SECTION 1 DESCRIPTION OF THE PROJECT				
No.	**Review Question**	**Relevant?**	**Adequately**	**What further information is needed?**
1.16	Is the reinstatement and after use of land occupied temporarily for operation of the Project described? (e.g. land used for mining or quarrying)	Yes	Yes	
1.17	Is the size of any structures or other works developed as part of the Project identified? (e.g. the floor area and height of buildings, the size of excavations, the area or height of planting, the height of structures such as embankments, bridges of chimneys, the flow or depth of water)	Yes	Yes	
1.18	Is the form and appearance of any structures or other works developed as part of the Projectdescribed? (e.g. the type, finish and colour of materials, the architectural design of buildings and structures, plant species, ground surfaces, etc.)	Yes	Yes	Given that the project is operational some supplementary photographs of the Development would be beneficial.
1.19	For urban or similar development projects, arethe numbers and other characteristics of new populations or business communities described?	No	N/A	
1.20	For projects involving the displacement of people or businesses, are the numbers and other characteristics of those displaced described?	No	N/A	
1.21	For new transport infrastructure or projects generating substantial traffic flows, is the type, volume, temporal pattern and geographical distribution of new traffic generated or divertedas a consequence of the Project described?	Yes	No	Whilst total increases in traffic during decommissioning are quantified, the number of vehicles per road link is not specified. Existing traffic flows are also not provided, therefore the total volume of traffic during decommissioning is not understood.
Production Processes and Resources Used				
1.22	Are all the processes involved in operating theProject described? (e.g. manufacturing or engineering processes, primary raw material production, agricultural or forestry production methods, extraction processes)	Yes	Yes	
1,23	Are the types and quantities of outputs produced by the Project described? (these could be primary or manufactured products, goods such as power or water or services such as homes, transport, retailing,	Yes	Yes	

	recreation, education, municipal services (water, waste, etc.))			
1.24	Are the types and quantities of raw materials and energy needed for construction and operation discussed?	Yes	No	Types of raw materials used in the construction are identified in Chapter 2. Quantities only given for some of the materials (concrete and crushed rock material). A Material Resources Chapter should be provided to set out the project's impact on the depletion of natural resources.
1.25	Are the environmental implications of the sourcing of raw materials discussed?	Yes	Yes	
1.26	Is efficiency in use of energy and rawmaterials discussed?	Yes	No	With the exception of using on site borrow pits (and associated reduction in materials movements), no further reference is made to measures taken to reduce the use of raw materials/use of energy.
1.27	Are any hazardous materials used, stored, handled or produced by the Project identified and quantified? • during construction • during operation • during decommissioning	Yes	Yes	

SECTION 1 DESCRIPTION OF THE PROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
1.28	Are the transport of raw materials to the Project and the number of traffic movementsinvolved discussed? (including road, rail and sea transport) • during construction • during operation • during decommissioning	Yes	No	Whilst total volumes of traffic are given during decommissioning, this has not been disaggregated into increases per road link. This additional information and evidence should be provided for the decommissioning of the project to understand the need for and effectiveness of mitigation measures.
1.29	Is employment created or lost as a result of the Project discussed? • during construction • during operation • during decommissioning	Yes	No	Failure of stability within the turbary area currently prevents access by the operator normally contracted by local stakeholders to obtain their winter fuel. The developers claim that the instability is not caused by their actions but available evidence suggests the possibility of a link. Investigation of the hydrological linkages between the windfarm drainage pattern and the identified zone of seepage associated with the areas of turbary slope failure is required.
1.30	Are the access arrangements and the number of traffic movements involved in bringing workers and visitors to the Project estimated? • during construction • during operation • during decommissioning	Yes	No	Whilst access arrangements and total volumes of traffic associated with personnel are given, this is not disaggregated to the link level.
1.32	Is the housing and provision of services for any temporary or permanent employees for the Project discussed? (relevant for Projects requiring migration of a substantial new workforce into the area for either construction or the long term)	No	N/A	
Residues and Emissions				

1.33	Are the types and quantities of solid waste generated by the Project identified? (including construction or demolition wastes, surplus spoil, process wastes, by-products, *surplus or reject products, hazardous wastes,* household or commercial wastes, agricultural or forestry wastes, site clean-up wastes, mining wastes, decommissioning wastes) • during construction • during operation • during decommissioning	Yes	No	Types of construction waste are identified but it is stated that construction waste quantities were not available for use in the rEIAR. However this information could have been estimated based on known construction details. No forecast quantities of waste during decommissioning are provided. A waste assessment should be undertaken to consider the likely significant effects of the project on the environment resulting from the disposal and recovery of waste.
1.34	Are the composition and toxicity or other hazards of all solid wastes produced by the Project discussed?	Yes	Yes	
1.35	Are the methods for collecting, storing, treating, transporting and finally disposing ofthese solid wastes described?	Yes	Yes	
1.36	Are the locations for final disposal of all solid wastes discussed?	Yes	Yes	
1.37	Are the types and quantities of liquid effluents generated by the Project identified? (including site drainage and run-off, process wastes, cooling water, treated effluents, sewage) • during construction • during operation • during decommissioning	No	N/A	Regular (at least monthly and ideally weekly) monitoring for DOC, POC and sediment load is required for all watercourses leaving the development site into all connected catchments.
1.38	Are the composition and toxicity or other hazards of all liquid effluents produced by theProject discussed?	No	N/A	
1.39	Are the methods for collecting, storing, treating, transporting and finally disposing ofthese liquid effluents described?	No	N/A	

SECTION 1	DESCRIPTION OF THE PROJECT			
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
1.40	Are the locations for final disposal of all liquid effluents discussed?	No	N/A	
1.41	Are the types and quantities of gaseous and particulate emissions generated by the Project identified? (including process emissions, fugitive emissions, emissions from combustion of fossil fuels in stationary and mobile plant, emissions from traffic, dust from materials handling, odours) • during construction • during operation • during decommissioning	Yes	No	Although carbon emissions from the development are presented as collective numbers derived from the various modules of the Scottish Government Carbon Calculator, individual input values are not presented. Consequently the collective numbers offered cannot be verified. These individual input values should be supplied, together with an explanation for each value used.
1.42	Are the composition and toxicity or other hazards of all emissions to air produce by the Project discussed?	No	N/A	
1.43	Are the methods for collecting, treating and finally discharging these emissions to air described?	No	N/A	
1.44	Are the locations for discharge of all emissions to air identified and the characteristics of the discharges identified? (e.g. height of stack, velocity and temperature of release)	No	N/A	
1.45	Is the potential for resource recovery from wastes and residues discussed? (including re-use, recycling or energy recovery from solid waste and liquid effluents)	Yes	No	A waste chapter should be provided which sets out the re-use and recycling rates.
1.46	Are any sources of noise, heat, light or electromagnetic radiation from the Project identified and quantified? (including equipment, processes, construction works, traffic, lighting, etc.)	Yes	Yes	
1.47	Are the methods for estimating the quantities and composition of all residues and emissions identified and any difficulties discussed?	No	N/A	
1.48	Is the uncertainty attached to estimates of residues and emissions discussed?	No	N/A	
Risks of Accidents and Hazards				

1.49	Are any risks associated with the Project discussed? • risks from handling of hazardous materials • risks from spills fire, explosion • risks of traffic accidents • risks from breakdown or failure ofprocesses or facilities • risks from exposure of the Project to natural disasters (earthquake, flood, landslip, etc.)	Yes	No	The risk of a further peat slide following decommissioning is not adequately addressed.
1.50	Are measures to prevent and respond to accidents and abnormal events described? (preventive measures, training, contingency plans, emergency plans, etc.)	Yes	No	A contingency plan has not been prepared to address the risk of a further peat slide even this was recommended in the AGEC (2004) report.

SECTION 2	CONSIDERATION OF ALTERNATIVES			
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
2.1	Is the process by which the Project was developed described and are alternatives considered during this process described? (for assistance, see the guidance on types of alternatives which may be relevant in Part B3 of the Scoping Guide in this series)	Yes	Yes	
2.2	Is the baseline situation in the No Project situation described?	Yes	Yes	
2.3	Are the alternatives realistic and genuine alternatives to the Project?	Yes	No	Consideration of alternative renewable technologies on the site do not seem realistic or genuine alternatives. The decommissioning and remediation options are given very brief consideration, and the reasons for selecting the chosen option are not dealt with in much detail. Further consideration of remediation and decommissioning options should be provided. The removal of turbines and access tracks prior to decommissioning should be considered as a reasonable alternative to ameliorate any adverse effects generated by the development.
2.4	Are the main reasons for choice of the proposed Project explained, including any environmental reasons for the choice?	Yes	Yes	
2.5	Are the main environmental effects of the alternatives compared with those of the proposed Project?	Yes	Yes	

SECTION 3 DESCRIPTION OF ENVIRONMENT LIKELY TO BE AFFECTED BY THEPROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
Aspects of the Environment				
3.1	Are the existing land uses of the land to be occupied by the Project and the surrounding area described and are any people living on or using the land identified? (including residential, commercial, industrial, agricultural, recreational and amenity land uses and any buildings, structures or other property)	Yes	No	Sufficient information / description of communities within the surrounding area not provided; recreation and amenity not adequately discussed; agricultural uses not identified.
3.2	Are the topography, geology and soils of the land to be occupied by the Project and the surrounding area described?	Yes	Yes	
3.3	Are any significant features of the topography or geology of the area described and are the conditions and use of soils described? (including soil quality stability and erosion, agricultural use and agricultural land quality)	Yes	No	Mapping is required of forestry plough lines, fissures along these ploughing furrows caused by peat shrinkage, and presence of other signs of peat deformation (such as sub-surface peat pipes).
3.4	Are the fauna and flora and habitats of the land to be occupied by the Project and the surrounding area described and illustrated on appropriate maps?	Yes	Yes	
3.5	Are species populations and characteristics of habitats that may be affected by the Project described and are any designated or protected species or areas defined?	Yes	Yes	
3.6	Is the water environment of the area described? *(including running and static* surface waters, groundwaters, estuaries, coastal waters and the sea and including run off and drainage. NB not relevant if water environment will not be affected by the Project)	Yes	Yes	
3.7	Are the hydrology, water quality and use of any water resources that may be affected bythe *Project described? (including use for* water supply, fisheries, angling, bathing, amenity, navigation, effluent disposal)	Yes	Yes	
3.8	Are local climatic and meteorological conditions and existing air quality in the area described? (NB not relevant if the atmospheric environment will not be	Yes	Yes	

	affected by the project)			
3.9	Is the existing noise climate described? (NB not relevant if acoustic environment will not be affected by the Project)	Yes	Yes	
3.10	*Is the existing situation regarding light, heat* and electromagnetic radiation described? (NB not relevant if these characteristics of the environment will not be affected by the Project)	Yes	Yes	
3.11	Are any material assets in the area that may be affected by the Project described? (including buildings, other structures, *mineral resources, water resources)*	Yes	Yes	
3.12	Are any locations or features of archaeological, historic, architectural or othercommunity or cultural importance in the area that may be bisected the Project described, including any designated or protected sites?	Yes	No	Consideration of the archaeological potential of peat deposits should be provided.
3.13	Is the landscape or townscape of the area thatmay be affected by the Project described, including any designated or protected landscapes and any important views or viewpoints?	Yes	No	All the viewpoints are from roads so only cover transient views. There are no viewpoints from public footpaths so amenity views are not captured.

SECTION 3 DESCRIPTION OF ENVIRONMENT LIKELY TO BE AFFECTED BY THEPROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
3.14	Are demographic, social and socio-economic conditions (e.g. employment) in the area described?	Yes	No	Basic demographic information (population numbers) provided, but no further context added.
3.15	*Are any future changes in any of the above* aspects of the environment, that may occur in the absence of the project, described? (the so-called Moving Baseline or No Project situation)	No	N/A	
Data Collection and Survey Methods				
3.16	Has the study area been defined widely enough to include all the area likely to be significantly affected by the Project?	Yes	Yes	
3.17	Have all relevant national and local agencies been contacted to collect information on the baseline environment?	Yes	No	No details are included with regard to stakeholder engagement are provided. If any engagement was undertaken this should be provided.
3.18	Have sources of data and information on the existing environment been adequately referenced?	Yes	No	Much relevant information contained within Lindsay & Bragg (2005) is not referred to, and should now be addressed.
3.19	Where surveys have been undertaken as part of the Environmental Studies to characterise the baseline environment are the methods used, any difficulties encountered and any uncertainties in the data described?	Yes	No	Extensive use of shear vane testing forms a key part of the slope stability assessment. There is much discussion within the relevant scientific literature about the debatable value of shear vane testing in peat, and the guidance claimed to be used by the rEIAR is very specific about these uncertainties. The rEIAR should include a meaningful discussion about the uncertainties involved in shear vane testing for peat soils.
3.20	Were the methods used appropriate for the purpose?	Yes	No	Notwithstanding the uncertainties associated with the use of shear vane testing in peat, the majority of results for the site were obtained using one of the smallest available shear vane devices – a device which can in any case only probe to a depth of 3 m – whereas specialist guidance recommends use of the largest vane size possible because large vane sizes are thought to reduce (but not eliminate) the errors. Re-survey of the site should be undertaken using a large-vaned (200+ mm)

				capable of testing to the full depth of the deepest peat.
3.21	Are any important gaps in the data on the existing environment identified and the *meansused to deal with these gaps during* the assessment explained?	Yes	No	The <u>existing</u> peat environment across the site as a whole has not been described because the site-wide field data were obtained some 15 years ago and the rEIAR states repeatedly that conditions have changed since then. New site-wide peat soil and hydrological data are required to substantiate this assertion. Limited instrumental monitoring was decommissioned in 2014. A site-wide set of instrumentation should be installed to provide ongoing evidence of site condition and stability.
3.22	If surveys would be required to adequately characterise the baseline environment but they have not been practicable for any reason, are the reasons explained and proposals set out for the surveys to be undertaken at a later stage?	Yes	Yes	

SECTION 4 DESCRIPTION OF THE LIKELY SIGNFICANT EFFECTS OF THE PROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
Scoping of Effects				
4.1	Is the process by which the scope of the Environmental Studies was defined described? (for assistance, see the Scoping Guide in this series)	Yes	No	There is no evidence of engagement with stakeholders to define and agree the scope of works, but best practice guidance has been followed.
4.2	Is it evident that a systematic approach to scoping was adopted?	Yes	No	There is no evidence of engagement with stakeholders to define and agree the scope of works.
4.3	Is it evident that full consultation was carried out during scoping?	Yes	No	There is no evidence of engagement with stakeholders to define and agree the scope of works.
4.4	Are the comments and views of consultees presented?	Yes	No	There is no evidence of engagement with stakeholders to define and agree the scope of works.
Prediction of Direct Effects				
4.5	Are direct, primary effects on land uses, people and property described and where appropriate quantified?	Yes	No	Direct, primary effects on land uses including farmland and turbary have not been properly described or quantified. Effects on people have not been described in sufficient detail, for example there is no detailed description of individual communities and populations to enable a robust assessment of these areas to take place.
4.6	Are direct, primary effects on geological features and characteristics of soils described and where appropriate quantified?	Yes	No	The effect of drainage for the windfarm infrastructure is discussed only in terms of increased strength or the peat resulting from actively managed drainage but there is no recognitions that such drainage also causes long-term shrinkage and cracking of peat soils, reducing the overall stability of the peat, particularly under projected climate conditions of long dry spells and intense rainfall. The peat slide risk assessment should be repeated using new field data for the condition of the peat soil and its hydrology across the site.
4.7	Are direct, primary effects on fauna and flora and habitats described and where appropriate quantified?	Yes	Yes	
4.8	Are direct, primary effects on the hydrology and water quality of water features described	Yes	No	Hydrology and peat soils are intimately related. See comment under 4.6.

