Chapter 5:

Soil & Geology

5.1 Introduction

5.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by Pinewoods Wind Ltd. to carry out an assessment of the potential impacts of the proposed development on the soil and geological environment.

This report provides a baseline assessment of the proposed development in terms of soils and geology and discusses the potential impacts that the construction and operation of the proposed development will have on them. Where required, appropriate mitigation measures to limit any identified significant impacts to soils and geology are recommended.

5.1.2 Relevant Legislation

The EIS is carried out in accordance with the follow legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) regulations and subsequent amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999; S.I. No. 450 of 2000; S.I No. 538 of 2001); S.I. No. 30 of 2000 the Planning and Development Act, 2000;, and S.I 600 of 2001 Planning and Development Regulations and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment; and,
- S.I. No. 4 of 1995: The Heritage Act, 1995.

5.1.3 Relevant Guidance

The soils and geology section of this EIS is carried out in accordance with guidance contained in the following documents:

- Environmental Protection Agency (2003): Advise Notes on Current Practice (in the Preparation on Environmental Impact Statements);
- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements; and,
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

5.1.4 Methodology

5.1.4.1 Desk Study

A desk study of the wind farm site and the surrounding study area was largely completed in advance of undertaking the walkover survey and site investigations. The desk study involved collecting all the relevant geological data for the wind farm site and the study area. This included consultation with the following:

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland - National Draft Bedrock Aquifer map;
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 18 (Geology of Tipperary). Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets;

- General Soil Map of Ireland 2nd edition (www.epa.ie).

5.1.4.2 Geological Mapping and Site Investigations

A walkover survey and geological mapping of the site was undertaken by HES on 11th March 2015 and a comprehensive site investigation comprising trial pits and gouge cores was undertaken by HES on 30th and 31st March 2015.

In summary, site investigations to address the soil and geology section of the EIS included the following:

- Trial pits (13 no.) were undertaken at (or in the proximity of) the proposed turbine and access road locations to investigate overburden thickness and subsoil and bedrock lithology;
- Where a trial pit could not be undertaken at the exact proposed location of a turbine due to access issues, a gouge core was undertaken instead to investigate the subsoil lithology;
- Logging of bedrock outcrops and subsoil exposures;
- Mineral subsoils and peat were logged according to BS: 5930 and Von Post Scale respectively; and,
- A peat slide risk assessment for the proposed wind farm development was undertaken by Whiteford Geoservices Limited (May 2015).

5.1.4.3 Impact Assessment

Using information from the desk study and data from the site investigation, an estimation of the importance of the soil and geological environment within the study area is assessed using the significance criteria set out in **Table 5.1** (NRA, 2005).

Importance	*Criteria*	*Typical Example*
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying site is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or high fertility soils. Moderately sized existing quarry or pit. Marginally economic extractable mineral resource.

Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying site is moderate on a local scale.	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed Wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying site is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral Resource.

Table 5.1: Estimation of Importance of Soil and Geology Criteria (NRA, 2005)

The statutory criteria (EPA, 2002 and EPA, 2003) for the assessment of impacts require that likely impacts are described with respect to their extent, magnitude, type (*i.e.* negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). In addition the two impact characteristics of proximity and probability are described for each impact and these are defined in **Table 5.2**.

In order to provide an understanding of this descriptive system in terms of the geological/hydrological environment, elements of this system of description of impacts are related to examples of potential impacts on the geology and morphology of the existing environment, as listed in **Table 5.3**.

Impact Characteristic	Degree/ Nature	Description
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Low	A low likelihood of occurrence of the impact.
	Medium	A medium likelihood of occurrence of the impact.
	High	A high likelihood of occurrence of the impact.

Table 5.2: Additional Impact Characteristics

Impact Characteristics		*Potential Geological/Hydrological Impacts*
Quality	*Significance*	
Negative only	Profound	Widespread permanent impact on: - The extent or morphology of a cSAC. - Regionally important aquifers. - Extents of floodplains. Mitigation measures are unlikely to remove such impacts.
Positive or Negative	Significant	Local or widespread time dependent impacts on: -The extent or morphology of a cSAC / ecologically important area. -A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). -Extent of floodplains. Widespread permanent impacts on the extent or morphology of a NHA/ecologically important area, Mitigation measures (to design) will reduce but not completely remove the impact – residual impacts will occur.
Positive or Negative	Moderate	Local time dependent impacts on: - The extent or morphology of a cSAC / NHA / ecologically important area. - A minor hydrogeological feature. - Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

Table 5.3: Impact descriptors related to the receiving environment

5.2 Description of the Existing Environment

5.2.1 Site Description and Topography

The proposed development is located approximately 8km to the east of Abbeyleix in Co. Laois. The site lies within the townlands of Ironmills (Kilrush), Boleybawn, Knockardugar, Graiguenahown, Garrintaggart Co. Laois and Crutt Co. Kilkenny. This area is part of the Castlecomer Plateau, a broad upland area which straddles the boundaries between counties Laois, Carlow and Kilkenny. The site straddles the county border between Laois and Kilkenny, with the town of Castlecomer around 8km away. It is an upland area with elevations ranging from 250 – 300m OD (meters above Ordnance Datum). The site consists, in part, of lands owned and operated by Coillte and, as such, a series of forest tracks and third class roads cross the site. The remainder of the landholding comprises agricultural land. The current land use within the subject site is predominately forestry along with agricultural land for cattle grazing. The ground conditions at the site were noted to be relatively firm under foot apart from some localised blanket peat and boggy areas within the forestry areas.

5.2.2 Soils and Subsoils

The published soils map (www.epa.ie) for the area shows that poorly draining mineral soil (AminPD), deep well draining mineral soil (AminDW) and shallow mineral soil (AminSW) are the dominant soil types at the site (refer to **Figure 5.1**). The majority of the proposed turbines are located in areas mapped as AminDW or AminSW. Other soil types mapped in the site include shallow poorly draining soil (AminSP) and blanket peat. Blanket peat is mapped on an area of elevated ground east of turbine locations TL06 and TL08.

A map of the local subsoil cover is illustrated in **Figure 5.2** (www.gsi.ie). This indicates that the proposed site is predominately underlain by Namurian sandstone and shale tills. Bedrock is mapped close or at the surface on the more elevated areas of the site and along steep, lower-lying sections particularly on the western facing slopes of the site. A localised section of blanket peat is mapped on an area of elevated ground east of turbine locations TL06 and TL08.

A trial pit investigation was undertaken at the proposed development site on 30th and 31st March 2015. A total of 13 no. trial pits were carried out across the proposed development footprint. The locations of the trial pits and a summary of the investigation findings are shown in **Table 5.4** below. The locations of the trial pits are also illustrated in **Figure 5.3**. Trial pit logs are included as **Appendix 5.1.**

Gouge cores were also undertaken along proposed access roads between turbine locations (refer to **Table 5.5** below and **Figure 5.3**). Trial pits were not undertaken as the depth of subsoils along the access roads is expected to be similar to the closest turbine locations. Also, it should be noted that excavation of mineral subsoils along proposed access roads will not be undertaken as the access road will be constructed on the mineral subsoil layer. Therefore, determining the subsoil depth along access roads is not required for estimation of excavation volumes, except where peat is present. Gouge cores are sufficient to determine peat depths.

Sandstone or shale tills were encountered at all of the trial pit locations and the till subsoil typically comprised firm SILT/CLAY or CLAY. The regular occurrence of CLAY subsoils and the general absence of sand as a subcomponent (*i.e.* sandy SILT/CLAY) would suggest the parent material of the subsoils in this area is predominately shale bedrock. However, silty sand was encountered in trial pits TP08 and TP09 which is a sandstone till.

Peat with an approximate thickness of 0.5m was encountered in trial pits TP08, TP09 and TP13. TP08 and TP09 were carried out just off the forestry access road east of turbine locations TL09 and TL10. TP13 was undertaken 50m west of turbine location TL05. Peat with an approximate thickness of 1m and 1.7m was encountered at gouge core locations GC5 and GC9 respectively which were undertaken at respective turbine locations TL05 and TL06. Peat was also encountered on proposed sections of access road between TL05 – TL06 (GC8) and TL04 – TL05 (GC6). The peat overage is relatively consistent with the GSI mapping which shows blanket peat mapped in the central section of the landholding, albeit based on the site investigation data the peat does exist further south and west than shown by the GSI mapping. Outside of the localised blanket peat area, the till subsoils were typically overlain by mineral topsoil in areas of agricultural land and thin peaty/organic topsoil in forestry areas. Only turbine locations TL05 and TL06 were found to have blanket peat present.

Based on the trial pits undertaken, the overall subsoil thickness within the proposed development site varies between 0.3 and 2m. An undefined transition zone between the subsoils and bedrock was noted in some areas that existed over weathered shale bedrock. The transition zone between the subsoil and bedrock was generally more defined where sandstone bedrock was encountered and this was due to the less weathered state of the sandstone.

No ground stability issues were identified by the trial pit investigation and all subsoils were found to be firm and cohesive which is generally typical of tills. A separate peat stability assessment for the blanket bog was undertaken by Whitefords Geoservices Ltd and this is reviewed below in this chapter.

