Technical Appendix 9.5: Peat Depth Survey Results

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9.5.1 Introduction

9.5.1.1 Ramboll was commissioned by the Applicant to undertake peat depth and coring surveys to aid the design process and to inform an assessment of the nature and condition of the peatland for the Proposed Development.

9.5.1.2 This Technical Appendix has been produced, in accordance with guidance published by the Scottish Environment Protection Agency (SEPA)[1], NatureScot[2], and the Scottish Government[3], which is referenced in the following sections.

9.5.1.3 This Technical Appendix is supported by the following figures in EIAR Volume 3a:

- Figure 9.3: Superficial Geology;
- Figure 9.4: Bedrock Geology;
- Figure 9.8: Peat Depths; and
- Figure 9.9: SNH Carbon and Peatland Map 2016 Extract.

9.5.1.4 Reference should also be made to Annex 1: Peat Coring Data in this report.

9.5.2 The Site and Study Area

9.5.2.1 The 'Site' (defined by the application boundary on **Figure 1.1 (EIAR Volume 3a)** is described in detail in terms of its setting and location within **Chapter 3: Site Description and Proposed Development (EIAR Volume 2)**.

9.5.2.2 Within the Site is the existing Novar 1 Wind Farm, comprising 34 turbines and associated infrastructure. The two existing Vehicular Access Points to the existing Novar 1 Wind Farm also form part of the Site. The remainder of the Site comprises open peat moorland, typified by rough grassland and heathland species.

9.5.2.3 The Site is situated along the ridgeline connecting Meall Mor, Meall an Tuirc, Bendeallt and Cnoc Gille Mo Bhrianaig with the elevation ranging within the Site from 625 m Above Ordnance Datum (AOD) to 310 m AOD, with the topography descending from the ridge in all directions to Loch Glass, Loch Moire and Strath Rusdale. The surrounding area includes the notable summits of Ben Wyvis (1,046 mAOD) and Beinn Dear (1,081 m AOD), with prominent hydrological features including the Cromarty Firth, Dornoch Firth, Loch Glass, Loch Morie, the River Averon and the River Glass.

9.5.2.4 According to British Geological Survey (BGS) 1:50,000 geological mapping[4], the Site is predominately underlain by superficial deposits of peat. Glacial Diamicton deposits are shown as present beneath the Internal Tracks to the northeast and southeast. This is shown in **Figure 9.3 (EIAR Volume 3a)**.

9.5.2.5 BGS 1:50.000 mapping indicates the Site is further underlain by bedrock geology of the Precambrian aged Tarvie Formation, Psammite rocks belonging to the Lloch Eil Group. This is shown in **Figure 9.4 (EIAR Volume 3a)**.

9.5.2.6 A review of the SNH Carbon and Peatland Map (2016)[2], an extract of which is shown on **Figure 9.9 (EIAR Volume 3a)**, indicates the majority of the Site is mapped as Class 1 peatland, which is classed as nationally important carbon-rich soils, deep peat and priority peatland habitat and areas likely to be of high conservation value. Smaller areas of the Site are mapped as Class 5 peatland, which is described as peat soil with no peatland vegetation (and is not classed as nationally important). Much of the Access Route is not mapped as being within an area of peatland.

9.5.3 Methodology

9.5.3.1 Peat surveys were undertaken at the Site to understand the baseline peat conditions and potential constraints, and to inform the design of the Proposed Development to minimise, as far as practicable, the potential direct and indirect effects on peat and carbon rich soils.

9.5.3.2 The surveys were undertaken by Ramboll and Fluid Environmental Consulting Limited on the following dates:

- Stage 1 peat probing in May 2024; and
- Stage 2 peat probing and coring in June 2025 and November 2025.

9.5.3.3 Peat probing and coring followed relevant guidance on peatland surveys[1,3]. The methods employed for peat depth probing and peat coring are detailed further below.