	and where appropriate quantified?			
4.9	Are direct, primary effects on uses of the water environment described and where appropriate quantified?	Yes	Yes	
4.10	Are direct, primary effects on air quality and climatic conditions described and where appropriate quantified?	Yes	No	Individual component input values to the Scottish Government Carbon Calculator are not presented, so although collective values are quantified it is impossible to validate these. Individual input values to the Carbon Calculator should be presented and explained.
4.11	Are direct, primary effects on the acoustic environment (noise or vibration) described and where appropriate quantified?	Yes	Yes	
4.12	Are direct, primary effects on heat, light or electromagnetic radiation described and where appropriate quantified?	Yes	Yes	
4.13	Are direct, primary effects on material assets and depletion of non-renewable natural resources (e.g. fossil fuels, minerals) described?	Yes	No	A Material Resources Chapter should be provided to set out the project's impact on the depletion of natural resources.
4.14	Are direct, primary effects on locations or features of cultural importance described?	Yes	Yes	
4.15	Are direct, primary effects on the quality of thelandscape and on views and viewpoints described and where appropriate illustrated?	Yes	Yes	
4.16	Are direct, primary effects on demography,social and socio-economic condition in the area described and where appropriate quantified?	Yes	No	Impacts of the project on recreational activities and amenity in the vicinity of the project are not considered to be adequately dealt with.
Prediction of Secondary, Temporary, Short Term, Permanent, Long Term, Accidental, Indirect, CumulativeEffects				

SECTION 4 DESCRIPTION OF THE LIKELY SIGNFICANT EFFECTS OF THE PROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
4.17	Are secondary effects on any of the above aspects of the environment caused by primary effects on other aspects described and where appropriate quantified? (e.g. effects on fauna, flora orhabitats caused by soil, air or water pollution or noise; effectson uses of water caused by changes in hydrology or water quality; effects on archaeological remains caused by desiccation of soils)	Yes	Yes	
4.18	Are temporary, short term effects caused during construction or during time limitedphases of project operation or decommissioning described?	Yes	Yes	
4.19	Are permanent effects on the environment caused by construction, operation or decommissioning of the Project described?	Yes	No	An explanation is required of the ecological and hydrological implications of leaving the roads, turbine bases and peat repository sites in place on decommissioning.
4.20	Are long term effects on the environment caused over the lifetime of Project operations or caused by build up of pollutants in the environment described?	Yes	No	Despite emphasising the importance for peat-slope stability of maintaining an efficient drainage system and prevention of water ponding during the life of the windfarm, the rEIAR proposes that the drainage system be allowed to choke up naturally (and therefore pond water) after decommissioning. The implications of this for subsequent peat slope stability should be evaluated and quantified.
4.21	Are effects which could result from accidents, abnormal events or exposure of the Project to natural or man-made disasters described and where appropriate quantified?	Yes	No	The effect of site drainage and consequent shrinkage and cracking of the peat is to make the peat mantle more prone to slope failure in the event that climate change results in longer dry spells followed by intense rainfall associated with convective storms. The implications of such a scenario should be evaluated.
4.22	Are effects on the environment caused by activities ancillary to the main project described? (ancillary activities are part of the project but usually take place distant from the main Project location e.g. construction of access routes and infrastructure, traffic movements, sourcing of aggregates or other raw materials,	Yes	No	Whilst offsite traffic movements are forecast, the magnitude of impacts and sensitivity of the existing environment are not defined. The significance of traffic and transport effects is therefore not adequately assessed.

	generation and supply of power, disposal of effluents or wastes			
4.23	Are indirect effects on the environment caused by *consequential development* described? (consequential development is other projects, not part of the main Project, stimulated to take place by implementation of the Project e.g. to provide new goods or services needed for the Project, to house new populations or businesses stimulated by the Project)	No	N/A	
4.24	Are *cumulative effects on the environment* off the Project together with other existing or planned developments in the locality described? (different future scenarios including a worst case scenario should be described). For further guidance on assessment of cumulative impacts see http://europa.eu.int/comm/ environment/eia/eia-support	Yes	No	An assessment of the cumulative tree felling at the site and in the surrounding area should be undertaken.
4.25	Are the geographic extent, duration, frequency, reversibility and probability of occurrence of each effect identified as appropriate?	Yes	No	In relation to peat slide risk, various 'likelihood' values are presented but the derivation of these values either does not follow the method recommended by the adopted guidance, or in the case of the key assessments presented, are not explained at all. A revised 'likelihood' assessment should be presented based on up-to-date field data.
Prediction of Effects on Human Health and Sustainable Development Issues				
4.26	Are primary and secondary effects on human health and welfare described and where appropriate quantified? (e.g. health effects caused by release of toxic substances to the environment, health risks *arising from major hazards associated with* the Project, effects caused by changes in disease vectors caused by the project, changes in living conditions, effects on vulnerable groups)	Yes	No	The peat slide risk assessment for the main site is not based on relevant (i.e. recent) data and key steps are not explained, but suggest that there is no risk to human health and welfare. Consequently the possible scale of peat slide risk to human health and welfare is not discussed. Once a revised peat slide risk assessment has been generated, the potential for risk to human health and welfare should be revisited.
4.27	Are impacts on issues such as biodiversity, global climate change and sustainable development discussed where appropriate?	Yes	Yes	
Evaluation of the Significance of Effects				

SECTION 4 DESCRIPTION OF THE LIKELY SIGNFICANT EFFECTS OF THE PROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
4.28	Is the significance or importance of each predicted effect discussed in terms of its compliance with legal requirement and the number, importance and sensitivity of people, resources or other receptors affected?	Yes	No	Lindsay & Bragg (2005) point to the use of avalanche corridor mapping, as used in alpine regions to generate maps of potential impact should peat slope failure occur down the many potential avenues highlighted by Lindsay & Bragg (2005). This approach should be employed to highlight potential areas of impact.
4.29	Where effects are evaluated against legal standards or requirements are appropriate local, national or international standards used and relevant guidance followed?	Yes	Yes	
4.30	Are positive effects on the environment *described as well as negative effects?*	Yes	Yes	
4.31	Is the significance of each effect clearly explained?	Yes	No	The assessment would benefit from tabulating receptors, their attributes, value assigned and rationale for this.
Impact Assessment Methods				
4.32	Are methods used to predict effects described and are the reasons for their choice, any difficulties encountered and uncertainties in the results discussed?	Yes	Yes	
4.33	Where there is uncertainty about the precise details of the Project and its impact on the environment are worst case predictions described?	Yes	Yes	
4.34	Where there have been difficulties in compiling the data needed to predict or *evaluate effects are these difficulties* acknowledged and their implications for the results discussed?	Yes	Yes	
4.35	Is the basis for evaluating the significance or importance of impacts clearly described?	Yes	Yes	
4.36	Are impacts described on the basis that all proposed mitigation has been implemented i.e. are residual impacts described?	Yes	Yes	
4.37	Is the level of treatment of each effect appropriate to its importance for the development consent decision? Does the discussion focus on the key issues and avoid irrelevant or unnecessary information?	Yes	No	The assessment of effects is lengthy, and all degrees of effect are described in the same detail. The assessment could be reported in a more focused and concise way.

4.38	Is appropriate emphasis given to the most severe, adverse effects of the Project with lesser emphasis given to less significant effects	Yes	No	See above comment

SECTION 5 DESCRIPTION OF MITIGATION

No.	Review Question	Relevant?	Adequately Addressed?	What further information is needed?
5.1	Where there are significant adverse effects on any aspect of the environment is the potential for mitigation of these effects discussed?	Yes	Yes	
5.2	Are any measures which the developer proposes to implement to mitigate effects clearly described and their effect on the magnitude and significance of impacts clearly explained?	Yes	No	Residual effects following the implementation are set out but the effect of mitigation measures on magnitude and significance of impacts is not clear.
5.3	If the effect of mitigation measures on the magnitude and significance of impacts is uncertain is this explained?	Yes	No	
5.4	Is it clear whether the Developer has made a binding commitment to implement the proposed mitigation or that the mitigation measures are just suggestions or recommendations?	Yes	No	No details of securing mechanisms for the proposed mitigation measures are included
5.5	Are the Developer's reasons for choosing the proposed mitigation explained?	Yes	Yes	
5.6	Are responsibilities for implementation of mitigation including funding clearly defined?	Yes	No	No details of these aspects are provided
5.7	Where mitigation of significant adverse effects is not practicable or the developer has chosen not to propose any mitigation are the reasons for this clearly explained?	Yes	N/A	
5.8	Is it evident that the EIA Team and the Developer have considered the full range of possible approaches to mitigation including measures to reduce or avoid impacts by alternative strategies or locations, changes to the project design and layout, changes to methods and processes, "end of pipe" treatment, changes to implementation plans and management practices, measures to repair or remedy impacts and measures to compensate impacts?	Yes	No	Although removal of turbines is not considered as a mitigation measure. There is also no plan for experimental testing of options to establish peat slope stability through restoration of a peat-forming habitat as the final stage of decommissioning. Such a programme is required to ensure long-term stability of the peat mantle across the site.
5.9	Are arrangements proposed to monitor and manage residual impacts?	Yes	No	
5.10	Are any negative effects of the proposed mitigation described?	Yes	No	

SECTION 6 NON TECHNICAL SUMMARY				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
6.1	Does the Environmental information include a Non-Technical Summary?	Yes	Yes	
6.2	Does the Summary provide a concise but comprehensive description of the Project, its environment, the effects of the Project on the environment and the proposed mitigation?	Yes	Yes	
6.3	Does the Summary highlight any significant uncertainties about the Project and its environmental effects?	Yes	Yes	The summary should highlight the uncertainties surrounding the assessment – particularly with regard to the retrospective nature of the assessment.
6.4	Does the Summary explain the development consent process for the Project and the role ofEIA in this process?	Yes	Yes	
6.5	Does the Summary provide an overview of the approach to the assessment?	Yes	Yes	
6.6	Is the Summary written in non-technical language, avoiding technical terms, detailed data and scientific discussion?	Yes	Yes	
6.7	Would it be comprehensible to a lay member of the public?	Yes	No	The documents are too long and contain large volumes of contextual information that draw focus away from the assessment.

SECTION 7 QUALITY OF PRESENTATION				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
7.1	Is the Environmental Information available in one or more clearly defined documents?	Yes	Yes	
7.2	Is the document(s) logically organised and clearly structured so that the reader can locate information easily?	Yes	No	Appendices are poorly labelled and it is not possible to identify their content without opening.
7.3	Is there a table of contents at the beginning of the document(s)	Yes	Yes	
7.4	Is there a clear description of the process which has been followed?	Yes	Yes	
7.5	Is the presentation comprehensive but concise, avoiding irrelevant data and information?	Yes	No	The reports include large volumes of information that make it difficult to follow the assessment.
7.6	Does the presentation make effective use of tables, figures, maps, photographs and other graphics?	Yes	Yes	
7.7	Does the presentation make effective use of annexes or appendices to present detailed data not essential to understanding the main text?	Yes	No	
7.8	Are all analyses and conclusions adequately supported with data and evidence?	Yes	No	
7.9	Are all sources of data properly referenced?	Yes	Yes	
7.10	Is consistent terminology used throughout the document(s)?	Yes	Yes	
7.11	Does it read as a single document with cross referencing between sections used to help the reader navigate through the document(s)?	Yes	Yes	
7.12	Is the presentation demonstrably fair and as far as possible impartial and objective?	Yes	No	

APPENDIX B

List of Complaints

Complainant	Summary of Complaint	Date Received
European Environmental Bureau	Substitute Consent Provisions	11 December 2020
South Galway Flood Relief Committee – David Murray	Flooding – lack of consultation and inaccuracies in the assessment	26 October 2020
National Parks and Wildlife – Patrick White	Siltation impact on qualifying features of European Designation Sites	11 March 1998
Duchas Heritage Service – Joanna Modzelewska	Lack of consideration of Protected Bird Species	20 September 2001
Martin Collins	No public participation and non-compliant rEIAR	12 October 2020
Martin Collins	Inadequate public consultation process	10 December 2020
Martin Collins	Infringement of turbary rights	26 April 2020
Peter Crossan	Unlawful consenting process	18 December 2020

List of Reviewed Derrybrien Wind Farm Project Documents

Document
Cover Letter
Application form
EIA portal confirmation notice
Site notice as erected on site at various locations on 21st August 2020
Newspaper notice as published in the Irish Independent and Connacht Tribune
Planning Report
Plans and Drawings
Remedial Environmental Impact Assessment Report
Remedial Natura Impact Statement

APPENDIX C

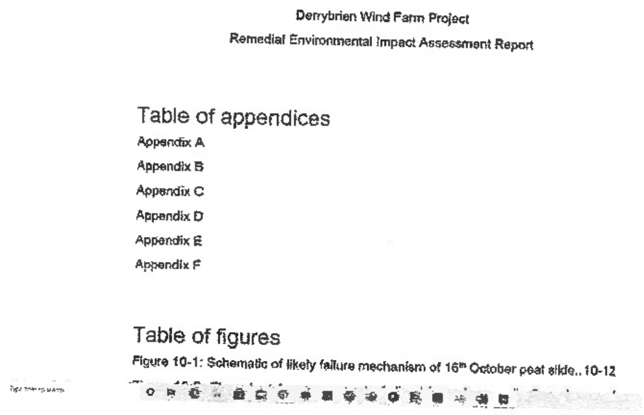
Geology and Soils – Supplementary Critique

Appendix C: Chapter 10. Geology, Soils and Land

1. Issues of Administration, Submission and Omission

The main rEIAS document, namely Chapter 10 – Soils, Geology and Land, Document No.: QS-000280-01-R460-001-000, submitted by ESB is essentially a synthesis of data and procedures rather than a presentation of the core factual information. The details of actual procedures, key data and decision-steps are largely contained in an Appendix titled Chapter 10 – Soils, Geology and Land Appendices, Document No.: QS-000280-01-R460-001-000.

The rEIAS document provides a list of contents for the document itself, but provides no information in the Contents pages about what is contained within the Appendices (see attached Figure).



Derrybrien Wind Farm Project
Remedial Environmental Impact Assessment Report

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Figure 10-1: Schematic of likely failure mechanism of 16th October peat slide.. 10-12

Figure 1: Contents of Appendices as listed in the Chapter 10 Main Chapter

This provided list of Appendices suggests that there are six Appendices, A – F, but what these contain and what their significance might be is left to the reader to guess. Turning to the Appendix document itself (namely Chapter 10 – Soils, Geology and Land <u>Appendices</u>, Document No.: QS-000280-01-R460-001-000), this provides no Contents page or Index at all, other than the contents pages of the individual reports presented within the appendices – to which there is no guide at the start of the document. Furthermore, it emerges that there are not six Appendices but instead a nested multitude of Appendices, in some cases going down as far as four levels of Appendix.

Lacking any sort of Contents page, this 2640-page document would be considered by many to be <u>not fit for purpose</u>, particularly as much crucial information is provided only within the Appendices document rather than in the rEIAS itself. As such, this raises questions about whether the rEIAS is itself fit for purpose.

2. Official rEIAS Guidance documents – the context

2.1 Legal requirements and available guidance

The legal basis of the requirement for an EIA in this case is Council Directive 85/337/EEC, in which Article 5 states that the following information must, as a minimum, be supplied with respect to the development proposal:

- a description of the project comprising information on the site, design and size of the project;
- a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects;
- the data required to identify and assess the main effects which the project is likely to have on the environment;
- a non-technical summary of the information mentioned in indents 1 to 3 .

