14. GEOLOGY & SOILS

Additional information relevant to Section 14 is presented in Appendix H in Volume 2 of 3 of the EIS.

14.1 RECEIVING ENVIRONMENT

14.1.1 Geology

Description

The area appears on the Geological Survey of Ireland (GSI) Sheet No. 21, Geology of Kerry-Cork.

Published geological mapping from the GSI is presented in Figure 14.1. This shows the underlying bedrock at the turbine locations comprises purple siltstone and fine sandstone from the Bird Hill Formation. A small section of the northern end of the site comprises cross bedded sandstone and siltstone of the Slaney Sandstone Formation.

Table 14.1: Bedrock Geology

Formation	Description
Bird Hill Formation	Purple-to-grey and grey-to-green fine grained sandstone units usually of less than 1 m thickness with generally massive purple siltstone units of up to 2.5 m thickness.
Slaheny Sandstone Formation	Alternating purple siltstone rich sequences and medium to coarse grained green to grey micaceous sandstones with occasional intra-formational conglomeratic units.

The geological structure found in the bedrock beneath the site is the Beara Anticline, which has an approximate west-east axis. Faults of various orientations are present within the vicinity of the site, but are only indicated to occur in the bedrock beneath the site in the site's northeast quadrant.

Geomorphology features are typical of a glacial valley. Natural gradients vary according to the near surface geology. Bedrock is exposed in steep natural gradients, forming distinctive scarps (50º - 70º). The overburden soils of peat and glacial debris deposit show flatter gradients of 5º - 7º, occasionally with flat surfaces.

The Teagasc soil data and the GSI internet resource indicates that the site generally has a soil covering of blanket peat and where peat is absent bedrock is at or near the surface. However, glacial till is present at low elevation and alluvium may be present along the course of Roughty River. The soil distribution is presented on Figure 14.2.

Soil Contamination

There are no known areas of soil contamination on the wind farm site. As the site is used occasionally by agricultural equipment, it is possible that minor fuel spills and leaks have occurred locally in the past. No areas of particular concern were observed during the site walkover.

Site Instability

GSI has a slope instability database containing locations and details of recorded landslides throughout the Republic of Ireland. Two recorded landslides (Figure 14.3) have taken place within 10 km of Grousemount Wind Farm, as follows:

- Fuhiry: A peat slide took place approximately 4 km northeast of the wind farm site in 1997 following a period of heavy rain and flooding. The slide occurred in a woodland area near an existing road and caused infrastructure damage.
- Gortacreenteen: A debris slide took place approximately 6 km southwest of the wind farm site in 2004 following a period of heavy rain and flooding. The slide occurred near a peat bog area and caused infrastructure damage covering a stretch of over 1 kilometre.

Aerial photographs of the site is available to view on the OS Mapviewer website. Aerial photographs of the site from 1995, 2000 and 2005 were examined and features relevant to the geotechnical assessment were noted. More recent satellite images from Google Maps and Bing Maps were also examined. The aerial photography presents no signs of peat instability on the site or the surrounding areas.

The presence of blanket peat in mountainous and elevated terrain, with recorded recent nearby slides, indicates that the potential risk from slope stability at Grousemount requires consideration by geotechnical specialists.

Geological Heritage

The Irish Geological Heritage Programme is a partnership between GSI and NPWS that aims to identify, document the geological heritage in Ireland within an overall framework of 16 themes, and protect and conserve it.

It has been confirmed that there are no proposed geological heritage sites within the boundary of the development. The nearest such sites, are as follows:

- Ballingeary esker (E513900, N668940), Co. Cork, has been recommended for County Geological Site designation under the IGH 7 Quaternary Theme;
- Gortnabinna (E516220, N571260), Co. Cork, comprising Devonian trace fossils, has been recommended for NHA designation under the IGH 10 Devonian Theme;
- Kilgarvan, Roughty River section (E500970, N573060), Co. Kerry, with shelf sequence and mining heritage, has been recommended for NHA designation under the IGH 8 Carboniferous Theme;
- Morley's Bridge roadcut (E505040, N577060), Co. Kerry, displaying the Glenflesk Chloritic Sandstone Formation, has been recommended for NHA designation under the IGH 10 Devonian Theme.

The locations of the above are shown on Figure 14.3.

14.1.2 Site Conditions

Walkover Surveys

Extensive peat probing has been carried out by specialist staff from ESBI during numerous site walkovers to determine the depth of peat across the site.

The surveys included a general reconnaissance reaching the proposed locations of all turbines, the site tracks, Coomataggart Substation, borrow pits and anemometer masts using a handheld GPS unit. The investigations had the following objectives:

- Assess the ground conditions including peat depth at each location.
- Make notes of all geological features and any physical constraints characterising

each location, e.g. rock outcrops, water channels, steep slopes, etc..

- Assess the general drainage patterns in the area.
- Make observations on the risks of ground movement / landslides arising from construction activities.

Geotechnical Investigation

A site investigation comprising trial pits along the access tracks, at turbine locations and at other infrastructure locations, together with rotary boreholes and geophysics at the locations of the turbines, the borrow pits and the permitted Coomataggart Substation, was commenced by IGSL in Spring 2015. The rotary borehole works on site are ongoing and are expected to be completed by late-Autumn 2015.

A total of 256 trial pits were excavated at the site.

Summary of Ground Conditions

The ground conditions across the site generally comprise peat overlying glacial till over sandstone and siltstone bedrock.

The peat on the site is described as soft, dark brown / black and fibrous with many rootlets which extend into the subsoil layer in places.

- Turbines: Peat depths are less than 1 m at just over 80% of the turbine locations and less than 0.5 m at more than 50% of the turbine locations. Turbine T22 is the only turbine where the peat depth (2.2 m recorded) is greater than 2.0 m.
- Access Tracks: Peat depths are less than 1 m along almost 80% of the proposed access tracks and less than 0.5 m along approximately 50% of the tracks. There are two pockets where peat depths of 2.2 m and 2.4 m were recorded. One location is on the track accessing turbine T30 and the other is on the main track between its junctions with accesses to turbines T24 and T35.
- Coomataggart Substation: Peat depths are in the range 0.4-2.5 m.
- Borrow Pits: Other that at Borrow Pits A & C, peat depths less than 1 m. Borrow pits A & C each have a pocket of deeper peat with depths of 1.4 m and 1.3 m respectively.

An important feature of the peat stability risk assessment is the subsoil condition of the strata located directly beneath the peat layer and the nature of the interface between the peat and the subsoil immediately beneath.

In the majority of the trial pits, soft to firm sandy gravelly silt was encountered directly beneath the peat. The thickness of this stratum varies from 0.2 m to 2 m. There are a few select locations across the site where the peat lies directly on gravel, cobbles and boulders or weathered rock, in particular along the main access track near Borrow Pit E.

Bedrock encountered in the trial pits and the rotary boreholes already completed is sandstone or siltstone. Approximately 80% of the trial pits excavated terminated at a depth shallower than that specified, due to an obstruction of possible bedrock. This depth varied from 0.1 m to 3.5 m below ground level. The borehole records indicate that the quality of the rock appears to improve with depth.

Groundwater was observed at less than 30% of the trial pit locations. Seepage was primarily from ground level and through the subsoil layers on occasion. Where water ingress was noted in the trial pits the side walls became unstable, in particular in cases where seepage was from ground level. Surface water and ground water management will be required during construction.

Data for the turbine and hardstand locations, for access tracks and for other infrastructure are presented in Tables 14.7–14.9.

14.1.3 Borrow Pits

Only competent rock that is not subject to mechanical breakdown will be used in construction of access tracks. Slake durability tests were carried out on rock samples of sandstone and shale/siltstone recovered from borrow pit locations in both the Barnastooka and Grousemount areas of the site. The results of the tests have shown to have slake durability values of between 98.3% and 99.3% after Cycle 1 and between 97.2% and 98.3% after Cycle 2 which classifies the samples as having high to very high durability (after Gamble 1971)[27].

The results confirm those already available for rock samples previously recovered at the site and compare favourably to those available from other wind farm projects carried out by ESB Wind Development (which yielded slightly lower Slake Durability results) where mechanical breakdown and sedimentation issues were not encountered.

14.2 IMPACT OF THE DEVELOPMENT

Construction impacts will arise from the construction of access tracks and cable trenches, turbine bases and hardstandings, Coomataggart Substation and temporary construction compounds. Operational impacts will arise from the increase in low permeability surfaces, on-site access tracks and ongoing maintenance. Impacts during decommissioning relate to removal of the development infrastructure and are similar to construction impacts.

14.2.1 Earthworks

Volumes of Excavation

Spoil will be created from excavated access tracks, the wind turbine foundations and associated hardstandings, and Coomataggart Substation.

Most access tracks will have a finished surface width of 5 m and will have an excavated width of approximately 7 m to allow for side slopes.

Each wind turbines will have a reinforced concrete foundation, the size of which will be determined by structural calculations based on loading information made available by the manufacturer following choice of the turbine model to be installed and the geotechnical conditions. It is currently envisaged that foundations will be approximately 18 m diameter in plan and will require excavation that provides a working area surrounding the foundation to allow placing of shuttering, etc..

The fenced area of Coomataggart Substation will have its surface replaced with gravel or, in some areas, concrete.

Other minor sources of spoil, which will not add significantly to the overall volume of material to be handled, will be the foundation for the anemometer masts and cable trenches for power and control cabling. The latter, which typically will be 0.5 – 1.0 m wide and 0.75 – 1.00 m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with them.

27 Gamble J.C., 1971, Durability plasticity classification of shales and other argillaceous rocks, PhD thesis, University of Illinois

The total volume of materials to be excavated for construction of the various components of the development is estimated as shown in Table 14.2.

Table 14.2: Excavated Materials (in-situ Volumes)

Main Access Tracks	Spur Access Tracks	Hardstandings & Turbines (38)	Coomataggart Substation	Total
174,800 m³	100,050 m³	151,700 m³	28,550 m³	455,100 m³

Given that some of the excavations will be in peat, an average bulking factor of 33% may be applied to calculate the volume of materials to be handled. With a suitable operations plan, earthworks can be undertaken safely and without long-term adverse impact on the receiving environment.

Potential Impacts

Potential impacts of excavations and earthworks could include the following:

- Excavation and removal of subsoils will be necessary at turbine locations and elsewhere. This could have a direct permanent impact on these soils and rock by way of increased erosion and sediment release. The latter could have additional impacts on water courses.
- Excavation and removal of peat in association with other construction activities and external factors, such as heavy rainfall, could give rise to peat instability.
- The uncontrolled stockpiling of material on peat, creating loading in excess of the bearing capacity of the in-situ peat could influence peat failure. However, this will not be permitted.
- Dewatering of excavations with inappropriate disposal of water could lead to erosion, undercutting of slopes or saturation and weakening of materials.

In summary, spoil arising throughout the site that is not re-used in the works will be used in reinstatement of borrow pits or will be re-instated into the landscape.

In some areas spoil material arising form the construction of excavated access tracks will be disposed of locally alongside the tracks as construction progresses. The peaty topsoil will be segregated from the remainder of the material and spoil will be layered into the contours of the existing topography to allow for natural re-vegetation. Excavated subsoil will be placed along the upslope verges and bedded in, to reconstitute a stable and settled ground surface on which natural vegetation can recover. The segregated peaty topsoil will be used to cap the resulting deposits

The spoil material will only be placed upslope of the turbine, cranepad and access track, with these acting to retain any potential movement of the underlying soil. It will be placed at a suitable angle of repose to mitigate the potential for movement following the placement of the material. Spoil will not be deposited on steep or unstable surfaces or slopes and all activities will be carried out in accordance with geotechnical recommendations. .

At the wind turbine bases some of the excavated material will be used for backfilling around the bases once they have been constructed. While detailed design of foundations is not completed, it is expected that they will comprise reinforced concrete pad footings measuring approximately 18 m in diameter.

Additional material arising at each wind turbine will be the excavations for the adjacent hardstanding to be used by cranes in erecting the turbine towers and attaching the turbine blades. Following completion of construction, the hardstandings will be retained on a precautionary basis to provide for the possibility of mobile cranes being required for maintenance activities during the lifetime of the wind farm. Thus, the spoil material arising here will not be backfilled.

The spoil from cable trench excavations will be sidecast on a temporary basis in areas where peat depth is < 0.5 m, with the peaty topsoil being segregated from the remainder of the material. When installation is completed the spoil will be backfilled and any excess material being spread locally. Re-seeding will be carried out if deemed necessary.

14.2.2 Site Stability - Assessment

General

The evaluation of the stability of peat at the site was carried out using a Peat Stability Risk Assessment (PSRA). The PSRA is based on the Natural Scotland Scottish Executive Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments (2006), which has also been recommended in the Irish Wind Energy Association (IWEA) “Best Practice Guidelines for the Irish Wind Energy Industry” (2008), and is supplemented by the experiences of ESBI on previously developed sites. The Scottish Guidelines set out four categories of risk and recommends various mitigation / avoidance actions for each category for each.

Peat stability risk is categorised as insignificant, significant, substantial or serious. Construction can take place in areas where risk categories range from insignificant to substantial with varying mitigation requirements. The insignificant and significant categories represent areas where the risk of peat instabilities are either considered negligible in a standard construction environment or considered manageable by the adoption of specific additional mitigation measures respectively.

14.2.3 Methodology for Peat Stability Risk Assessment

The PSRA quantifies the risk level by assessing the likelihood of a peat instability event and the impact of that event. The risk rating is the product of the likelihood and the impact, as follows:

$$\text{Risk Rating} = \text{Likelihood} \times \text{Impact}$$

The likelihood is evaluated by considering all the available geotechnical, topographical, hydrological and hydrogeological characteristics of the site. The amount of information available depends of the level of site investigation that has been carried out.

