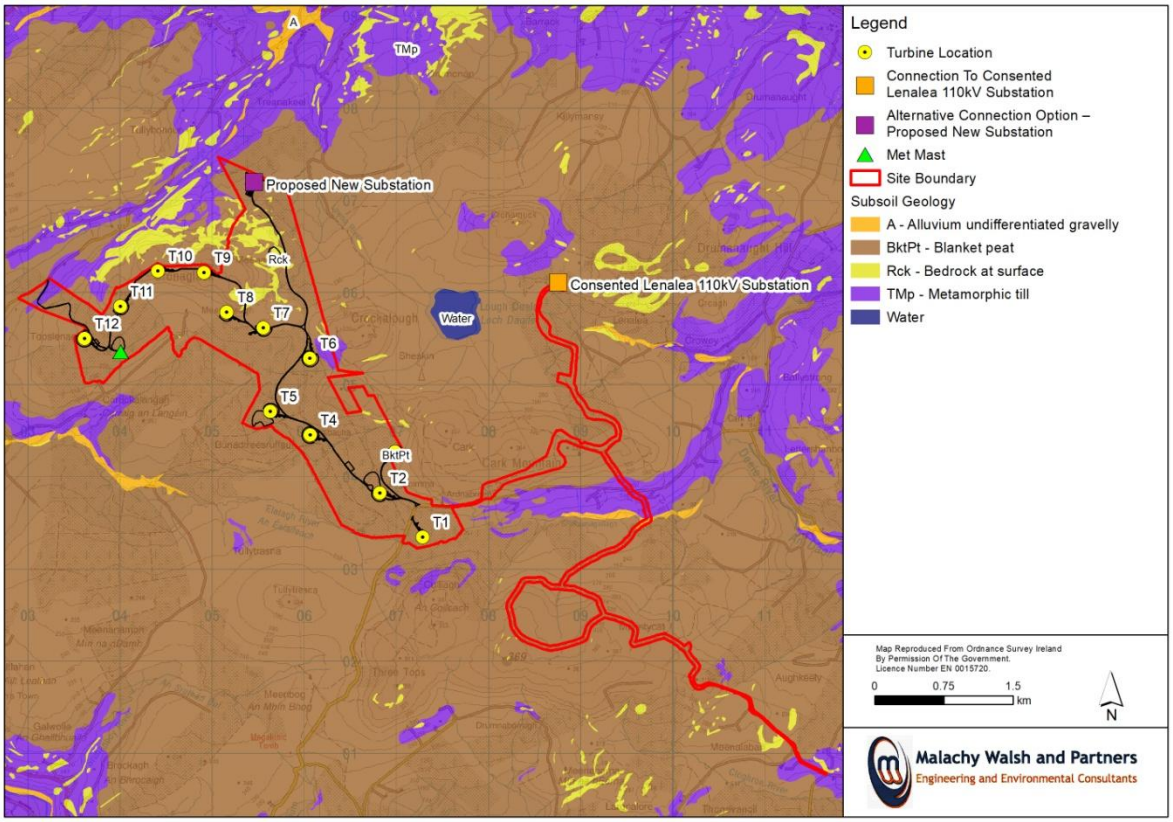

Figure 2-4:Sub-Soil Map

2.3 Existing Land use

The mapped land use of the site is shown in Figure 2-5. This mapping was created using information from CORINE Land Cover 2018 available on the EPA online mapping system. The following land uses have been identified at the site:

- Transitional Woodland Scrub
- Land principally occupied by agriculture with significant areas of natural vegetation
- Peat Bogs
- Coniferous Forests

T3, T7 to T12 and the Permanent Met Mast are located in areas mapped as *Peat Bogs*. T2 and T6 are located in mapped areas of *Transitional Woodland Scrub*. T5 is located in an area of *Coniferous Forests*. T4 is located at an interface area of *Coniferous Forests* and *Transitional Woodland Scrub*. T1 is located within *Land Principally Occupied by Agriculture with Significant Areas of Natural Vegetation*. The proposed access tracks and cable routes traverse areas of *Peat Bogs, Land Principally Occupied by Agriculture with Significant Areas of Natural Vegetation* and *Coniferous Forests*.

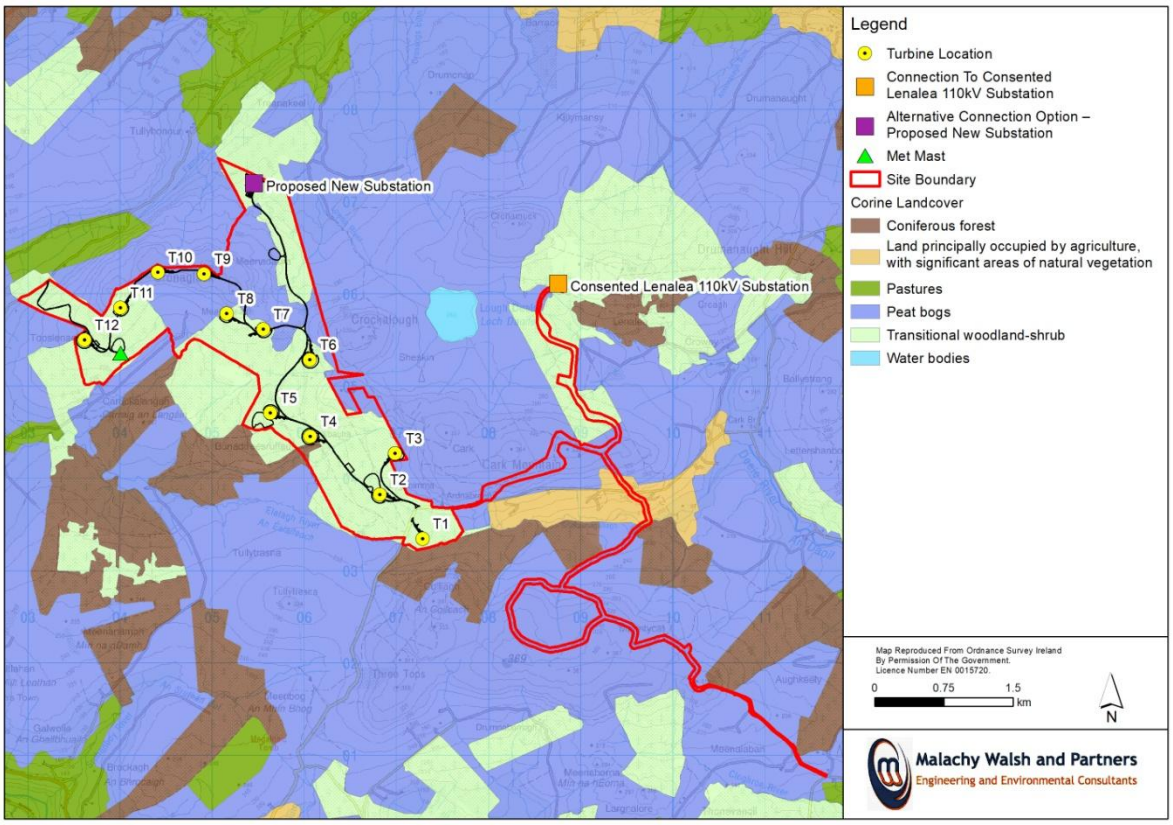

Figure 2-5: Land Cover (CORINE)

2.4 Site Reconnaissance

The initial site reconnaissance survey completed by MWP for this report was carried out in June 2019. Further site investigations and site visits were carried as part of the iterative design process on the dates detailed in Table 2-1.

Table 2-1 List of Site Visits

Names	Date	Purpose
Cormac Murphy	27th June 2019	Initial site reconnaissance to inform initial site layout
Eoin Doyle and Fergus Doyle	19th September 2019	Peat probing at locations of the proposed infrastructure.
Paddy Curran	17th December 2019	Site reconnaissance to further refine layout and view proposed borrow pit locations
Eoin Doyle and Paddy Curran	21st January 2020	Review of options for proposed access road from T7 through to T12. Further peat probing conducted in this area.
Eoin Doyle and Cormac Sheehy	29th January 2020	Review of location of proposed substation and battery storage facility. Further peat probing conducted in this area.

The key objective of the site reconnaissance is to obtain reliable information from which an accurate analysis of the site can be performed. The interpretations and conclusions of this report are made in light of these walkovers and the resultant analytical assessment.

The site is under commercial forestry management and blanket peat. The majority of the site has had extensive drainage works associated with commercial forestry with a full forestry rill and collector network of drains in all the areas under forestry.

Existing forestry access tracks were noted in the eastern areas of the site from the proposed location of T1 to T5 approximately.

Rock was noted immediately under the peat in a number of areas of the site, particularly from T8 through to T12. Areas of heavily eroded peat were also noted from T8 through to T12. This may be due to overgrazing. See photographs in Figure 2-6.

Figure 2-6 Typical soil profile

2.5 Conclusions from Review of Data from Desk Study

From the desk study it is clear that the site is variable in terms of topography and landslide susceptibility. Peat is the dominant soil type across the site. While large parts of the site have gentle slopes, there are areas of the site with relatively steep ground gradients.

Due to the presence of peat across the site, areas of steeper ground and range of landslide susceptibility within the site, it was concluded that a full peat stability risk assessment should be undertaken.

3 Stage 2 – Detailed Peat Stability Risk Assessment

For the design of the Drumnahough Wind Farm, MWP adopted a constraint driven approach to identifying areas suitable for the construction of civil infrastructure associated with wind turbine delivery and erection. The objective was to reduce the site to areas requiring further detailed assessment.

To this end MWP buffered all existing watercourses, designated areas, areas of high conservation forestry and areas of ecological interest.

SSE & Coillte procured high resolution LiDAR topographical surveying of the entire area, and provided this to MWP to assist in design progression.

Using the LiDAR data MWP completed slope analysis for the site as illustrated below in Figure 3-1.