Trial Pit Name	*Location*	*Primary Subsoil Lithology*	*Depth to Bedrock (m)*
TP01 (TL02)	Turbine location 2	Firm CLAY – CLAY/SILT	1.2
TP02 (TL01)	Turbine location 1	Soft to firm SILT/CLAY	0.3
TP03	Access road north Of T1	Firm CLAY/SILT over very firm CLAY	0.75
TP04 (TL04)	Turbine location 4	Soft to firm SILT over firm sandy SILT/CLAY	0.8
TP05	Access road north Of T4	Soft to firm sandy SILT	2.0
TP06 (TL03)	Turbine location 3	Soft to firm CLAY	0.9
TP07 (TL08)	15m north of T8	Soft to firm SILT over firm CLAY	1.6
TP08 (TL09)	60m east of T9	PEAT over dense silty SAND	1.3
TP09 (TL10)	100 east of T10	PEAT over dense silty SAND	2.0
TP10 (TL07)	Turbine location 7	Firm, gravelly SILT/CLAY	1.2
TP11 (TL11)	Turbine location 11	Firm SILT/CLAY	1.1
TP12	Off forestry track	Soft to firm sandy SILT	1.2
TP13 (TL05)	50m west of T5	Soft to firm CLAY	1.9

Table 5.4: Summary of the Trial Pit Investigation

Location	Easting	Northing	Soil/subsoil Description
GC1	251,928	182,708	soil over SILT/CLAY
GC2	251,690	182,410	Organic soil over SILT
GC3	251,634	182,174	Organic soil over SILT
GC4	251,545	181,870	Mineral soil over SILT/CLAY
GC5	251,206	181,628	1m PEAT over CLAY
GC6	251,140	181,781	0.3m PEAT over SILT/CLAY
GC7	250,964	181,934	Mineral soil over SILT/CLAY
GC8	250,929	181,497	0.6m PEAT over SILT/CLAY

Location	Easting	Northing	Soil/subsoil Description
GC9	250,755	181,487	1.7m PEAT over SILT/CLAY
GC10	250,484	181,154	Organic soil over SILT/CLAY
GC11	250,742	180,675	Peaty topsoil over SILT/CLAY
GC12	250,826	180,372	Peaty topsoil over SILT/CLAY
GC13	250,595	180,409	Mineral soil over SILT/CLAY

Table 5.5: Summary of Soil/Subsoil Gouge Cores

5.2.3 Bedrock Geology

Based on the GSI bedrock map the bedrock units underlying the proposed development site comprises Namurian shales and sandstones and Westphalian shales and sandstones. Both shale and sandstone bedrock was encountered in the trial pits. Evidence of coal was noted within the shale bedrock at turbine location TL03. As stated above the depth to bedrock at the proposed development site is between 0.3 and 2m. The bedrock is poorly exposed within the proposed development site.

The upper profile of the shale bedrock was found to be generally weathered or very soft with excavation of the shale been possible with the excavator bucket. The sandstone bedrock was generally noted to be more competent with the exception of trial pit locations TP08 and TP09 where soft sandstone was proved down to a depth of 4.5m below ground level.

The Castlecomer Plateau, of which this area is a part, is a broad gentle syncline (V-shaped fold) in which the rock strata generally dip towards the centre. The Plateau is then subdivided into a series of compartments by NE-SW and NW-SE trending faults. There are no mapped faults in the area of the proposed development. A bedrock geology map of the area is illustrated in **Figure 5.4**.

5.2.4 Peat Stability Assessment

This section summarises the report on assessment of peat stability undertaken by Whitefords Geoservices Ltd (May, 2015). The peat stability risk assessment report is included as **Appendix 5.3** of this EIS.

The purpose of the peat stability investigation was to obtain sufficient information to allow an assessment of the potential risk of 'Peat Slide' occurrence during development works and to propose mitigation and management to ensure site stability during construction and during the lifetime of the wind energy scheme.

The mean peat/organic topsoil depth encountered in readings across the proposed development site was 0.40m. Peat thickness displayed a range from 0m to 1.90m within the potential development area surveyed by Whiteford Geoservices Ltd. The results of the peat probing are shown in **Table 5.6** below.

ID		*Co-ordinates*	*Peat Depth (m)*
	Easting	*Northing*	
T1	251604	182460	0.00 – 0.10*
T2	251693	182105	0.25 – 0.45*
T3	251676	181781	0.00 – 0.30*
T4	250937	181833	0.20 – 0.40#

ID		Co-ordinates	Peat Depth (m)
	Easting	Northing	
T5	251205	181628	0.80 – 1.00#
T6	250756	181489	0.50 – 1.90#
T7	250403	181186	0.00 – 0.10*
T8	250682	180984	0.00 – 0.10*
T9	250742	180675	0.00 – 0.10#
T10	250826	180372	0.00 – 0.10#
T11	250276	180413	0.00 – 0.10*

Table 5.6: Summary Peat Depths (Whitefords Geoservices Ltd)

* Topsoil/organic topsoil. # Blanket Peat

The appraisal of the Hazard Rankings for each proposed turbine and structure location indicates that the site (encompassing Turbines T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and the electrical substation and permanent met-mast) carry INSIGNIFICANT Hazard Rankings as determined in accordance with the guidelines outlined by The Scottish Executive & Halcrow Group Ltd in *"Peat Slide Hazard and Risk Assessment - Best Practice Guide for Proposed Electricity Generation Developments",* December 2006.

Based on the assessment, the site is deemed suitable for the proposed development. Peat slide risk has indicated an INSIGNIFICANT risk of instability in relation to the structural aspects of the proposed development.

5.2.5 Geological Resource Importance

The sandstone and shale bedrock at the site could be classified as "Medium" importance. The bedrock could be used on a "sub-economic" local scale for construction purposes. The bedrock has not been used in the past at the site for this purpose.

The mineral subsoil deposits at the site could be classified as "High to Medium" in terms of agricultural and forestry usage respectively. Refer to **Table 5.1** for definition of these criteria.

5.2.6 Geological Heritage and Designated Sites

There are no GSI recorded Geological Heritage sites, mineral deposit sites or mining sites (current or historic) within the proposed development area. The proposed development is not located within any designated site. The closest geological heritage sites to the proposed development are located at The Swan which exists 4km to the east of the site. There will be no impact on this heritage site.

5.3 Description of Likely Impacts

The proposed development will typically involve removal of peat (where present), subsoils and bedrock for on-site access road, hardstandings and turbine foundations. Bedrock for construction will be sourced from local quarries as there are no proposals for an on-site borrow pit.

Estimated volumes of topsoil and peat to be removed are shown in **Table 5.7**.

Settlement ponds where constructed will be volume neutral, i.e. all material excavated will be used to form side bunds and landscaping around the ponds. There will be no excess material from settlement pond construction. The material will also be reinstated during decommissioning.

Development	*Number*	*Length*	*Avg Width*	*Depth*	*M3*	*Allow 10% extra*
Roads	1	7400	5	0.5	18500	20350
Turbine Hardstanding	11	50	20	1	11000	12100
Met Mast Hardstanding	1	22	15	1	330	363
Substation	1	94	21	2.25	4441.5	4886
Junction Upgrade	1	20	50	0.5	500	550
Compound Area	1	33	43	0.5	709.5	780

Table 5.7: Estimated Topsoil and Peat Excavation Volumes

5.3.1 "Do Nothing" Impacts

Surface water drainage excavations carried out in areas of existing access road, coniferous plantations and agricultural land will continue to function and may be extended in the case of all three. Coniferous forestry will be felled as forestry compartments reach maturity. Re-planting of these areas with more coniferous trees is likely to occur. Plantations will be re-ploughed where necessary to facilitate afforestation.

5.3.2 "Worst Case" Impacts

The impacts of a 'worst case' scenario are:-

- Localised contamination of soils and subsoils during the construction phase due to fuels/oils leaks and spillages.
- Localised soil stability issues due to the movement and storage of peat.

The "worst case" impacts are not deemed to be significant.

5.3.3 Potential Construction Phase Impacts

5.3.3.1 Peat, Subsoil Excavation and Bedrock Excavation

Excavation of peat, subsoil and bedrock will be required for site leveling, for the installation of foundations for the access roads and turbines etc. This will result in a permanent removal of peat, subsoil and bedrock at excavation locations. Estimated volumes of peat and subsoils to be relocated are shown in **Table 5.7** above.

The overall impact is determined not to be significant due to the following:

- A minimal volume of soil, subsoil and bedrock in comparison to the total volume present on the site will be removed to allow for infrastructural work to take place;
- The soil, subsoil and bedrock which will be removed during the construction phase will be localised to the turbine location and access roads;
- The bedrock at the site can be classified as "Medium" importance;
- The soils and subsoil at the site can be classified as "High to Moderate" importance with the former relating to agricultural land and the latter to forestry.

Mechanism*:* Extraction/excavation.

Receptor*: Peat, subsoil and bedrock*

Pre-mitigation Impact*:* Negative, slight/moderate, direct, high probability, permanent impact on peat, subsoil and bedrock.

5.3.3.2 Contamination of Soil by Leakages and Spillages and Alteration of Peat/Soil Geochemistry

Pathway*:* Peat, subsoil and bedrock pore space.

Receptor*:* Peat, subsoil and bedrock.

Pre-mitigation: Negative, direct, slight, short term, medium probability impact on peat, soils and bedrock.

5.3.3.3 Erosion of Exposed Subsoils During Tree Felling, Access Road and Turbine Base Construction Work

Mechanism*:* Vehicle movement, surface water and wind action.

Receptor: Peat, subsoil & weathered bedrock.

Pre-Mitigation Impact*:* Negative, direct, slight, high probability impact on peat, subsoils and bedrock.

5.3.3.4 Peat Instability and Failure

Peat instability or failure refers to a significant mass movement of a body of peat that would have an adverse impact on proposed wind farm development and the surrounding environment. Peat failure excludes localised movement of peat that could occur below an access road, creep movement or erosion type events. The consequence of peat failure at the study area may result in:

- Death or injury to site personnel;
- Damage to machinery;
- Damage or loss of access tracks;
- Drainage disrupted;
- Site works damaged or unstable;
- Contamination of watercourses, water supplies by particulates;
- Degradation of the peat environment.