Stage 1 Peat Probing

9.5.3.4 The Stage 1 survey is a preliminary, low-density survey and was carried out on a 100 m grid across the Site within areas of likely peatland. The probing was carried out using collapsible avalanche probes, allowing for probing in excess of 6 m. However, such depths were not reached. This peat depth data along with other environmental and engineering constraints were used to inform the layout of the Proposed Development.

9.5.3.5 The survey points and field data were collected using a handheld Trimble GPS unit. Peat depth data was modelled using Inversive Distance Weighted (IDW) interpolation in GIS software, and a depth model generated using incremented peat depth categories.

Stage 2 Peat Probing and Coring

9.5.3.6 The high-density probing during the Stage 2 surveys was carried out along the Access Route and Internal Tracks, and in the planned turbine, hardstanding, and compound locations, known at the time of the surveys. This included a 50 m micrositing zone around each turbine location. The sampling pattern comprised:

- Proposed turbine locations: peat probing was undertaken at 10 m intervals along cardinal points from the central point of the infrastructure up to 50 m; and
- Access Route and Internal Tracks: the alignment was probed at 50 m intervals and at points every 10 m perpendicular to the centreline on either side of the proposed Route/Track. Where sections of existing route/tracks form part of the Proposed Development, the same sampling

[1] Scottish Renewables and SEPA (2012). Development on Peatlands. Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste.

[2] Scottish Natural Heritage. (2016). Carbon and Peatland 2016 Map (http://map.environment.gov.scot/soil_maps/)

[3] Scottish Government, Scottish Natural Heritage, SEPA. (2017). Peatland Survey. Guidance on Developments on Peatland. Available at: https://www.gov.scot/publications/peatland-survey-guidance/

[4] British Geological Survey Online Viewer (https://geologyviewer.bgs.ac.uk/)

method was used, with the centreline recorded as existing hardstanding and therefore having a peat depth of 0m.

9.5.3.7 This was carried out using collapsible avalanche probes, allowing for probing in excess of 6 m, and data collected using a handheld Trimble GPS unit.

9.5.3.8 The peat depth probe locations are shown in **Figure 9.8 (EIAR Volume 3a)**.

9.5.3.9 Peat cores were taken using a Russian auger, with a sample volume of 0.5 litre (l), and a number of field tests and observations were undertaken. In total, 25 peat core samples were taken in locations where new sections of track or turbines and associated infrastructure are proposed. The peat core results are included in Annex 1 of this Technical Appendix, and records taken include:

- Depth of acrotelm;
- Degree of humification to establish amorphous, intermediate, fibrous and content;
- Degree of humification using the Von Post classification;
- Fine fibre content, based on a scale of F0 (none) to F3 (very high);
- Coarse fibre content, based on a scale of R0 (none) to R3 (very high);
- Water content, based on a scale of B1 (dry) to B5 (very wet); and
- Substrate underlying the peat where this was possible.

9.5.4 Limitations

9.5.4.1 Peat probing and mapping has been used to inform the design process, at strategic points in the design evolution of the Proposed Development. However, there are some differences between the final design and the extent of the peat survey results based on design changes made through this process, due to micrositing.

9.5.4.2 The peat survey probing points do provide high resolution coverage of the Site. It is considered that the peat depth data collected, and interpolations derived from these data, are representative of the Site and have adequately informed the layout of the Proposed Development and are sufficient to inform a robust Peat Landslide Hazard Risk Assessment (**Technical Appendix 9.7 (EIAR Volume 4)**) and Outline Peat Management Plan (**Technical Appendix 9.6 (EIAR Volume 4)**).

9.5.4.3 Should turbines be microsited within a distance greater than 100 m, then further targeted peat probing would be undertaken post application.