Factors that are considered to be indicative of slope instability such as peat depth, subsoil conditions and slope angles, are measured. Other factors that have an indirect affect on peat stability, such as drainage, topography, vegetation, land use and previous peat slides in the locality, are also assessed.

An impact assessment is carried out based on factors related to the volume of peat in a potential peat slide and the effect of a peat slide down slope. These factors include peat volume, downslope topography and sensitivity of ecological environment in environment, infrastructure and buildings in potential flow paths.

In the PSRA, 22 likelihood factors and nine impact factors are scored on a scale of 0 to 3. A score of 0 indicates the factor is not relevant and scores of 1 – 3 are assigned depending on the risk associated with the factor from 1 (low) to 3 (high).

Likelihood factors having the greatest influence on a potential peat failure and impact factors having the greatest influence on the severity of the consequences are given a weighting to reflect their relative importance.

The score for each factor is multiplied by the weighting and the total of all the factor scores is expressed as a ratio of the maximum possible score.

The maximum possible score only includes the factors that have been used in the assessment, i.e. factors with a score of 0 are not relevant and so do not contribute to the maximum possible score.

$$\text{Likelihood Score} = \frac{\Sigma\,(\text{Likelihood Factor Score x Factor Weighting})}{\Sigma\,(3 \text{ x Factor Weighting})^*}$$

$$\text{Impact Score} = \frac{\Sigma\,(\text{Impact Factor Score x Factor Weighting})}{\Sigma\,(3 \text{ x Factor Weighting})^*}$$

*only non zero factors counted

The likelihood and impact scores fall into four categories from negligible to high, as follows:

Table 14.3: Likelihood and Impact Scoring System

Likelihood Score		Impact Score	
0.0-0.3	Negligible	0.0-0.3	Negligible
0.3-0.5	Low	0.3-0.5	Low
0.5-0.7	Medium	0.5-0.7	Medium
0.7-1.0	High	0.7-1.0	High

The risk rating is determined by multiplying the likelihood score by the impact score. The risk rating ranges between 0 and 1 and four risk levels are determined based on the risk rating result. It is to be noted that the score in the risk rating does not indicate the probability of a peat slip occurring.

The risk levels categorisations derive from the Scottish Guidelines – Peat Landslide Hazard and Risk Assessment and are shown in Table 14.4. They are used to determine the level of site investigation required.

Table 14.4: Risk Ratings and Risk Levels

Risk Rating	Risk Level	Action Required
0.0 - 0.18	Insignificant	Normal Site Investigations (SI)
0.19 - 0.42	Significant	Targeted SI. Design of specific mitigation measures. Part-time supervision during construction.
0.43 - 0.66	Substantial	Avoid construction in the area if possible. If unavoidable, detailed SI and design of specific mitigation measures. Full time supervision during construction.
0.67 - 1.0	Serious	Avoid construction in this area.

Insignificant: Essentially there is no peat depth of consequences on site. There is no likelihood of a peat instability occurring and no significant impact. Good construction practice should be followed but no peat stability risk exists. This amounts to areas where peat depth is less than 0.5 m and this is further supported in the Irish document “Best

Practice for Wind Energy Development in Peatlands" issued by the Department of the Environment, Community and Local Government.

Significant: Peat exists on site greater than depths of 0.5 m. However, the combination of the risk of an instability event occurring and impact is relatively low. Good construction practice should be followed with elimination of the risk through mitigation by design. Periodic supervision by a geotechnical engineer is required to ensure adequacy of the designed mitigation.

Substantial: In this case peat depths are greater than 0.5m depth. A number of broad scenarios can occur which will place the risk assessment of a site into the substantial category and are as follows:

- The risk of an instability event is high but the impact of such an event occurring is low (e.g. a depth of peat greater than 1.0m on a north facing slope of 3–7° close by a sensitive river which would be likely to develop a medium volume of peat flow). In this case only a localised impact may occur and no significant impact will occur overall. Further site investigation serves to refine the risk rating. The detailed design is carried out based on this information with specific mitigation measures. Contractors and site geotechnical staff develop method statements to minimise and mitigate the risk which are signed off. It also requires supervision and monitoring of ground conditions by a geotechnical engineer.
- The risk of an instability event is low and the impact of such an occurrence is high, e.g. a depth of peat greater than 1 m on a south facing slope of < 3° but far removed from a sensitive river which, in the case of an instability event, would be likely to develop a large volume of peat flow. In the unlikely event that such an instability event occurs then the impact will be substantial. Mitigation is as above.
- The risk of an instability event is high and the impact of such an occurrence is also high, e.g. a depth of peat greater than 1 m on a north facing slope of 3–7° but far removed from a sensitive river which would be likely to develop a large volume of peat flow. In this case the impact of the occurrence will be substantial.

Serious: In this case peats depths, slope and potential level of impacts are high with the risk of occurrence very high also. Mitigation is generally not possible and it is not therefore possible to reduce the risk to a manageable or safe level. Construction should not proceed at locations with this risk category

Factors Affecting Peat Stability

The following table presents a list of factors that effect the outcome of the peat stability assessment at the site combined with associated comments relevant to the Grousemount site.

Table 14.5: Factors Affecting Peat Stability

Factors		
Factors	**Explanation**	**Comments**
Likelihood Factors - Peat Characteristics		
Peat Depth	This is a critical factor in stability of peat on slopes and is therefore highly weighted	Depth based on peat probes and trial pits.

Factors		
Factors	**Explanation**	**Comments**
Peat Stability Condition	This indicates strength and stability of the peat.	Based on trial pits excavated by IGSL.
Likelihood Factors - Subsoil Conditions		
Subsoil Type	The nature of the subsoil can have an effect on the likelihood of an instability issue, i.e. firm glacial till materials present a lesser risk than soft sensitive soils.	Based on trial pits excavated by IGSL.
Transition Zone and Peat Subsoil interface	The nature of the interconnection between the peat and the mineral subsoil impacts on the stability.	Based on trial pits excavated by IGSL.
Likelihood Factors - Topography		
Elevation	Historically sites with elevations > 200 mOD have been more prone to peat slides.	Elevations at Grousemount Wind Farm are all greater than 200mOD.
Slope Aspect	Slopes to the north, north west and north east present a higher risk of peat instability than to the east, south and west due to increased difficulty in drying.	The turbines, hardstands, roads and other proposed areas of construction at Grousemount Wind Farm are sloping in various directions.
Ground Slope	The angle of the ground slope tends to have a significant impact on the stability of peat slopes and this is therefore highly weighted.	Slopes across the site are generally steep; >10° across a large proportion of the site.
Slope Characteristics Downslope	This includes the nature of the slope, i.e. whether planar or convex and the distance to the break in the slope.	Slope characteristics downslope features are based on LiDar data.
Likelihood Factors – Hydrology		
Distance from Defined Water Course	This facture tends to affect the likelihood of an event with the sites closer to defined water courses presenting more risk.	Measurements to the nearest identified desktop watercourse has been applied.
Surface Water	This factor indicates a high water table level which can suggest a potential for failure.	Based on aerial photography and site walkover.
Direction of Existing Drainage Ditches	Drainage ditches that are aligned cross slope can have an effect on the overall stability of a slope face.	Based on aerial photography and site walkover.
Annual Rainfall	The annual rainfall level for the	Based on Met Éireann rainfall data.

Factors		
Factors	**Explanation**	**Comments**
	site effects how saturated the peat a the site can become and thus effect the strength of the peat, the peat subsoil interface and the load on the peat.	Taken as >1400 mm per annum.
Likelihood Factors - Slide History		
Previous Slides in the Locality	This is relatively heavily weighted and suggests that if a peat slide has occurred at the site or within a 10 kilometre radius then there is a graduated risk of an occurrence at the site. However, this does not account for the relative nature of the site topographies or peat depths.	Two recorded landslides have taken place within 10 km of Grousemount Wind Farm; Fuhiry (approximately 4 km northeast in 1997), and Gortacreenteen (approximately 6 km southwest in 2004). Both slides occurred following periods of heavy rain and flooding.
Evidence of Peat Movement	This factor evaluates the effect of any existing on-site peat movement indicators such as tension cracks.	There is no evidence based on the site walkover.
Likelihood Factors – Others Issues		
Vegetation	This is an indicator of the type of peat at the site and the hydrological nature of the site.	The site predominantly comprises of grasses, rushes and heathers.
Peat working	This factor evaluates the effect of various peat workings on the stability of the peat.	No previous peat working are evident at the Grousemount Wind Farm site.
Existing Road Type	This in an indicator of the depth of peat in the area and the likelihood of some stabilising measures.	There are no existing roads across the majority of the site, however it has been assumed that solid roads would be constructed across the site based on the results of the site investigation.
Time of year of construction	This is linked to the rainfall level at various stages through the year.	A conservative time of year, i.e. late summer / autumn, has been assumed for all locations across the site.
Impact Factors		
Volume of Peat in Potential Peat Flow	This is the most heavily weighted factor of all factors. It is calculated based on the distance from the nearest defined watercourse and the depth of peat in the area.	A medium (1,000 – 20,000 m3) peat flow has been calculated for a failure at each of the locations analysed.
Downslope features	This factor accounts for the type / shape of down slope features.	Downslope features are based on LiDar data. Downslope valleys exist across the majority of the site.
Proximity to Defined	This is the distance from the site	Distance taken from topographical

Factors		
Factors	**Explanation**	**Comments**
Valley	to the nearest defined river valley.	maps.
Valley profile	This factor accounts for the shape of the valley of the river in question.	Profiles are generally steep across the site.
Downstream Aquatic Environment	Reflects the severity of the impact a peat slide event would have on the receiving aquatic environment.	Assumed to be sensitive throughout the site due to the River Roughty, and important fishery.
Public Roads In Potential Peat Flow Path	Rates the impact of a peat slide striking a public road.	There are a number of regional and local roads near the northern section of the main wind farm site. At the majority of locations assessed it has been deemed that a peat slide would strike watercourses prior to striking existing roads.
Overhead Lines In Potential Peat Flow Path	Rates the impact of a peat slide striking a service line.	There are a number of low voltage electricity lines near the north-eastern section of the main wind farm site. At the majority of locations assessed it has been deemed that a peat slide would strike watercourses prior to striking existing overhead lines.
Buildings In Potential Peat Flow Path	Rates the impact of a peat slide striking a habitable structure.	There are a number of residential dwellings near the north-eastern section of the main wind farm site. At the majority of locations assessed it has been deemed that a peat slide would strike watercourses prior to striking existing buildings.
Capability to Respond (access and resources)	Rates the capability of the site staff to respond to a peat instability event.	Assumed to be good based on site facilities during construction.

Assessment Areas

A PRSA has been applied at each turbine and hardstand location, at individual sections of access track at other infrastructure locations where this is found to be the case. As outlined in the Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments, areas with a peat depth of 0.5 m or less do not require a PSRA to be carried out.

14.2.4 Cumulative Impacts

Cumulative impacts of Grousemount Wind Farm and Coomataggart Substation have been considered herein. There is no potential for impacts of the underground cable form Coomataggart Substation to ESB Network's Ballyvouskill Substation on geology and soils.

14.3 MITIGATION

14.3.1 Spoil Management

The primary considerations in the management of earthworks at the site will be as follows:

- Ensuring the geotechnical safety of the site.
- Protecting the aquatic environment by preventing sediment laden surface water runoff to watercourses.

A further aspect of earthworks management will be to minimise and control dust from the site (see Section 13).

A spoil management strategy has been developed to store the vast majority of peat within excavated borrow pits and bunded peat repositories on the site so that the risk of a peat slide from uncontrolled peat storage is negligible. The quantities of stone to be excavated from each of nine proposed borrow pits / repositories across the site, and quantities of peat and spoil to be returned to each location have been calculated.

A small amount of the excavated peat (up to 69,000m^3) will be sidecast on the site up to a maximum height of 1 m in areas with gradients of 5° or less. The remaining volume of excavation is approximately 386,000 m^3.

Nine borrow pits (BP-A to BP-I) are located across the site. It is proposed to construct an engineered rockfill berm on the downslope side of six of these (BP-A, BP-B, BP-D, BP-G, BP-H and BP-I) to create peat repositories.

The peat storage capacity of the repositories and the peat produced from the site infrastructure construction has been calculated using AutoCAD Civil 3D combined with LiDAR, survey, probe data and site investigation results. The storage capacity of each of the repositories is summarised in Table 14.6.

Table 14.6: Peat Repository Storage Capacity (m^3)

BP-A	BP-B	BP-D	BP-F	BP-G	BP-H	BP-I	Total
104,750	72,000	137,000	51,750	90,000	46,250	54,500	556,250

With a total excavated volume of approximately 455,000 m^3, sidecasting of approximately 69,000 m^3 of material and applying a bulking factor of 33% to the remaining material, the required storage capacity is approximately 514,000 m^3. The storage capacity is fully adequate to meet requirements.

14.3.2 Mitigation - Design and Implementation

The general process for risk mitigation that is applied in such sites is demonstrated by the flow chart in Figure 14.4. The level of site investigation, design and control varies in order to minimise the risk as the project progresses through different stages; from pre-planning to detailed design to construction to operation and maintenance.

The process can be summarised as follows:

Pre-Planning Phase

Tasks for the pre planning phase are as follows:

- Carry out a desk top study of the site and a preliminary site investigation.
- Carry out a PSRA for the site based on the site investigation and desk top study.

- Define a risk category for the site based on the PSRA so that the minimum requirements for the detailed design and construction phase are determined or the site is rejected based on severity of peat instability risk.

Detailed Design

Tasks for the detailed design phase are as follows:

- Carry out detailed site investigation if required by the PSRA inclusive of in-situ testing and laboratory testing in specific risk areas on the site.
- Develop a Geotechnical Risk Register (GRR).
- For the site to encapsulate all geotechnical risks associated with the areas of the site in question. This will include, if required, a Zonal Peat Stability Assessment (ZPSA) to determine the revised risk at specific areas identified by the PSRA based on the detailed design and detailed site investigation. A ZPSA involves dividing the site up in to areas chosen where ground and hydrological conditions are similar and/or where the construction methodology is similar. A detailed risk assessment is then carried out by a multi-disciplinary team including Engineering Geologist, Engineering Geomorphologist, Geotechnical Engineer, Hydrogeologist / Hydrologist and Ecologist.