Mechanism: Vehicle movement and excavations.

Receptor*:* Peat subsoils.

Pre-mitigation Impact*:* Direct, negative, significant, low probability impact on peat and subsoils.

5.4 Mitigation & Monitoring Measures

5.4.1 Construction Phase Mitigation Measures

5.4.1.1 Peat, Subsoil Excavation and Bedrock Excavation

- No turbines or directly related infrastructure will be constructed near or on any designated sites such as NHAs or SACs;
- Rock aggregate for construction purposes is to be sourced off-site to avoid large on-site borrow pits;
- The soil, subsoil and bedrock which will be removed during the construction phase will be localised to the turbine location and access roads.

Residual Impact:

Negative, Imperceptible, direct, short term, low probability impact.

Significance of Effects:

No significant impact on soils, subsoils or bedrock are anticipated.

5.4.1.2 Contamination of Soil by Leakages and Spillages and Alteration of Peat/Soil Geochemistry

Proposed Mitigation Measures:

- Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Off-site refuelling will occur at a controlled fueling station;
- On site refuelling will be undertaken using a double skinned bowser with spill kits on the ready for accidental leakages or spillages;
- Fuels stored on site will be minimised. Storage areas, where required, will be bunded appropriately for the fuel storage volume for the time period, and fitted with a storm drainage system and an appropriate oil interceptor;
- The electrical control building will be bunded appropriately to the volume of oils likely to be stored; and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose;
- An emergency plan for the construction phase to deal with accidental spillages will be contained within Environmental Management Plan. Spill kits will be available to deal with and accidental spillage in and outside the refuelling area.

Residual Impact:

Negative, Imperceptible, direct, short term, low probability impact.

Significance of Effects:

No significant impact on soils, subsoils or bedrock are anticipated.

5.4.1.3 Erosion of Exposed Subsoils During Tree Felling, Access Road and Turbine Base Construction Work

Proposed Mitigation Measures

- Peat and subsoils removed from turbine locations and access roads will be used for landscaping, cast aside and deposited on-site;
- Any excess temporary mounded subsoils in storage for long periods will be covered by a polyethylene sheets or seeded at the earliest opportunity. This will prevent erosion of soil. Silt fences will be installed around stockpiles to limit movement of entrained sediment in surface water runoff. The use of bunds around earthworks and mounds will prevent egress of water from the works;
- In order to minimise erosion of mineral subsoils stripping of topsoil will not take place during extremely wet periods (to prevent increased silt rich runoff). Temporary drainage systems will be required to limit runoff impacts during the construction phase;
- In forestry areas, brash mats will be used to support vehicles on soft ground, reducing topsoil and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting.

Residual Impact:

Negative, slight, direct, medium probability impact on peat, subsoils and weathered bedrock

Significance of Effects:

No significant impact on soils, subsoils or bedrock are anticipated.

5.4.1.4 Peat Instability and Failure

Impact Assessment / Mitigation Measures

Whitefords Geoservices Ltd appraisal of the Hazard Rankings, for each proposed turbine and structure location indicates that the site (encompassing turbines T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and the electrical switchroom and permanent met-mast) carry INSIGNIFICANT Hazard Rankings in relation to peat instability. Please refer to the peat stability assessment report for proposed measures to prevent peat slide and bog burst **(Appendix 5.2)**.

Residual Impact:

There are no residual impacts anticipated on the soils and geological environment.

Significance of Effects:

No significant impact on soils, subsoils or bedrock are anticipated.

Appendix 5.1: Trial Pit Logs

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

TRIAL PIT LOG

TRIAL PIT NUMBER: TP01-TL02

PROJECT NUMBER: P1264	**DATE STARTED:** 30/3/15	**EASTING:** 251693
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 182105
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.20			Topsoil (Organic)
				-0.50			Dark brown, soft SILT/CLAY
				-1.20	1		Greyish blue, firm CLAY - SILT/CLAY with orange mottling
					2		SHALE (Flat slab of SHALE on base of hole) Bedrock Met Total Depth 1.2m
					3		
					4		
				-5.00	5		

REMARKS: Trial pit at turbine location TL02

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 1.2m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

SCALE

HYDRO-ENVIRONMENTAL SERVICES 22 Lower Main Street Dungarvan Co. Waterford Tel: 058-44122 Fax: 058-44244 Email: info@hydroenvironmental.ie

ENVIRONMENTAL ENGINEERING
HYDROLOGY HYDROGEOLOGY

TRIAL PIT LOG

TRIAL PIT NUMBER: TP02-TL01

PROJECT NUMBER: P1264	**DATE STARTED:** 30/3/15	**EASTING:** 251604
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 182460
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
							Topsoil
				-0.30			Reddish brown, soft to firm SILT/CLAY
							Weathered, broken SHALE (flakey)
				-0.70			Broken SHALE (getting more blocky)
					1		Bedrock Met
				-1.30			Total Depth 1.3m
					2		
					3		
					4		
				-5.00	5		

REMARKS: Trial pit at turbine location TL01

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 1.3m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

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ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

TRIAL PIT LOG

TRIAL PIT NUMBER: TP03-SSN

PROJECT NUMBER: P1264	**DATE STARTED:** 30/3/15	**EASTING:** 251780
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 182580
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.20			Topsoil
				-0.50			Bluish grey, firm to very firm SILT/CLAY
				-0.75			Greyish blue, very firm CLAY with some orange mottling
				-1.10	1		Grey blue weathered SHALE
							Bedrock Met
							Total Depth 1.1m
					2		
					3		
					4		
				-5.00	5		

REMARKS: Trial pit at Substation North location

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 1.1m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

TRIAL PIT LOG

TRIAL PIT NUMBER: TP04-TL04

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

PROJECT NUMBER: P1264	**DATE STARTED:** 30/3/15	**EASTING:** 250937
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 181833
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.15			Topsoil (Organic)
				-0.30			Grey, soft to firm SILT
							Reddish brown, soft to firm, slightly sandy SILT/CLAY
				-0.80			Reddish brown, weathered SANDSTONE
					1		Bedrock Met
							Total Depth 0.9m
					2		
					3		
					4		
				-5.00	5		

REMARKS: Trial pit at turbine location TL04

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 0.9m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

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ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

TRIAL PIT LOG

TRIAL PIT NUMBER: TP05-SSS

PROJECT NUMBER: P1264	**DATE STARTED:** 30/3/15	**EASTING:** 251080
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 181820
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00			Ground Surface
				-0.15	0		Topsoil
				-1.00			Greyish orange, firm, sandy SILT
				-2.00	1		Soft to firm, sandy SILT (with blue CLAY discontinuities and boulders and cobbles)
					2		SANDSTONE Bedrock Met
							Total Depth 2.0m
					3		
					4		
				-5.00	5		

REMARKS: Trial pit at Substation South location

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 2.0m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

SCALE

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TRIAL PIT LOG

ENVIRONMENTAL ENGINEERING
HYDROLOGY HYDROGEOLOGY

TRIAL PIT NUMBER: TP06-TL03

PROJECT NUMBER: P1264
DATE STARTED: 30/3/15
EASTING: 251677
SITE: Pinewoods WF, Co. Laois
LOGGED BY: DB
NORTHING: 181752
CLIENT: Pinewoods Wind Ltd.
CONTRACTOR: Shay Power
ELEVATION:

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
							Topsoil
				-0.40			Brown, soft SILT/CLAY
				-0.90			Grey, soft to firm CLAY (with evidence of coal)
				-1.70	1		Dark grey, soft SHALE Bedrock Met
					2		Total Depth 1.7m
					3		
					4		
				-5.00	5		

REMARKS: Trial pit at turbine location TL03

PIT LENGTH:
PIT BREADTH:
FINAL DEPTH: 1.7m
EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

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TRIAL PIT LOG

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

TRIAL PIT NUMBER: TP07-TL08

PROJECT NUMBER: P1264	**DATE STARTED:** 30/3/15	**EASTING:** 250682
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 180995
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.15			Topsoil
				-0.60			Greyish orange, soft to firm SILT
				-1.60	1		Bluish grey, firm CLAY
				-3.20	2, 3		Soft, broken SHALE Bedrock Met
					4, 5		Total Depth 3.2m

REMARKS: Trial pit 15m north of turbine location TL08

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 3.2m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

SCALE

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TRIAL PIT LOG

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

TRIAL PIT NUMBER: TP08-TL09

PROJECT NUMBER: P1264
DATE STARTED: 31/3/15
EASTING: 250802

SITE: Pinewoods WF, Co. Laois
LOGGED BY: DB
NORTHING: 180673

CLIENT: Pinewoods Wind Ltd.
CONTRACTOR: Shay Power
ELEVATION:

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.60			PEAT
				-1.30	1		Orange, dense, silty SAND (coarse)
				-2.90	2		Soft, weathered SANDSTONE Bedrock Met
				-5.00	3, 4, 5		Total Depth 2.9m

REMARKS: Trial pit 60m east of turbine location TL09

PIT LENGTH:
PIT BREADTH:
FINAL DEPTH: 2.9m
EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

TRIAL PIT LOG

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

TRIAL PIT NUMBER: TP09-TL10

PROJECT NUMBER: P1264
DATE STARTED: 30/3/15
EASTING: 250928

SITE: Pinewoods WF, Co. Laois
LOGGED BY: DB
NORTHING: 180414

CLIENT: Pinewoods Wind Ltd.
CONTRACTOR: Shay Power
ELEVATION:

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.50			PEAT
				-2.00	1		Orange brown, dense, silty SAND
				-4.50	2, 3, 4		Orange brown, soft, weathered SANDSTONE Bedrock Met
				-5.00	5		Total Depth 4.5m