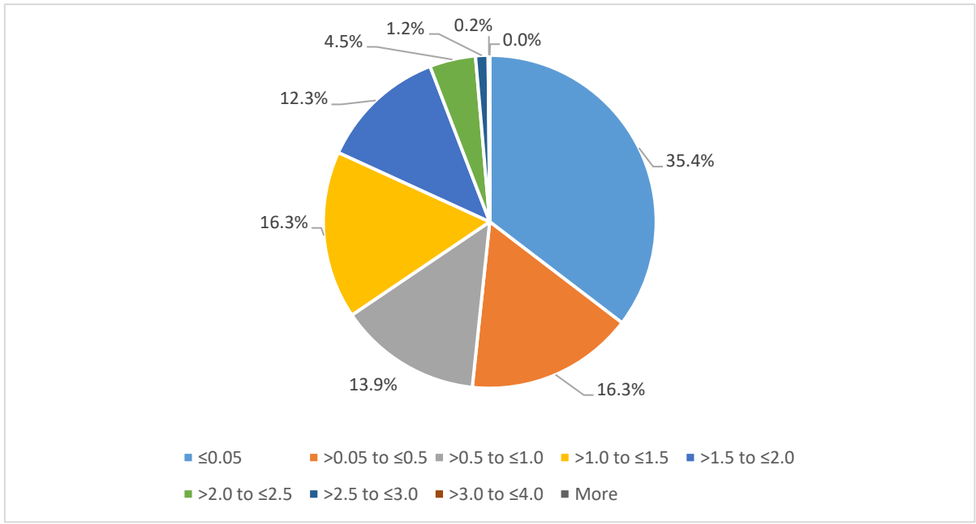
9.5.5 Results

Peat Probing

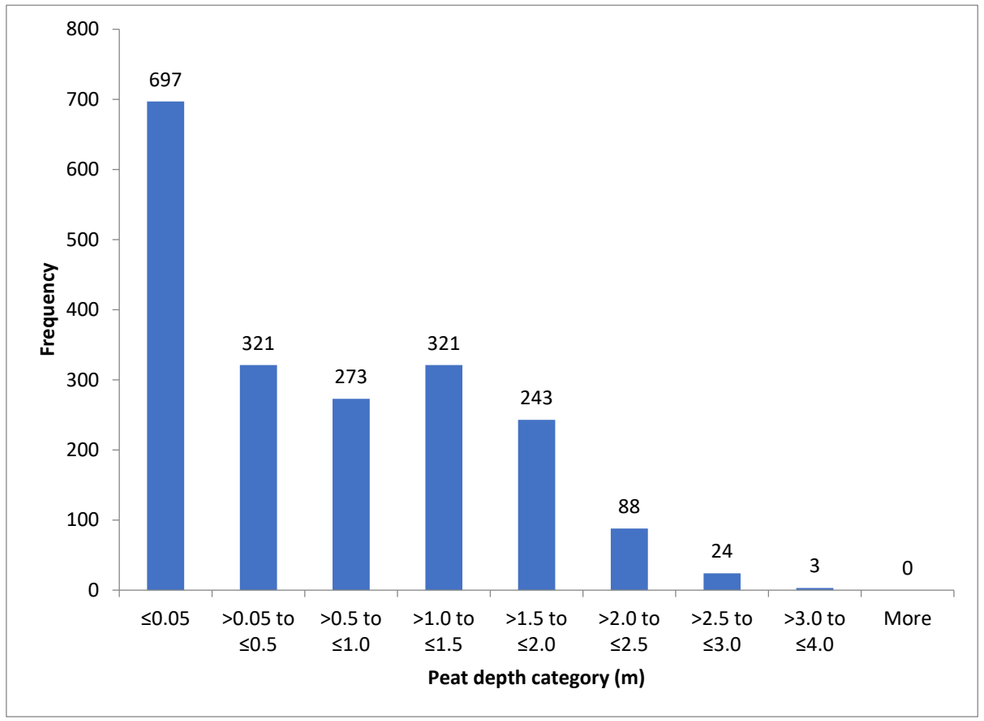
9.5.5.1 A combined total of 1,971 peat depth probes were taken during the peat surveys. This included 314 peat depth probes during the Stage 1 survey, and 1,657 peat depth probes during the Stage 2 surveys.