Guidance for projects required to undertake such an EIA is provided in the form of:

- European Commission (2017) *Environmental Impact Assessment of Projects - Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU),* and
- European Commission (1999) *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions.*

While these guidance documents provide much valuable information about setting out what should be included within an EIA, this information is necessarily generic because it is designed to cover all forms of potential development. Consequently, while the topic headings and principles are valuable guides for any form of development there is nothing specific to windfarm development on peat. The onus is on the developer to ensure that the an EIA is conducted in such a way that the findings will meet the required generic requirements. In order to meet such requirements it is evident that the developer must make use of the best available guidance specific to windfarm development on peat covered landscapes.

The rEIAS investigations into geology, soils and land are thus best viewed within the context of rEIAR's own professed intent to follow the best available official guidance. The precise nature of the guidance followed for various stages in the assessment, however, is not always entirely clear because the work is variously described as having been undertaken in accordance with two (or more) different documents. The two main documents referred to are:

- **Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Projects, published by the Scottish Government Energy Consent Unit (2nd Edition, April 2017)**; and

- ***EPA 2017 Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.***

No specific reference is made in the rEIAR to the 1999 and 2017 EU guidance documents, though the EPA 2017 Draft Guidelines refer extensively to the requirements set out in the Directive itself, as amended.

Given the complexity of the rEIAS and its accompanying Appendix document, specific reference to particular parts of these documents will be indicated thus: '*Example*'

2.2 Documents referred to as the basis for the rEIAS assessment of Geology, Soils and Land

'*Section 10.1.2.2*' states that the probability of peat failure has been assessed "*...in accordance with current best practice guidelines for peat landslide hazard and risk assessments for wind farm developments on upland blanket bogs (e.g.* ***Scottish Government – Energy Consent Unit, 2017****).*"

'*Section 10.1.2.2*' goes on to state that the impact assessment "*...has necessarily been carried out in accordance with the current* ***EPA Guidelines (EPA, 2017)*** *as well as current best practice guidelines for peat landslide hazard and risk assessments for wind farm developments on upland blanket bogs* ***(Scottish Government – Energy Consent Unit, 2017)***".

'*Section 10.1.2.2*' also observes that the Scottish Government guidance was "*...first referenced for assessing the impact of wind farms on peat soils in the 2008 version of the* ***Best Practice Guidelines for the Irish Wind Energy Industry (IWEA, 2008)***" but it is not made clear whether the current rEIAR assessment used these Irish Wind Energy Industry guidelines.

'*Section 10.1.5*' then states that the methodology used "to assess the impact of the various project activities on the receiving soils, geology and land on the site is based on the recommendations in **Section 3.7 of the 2017 Draft EPA Guidelines on Information to be Contained in Environmental Impact Assessment Reports (Environmental Protection Agency, 2017)**".

It also notes, under Probability of Occurrence (Peat Failure) that the assessment is "consistent with the **EPA Guidelines (EPA, 2017)** as well as current best practice guidelines for peat landslide hazard and risk assessments in **Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Projects, 2nd Edition, April 2017 (Scottish Government – Energy Consent Unit, 2017).**"

'*Section 10.2.4*' states that "...peat stability assessments *have been carried out in accordance with the best practice guidelines given in "****Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Projects, published by the Scottish Government Energy Consent Unit (2nd Edition, April 2017)****"*.

'Section 10.2.4.1' states that the Peat Slide Risk Assessment (PSRA) "*...has been carried out in accordance with the current best practice guidelines for peat landslide risk assessments for wind farms on upland blanket bogs* ***(Scottish Government, Energy Consent Unit, 2017)***".

'Section 10.2.4.3' states that the stability risk assessment for the Peat Slide-Source Area was undertaken "*...in accordance with the best practice guidelines*" and then cites the **Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Projects, published by the Scottish Government Energy Consent Unit (2nd Edition, April 2017).**

'Section 10.3.2.1.1.3' states that the probability of peat failure associated with the Construction Phase (2003-2006) has been assessed in a way that is "*...consistent with the* ***EPA Guidelines (2017)*** *as well as current best practice guidelines for peat stability risk assessments* ***(Scottish Government, Energy Consent Unit, 2017)***".

'Section 10.3.2.1.1.3.1' considers those effects of the 2003 peat slide on the receiving soils, geology and land that were considered 'Significant', and notes that the compounding factors identified by AGEC (2003) "*...would indicate that the peat on the slope in this area could have been at or close to the point of failure when the construction works were being carried out. This is consistent with the current best practice guidelines for assessing the risk of peat instability for wind farm developments on upland blanket bogs* ***(Scottish Government – Energy Consent Unit, 2017)***".

'Section 10.7: Conclusions' – states "*The assessment has been carried out in accordance with the 2017* ***EPA Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.***"

2.3 Content and quality of referenced guidance documents

Accepting that these various documents have acted as the framework shaping the nature and content of the rEIAR, it is instructive to examine the quality and content of these referenced documents themselves within the context of the subject-specific issues relevant to the rEIAR.

Considering firstly the oldest of the documents referred to – namely the ***Best Practice Guidelines for the Irish Wind Energy Industry (IWEA, 2008, updated 2012)*** – this itself refers to an even earlier document: **Geology in Environmental Impact Statements – A Guide" (2002)** published by the Institute of Geologists of Ireland. The latter older document does not specifically identify windfarm construction on peat as an activity but it sets out a general framework for geological investigation, consisting of:

- The use of regional geology maps.

- A site investigation to include the appropriate use of mapping, sampling, trenching/pitting, drilling, geophysics, geotechnical appraisal of soil and rock properties and laboratory analysis of soil, rock and water samples.
- The preparation of a geological report including appropriate maps and sections.

The **2012 IWEA Guidelines** then identify a longer list of factors to consider for *windfarm projects on peat but provide no further detail (in fact less detail) than that* offered by the IGI guidance:

- impacts on ground stability;
- contamination of the soil by leakages or spillages;
- compaction of the soil and removal of the soils from site;
- the removal of surficial/bedrock deposits and stability of same;
- impact of construction activities on peatlands;
- impact on groundwater levels and abstraction potential and pollution of same;
- impact on geological heritage sites (CGS or NHA) identified by GSI.

The IWEA Guidelines also provide a flowchart (as an Appendix F) designed to guide decision-making in relation to the assessment of peat stability. The flowchart consists almost entirely of decision-making processes with just two boxes that *address actual assessment processes, described as:*

- Carry out Peat Stability Assessment; Produce Hazard Zone Plan;
- Carry out detailed site investigations where development impinges on peat-covered areas.

The practical guidance for site investigation is thus far based solely on the older, general guidance produced by IGI, which advises the developer to assess potential geology and soil impacts, and specifically peat stability, through the use of:

- mapping;
- sampling;
- trench/pitting;
- drilling;
- geophysics;
- geotechnical appraisal;
- laboratory analysis.

The later 2012 IWEA Guidelines provide no further detail about what type of sampling or geotechnical appraisal should be undertaken, nor how the results should be assessed.

The **EPA Draft Guidelines (2017) on the Information to be Contained in Environmental Impact Assessment Reports** represent the latest guidance provided to developers in Ireland, transposing the requirements of **EU Directive 2011/92/EU** and indicating subsequent changes required by the amending **EU Directive 2014/52/EU.** These Guidelines, however, contain no specific guidance about developments on peat soils. The guidance consists entirely of generic decision-making processes. Developers are given no guidance about what specifically should be assessed in relation to windfarm developments on peat. There is no reference even to the first edition of the **Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Projects,** published by the Scottish Government Energy Consent Unit and in its revised edition acknowledged in the rEIAS as the best available guidance for peatslide risk assessment.

When the rEIAS therefore states that its reporting is consistent with the *requirements of the **EPA Draft Guidelines (2017) on the Information to be*** **Contained in Environmental Impact Assessment Reports** what it means is that the recommended <u>decision-making steps</u> have been taken but this does not indicate that the decisions are based on appropriate testing or data. It would appear that the only source of subject-specific guidance for actual testing referred to (albeit indirectly) by the rEIAS and provided by the Irish authorities is the list of factors to measure originally set out in the **Geology in Environmental Impact Statements – A Guide"** *published in 2002 by the Institute of Geologists of Ireland.*

On the other hand, the rEIAS does state repeatedly that its testing and assessments are also based on the **Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Projects, published by the Scottish Government Energy Consent Unit (2nd Edition, April 2017)** – hereafter referred to as **SGG-2017**. This document <u>does</u> set out a detailed set of procedures for the testing of peat-covered landscapes subject to proposals for windfarm development.

2.4 Supplementary supporting reference material

Supplementing the SGG-2017 guidelines is a body of specialist literature which explores in considerable depth the current state of knowledge about peatslide events, what predisposes any given piece of ground to slope failure, and what factors may trigger such failure. Dykes (2008) summarises succinctly and effectively the factors which are now recognised as pre-disposing peat ground to instability as *well as the factors associated with triggering instability. The list is not long. It is* expressed with such clarity that the issues should be clear to the general reader. The key factors identified by Dykes (2008) are:

- Heavy rainfall being the trigger for the majority of peat landslides;
- Changing climate, giving drier summers and more intense rainfall events combine with cracking of the peat surface due to drying of the peat to generate various adverse hydrological effects;

- Land drains and boundary ditches acting to focus water runoff;
- Reduced lateral support caused by land drains and boundary ditches cutting through the peat matrix;
- Disruption of natural mechanical and hydrological continuity by a range of forestry activities;
- Loading of peat by 'floating' roads across the peat;
- Loading of peat by placement of excavated spoil on the peat.

Additional specialist literature includes O'Kelly (2017), Long, Jennings and Carroll (2011), Boylan, Jennings and Long (2008), Dykes (2008), Dykes and Warburton (2008), Dykes and Warburton (2007a,b), Dykes and Kirk (2006), Long and Jennings (2006), Yang and Dykes (2006), Creighton (2006), Long (2005), Warburton, Holden and Mills (2004), Lindsay and Bragg (2005).

While much of this body of knowledge is incorporated into SGG-2017, there are some issues where SGG-2017 acknowledges ongoing scientific uncertainty with respect to certain aspects of peatland properties. SGG-2017 therefore makes clear that an awareness of the available body of relevant literature should still shape actions in terms of data collection as well as informing subsequent decision-making.

In terms of the detailed site- and subject-specific objectives which the rEIAS sets for itself, it would therefore seem that these should be formally measured against the details set out in SGG-2017, particularly as this guidance fits seamlessly into the requirements set out in the Council Directive (as amended) and the guidance provided by the European Commission. This is particularly the case given the Irish authorities do not appear to have provided any detailed guidance for this topic. Given the centrality of SGG-2017 guidance to the work of the rEIAS, it is therefore worth using this guidance to evaluate and compare the data types, the data-gathering methods and the risk assessment procedures presented within the rEAIS.

3. Context of SGG-2017 and Derrybrien sequence of events

It is important to acknowledge that the original pre-construction EIS, as well as the start of construction, the major peatslide, the immediate post-peatslide responses and then final completion of construction, all pre-date publication of the SGG-2017 guidance. As such, close adherence to that particular guidance cannot necessarily be expected from those pre-2017 activities although it is reasonable to expect that these activities would be informed by specialist literature available at the time.

It is also necessary to point out that most of the immediate post-slide actions pre-dated publication of, and issues highlighted by, Lindsay & Bragg (2005) whose report underpinned subsequent rulings by the Irish High Court and by the Court of Justice of the European Communities.

Actions and data collection undertaken between 2005 and 2017 have, however, been undertaken in the knowledge of issues raised by Lindsay & Bragg (2005), as well as issues raised by AGEC (2004, 2005). It is also important to note that the first edition of the Scottish guidance was published in 2006.

The submitted rEIAS and the risk assessments it presents, however, post-date all of this published information and guidance. While the field data on which the rEIAS is *based comes from 2005 or earlier (a point that will be explored in more detail later)*, the procedures for peatslide risk assessment should have been made in the full knowledge of all the preceding information and guidance, and in particular the guidance provided by SGG-2017. Indeed, this is the stated approach of the rEIAS.

The sections below therefore follow the structure and headings of the SGG-2017 guidance.

4. Controls of peat instability - Overview

4.1 SGG-2017

The Scottish guidance begins with a context-setting review of peat landslides and the factors recognised as having a bearing on their likelihood. It categorises these factors under four main headings - preconditions, preparatory factors, pre-failure indicators and triggering factors.

4.1.1 Preconditions

These are described as 'static' or 'inherited' factors having the property of rendering any peat-covered slope more prone to slope failure, and, to a certain extent, generally being factors that cannot readily be altered and so must be allowed for:

- A peat layer overlying an impermeable mineral base (for example an iron pan);
- A convex slope or a slope with a break of slope;
- Proximity to zones of local drainage;
- Connectivity between surface drainage and sub-surface drainage, particularly connectivity to the peat-mineral interface.

4.1.2 Preparatory factors

These are defined as factors which change over time (tens to hundreds of years). They must therefore be catered for within both the design and operation of the development as well as in the years after development:

- Peat accumulation leading to increased mass on a slope;
- Increased water content (and thus mass) sitting on a slope;

These two factors are inherent parts of peat formation and accumulation. Nevertheless, although conventional slope-failure analysis and Factor of Safety

formulations identify increased mass on a slope as a factor which increases the potential for slope failure, in practice peatland systems appear to have a number of self-regulatory processes which act to reduce this tendency, resulting in the very low occurrence of failure within natural, undisturbed peat systems.

The Scottish Guidance then identifies a set of Preparatory factors associated with human disturbance which, in contrast, have often been associated with slope failure (e.g. *Warburton et al., 2004; Dykes & Warburton, 2008; Dykes, 2008*):

- Increased mass on a slope resulting from afforestation;
- Reduction in shear strength of peat or mineral base caused by cracking, chemical or physical weathering;
- Loss of surface vegetation and thus loss of associated tensile strength;
- Increased buoyancy through formation of sub-surface pools or water-filled pipe networks
- Increased buoyancy caused by wetting up of desiccated areas of peat (which becomes lighter and more buoyant when dried);
- Drying and cracking of the peat as a result of afforestation.

4.1.3 Pre-failure indicators

These indicators provide evidence that the site may be prone to slope failure based on identifiable features of features which should be investigated:

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

4.1.4 Triggering factors

Natural triggering factors commonly occurring in the UK are, of themselves, not necessarily or normally a threat to slope stability:

- Intense rainfall causing localised transient high pore-water pressures along potential rupture surfaces;
- Snow-melt causing similar effects.

Triggers associated with human activities include:

- Alteration of natural drainage pattern in such a way that drainage is focused to potential rupture surfaces (e.g. the peat-mineral interface);
- Ground accelerations caused by, for example, blasting, resulting in greater shear stress;
- Removal of the downslope 'toe' of a peat mass, reducing support to the peat upslope by, for example, construction of access tracks;
- Increased loading forces on the peat by, for example, heavy plant, structures or excavated arisings;
- Digging and tipping within the peat and sub-peat mineral base.

4.2 rEIAS - Controls of peat instability – Overview

The rEIAS does not specifically address at any point the list of preconditioning factors, preparatory factors, pre-failure indicators and triggering factors identified in the Scottish Government Guidance (2017) document. Most of these factors do appear in one form or another in one or more of the documents contained within the Appendix document but there is no direct use of these in setting the context of the rEIAS approach. It is reasonable to believe that these should have been considered as the framework for the rEIAS because, as with the SGG-2017, these factors inevitably set the context for all further work because these are what have been identified in the available literature as key contributors to peatslope stability. Instead, no formal framework for the rEIAS approach is presented within the introductory '*10.1.1 – Chapter Scope*', nor indeed at any later stage in the rEIAS.