REMARKS: Trial pit 100m east of turbine location TL10

PIT LENGTH:
PIT BREADTH:
FINAL DEPTH: 4.5m
EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

TRIAL PIT LOG

TRIAL PIT NUMBER: TP10-TL07

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

PROJECT NUMBER: P1264	**DATE STARTED:** 31/3/15	**EASTING:** 250403
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 181186
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
							Topsoil
				-0.50			Beige, firm, slightly gravelly SILT/CLAY
				-1.20	1		Grey, firm to very firm, very shaley SILT/CLAY
				-3.50	2, 3		Soft SHALE (very flakey) Bedrock Met
				-5.00	4, 5		Total Depth 3.5m

REMARKS: Trial pit at turbine location TL07

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 3.5m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

TRIAL PIT LOG

TRIAL PIT NUMBER: TP11-TL11

PROJECT NUMBER: P1264	**DATE STARTED:** 31/3/15	**EASTING:** 250276
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 180413
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.15			Topsoil
				-1.10	1		Reddish brown, firm SILT/CLAY
				-1.50			Weathered SHALE with high SILT/CLAY content
				-3.80	2, 3		Soft SHALE Bedrock Met
				-5.00	4, 5		Total Depth 3.8m

REMARKS: Trial pit at turbine location TL11

PIT LENGTH:

PIT BREADTH:

FINAL DEPTH: 3.8m

EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

SCALE

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TRIAL PIT LOG

TRIAL PIT NUMBER: TP12

ENVIRONMENTAL ENGINEERING HYDROLOGY HYDROGEOLOGY

PROJECT NUMBER: P1264
SITE: Pinewoods WF, Co. Laois
CLIENT: Pinewoods Wind Ltd.
DATE STARTED: 31/3/15
LOGGED BY: DB
CONTRACTOR: Shay Power
EASTING: 225112
NORTHING: 181033
ELEVATION:

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.30			Peaty Topsoil
				-1.20	1		Orange/grey, soft to firm, slightly sandy SILT
				-2.50	2		Weathered SHALE Bedrock Met
					3		Total Depth 2.5m
					4		
				-5.00	5		

REMARKS: Trial pit just off existing forestry track

PIT LENGTH:
PIT BREADTH:
FINAL DEPTH: 2.5m
EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

PAGE 1 of 1

SCALE

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TRIAL PIT LOG

TRIAL PIT NUMBER: TP13-TL05

ENVIRONMENTAL ENGINEERING
HYDROLOGY HYDROGEOLOGY

PROJECT NUMBER: P1264	**DATE STARTED:** 30/3/15	**EASTING:** 251155
SITE: Pinewoods WF, Co. Laois	**LOGGED BY:** DB	**NORTHING:** 181623
CLIENT: Pinewoods Wind Ltd.	**CONTRACTOR:** Shay Power	**ELEVATION:**

Comments	Sample Number	Sample Type	Water Strikes	Elevation	Meters Below Ground Surface	Lithology	Formation Description
				0.00	0		Ground Surface
				-0.50			PEAT
				-1.90	1		Bluish grey, soft to firm CLAY
					2		SANDSTONE Bedrock Met
							Total Depth 1.9m
					3		
					4		
				-5.00	5		

REMARKS: Trial pit 50m west of turbine location TL05

PIT LENGTH:
PIT BREADTH:
FINAL DEPTH: 1.9m
EXCAVATOR:

LEGEND
∇ - Water strike
D - Disturbed sample
B - Bulk disturbed sample
W - Water sample
V - Vane test
T - No. of threads
R - Average length of ribbons
Dil - Dilatancy recorded
ND - No dilatancy recorded

SCALE

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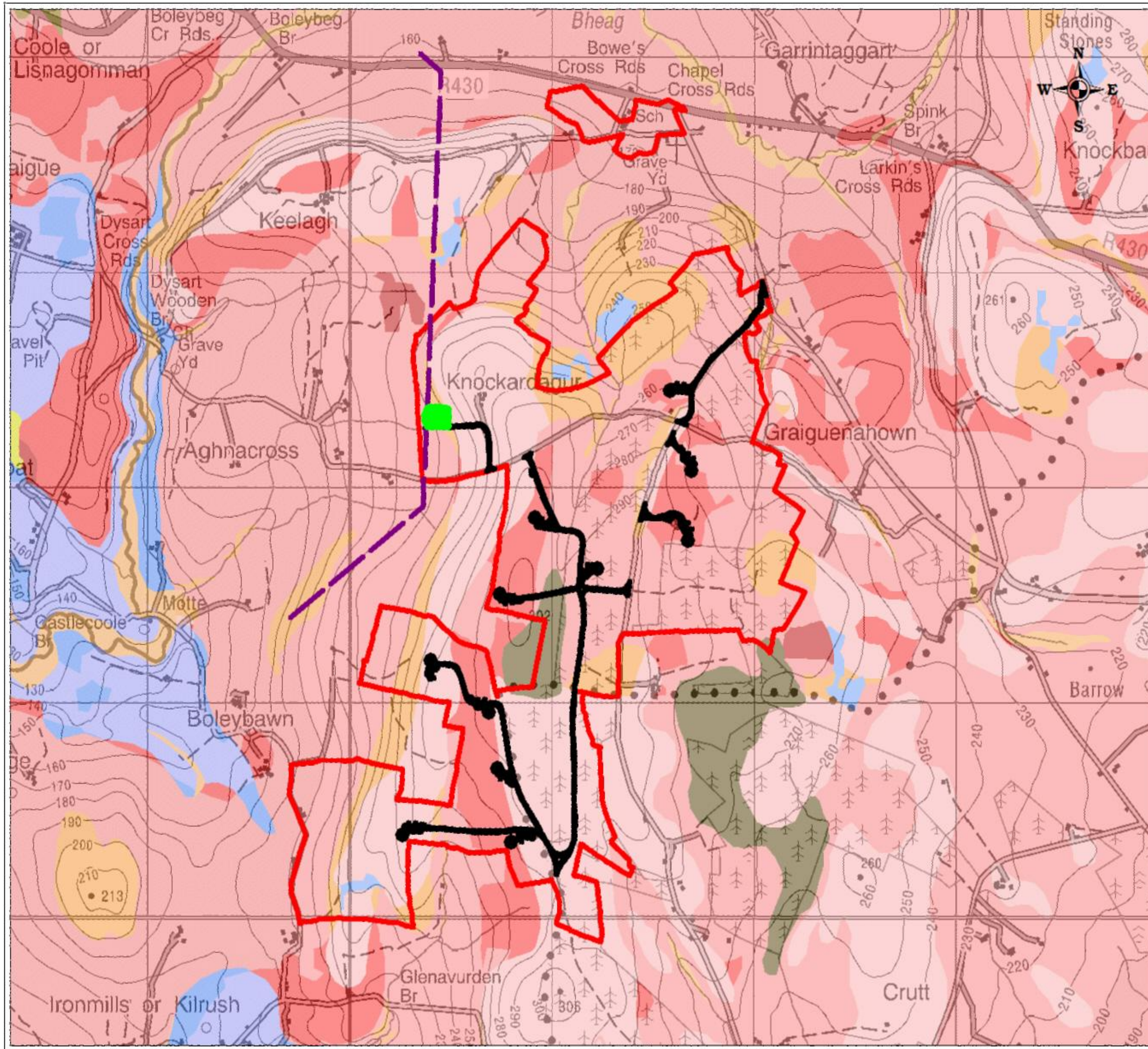
Appendix 5.2: Figures



Legend:

- Landholding / Study Area
- Acid Brown Earths/ Brown Podzolics
- Surface water Gleys/ Groundwater Gleys Acidic
- Lithosols/Regosols
- Blanket Peat
- Surface water Gleys/ Groundwater Gleys Shallow
- Surface water Gleys/ Groundwater Gleys
- Podzols Peaty
- Development Footprint
- Grid Connection
- Switching Station