9.5.5.2 **Graph 1** and **Graph 2** present the percentage and frequency of peat probe results within the specific peat depth categories recorded during the surveys.

9.5.5.3 **Figure 9.8 (EIAR Volume 3a)** shows the results of the peat depth survey at the Site with the indicative peat depth contours, which is based on IDW data interpolation of the survey results.



Graph 1: Percentage of samples within each peat depth category in metres



Graph 2 Peat depth frequency distribution

9.5.5.4 The peat depth survey results indicate approximately half of the locations surveyed to be underlain by areas where either no peat is present or a shallow depth of peat is present (approximately 52% of peat depth probes recorded peat depths less than or equal to 0.5 m depth). This includes areas where existing track is present and where therefore peat has already been excavated. Approximately 34% of points surveyed recorded peat depths greater than 1 m depth, with the maximum peat depth recorded being 3.55 m. The mean peat depth recorded during the surveys was 0.73 m.

9.5.5.5 The frequency distribution of peat depths recorded is represented in **Graph 2** and summarised as follows:

- 697 no. samples (35.4%) located on land with no peat present;
- 321 no. samples (16.3%) located on land with > 0.0 m and ≤ 0.5 m depth of peat or organo-mineral soil;
- 273 no. samples (13.9%) located on land with > 0.5 m and ≤ 1.0 m depth of peat;
- 321 no. samples (16.3%) located on land with > 1.0 m and ≤ 1.5 m depth of peat;
- 243 no. samples (12.3%) located on land with > 1.5 m and ≤ 2.0 m depth of peat;
- 88 no. samples (4.5%) located on land with > 2.0 m and ≤ 2.5 m depth of peat;
- 24 no. samples (1.2%) located on land with > 2.5 m and ≤ 3.0 m depth of peat; and
- 3 no. samples (0.2%) located on land with > 3.0 m and ≤ 4.0 m depth of peat.

9.5.5.6 The peat probe depth and interpolated contours are shown on **Figure 9.8 (EIAR Volume 3a)**. Sections of existing Internal Track have been used where possible, which reduces the sections of new Internal Track required in areas of deep peat. The turbines and associated hardstanding have been sited where possible to avoid the areas of deepest peat within the Site. However, it has not been possible to site them in areas where no peat or only shallow depths of peat are present. Table 9.5.1 details the mean peat depth for each of the new infrastructure elements of the Proposed Development. With the exception of the proposed location for turbine 1 and the hardstanding for Turbine 6, where the mean peat depths were recorded to be 1.73 m and 1.59 m respectively, all of the proposed infrastructure is sited in areas where the mean peat depth is less than 1.5 m.

Table 9.5.1: Mean peat depths for the Proposed Development infrastructure

Infrastructure element	Mean peat depth (m)
Turbine 1	1.73
Turbine 2	1.16
Turbine 3	1.25
Turbine 4	1.22
Turbine 5	0.59
Turbine 6	1.39
Turbine 7	1.07
Turbine 8	1.02
Turbine 9	0.71
Permanent hardstanding for Turbine 1	1.47
Permanent hardstanding for Turbine 2	0.84
Permanent hardstanding for Turbine 3	1.28
Permanent hardstanding for Turbine 4	1.33
Permanent hardstanding for Turbine 5	0.48
Permanent hardstanding for Turbine 6	1.59
Permanent hardstanding for Turbine 7	1.19
Permanent hardstanding for Turbine 8	0.62
Permanent hardstanding for Turbine 9	0.95
New Internal Tracks (average)	0.47
Substation	0.34
Borrow pit (excluding tie in)	0.08