The set of factors used by the rEIAS to set the context of Risk Assessment is found in '*Section 10.1.2.1*' where the rEIAS cites the conclusions of the AGEC (2004) report which recognises that a number of factors probably contributed to triggering the slide and influenced the scale of the slide. The factors listed by the rEIAS as *recognised by the AGEC survey of 2003 are:*

- Loading of the peat by floating roads;
- Presence of a natural drainage line;
- A zone of weaker peat within the drainage line;
- The fact that drainage works were being undertaken downslope from the head of the failure (which may have acted as the trigger, or contributed to triggering the slide); and
- Existing furrows within the afforested areas dissecting the peat.

The 2003 AGEC survey, however, also identifies that water pooled in the excavation associated with Turbine 68 may have been transmitted via sub-surface drainage systems to the base of the peat, leading to *"build-up of water pressure at the base of the peat reducing effective stresses"* and that evidence of previous instability may have played a factor (AGEC, 2004, p.5). These factors are not highlighted here in the rEIAS.

Even turning to '*Section 10.2.4 – Baseline Peat Stability Risk Assessment*', there is no review of site condition factors for the site, although SGG-2017 makes clear that these should underpin all peatslide risk assessment. The reader is referred to '*Appendix B*' which consists of numerous earlier reports and documents, the majority of which date from the period 2001-2005. Of the two AGL reports in '*Appendix B*' which are dated 2020 (and therefore post-date SGG-2017), the first provides a '*Geotechnical Characterisation of Baseline Site Conditions*'. This identifies some specific and some generalised factors which form the basis of the Risk Assessment, namely:

- Deposits of deep (3-6 m) and relatively deep (2-3m) weak peat (cu ≈ 4-5 kPa) with low infinite slope Factor of Safety (<1.0-1.3);
- Areas of intermediate slope angles of 3-5° in close proximity to a convex break in slope to slope angles >5°;
- *Zones that are in the broad valleys directly upslope from the rivers and* streams downslope from the site boundary;
- Zones of deep peat with poor drainage and ponded surface water at the head of a watercourse, or along the edges of the terraces on the north side of the site; and
- Areas adjacent to the previous slide that have similar site characteristics.

It is instructive to compare the lists given above with those set out in SGG-2017 as factors requiring consideration within a peatslide risk assessment but which are not specifically articulated as context for a risk assessment within the rEIAS documents described above. Although several of these factors feature in the data gathering process at various stages, their use within the actual risk assessments presented is, at best, obscure.

Preconditions

- Connectivity between surface drainage and sub-surface drainage, particularly connectivity to the peat-mineral interface.

Preparatory factors

- Increased mass on a slope resulting from afforestation;
- Reduction in shear strength of peat or mineral base caused by cracking, chemical or physical weathering;
- Loss of surface vegetation and associated tensile strength;
- Increased buoyancy through formation of sub-surface pools or water-filled pipe networks
- Increased buoyancy caused by wetting up of desiccated areas of peat (which becomes lighter and more buoyant when dried);
- Drying and cracking of the peat as a result of afforestation.

Triggering factors

- Climate change resulting in more violent storms with intense rainfall causing localised transient high pore-water pressures along potential rupture surfaces;
- Snow-melt causing similar effects.
- Alteration of natural drainage pattern in such a way that drainage is focused to potential rupture surfaces (e.g. the peat-mineral interface);
- Removal of the downslope 'toe' of a peat mass, reducing support to the peat upslope by, for example, construction of access tracks.

This is a substantial list of factors which do not feature in any clear or explicit way in the risk assessment processes set out in the rEIAS and its Appendices. The absence of such factors in risk-assessment thinking and framing perhaps explains a great deal of what then follows in the remainder of the rEIAS. It also highlights the first area in which the rEIAS departs from the SGG-2017 guidance.

5. *Methodology – Detailed site assessment*

Following an initial scoping exercise to determine whether a peatslide risk assessment is required, the recommended approach of SGG-2017 to peat landslide hazard risk assessment (PLHRA) consists of:

- a desk study of available material;
- site reconnaissance;
- site mapping and probing;
- hazard and risk assessment; and
- reporting.

5.1 Desk study

The desk study involves assembling and collating as much information as possible relevant to the character of the site and the behaviour of peat within the conditions *found on the site.*

5.1.1 SGG-2017 – Desk study

5.1.1.1 Extent of site investigations

The guidance emphasises that the assessment should not be restricted to the footprint of the development but must instead embrace "*...any areas of the*

landscape that the development might impact on…", and that *"Typically, the study area will be determined by catchments and topography…"*

5.1.1.2 Review of existing information

The guidance emphasises that *"…any and all relevant information relating to the site…"* should be identified and assembled in order to inform decision-making both in terms of designing an appropriate programme of field survey and monitoring, but also in assessing risk once the necessary information has been gathered and analysed.

5.1.2 rEIAS – Desk study

5.1.2.1 Extent of site investigations

In *'Section 10.1.2.2'* it is stated that the peatslide which occurred in October 2003 has been taken as the worst case scenario for the project. *'Section 10.1.5'* then further states that *"…the possible **Extent** of a peat slide and the **Sensitivity of the receiving soils, geology and land** have been calibrated by the scale of the very large peat slide that occurred on 16th October2003, and by the land that was directly impacted by the slide….Therefore, it has reasonably been considered as the worst-case scenario in assessing stability impacts on this project."*

This stated position does not reflect SGG-2017 guidance on determining the extent of area to be considered, nor can adopting only the area of the slide and the land directly impacted by the slide as the impact zone be justified on the basis that this is the 'worst-case scenario'. In terms of impact, material from the 2003 slide travelled 17 km to Lough Cutra causing substantial fish-kills and disruption to the water supply for the town of Gort.

While *'Chapter 10'* is focused on geology, soils and land, it is also the main vehicle for assessing the likelihood of peatslide risk and possible scale of impact. It cannot be the case, therefore that this chapter should define the extent of site investigations and assessment of impact solely on the basis of land potentially affected when it is clear from the 2003 peatslide (and other large slides which have occurred on windfarms in Ireland since) that the receiving area of impact for due assessment should include watercourses too. It should be noted that SGG-2017 makes no such distinction between geology, soils and aquatic environment when describing how the area of investigation and the receiving area of impact should be assessed.

Furthermore, the constrained approach adopted by Chapter 10 of the rEIAS does not meet the requirement set out in Para.109 of the Judgement of the Court (Second Chamber) 3 July 2008 of the Court of Justice of the European Communities, Case C-215/06, highlighting *'…the environmental sensitivity of*

the geographical area, which must be considered having regard, inter alia, to 'the absorption capacity of the natural environment', paying particular attention to mountain and forest areas.'

5.1.2.2 **Review of existing information**

There is a stark difference between the list of reference material cited by the SGG-2017 guidance (81 documents) and the reference material cited by the rEIAS (16 documents). Had the rEIAS reference list focused solely on papers directly linked to Derrybrien this small number might have been understandable, but only two of the 16 cited documents relate directly to Derrybrien (and one of these is mis-spelled). The remainder are more general references to peat and its properties. As such, the rEIAS appears to have shaped its content around a very limited information-base.

As an example, taking a single author cited in the rEIAS reference list, Dykes appears twice in the rEIAS references but five times in the SGG-2017 guidance, and since the 2003 peatslide alone he has published 19 papers relevant to the issues covered by the rEIAS. Dykes himself has identified 166 papers specific to peat failures or engineering on peat (but does not claim to have been comprehensive). Many of his papers highlight the challenges involved because of the relatively young and undeveloped science of peatland engineering compared with engineering in mineral soils – a point also highlighted in the SGG-2017 guidance.

Turning to the two references cited by the rEIAS which are relevant to Derrybrien itself, one has no direct link to the question of peatslope stability. Inis Environmental Services (2004) is instead concerned solely with the impact of the 2003 slide on the river ecology of the Owendalluleegh River and thus provides no information about the peat within the windfarm site.

In contrast, the second reference, Lindsay and Bragg (2005), explores in very considerable detail the background to the 2003 slide, the nature of the peatslide, the consequences of the slide, possible further areas of concern, and makes a number of recommendations about what further considerations should be given to a range of factors going forward into the future life (and afterlife) of the windfarm. The rEIAS, however, cites this report only with reference to the *additional* peatslide which occurred on Sonnach Old across the valley from the Derrybrien windfarm. It makes no use of the detail provided by Lindsay and Bragg (2005) about the Derrybrien windfarm development itself, despite the fact that this report was central to judgements by both the Irish High Court and the Court of Justice of the European Communities. A great many issues are highlighted by Lindsay and Bragg (2005) but none of these is acknowledged or addressed by the rEIAS.

The 18 reports contained within rEIAS Chapter 10 – Soils, Geology and Land Appendices, Document No.: QS-000280-01-R460-001-000, together cite 37 references which are new and are neither repeats from the main rEIAS report nor repeated in others of these 18 reports. Some 11 or 12 of the cited papers do address the challenges of testing and working with peat soils. Again, however, none of the reports refers to Lindsay and Brag (2005) nor the issues raised therein.

Also surprising is the fact that the rEIAS reference list does not include one the most extensive reviews of Irish landslides to date, which is Creighton (2006), *'Landslides in Ireland'* – a report of the Irish Landslide Working Group. This report examines Irish landslides as a whole, but provides extensive information about Irish peatslides, including the 2003 Derrybrien peatslide.

5.2 Reconnaissance – ground conditions assessment

A site reconnaissance survey is recommended by SGG-2017 as a means of confirming evidence provisionally identified during the desk study, to confirm the general condition of the site as a whole and identify any practical issues likely to be faced during the subsequent more detailed ground conditions assessment.

5.2.1 SGG-2017 – Site mapping

As the SGG-2017 guidance states, *"At its most basic, a geomorphological map [which is required] should show..."*:

- The position of major slope breaks;
- The position and alignment of major natural drainage features (e.g. peat gullies and streams);
- The location and extent of erosion complexes;
- Outlines of past peat landslides (including source areas and deposits), if visible;
- Location, extent and orientation of cracks, fissures, ridges and other pre-failure indicators.

Additionally:

- The position and alignment of artificial drains;
- Turbary;
- Forest stands.

In the case of Derrybrien, there are no erosion complexes but all other factors are relevant.

5.2.2 rEIAS – Site mapping

The rEIAS does not offer a **geomorphological map** of the type specified by SGG-2017, even "at its most basic", although a conventional geomorphological map is presented for the grid connection and then essentially repeated for the downstream landscape of the peatslide area (*'rEAIS, Figure 10-26 and Figure 10-32'*). The rEIAS provides various maps, including a map of slopes (*'rEIAS, Figure 10-6'*) and a map of drainage features, both natural and artificial (*'Drawing 003 of Appendix A of Appendix B'*, and *'rEIAS, Figure 10-16'*).

There is, however, no map indicating past slope failures even though the AGEC (2004) report indicates evidence of relict failure on the site's northern slopes (*'Appendix A, Fig.3'*). The maps of slopes are merely presented as they emerge from the mapping analysis with no apparent attempt to zone areas in relation to slope convexity or critical breaks in slope. While presenting an impressive appearance of detailed analysis, the key step of interpreting these results into something meaningful for peatslide risk is either absent or so obscurely hidden within decision-making that it cannot be identified.

Nor is there a **map indicating location, extent and orientation of cracks, fissures, ridges or other pre-failure indicators**. That such cracks and fissures exist at Derrybrien is highlighted repeatedly by Lindsay & Bragg (2005), who emphasise that cracks can be found extensively throughout the forested areas (see Figure 1).

Such cracking is a well-known phenomenon of plantations on peat as a result of drying out and consequent peat shrinkage. The smooth faces of many peat blocks, as illustrated by Lindsay & Bragg (2005), show where the peat separated into long ribbons of peat along these cracks during the 2003 slide. Such smooth-faced ribbons contrast markedly with the jagged faces of blocks typical of many peatslides where the peat has simply been torn apart.

A key, indeed a critical, part of the Derrybrien rEIAS should therefore have been the mapping of all such cracks and fissure, but the rEIAS makes no mention of such cracking. As SGG-2017 observes: *"In preparing assessments of peat stability, developers should give afforested peatlands (which are often hydrologically disrupted and physically degraded) the same scrutiny as peatlands without forest, even if this may be more arduous in practice (due to concealment of the ground surface by tree cover and associated access difficulties)."*

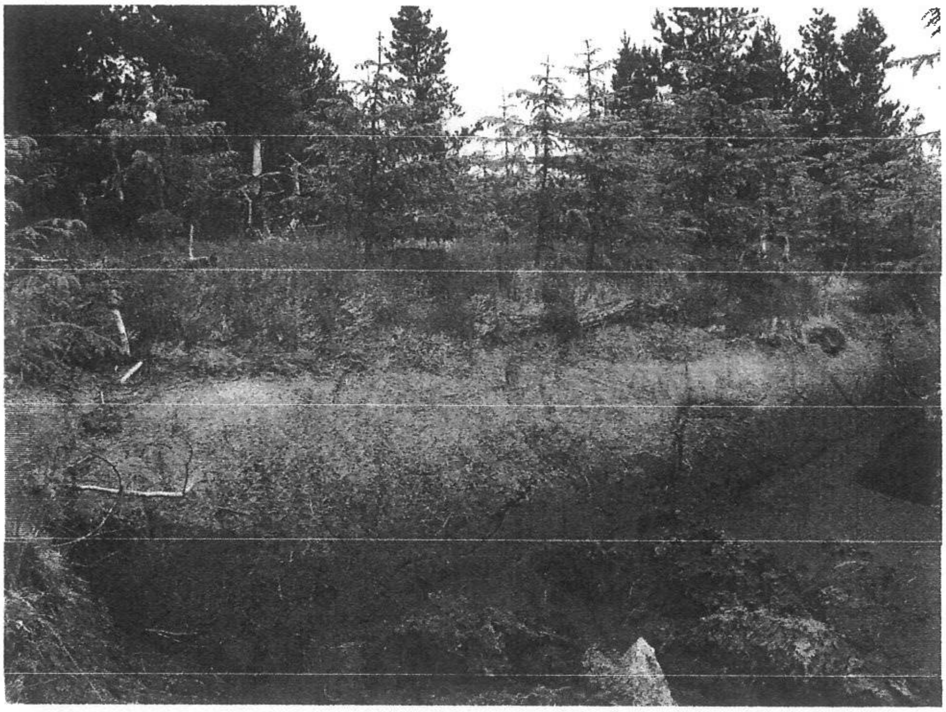

Figure 1. Smooth face of a peat crack, or fissure, resulting from peat shrinkage caused by water loss from the peat matrix as a result of drainage. The face is aligned along a former forestry ploughing furrow. Photograph taken during a 2004 field investigation of the Derrybrien windfarm site.

While the work undertaken between 2001 and 2005 evidently involved much arduous work in gathering data across the site, including within forested areas, there is not a single mention of mapping the cracks so clearly highlighted by Lindsay & Bragg (2005) within the forested areas. All references to cracks and fissures in the rEIAS relate to failures around turbines or roads, with no suggestion that cracks have developed or have been investigated elsewhere across the site.