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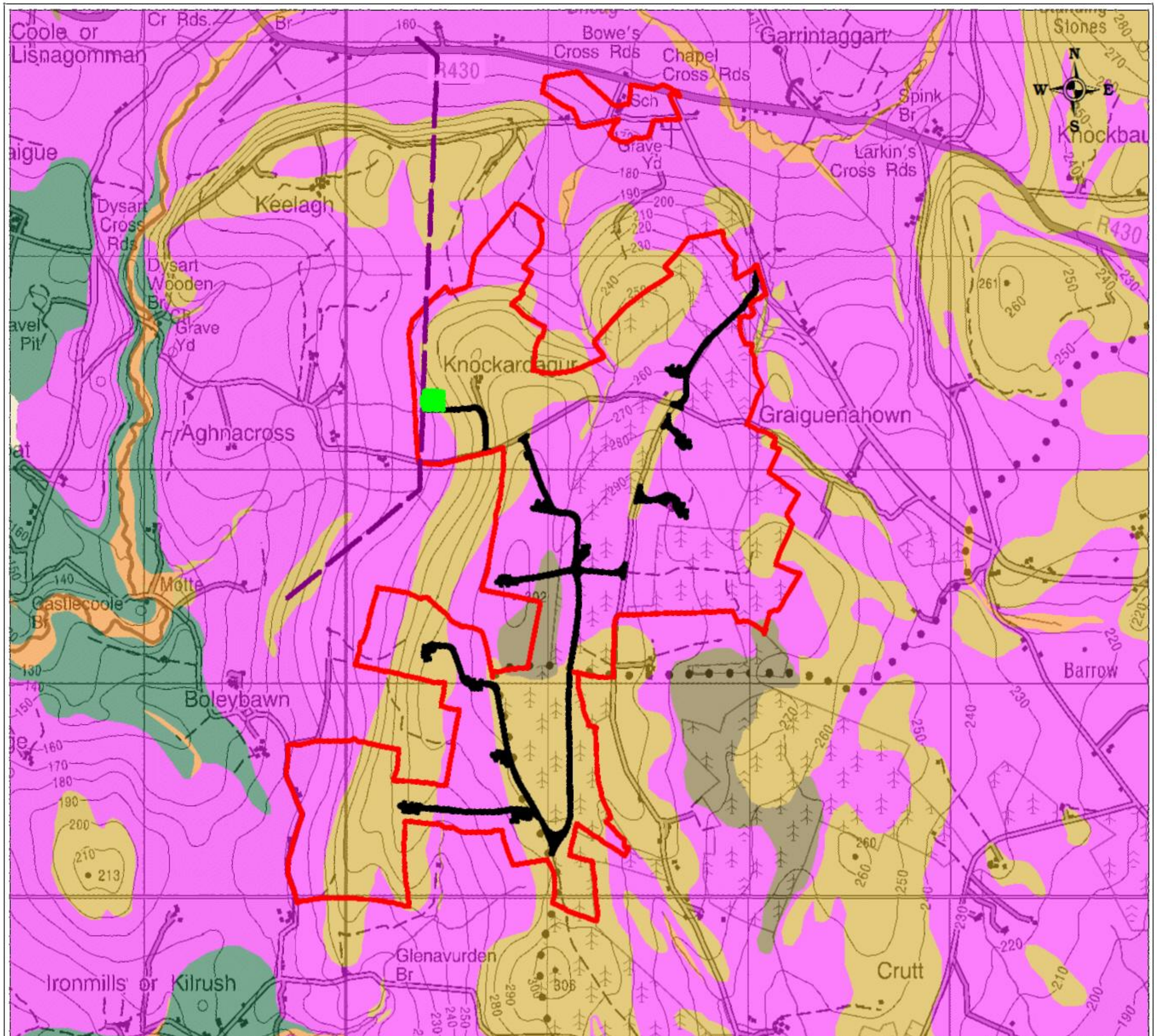
web: www.hydroenvironmental.ie

Title: Soils Map	
Client: Pinewoods Wind Ltd	
Job: Pinewoods WF, Co. Laois	
Project No: P1264-0	
Figure No: 5.1	
Sheet Size: A4	
Drawing No: P1264-0-0416-A4-501-00A	
Date: - 27/04/2016	
Scale: - 1:25000	
Drawn By: GB	Checked By: MG



Legend:

- Landholding / Study Area
- Namurian Shales & Sandstones
- Bedrock at or close to Surface
- Undifferentiated Alluvium - Gravelly
- Blanket Peat
- Limestone Sand and Gravels
- Development Footprint
- Grid Connection
- Switching Station

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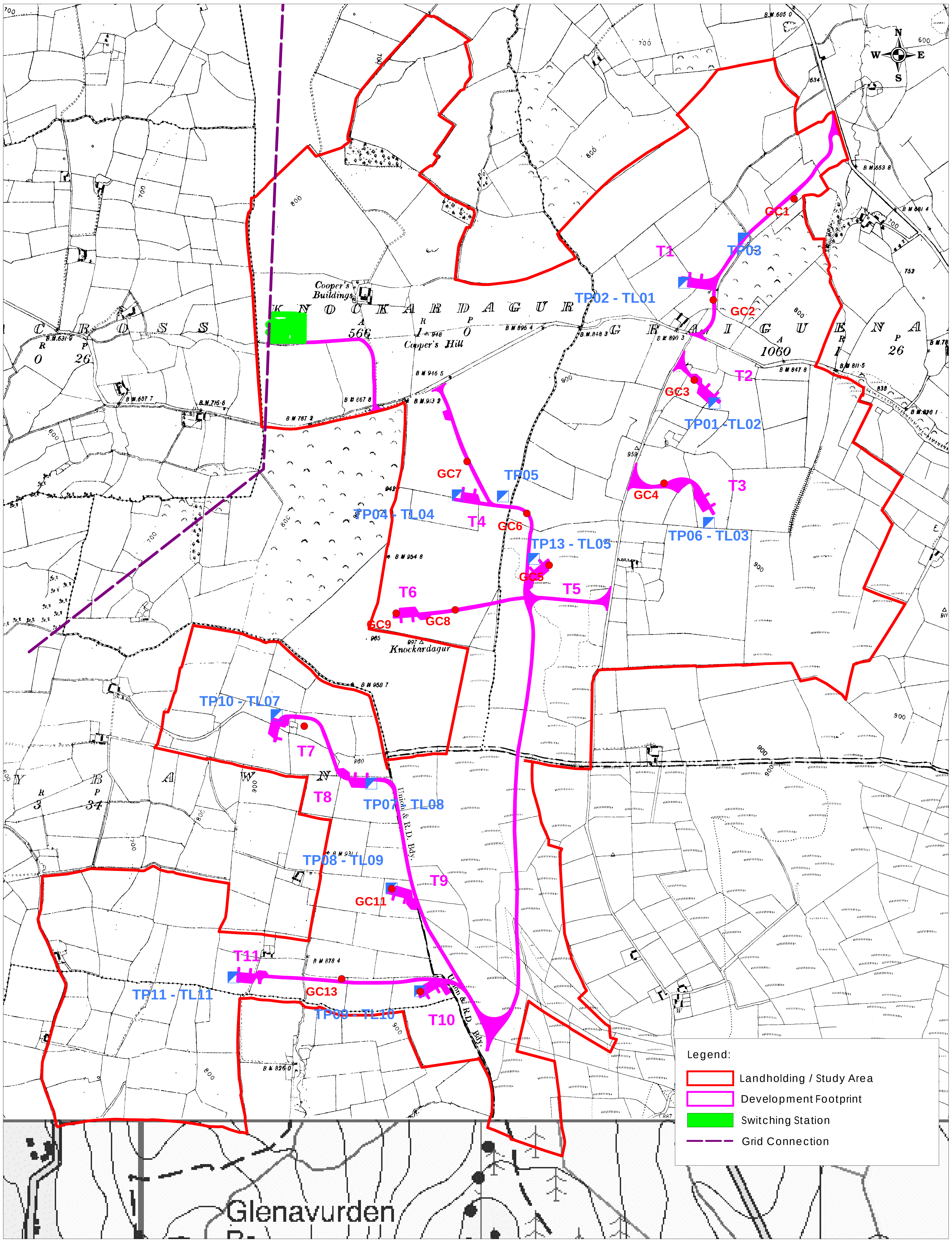
Title: Subsoils Map	
Client: Pinewoods Wind Ltd	
Job: Pinewoods WF, Co. Laois	
Project No: P1264-0	
Figure No: 5.2	
Sheet Size: A4	
Drawing No: P1264-0-0416-A4-502-00A	
Date: - 27/04/2016	
Scale: - 1:25000	
Drawn By: GB	Checked By: MG



Client: Pinewoods Wind Ltd

Job: Pinewoods WF Co. Laois / Kilkenny

Title: Site Investigation Map

Figure No: 5.3

Drawing No: P1264-0-0416-A3-503-00A

Sheet Size: A3 | Project No: P1264

Scale: - 1:10000 | Drawn By: DB

Date: - 27/04/2016 | Checked By: MG

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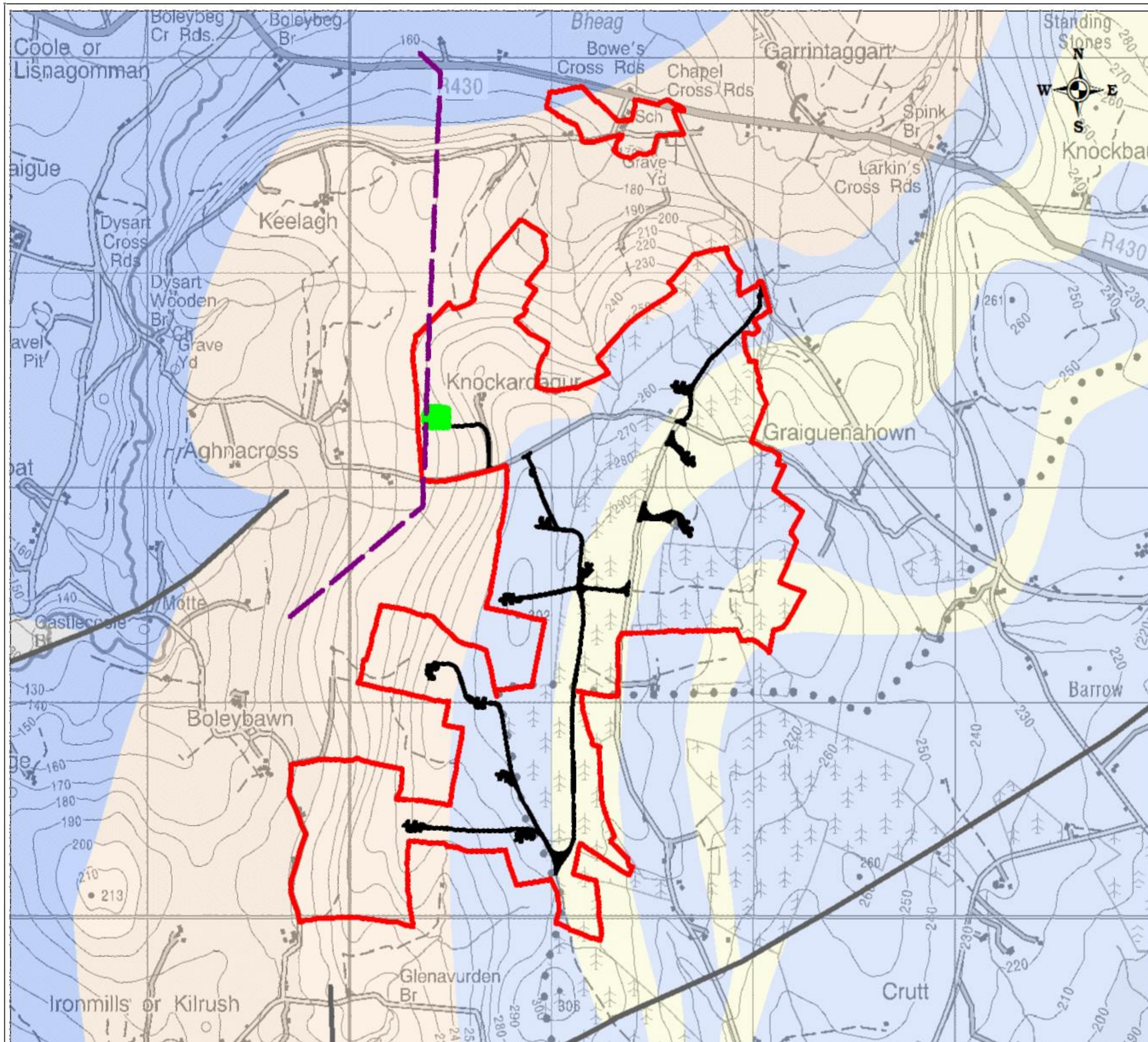