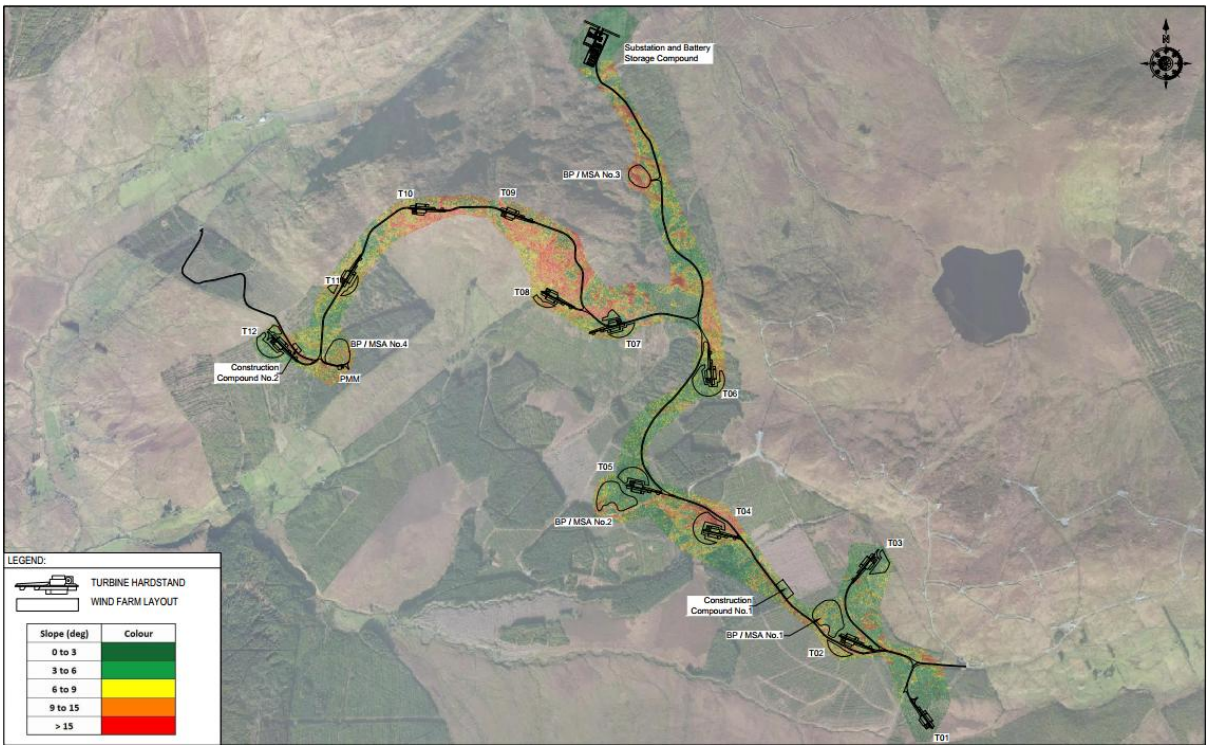

Figure 3-1 – Slope Analysis for proposed layout from High Resolution LiDAR data

3.1 Ground Investigation

MWP completed extensive peat probing and hand shear vane testing of the study area over the course of 6 months from September 2019 to January 2020.

The ground investigation was carried out in an iterative approach where turbine infrastructure locations were proposed using the constraints approach and then ground proofed using peat probing.

The iterative approach to infrastructure layout design using ground slope as one of the primary constraint drivers ensured that the infrastructure location would be suitable for development subject to a peat depth-shear strength combination.

In total 560 peat probes were taken across the study area. The maximum peat depth encountered was 4.5m deep, the minimum depth of peaty cover was 0.1m. The average depth for the data set across the study area was 1.73m.

Shear values were collected at 292 probe locations using a hand shear vane with results which range from 7kPa to 49kPa across the site.

Details of the peat probe data are provided in Appendix 1, with associated peat probe locations outlined in Figure 3-2.

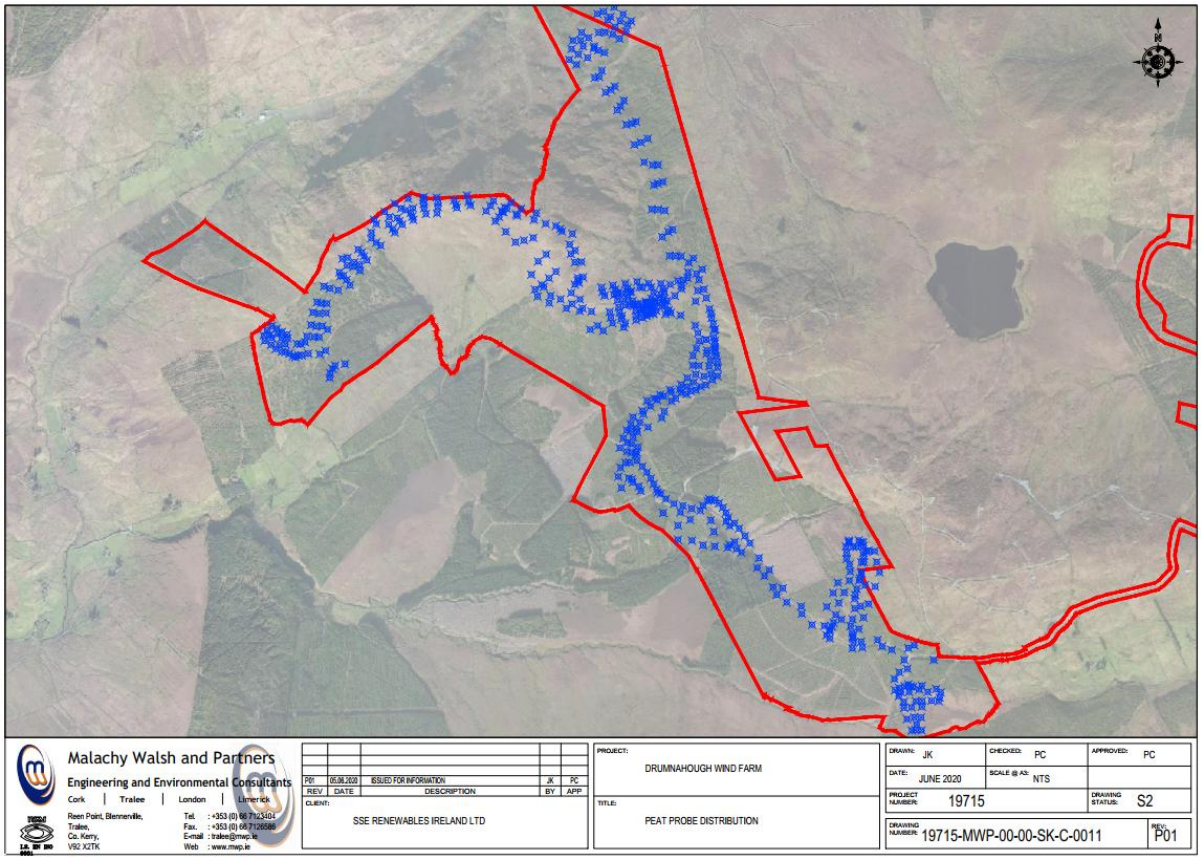

Figure 3-2 – Peat probe locations

3.2 Peat Slide Risk Assessment

The method chosen for this assessment, one of the more conservative approaches in terms of incorporating historical land use risk, is the Peatslide Hazard Rating System (Nichol, 2006), which provides a pseudo-quantitative method of assessing the influence of the following hazards, which are widely acknowledged to contribute to an increased risk of peat slide.

1. Rainfall and climate
2. Presence of water on the slope
3. Peat/Sub-strata interface
4. Peat profile and thickness
5. Shear strength of peat
6. Surface slope gradient and regularity
7. Geomorphology and Site History
8. The extent and condition of subterranean drainage pipes
9. Peatslide history
10. Potential impact of peatslides

The impact of each hazard factor is assessed against a cubic exponential scoring system, which reflects the disproportionate increase in risk associated with adverse indicators for each category. Guidance on the selection of scores for each category is provided in the technical paper entitled Peatslide Hazard Rating System (PHRS) for Wind Farm Development Purposes (Nichol, 2006). A common scale of scores is adopted for each category, as follows:

Low Risk – 3 points

Moderate Risk – 9 points

High Risk – 27 points

Very High Risk – 81 points

The rating system provides scope for the discretionary adjustment of scores in some instances. For any given location, the overall risk rating is defined by the sum of the scores assigned to all hazard factors.

This approach is acknowledged as being systematic and compliant with industry best practice guidance, as published by the Scottish Government PLHRA (2nd Ed 2017).

3.3 Peat Stability Hazard Ranking Assessment

The Peat Stability Hazard Ranking Assessment gives a score to various criteria that are considered risk factors to peat stability. The Hazard rankings for each of these factors is shown in Table 3-1 and are discussed further under in the subsequent sections of this report.

Table 3-1 Hazard Rating Criteria

Category	Rating Criteria and Score			
	Points 3	Points 9	Points 27	Points 81
Rainfall and climate	Low to moderate precipitation	Moderate precipitation	High precipitation	High precipitation
Presence of water on slope	No water on slope	Intermittent water on slope	Continual water on slope	Continual water on slope
Rockhead or subsoil	Rough and irregular rockhead or granular subsoil of sand & gravel	Undulating rockhead or granular subsoil	Planar and regular rockhead or cohesive subsoil	Smooth, polished and regular rockhead or cohesive clay subsoil
Peat profile and depth	Single layer profile less than 1 m deep	Double layer profile less than 2 m deep	Triple layer profile greater than 2 m deep	Complex profile greater than 4 m deep
Peat strength (vane test)	40 kPa	30 kPa	20 kPa	10 kPa
Slope and slope regularity	2° ; even	5° ; uneven	10° ; irregular	15° ; very irregular
Geomorphology and site history	Few differential erosion features	Occasional erosion features	Many erosion features	Major erosion features
Sub-profile drainage	Few pipes	Occasional pipes	Many pipes	Many pipes and sinkholes
Peatslide history	Few slides	Occasional slides	Many slides	Major peatslides
Potential peatslide severity	Few consequences; small impacted area	Minor consequences; minor impacted area	Many consequences; large impacted area	Major consequences; large impacted area

3.3.1 Rainfall and Climate

Rainfall data was obtained from Met Éireann for Finner Camp Station in Co. Donegal. The mean annual rainfall for 2017, 2018 and 2019 is 1230.3mm/Year.

This represents a moderate precipitation hazard for this assessment.

3.3.2 Presence of water on slope

The gradients in the study areas are such that water does not persist on slopes but during periods of heavy rainfall saturation of the ground occurs.

This represents an intermittent rating hazard for this assessment.

3.3.3 Rockhead or subsoil

From the peat probing data and observations of rock outcrops onsite, a mixture of rock, granular soils with some cohesive soils were encountered. During the site reconnaissance, rock head was observed in forestry track cuttings, historical borrow pits, and natural rock outcrops throughout the site. Photographs of typical rock exposures are given in Figure 2-6 in Section 2.4. This represents a low to moderate risk rating for most areas in this assessment.

3.3.4 Peat profile and depth

Peat probing was carried out across the site. The depth and nature of the cover is typical of upland blanket peat. The maximum depth to rock or subsoil encountered was 4.5m with an average cover depth of 1.73m.

The peat depth and subsoil profile in terms of this risk assessment is identified for each individual area assessed.

3.3.5 Peat Strength

MWP recorded shear strengths ranging from 7kPa to 49kPa.