These zones then become distinct units in the construction programme for which separate permits are required. The certification is provided by the Client appointed Geotechnical Engineer / Site Geotechnical Supervisor. The certification and supervision procedures used during construction are described below in the Construction Phase.

- Determine specific detailed mitigation measures that will be included in the construction process for each section of work.
- Develop a Materials Management Plan (MMP). The purpose of an MMP is to quantify accurately the volume of material for disposal due to the development. Estimates of the volume of peat generated in construction are made during the pre-planning phase. These estimates will be re-visited in the design phase as the detailed site investigation will provide better information and enable more accurate estimates to be made. The in-situ volume will be factored to take account of the bulking of excavated materials.
- Include outcomes of the detailed design process in the tender documentation to ensure that contractors are aware of the risks associated with the site.

Construction Phase

Tasks for the construction phase are as follows:

- The Client's Geotechnical Engineer will provide a Geotechnical Induction to all contractor supervisory staff.
- The Client will appoint a Site Geotechnical Supervisor to carry out supervision of site works as required. The Site Geotechnical Supervisor will be required to inspect that works are carried in accordance with the requirements of the ZPSA, identifying new risks and ensuring all method statements for works are in place and certified.
- A Site Geotechnical Folder will be retained and it will contain all the geotechnical aspects of the site including but not limited to GRR, site investigation information, method statements etc.

- The Contractor will develop a Method Statement for the works to be carried out in each of the ZPSA areas cognisant of the required mitigating measures.
- Client's Geotechnical Engineer / Site Geotechnical Supervisor to approve the method statement via a Geotechnical Approval Certificate.
- Contractor to provide tool box talks and on site supervision prior to and during the works.
- Daily sign off by supervising staff on completed works.
- Implementation of emergency plan and unforeseen event plan by the contractor.

Operation and Maintenance Phase

Tasks for the operation and maintenance phase are as follows:

- Residual peat risk will be communicated to appropriate site operatives.
- Ongoing monitoring of residual risks and maintenance will be undertaken as required. This will consist of regular inspection of drains to prevent blockages, inspections of specific areas after a significant rainfall event.

The tasks identified in the pre-planning phase have been carried out for this development.

14.3.3 Mitigation Measures - Preliminary Design

A comprehensive PSRA for the development has been carried out at the preliminary design stage and it has advised on the layout of the access roads, turbines and crane hardstandings taking the results into account in order to reduce peat stability risks. The following mitigation measures have been implemented:

- A comprehensive desk study and ground investigation was carried out to characterise the peat and subsoil conditions across the site and to identify peat stability risk factors, including topography, hydrology and hydrogeology.
- Earthworks volumes were calculated using the site investigation data, LiDar and Autocad Civil 3D software.
- The site layout has been optimised during the detailed site investigations to avoid or minimise risks identified; e.g. realigning access tracks to areas of shallower peat.
- Peer review by a specialist independent geotechnical engineer with adequate specialist experience in construction on upland peat sites indicating that the peat stability risk assessments were carried out to industry best practice and that the lowest risk methodology is proposed for storing peat. The letter of review is presented in Appendix H.1.

14.3.4 Mitigation Measures - Detailed Design

As the project proceeds into the detailed design stage, ongoing detailed site investigation works will be completed and these may identify new risk. Comprehensive site investigation has been carried out to date to enable the completion of peat stability risk assessments, with all trial pitting works completed. Rotary borehole works are currently ongoing on site, the results of which will enable detailed design of the works.

The following mitigation measures are recommended during the detailed design stage:

- A Geotechnical Risk register (GRR) will be developed for the site.

- All tracks will be solid construction unless approved by a geotechnical engineer.
- The formation levels for turbines will be finalised following the availability from rotary boreholes of confirmed depths to rock. The results of the completed trial pit excavations indicate that piling will not be required and that conventional spread footings on either stiff glacial till or weathered rock will be adequate.
- A detailed materials management plan will be developed following detailed design and it will specify where material excavated from each turbine or section of access track is to be disposed.
- Side casting of materials, where permitted, will generally take place upslope of roads or as approved by the Site Geotechnical Supervisor.
- A Zonal Peat Stability assessment (ZPSA) will be carried out for each turbine, section of access track and all infrastructure on the site. This peer reviewed peat stability risk assessment will be carried out following the detailed site investigation, and it will incorporate inputs of geotechnical, hydrology and other experts.

14.3.5 Construction Mitigation Measures

Documentation

Construction works in areas of significant risk, where required by the ZPSA, will be strictly controlled by the Client's Site Geotechnical Supervisor and other site supervisory staff. The following Quality Assurance procedures will be implemented:

- The Contractor will be supplied with a GRR detailing geotechnical risks.
- Construction methods will be directed by the Client's Geotechnical Engineer / Site Geotechnical Supervisor and strictly adhered to by the Contractor.
- The Contractor will produce a Method Statement for work in peat, taking due account of the peat related risks and other geotechnical risks detailed in the GRR. This will be approved by the Client's Geotechnical Engineer, who will issue a certificate to that effect.
- No work in peat will take place without a Geotechnical Approval Certificate.
- the Contractor's operatives will receive a toolbox talk prior to commencing work in peat areas.
- Excavation in peat areas will be subject to appropriate supervision by the Site Geotechnical Supervisor, depending on the outcome of the GRR and the ZPSA.
- A daily record of peat excavations will be completed by the Site Geotechnical Supervisor. Any new risks that come to light will be communicated to the Geotechnical Engineer.

Construction Control Measures

The following control measures will be enforced during construction in areas of deep peat:

- No stockpiling of materials or parking plant on peat will be permitted.
- Tracking machinery on peat will be minimised.
- Length of unsupported excavations in peat will be minimised.
- Side slopes of cuttings in peat will be trimmed back to stable permanent side slopes. In soft potentially unstable peat a berm of mineral soil will be constructed

across the top of the cutting slopes to support the peat face.

- No work will be carried out down slope of a peat excavation at any time.
- Water build up in excavations will to be avoided.
- Peat excavations will not to be left unsupported for extended periods or overnight.
- The use of vibrating rollers will not be permitted in peat areas.
- Stringlines with posts will be required at 10 m centres downslope of access tracks and turbines in peat. They will be installed prior to commencement of construction and remain in place for the duration of the works to monitor potential movements.
- Upslope cut-off drains will be installed in advance of construction.
- The existing drainage patterns in the peat will be maintained as far as is practicable.
- There will be no uncontrolled discharges of water onto peat.
- If there is any deviation from the agreed work methodology, or if work practices are unsafe, the Site Geotechnical Supervisors will give instructions to the Contractor's Supervisor or directly to the Site Operatives.
- The Site Geotechnical Supervisor will suspend work if work practices or weather conditions are unsafe.

14.3.6 Mitigation Measures - General Spoil Management Risk

Controlled handling and deposition of excess peat and mineral soil from all excavations is an integral component of peat stability risk management for a wind farm site. Uncontrolled deposition of spoil and excessive loading on peat in high risk areas can lead to a bearing capacity failure or a large scale translational peat slide due to the increased shear stress at the base of the peat under the applied surcharge load.

To reduce the risk of a peat slide due to spoil management, the following general risk mitigation measures will be adopted:

- Peat and mineral soil will be stored in borrow pits and repository areas secured with rockfill bunds.
- No permanent sidecast storage of mineral soil will be permitted on the peat.
- Sidecasting of peat will be to a maximum height of 1 m on gradients of 5° or less. Boundary markers will be used within the sidecasting area to control the extent and depth of excavated peat placed during sidecasting. The sidecast peat will be spread evenly over the surface of the slope to promote runoff and to prevent ponding of rainwater in the remoulded peat. Interceptor drains will be constructed upslope from the sidecast peat to prevent the peat from becoming saturated from surface runoff.
- Excavated peat will be inspected by the Geotechnical Engineer To ensure that it is stable on the slopes at the time of deposition, and it will be monitored for signs of creep or movement over the course of construction. The highest risk arises in the short term when the remoulded peat has been freshly placed on the slopes. Over time the material will dry out and re-vegetate, which will improve the strength and stability of the excavated material, allowing the peat to regenerate.

14.3.7 Mitigation Measures - Specific Spoil Management Risk

The peat storage capacity of the repositories and the peat produced from the site infrastructure construction was calculated using AutoCAD Civil 3D combined with LiDAR, survey, probe data and site investigation results.

Repositories

Six of the nine borrow pit locations which have been designed as repositories (BP-A, BP-B, BP-D, BP-G, BP-H and BP-I) will have engineered rock fill embankments on their lower sides to contain the peat and mineral soil stored within them. The berms will be constructed on the firm ground below the peaty layer, thereby acting as a shear key against failure. The outer embankment slopes will be formed at 1V:1.5H and the inner slopes to 1V:1H.

The peat and mineral soil will be placed in the repository areas by end-tipping from dump trucks at suitable access points off the site tracks or perimeter berms. The material will then be spread out across the deposition areas using long-reach excavators on the berms and with wide-tracked excavators suitable for working on the intact material. The spoil material will be supported by the rock fill berms at all times. No material will be placed in the repositories until the downslope rock fill berms have been constructed. The final surface of the placed peat (< 2°) will be much flatter than the existing peat slopes.

The repositories are located in areas of low peat instability risk when the appropriate mitigation measures are applied.

Figure 14.5 shows an example of the successful storage of peat on an existing ESBI designed wind farm for ESB Wind Development.

Cut Slopes in Peat

Where peat is exposed on permanent slopes in cuttings it will be trimmed back to stable slopes of 1V:1H or flatter. For deeper peat or where the peat is too soft to trim it back to permanent slopes of 1V:1H, a berm of rockfill will be constructed along the edge of the slope to support the peat.

Temporary support will be provided to the sides of the turbine excavations during their construction, unless the sides can be battered back to a stable temporary slope for the duration of the turbine construction.

In relatively shallow peat, typically less than about 2.0–2.5 m deep, where the peat strength and groundwater conditions are favourable it is often possible to trim the sides of the excavation in peat back to stable slopes of about 1V:1H to 1V:3H.

Figure 14.6 shows an excavation in peat up to about 2.5–3.0 m deep during construction of an ESB Wind Farm site in Co. Tyrone where the peat conditions were very favourable and the sides were trimmed back to temporary slopes of about 1V:1H during construction.

Areas where it may be possible to trim back the side slopes of turbine excavations are often indicated by stable trial pits in peat with little or no ingress of groundwater during excavation. Relatively high shear strengths (>5–10 kPa) from a hand vane would also indicate where the side slopes could be stable. The suitability will be confirmed on site during excavation by inspection by the Geotechnical Engineer.

Where there are deep deposits of weak amorphous peat with a high groundwater table and significant groundwater ingress in the excavation, it will generally be necessary to provide some temporary support to the peat slopes during or in advance of excavation to prevent any shear failure in the peat and to stabilise the excavation. This can normally be achieved with sheetpiles or by constructing a rockfill berm around the perimeter of the turbine excavation over the full depth of peat in advance of excavation. Rockfill berms are normally constructed in a trench using the controlled displacement of peat. This involves initially excavating to a stable depth in the peat and then pushing coarse rockfill into the weak peat below this level to refusal on the underlying mineral soil. The weak peat is displaced largely upward and removed in the process to form a berm with a matrix of rockfill supported on the mineral soil. The rockfill berm is then constructed up to original ground level to support the peat over the full height.

The berm is constructed in a continuous operation around the perimeter of the turbine, starting on the upslope side. The peat inside the berm is subsequently excavated out to complete the turbine excavation to formation. The berm has to be set out in advance to allow sufficient clearance to provide stable temporary side slopes in the mineral soil above formation. The berms are usually up to 4 m wide to support a mechanical excavator used to construct the berm. The inside face is subsequently trimmed back to a stable angle of repose at about 1V:1H. It may be necessary to construct such a berm along the upslope side of turbine T38 where the peat is deeper in the proposed cutting for the turbine hardstanding.

Figure 14.7 shows a turbine excavation in 4.5 m of very soft and weak peat where a rockfill berm was constructed around the perimeter of the excavation to support the peat.

14.3.8 Results Following Mitigation Measures

Methodology

The template used in the Peat Stability Risk Assessment is presented in Figure 14.8.

Tables 14.10-14.12 present a summary of the results and provide a comparison of risk ratings before and after implementation of mitigation measures. The hazard likelihood and impact of failure have been re-assessed on the basis of the general design and construction risk mitigation measures that have been recommended herein.

While the interpretation of the Likelihood and Impact of a peat slide after implementation of risk mitigation measures is open to engineering judgement, the following general principles have been adopted in the assessment:

- The potential Impact of a peat slide at a particular location cannot be reduced significantly unless positive measures are taken to effectively contain the peat or sediment along potential flow paths prior to construction. The potential impact can be reduced slightly with effective contingency planning where there are readily accessible points of intervention to rapidly implement containment measures in the event of a peat slide.
- Effective design and construction risk mitigation measures can be used to reduce the Likelihood of a peat slide to a low or negligible level, even in high risk areas. This interpretation of the mitigated risk of a peat slide in each location assessed is based on experience in implementing these measures to successfully complete the construction of the access tracks, crane hardstandings and turbines on other wind farm projects.

With the appropriate design and construction risk mitigation measures outlined herein, and with appropriate controls during construction, it will be possible to reduce the Likelihood of Occurrence, L, to < 0.3 (Negligible), for all of the areas.

The primary risk mitigation measures that reduce the likelihood of a slide include constructing the tracks and hardstandings by excavate / replace down onto the underlying glacial till or weathered rock below the peat, and the implementation of specific spoil handling procedures to control storage of excavated peat and mineral soil.