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Title: Bedrock (Unit) Map	
Client: Pinewoods Wind Ltd	
Job: Pinewoods WF, Co. Laois	
Project No: P1264-0	
Figure No: 5.4	
Sheet Size: A4	
Drawing No: P1264-0-0416-504-A4-0A	
Date: - 27/04/2016	
Scale: - 1:25000	
Drawn By: GB	Checked By: MG

Appendix 5.3: Peat Slide Risk Assessment

Pinewoods Wind Farm
Peat Slide Risk Assessment

Report No: 1502-14 Rev 3

12th May 2016

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

Pinewoods Wind Ltd

Galetech Energy Developments Ltd

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

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www.whitefordgeoservices.com

Peat Slide Risk Assessment at Pinewoods Wind Farm, Co. Laois and Co. Kilkenny

Client: Galetech Energy Developments Ltd c/o Pinewoods Wind Ltd
Date: 12th May 2016

Report No. 1502-14 Rev 3 PWL

Statement of Authority

John Whiteford BSc (Hons) Geol MIOSH MEAGE has more than 15 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 in 1993 he has been engaged in full-time consultancy for the past 15 years and since 1996 trading as Whiteford Geoservices Ltd. The company has a staff of more than 10 professional and technical personnel and has completed in excess 700 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 80 wind power projects where our services have been sought in relation to foundation design, peat slide risk assessment, geophysics, electrical earthing design and thermal resistivity analysis.

The following report is based upon the guidance contained within the Scottish Executive's "*Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments*", published as a final version in December 2006 (referred to as "the Scottish Guidance"). Unless otherwise stated, all assessments and conclusions contained within this report are made with reference to this publication. However, there are a significant number of variations from the guidance and where this occurs the reason for the divergence is provided, either within the text or as a footnote.

This report details the works undertaken by Whiteford Geoservices Ltd on the site of the proposed Pinewoods Wind Farm, Co. Laois and Co. Kilkenny.

1.0 INTRODUCTION

1.1.1 Background and Purpose

At the request of Galetech Energy Developments Ltd, on behalf of Pinewoods Wind Ltd, Whiteford Geoservices Ltd has undertaken a walk over survey and peat slide risk assessment at the site of the proposed Pinewoods Wind Farm, Co. Laois and Co. Kilkenny.

The purpose of this investigation was to obtain sufficient information to allow an assessment of the potential risk of ‘Peat Slide’ occurrence during development works and to propose mitigation and management to ensure site stability during construction and during the lifetime of the wind energy scheme.

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

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

Whiteford Geoservices Ltd personnel visited the site on 1st August and 22nd November 2014 to undertake a walkover survey for the assessment of topography, superficial geology, drainage and ground stability conditions.

1.1.2 The Site

The site of the proposed Pinewoods Wind Farm is located within the townland of Knockardagur, approximately 7.5km east of Abbeyleix in County Laois. The site lies south of the R430 carriageway.

The site is relatively flat and is serviced with an extensive network of drains associated with forestry on-site. The terrain consists mainly of good to rough pasture with rushes prevalent. Shrubs and small trees, along with moderately large areas of dense juvenile forestry, are present throughout the proposed site.

Turbines T1, T3, T4, T7, T11, the Met Mast and Substation are situated within agricultural pastureland.

Turbines T5 and T6 are positioned within existing juvenile forestry.

Turbines T8, T9 and T10 are located within forestry.

Turbine T2 is located within an area of rough “boggy” land adjacent to agricultural pastureland.

1.2 Methodology

The survey at the proposed Pinewoods Wind Farm was carried out as follows:

Stage 1

Selected depth probing was undertaken at proposed turbine locations by the low impact method of plunging a series of rigid rods (commonly known as “depthing rods” provided in 1.00m long screw-together sections) through the peat / organic topsoil to determine at what level refusal was encountered on the underlying till or bedrock.

Although this method of investigation is not covered in the Scottish Guidance it remains the optimal technique for rapidly mapping the thickness of peat. This technique is commonly employed by consultants for the purpose of Peat Slide Risk Assessment undertaken prior to construction works and is documented in the Scottish Government publication “Guidance: Developments on Peatland: Site Surveys” Scottish Natural Heritage, Scottish Environment Protection Agency and The James Hutton Institute.

For further reference to the use of “depthing rods” and peat quality assessment by gouge core / auger, shear vane and Von Post assessment please refer to the following two sources:-

1. *Soil Survey of Scotland. 1984. “Organisation and Methods. Handbook 8”. MacAulay Institute for Soil Research.*
2. *Soil Survey of Scotland “Scottish Peat Surveys, 1964 Volume 1 HMSO, Edinburgh.*

A Thales DGPS system was employed to record the location of each depth probed. Waypoints were entered into the DGPS to establish each survey line, which allowed the operator to navigate between individual probe locations and fix their positions.

Probing was undertaken manually by driving a series of rods into the ground until a significant change in resistance was registered within the sub-soil. The depth of peat / organic topsoil observed was then measured and recorded along with the relevant co-ordinates into a hand-held PDA Logger.

2.1 EXISTING ENVIRONMENT

2.2 Geology

Published geological maps of the area and Geological Survey of Ireland (GSI), show the site to be underlain by Fluvio-deltaic and basinal marine (Turbiditic) Shale, sandstone, siltstone and coal, which is shown to be overlain by glacial till and fluvio-glacial deposits. These are in turn mantled by geologically recent materials, composed mainly of negligible peat cover.

The mean peat / organic topsoil depth encountered in readings across the potential Pinewoods development area was 0.40m. Peat / organic topsoil thickness displayed a range from 0.00m to 1.90m within the potential development area surveyed by Whiteford Geoservices Ltd.

ID	Co-ordinates		Peat / Organic Topsoil Depth (m)
	Easting	Northing	
T1	251604	182460	0.00 – 0.10*
T2	251693	182105	0.25 – 0.45*
T3	251676	181781	0.00 – 0.30*
T4	250937	181833	0.20 – 0.40#
T5	251205	181628	0.80 – 1.00#
T6	250756	181489	0.50 – 1.90#
T7	250403	181186	0.00 – 0.10*
T8	250682	180984	0.00 – 0.30*
T9	250742	180675	0.00 – 0.50#
T10	250826	180372	0.00 – 0.50#
T11	250276	180413	0.00 – 0.20*
Substation	250435	182335	0.10 – 0.30*
Met Mast	250890	182093	0.00 – 0.10*

Table 1 – Peat / Organic Topsoil Depth at proposed Structure Locations

N.B. Obstructions within the peat layer can cause an increase in resistance or refusal, which may result in inaccurate depth measurement during the probing survey. Results of probing are therefore indicative only.

Blanket peat present
* *Organic topsoil / No peat present*

2.3 Potential for Bog Failure

An analysis was made of available topographic survey data and collected peat / organic topsoil depth thickness at each turbine to determine the potential for movement. From this information the following table of potential risks was produced.

Reference is made, in this section, to "*Peat Slide Hazard and Risk Assessment Best Practice Guide for Proposed Electricity General Developments*", produced by The Scottish Executive & Halcrow Group Ltd (Dec 2006).

Stability Issue	New Access Route	Turbine Base Location and Other Infrastructure
Existing Slopes	The slopes encountered at the proposed site are generally low to moderate and vary between approximately 0 – 10 degrees to the horizontal.	Slopes encountered at the proposed turbine locations are low to moderate and display magnitudes of 0 – 10 degrees to the horizontal.
Landslip / Peat Slide	*Excavations* The favoured method of construction for new access roads will be to found, where possible, directly on top of the natural soils present immediately underlying the peat / topsoil. Where this is carried out and slopes are of low to moderate magnitude (0 – 10 degrees) the potential for peat slide, at a time post-dating the completion of the site works, is classified to be at INSIGNIFICANT RISK (where peat is < 1.50m). 1. This is anticipated to **apply to all** proposed access tracks at the Pinewoods Wind Farm site. *"Floated" Road Construction* Where the peat thickness is in excess of 1.50m, "floated road" construction is considered to be more effective than excavation. This method of construction **is not anticipated to be applicable** for any proposed access roads at Pinewoods Wind Farm.	Analysis of available topographic information and peat depth data gives the following assessment at each proposed turbine location. *Excavations* At turbine locations T1, T2, T3, T4, T5, T6, T7, T8, T9, T10 and T11, the substation and the permanent meteorological mast, the combination of negligible to shallow peat thickness and low to moderate slope gradient is not considered to give cause for concern. Consequently, these proposed locations can be classified to have INSIGNIFICANT RISK. The designation INSIGNIFICANT RISK does not however mean that the risks of constructing within environments where PEAT is present can be ignored. These designations all make the assumption that the general procedures outlined in the ***Mitigation*** section will be adopted and implemented fully during the construction period.