The profile in terms of this risk assessment is identified for each individual area assessed.

3.3.6 Slope and Slope regularity

The slopes ranged from 0^{o} to 25^{o} in localised areas. See detailed mapping of slopes on Figure 3-1 in Section 3.

The topographical profile in terms of this risk assessment is identified for each individual area assessed.

3.3.7 Geomorphology and Site History

Natural erosion features such as hags, mounds, ridges, pools and incised streams, as well as disruption of the ground surface by grazing, burning, forestry, drainage ditches, tracks, fence lines and man-made cuttings, all affect the integrity of the near surface layers of peat and the tensile strength of the root-mat in particular. In addition, they may create localised over-steepening of slopes or unsupported blocks of peat.

The degree of hazard caused by erosion and degradation, and thus the score given in this category, should reflect how quickly erosion and degradation are taking place, the size of the blocks or units being exposed, and the amount of material being released.

The peaty surface in the study area displays some of the above erosion features, particularly in the area from T9 to T11. Peat has been eroded in this area by agricultural activities, possibly due to overgrazing. This has created preferential surface water flow paths and blocks of peat with over steepened sides. In areas of the site where forestry is present, the main geomorphological feature is rill drains for forestry drainage.

3.3.8 Sub-profile drainage

As a blanket bog develops over millennia, a network of peat pipes will also develop naturally, with new tributary pipes forming as branches of the primary pipe. The principal pipes within a drainage network may grow to such diameter that the peat forming the roof of the pipe is no longer able to bridge across the void, resulting in collapse. If the debris resulting from roof collapse forms a blockage within a pipe network, groundwater pressures upstream of the blockage may build to such levels that a new spring is formed, and porewater pressures are redistributed within the peat mass, such that the continued development of the critical internal drainage network takes on a new direction.

Within the downstream reaches of a bog drainage network, pipe collapses may join together, so that an open drainage gulley is formed. Such gullies receive and convey both surface water runoff and shallow groundwater flow, emerging from peat pipes. The network of pipes and gullies enable a blanket bog to remain stable under a wide range of groundwater conditions. When a drainage network is interrupted, either due to a natural event, such as pipe collapse or landslide, or due to construction works, an increase in the risk of peat instability will result from the destabilising build-up of elevated porewater pressure within the peat mass.

Few of the above features were observed in the study area at Drumnahough.

3.3.9 Peat Slide History

There are no recorded peat slide events within the site and the surrounding area.

3.3.10 Potential Peat Slide Severity

The potential severity of a slide event at each location of infrastructure has been assessed on an individual basis. The potential severity reflects the likelihood of a propagating peat slide to develop a large volume of debris, where that debris trail might run, the ability of a developer to implement containment measures (i.e. access roads downslope of infrastructure would allow a quick response for the construction of containment berms), and the proximity of watercourses.

3.4 Calculation of Overall Peat Stability Hazard Ranking

MWP tabulated the hazard rankings in accordance with the assessment criteria in Table 3-1 Hazard Rating Criteria. The findings of the hazard ranking are presented in Table 3-2.

Table 3-2 Hazard Ranking Scores

Hazard Category	Hazard Factor Scores																	
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**T11**	**T12**	**BP1**	**BP2**	**BP3**	**BP4**	**PMM**	**Sub - station**
Rainfall and climate (1230 mm/year)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Presence of water on Slope	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Peat/sub-strata interface (rockhead/sub-soil)	9	3	9	9	3	9	9	9	3	3	3	3	3	3	3	3	3	9
Peat profile and depth	27	9	9	9	27	27	27	9	9	9	27	9	9	9	9	27	27	81
Peat strength (vane test - based on lowest value encoutered onsite)	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81	81
Surface slope gradient and regularity	3	9	3	27	3	27	9	27	81	81	27	9	9	9	9	9	27	3
Geomorphology and Site History	3	3	3	3	3	3	3	3	27	27	27	3	3	3	3	3	3	3
Sub-profile drainage	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Peatslide history	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Potential peatslides severity	3	3	3	9	9	3	3	3	27	27	27	27	3	9	9	9	9	9
Peatslide Hazard Rating Score	150	132	132	162	150	174	156	156	252	252	216	156	132	138	138	156	174	210
Peatslide Hazard Risk Class	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**4**	**4**	**4**	**3**	**2**	**2**	**2**	**3**	**3**	**4**
Peatslide Hazard Rating Score	Low	Very Low	Very Low	Low	Low	Low	Low	Low	Low-Moderate	Low-Moderate	Low-Moderate	Low	Very Low	Very Low	Very Low	Low	Low	Low-Moderate

PHRS scores are intended as a means of comparing different sites and as a tool for prioritising mitigation works. The PHRS system itself does not attach any particular significance to the total score for each site and leaves it to the project engineers to draw their own conclusions, based on an understanding of the local conditions that apply. However, industry practice is that sites with an average rating of less than 200 are assigned a low priority, while those with an average rating of more than 400 are identified for urgent attention.

3.5 Peat Stability Risk Assessment

Table 3-3 shows the risk assessment matrix for the proposed infrastructure on this project. The rankings range from **Very Low** to **Low-Moderate** for different areas of infrastructure within the proposed development.

Table 3-3 Risk Assessment Matrix Summary

Risk Class	Hazard Ranking	Engineering Response	Area of Infrastructure
Risk Level 1 (0 to 70)	Negligible	Do nothing. Acceptable.	-
Risk Level 2 (71 to 140)	Very Low	Monitor and review. Manage by normal slope maintenance procedures.	T2, T3 BP1, BP2, BP 3
Risk Level 3 (141 to 200)	Low	Further investigation of the peat slide hazard may be required. Manage by normal slope maintenance procedures.	T1, T4, T5, T6, T7, T8, T12
Risk Level 4 (201 to 300)	Low-Moderate	Peat slide stabilisation works may be required.	T9, T10, T11 BP4 PMM Substation & battery storage area
Risk Level 5 (301 to 400)	Moderate	Peat slide stabilisation works may be required. Further studies required to refine judgements.	-
Risk Level 6 (401 to 500)	High	Peat slide stabilisation works likely to be required. Further investigations will be required, including a comprehensive assessment of risks.	-
Risk Level 7 (>500)	Very High	Large scale mitigation works will be required. Urgent requirements for further investigations, including a comprehensive assessment of risks.	-

The engineering response for a **Very Low** rating is monitor and review. The engineering response for a **Low** rating is that further investigation of the peat slide hazard may be required. Both Very Low and Low ratings can be managed by normal slope maintenance procedures. The engineering response for **Low-Moderate** rating is peat-slide stabilisation works may be required. This is typically in the form of granular berms constructed on the downslope side of the construction area to prevent movement of peat during construction.

Further quantitative slope stability assessment is carried out in the following sections of this report, as recommended for the Risk Level 3 (Low rating). This assessment is carried out below in accordance with the guidance of the Scottish Government PLHRA (2nd Ed 2017).

3.5.1 Infinite Slope Stability Analysis

The Scottish Executive Guidelines for Peat Landslide Hazard and Risk Assessments recommends the use of Infinite Slope Stability Analysis to calculate a Factor of Safety (FoS) for each area of a study site.

Factors of safety were calculated for the un-drained condition using the equation. This formula was applied across the area of proposed infrastructure within the wind farm site and results are displayed in the colour coded map in Figure 3-5:

$$FoS = \frac{S_u}{\gamma z Sin\theta Cos\theta}$$

where S_u= Shear Strength, γ = Density, z = depth, θ = Slope Angle

3.5.1.1 Peat Depth Data

As described above a data set of 560 peat probes was collected with their GPS coordinates logged for incorporation into peat stability analysis. The maximum peat depth encountered was 4.5m deep, the minimum depth of peaty cover was 0.1m. The spatial distribution of peat depths is given in Figure 3-3.

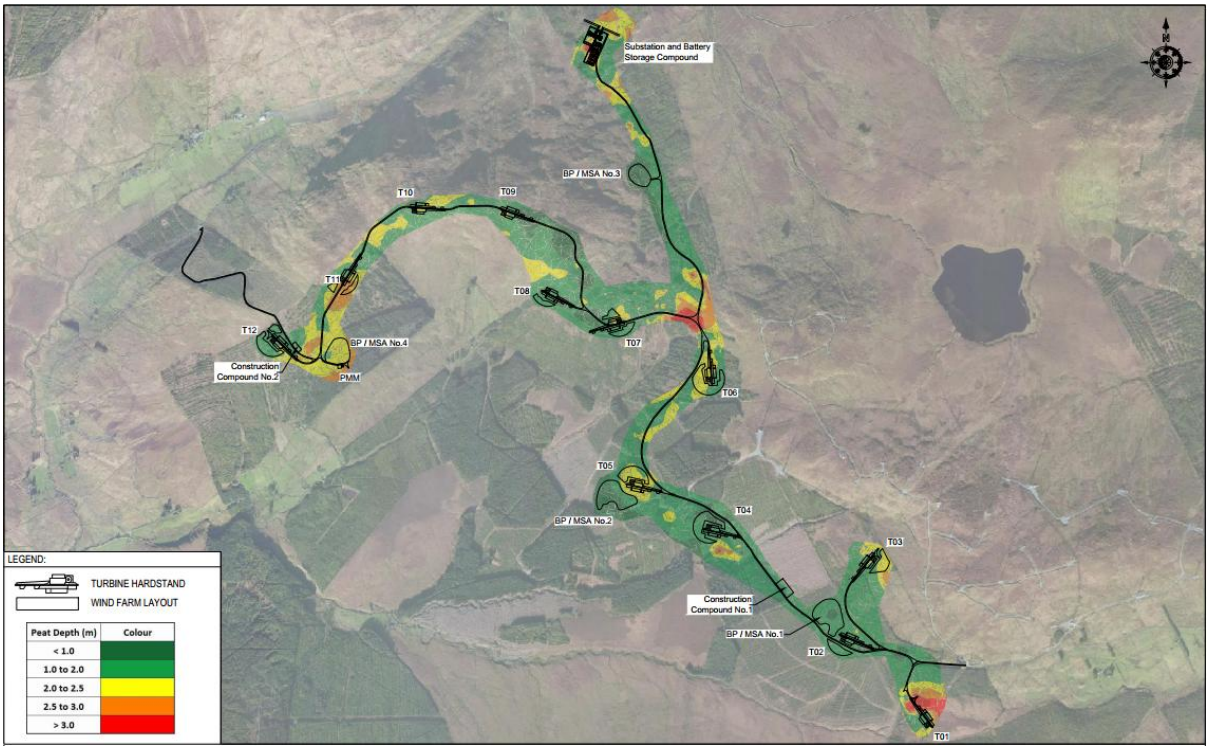

Figure 3-3 Peat Depth Spatial Distribution

3.5.1.2 Slope Angle

For the purpose of calculating slope angle for each data point of the peat probe dataset MWP employed the Digital Elevation Model (DEM) created using the LiDAR data. For each peat probe point the software interrogated the DEM at 3 points on a 5m radius around the peat probe (identified in red circles in the screenshot below). The software uses the elevation of those three

points to create an inclined plane centred on the peat probe. The geometric slope of that inclined plane is then calculated mathematically to give the ground slope for each peat probe in the data set.