Dykes (2008) summarises the risks poised by such regularly and intensively disrupted peat thus: *"...forestry operations necessarily disrupt the natural mechanical and hydrological continuity of the peat deposits through the pre-plantation ploughing and, in one known case so far, the loading of sloping blanket bog from a forestry road."* In terms of assessing peatslide risk it is thus clear that careful mapping of such shrinkage features created within the forestry land must be a priority.

It might be claimed that the windfarm operators were not responsible for the forestry and its impacts. This may be offered as justification for only looking at cracks and similar failures directly associated with windfarm infrastructure. However, by taking on responsibility for the land the operators also took on responsibility for the condition of that land, given that their operations have an

impact on the pre-existing condition of the land. This is particularly the case becasue the bulk of operations associated with the windfarm have since *increased* the rate of water loss from the peat habitat – indeed one of the key recommendations of the original AGEC (2004) report was that a 'robust drainage network' be established as quickly as possible across the site. Such operations can only have added to the existing shrinkage of the peat and prevented re-wetting of the ground where forestry has since been removed.

It might also be argued in defence that the majority of fieldwork had been completed by the time Lindsay & Bragg (2005) had been published and highlighted the presence of cracks, to which there are four possible responses:

- the evidence of intense cracking beneath forestry has been in the public domain since the 1990s, and Lindsay & Bragg (2005) merely highlighted what was already known;
- the AGEC (2004) report also mentions cracking within the forestry plantations;
- once the cracking had been pointed out, further ground survey should have been undertaken to establish the scale and extent of this problem. No such ground survey has ever been undertaken;
- by 2020, ignorance of such cracking is not a tenable position, meaning that it should have played a key part in the peatslide risk assessment undertaken in 2020.

It seems likely that there is further failure in basic mapping of the ground condition in terms of how the information obtainable from **aerial photography has been interpreted**. With reference to the aerial photographs provided as *'Figure 10-4 in Section 10.2.1.3'* of the rEIAS and *'Figure 2-1 of Appendix E'*, the latter figure points to a dark sinuous band of colour crossing the turbary area and describes it as *'deep peat along subsurface drainage channel'* which is undoubtedly the case, given the sinuous nature of the dark shading.

A similar band of sinuous shading which forms a huge crescentic shape leading down into the same 'shallow valley' which experienced the 2003 peatslide (see Figure 2) is merely identified (along with others) as an *'Area of deeper peat and high water table on flat terraces (Darker vegetation)'* but with no mention of the (very likely) possibility that this, too, is an area of sub-surface piping and/or seepage. Furthermore, the dark zones identified in the NW corner of the aerial photograph and lying just outside the windfarm boundary actually point downslope and converge on a natural drainage line, so it is possible that these, too, are seepage zones or areas of sub-surface piping.

Further areas of dark ground can just be discerned vanishing into the forest blocks within the windfarm site, so it is possible that sub-surface seepage is widespread within the site. These may be natural zones of seepage, but published evidence from, for example, Holden *et al.* (2002) and Holden (2005) have identified a clear linkage between drying peatlands and prevalence of sub-surface piping.

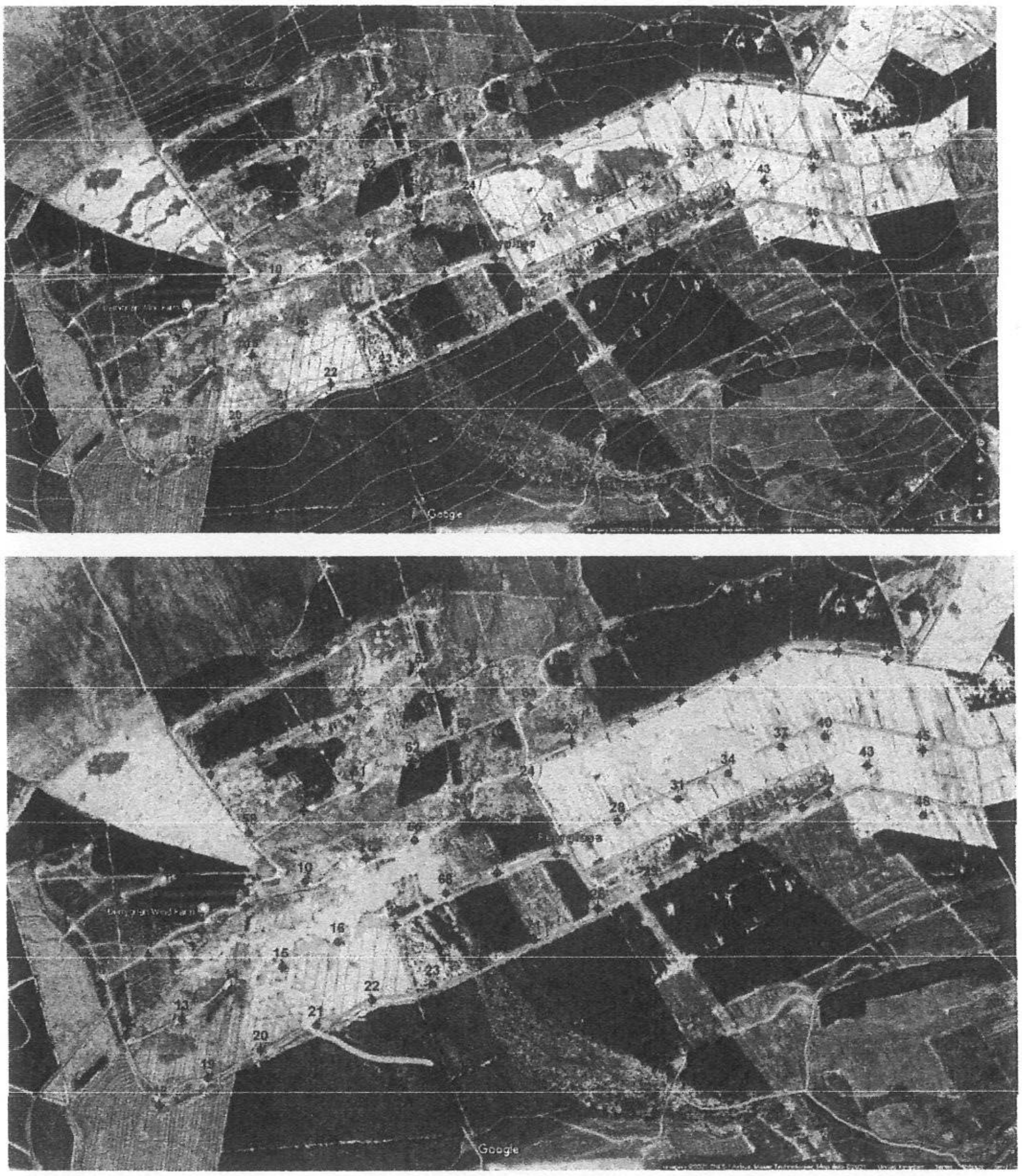

Figure 2. Aerial photograph of the Derrybrien windfarm site with (top) Google Maps aerial photo, contours and turbines; (bottom) Google Maps aerial photo with pale blue shading indicating possible zones of surface/sub-surface seepage. Dotted blue zones indicate areas of possible seepage obscured by tree cover or forest felling operations.

Holden et al. (2002) and Holden (2005) identified such sub-surface piping using ground penetrating radar but there has been no such testing at the Derrybrien site. Sub-surface seepage and piping are identified by SGG-2017 as key features to consider when assessing peatslide risk. Evidence from this initial stage of site mapping, combined with available published literature, plus the guidance from SGG-2017, should all have been brought into the thinking at this stage of the rEIAS, using evidence from aerial photography as well as documented seepage reported extensively from the field data gathered between 2003 and 2005.

It should also be noted that the heads of the pale blue seepage zones in Figure 2 all begin along the line from Turbines 27 to Turbine 42.

5.3 <u>Ground investigation</u>

5.3.1 *SGG-2017 – Ground investigation*

Ground investigation is divided into three main stages:

- scoping of the investigation;
- peat-depth probing and coring; and
- logging of the peat stratigraphy.

Of particular note are two requirements during this phase:

- within the scoping stage, to record and map evidence of surface and sub-surface drainage pathways and the depth of water strikes encountered during peat probing; and
- to note for the purposes of logging peat stratigraphy that standard approaches to such logging are not suitable and that peat stratigraphy be logged using <u>both</u> the Troels-Smith system and a modified von Post system.

Although shear vane testing is largely covered by SGG-2017 under 'Laboratory testing' (see Section 5.5 below) it is worth highlighting here that the limitations of shear vane testing in peat soils are highlighted within SGG-2017. To summarise the limitations, which are explored more in Section 5.5, there is a tendency for shear vanes to over-estimate the strength of tested peat, and larger-diameter vanes are preferable and more informative than those with smaller diameter vanes.

5.3.2 *rEIAS – Ground investigation*

There is no doubting the fact that an enormous amount of effort, undoubtedly under arduous conditions, has been expended in gathering peat depth and stratigraphic data from across the windfarm site, particularly between 2003 and 2005.

For present purposes, however, this time period is unfortunate because it pre-dates the guidance provided by SGG-2017. Thus, while the peat-probe data remain robust

and extremely valuable, the **auger data** are less informative because they do not provide the type of information recommended by SGG-2017. Indeed the data would be described as 'unsuitable' by SGG-2017 for the purposes of recording the detailed differences between peat layers because the data do not include von Post or Troels-Smith data.

The solution would seem to have been further collection of auger data using the new recommended recording system. Since 2005, however, coring and trial pits have been almost entirely restricted to the site of the 2003 slide, the peat repository areas or the grid connection route, as indicated in '*Drawing 003 of Appendix A of Appendix B*' and '*Figure 2 and Drawing no: P2159-0600-OHL-0001 of Appendix D*'.

In addition, while the **peat probe data** are indeed robust, it is clear that sample points have consistently been restricted to spot locations where the peat is intact rather than cracked or fissured. Had some probe measurement been taken from the bottom of forestry ploughing furrows, for example, there would undoubtedly have been many measurements that would have registered as anomalous within the datasets. It is, in fact, very difficult to judge the actual depth of peat remaining at the bottom of a deep fissure, so it may be that some measurements were attempted to be obtained but were abandoned in favour of probing an adjacent area of peat that was not fissured.

Whatever the reason for a complete absence within the peat-probe data of anomalous data values indicating fissures, it is most unfortunate that the probing work did not *also* record the presence of fissures along the bottom of forestry ploughing furrows while taking probe readings. It is easy enough to do, simply probing along the base of the furrow with whatever is used to measure peat depths while walking alongside the furrow. Often such fissures are hidden because they are covered with needle-fall, but a probe will immediately and easily pass through this layer to reveal a void beneath.

The largest body of data presented in the rEIAS concerning peat strength is based on hand-held shear vane testing in the field. These shear vane tests were mostly carried out using a Geonor H-60 hand-held shear vane. This device has an extremely small vane diameter (25.4 mm maximum) and can only sample to a depth of 3 m. Consequently, extensive areas of the site could not be sampled at depth (see '*Figure 10-9, rEIAS*') using this device.

Finally, there are numerous references in the field data to the presence of **surface and sub-surface seepage**. Some field sheets ever require a record to be made of such features (e.g. '*Peat Stability Assessment Worksheets, Appendix B of Appendix B*'. However, although '*Drawing 11-147-03 of Appendix B of Appendix B*' claims to show both the natural pattern of drainage plus added artificial drainage, there is no attempt to link up the field data and indicate on this or any other map areas of surface seepage and suspected sub-surface seepage or piping across the windfarm

site or the line of the grid connection. The only mapped indication of seepage is offered for the Turbary area, in *'Figure 2-1 of Appendix E'*.

This failure to collate the information obtained during field survey into some form of map display means that, at the very least, the process of subsequently integrating the factors relevant to slope stability into a risk assessment is not transparent to the reader. It also leaves open the possibility that current risk analyses may have failed to integrate adequately the information contained within these field data (field data, it should be noted, which are now in any case as much as 20 years old and perhaps no longer representative of current conditions).

Regarding the route of the Grid Connection, *'rEIAS, Figure 10-23'* shows peat depths along the corridor of the grid connection chosen for assessment. No explanation is provided in the rEIAS or its Appendices for the width of the corridor selected, but *'Drawing No. P2159-0600-OHL-0002, Appendix D'* states that the corridor is 100 m wide. It is inappropriate and contravenes the principles set out in SGG-2017 for the grid connection assessment to employ a constant width of assessment corridor when ground conditions are so varied along the route. Given that peat depths alone range from zero to 5.6 m, then other factors identified as important by SGG-2017 also vary, any assessment should adjust the width of potential impact according to these changing conditions. Furthermore, the fact that almost the entire length of the grid connection route runs through afforested peatland of varying depths (*'Section 3.2, Appendix D'*), and this peatland is certain to have experienced shrinkage and fissuring, mapping of such features in relation to the chosen route would have been a major source of valuable information in terms of assessing potential risk. Such mapping was not undertaken.

However, even within the constrained approach adopted for the rEIAS, the methodology employed fails to meet the guidance provided by SGG-2017. The *report for the grid connection provided by Fehily Timoney ('Appendix D') states that: "Shear vane testing was carried out using a Geonor H-60 hand field vane tester. From FT's experience hand vanes give indicative results for the in-situ undrained shear strength of peat and would be considered best practice for the field assessment of peat strength. 75 no. hand shear vane strength tests were undertaken by AGEC at depths from 0.5 to 2.5m bgl."*

It would seem that although Fehily Timoney (2020) claim to be using SGG-2017 as guidance (*'Section 8, Appendix D'*) they do not address the cautionary statements made by SGG-2017 regarding the use of shear vane testing for risk assessment. Furthermore, the Geonor H-60 only has a maximum blade diameter of 25.4 mm and can only be used down to a depth of 3 m. The small blade size fails to meet the very clear guidance from Long (2005) that the largest possible blade diameter should be usedif employing shear vane testing in peat. The specification of the device also means that testing to depth in the deepest areas of peat identified along the grid connection route – namely PS28, PS36 and PS37 to PS39 – was not possible. No

auger samples were taken and only two trial pits, near the sub-station, were made. The ground investigation thus fails along the entire length of the grid connection to provide von Post data and Troels Smith data, as recommended by SGG-2017. This also means that there are no corroborating data against which to judge the shear vane measurements, nor to provide evidence of conditions within the peat at depths greater than 3 m.

5.4 Other ground investigation techniques

5.4.1 *SGG-2017 – Other ground investigation techniques*

SGG-2017 guidance identifies four aspects of ground investigation for consideration:

- Geophysical testing using non-intrusive methods;
- Digging and examination of trial pits;
- Instrumentation and monitoring; and
- Representation of peat-depth data.

The SGG-2017 guidance provides a summary (*'SGG-2017, Appendix B'*) of possible non-intrusive geophysical methods than can be used to investigate the below-ground structure of the peat. These methods can be extremely useful in identifying voids or cracks within the peat, as demonstrated by Holden et al. (2002). Such methods are used as standard practice in much archaeological investigation to identify hidden discontinuities within the soil.

Instrumentation is highlighted as being particularly useful for monitoring water tables, characterising the hydrological behaviour of the peat and identifying signs of movement at crack locations. It notes that: *"The shorter the monitoring period, the less representative the data will be of longer-term trends and extreme responses...In areas where ground movement is possible, the monitoring would...comprise a baseline survey and permanent monitoring network such that if movement were to occur, it could be accurately determined from retrospective surveys."*

The SGG-2017 guidance also emphasises the importance of presenting the results of peat depth surveys appropriately.