Table 2 – Summary of Peat Slide Analysis for Pinewoods Wind Farm

These potential risks have been used to calculate a risk ranking, based upon the following:-

Hazard: *Likelihood of the peat slide event occurring*

(This relates to the potential for a peat slide to be triggered. Factors considered include the topographic slope, peat thickness, strength of peat, type of peat present and method of construction proposed.)

The table below gives a general view of some of the factors used to establish HAZARD:-

Scale of Risk	***Hazard***
0	*Peat not present and average slopes < 5 degrees to the horizontal*
1	*Peat less than 2.50m thick and slopes < 5 degrees to the horizontal*
2	*Peat less than 2.50m thick and slopes 5 – 10 degrees to the horizontal* *Peat 2.50m to 4.00m and slope < 5 degrees to the horizontal* *Where peat cover is greater than 1.50m, the construction of "floated" roads is recommended*
3	*Peat 2.50m to 4.00m thick and slopes > 5 and < 10 degrees to the horizontal*
4	*Peat 2.50m to 4.00m thick and slopes > 10 and < 22.5 degrees to the horizontal* *Peat > 4.00m thick and slopes > 5 and < 10 degrees to the horizontal*

Table 3
Qualitative assessment of Peat Slide Hazard

Exposure: *Impact that such an event might have at this particular location*

(This relates to the receptor in the event of a peat slide. This can range from adjacent areas of blanket bog, to farmland, watercourses, water abstraction sites, roads, un-occupied structures and occupied structures.)

The Scottish Guidance assesses exposure in terms of impact, e.g. Very Low Impact to Extremely High Impact, but does not state directly what receptors are of concern. In fact the guidance leaves this determination very much up to the consultant / engineer. The two receptors identified by the Scottish Guidance are potential for "Financial Impact" and / or "Environmental Impact".

The nature of these EXPOSURE receptors is often debated by consultants. The chosen rationale promoted in this report is as follows:-

1. The main purpose of this report is to determine the risk to 3rd parties. That is infrastructure, structures and environmentally sensitive receptors, such as watercourses and protected zones.

That being the case, the individual EXPOSURES employed and their relative weighting are summarised in Table 4, below.

The table below gives a general view of some examples of the factors used to establish EXPOSURE:-

Scale of Exposure	*Examples of Determining Factors*	*Impact upon total project*
1	*Flat agricultural land or blanket bog within 100m of structure or 50m for roads* *(i.e. Structure >100m or site tracks >50m from an unspecified environmental receptor, such as an undesignated stream,*	*Very low Impact (< 1%)*
2	*Structure <100m from minor water course or other sensitive landform or <50m for site tracks*	*Low Impact (1% - 4%)*
3	*Structure or site tracks <100m from receptor of high environmental sensitivity – e.g. major designated water course, or uninhabited buildings, minor roads, public utilities*	*High Impact (4% - 10%)*
4	*Structure <100m from major public road, area of special scientific interest, sensitive buildings, water abstraction etc.*	*Very High Impact* *(10% - 100%)*
5	*Structure <100m proximity to temporary or permanently inhabited buildings, important commercial property, areas of public congregation*	*Extremely High Impact* *(> 100%)*

Table 4

Qualitative assessment of Peat Slide Exposure

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

By assessing each peat slide event against the scales given above, it is possible to assess the hazard ranking by multiplying the hazard and exposure of each event.

This results in a Hazard Ranking value as follows;

HAZARD RANKING = HAZARD x EXPOSURE

The following table outlines the suggested action for the different levels of hazard ranking. The rationale employed to determine the relative severity of Hazard Rankings is based upon the Scottish Guidance.

Hazard Ranking	*Hazard Ranking Level*	*Action Suggested*
≥17	**Serious**	Avoid project development at these locations
11 – 16	**Substantial**	Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to significant or less.
5 – 10	**Significant**	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations
0 – 4	**Insignificant**	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

Table 5

Hazard Ranking and Suggested Actions (Refer to “*Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments*”, December 2006)

The following table summarises the relative Hazard Ranking of each Turbine and structural location to be constructed at Pinewoods Wind Farm.

ID	Co-ordinates		Peat Slide Hazard Ranking
	Easting	Northing	
T1	251604	182460	1
T2	251693	182105	1
T3	251676	181781	0
T4	250937	181833	0
T5	251205	181628	1
T6	250756	181489	1
T7	250403	181186	1
T8	250682	180984	0
T9	250742	180675	1
T10	250826	180372	1
T11	250276	180413	0
Substation	250435	182335	0
Met Mast	250890	182093	1

Table 6
Hazard Ranking for each proposed structural location at Pinewoods Wind Farm

2.4 Site Features

The site is relatively flat and is serviced with an extensive network of drains. The terrain consists mainly of good to rough pasture with rushes prevalent. Shrubs and small trees, along with moderately large areas of dense juvenile forestry, are present throughout the proposed site.

Turbines T1, T3, T4, T7, T11, the Met Mast and Substation are situated within agricultural pastureland.

Turbines T5 and T6 are positioned within existing juvenile forestry.

Turbines T8, T9 and T10 are located within forestry.

Turbine T2 is located within an area of rough “boggy” land adjacent to agricultural pastureland.

2.5 Peatland Disturbance, Soil Removal and Drainage

Ecological mapping was undertaken at the Pinewoods site previously by other consultants. Low slope gradients are to the advantage of the proposed development in terms of ground stability and reduced potential for pollution run off into surface water systems.

A relatively extensive network of existing man-made surface drainage channels currently services the site.

3.1 CHARACTERISTICS OF THE DEVELOPMENT

The proposed Pinewoods Wind Farm development includes the following aspects:

- Excavation and construction of 11 Nr. turbine base foundations, each approximately $324m^2$, with a minimum excavation depth of 2.65m below existing ground level.
- Construction of 11 Nr. hardstanding areas of approximately $1,000m^2$.
- Erection of 11 Nr. wind generating turbines of hub height 82m, rotor diameter 103m and a maximum overall height not exceeding 136.50m.
- An electrical substation of $8000m^2$ in area.
- Construction compound of $1,400m^2$ in area.
- 1 Nr. permanent meteorological mast.
- Construction of approx. 7,400m of 5.00m wide site access tracks.
- Upgrade of existing site access tracks.
- Installation of underground electrical cabling.
- Overall development site area of approximately 18.42 hectares.

These development changes will consist of the following earthworks excavations and movement:

- Excavation for turbine foundations / bases and hardstanding areas.
- Excavation for substation building and compound.
- Site tracks will be installed to facilitate the transport of turbine components and turbine maintenance.
- No site access tracks are proposed to be constructed using “Floated road” techniques.

4.1 Potential Impacts as a Result of the Proposed Development

4.2 Construction Phase without mitigation

4.2.1 Earthworks Activities

Implementation of the proposed development will result in the removal of peat in parts of the subject site to facilitate construction of site access tracks and foundations for the wind turbines to a competent bedrock or substrate foundation.

Analysis of peat depths recorded along proposed site tracks and turbine locations indicates a range of 0.00m to 1.90m across the Pinewoods development area with an average peat / organic topsoil depth of 0.40m within the construction zone.

Assuming average peat / organic topsoil depths prevail across the construction footprint, the volume of peat to be extracted is estimated to be approximately 22,110m^3.

Assuming an average depth to competent bearing stratum of 0.50m for tracks, 1.00m for hardstandings and 2.50m for turbine foundations, the volume of drift / glacial soil to be extracted is estimated to be approximately 21,780m^3.

Ground conditions vary across the site with a fluctuating peat cover due to the site's exposure and underlying bedrock topography. At the turbine bases, excavations deeper than 3.00m may be required to achieve a suitable, stable foundation. Where rock is ultimately present at shallow depth (i.e. < 2.00m below existing ground level), rock excavation may be required.

4.2.2 Potential for Bog Failure

Site investigations did not reveal any evidence of peat failure or bog bursts within the proposed development area.

Consideration has been given to the potential for bog failure at the Pinewoods Wind Farm site.

These mass movements of peat can take the form of either bog burst or bog slide. Historical evidence suggests that raised bogs are more prone to bog bursts while bog slides are more common on blanket bogs. Because of their peculiar topography, geology and hydrology, certain upland areas are especially prone to bog failure[1].

These peat failures generally occur either during or immediately after periods of heavy rainfall. Failures are especially likely to occur where there is a break of slope at the edge of an upland plateau of peat. Records indicate that bog bursts naturally occur on shallow slope angles varying between 3 and 6 degrees while bog slides generally occur on slopes that are greater than 6 degrees.

Following well documented bogslides on the slopes of Dooncarton and Barnachuille mountains, Co. Mayo in September 2003 and more significantly at Derrybrien, Co. Galway in October 2003, the potential for bog failure has come to the fore in consideration of planning for a wind farm development. The following potential causal factors for bog failure are identified following research and assessment of recent slides and from historical evidence over the last 200 years in Ireland.

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

[1] Feehan, J. and O' Donovan, G. (1996) *The Bogs of Ireland - An Introduction to the natural, Cultural and Industrial Heritage of Irish Peatlands*. University College Dublin, The Environmental Institute

2. The following criteria are considered to be the causal or contributory factors to bog slide occurrence:

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

(b) The **depth of peat** and its relationship to humification (the degree to which the fibre structure of the peat has decayed), pore water pressure, shear vane strength and other parameters generally indicates that the deeper the peat profile the more unstable it is, if external controls such as slope, drainage, removal of adjoining earth materials are changed. Exact depth threshold of stability are not applicable due to the variability of peat environments (raised bog, blanket bog or fen habitats) and their site specific conditions. However, as a rule of thumb peat of depths greater than 2.00m are significantly more vulnerable to instability than shallower peat at < 1.00m depth, and in particular the top-layer of acrotelm (living) peat at < 0.30m.