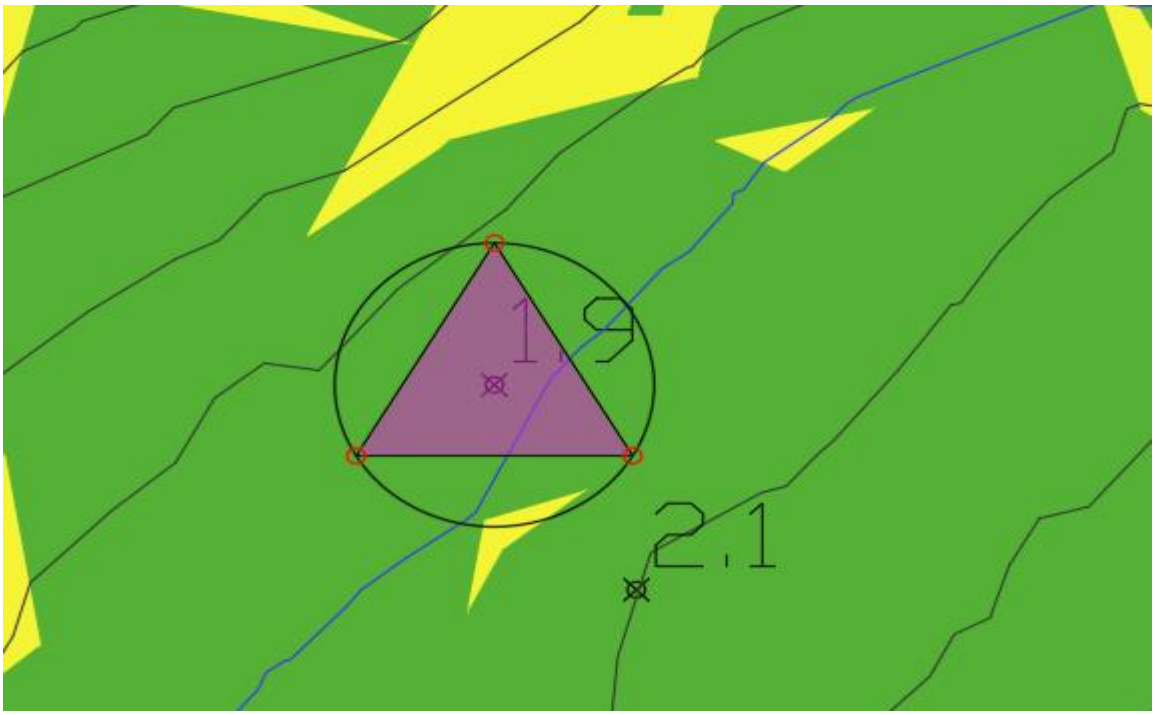

Figure 3-4 Example of DEM interrogation for slope dataset calculation

3.5.1.3 Shear Strength of Peat

Shear values were collected at 292 probe locations which range from 7kPa to 49kPa. Where shear data was not collected a default shear value of 7kPa (this represents a minimum value) was allocated to the datapoint for the purpose of calculating a FoS for that data point.

3.5.1.4 Bulk Density of Peat

For the purpose of calculating FoS a peat bulk density of 10kN/m^3 was adopted. This value has been adopted based on information from "Peat slope failure in Ireland, Article in Quarterly Journal of Engineering Geology and Hydrogeology", February 2008, N. Boylan, P. Jennings and M. Long. This paper states that the "bulk density of peat is typically similar to or less than that of water."

3.5.1.5 Factor of Safety Analysis Output

For the purpose of the stability check the FoS was calculated with 0.5m of peat surcharge across the site.

FoS analysis was completed for each data point in the peat probe data set. The outputs of these calculations are presented graphically in Figure 3-5 with colour contouring to illustrate the spatial distribution of calculated FoS across the site.

As illustrated in Figure 3-5, the majority of the proposed infrastructure on site is located in areas with a Factor of Safety (FoS) against a peatslide greater than 4. Localised areas have a FOS between 2 and 4. No infrastructure has been placed in areas with a FOS less than 2. This analysis is in line with the Risk Ratings present in Table 3-6.

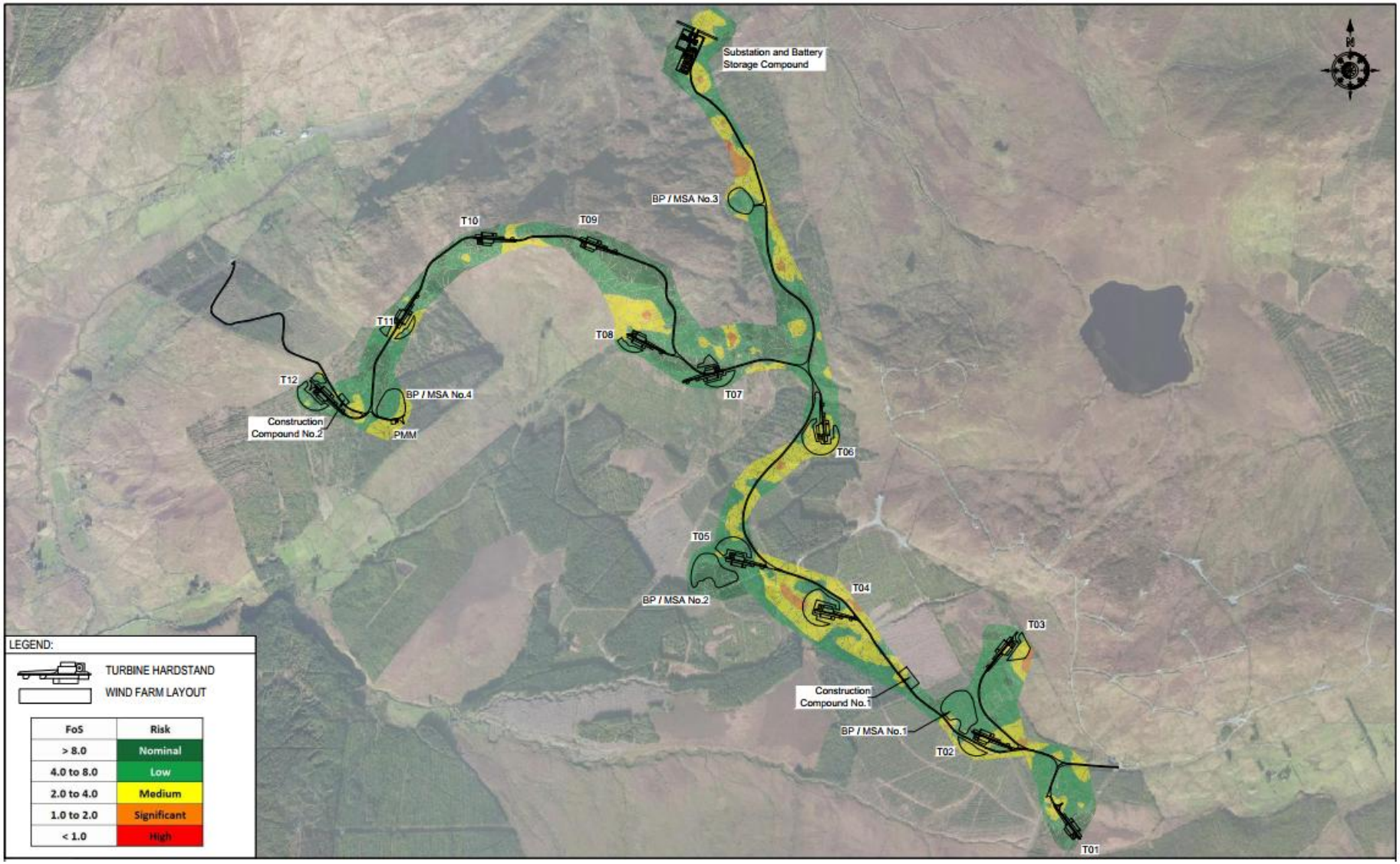

Figure 3-5 Site Layout overlaid on Factor of Safety Mapping

3.6 Impact Assessment.

The finding of the Peat Stability Risk Assessment is that there is a **Low to Low-Moderate** risk of a peat slide event occurring at Drumnahough. This finding is consistent with the initial design constraints approach to identify areas of the site where slope gradients were low and place infrastructure in those areas.

The Scottish Government PLHRA (2nd Ed 2017) offers guidance on Risk Determination. Table 3-4 to Table 3-7 are taken from that guidance.

In the case of the study area it is reasonable to rate the likelihood of a landslide run-out occuring on the site over the life of the project as being **Unlikely** (See Table 3-4).

The infrastructure has been located in areas of shallower peat, away from watercourses and steep slopes. In the unlikely event of a slide, the run-out from the slide would be limited due to the precautions taken in selecting the infrastructure layout. Based on this, the impact of a slide at Drumnahough is considered **Low** (1 to 4% damage to receptor) (See Table 3-5).

Table 3-4 Likelihood Ranking

Scale	Likelihood	Probability of occurrence
5	Almost certain	> 1 in 3
4	Probable	1 in 10 – 1 in 3
3	Likely	1 in 10^2 – 1 in 10
2	Unlikely	1 in 10^7 – 1 in 10^2
1	Negligible	< 1 in 10^7

Table 3-5 Impact Ranking

Scale	Adverse consequences	Impact as % damage to (or loss of) receptor
5	Extremely high	> 100% of asset (e.g. infrastructure or habitat)
4	Very high	10% - 100%
3	High	4% - 10%
2	Low	1% - 4%
1	Very Low	< 1% of asset (e.g. infrastructure or habitat)

Table 3-6 Risk Ranking Matrix

		Adverse consequence				
		Extremely High	High	Moderate	Low	Very Low
Peat landslide probability or likelihood	Almost certain	High	High	Moderate	Moderate	Low
	Probable	High	Moderate	Moderate	Low	Negligible
	Likely	Moderate	Moderate	Low	Low	Negligible
	Unlikely	Low	Low	Low	Negligible	Negligible
	Negligible	Low	Negligible	Negligible	Negligible	Negligible

Table 3-7 Risk Level Action Table

Risk Level	Action suggested for each zone
High	Avoid project development at these locations
Medium	Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible
Low	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations
Negligible	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

3.6.1 Risk to the Wind Farm Infrastructure

The infrastructure of the Wind Farm itself is robust and would suffer little consequence to a peat slide run-out.