Core Sample Results

Depth of Acrotelm

9.5.5.7 The acrotelm and catotelm represent two distinct layers within undisturbed peat that control the hydrological regime. The catotelm is the bottom layer of peat that is mostly below the water table. The acrotelm overlies the catotelm and is the 'living' layer in which most water table fluctuations occur. The thickness of the acrotelm usually varies up to around 50 cm but is largely depends upon the habitat. Anaerobic and aerobic conditions alternate periodically with the fluctuation of the water table, favouring more rapid microbial activity than in the catotelm. The acrotelm consists of the living parts of mosses and dead and poorly decomposed plant material. It has a very loose structure that can contain and release large quantities of water in a manner that limits variations of the water table in peat bogs.

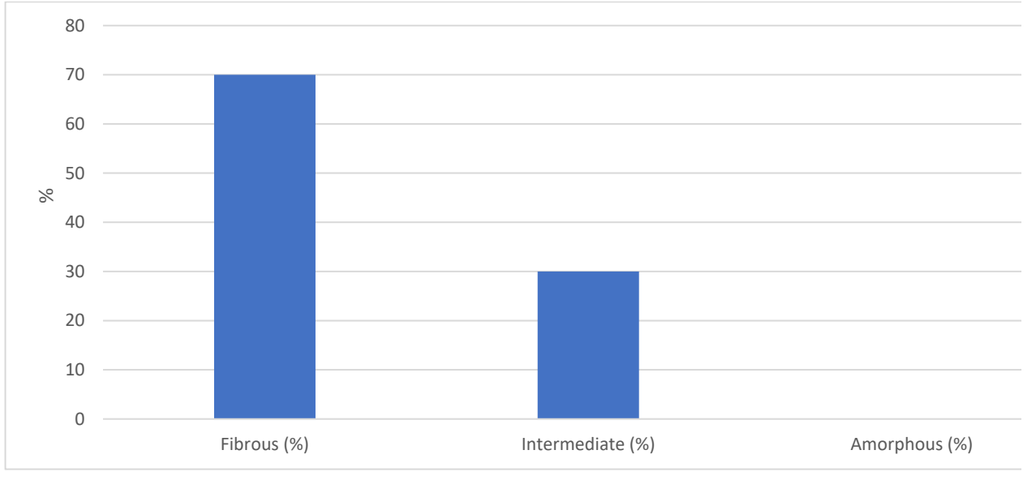
9.5.5.8 The depth of acrotelm was measured in six of the peat core samples. The mean depth of acrotelm recorded was 0.14 m.

9.5.5.9 In the context of any development, it is recommended that for the purposes of construction and subsequent reinstatement, that where a sufficient peat depth exists, the top 50 cm of material should be treated as acrotelm. This approach will allow excavation of intact turves for reinstatement purposes where they are present, which will in turn facilitate quicker regeneration of disturbed areas. Even if little vegetation is present within this top layer it should still be treated as acrotelmic material as it may contain a seedbank, particularly in open habitats, which will aid re-vegetation of reinstatement areas. Whilst the mean depth of acrotelm is recorded >0.5 m, this is considered to be a conservative approach for the assessment of reuse and handling of peat and peaty soils.

Degree of Humification

9.5.5.10 The degree of humification was recorded in the field for 18 of the peat core samples taken. With each peat core sample analysed, the percentage of the sample classed as fibrous, intermediate and amorphous peat was recorded.

9.5.5.11 **Graph 3** summarises the degree of humification for the peat cores sampled. Peat cores samples were recorded as a mixture of intermediate and fibrous peat, with no core samples recorded as partially comprising amorphous peat.