It has been assumed that the impact of a peat slide would remain the same even after the mitigation measures have been implemented. Therefore, the Impact of Occurrence will remain between Insignificant to Significant, which is tolerable and acceptable with regular attention to monitor the risk throughout construction.

Turbines and Hardstands

The results of the PSRA indicate that the risk of peat instability at the turbine and hardstand locations vary from insignificant to significant following application of mitigation measures.

The PSRA results following mitigation measures are presented graphically on Figures 14.6-14.9. These graphs put the risk ratings for Grousemount Wind Farm into context as the results are presented along with risk ratings for sites of known peat failures. Those sites are Derrybrien, Garvagh Glebe North, Garvagh Glebe South, which are ESB Wind Farms, and a peat slide that occurred in Kerry in 2008.

14.3.9 Wind Farm Operation

There will be no activities involving heavy loads on the site tracks during the operational phase. Although only lightweight vehicles will be the predominant visitors during standard operational activities and no future additional loading of the peat is anticipated, regular inspection and routine maintenance will be undertaken to ensure that the post-construction level of site stability is maintained.

A manual outlining the Operation & Maintenance Provisions for Long-Term Peat Stability will be developed for the site. It will define the inspection and maintenance regime to be followed for the operational life of the wind farm. It is anticipated that the manual may require regular review, amendment and updating during the early stages of its implementations, as inspection observations are made and maintenance works are carried out.

It is anticipated that the inspection regime in the operational phase will be performed according to the following schedule:

- Daily recording of rainfall.
- Monthly routine site inspection by wind farm operational staff.
- Annual site inspection by a geotechnical engineer and surveyor.

14.4 CONCLUSIONS

The peat stability risk assessments showed that there is an insignificant to substantial risk of peat instability at Grousemount Wind Farm site prior to the implementation of appropriate mitigation measures.

It has been demonstrated that after mitigation measures have been applied at preliminary design stage, detailed design stage and construction stage the peat stability risk ratings across the site have been improved to range from insignificant to significant.

Taking mitigation measures into account, it is concluded that Grousemount Wind Farm can be constructed safely from a geotechnical perspective and that the proposed development will not result in significant long-term adverse environmental impacts.

Table 14.7: Critical PSRA Factors at Turbine / Hardstand Locations

Location	Ground Conditions / Topography			Location	Ground Conditions / Topography		
	Peat Depth	Ground Slope	Nearest Watercourse		Peat Depth	Ground Slope	Nearest Watercourse
Turbine T1	< 0.5 m	No further assessment required		Turbine T20	0.5 m	> 7°; SE	< 200 m
Turbine T2	< 0.5 m	No further assessment required		Turbine T21	0.5 m	> 7°; SE	< 200 m
Turbine T3	< 1m	> 7°; SW	< 200 m	Turbine T22	2.2 m	0º - 7°; N	< 200 m
Turbine T4	< 0.5 m	No further assessment required		Turbine T23	1.3 m	> 7°; NE	< 200 m
Turbine T5	< 1 m	3° - > 10°; NW	200 – 300m	Turbine T24	1.7 m	3º - > 10°; NW	< 200 m
Turbine T6	0.5 m	> 7°; SW	> 300 m	Turbine T25	0.5 m	> 7°; E	> 300 m
Turbine T7	1 m	> 7°; W	< 200m	Turbine T26	0.5 m	0º - > 10°; N	< 200 m
Turbine T8	0.7 m	7° - > 10°; N	> 300 m	Turbine T27	< 0.5 m	No further assessment required	
Turbine T9	> 1.5 m	3° - > 10°; W	> 300 m	Turbine T28	< 0.5 m	0º - > 10°; N	< 200 m
Turbine T10	1.0-1.7 m	0° - > 10°; NE	< 200 m	Turbine T29	0.8 m	0º - > 10°; S	< 200 m
Turbine T11	0.8 m	0° - 5°; SW	> 300 m	Turbine T30	2.4 m	0º - > 10°; SE	< 200 m
Turbine T12	< 0.5 m	No further assessment required		Turbine T31	0.5 m	0º - > 10°; SE	< 200 m
Turbine T13	0.5-1.0 m	3° - > 10°; NW	> 300 m	Turbine T32	< 0.5 m	No further assessment required.	
Turbine T14	0.8 m	> 7°; N	< 200 m	Turbine T33	0.6 m	0° - > 10°; SE	< 200 m
Turbine T15	1.2 m	> 7°; N	200 - 300 m	Turbine T34	0.6 m	> 7°; N	< 200 m

Location	Ground Conditions / Topography			Location	Ground Conditions / Topography		
	Peat Depth	Ground Slope	Nearest Watercourse		Peat Depth	Ground Slope	Nearest Watercourse
Turbine T16	< 0.7 m	> 7°; SE	< 200 m	Turbine T35	1.2 m	> 7°; SE	< 300 m
Turbine T17	1.2 m	> 7°; SE	< 200 m	Turbine T36	< 0.5 m	No further assessment required.	
Turbine T18	0.6 m	> 7°; E	> 300 m	Turbine T37	1.0 m	> 7°; NW	< 200 m
Turbine T19	< 0.5 m	No further assessment required		Turbine T38	0.6 – 2.4 m	> 7°; N	< 200 m

In all of the above the turbine / hardstand is located in grasslands.

Table 14.8: Critical PSRA Factors at Access Track Locations

Location	Ground Conditions / Topography			Location	Ground Conditions / Topography		
	Peat Depth	Ground Slope	Nearest Watercourse		Peat Depth	Ground Slope	Nearest Watercourse
Access Track (AT) 1: T1 – T2 Junction	0.7 m	>10°; E	< 200 m	AT29: Ch. 1400 – Borrow Pit E	1.9 m	0° - > 10°; N	< 200 m
AT2: T2 Spur	< 0.5 m	No further assessment required		AT30: Borrow Pit E – Main Spine Road Parts 3 & 4 Intersection	1.9 m	3° - > 10°; NE	< 200 m
AT3: T2 Junction – T3 Junction	< 0.5 m	No further assessment required		AT31: T20 Spur	1.1 m	0° - > 10°; SE	< 200 m
AT4: T3 Spur	< 0.5 m	No further assessment required		AT32: Main Spine Road Parts 3 & 4 Intersection – T24 Junction	0.8m	0° - 5°; E	< 200 m
AT5: T3 Junction – Public Road	< 0.5 m	No further assessment required		AT33: T22 Spur	< 0.5 m	No further assessment required	

Location	Ground Conditions / Topography			Location	Ground Conditions / Topography		
	Peat Depth	Ground Slope	Nearest Watercourse		Peat Depth	Ground Slope	Nearest Watercourse
AT6: Public Road – T6 Junction	1.4 m	> 10°; E	< 200 m	AT34: T24 Spur	1.3 m	0° - > 10°; NW	> 300 m
AT7: T6 Junction – T6	< 0.5 m	No further assessment required		AT35: T24 Junction – T35 Junction	2.4 m	0° - > 10°; N	< 200 m
AT8: T6 Junction – T4 Junction	1 m	> 10°; E	< 200 m	AT36: T35 Spur	0.7m	0° - > 10°; SE	< 200 m
AT9: T4 Spur	< 1 m	> 10°; E	200 – 300 m	AT37: T35 Junction – T31	0.6m	3° - > 10°; SE	< 200 m
AT10: T4 Junction – T7 Junction	1.2 m	0° - > 10°; E	< 200 m	AT38: T31 – T30 Site Access Junction	< 0.5 m	No further assessment required	
AT11: T7 Spur	0.6 m	0° - > 10°; E	< 200 m	AT39: T30 Site Access (Ch. 1450 – Ch. 2350)	1.3 m	3° - > 10°; SE	< 200 m
AT12: T7 Junction – T10 Junction	1.8 m	3° - > 10°; N	< 200 m	AT40: T30 Site Access (Ch. 650 – Ch. 1450)	< 0.5 m	No further assessment required	
AT13: T10 Junction – T8	0.8 m	0° - > 10°; NE	< 200 m	AT41: T30 Site Access (Ch. 0 – Ch. 650)	2.2 m	3° - > 10°; SE	< 200 m
AT14: T10 Junction – T9	1.5 m	3° - 7°; NW,	> 300 m	AT42: T30 Site Access Junction – T29 Junction	0.6 m	0° - > 7°; SE	< 200 m
AT15: T9 Junction – T11 Junction	1.4 m	3° - 7°; NW	< 200 m	AT43: T30 Spur	< 0.5 m	No further assessment required	
AT16: T11 Junction – Borrow Pit G	1.1 m	0° - > 10°; SW	> 300 m	AT44: T29 Spur	< 0.5 m	No further assessment required	
AT17: Borrow Pit G – T13	< 1 m	> 7°; NW	< 200 m	A45: T29 Junction – T27	0.6 m	0° - > 10°; SE	< 200 m
AT18: T12 Spur	< 1 m	> 7°; W	< 200 m	AT46: T27 – T30 Site Access Junction	1.2 m	3° - > 10°; E	< 200 m

Location	Ground Conditions / Topography			Location	Ground Conditions / Topography		
	Peat Depth	Ground Slope	Nearest Watercourse		Peat Depth	Ground Slope	Nearest Watercourse
AT19: T14 Spur	< 1 m	> 7°; W	< 200 m	AT47: T26 Spur	0.9 m	3° - > 10°; SE	< 200m
AT20: Borrow Pit G – T15 Spur Ch. 900	0.8 m	> 7°; W, NW.	< 200 m	AT48: T38 Spur (Ch. 80 – Ch. 300)	< 0.5 m	No further assessment required	
AT21: T15 Spur Ch. 900 – T15	1.3 m	>7°; NW	< 200 m	AT49: T38 Spur (Ch. 300 – Ch. 410)	0.8 m	3° - > 10°; N	< 200 m
AT22: T11 Junction – Borrow Pit F	0.9 m	>7°; W.	< 200 m	AT50: T36 Spur	0.8 m	3° - > 10°; E	< 200 m
AT23: Borrow Pit F – River Roughty	1.3 m	0° - > 10°; N	< 200 m	AT51: T25 Site Access (Ch. 400 – Ch. 1650)	1.4 m	3° - > 10°; NE	> 300 m
AT24: River Roughty – T16	< 0.5 m	No further assessment required		AT52: T25 Site Access (Ch. 230 – Ch. 400) farmland	< 0.5 m	No further assessment required	
AT25: T16 - T18	1 – 3 m	> 7°; SE	< 200 m	AT53: T25 Site Access (Ch. 0 – Ch. 230) Coillte	< 0.5 m	No further assessment required	
AT26: T16 – T17	1.3 m	3° - > 10°; SE	< 200 m	AT54: Everwind Wind Farm Site Entrance	< 0.5 m	No further assessment required	
AT27: T17 – Ch. 1850 (including T19 spur)	1.5 m	> 7°; E	> 300 m	AT55: Coillte track through Everwind Wind Farm	< 1 m	3° - > 10°; SW	< 200 m
AT28: Ch. 1850 – Ch. 1400	0.6 m	3° - > 10°; E	< 200 m				

In all of the above the access track is in grasslands.

Table 14.9: Critical PSRA Factors at Other Infrastructure Locations

Location	Ground Conditions / Topography			Location	Ground Conditions / Topography		
	Peat Depth	Ground Slope	Nearest Watercourse		Peat Depth	Ground Slope	Nearest Watercourse
Substation	1 – 3 m	0° - > 10°; N	< 200 m	Borrow Pit G	0.2 – 1.2 m	> 10°; SW	< 200 m
Borrow Pit A	0.4 – 1.4 m	0° - > 10°; SE	< 200 m	Borrow Pit H	0.5 – 0.8 m	0° - > 10°; NE	200 – 300 m
Borrow Pit B	< 1 m	3° - 7°; SE	< 200 m	Borrow Pit I	< 1 m	0° - > 10°; NW	< 200 m
Borrow Pit C	0.2 – 1.3 m	0° - > 10°; SE	< 200 m	Anemometer Mast 1	< 0.5 m	No further assessment required	
Borrow Pit D	< 1 m	0° - > 10°; SE	> 300 m	Anemometer Mast 2	1.9 m	0° - > 10°; NW	< 200 m
Borrow Pit E	0.1 – 1.2 m	3° - > 10°; N	> 300 m	Anemometer Mast 3	< 0.5 m	No further assessment required	
Borrow Pit F	0.3 – 0.7 m	> 10°; NW, N	< 200 m	Anemometer Mast 4	< 0.5 m	No further assessment required	

All of the above locations are in grasslands.