The output of the Risk Ranking matrix is that an **Unlikely** event with a **Low** impact represents a **Negligible Risk** level to the project (See Table 3-6).

The output of a Risk Assessment carried out in accordance with the Scottish Guidance on Best Practice is that peat landslide represents a **Negligible Risk** to the Wind Farm Infrastructure and that the project should proceed with monitoring and appropriate mitigation (Table 3-7).

3.6.2 Risk to surrounding Environment

In assessing the risk to receiving Environment, while the likelihood of a slippage remains unlikely, the adverse outcome could be more significant. A peat slide would result in run out of peaty water which would make its way to the watercourses. A set-back buffer of 100m has been incorporated to all-natural streams in the site.

Applying the above criteria to the risk represented by a landslide to the Drumnahough Site will output an **Unlikely** likelihood of a **Low** consequence which outputs a **Negligible Risk** level (See Table 3-6). This low risk of a peat slide warrants assessment of mitigation measures as per the recommendations of the Scottish Executive guidelines (Table 3-7).

3.7 Mitigation

The findings of the Peat Stability Risk Assessment is that there is a **Negligible Risk** to the project therefore no further planning stage design measures are considered necessary.

Peat monitoring by sightline monitoring method shall be carried out by the appointed contractor for this development. Monitoring will be carried out at areas of deep excavations (eg turbine bases), material deposition areas and any area of works with a risk rating higher than “low” as shown on Figure 3-5.

Monitoring by sightlines entails driving a series of posts at approximately 5m centres, exactly aligned, across the section of bog being monitored. An illustration of this approach is given below in Figure 3-6. Any signs of distress or deformation in the bog will quickly manifest itself by some of the posts moving out of alignment. Early discovery of stress in the peat will give the developer a opportunity to implement emergency procedures to prevent the onset of a bog burst or localised peat slide. While the risk of such occurrence is low in this instance, the precautionary principle dictates that monitoring posts should be installed in work areas where there are areas with a risk rating higher than “low” as shown on Figure 3-5 adjacent to the works area. Emergency procedures are the responsibility of the appointed contractor and are to be included in the appointed contractors method statements. As a minimum, the following shall be included in the contractor’s methodologies:

- Emergency response procedures to protect the health and safety of workers and to implement containment procedures for remoulded peat slurry on or off site.
- Identification of potential flow paths of peat slides to determine accessible intervention points on or off site to construct barrages, settlement ponds and silt traps to contain the peat slurry and to prevent downstream contamination of watercourses.
- Stockpiling of rockfill on or off site to use in the construction of emergency containment barrages in the event of a slide.

The Construction Manager for the project should impart the philosophy that everyone on the site is aware of peat stability and report any sign of misalignment in monitoring posts. Vigilance is a fundamental requirement when working on peat where inappropriate construction methodology can cause instability in otherwise benign conditions.

A Geotechnical Engineer experienced in working in the upland peat environment should be employed full-time to ensure the implementation of best practice in this environment. The

methodology of all civil works should be reviewed by the Geotechnical Engineer and the monitoring posts should be the subject of a dedicated inspection on a weekly basis by the Geotechnical Engineer.

The following general measures incorporated into the construction phase of the project will assist in the management of the risks for this site:

- Appointment of experienced and competent contractors and detailed designers;
- The construction works on site will be supervised by experienced and qualified personnel;
- Ensure construction method statements are followed or where agreed modified/ developed.
- Allocate sufficient time for the project to be constructed safely with all peat stability mitigation measures included in the programme;
- Set up, maintain and report findings from monitoring systems, including sightline monitoring;
- Maintain vigilance and awareness through Tool-Box-Talks (TBTs) on peat stability;
- Prevent undercutting of slopes and unsupported excavations;
- No sidecasting of excavated material other than in areas selected for such activities by a suitably qualified environmental professional or site geotechnical engineer.
- Prevent placement of loads/overburden on marginal ground; and,
- Manage and maintain a robust drainage system.

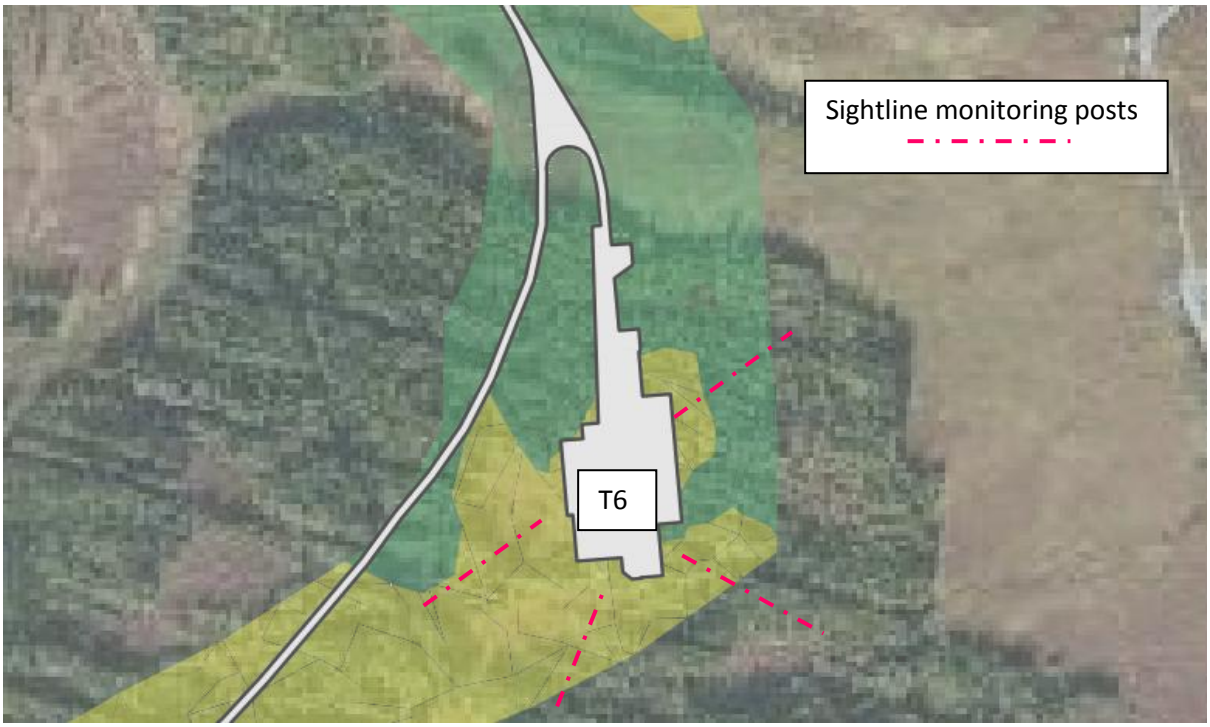

Figure 3-6 Example of a typical monitoring post layout

4 Conclusions

The study used a two-stage approach to peat stability risk assessment that combined desk study, site reconnaissance, qualitative and quantitative analysis to identify the level of risk from peat landslide for the proposed wind farm site.

MWP employed the Peat Slide Hazard Rating System for Wind Farm Development Purposes (Nichol, 2006) to assess the hazard ranking of the study area. The output of this method of analysis was that the area represented a **Low to Low-Moderate Hazard Rating** for peat slide. The findings reflect the mitigation by design philosophy adopted in designing the wind farm infrastructure of avoiding areas of steeper slopes from the outset.

The engineering response for a **Low** rating in the Nichol (2006) PHRS is that *Further investigation of the peat slide hazard may be required*. The recommended engineering response to a finding of a **Low-Moderate** is *Peat-slide stabilisation works may be required.* This is typically in the form of a granular berm on the downslope side of the infrastructure to prevent peat movement.

MWP progressed to a risk assessment carried out in accordance with the guidance of the Scottish Government PLHRA (2nd Ed 2017). This Included infinite slope analysis and risk assessment. The output of the Peat Landslide Hazard Risk Assessment was that peat landslide presented a **Negligible Risk** to the infrastructure of the Wind Farm and surrounding area.

5 References

Geohive 2020, Online Map Viewer, viewed on 7th May 2020, https://geohive.ie/

Geological Survey of Ireland 2020, Online Geological Map Viewer, viewed on 7th May 2020, https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx

Met Eireann 2020, Rainfall Data, viewed on 7th May 2020, https://www.met.ie/climate/available-data/monthly-data

Nichol, D., 2006. Peatslide hazard rating system for wind farm development purposes. Proceedings of the 28th Annual Conference of the British Wind Energy Association (BWEA28), 10-12 October 2006, Glasgow, B2.

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

Peat slope failure in Ireland, Article in Quarterly Journal of Engineering Geology and Hydrogeology · February 2008 DOI: 10.1144/1470-9236/06-028, N. Boylan, P. Jennings and M. Long

Appendix 1: Peat Probe Data

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 1	ITM	607141	903426	Peat	4.3	
GC 2	ITM	607171	903483	Peat	4.2	
GC 3	ITM	607210	903430	Peat	4.2	
GC 4	ITM	607298	903433	Peat	4	
GC 5	ITM	607246	903431	Peat	3.9	
GC 6	ITM	607339	903430	Peat	3.7	
GC 7	ITM	605920	905860	Peat	3.4	11
GC 8	ITM	607345	903450	Peat	3.4	
GC 9	ITM	606009	905763	Peat	3.2	29
GC 10	ITM	605441	907335	Peat	3.2	
GC 11	ITM	607350	903480	Peat	3.2	
GC 12	ITM	606072	904307	Peat	3.2	
GC 13	ITM	605982	905817	Peat	3.1	21
GC 14	ITM	605407	907323	Peat	3.1	
GC 15	ITM	605570	907223	Peat	3.1	
GC 16	ITM	605571	906696	Peat	3.1	
GC 17	ITM	606023	905714	Peat	3	36
GC 18	ITM	607277	903482	Peat	3	
GC 19	ITM	603752	905463	Peat	2.9	14
GC 20	ITM	603832	905492	Peat	2.9	19
GC 21	ITM	603987	905817	Peat	2.9	20
GC 22	ITM	607244	903518	Peat	2.9	
GC 23	ITM	606144	904300	Peat	2.9	
GC 24	ITM	603714	905388	Peat	2.8	12
GC 25	ITM	603796	905632	Peat	2.8	21
GC 26	ITM	603875	905682	Peat	2.8	20
GC 27	ITM	603940	905758	Peat	2.8	19
GC 28	ITM	604865	906204	Peat	2.8	17
GC 29	ITM	606042	905652	Peat	2.8	32
GC 30	ITM	605598	907282	Peat	2.8	
GC 31	ITM	605481	907306	Peat	2.8	
GC 32	ITM	605454	906878	Peat	2.8	