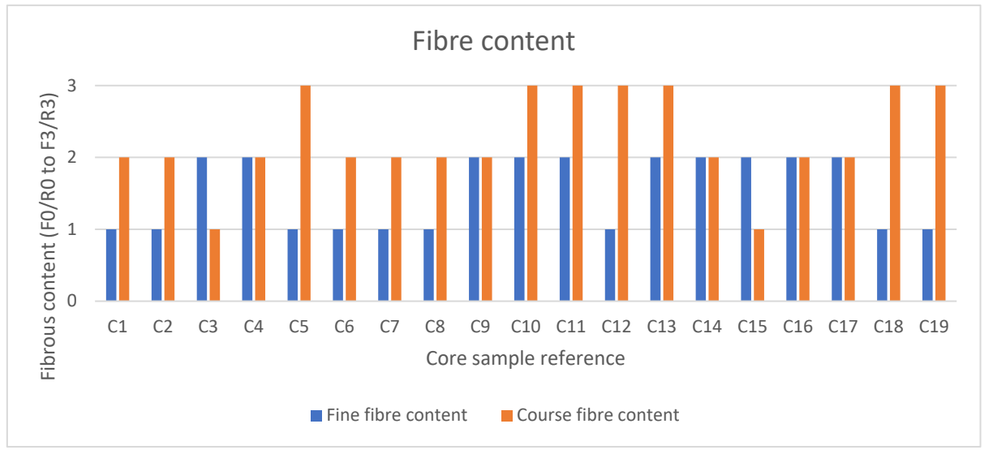


Graph 3: Mean degree of humification

Fibrous Content

9.5.5.12 The proportions of fine and course fibres within the peat samples were derived in the field according to the Hobbs[5] scale, where F0/R0 indicate no fine/ coarse fibre content to F3/R3 which are indicative of high fine/coarse fibre respectively.

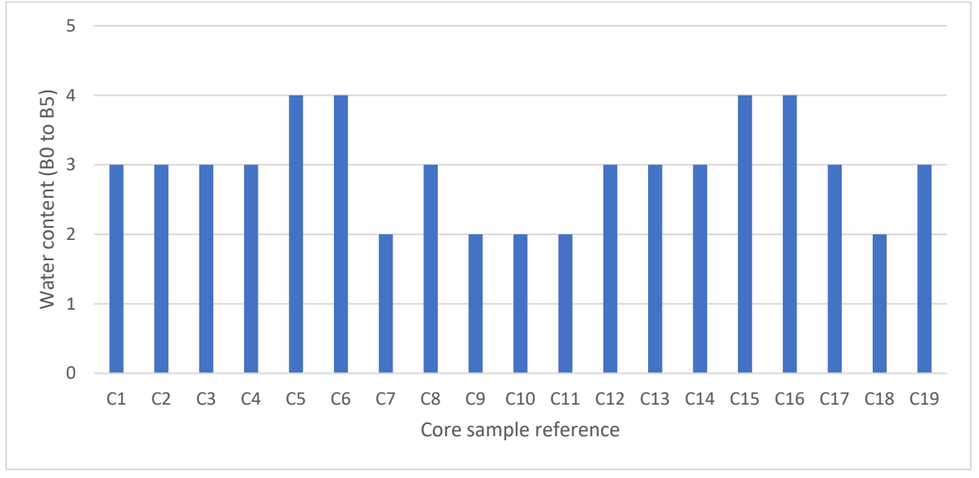
9.5.5.13 The results show that all samples were assessed as having a low to moderate fine fibre content (F1 or F2 on the Hobbs scale). The course fibre content of the samples varied from low to high course fibre content (R1 to R3 on the Hobbs scale). These results are summarised in **Graph 4**.



Graph 4: Fibrous content

Water Content

9.5.5.14 The water content of the samples was determined in the field using the Hobbs[5] scale, where B1 is dry and B5 is very wet. The results are summarised in **Graph 5**.



Graph 5: Water Content

9.5.5.15 Water content was recorded as varying from moderately dry (B2) to wet B4).

Von Post (Degree of Humification)

9.5.5.16 An estimate of the degree of humification according to the Von Post scale was carried out on 19 of the core samples. The criteria associated with the Von Post scale is included in Table 9.5.2.