(c) The pattern of **recent precipitation** such as intense localised rainfall (or melting snow) is an important trigger mechanism.

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

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

Finally the following items are noted:

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

The possibility of peat slide occurring is considered to be an unlikely event at the proposed Pinewoods Wind Farm site. There are no published records of bog failures at the subject site.

4.2.3 Water Quality

The following impacts both likely and potential are identified:

(a) Suspended solids release during excavations

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

The most vulnerable areas to surface water quality deterioration are (a) access road crossings of man made drains and (b) turbine hardstand and infrastructure development at moderate gradient slopes proximal to existing waterways, which this site should not be threatened by as it has relatively low gradients and no natural waterways near turbine locations.

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

4.3 Operational Phase

4.3.1 Change to Hydrological Regime

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

4.3.2 Water Quality

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

4.4 "Worst Case" Scenario without mitigations

The worst-case scenario without the implementation of mitigation measures which may arise from the proposed development could include:

(a) Sudden slope failure, by shearing, giving rise to a debris flow. Where this debris flow occurs on a slope all elements down slope are potentially at risk.

Such ground movements have the ability to cause disruption to construction works; loss of plant and machinery; structural damage; loss of life and ultimately major financial loss.

(b) Pollution of waters may occur due to suspended solids, which will be temporary and short term, hydrocarbons (medium term), nutrients and waste (medium-term).

Overall the groundwater is unlikely to be affected due to the natural attenuation processes by overlying substrates. The net results would be temporary pollution and deterioration of surface waters.

Long-term changes to the hydrological regime are likely to occur. These effects will include local drying out of some areas of the site by introduced drainage and wetting of other areas by soakaways or buffered outfalls.

5.1 MITIGATION MEASURES

Ecological and peat depth investigations at this site have indicated low to moderate slopes and negligible to shallow peat areas. These areas have been taken into consideration as part of the design of the development.

Avoidance of construction within the proposed buffer zones will be adhered to, reducing potential for adverse impacts.

5.2 Construction Phase with mitigation

5.2.1 Earthworks Activities

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

It is noted that the “natural hydrology” of parts of the site have been previously altered by man-made land drainage. That notwithstanding, measures will be put in place to minimise any additional impact to the existing site hydrology, that would otherwise result from the construction of the wind farm.

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

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

5.2.2 Potential for Bog Failure

Construction Mitigation of Risk

<u>General Constraints and Anecdotal Evidence</u>

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

1. Excessive quantities of spoil loaded onto sensitive peat covered sloping ground. (In such cases the gradient of the slope should be no more than an average of 5 degrees to the horizontal). Where peat is not of a sensitive nature, as is the case at the Pinewoods site, it will be possible to load spoil onto slopes up to a maximum of 10 degrees to the horizontal.
2. The angle of repose of the cut face of excavations is all too often found to be too high, sometimes 70 – 80 degrees to the horizontal. Battering back the sides of an excavation to approx. 45 degrees helps to reduce the potential for slippage, which will significantly reduce the potential for movement.
3. The consequences of peat slide can be identified as Damage to Machinery, Damage or Loss of Site track, Damage to Site Drainage, Site Works Damaged, Death or Injury to Personnel or Degradation to the Environment.

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

Prevention of Peat Slide and Bog Burst

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

1. Excavated spoil will not be deposited on the down slope or up slope edges of the adjacent peat. This spoil will instead be deposited on the two flanks either side of the excavation where gradient is least.
2. Bog Burst is recognised to be a difficult condition to mitigate against. Bog Burst tends to occur within deep peat (> 3.00m thickness) after very heavy or prolonged precipitation. To ward against this possibility the design of turbine bases should be engineered to ensure that excavations do not cut into deep peat (> 2.50m). This does not apply to the proposed Pinewoods Wind Farm site.
3. The hardstandings surrounding the turbine bases should be designed in a manner such that crane loadings can be transferred directly onto the competent strata underlying the peat soils. In order to facilitate these works it will be necessary to undertake limited excavations.
4. Movement can often occur during or following severe rainstorm events, particularly when following a prolonged dry spell. Extra vigilance will be maintained at such times, during construction.
5. All slopes will be regularly checked for development of tension cracks.
6. Extra care will be taken where the peat has previously been tilled. Note; during site visits there was evidence of peat harvesting at the proposed site.
7. Method statements will be followed at all times.
8. Slopes will not be undercut or excavations left unsupported for periods in excess of 24 hours. Excavations are to be backfilled as soon as practicable. Excavation and filling operations shall be coordinated to minimise the time an excavation remains opened.
9. Pore water pressure within excavations should be kept low at all times by draining deliberate or intentional sumps at regular intervals. This is to prevent ponding of water within excavations which can in turn increase hydraulic heads locally and potentially lead to instability.
10. The potential for Peat Slide will be monitored regularly during the construction works, by means of regular site visits and assessments, by a suitably qualified and experienced professional.
11. Site staff will also undergo induction training to learn about the risks associated with working on “upland environments” and procedures aimed at reducing Peat Slide risk.

Storage of Surplus Excavated Material

Surplus excavated material will invariably be generated during excavations for foundations at turbines and along new site tracks.

Minimisation of the production of this excess excavated material will be treated as a high priority, but it is nevertheless expected that there will be in the region of 22,110m^3 of peat / organic topsoil and 21,780m^3 of glacial spoil excavated during site works.

The above figures have been derived from calculations assuming the following:

- Average peat depth of 0.40m across the site, an excavated depth of approx. 2.50m to rock / suitable bearing strata at turbine base locations and an average excavated depth of 1.00m of glacial soils at hardstandings and met-mast location, 2.25m at the substation and 0.50m at the compound.
- Excavated areas at turbines and hardstandings of $324m^2$ and $1,000m^2$ respectively.
- Excavated area at substation and compound of $8000m^2$ and $1,400m^2$ respectively.
- Excavated area at met mast location of $330m^2$.
- Excavated access track area estimated to be approximately $37,000m^2$, with an average excavated depth of 0.50m.

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

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

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

This is described further as follows:

Glacial soil:

1. Surplus excavated glacial soil should be permanently stored at a pre-designated site, preferably close to the temporary compound and / or turbines and other infrastructure.
2. Each storage area will be clearly defined on a site drawing and clearly identified on site.
3. Glacial soil will be deposited, in layers of 0.50m and will not exceed a total thickness of 2.00m.
4. Glacial soil will only be deposited on slopes of < 10 degrees to the horizontal and greater than 10m from the top of a cutting. The exact location of such areas will be determined in consultation with the geotechnical specialist.
5. All storage areas shall be located outside of the watercourse / environmental buffers.
6. A Glacial Soils Stability Register will record the location of each storage site used and regular weekly assessment will be made by the construction manager or other suitably qualified individual.
7. Once construction is complete the storage site should be landscaped (including landscaping of the temporary compound area) and re-vegetated with either the "Top Mat" removed at the commencement of storage operations or re-seeded as directed by the Ecologist.

Surplus excavated peat:

1. Surplus excavated peat / organic topsoil will be stored in a designated area adjacent to each individual structure or the temporary construction compound, on slopes of < 10 degrees to the horizontal and outside areas of environmental constraints (i.e. within watercourse buffers as delineated in the Hydrology and Hydrogeology Report).
2. Surplus peat will only be deposited on slopes of < 10 degrees to the horizontal and greater than 10m from the top of a cutting. The exact location of such areas will be determined in consultation with the geotechnical specialist.
3. In the vicinity of site tracks which are constructed using an excavated technique, surplus excavated peat shall be temporarily stored immediately adjacent to the site track and following the completion of sections of site track construction shall be

carefully placed along track side verges.

4. The "Top Mat" of the peat will be transplanted to a pre-designated area and maintained for re-use during restoration operations.
5. Surplus peat will be deposited, in layers of 0.50m and will not exceed a total thickness of 2.00m. This surplus peat will be used to reinstate trackside verges and any areas used for temporary deposition of material during construction.
6. Surplus peat storage should be avoided in areas where underlying peat is thicker than 2.00m.
7. A Peat Stability Register will record the location of each storage area used and regular weekly assessment will be made by the construction manager or other suitably qualified individual.

Once construction works are complete the storage sites will be re-vegetated with either the "Top Mat" removed at the commencement of storage operations or through re-seeding.

6.0 CONCLUSION

Appraisal of the Hazard Rankings for each proposed turbine and structure location indicates that the site (encompassing turbines T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and the electrical substation and permanent met-mast) carry **INSIGNIFICANT** Hazard Rankings as determined in accordance with the guidelines outlined by The Scottish Executive & Halcrow Group Ltd in "*Peat Slide Hazard and Risk Assessment - Best Practice Guide for Proposed Electricity Generation Developments*", December 2006.

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

In the case of the proposed Pinewoods Wind Farm the thickness of sensitive peat appears to be <2.00m, although thicker sequences of peat may be present in certain areas.

Regardless of the above the Hazard Ranking attributable to the access roads is anticipated to remain **INSIGNIFICANT**, according the Scottish Executive guidance.

The Pinewoods Wind Farm site is suitable for development as proposed. Peat slide risk assessment has indicated an INSIGNIFICANT risk of instability in relation to the structural aspects of the proposed development.

This report has been prepared on behalf of Galetech Energy Developments Ltd and Pinewoods Wind Ltd

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