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 33	ITM	607004	904160	Peat	2.8	
GC 34	ITM	607167	903525	Peat	2.8	
GC 35	ITM	607113	903459	Peat	2.8	
GC 36	ITM	607180	903514	Peat	2.7	
GC 37	ITM	603770	905399	Peat	2.6	16
GC 38	ITM	603802	905493	Peat	2.6	18
GC 39	ITM	603891	905261.3	Peat	2.6	13
GC 40	ITM	603908	905313	Peat	2.6	14
GC 41	ITM	603952	905837	Peat	2.6	20
GC 42	ITM	603978	905340	Peat	2.6	17
GC 43	ITM	605546	905613	Peat	2.6	12
GC 44	ITM	605846	905726	Peat	2.6	13
GC 45	ITM	606025	905399	Peat	2.6	19
GC 46	ITM	606039	905327	Peat	2.6	12
GC 47	ITM	606874	904304	Peat	2.6	
GC 48	ITM	605466	907288	Peat	2.6	
GC 49	ITM	605493	907207	Peat	2.6	
GC 50	ITM	605505	906912	Peat	2.6	
GC 51	ITM	607214	903298	Peat	2.6	
GC 52	ITM	607229	903496	Peat	2.6	
GC 53	ITM	605652	904622	Peat	2.6	
GC 54	ITM	603606	905446	Peat	2.5	12
GC 55	ITM	604287	906149	Peat	2.5	22
GC 56	ITM	606046	905362	Peat	2.5	15
GC 57	ITM	606053	905601	Peat	2.5	22
GC 58	ITM	605779	904496	Peat	2.5	
GC 59	ITM	603786	905561	Peat	2.4	20
GC 60	ITM	604063	905869	Peat	2.4	14
GC 61	ITM	604424	906246	Peat	2.4	25
GC 62	ITM	605033	905847	Peat	2.4	16
GC 63	ITM	605172	905863	Peat	2.4	13
GC 64	ITM	605482	905602	Peat	2.4	13

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 65	ITM	605527	905662	Peat	2.4	13
GC 66	ITM	605717	905684	Peat	2.4	11
GC 67	ITM	605982	905330	Peat	2.4	11
GC 68	ITM	606050	905626	Peat	2.4	27
GC 69	ITM	606067	905533	Peat	2.4	24
GC 70	ITM	605633	904956	Peat	2.4	
GC 71	ITM	605935	905187	Peat	2.4	
GC 72	ITM	605584	904694	Peat	2.4	
GC 73	ITM	605535	907282	Peat	2.4	
GC 74	ITM	605557	906832	Peat	2.4	
GC 75	ITM	605653	906595	Peat	2.4	
GC 76	ITM	607187	903264	Peat	2.4	
GC 77	ITM	607194	903511	Peat	2.4	
GC 78	ITM	607325	903499	Peat	2.4	
GC 79	ITM	605641	904646	Peat	2.4	
GC 80	ITM	605589	904783	Peat	2.4	
GC 81	ITM	603683	905384	Peat	2.3	12
GC 82	ITM	603733	905389	Peat	2.3	12
GC 83	ITM	603892	905768	Peat	2.3	19
GC 84	ITM	603992	905942	Peat	2.3	13
GC 85	ITM	604155	906027	Peat	2.3	20
GC 86	ITM	604226	906130	Peat	2.3	26
GC 87	ITM	604505	906256	Peat	2.3	19
GC 88	ITM	604678	906259	Peat	2.3	17
GC 89	ITM	604875	906200	Peat	2.3	18
GC 90	ITM	605725	905747	Peat	2.3	11
GC 91	ITM	605754	905685	Peat	2.3	14
GC 92	ITM	605918	905827	Peat	2.3	10
GC 93	ITM	605964	905282	Peat	2.3	7
GC 94	ITM	606073	905537	Peat	2.3	23
GC 95	ITM	605693	904982	Peat	2.3	
GC 96	ITM	605965	905193	Peat	2.3	

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 97	ITM	605818	905195	Peat	2.3	
GC 98	ITM	605450	907219	Peat	2.3	
GC 99	ITM	605538	904753	Peat	2.3	
GC 100	ITM	606929	904278	Peat	2.3	
GC 101	ITM	606912	904307	Peat	2.3	
GC 102	ITM	607115	903506	Peat	2.3	
GC 103	ITM	605602	904687	Peat	2.3	
GC 104	ITM	605687	904726	Peat	2.3	
GC 105	ITM	607145	903515	Peat	2.24	
GC 106	ITM	603663	905399	Peat	2.2	12
GC 107	ITM	603963	905936	Peat	2.2	15
GC 108	ITM	604273	906167	Peat	2.2	22
GC 109	ITM	605071	905921	Peat	2.2	21
GC 110	ITM	605103	905776	Peat	2.2	12
GC 111	ITM	605598	905752	Peat	2.2	10
GC 112	ITM	605614	905669	Peat	2.2	10
GC 113	ITM	606010	905270	Peat	2.2	7
GC 114	ITM	606023	905478	Peat	2.2	28
GC 115	ITM	606062	905567	Peat	2.2	21
GC 116	ITM	605763	905166	Peat	2.2	
GC 117	ITM	606184	904332	Peat	2.2	
GC 118	ITM	605566	904781	Peat	2.2	
GC 119	ITM	605525	904702	Peat	2.2	
GC 120	ITM	606988	904218	Peat	2.2	
GC 121	ITM	605785	905071	Peat	2.2	
GC 122	ITM	605608	904669	Peat	2.2	
GC 123	ITM	605596	904962	Peat	2.2	
GC 124	ITM	603641	905408	Peat	2.1	12
GC 125	ITM	603728	905452	Peat	2.1	12
GC 126	ITM	603762	905498	Peat	2.1	16
GC 127	ITM	603871	905628	Peat	2.1	20
GC 128	ITM	604127	906051	Peat	2.1	19

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 129	ITM	604302	906130	Peat	2.1	22
GC 130	ITM	604362	906222	Peat	2.1	28
GC 131	ITM	604426	906222	Peat	2.1	25
GC 132	ITM	604888	906089	Peat	2.1	21
GC 133	ITM	605436	905748	Peat	2.1	12
GC 134	ITM	605532	905632	Peat	2.1	13
GC 135	ITM	605664	905601	Peat	2.1	9
GC 136	ITM	605724	905625	Peat	2.1	12
GC 137	ITM	605777	905768	Peat	2.1	16
GC 138	ITM	605947	905332	Peat	2.1	11
GC 139	ITM	606023	905478	Peat	2.1	28
GC 140	ITM	606028	905417	Peat	2.1	21
GC 141	ITM	606072	905472	Peat	2.1	27
GC 142	ITM	606073	905425	Peat	2.1	22
GC 143	ITM	606911	904330	Peat	2.1	
GC 144	ITM	605951	905236	Peat	2.1	
GC 145	ITM	605825	905182	Peat	2.1	
GC 146	ITM	605771	905034	Peat	2.1	
GC 147	ITM	605826	905129	Peat	2.1	
GC 148	ITM	605992	905212	Peat	2.1	
GC 149	ITM	605729	905146	Peat	2.1	
GC 150	ITM	605552	907321	Peat	2.1	
GC 151	ITM	605391	906961	Peat	2.1	
GC 152	ITM	607142	903393	Peat	2.1	
GC 153	ITM	606914	904253	Peat	2.1	
GC 154	ITM	606840	903856	Peat	2.1	
GC 155	ITM	605709	904692	Peat	2.1	
GC 156	ITM	603698	905378	Peat	2	12
GC 157	ITM	605632	905678	Peat	2	10
GC 158	ITM	605681	905616	Peat	2	9
GC 159	ITM	605712	905712	Peat	2	10
GC 160	ITM	605883	905765	Peat	2	11

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 161	ITM	606065	905492	Peat	2	27
GC 162	ITM	606901	904217	Peat	2	
GC 163	ITM	605688	905131	Peat	2	
GC 164	ITM	606853	903798	Peat	2	
GC 165	ITM	606942	903981	Peat	2	
GC 166	ITM	607208	903267	Peat	2	
GC 167	ITM	606887	904341	Peat	2	
GC 168	ITM	607092	903492	Peat	2	
GC 169	ITM	605577	904895	Peat	2	
GC 170	ITM	603621	905409	Peat	1.9	12
GC 171	ITM	603640	905452	Peat	1.9	12
GC 172	ITM	603816	905553	Peat	1.9	20
GC 173	ITM	603835	905396	Peat	1.9	14
GC 174	ITM	604031	905916	Peat	1.9	12
GC 175	ITM	604260	906085	Peat	1.9	27
GC 176	ITM	604358	906174	Peat	1.9	26
GC 177	ITM	604421	906270	Peat	1.9	25
GC 178	ITM	604499	906193	Peat	1.9	20
GC 179	ITM	604611	906225	Peat	1.9	14
GC 180	ITM	604668	906295	Peat	1.9	16
GC 181	ITM	604894	906220	Peat	1.9	18
GC 182	ITM	605477	905635	Peat	1.9	13
GC 183	ITM	605520	905701	Peat	1.9	13
GC 184	ITM	605578	905770	Peat	1.9	11
GC 185	ITM	605649	905653	Peat	1.9	10
GC 186	ITM	605685	905615	Peat	1.9	9
GC 187	ITM	605711	905774	Peat	1.9	10
GC 188	ITM	605766	905733	Peat	1.9	15
GC 189	ITM	605775	905664	Peat	1.9	16
GC 190	ITM	605894	905815	Peat	1.9	11
GC 191	ITM	605967	905428	Peat	1.9	22
GC 192	ITM	606072	905456	Peat	1.9	25