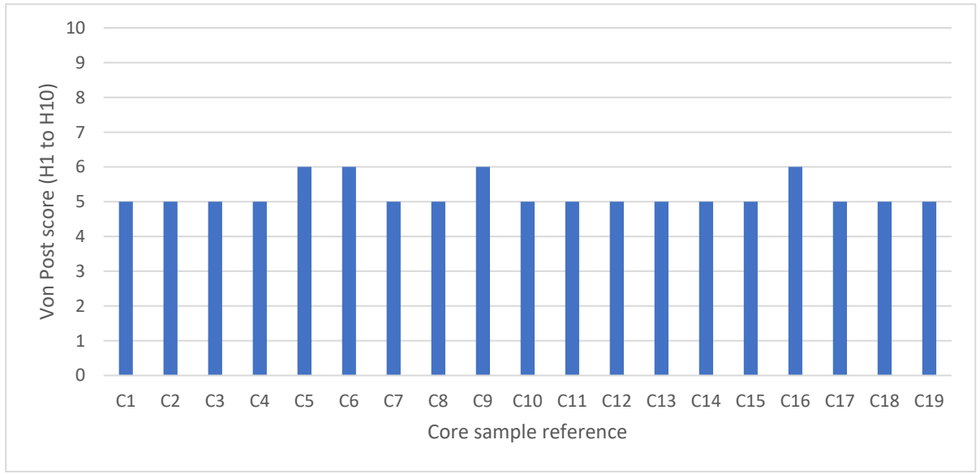
Table 9.5.2: Degree of humification

Von Post Scale	Humification Description (Decomposition, Plant Material Present, Water Content, Character)
H1	Completely undecomposed peat free of amorphous material. On squeezing, clear colourless water is pressed out.
H2	Nearly undecomposed peat, free of amorphous material, yielding only yellowish brown water on pressing.
H3	Very slightly decomposed peat, containing a little amorphous material. On squeezing, muddy brown water but no peat passes between the fingers. Residue is not pasty.
H4	Slightly decomposed peat containing some amorphous material. Strongly muddy brown water but no peat passes between the fingers. Residue is somewhat pasty.
H5	Moderately decomposed peat containing a fair amount of amorphous material. Plant structure recognisable though somewhat vague. On squeezing, some peat but mainly muddy water issues. Residue is strongly pasty.
H6	Moderately decomposed peat with a fair amount of amorphous material and indistinct plant structure. On pressing, about one third of the peat passes between the fingers. Residue is strongly pasty but shows the plant structure more distinctly than in unsqueezed peat.
H7	Strongly decomposed peat with much amorphous material and faintly recognisable plant structure. On squeezing, about one half of the peat is extruded. The water is very dark in colour.

5 Hobbs, N.B. (1986). Mire morphology and the properties and behaviour of some British and foreign peats. QJEG, London

Table 9.5.2: Degree of humification	
Von Post Scale	**Humification Description (Decomposition, Plant Material Present, Water Content, Character)**
H8	Strongly decomposed peat with much amorphous material and very indistinct plant structure. On squeezing, two thirds of the peat and some water passes between the fingers. Residue consists of plant tissues capable of resisting decomposition (roots, fibres, wood, etc.).
H9	Practically fully decomposed peat with almost no recognisable plant structure. Nearly all the peat squeezed between the fingers as a uniform paste.
H10	Completely decomposed peat with no discernible plant structure. On squeezing, all the peat, without water, passes between the fingers.

9.5.5.17 The results are shown in **Graph 6**, where the vertical axis refers to the Von Post scale of peat decomposition (on a scale of H1 to H10).