Table 14.10: PSRA Results Before and After Mitigation Measures – Wind Turbines

Area	Before Mitigation Measures				After Mitigation Measures			
	L	I	Risk Rating	Level	L	I	Risk Rating	Level
T1 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T2 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T3 Turbine & Hardstanding	0.59	0.64	0.38	Significant	0.10	0.64	0.06	Insignificant
T4 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant

Area	Before Mitigation Measures				After Mitigation Measures			
	L	I	Risk Rating	Level	L	I	Risk Rating	Level
T5 Turbine & Hardstanding	0.64	0.61	0.39	Significant	0.10	0.61	0.06	Insignificant
T6 Turbine & Hardstanding	0.56	0.61	0.34	Significant	0.10	0.61	0.06	Insignificant
T7 Turbine & Hardstanding	0.67	0.64	0.43	Substantial	0.10	0.64	0.06	Insignificant
T8 Turbine & Hardstanding	0.61	0.58	0.35	Significant	0.10	0.58	0.06	Insignificant
T9 Turbine & Hardstanding	0.65	0.61	0.39	Significant	0.15	0.61	0.09	Insignificant
T10 Turbine & Hardstanding	0.68	0.61	0.41	Significant	0.15	0.61	0.09	Insignificant
T11 Turbine & Hardstanding	0.58	0.58	0.34	Significant	0.10	0.58	0.06	Insignificant
T12 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T13 Turbine & Hardstanding	0.69	0.58	0.40	Significant	0.10	0.58	0.06	Insignificant
T14 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T15 Turbine & Hardstanding	0.65	0.61	0.40	Significant	0.15	0.61	0.09	Insignificant
T16 Turbine & Hardstanding	0.58	0.64	0.37	Significant	0.10	0.64	0.06	Insignificant
T17 Turbine & Hardstanding	0.67	0.64	0.42	Significant	0.15	0.64	0.10	Insignificant
T18 Turbine & Hardstanding	0.56	0.58	0.32	Significant	0.10	0.58	0.06	Insignificant
T19 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T20 Turbine & Hardstanding	0.58	0.64	0.37	Significant	0.10	0.64	0.06	Insignificant
T21 Turbine & Hardstanding	0.58	0.64	0.37	Significant	0.10	0.64	0.06	Insignificant
T22 Turbine & Hardstanding	0.75	0.64	0.48	Substantial	0.30	0.64	0.19	Significant

Area	Before Mitigation Measures				After Mitigation Measures			
	L	I	Risk Rating	Level	L	I	Risk Rating	Level
T23 Turbine & Hardstanding	0.67	0.64	0.42	Significant	0.15	0.64	0.10	Insignificant
T24 Turbine & Hardstanding	0.69	0.64	0.44	Substantial	0.20	0.64	0.13	Insignificant
T25 Turbine & Hardstanding	0.60	0.73	0.43	Substantial	0.10	0.73	0.07	Insignificant
T26 Turbine & Hardstanding	0.61	0.64	0.39	Significant	0.10	0.64	0.06	Insignificant
T27 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T28 Turbine & Hardstanding	0.63	0.64	0.40	Significant	0.10	0.64	0.06	Insignificant
T29 Turbine & Hardstanding	0.61	0.64	0.39	Significant	0.10	0.64	0.06	Insignificant
T30 Turbine & Hardstanding	0.60	0.64	0.38	Significant	0.10	0.64	0.06	Insignificant
T31 Turbine & Hardstanding	0.60	0.64	0.38	Significant	0.10	0.64	0.06	Insignificant
T32 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T33 Turbine & Hardstanding	0.63	0.64	0.40	Significant	0.10	0.64	0.06	Insignificant
T34 Turbine & Hardstanding	0.62	0.58	0.36	Significant	0.10	0.58	0.06	Insignificant
T35 Turbine & Hardstanding	0.70	0.64	0.45	Substantial	0.10	0.64	0.06	Insignificant
T36 Turbine & Hardstanding	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
T37 Turbine & Hardstanding	0.65	0.64	0.42	Significant	0.10	0.64	0.06	Insignificant
T38 Turbine & Hardstanding	0.64	0.64	0.41	Significant	0.30	0.64	0.19	Significant

Table 14.11: PSRA Results Before and After Mitigation Measures – Access Tracks

Area		Before Mitigation Measures				After Mitigation Measures			
		L	I	Risk Rating	Level	L	I	Risk Rating	Level
AT1	T1 - T2 Junction	0.61	0.76	0.46	Substantial	0.10	0.76	0.08	Insignificant
AT2	T2 Spur	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT3	T2 Junction - T3 Junction	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT4	T3 Spur	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT5	T3 Junction - Public Road	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT6	Public Road - T6 Junction	0.65	0.67	0.44	Substantial	0.20	0.67	0.13	Insignificant
AT7	T6 Junction - T6	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT8	T6 Junction - T4 Junction	0.68	0.64	0.43	Substantial	0.10	0.64	0.06	Insignificant
AT9	T4 Spur	0.61	0.61	0.37	Significant	0.10	0.61	0.06	Insignificant
AT10	T4 Junction - T7 Junction	0.71	0.64	0.45	Substantial	0.15	0.64	0.10	Insignificant
AT11	T7 Spur	0.65	0.64	0.42	Significant	0.10	0.64	0.06	Insignificant
AT12	T7 Junction - T10 Junction	0.76	0.64	0.49	Substantial	0.20	0.64	0.13	Insignificant
AT13	T10 Junction - T8	0.65	0.64	0.42	Significant	0.10	0.64	0.06	Insignificant
AT14	T10 Junction - T9	0.67	0.48	0.32	Significant	0.15	0.48	0.07	Insignificant
AT15	T9 Junction - T11 Junction	0.69	0.64	0.44	Substantial	0.15	0.64	0.10	Insignificant
AT16	T11 Junction - Borrow Pit G	0.64	0.58	0.37	Significant	0.15	0.58	0.09	Insignificant
AT17	Borrow Pit G - T13	0.58	0.64	0.37	Significant	0.10	0.64	0.06	Insignificant
AT18	T12 Spur	0.57	0.64	0.36	Significant	0.10	0.64	0.06	Insignificant
AT19	T14 Spur	0.58	0.64	0.37	Significant	0.10	0.64	0.06	Insignificant

Area		Before Mitigation Measures				After Mitigation Measures			
		L	I	Risk Rating	Level	L	I	Risk Rating	Level
AT20	Borrow Pit G - T15 Spur Ch. 900	0.61	0.64	0.39	Significant	0.10	0.64	0.06	Insignificant
AT21	T15 Spur Ch. 900 - T15	0.68	0.64	0.43	Substantial	0.15	0.64	0.10	Insignificant
AT22	T11 Junction - Borrow Pit F	0.61	0.64	0.39	Significant	0.10	0.64	0.06	Insignificant
AT23	Borrow Pit F - River Roughty	0.72	0.64	0.46	Substantial	0.15	0.64	0.10	Insignificant
AT24	River Roughty - T16	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT25	T16 - T18	0.65	0.64	0.42	Significant	0.15	0.64	0.10	Insignificant
AT26	T16 - T17	0.68	0.64	0.43	Substantial	0.15	0.64	0.10	Insignificant
AT27	T17 - Ch. 1850 (including T19 Spur)	0.64	0.58	0.37	Significant	0.15	0.58	0.09	Insignificant
AT28	Ch. 1850 - Ch. 1400	0.64	0.64	0.41	Significant	0.10	0.64	0.06	Insignificant
AT29	Ch. 1400 - Borrow Pit E	0.69	0.64	0.44	Substantial	0.20	0.64	0.13	Insignificant
AT30	Borrow Pit E - Main Spine Road Parts 3 & 4 Intersection	0.71	0.64	0.45	Substantial	0.20	0.64	0.13	Insignificant
AT31	T20 Spur	0.69	0.64	0.44	Substantial	0.15	0.64	0.10	Insignificant
AT32	Main Spine Road Parts 3 & 4 Intersection - T24 Junction	0.71	0.64	0.45	Substantial	0.10	0.64	0.06	Insignificant
AT33	T22 Spur	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT34	T24 Spur	0.67	0.58	0.38	Significant	0.15	0.58	0.09	Insignificant
AT35	T24 Junction - T35 Junction	0.67	0.64	0.43	Substantial	0.25	0.64	0.16	Insignificant
AT36	T35 Spur	0.60	0.64	0.38	Significant	0.10	0.64	0.06	Insignificant
AT37	T35 Junction - T31	0.60	0.64	0.38	Significant	0.10	0.64	0.06	Insignificant

Area		Before Mitigation Measures				After Mitigation Measures			
		L	I	Risk Rating	Level	L	I	Risk Rating	Level
AT38	T31 - T30 Site Access Junction	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT39	T30 Site Access (Ch. 1450 - Ch. 2350)	0.67	0.64	0.42	Significant	0.15	0.64	0.10	Insignificant
AT40	T30 Site Access (Ch. 650 - Ch. 1450)	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT41	T30 Site Access (Ch. 0 - Ch. 650)	0.65	0.64	0.42	Significant	0.25	0.64	0.16	Insignificant
AT42	T30 Site Access Junction - T29 Junction	0.67	0.64	0.42	Significant	0.10	0.64	0.06	Insignificant
AT43	T30 Spur	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT44	T29 Spur	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT45	T29 Junction - T27	0.67	0.64	0.42	Significant	0.10	0.64	0.06	Insignificant
AT46	T27 - T30 Site Access Junction	0.69	0.64	0.44	Substantial	0.15	0.64	0.10	Insignificant
AT47	T26 Spur	0.61	0.64	0.39	Significant	0.10	0.64	0.06	Insignificant
AT48	T38 Spur (Ch. 80 - Ch. 300)	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT49	T38 Spur (Ch. 300 - Ch. 410)	0.64	0.64	0.41	Significant	0.10	0.64	0.06	Insignificant
AT50	T36 Spur	0.68	0.64	0.43	Substantial	0.10	0.64	0.06	Insignificant
AT51	T25 Site Access (Ch. 400 - Ch.1650)	0.65	0.58	0.38	Significant	0.15	0.58	0.09	Insignificant
AT52	T25 Site Access (Ch. 230 - Ch. 400) farmland	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT53	T25 Site Access (Ch. 0 - Ch. 230) Coillte land	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT54	Everwind Wind Farm Site Entrance	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
AT55	Coillte track through Everwind	0.59	0.67	0.39	Significant	0.10	0.67	0.07	Insignificant

Table 14.12: PSRA Results Before and After Mitigation Measures – Other Infrastructure

Area	Before Mitigation Measures				After Mitigation Measures			
	L	I	Risk Rating	Level	L	I	Risk Rating	Level
Substation	0.74	0.64	0.47	Substantial	0.25	0.64	0.16	Insignificant
Borrow Pit A	0.65	0.64	0.42	Significant	0.15	0.64	0.10	Insignificant
Borrow Pit B	0.61	0.64	0.39	Significant	0.10	0.64	0.06	Insignificant
Borrow Pit C	0.65	0.64	0.42	Significant	0.15	0.64	0.10	Insignificant
Borrow Pit D	0.67	0.61	0.40	Significant	0.10	0.61	0.06	Insignificant
Borrow Pit E	0.63	0.64	0.40	Significant	0.15	0.64	0.10	Insignificant
Borrow Pit F	0.61	0.64	0.39	Significant	0.10	0.64	0.06	Insignificant
Borrow Pit G	0.63	0.64	0.40	Significant	0.15	0.64	0.10	Insignificant
Borrow Pit H	0.63	0.61	0.38	Significant	0.10	0.61	0.06	Insignificant
Borrow Pit I	0.67	0.64	0.42	Significant	0.10	0.64	0.06	Insignificant
Anemometer Mast 1	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant
Anemometer Mast 2	0.68	0.64	0.43	Substantial	0.20	0.64	0.13	Insignificant
Anemometer Mast 3	0.00	0.00	0.00	Insignificant	0.00	0.00	0.00	Insignificant