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 193	ITM	606850	903895	Peat	1.9	
GC 194	ITM	606898	904331	Peat	1.9	
GC 195	ITM	605914	905211	Peat	1.9	
GC 196	ITM	605912	905170	Peat	1.9	
GC 197	ITM	605916	905261	Peat	1.9	
GC 198	ITM	605662	905075	Peat	1.9	
GC 199	ITM	605507	907249	Peat	1.9	
GC 200	ITM	605502	907362	Peat	1.9	
GC 201	ITM	605578	907262	Peat	1.9	
GC 202	ITM	605537	906799	Peat	1.9	
GC 203	ITM	605692	906616	Peat	1.9	
GC 204	ITM	605727	906353	Peat	1.9	
GC 205	ITM	606066	904390	Peat	1.9	
GC 206	ITM	606976	904280	Peat	1.9	
GC 207	ITM	607242	903265	Peat	1.9	
GC 208	ITM	607088	903556	Peat	1.9	
GC 209	ITM	607019	903741	Peat	1.9	
GC 210	ITM	606722	903786	Peat	1.9	
GC 211	ITM	603551	905505	Peat	1.8	12
GC 212	ITM	603586	905425	Peat	1.8	12
GC 213	ITM	603843	905683	Peat	1.8	20
GC 214	ITM	603849	905554	Peat	1.8	19
GC 215	ITM	603859	905780	Peat	1.8	19
GC 216	ITM	604027	905891	Peat	1.8	14
GC 217	ITM	604073	905971	Peat	1.8	11
GC 218	ITM	604595	906267	Peat	1.8	14
GC 219	ITM	604943	906030	Peat	1.8	16
GC 220	ITM	605430	905773	Peat	1.8	11
GC 221	ITM	605492	905571	Peat	1.8	14
GC 222	ITM	605565	905795	Peat	1.8	12
GC 223	ITM	605667	905645	Peat	1.8	9
GC 224	ITM	605693	905662	Peat	1.8	9

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 225	ITM	605697	905796	Peat	1.8	9
GC 226	ITM	605709	905688	Peat	1.8	10
GC 227	ITM	605730	905664	Peat	1.8	12
GC 228	ITM	605733	905696	Peat	1.8	12
GC 229	ITM	605766	905795	Peat	1.8	14
GC 230	ITM	605778	905703	Peat	1.8	16
GC 231	ITM	605883	905785	Peat	1.8	11
GC 232	ITM	606070	905433	Peat	1.8	23
GC 233	ITM	606020	905222	Peat	1.8	
GC 234	ITM	605781	905157	Peat	1.8	
GC 235	ITM	606915	904217	Peat	1.8	
GC 236	ITM	606855	904304	Peat	1.8	
GC 237	ITM	605882	905222	Peat	1.8	
GC 238	ITM	605609	905039	Peat	1.8	
GC 239	ITM	605410	907116	Peat	1.8	
GC 240	ITM	605482	906893	Peat	1.8	
GC 241	ITM	605788	906209	Peat	1.8	
GC 242	ITM	605881	905950	Peat	1.8	
GC 243	ITM	606887	903839	Peat	1.8	
GC 244	ITM	606864	903955	Peat	1.8	
GC 245	ITM	605872	905196	Peat	1.8	
GC 246	ITM	606907	903734	Peat	1.8	
GC 247	ITM	606222	904273	Peat	1.8	
GC 248	ITM	606005	904313	Peat	1.8	
GC 249	ITM	605863	904425	Peat	1.8	
GC 250	ITM	605840	904548	Peat	1.8	
GC 251	ITM	603969	905840	Peat	1.7	19
GC 252	ITM	604851	906173	Peat	1.7	17
GC 253	ITM	605501	905731	Peat	1.7	14
GC 254	ITM	605623	905642	Peat	1.7	10
GC 255	ITM	605654	905631	Peat	1.7	9
GC 256	ITM	605681	905691	Peat	1.7	9

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 257	ITM	605948	905387	Peat	1.7	17
GC 258	ITM	606849	903817	Peat	1.7	
GC 259	ITM	605745	905136	Peat	1.7	
GC 260	ITM	605532	907182	Peat	1.7	
GC 261	ITM	606863	904011	Peat	1.7	
GC 262	ITM	606478	903990	Peat	1.7	
GC 263	ITM	603560	905449	Peat	1.6	12
GC 264	ITM	604321	906211	Peat	1.6	26
GC 265	ITM	605053	905762	Peat	1.6	13
GC 266	ITM	605133	905826	Peat	1.6	13
GC 267	ITM	605279	905790	Peat	1.6	18
GC 268	ITM	605515	905738	Peat	1.6	13
GC 269	ITM	605565	905570	Peat	1.6	12
GC 270	ITM	605580	905717	Peat	1.6	11
GC 271	ITM	605607	905698	Peat	1.6	10
GC 272	ITM	605667	905645	Peat	1.6	9
GC 273	ITM	605707	905682	Peat	1.6	10
GC 274	ITM	605786	905748	Peat	1.6	16
GC 275	ITM	605801	905697	Peat	1.6	18
GC 276	ITM	605983	905471	Peat	1.6	28
GC 277	ITM	605609	904925	Peat	1.6	
GC 278	ITM	606832	904332	Peat	1.6	
GC 279	ITM	605850	905144	Peat	1.6	
GC 280	ITM	605596	904999	Peat	1.6	
GC 281	ITM	605414	907217	Peat	1.6	
GC 282	ITM	605832	906101	Peat	1.6	
GC 283	ITM	605932	904458	Peat	1.6	
GC 284	ITM	606818	904237	Peat	1.6	
GC 285	ITM	606979	904079	Peat	1.6	
GC 286	ITM	607185	903395	Peat	1.6	
GC 287	ITM	606875	904066	Peat	1.6	
GC 288	ITM	607116	903594	Peat	1.6	

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 289	ITM	605573	904844	Peat	1.6	
GC 290	ITM	605725	904660	Peat	1.6	
GC 291	ITM	605794	904576	Peat	1.6	
GC 292	ITM	603946	905859	Peat	1.5	19
GC 293	ITM	604052	905989	Peat	1.5	11
GC 294	ITM	604060	905903	Peat	1.5	12
GC 295	ITM	604365	906156	Peat	1.5	26
GC 296	ITM	604503	906229	Peat	1.5	19
GC 297	ITM	604605	906242	Peat	1.5	14
GC 298	ITM	604689	906239	Peat	1.5	18
GC 299	ITM	604865	906204	Peat	1.5	17
GC 300	ITM	605448	905727	Peat	1.5	12
GC 301	ITM	605523	905742	Peat	1.5	13
GC 302	ITM	605565	905672	Peat	1.5	12
GC 303	ITM	605592	905746	Peat	1.5	11
GC 304	ITM	605647	905776	Peat	1.5	10
GC 305	ITM	605702	905622	Peat	1.5	9
GC 306	ITM	605740	905641	Peat	1.5	13
GC 307	ITM	605752	905713	Peat	1.5	14
GC 308	ITM	605864	905810	Peat	1.5	13
GC 309	ITM	606831	904340	Peat	1.5	
GC 310	ITM	605647	905010	Peat	1.5	
GC 311	ITM	605603	906702	Peat	1.5	
GC 312	ITM	605616	906582	Peat	1.5	
GC 313	ITM	605720	906467	Peat	1.5	
GC 314	ITM	605777	906371	Peat	1.5	
GC 315	ITM	605809	906088	Peat	1.5	
GC 316	ITM	606942	904283	Peat	1.5	
GC 317	ITM	607239	903338	Peat	1.5	
GC 318	ITM	607144	903663	Peat	1.5	
GC 319	ITM	606269	904325	Peat	1.5	
GC 320	ITM	603563	905489	Peat	1.4	12

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 321	ITM	603989	905898	Peat	1.4	15
GC 322	ITM	604180	906011	Peat	1.4	20
GC 323	ITM	604248	906104	Peat	1.4	26
GC 324	ITM	605117	905961	Peat	1.4	23
GC 325	ITM	605259	905743	Peat	1.4	20
GC 326	ITM	605575	905751	Peat	1.4	11
GC 327	ITM	605608	905675	Peat	1.4	10
GC 328	ITM	605687	905686	Peat	1.4	9
GC 329	ITM	605783	905713	Peat	1.4	16
GC 330	ITM	605791	905679	Peat	1.4	17
GC 331	ITM	606058	905250	Peat	1.4	7
GC 332	ITM	606081	905385	Peat	1.4	18
GC 333	ITM	606833	904113	Peat	1.4	
GC 334	ITM	605554	904920	Peat	1.4	
GC 335	ITM	605629	904974	Peat	1.4	
GC 336	ITM	605600	904887	Peat	1.4	
GC 337	ITM	605882	905178	Peat	1.4	
GC 338	ITM	606894	904126	Peat	1.4	
GC 339	ITM	606830	904327	Peat	1.4	
GC 340	ITM	605417	906966	Peat	1.4	
GC 341	ITM	605519	906778	Peat	1.4	
GC 342	ITM	605852	905952	Peat	1.4	
GC 343	ITM	605877	904500	Peat	1.4	
GC 344	ITM	606817	904271	Peat	1.4	
GC 345	ITM	607167	903731	Peat	1.4	
GC 346	ITM	607244	903399	Peat	1.4	
GC 347	ITM	606852	903788	Peat	1.4	
GC 348	ITM	605636	904869	Peat	1.4	
GC 349	ITM	607161	903614	Peat	1.4	
GC 350	ITM	606156	904316	Peat	1.4	
GC 351	ITM	605661	904760	Peat	1.4	
GC 352	ITM	606073	904569	Peat	1.4	

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 353	ITM	606242	904366	Peat	1.4	
GC 354	ITM	606720	903828	Peat	1.4	
GC 355	ITM	603523	905471	Peat	1.3	12
GC 356	ITM	603564	905555	Peat	1.3	12
GC 357	ITM	604349	906196	Peat	1.3	27
GC 358	ITM	604436	906190	Peat	1.3	25
GC 359	ITM	604819	906264	Peat	1.3	20
GC 360	ITM	605541	905593	Peat	1.3	13
GC 361	ITM	605656	905682	Peat	1.3	9
GC 362	ITM	605662	905774	Peat	1.3	9
GC 363	ITM	605706	905649	Peat	1.3	10
GC 364	ITM	605819	905790	Peat	1.3	17
GC 365	ITM	606086	905351	Peat	1.3	16
GC 366	ITM	606804	904046	Peat	1.3	
GC 367	ITM	606834	904205	Peat	1.3	
GC 368	ITM	605573	904965	Peat	1.3	
GC 369	ITM	605748	906362	Peat	1.3	
GC 370	ITM	605816	905953	Peat	1.3	
GC 371	ITM	606913	903904	Peat	1.3	
GC 372	ITM	606922	904087	Peat	1.3	
GC 373	ITM	607201	903339	Peat	1.3	
GC 374	ITM	605600	904838	Peat	1.3	
GC 375	ITM	605707	905100	Peat	1.3	
GC 376	ITM	606850	903729	Peat	1.3	
GC 377	ITM	606564	903925	Peat	1.3	
GC 378	ITM	606311	904186	Peat	1.3	
GC 379	ITM	603591	905540	Peat	1.2	12
GC 380	ITM	603598	905511	Peat	1.2	12
GC 381	ITM	603832	905626	Peat	1.2	21
GC 382	ITM	604829	906149	Peat	1.2	17
GC 383	ITM	605043	906055	Peat	1.2	18
GC 384	ITM	605092	905789	Peat	1.2	13