Graph 6: Von Post Scale of Humification

9.5.5.18 All of the peat core samples scored H5 or H6 on Von Post scale, indicative of moderately decomposed peat.

9.5.6 Summary

9.5.6.1 Stage 1 and Stage 2 peat surveys were carried out at the Site including peat depth probing and coring. A combined total of 1,971 peat depth probes were taken across the Site and, in selected areas where key infrastructure of the Proposed Development is proposed, 25 peat core samples were taken and analysed.

9.5.6.2 The peat depth survey results indicate that approximately half of the locations surveyed were underlain by areas where either no peat is present, or a shallow depth of peat is present (approximately 52% of peat depth probes recorded peat depths less than or equal to 0.5 m depth). This includes areas where existing track is present and therefore peat has already been excavated. Approximately 34% of locations recorded peat depths greater than 1 m depth, with the maximum peat depth recorded being 3.55 m. The mean peat depth recorded during the surveys was 0.73 m.

9.5.6.3 The turbines and associated hardstanding have been sited where possible to avoid the areas of deepest peat within the Site. However, it has not been possible to site them in areas where no peat or only shallow depths of peat are present.

9.5.6.4 With the exception of Turbine 1, where the mean peat depths were recorded to be 1.73 m and 1.59 m respectively, all of the new permanent infrastructure is sited in areas where the mean peat depth is less than 1.5 m.

9.5.6.5 The mean depth of the acrotelm from the peat core sample locations where this was analysed was 0.14 m but it is likely that this is not representative and therefore the depth of the acrotelm has been assumed as 0.5 m based on a precautionary approach.

9.5.6.6 The peat across the Site is generally fibrous and intermediate in nature (as opposed to amorphous). Concerning the fibrous content, the majority of the peat core samples indicated a low to moderate fine fibre content and a variable course fibre content.

9.5.6.7 The water content of the peat across the peat core samples was recorded to be variable from moderately dry (B2) to wet (B4).

9.5.6.8 All of the peat core samples scored between H5 and H6 on the Von Post scale indicating the peat sampled to be moderately decomposed.

Annex 1: Peat Coring Data

Peat core sample reference	Substrate	Peat depth (m)	Depth peat core taken to (m)	Acrotelm depth (m)	Fibrous (%)	Intermediate (%)	Amorphous (%)	Fine fibre content	Course fibre content	Water content	Von Post scale for humification
C1	Rock	2.4	1		50	50	0	F1	R2	B3	H5
C2	Rock	2.4	1		50	50	0	F1	R2	B3	H5
C3	Cohesive	2	1		50	50	0	F2	R1	B3	H5
C4	Rock	1.2	1		50	50	0	F2	R2	B3	H5
C5	Rock	1.6	1		50	50	0	F1	R3	B4	H6
C6	Rock	0.9	1					F1	R2	B4	H6
C7	Granular	1.9	1		70	30	0	F1	R2	B2	H5
C8	Granular	2	1		50	50	0	F1	R2	B3	H5
C9	Granular	2	1		50	50	0	F2	R2	B2	H6
C10	Rock	1	1		80	20	0	F2	R3	B2	H5
C11	Rock	1	1		70	30	0	F2	R3	B2	H5
C12	Granular	1.6	1		80	20	0	F1	R3	B3	H5
C13	Rock	1.7	1		90	10	0	F2	R3	B3	H5
C14	Rock	1	1		100	0	0	F2	R2	B3	H5
C15	Rock	1.4	1		60	40	0	F2	R1	B4	H5
C16	Granular	1.1	1		80	20	0	F2	R2	B4	H6
C17	Granular	0.9	0.9		100	0	0	F2	R2	B3	H5
C18	Granular	1.2	1		100	0	0	F1	R3	B2	H5
C19	Rock	1.3	1		80	20	0	F1	R3	B3	H5
FC1		0.65	0.65	0.1							
FC2		1.7	1.8	0.2							
FC3		1.2	1.2	0.15							
FC4		0.6	0.6	0.1							
FC5		0	1.35	0.2							
FC6		0.6	0.6	0.1							