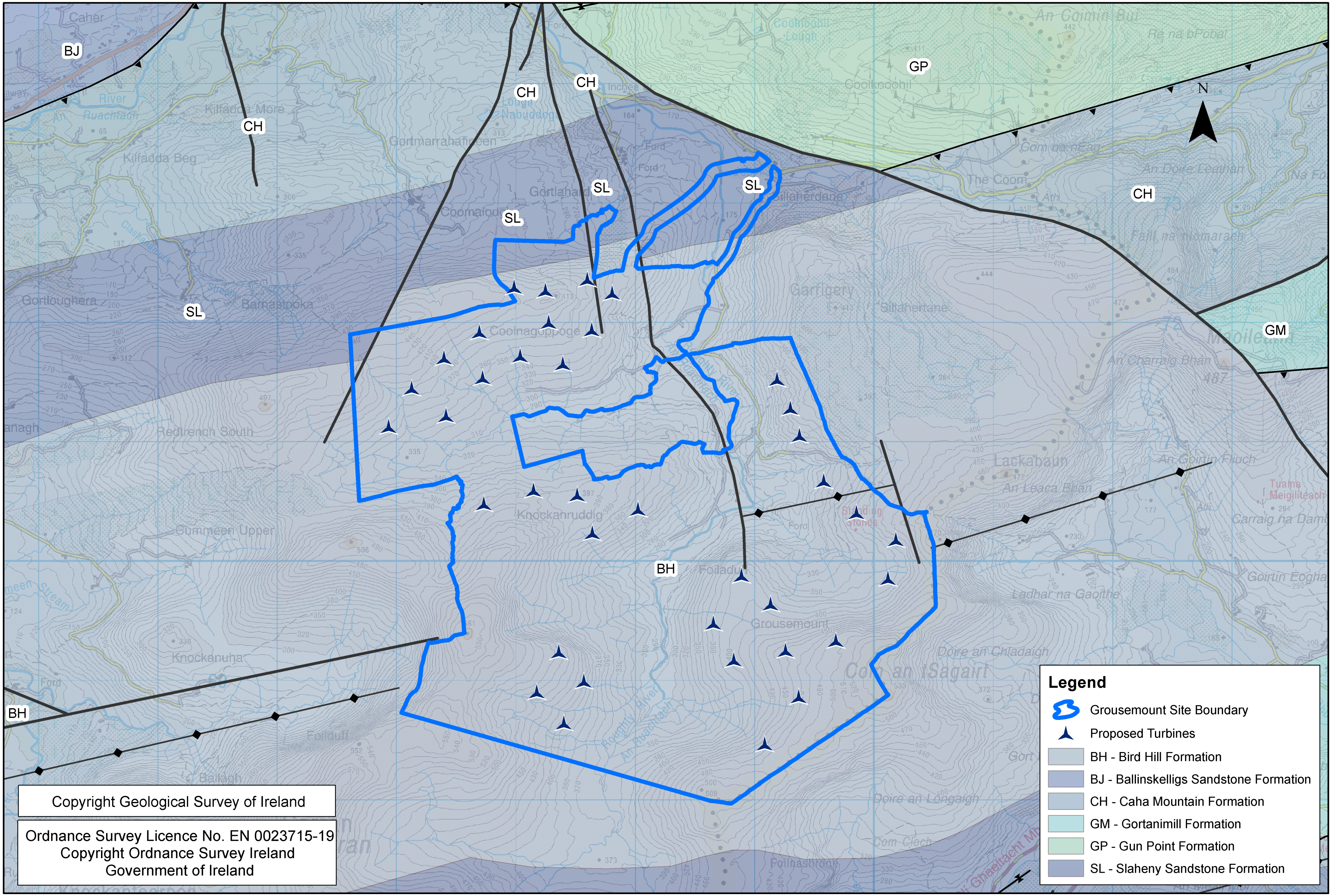

Figure 14.1 - Bedrock Formations

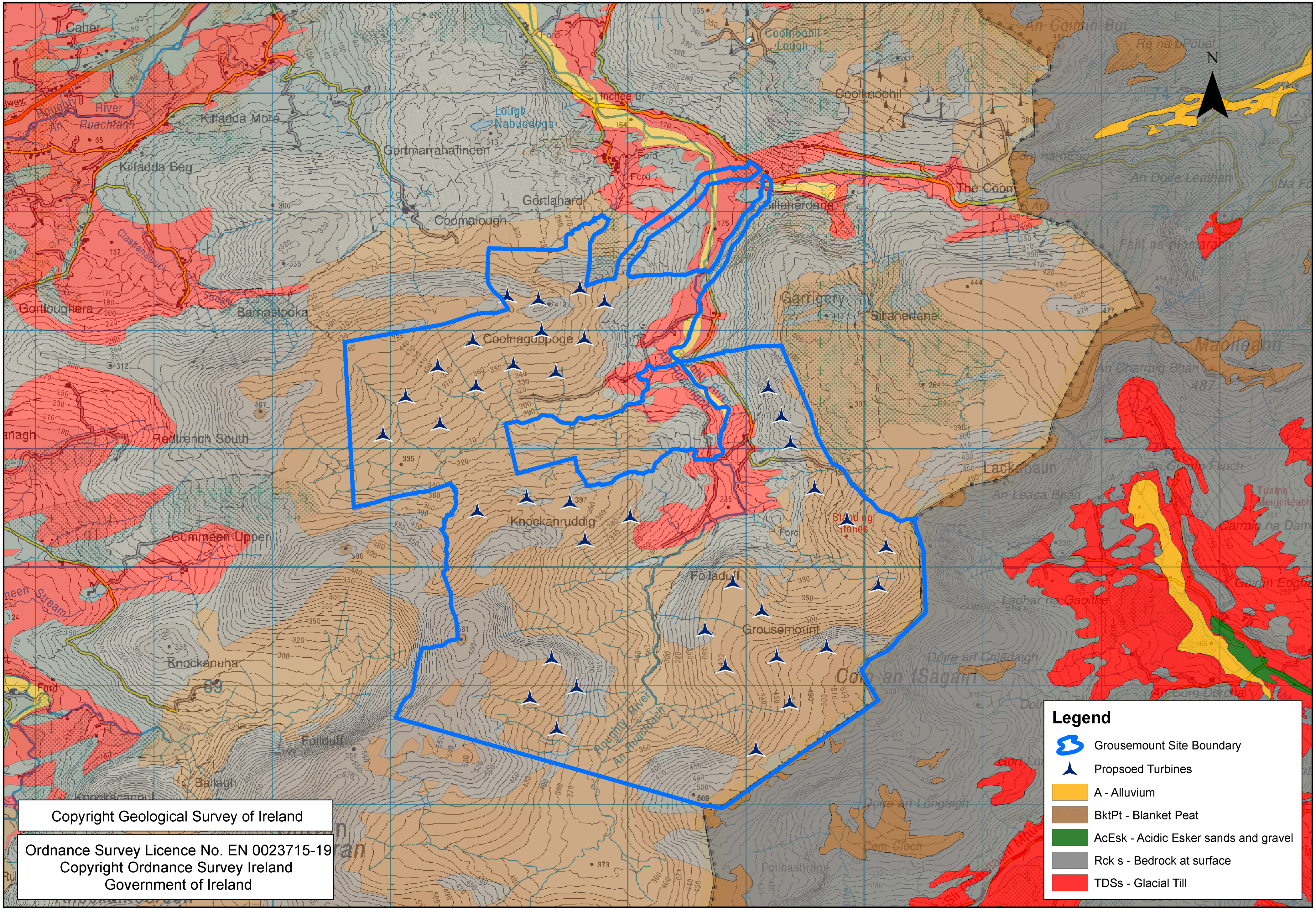

Figure 14.2 - Soil Formations

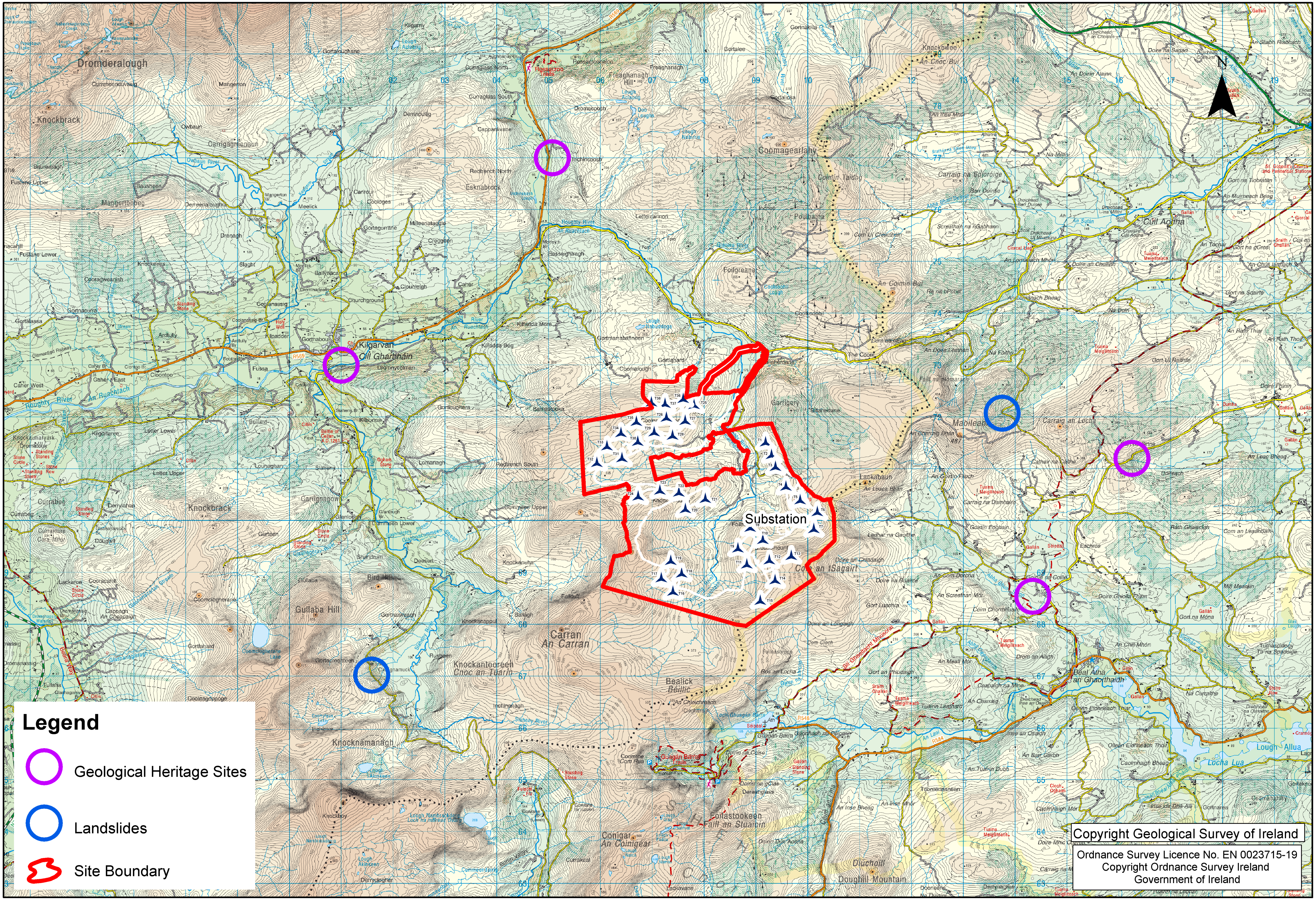

Figure 14.3 - Recorded Landslides and Geological Heritage Sites

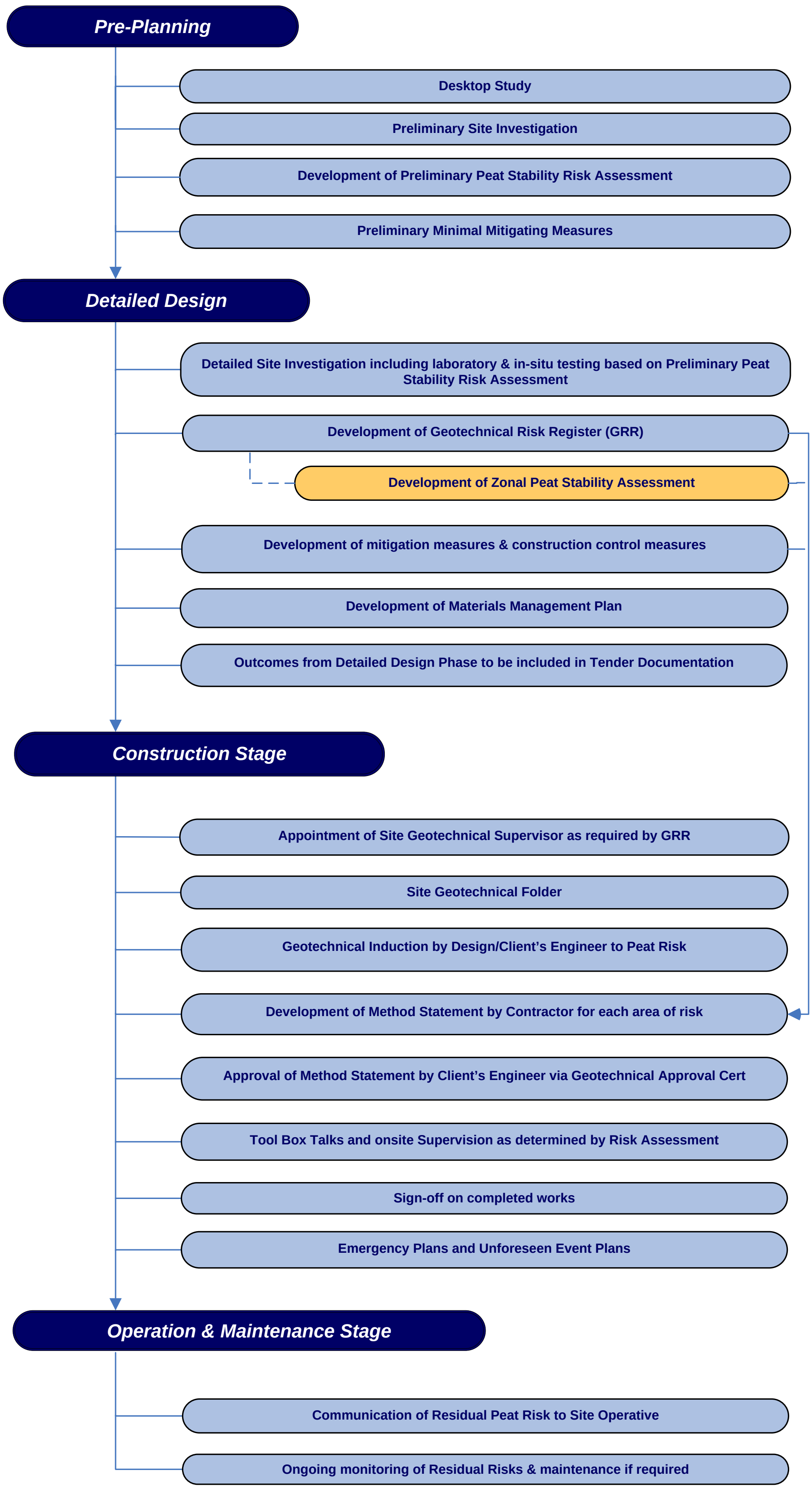

Figure 14.4: Peat Stability Flowchart

Figure 14.5: Rockfill Peat Repository on an Existing ESB Wind Farm

Figure 14.6: Turbine Excavation Trimmed Back to a Stable Temporary Side Slope

Figure 14.7: Rockfill Berm Around an Area of Deep Peat at an ESB Wind Farm

ESB International

Peat Stability Risk Assessment

Grousemount Wind Farm

Location:	[Insert Turbine No, Access Track etc.]
Inspected on:	2015
Inspected by:	ESBI / BLP
Completed by:	
Date:	August 2015

[Insert Turbine No, Access Track etc.]