5.4.2 *rEIAS – Other ground investigation techniques*

Given the identified fact that the peat beneath the forest plantations is significantly dissected by fissures resulting from peat shrinkage as the peat has dried beneath the plantation. Given the significance afforded by Dykes (2008) to such conditions, there can be little doubt that a **geophysical survey**, even if across only a sample zone, would provide a clearer indication of the scale of the problem than is currently recognised in the rEIAS. Although some resistivity work was undertaken for AGEC (2004) no results were ever reported.

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As identified in 5.3.2 above, a simple peat probe can provide a practical method of mapping site-wide fissures, but such information would benefit from additional geotechnical mapping in order to identify the presence of sub-surface piping – a feature that cannot readily be identified using a peat probing rod.

With regard to **instrumentation and monitoring**, particularly in the light of the explicit recognition given in SGG-2017 to the monitoring of cracks and fissures, there would appear to be a compelling case for a permanent site-wide monitoring system focused particularly on the fact that much of the peat has been (and in some cases continues to be) subject to drying, shrinkage and fissuring as a result of the historic use of the site for plantation forestry. The same holds true for the turbary area, particularly because of the large seepage zone traversing it, although continued use of the turbary poses certain challenges for the maintenance of permanent marker points.

The rEIAS repeatedly states that mitigation measures will alter the nature of the peat by drying it out, thus increasing its tensile strength. Such drying inevitably means physical deformation of the peat as it loses the prime component of its volume. While deformation beneath the loading of roads and other infrastructure will probably (though not certainly) mean that such deformation will occur largely in the vertical direction leading to subsidence of the 'floating roads' (of which more later), areas not under vertical compressive load are free to shrink in 3 dimensions. This inevitably leads to cracking, fissuring, formation of internal voids and piping or even lifting of the peat from the mineral sub-base to form water channels. Such features are precisely what many authors including Warburton, Holden & Mills (2004), Dykes & Warburton (2007a) and Dykes & Warburton (2007b) highlight as key contributory factors to peatslope failure in the event of powerful convective rainstorms following extended dry periods.

Movement resulting from cracking, fissuring and other forms of deformation can be monitored and measured using a range of standard devices, and indeed following recommendations set out in AGEC (2005) and ESBI (2006), for the period between 2006 and 2014 a set of automatic monitoring devices was installed at four locations across the site measuring soil-water depth/pressure (12 piezometers) and ground movement (15 tilt-meters). By 2012 these instruments had apparently ceased to function so they were decommissioned permanently in 2014.

In addition, seven 'sighting posts' were installed at four locations of concern withing the 2003 slide area, to be measured for signs of movement. Details of these monitoring devices are given in '*Appendix B, Section 3.3.3.1*' and '*Appendix C, Section 7*'. The location of the 'sighting posts' is given in '*Appendix B, Section 5.2.1*' while the detailed locations of the automated piezometers and tilt-meters are shown in '*ESB (2006) Operation and Maintenance – Provisions for Long Term Site Stability, Appendix 1*' (listed but not supplied) and in more general form by '*Drawing No: QS-00192-01-D451-016 in Appendix A of Appendix B*'.

A number of observations can be made about these monitoring systems:

- A key recommendation of AGEC (2004) is that: *"Ongoing ground investigation work should continue with regular monitoring of specialist movement detection equipment, site roads and other works."* Furthermore, Fehily Timoney (2020) '*Appendix C, Section 7*' notes that this instrumentation was: *"...installed to give early warning of irregular/unusual ground movements or water pressure build up."* Given the repeatedly-stated expectation of the rEIAS that the peat will change in character over the lifetime of the windfarm, together with the concerns of SGG-2017, Dykes (2008) and others over fissuring as a result of such drying and the focusing of intense rainfall into such fissures, the decision to de-commission this monitoring array would not seem to be justified.
- The remaining monitoring system – namely the 'sighting posts' – are located outside the main windfarm site and are designed purely to monitor material that has already suffered failure. This is probably the least likely area to experience further movement now that the bulk of material has settled or passed out of the area completely. Of much greater concern are the areas of deep peat still located within the windfarm site and currently undergoing drainage in an effort to 'mitigate risk of a further peatslide' – although such actions actually have the potential to *increase* the risk of further slope failure (see later).
- Even if the automated monitoring systems had been retained, their limited number and distribution across the site would have provided only the most localised information about possible signs of fissuring or movement. It is unfortunate, for instance, that the instrumentation linked to Logger 3 was not located within the identified zone of sub-surface seepage crossing the turbary area because then perhaps an increase in soil-water pressure might have given warning of the peat failure in Turbary Plot No.161, which lies directly in the path of this seepage line (see Figure 1 above). Other areas of seepage or peat piping identified from field data sheets would also have benefitted from (and would continue to benefit from) such instrumentation. A compelling case can be made for much wider instrumentation of this type to be distributed across the site and for it to be maintained, as a minimum, for the operational life of the windfarm.
- As a supplement to such instrumentation, the possibility now exists to use satellite data to monitor ground movement. Using InSAR satellite data, Professor David Large at the University of Nottingham has studied another large peatslide which recently occurred at an afforested windfarm in Ireland. His initial unpublished results suggest that, not unlike a volcano before it erupts, distinctive ground-motion signals detectable using InSAR may provide early warning of possible failure. As with all remote sensing, ground-truth data are still necessary in order to validate such analysis, but

this may enable the scale of ground-truth instrumentation to be reduced and thus make the monitoring programme more cost-effective.

With regard to **presentation of the peat-depth data**, while the interpolation method used in *'rEIAS, Figure 10-9'* appears reasonable, what is not reasonable is the choice of colours to display that map. This may seem a trivial point, but it is normal when displaying a gradient of something to go continuously from dark to light or light to dark. In the case of *'rEIAS, Figure 10-9'*, this convention is not followed. Rather than the palest colour (yellow) indicating the shallowest peat this colour actually represents peat depths between 1 m and 2 m – so substantial depths – whereas the darker red shading indicates depths of between 0 m and 1 m. The position is rendered even more confusing because in *'Figure 3, Appendix XIV of Appendix D of Appendix B'* the green and yellow shading are reversed, with the paler yellow colour now representing peat that is 2 m to 3 m deep.

5.5 Laboratory testing

5.5.1 *SGG-2017 – Laboratory testing*

SGG-2017 guidance identifies three issues to consider when undertaking laboratory testing of peat samples:

- Physical properties of peat;
- Shear strength tests in peat; and
- Selection of appropriate site plant and safe working practice.

The SGG-2017 guidance provides a number of cautionary statements concerning the testing of peat and its physical properties, as do papers such as O'Kelly (2017), Dykes (2008), Yang and Dykes (2006) and Long (2005):

- Standard particle size distribution tests can be misleading and should be used with caution;
- Fibre-content is an important consideration and tests which take this into account are often more informative;
- Standard shear-strength testing can be unreliable in peat depending on the nature of the peat being tested;
- Any laboratory testing should state clearly the precautionary measures taken to allow for the particular properties of peat (e.g. provisions for effects of fibre content) and highlight possible areas of uncertainty.

It is important to recognise, however, that such testing only relates to intact blocks of peat, as highlighted in SGG-2017. Such testing gives little or no information about

the behaviour of a peat mass which is riven with cracks and fissures, nor a mass that has separated through vertical shrinkage along a weak layer or at the peat-mineral interface. As such, the capacity for shrinkage of peat when subject to drying is a major consideration which lies outside the capacity of laboratory (or even much field-based) testing to measure, other than identification of the humification state of the peat or perhaps the occasional fortuitous capture of a fissure during shear-vane testing, giving rise to anomalous results.

While actual identification of fissures obviously gives a direct indication of ground state, the degree of humification as indicated by a von Post test gives an indication of the susceptibility of a given section of peat to shrink and crack under the stresses generated by drainage. Peat with a low von Post value of anywhere between H0 and H4 will shrink much less than a highly decomposed peat with a von Post value of H8 or H9. This is because little-decomposed peat contains many more long fibres which help to bind the peat matrix together and give it a high tensile strength. Figure 3 shows a close-up of peat with a von Post value of H1 (i.e. largely undecomposed). The mass of Sphagnum bog moss stems and branch spindles can be seen to interconnect somewhat like tangled scaffolding, preventing any significant degree of shrinkage.

Figure 3. Close-up of largely undecomposed peat (von Post value of H1) showing the numerous lengths of moss stem and branch spindles set within the matrix of loose leaves.

Figure 4 shows the difference in shrinkage between peat cores having differing von Post values. The higher the von Post value (i.e. the more decomposed the peat) the greater the extent of shrinkage, cracking and fragmentation.

Laboratory testing is thus only part of the story because it cannot readily mirror and test the effect of such fissuring on the mass of peat as a whole.

Figure 4. Variable shrinkage due to drying of peat cores, taken from a bog in northern England, having differing von Post values. (top) Core just after removal from the bog; (middle) Core unwrapped for drying; (bottom) Differential shrinkage and fragmentation of cores following drying, with greatest shrinkage occurring in cores with high von Post values.

5.5.2 rEIAS – Laboratory testing

Between 2001 and 2005 some peat samples were subjected to laboratory analysis, but the text is contradictory about where these samples were taken. The only descriptions of samples taken for laboratory testing relate to the peatslide area and a section of floating road, but then the text ('*Annex B, pp. 29-30*') talks of samples 'away from the slide area', without any details of what this means. As far as can be ascertained from '*Annex B, Figure 2-7*', this refers to a set of samples taken at Turbine 22. Consequently the full set of laboratory-tested material consisted solely of:

- 12 peat samples taken in 2001 for which moisture content was calculated (although the results are profoundly anomalous for peat and suggest that they cannot be relied upon), together with chemical analyses undertaken on six of these samples;
- an un-specified number of samples taken from the area of the 2003 peatslide (possibly 11 samples) and 'away from the slide' – at Turbine 22 (possibly 21 samples), which were subject to shear strain and triaxial testing; and
- an unlisted number of samples taken adjacent to the floating road west of Turbine 17 following signs of movement, also subject to shear strain and triaxial testing.

This hardly represents site-wide laboratory testing of peat characteristics, but, as indicated above, the strength of intact peat is not the key issue in this case. It is the *in-situ* behaviour of the peat body when subject to drying and consequent shrinkage which is of greater concern, particularly as rEIAS field-data sheets (final items in '*Appendix B of Appendix B*') suggest widespread occurrence of peat which is H8-H9 and therefore especially prone to substantial shrinkage on drying. The fact that H8-H9 peat also has much less tensile strength than less decomposed peat is a compounding concern.

6. Hazard and risk assessment

The SGG-2017 guidance highlights the fact that the probability of a peat landslide *"...reflects the combined influence of preconditions, preparatory factors and*

triggering factors, or collectively 'controls', on the stability of a peat deposit." It also makes clear the potential de-stabilising impact of human activity on peat stability.

6.1 Assessing the likelihood of a peat landslide

The SGG-2017 guidance offers four ways to assess the likelihood of a peat landslide occurring, grouped into two broad categories:

Probabilistic:

- Historic frequency of peat landslides;
- Use of possible triggering events as indicators of likelihood;
- Estimation of probability using expert judgement using general principles and available evidence;

Stability analysis

- Use of stability analysis and Factor of Safety calculations.

6.1.1 Historic evidence of frequency

6.1.1.1 *SGG-2017 – Historic frequency of peat landslides*

This approach relies on collation of evidence for peat landslides *within the area* together with the timing of those events. The timescale chosen for such a calculation is obviously a key factor. The example given in SGG-2017 is a 100-year timespan, and *'Table 6.1 of Appendix C'* identifies two peatslide events which have occurred within a 10 km radius of the Derrybrien windfarm site since 1921.

Combining these with two on-site failures in 2003 (Turbine 68 and the earlier failure at Turbine 17), plus the failure in Turbary Plot No.161, gives a total of five failures in the area within the past 100 years.

From this, the Annual probability = 5 slides/100 years = 0.05 or 5%.

Taking the windfarm lifetime of 25 years, the calculation suggested by the SGG-2017 guidance is:

Prob. (Peat landslide) in 25 years = $1 - (1 - 0.05)^{25} = 0.72$ or **72%**

In practice, however, conditions prevailing in the general area have changed significantly in the past 50 years with the establishment of plantation forestry over many blanket mire areas. More recently still, construction of windfarms within these forested areas has had further impacts. This might suggest, therefore, that a more realistic contextual timescale reflecting current conditions could be 50 years or even time since 2001, when widespread windfarm construction began in the area. On this basis, the calculation becomes:

Annual probability = 5 slides/21 years = 0.238 = 23.8% and

Prob. (Peat landslide) in 25 years = $1 - (1 - 0.238)^{25}$ = 0.998 = **approx. 100%**

Even just taking the large 2003 slide and the slide at Sonnagh Old, this gives:

Annual probability = 2 slides/21 years = 0.095 = or 9.5%

Prob. (Peat landslide) in 25 years = $1 - (1 - 0.095)^{25}$ = 0.917 = **approx. 92%**

Using the historical frequency of landslides *in the area*, this calculation of risk suggests that within the remaining life of the windfarm there is a significant risk of a further peat landslide.

Of course the area on which the calculation is based could be expanded, for example to Ireland as a whole, but in doing so this would merely increase the annual frequency of events, given the number of peat landslides which have been recorded in recent times, many of them associated with windfarm development on blanket bog habitat.

While it must be recognised that this is a rather crude, blunt tool to assess likelihood, this calculation nevertheless gives a broad indication of the **distinct possibility that another peatslide will occur within the Derrybrien windfarm site during the operational life of the windfarm or shortly thereafter**. The calculation gives no indication of scale or locality, but this should alert the windfarm operators to apply all possible measures to minimising such an event and containing its consequences. AGEC (2004) make a specific recommendation that a Contingency Plan be drawn up to prepare for such an event, but there is no evidence that this 2004 recommendation has ever been followed up with practical action.

6.1.1.2 rEIAS – Historic frequency of peat landslides

The rEIAS does not adopt the recommended approach to probabilistic assessment using historical evidence, as set out in the SGG-2017 guidance. Despite stating that "*...the peat stability assessments have been carried out in accordance with the best practice guidelines given in [SGG-2017]*", the rEIAS instead employs its own formulation for risk assessment, based on peatslides per kilometre of windfarm road construction in Ireland per annum ('*Appendix B, Table 1-1*').

This is a very different concept from that set out in SGG-2017 and is guaranteed to reduce to a minimum the 'likelihood' value because even a very large peatslide will only ever arise from a relatively limited extent of windfarm road, meaning that the likelihood *per kilometre* constructed is always going to be low.

Such a metric does not in any way reflect the possible likelihood per windfarm development. This is because likelihood is also linked to ground

conditions, meaning that if ground conditions are unsuitable across the whole development a small windfarm may still have a high likelihood of slope failure.

It is not clear how the 'Probability of Occurrence' in '*Appendix B, Table 1-1*' ultimately influences or relates to the Peatslide Risk Assessment zones arrived at from '*Appendix B, Table 2-2*' and displayed in '*Appendix B, Figure 2-17*' but it is clear that the effect of '*Appendix B, Table 1-1*' is to suggest that a peatslide is an extremely unlikely event. This is a very different message from that obtained if using the approach recommended in the SGG-2017 guidance.

6.1.2 Role of triggering factors

6.1.2.1 SGG-2017 – landslide triggering factors

The SGG-2017 guidance points readers to published evidence of the role that triggers play in causing peatslide events. The guidance cites Evans & Warburton (2007), Dykes and Warburton (2007a) and Creighton (2006), but Dykes (2008) has undertaken an extensive analysis of peatslide events and produced a table which summarises the various factors that appear to play some part in triggering such events or preconditioning sites to the effects of triggers. An extract of his results relevant to the present case is presented in Table 1.