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 385	ITM	605264	905680	Peat	1.2	18
GC 386	ITM	605508	905762	Peat	1.2	14
GC 387	ITM	605546	905741	Peat	1.2	12
GC 388	ITM	605587	905679	Peat	1.2	11
GC 389	ITM	605661	905664	Peat	1.2	9
GC 390	ITM	605717	905632	Peat	1.2	11
GC 391	ITM	606774	903987	Peat	1.2	
GC 392	ITM	605534	904865	Peat	1.2	
GC 393	ITM	605668	905056	Peat	1.2	
GC 394	ITM	606788	903893	Peat	1.2	
GC 395	ITM	605388	907139	Peat	1.2	
GC 396	ITM	605749	906468	Peat	1.2	
GC 397	ITM	606814	904306	Peat	1.2	
GC 398	ITM	606744	903875	Peat	1.2	
GC 399	ITM	605629	904840	Peat	1.2	
GC 400	ITM	606622	903863	Peat	1.2	
GC 401	ITM	605748	904612	Peat	1.2	
GC 402	ITM	605630	904792	Peat	1.2	
GC 403	ITM	605890	904538	Peat	1.2	
GC 404	ITM	606050	904568	Peat	1.2	
GC 405	ITM	606095	904551	Peat	1.2	
GC 406	ITM	606209	904408	Peat	1.2	
GC 407	ITM	606380	904174	Peat	1.2	
GC 408	ITM	606560	903967	Peat	1.2	
GC 409	ITM	603519	905502	Peat	1.1	12
GC 410	ITM	603620	905522	Peat	1.1	12
GC 411	ITM	603654	905485	Peat	1.1	12
GC 412	ITM	603820	905690	Peat	1.1	21
GC 413	ITM	604086	905950	Peat	1.1	10
GC 414	ITM	604777	906206	Peat	1.1	21
GC 415	ITM	605685	905681	Peat	1.1	9
GC 416	ITM	606050	905285	Peat	1.1	10

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 417	ITM	606072	905405	Peat	1.1	20
GC 418	ITM	606867	904032	Peat	1.1	
GC 419	ITM	605751	906215	Peat	1.1	
GC 420	ITM	606401	904076	Peat	1.1	
GC 421	ITM	606041	904576	Peat	1.1	
GC 422	ITM	606148	904471	Peat	1.1	
GC 423	ITM	606182	904438	Peat	1.1	
GC 424	ITM	606692	903857	Peat	1.1	
GC 425	ITM	604102	905927	Peat	1	10
GC 426	ITM	606088	905319	Peat	1	13
GC 427	ITM	606733	903854	Peat	1	
GC 428	ITM	606722	903836	Peat	1	
GC 429	ITM	606900	904159	Peat	1	
GC 430	ITM	606756	903919	Peat	1	
GC 431	ITM	605432	907002	Peat	1	
GC 432	ITM	607201	903747	Peat	1	
GC 433	ITM	606352	904139	Peat	1	
GC 434	ITM	605624	904828	Peat	1	
GC 435	ITM	606005	904537	Peat	1	
GC 436	ITM	606117	904527	Peat	1	
GC 437	ITM	606456	904070	Peat	1	
GC 438	ITM	603537	905530	Peat	0.9	12
GC 439	ITM	603619	905488	Peat	0.9	12
GC 440	ITM	603650	905507	Peat	0.9	12
GC 441	ITM	604801	906236	Peat	0.9	21
GC 442	ITM	604991	906040	Peat	0.9	16
GC 443	ITM	605495	905785	Peat	0.9	14
GC 444	ITM	605556	905708	Peat	0.9	12
GC 445	ITM	605628	905612	Peat	0.9	10
GC 446	ITM	605698	905644	Peat	0.9	9
GC 447	ITM	606914	904270	Peat	0.9	
GC 448	ITM	606897	903967	Peat	0.9	

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 449	ITM	607159	903329	Peat	0.9	
GC 450	ITM	606838	904165	Peat	0.9	
GC 451	ITM	607125	903481	Peat	0.9	
GC 452	ITM	606422	904033	Peat	0.9	
GC 453	ITM	605940	904521	Peat	0.9	
GC 454	ITM	606322	904241	Peat	0.9	
GC 455	ITM	606993	903777	Peat	0.9	
GC 456	ITM	603706	905454	Peat	0.8	12
GC 457	ITM	606856	903761	Peat	0.8	
GC 458	ITM	606049	904455	Peat	0.8	
GC 459	ITM	606889	904114	Peat	0.8	
GC 460	ITM	606903	904155	Peat	0.8	
GC 461	ITM	605446	907103	Peat	0.8	
GC 462	ITM	605626	906712	Peat	0.8	
GC 463	ITM	605671	906483	Peat	0.8	
GC 464	ITM	605774	906060	Peat	0.8	
GC 465	ITM	607311	903663	Peat	0.8	
GC 466	ITM	605863	904345	Peat	0.8	
GC 467	ITM	605741	904628	Peat	0.8	
GC 468	ITM	605765	904605	Peat	0.8	
GC 469	ITM	605989	904510	Peat	0.8	
GC 470	ITM	606031	904565	Peat	0.8	
GC 471	ITM	606134	904497	Peat	0.8	
GC 472	ITM	605626	905587	Peat	0.7	10
GC 473	ITM	605632	905806	Peat	0.7	10
GC 474	ITM	605712	905657	Peat	0.7	10
GC 475	ITM	606704	903804	Peat	0.6	
GC 476	ITM	606900	903767	Peat	0.6	
GC 477	ITM	605715	906216	Peat	0.5	
GC 478	ITM	607073	903721	Peat	0.5	
GC 479	ITM	605942	904340	Peat	0.5	
GC 480	ITM	606195	904293	Peat	0.4	

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 481	ITM	605976	905515	Peat	0.6	19
GC 482	ITM	605961	905558	Peat	3.6	26
GC 483	ITM	605963	905695	Peat	2	15
GC 484	ITM	605975	905755	Peat	1.2	15
GC 485	ITM	605967	905851	Peat	2.1	15
GC 486	ITM	605924	905914	Peat	1.5	18
GC 487	ITM	605878	905616	Peat	4.2	12
GC 488	ITM	605823	905630	Peat	4.5	14
GC 489	ITM	605811	905646		0	
GC 490	ITM	605803	905636	Peat	2	12
GC 491	ITM	605793	905622	Peat	3	7
GC 492	ITM	605373	905637	Peat	0.5	33
GC 493	ITM	605323	905655	Peat	0.1	30
GC 494	ITM	605308	905706	Peat	2.5	10
GC 495	ITM	605198	905707	Peat	0.6	21
GC 496	ITM	605142	905727	Peat	1	20
GC 497	ITM	605302	905800		0	
GC 498	ITM	605296	905813	Peat	0.4	30
GC 499	ITM	605297	905827		0	
GC 500	ITM	605279	905916	Peat	2.5	20
GC 501	ITM	605257	905963	Peat	0	
GC 502	ITM	605250	906017	Peat	0.3	17
GC 503	ITM	605206	906091		0	
GC 504	ITM	605196	906105	Peat	0.3	44
GC 505	ITM	605172	906122		0	
GC 506	ITM	605114	906134	Peat	2.3	9
GC 507	ITM	605048	906157	Peat	0.5	49
GC 508	ITM	604953	906180	Peat	0.8	25
GC 509	ITM	604947	906188		0	
GC 510	ITM	604882	906228	Peat	1.4	17
GC 511	ITM	604296	906221	Peat	1.9	26
GC 512	ITM	604228	906172	Peat	1.2	17

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 513	ITM	604155	906133	Peat	2.1	21
GC 514	ITM	604127	906085	Peat	2.5	14
GC 515	ITM	604142	906157	Peat	2.1	21
GC 516	ITM	604203	906202	Peat	1.2	17
GC 517	ITM	604259	906248	Peat	1.9	24
GC 518	ITM	604335	906276		0	
GC 519	ITM	604497	906283	Peat	2.5	20
GC 520	ITM	604423	906285	Peat	1.8	25
GC 521	ITM	603879	905535	Peat	2	19
GC 522	ITM	603868	905415	Peat	1.8	16
GC 523	ITM	604005	905786	Peat	2.5	16
GC 524	ITM	604917	906253	Peat	1.8	27
GC 525	ITM	605060	906195	Peat	0.7	48
GC 526	ITM	604974	906219		0	
GC 527	ITM	605265	906078	Peat	0.4	33
GC 528	ITM	605280	905983	Peat	0.2	17
GC 529	ITM	605316	905919	Peat	1.5	18
GC 530	ITM	605326	905831	Peat	0.4	22
GC 531	ITM	605134	905686	Peat	1.2	21
GC 532	ITM	605068	905722	Peat	1.5	18
GC 533	ITM	605231	905655	Peat	1.2	23
GC 534	ITM	605307	905640	Peat	0.5	28
GC 535	ITM	605440	905528	Peat	1.6	13
GC 536	ITM	605366	905535	Peat	1.3	14
GC 537	ITM	605408	905557	Peat	0.9	14
GC 538	ITM	605555	905548	Peat	1.7	13
GC 539	ITM	605950	905939	Peat	1.3	18
GC 540	ITM	606001	905876	Peat	1.8	15
GC 541	ITM	605543	904638	Peat	2.3	
GC 542	ITM	606769	904101	Peat	1.1	
GC 543	ITM	606742	904043	Peat	1.3	
GC 544	ITM	606706	903965	Peat	0.9	

GC or PP	Grid Ref - ING Letter or "ITM"	Easting	Northing	Substrate Description	Total Peat Depth (m)	kPa Value
GC 545	ITM	606087	905272	Peat	1.3	9
GC 546	ITM	603894	905289	Peat	2.5	
GC 547	ITM	603922	905331	Peat	2.3	
GC 548	ITM	606136	904449	Peat	1.2	
GC 549	ITM	606156	904423	Peat	1	
GC 550	ITM	605247	907063	Peat	2.3	11
GC 551	ITM	605288	907036	Peat	0.7	13
GC 552	ITM	605351	907075	Peat	3.5	8
GC 553	ITM	605299	907094	Peat	0.7	12
GC 554	ITM	605260	907124	Peat	2.5	10
GC 555	ITM	605326	907140	Peat	3.8	13
GC 556	ITM	605387	907127	Peat	3.5	8
GC 557	ITM	605357	907188	Peat	2.7	11
GC 558	ITM	605317	907217	Peat	1.1	20
GC 559	ITM	605312	907173	Peat	0.8	25
GC 560	ITM	605269	907172	Peat	0.1	