No.	Likelihood/ Impact Factors	Value	Rating 1	Rating 2	Rating 3	Rating Value	Weighting	Score	Comment
	LIKELIHOOD								
1.0	**Ground Conditions**								
	Peat								
1.1	Peat Depth		<1m	>3m	1-3m		2	0	
1.2	Peat Condition in Trial Pits		Dry/ Stands well	Slowly squeezing	Extremely Wet/ Undiggable		1	0	
	Subsoil Characteristics								
1.3	Subsoil Type		Gravel/ Firm Glacial Till	Smooth Rock	Soft Sensitive Clay		1	0	
1.4	Peat fibres continuous across transition to subsoil		Yes	Partially	No		1	0	
2.0	**Topography**								
	Situation								
2.1	Elevation OD [m]		<200m		>200m		1	0	
2.2	Slope Aspect		SW, S, SE	W, E	NW, N, NE		1	0	
	Slope Angle								
2.3	Slope Angle - Ground Surface		<3°	>7°	3° - 7°		2	0	
	Geomorphology								
2.4	General slope characteristics downslope		-	Planar	Convex		1	0	
2.5	Distance from break in slope		> 100m	50-100m	< 50m		1	0	
3.0	**Hydrology**								
	Hydrology								
3.1	In broad valley upslope from defined watercourse		-	Yes, slopes < 3°	Yes, slopes ≥ 3°		1	0	
3.2	Distance from head of defined watercourse		> 300m	200 - 300m	< 200m		1	0	
3.3	Surface water		Localised	Ponded in drains	Springs/ Surface Water		1	0	
3.4	Evidence of piping		-	-	Yes		1	0	
3.5	Existing drainage ditches		Down slope	Varied / Oblique	Across slope		1	0	
3.6	Annual Rainfall		<1000 mm/yr	1000-1400 mm/yr	>1400 mm/yr		1	0	
4.0	**Other Factors**								
	Vegetation								
4.1	Vegetation		Dry Heather	Grasslands	Wetlands		1	0	
4.2	Forestry (if applicable)		Good Growth	Fair	Stunted Growth		1.5	0	
	Slide History								
4.3	Previous slides in locality		5 to 10km	< 5km	On site		2	0	
4.4	Evidence of movement in peat (e.g. tension cracks, step features, compression features)		-	-	Yes		1	0	
	Land Use								
4.5	Peat Workings		-	Cutaway/Turbary	Machine Cut		1	0	
	Other Factors								
4.6	Existing roads in place		Solid Road		Floating Road	1	1	1	
4.7	Time of year for construction		Spring	Winter, Early Summer	Late Summer, Autumn		1	0	
	Likelihood Rating								
							Total	1	
							Max Possible	3	
							Likelihood	0.33	

Likelihood Score		Scale
0.0-0.3	Negligible	1
0.3-0.5	Low	2
0.5-0.7	Medium	3
0.7-1.0	High	4

No.	Likelihood/ Impact Factors	Value	Rating 1	Rating 2	Rating 3	Rating Value	Weighting	Score	Comment
	IMPACT								
5.0	**Impact Factors**								
5.1	Volume of peat in potential peat flow		Small volume (<1,000m^3)	Medium (1,000 -	Potential for Bog burst		3	0	
5.2	Downslope features		Bowl/ contained	Minor undefined watercourse	Valley		1	0	
5.3	Proximity to defined valley		>500m	200-500m	<200m		1	0	
5.4	Valley profile		Flat	Intermediate	Steep		1	0	
5.5	Downstream aquatic environment		Non-sensitive	Sensitive	Drinking water supply		1	0	
5.6	Public roads in potential peat flow path		-	Local Road	Regional Road		1	0	
5.7	Overhead lines in potential peat flow path		Phone Lines	Electricity, LV	Electricity MV, HV		1	0	
5.8	Buildings in potential peat flow path		Farm out-houses	-	Dwelling		1	0	
5.9	Capability to respond (access and resources)		Good	Fair	Poor		1	0	
	Impact Rating								
							Total	0	
							Max Possible	0	
							Impact	#DIV/0!	

Impact Score		Scale
0.0-0.3	Negligible	1
0.3-0.5	Low	2
0.5-0.7	Medium	3
0.7-1.0	High	4

RISK RATING

Risk Rating = Likelihood * Impact

Risk Rating = 0.33 #DIV/0! = #DIV/0! #DIV/0!

Risk Rating	Risk Level	Action Required
0.0 - 0.18	Insignificant	Normal SI
0.19 - 0.42	Significant	Targeted SI, design of specific mitigation measures. Part time supervision during construction.
0.43 - 0.66	Substantial	Avoid construction in the area if possible. If unavoidable, detailed SI and design of specific mitigation measures. Full time supervision during construction.
0.67 - 1.0	Serious	Avoid construction in this area.

Figure 14.8: Template - Peat Stability Risk Assessment

PSRA Comparative Chart - After Mitigation Measures (Turbines Chart 1 of 2)

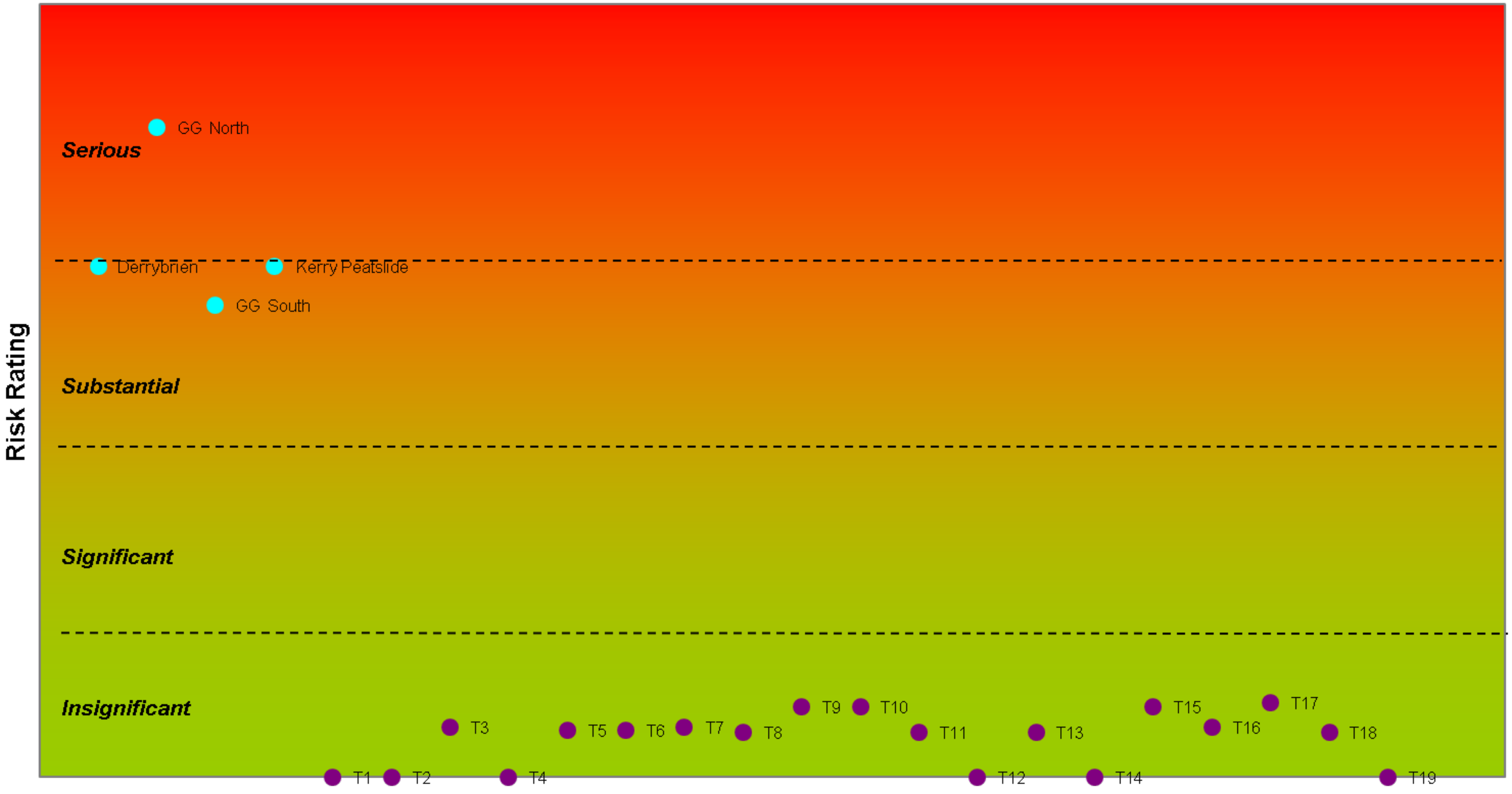

Figure 14.9(1): Peat Stability Risk Assessment – Turbines (1)

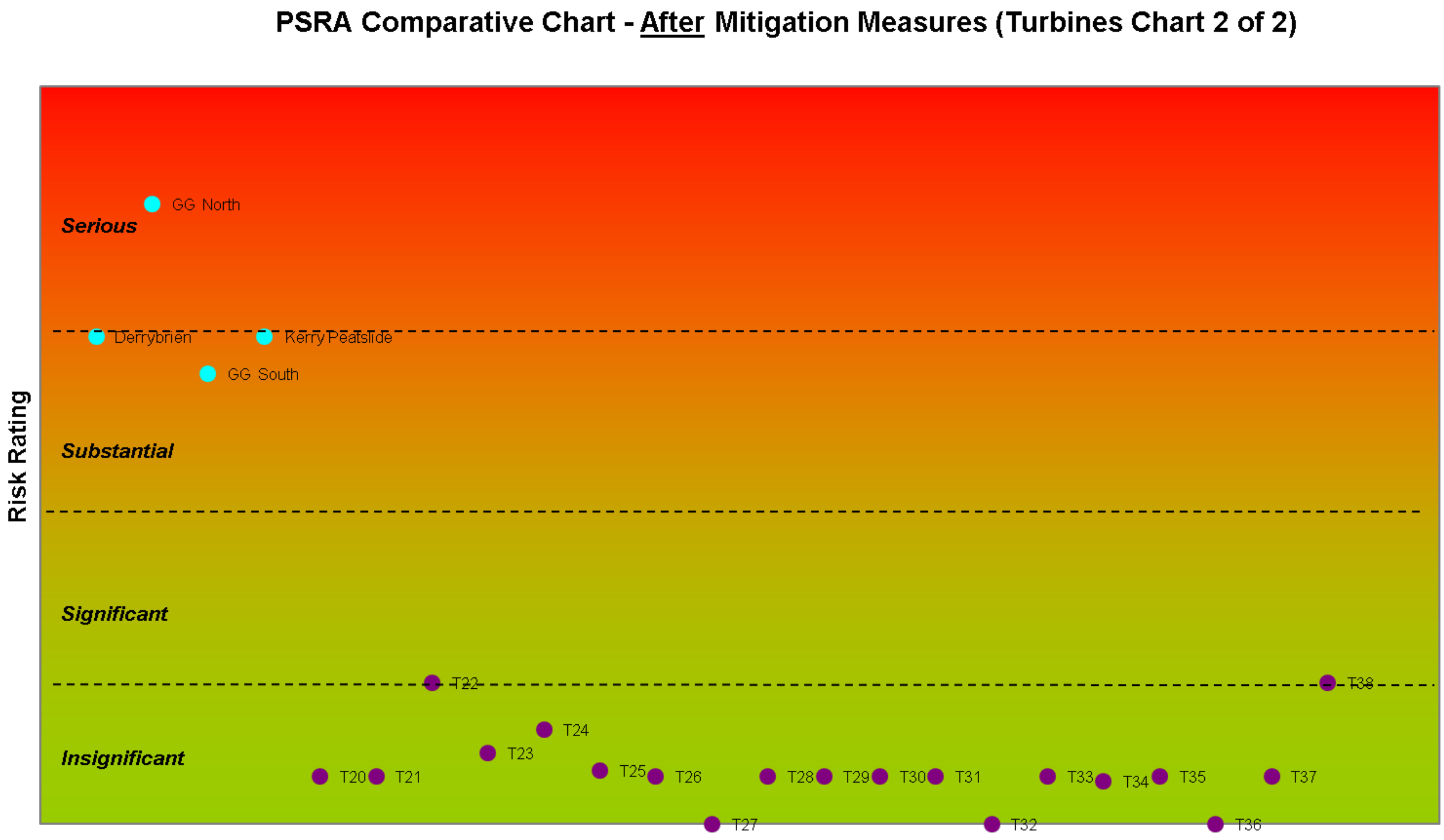

Figure 14.9(2): Peat Stability Risk Assessment – Turbines (2)

PSRA Comparative Chart - After Mitigation Measures (Access Tracks Chart 1 of 3)

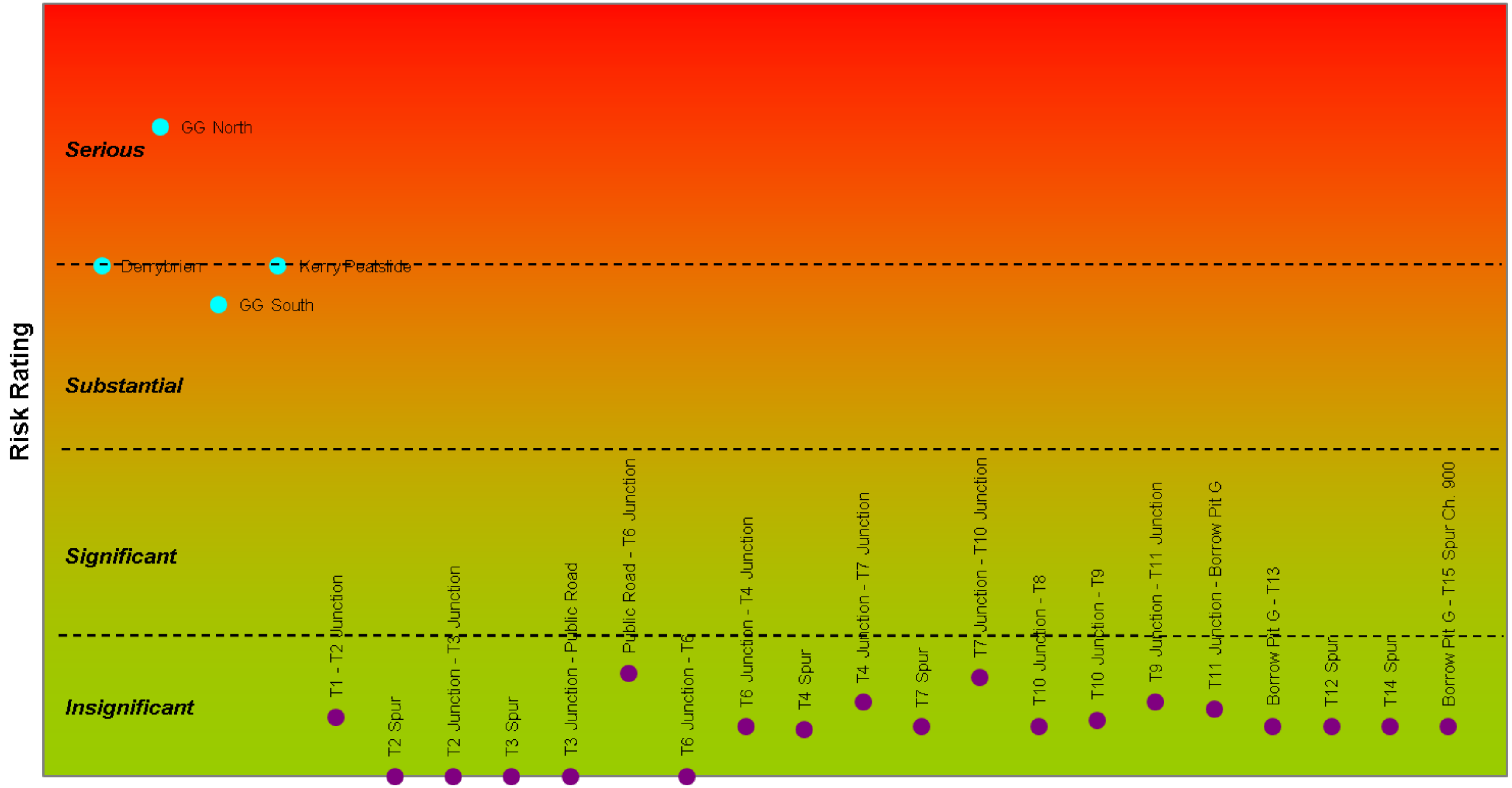

Figure 14.10(1): Peat Stability Risk Assessment – Access Tracks (1)