It can be seen from Table 1 that preconditioning and trigger factors relevant to Derrybrien are not factors that occur rarely. They are instead common features of many recorded peat failures. Of particular note is the regularity with which convex slopes and heavy rainfall feature in such events. Convex slopes are a widespread feature of the windfarm site. Meanwhile, climate projections indicate that rainfall is likely to become more intense, along with extended dry periods. This would intensify the tendency for peat to shrink and fissure where it is already under drainage pressure, providing many more routes for intense rainfall to find weak points in the fissured matrix and lift the peat from the mineral sub-soil.

In direct contrast with the stated intention to maintain robust drainage across the site, it is widely acknowledged that the most effective strategy for peatland systems in the face of such shifts in climate is to encourage restoration of Sphagnum-rich peat-forming vegetation. This is because Sphagnum-rich assemblages have self-regulatory processes which enable them to adapt to such changes while still laying down fresh peat. This new peat can, amongst other things, provide a protective layer of high tensile strength.

Table 1. A selection of Irish blanket bog failures and inferred contributory factors (taken from Dykes, 2008). B/E = burnt or eroded; BD = boundary ditch; DD = drainage ditch; FD = forestry drainage/ploughing; PC = manual peat cutting; PE = machine/Difco extraction; PL = loading onto peat; CV = concave slope; CX = convex slope; HA = heavy antecedent rain; LA = dry antecedent conditions; mineral sub-soil failure; SP = seepage peat pipes; PB = peat bank; HR = high rainfall; UN = unknown trigger. Yellow shading indicates those factors relevant to Derrybrien, from which it can be seen that those factors have been common features of many recorded peatslides.

Peat landslide	Anthropogenic preconditioning factors							Natural preconditioning factors							Triggers	
	B/E	BD	DD	FD	PC	PE	PL	CV	CX	HA	LA	MS	SP	PB	HR	UN
Lough Boleynagee, Co. Mayo									Y	Y			(Y)	(Y)		Y
Maghera (1939), Co. Claire									Y						Y	
Glendun, Co. Antrim								Y		Y					Y	
Barnesmore, Co. Donegal			Y		Y			Y							Y	
Carrowmaculla, Co. Fermanagh	B	Y							Y	Y					Y	
Tullynascreen, Co. Sligo						Y			Y	Y					Y	
Straduff, Co. Sligo	B								Y		Y	Y			(Y)	
Maghera (200?), Co. Claire				Y					Y							Y
Slieve Bloom (1988), Co. Laois			Y						Y							Y
Conaghra, Co. Mayo				Y					(Y)					(Y)		Y
Meenacharvy, Co. Donegal	E				Y				Y						Y	
Slieve Rushen (1965), Co. Cavan					Y				Y	Y					Y	
Berllacorrick Forest, Co. Mayo				Y				Y			Y					
Skerry Hill (x2), Co. Antrim			Y					Y			(Y)				Y	
Carntogher, Co. Londonderry	E		Y					(Y)	Y	Y			(Y)		Y	
East Cuilcagh (1986), Co. Cavan								Y						Y		Y
East Cuilcagh (1992), Co. Cavan								Y						Y	Y	

Peat landslide	Anthropogenic preconditioning factors							Natural preconditioning factors							Triggers	
	B/E	BD	DD	FD	PC	PE	PL	CV	CX	HA	LA	MS	SP	PB	HR	UN
East Cuilcagh (1998), Co. Cavan								Y						Y		Y
Slieve Bloom (1973), Co. Offaly			Y													Y
Cuilcagh (1986), Co. Fermanagh										Y		(Y)			Y	
Dooncarton Mtn., Co. Mayo						Y					Y	(Y)			Y	
Slieve-an-Orra (x7), Co. Antrim			Y	Y				Y	Y	Y		Y			Y	
Slievenakilla (x2), Co. Leitrim					(Y)			Y	Y		Y	Y			Y	
Cuilcagh (1998), Co. Fermanagh			Y								(Y)	Y	Y		Y	
Cuilcagh (2000), Co. Fermanagh			Y								Y	Y			Y	
Dooncarton Mtn.		Y							Y		Y	Y	Y		Y	
Dooncarton Mtn. (x9), Co. Mayo									Y		Y	Y	Y		Y	
Slieve Bearnach, Co. Claire				Y			Y	Y								
Sonnagh Old, Co. Galway				(Y)			Y		Y							
Derrybrien (x2), Co. Galway			Y	Y			Y	(Y)			Y					

6.1.2.1 *rEIAS – landslide triggering factors*

Although in "*Appendix B, Table 3-3*" the rEIAS acknowledges most of the factors identified by Dykes (2008) and displayed in Table 1, it appears to summarise these into a small number of factors to which it then allocates a scoring system in '*Appendix B, Section 2.5.3 and Table 2-2*'. These factors are:

- Deposits of deep (3-6 m) and relatively deep (2-3m) weak peat (cu ≈ 4-5 kPa) with low infinite slope Factor of Safety (<1.0-1.3);
- Areas of intermediate slope angles of 3-5° in close proximity to a convex break in slope to slope angles >5°;
- Zones that are in the broad valleys directly upslope from the rivers and streams downslope from the site boundary;
- Zones of deep peat with poor drainage and ponded surface water at the head of a watercourse, or along the edges of the terraces on the north side of the site; and
- Areas adjacent to the previous slide that have similar site characteristics.

This list does not mention presence of drains or forestry ploughing and the impact these have on breaking the tensile connectivity across the peat mass, nor does it mention the impact drainage has on the shrinkage and deformation of peat, nor does it recognise the implications of future intense rainfall or longer periods of dry weather. It focuses instead on areas of poor drainage with high water tables, with the implication that these must be drained in order to provide improved stability – and indeed this is the main mitigating strategy offered by the rEIAS throughout all the documents.

6.1.3 Expert judgement

6.1.3.1 *SGG-2017 – Expert judgement*

If using expert judgement, the SGG-2017 guidance states that such an approach may use a ranking system, ranked on the basis of expert judgement, based on: "*...the presence or absence of instability features at the site, or combinations of scored 'hazard factors' (e.g. slope, peat depth, orientation of slope drainage) whereby higher scores indicate higher probability of future peat landslides.*"

The guidance goes on to emphasise that: "*Where expert judgement is used, judgements should be transparent through full documentation of sources of evidence, and the logic behind any factoring or scoring approach should be clearly detailed.*"

6.1.3.2 *rEIAS – Expert judgement*

The rEIAS presents a case which, on the face of it, is based on thorough and rigorous quantitative measurement of site conditions rather than employing expert judgement to assess the probability of slope failure or other negative impacts. However, expert judgement is central to the process of deciding what factors to measure, how extensively these factors should be measured, and ultimately how the results should be interpreted.

The consequences of expert judgement in this case have significant implications for the results obtained and conclusions derived from the quantitative approach to risk assessment. These issues are explored in detail below.

6.1.4 Stability analysis

6.1.4.1 *SGG-2017 – Stability analysis and Factor of Safety*

The approach offered by the SGG-2017 guidance allows for a quantitative approach to hazard and risk assessment. This is the approach most familiar to geologists, soil scientists and engineers. It uses factors such as soil cohesion, angle of internal friction of the material, slope angle and weight of the material to calculate a Factor of Safety (FoS). If the calculated FoS for a portion of ground is less than 1 it is assumed that slope failure is certain, but it is general practice to allow for a margin of safety such that a value of 1.3 or 1.4 is taken to be the limit of acceptability.

Several software packages are available from which to derive FoS values, based on a variety of different approaches by which FoS values are calculated. As highlighted in SGG-2017, the favoured system, particularly for peatland soils, has increasingly become the 'infinite slope model' which divides a slope into small segments in order to calculate differing values for differing portions of a slope.

The general underlying calculation used to generate FoS values when the ground is drained is:

$$FoS = \frac{c' + (\gamma - m\gamma_w)z\cos^2\beta \tan\emptyset'}{\gamma z \sin\beta \cos\beta}$$

where:
- c' is effective cohesion
- γ is bulk weight of saturated peat
- γ_w is bulk weight of water
- m is the fractional height of water in the peat column
- z is (in effect) the peat depth
- β is the slope angle
- ϕ' is the effective angle of internal friction of the peat

The important point to bear in mind is that this formula describes the characteristics and behaviour of peat as a discrete entity but if the peat is fissured and deformed as a result of shrinkage then values obtained by shear-vane testing for c' are unlikely to capture the true effective cohesion of the peat slice, even if the vane happens to intersect with a fissure.

In addition, if the peat has fissures and internal pipes resulting from shrinkage and deformation, thereby permitting water to enter weak layers in the peat or voids at the interface between the peat and underlying mineral, the effective angle of internal friction ϕ' will also be different from that calculated for normal conditions because water will lubricate that layer, reducing the angle of friction.

From the formula above it can been that, for a constant depth of peat and slope angle, if effective cohesion and angle of internal angle of friction are reduced, the Factor of Safety will also be reduced.

If the peat has been subject to intense drying through a combination of drainage and a long dry spell, the weight of the peat will also be reduced, making it more buoyant and more easily lifted from a weak layer by hydrostatic water pressure.

These factors together mean that considerable caution is required when using calculated Factor of Safety values for an area of drained peat. As Dykes and Warburton (2008) observe: *"In the context of high magnitude, high intensity rainfall events, landslide hazard assessments should identify any disturbance to the physical integrity of a peat deposit, and any undisturbed blanket peat cover on convex upper mountain slopes (not visibly affected by erosion or previous failure), as sites susceptible to failure."*

O'Kelly (2017) further concludes that: *"The tensile strength of fibrous peat material is important in understanding bog burst and bogflow events in upland blanket bog peat deposits, for the stability of 'floating' roads over peatland, and also seems important in stability assessments of embankments, dikes and foundations over peat substratum...Since back-analyses of slope and foundation failures involving peat deposits indicate that even a small [cohesion and tensile strength] value can play a significant role, further investigations on the tensile strength mobilised for submerged test specimens with different botanical compositions are necessary, along with a renewed effort on understanding tensile strength development and fracturing of in-situ peat deposits under loading."*

6.1.4.2 *rEIAS – Stability analysis and Factor of Safety*

A succession of sampling and testing regimes to determine peat strength as well as other factors relevant to peat stability, has been undertaken since 2001.

In 2001, IGSL dug eight **trial pits** from which they determined the depth of peat and its general composition (*'Appendix I of Appendix D of Appendix B'*). A **light dynamic probe** was used to determine the strength of material at 58 locations, but this type of probe is not well suited to peat soils, meaning that with a single tap the probe reached the mineral sub-base and therefore not revealing much about the nature of the peat. In addition, 24 samples were obtained for laboratory analysis using a **hand auger**, with the intention that measured water content would give an indication of peat strength.

The trial pits and probe did not provide any useful information about peat strength, while the reported water contents obtained from the auger samples were so low (for peat) that there must be a suggestion of something having gone awry during the course of testing. Nonetheless, IGSL concluded that: "*...The peat must be considered unsuitable as a founding material, from both a strength and compressibility viewpoint...*"

This was the only testing of peat stability undertaken prior to the start of construction.

Table 2 summarises those surveys providing **field data** relevant to peat strength which have been undertaken since the 2003 peatslide, from which it can be seen that all testing of the site as a whole ended in 2005. Testing since then has been limited to individual points of concern such as the source area of the slide, the peat barrage repositories or areas of instability associated with individual turbines and their road sections.

At the same time (as the rEIAS emphasises repeatedly) the nature of the peat across the development has been changing because of the construction loading and the extensive drainage programme. However, these changes are not being monitored. They are instead merely assumed to be proceeding within an expected framework of behaviour. This framework is, however, limited in its outlook and does not recognise potential changes due to shrinkage that lie outside this conceptual framework – despite clear warnings about such changes set out in literature ranging from Lindsay & Bragg (2005) to the SGG-2017 guidance and beyond.

Lindsay & Bragg (2005) illustrate the scale of cracking and fissuring to be expected beneath any forestry plantation established on peat. Their Plates 3.1 and 3.2 show just how intense and deep this fissuring can be. Adding to this, the ongoing and additional drainage regime maintained in order to keep

windfarm operations free from waterlogging leads to further de-watering, with consequent loss of volume, within the surrounding peat.

Notwithstanding the lack of data since 2005, the existing datasets for shear strength highlight three significant features which are noted within the rEIAS and its accompanying documents, though the implications of these features are not explored at all.

Firstly, It will be noted from Table 2 that shear vanes come in different sizes – specifically the vane-blade widths used in the rEIAS datasets range from 25.4 mm diameter (AGEC, 2004) to 270 mm diameter ('*Section 3.3.2, Appendix D of Appendix B*'). Despite the conclusion by Landva (1980) that shear vane testing of peat "*does not serve any useful purpose*", and the SGG-2017 guidance highlighting questions raised by Long and Boylan (2012) about the reliability of such tests, shear vane testing continues to be widely used in EIA work because of its reliability on soils other than peat. It is consequently regarded as an 'industry-standard' technique for all EIA investigations despite its unsuitability for peat soils.

O'Kelly (2017) highlights the fact that, in peat, larger vane blades tend to produce lower values, attributing this to the fibrous nature of peat. The question therefore arises: Do the lower values obtained by larger blades better reflect the true strength of the peat than smaller blades? Long (2005) is very clear on this point: "*If the field vane is to be used in practice, it should be as large as possible...*" Long and Boylan (2012) furthermore state that "*...in-situ vane tests may grossly over-estimate the shear strength of peat deposits...*" They go on to observe that "*...vane tests in peat may give misleading and non-conservative results and should be treated with great caution.*"

Table 2. Surveys which obtained field data relevant to the assessment of peat strength and stability.

Date	Company	Locations	Test type	Function	Appendix No.
Feb. 2004	AGEC	50 locations 'T-cells' ?	Shear vane (small)	Shear strength of peat	Appx. A
Nov. 2004	AGL/Ascon 03-104-R01	Turbine 36 x 'T-cells'	Gouge auger	Peat depth, slope angle	Appx. B, D, III, A
"	"	" 25 x 'T-cells'	Shear vane (large)	Shear strength of peat	"
Dec. 2004	AGL 03-104-R02	Roads 42 x 'T-cells'	Gouge auger	Peat depth, slope angle	Appx. B, D, IV, A
"	"	" 36 x 'T-cells'	Shear vane (large)	Shear strength of peat	"

Jan. 2005	ESBI 78015-C11-R1 REV 1	Throughout the site	Abney level	Slope angle	Appx. B, D, XIV, A
"	"	" 222 x locns.	Gouge auger	von Post humification	Appx. B, D, XIV, B
"	"	" 1179 x locns.	Shear vane (large)	Shear strength of peat	Appx. B, D, XIV, C
May 2005	AGL 03-104-R06	Test road 4 x sample locations	Gouge auger	Peat depth, consistency	Appx. B, D, VI, A
"	"	"	Shear vane (large & v. large)	Shear strength of peat	"
May 2005	AGL 03-104-R05	Road by T70	Gouge auger	Peat depth, slope angle	Appx. B, D, XIII, A
"	"	"	Shear vane (large)	Shear strength of peat	"
Dec. 2011	AGEC	Barrages 48 x locns.	Shear vane (?)	Shear strength of peat	Appx. C, G
"	"	Peat-slide area 48 x locns.	"	"	Appx. C, G
June 2018	AGEC	Repository areas	Shear vane (large?)	Shear strength of peat	Appx. C, B
July 2020	Fehily Timoney	Peat-slide area	Shear vane (large?)	Shear strength of peat	No data
"	"	Repository areas	Macintosh probes	Strength of peat	Appx. C, B
"	"	"	Trial pits	Von Post humification	"

Landva's published results and conclusions date back to 1980 with such concerns being repeated frequently since, even being highlighted within the SGG-2017 guidance. It is a thus source of considerable concern that shear vane testing forms such a central part of the rEIAS assessment of peatslide risk without any discussion about the uncertainties inherent in such an approach. The reliance on shear vane testing inevitably creates a degree of confidence that is potentially unfounded, but no significant attempt is made to acknowledge and explore the potential for such error.