PSRA Comparative Chart - After Mitigation Measures (Access Tracks Chart 2 of 3)

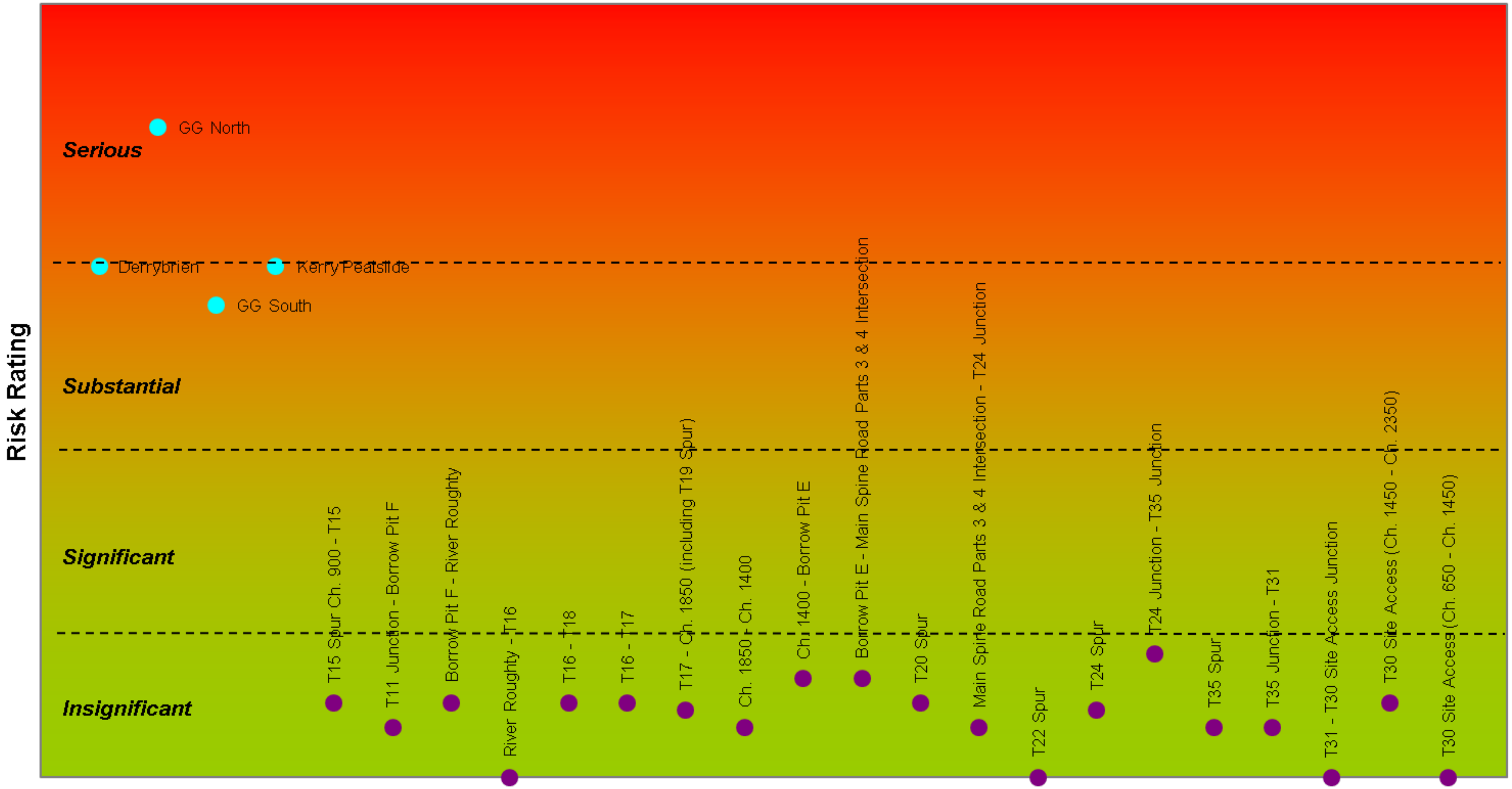

Figure 14.10(2): Peat Stability Risk Assessment – Access Tracks (2)

PSRA Comparative Chart - After Mitigation Measures (Access Tracks Chart 3 of 3)

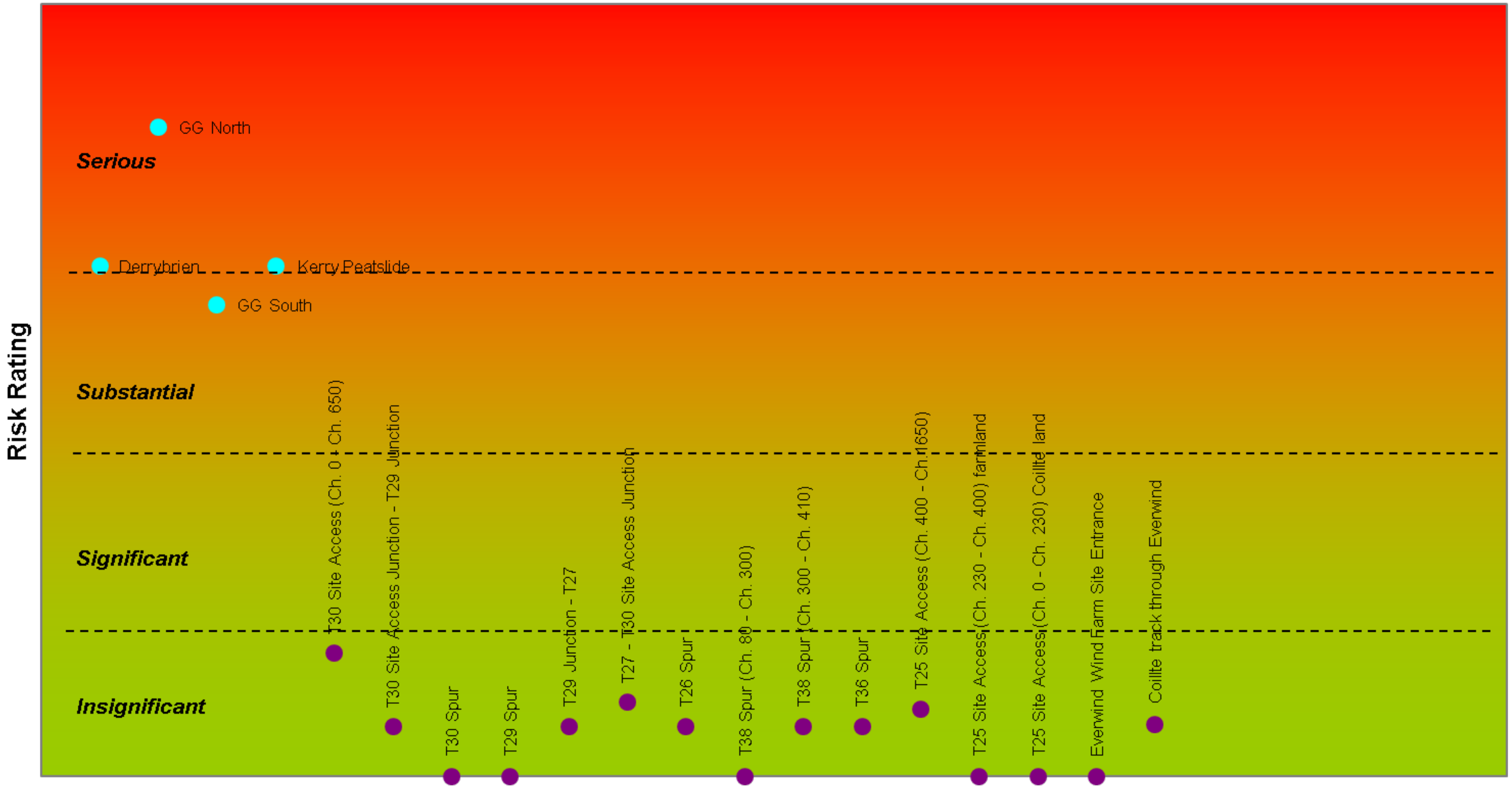

Figure 14.10(3): Peat Stability Risk Assessment – Access Tracks (3)

PSRA Comparative Chart - After Mitigation Measures (Other Infrastructure Chart 1 of 1)

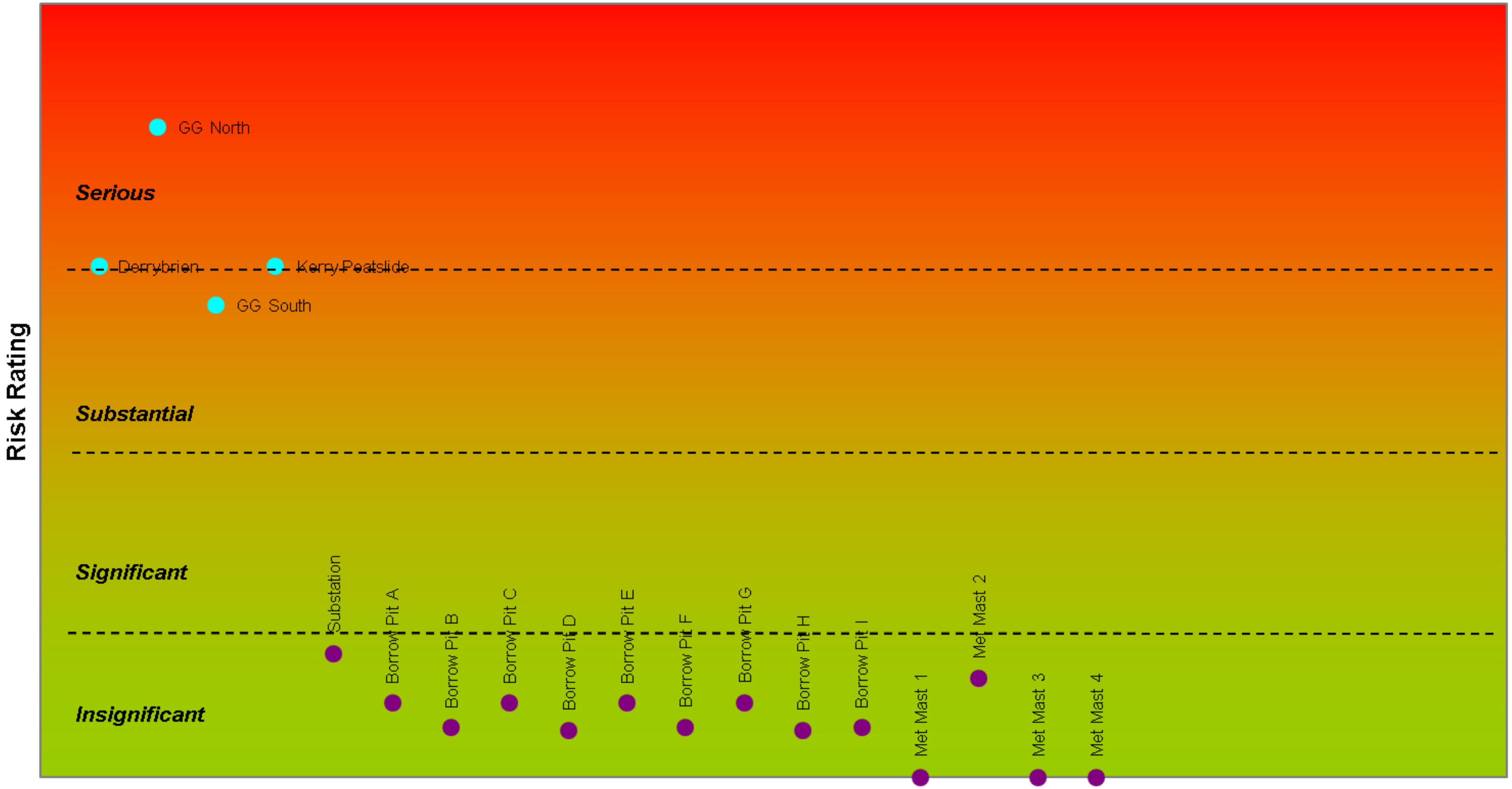

Figure 14.11: Peat Stability Risk Assessment – Other Infrastructure