Indeed '*Section 10.2.3.2.4, rEIAS*' states: *"Shear vane testing was carried out using a Geonor H-60 hand field vane tester. From FT's experience hand vanes give indicative results for the in-situ undrained shear strength of peat and would be considered best practice for the field assessment of peat strength."*

This statement differs significantly from what SGG-2017 and other acknowledged authors says about shear vane testing.

Furthermore, when differing sizes of shear-vane blade have been employed, as discussed and illustrated in '*Section 3.3.2, Appendix III of Appendix D of Appendix B*', the trend revealed within the rEIAS shear vane data displays a clear shift of 30% or more towards reduced peat strength as more appropriate, larger, vane dimensions were used. It is unfortunate that the largest dimension shear vane was used on only a very small testing location within the site.

A second feature of note in this particular dataset (i.e. '*Section 3.3.2, Appendix III of Appendix D of Appendix B*') is that two locations are tested. The first location is Turbine 68, which sits at the head of the 2003 peatslide although the peat around the turbine itself remained in place. The second location is Turbine 56 which is described as "*in forest*". It is striking that both the smaller H10 blade and the larger ESBI blades both give lower strength values for Turbine 56, but the larger-bladed ESBI vane returns an extremely low strength value of 2 kNm^2 at 3 m depth.

One explanation for such a value is that the larger blade encountered a fissure caused by shrinkage of the peat beneath the forestry whereas the smaller blade did not, or did not encounter as much of the cracking as the larger blade. Unfortunately, as can be seen from Table 2, this larger blade was used on only this one occasion, so the implications for the wider site and presence fissures are not revealed in any data presented within the rEIAS. The response in '*Section 3.3.2, Appendix III of Appendix D of Appendix B*' to these limited results is simply to observe: "*However it is difficult to account for the difference between the cu_{vane} determined for the different sizes from these considerations. Reliance must therefore be made on practical experience and, if possible, on-site calibration of the results.*" The main rEIAS makes no mention of these results whatsoever and so does not discuss the issue.

A third source of concern must be raised about the rEIAS shear vane results more generally. This is particularly so in the light of issues discussed above about the doubts expressed within the geoengineering community and the size of blades used to obtain peat strength values for the site.

'*Appendix A of Appendix IV of Appendix D of Appendix B*' presents in both tabular and graphical form the field data for shear vane tests taken along the road system 2004, while '*Appendix B of Appendix XIV of Appendix D of Appendix B*' presents in tabular form the field data for the shear vane tests taken from 1179 locations distributed across the site as a whole (and shown in '*Drawing No.3 of Appendix A of Appendix B*').

On looking through both the graphs and the data, it steadily becomes evident that there is a general pattern of a dense uppermost layer of peat but then the strength often declines, sometimes dramatically, at somewhere between 1 m and 2 m depth. There then appears to be a second zone of reduced strength at around 3 m depth.

This pattern is only mentioned within the rEIAS document as indicating a strong, desiccated layer near the surface. There is no comment about these apparently weaker layers although the values associated with these weaker layers are often as low as 4 kNm^2 with the 140 mm diameter shear vane. A reduction of 30% might be expected for a 270 mm diameter shear vane, which would reduce such values to between 2 and 3 kPa (or kN/m^2 – these units are equivalent). Such low strength values would have a significant impact on the overall pattern of Factor of Safety calculations across the site. This should, as a minimum, give rise to expressions of considerable caution if not outright concern.

The presence of such a weak layer would fit with the recorded details of the major slide at Turbine 68 and the lesser slide at Turbine 17. In both cases the recorded shear surface is described as being within the peat some 200-500 mm above the mineral base - i.e. some 1 - 1.5 m below the likely original peat surface ('*Section 3.1.1, Appendix C*', and *Section 9.1 (1), Appendix A*'). This coincidence is potentially significant, worth investigating further, but is not recognised, or at least not commented on, within the rEIAS.

Further evidence for such a significantly weaker layer somewhere between 1 m and 2 m below ground level can be found in the collated shear vane data displayed in AGEC (2004). '*Figures 4 and 5, Appendix A*' highlight the fact that a large number of low-strength values were obtained from between 1 m and 1.5 m below ground level. It should be noted that these values were largely obtained using a very small vane size (25 mm) and therefore almost certainly give higher strength values than would be obtained by the size of vane recommended by Long (2005).

Adding even more weight to the argument that AGEC (2004) values are high and un-representative, the shear vane tests were mostly performed either in the excavated face of a turbine base or in a ditch nearby ('*Appendix B of Appendix A*'). Both of these types of locality would already have at least undergone primary consolidation as a result of drainage effects and therefore not have been representative of the surrounding peat. Such consolidation would tend to give higher shear vane values, giving an impression of greater strength than would be likely in the surrounding peat (unless of course the vane hit a shrinkage crack, but with such small vanes this probability would be substantially reduced).

The same concerns expressed by Long (2005) and Long and Boylan (2012) and the SGG-2017 apply to the 1179 shear vane tests carried out by ESBI (2005) across the site as well as to the 56 tests carried out by either AGL at turbine sites or along roads. If the majority of the values obtained were to be adjusted downwards by some 30%, the many low records at around 1 m-1.5 m would then fall as low as 3 kPa, resulting in a significant shift in calculated Factor of Safety values. The observation of Long and Boylan (2012) that any shear vane test has a tendency to "*...grossly over-estimate the strength of peat deposits...*" should have raised further significant concerns within the rEIAS.

6.1.5 Probability of occurrence

The probability of slope-failure occurrence is generated by assembling all the information described above. It is normally assumed that landslide probability is spatially variable across a site because conditions inevitably differ from location to location across landscapes.

6.1.5.1 SGG-2017 – Probability of occurrence

The SGG-2017 guidance makes clear that the developer should formulate any scale of likelihood based on the developer's understanding of the site conditions. As we have seen above, it is not at all clear that the developer has a good grasp of the site conditions – or even an understanding of their own data.

6.1.5.1 rEIAS – Probability of occurrence

The creation of an inappropriate scale of probability by the developer has already been discussed earlier. Of more interest and significance here is the way in which the rEIAS and the documents on which it is based have assembled the accumulated field data into a spatial picture of peatslide susceptibility.

No such picture was developed prior to commencement of works, but following the 2003 peatslide, AGEC (2004) divided the development area into a contiguous set of seventy one 200 m x 200 m grid squares (hereafter referred to as 'T-cells'), thus creating a somewhat 'pixelated' map of the development. Relevant information for each of these squares was then assembled to generate an indication of susceptibility for each square, with each square being assigned a susceptibility value. Smaller 50 m x 50 m squares around each turbine were also treated in the same way to give a more focused assessment of the peat immediately associated with each turbine

AGEC's 200 m x 200 m T-cells, with a single turbine at the centre of each, have formed the basis of most site-wide assessments of stability and peatslide risk ever since. The key susceptibility map presented within the

rEIAS *"based on site conditions in 1998"* ('*Figure 10-34, rEIAS*') uses the same T-cells developed by AGEC for their 2004 report.

AGEC (2004) used the recorded shear vane values together with measured values for peat depth and slope angle to calculate a Factor of Safety value for each of the 71 T-cells. Where no shear vane value was available, a strength value of 4 kPa was used. The same value was used where there was evidence of instability. These FoS calculations were based for each T-cell on a single shear vane sampling location using the very small 25mm hand-operated shear vane and in some instances a single location for a somewhat larger 55 mm mechanical shear vane.

'*Section 10.5.1, Appendix A*" states that over 250 shear vane tests were carried out *"across the site"*, but in fact only 50 of the 71 T-cells were tested. The statement that *"over 250 shear vane tests"* were carried out refers to the fact that values were obtained from different depths in the peat at most of these 50 locations ('*Appendix D of Appendix A*'). Thus while peat strength values were obtained for 50 of the T-cells, no values were obtained for 21 squares (30% of the site). Instead, strength values were merely estimated for these 21 squares when assessing Factor of Safety values ('*Appendix D of Appendix A*').

As discussed earlier, a FoS of 1 is considered to be the point of failure, so in accordance with general practice AGEC (2004) chose 1.4 as the threshold for acceptable stability. On the basis of the calculated FoS values, AGEC (2004) concluded that only four of the T-cells had FoS values less than this threshold.

AGEC (2005) then took the lowest recorded strength value (2.8 kPa obtained from T-cell 34) and added a theoretical load in order to test the effect of a hypothetical weak zone within the peat (though perhaps in reality it was not so hypothetical). This resulted in 31 of the 71 T-cells achieving a FoS value less than the designated safety threshold of 1.4. AGEC (2004) concluded that because some of these T-cells already had constructed roads and turbines, the hypothetical model they had used was too cautious.

Three points are worth making about this AGEC (2004) analysis. Firstly, a very small-bladed shear vane was used, so with adjustments for the errors arising from such a device highlighted by Long (2005) and Long and Boylan (2012), using a shear strength of 2.8 kPa may have been closer to reality than was appreciated by AGEC.

Secondly, the FoS calculation for each T-cell was based on testing the peat in only a single location in each T-cell, and even this in only a proportion of the full set of T-cells (see Figure 6).

The degree of extrapolation from one sample location across an area of 200 m x 200 m, and then extrapolating across to other cells, represents a considerable act of faith. In a great many ways it does not conform to the guidance provided in SGG-2017. Of course the AGEC work was completed some 13 years before the SGG-2017 guidance was published, but the seminal Landva (1980) paper had been available for more than 20 years prior to start of the AGEC investigation. Its implications should have been clear and taken into account.

Finally, this assessment was based solely on FoS calculations derived from partial shear vane, peat depth data and slope. It did use signs of instability (tension cracks) to decide on the use of a minimum shear strength for the FoS calculation in some locations, but there are several areas where it cannot be said to have met the criteria set out in the later SGG-2017 guidance. It is therefore a valuable initial, if partial, indication of those areas meriting further investigation – albeit couched in wording which speaks of 'hypothetical' conditions which are described as 'unrealistic'.

There is little indication that the AGEC (2004) findings, albeit from what is described as an 'unrealistic hypothetical' case, were used to guide further consideration of risk. The risk assessment presented in the rEIAS is instead based on the much larger dataset provided by ESBI (2005) and now presented in '*Appendix XIV (Vols. 1 and 2) of Appendix D of Appendix B*'. This represents the only additional site-wide data currently available. There has been no extensive survey since that time, and even the data collected in 2004 and 2005 cannot be described as comprehensively site-wide. Significant areas of the site remain largely un-tested even today, despite indications that critical factors may be at play in these areas. For example, although '*Appendix XIV of Appendix D of Appendix B*' states that 1179 shear vane tests were carried out across the site, when the distribution of these tests is examined (see Figure 7) it becomes evident that many of AGEC's T-cells still either have no shear vane sample or at most only one or two.

The risk assessment offered in '*rEIAS, Section 10.2.4.4 and Figures 10-34, 10-35, 10-36*' is thus based on a synthesis of the data gathered some 16 years ago in 2004/5 across only parts of the site and is essentially a re-working of this information into a risk assessment.

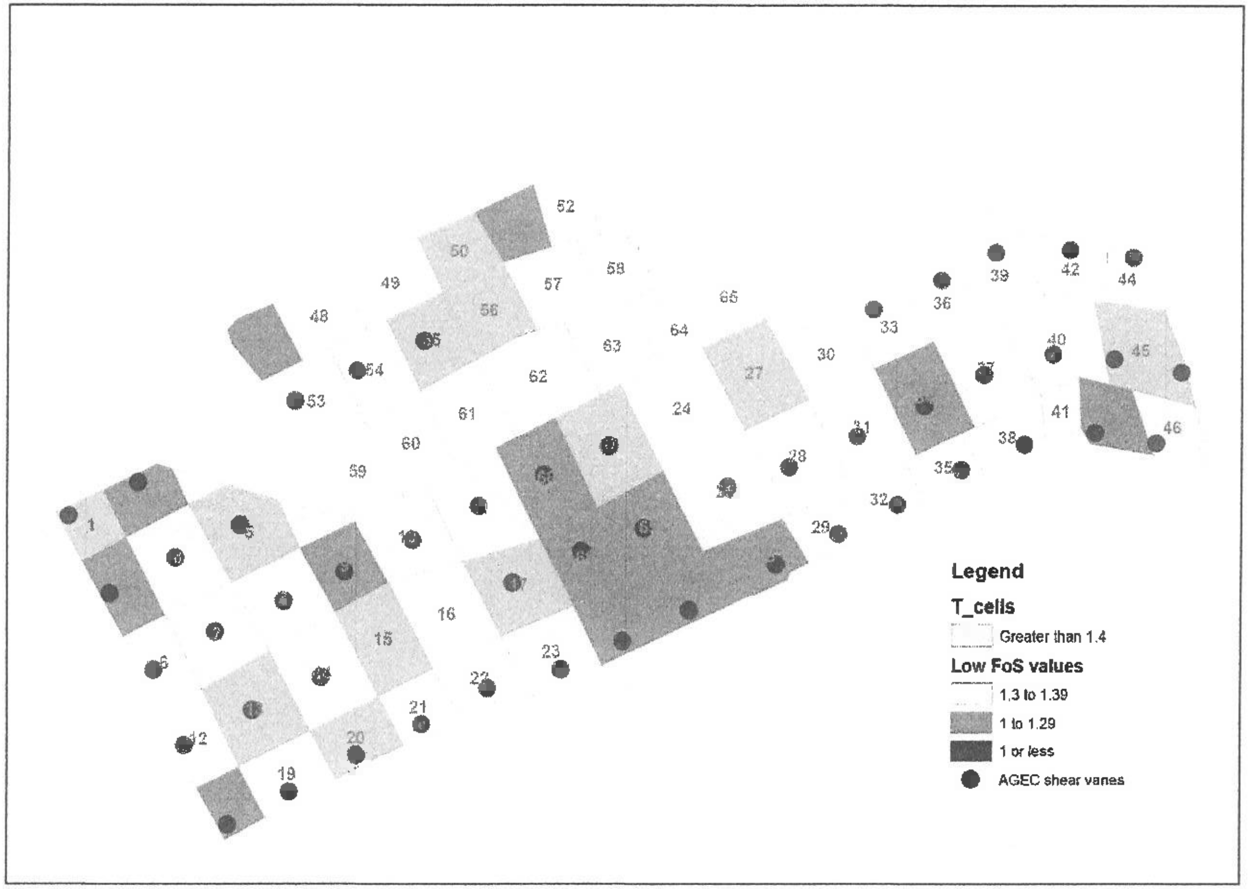

Figure 6. The 71 'T-cells' created by AGEC (2004). Each 200 m x 200 m cell is centred on a numbered turbine. Coloured shading indicates those cells with calculated Factor of Safety values less than 1.4, based on a hypothetical load of 10 kPA (equivalent to 1 m depth of excavated peat) and a weak layer within the peat (see Section 10.7, AGEC, 2004). Black circles indicate AGEC shear vane measurements. Note that the northern area of the windfarm in particular has few actual shear vane measurements yet parts are still indicated as at maximum risk under this scenario. The zone around T68 from where the 2003 failure flowed is clearly indicated as a high-risk region.

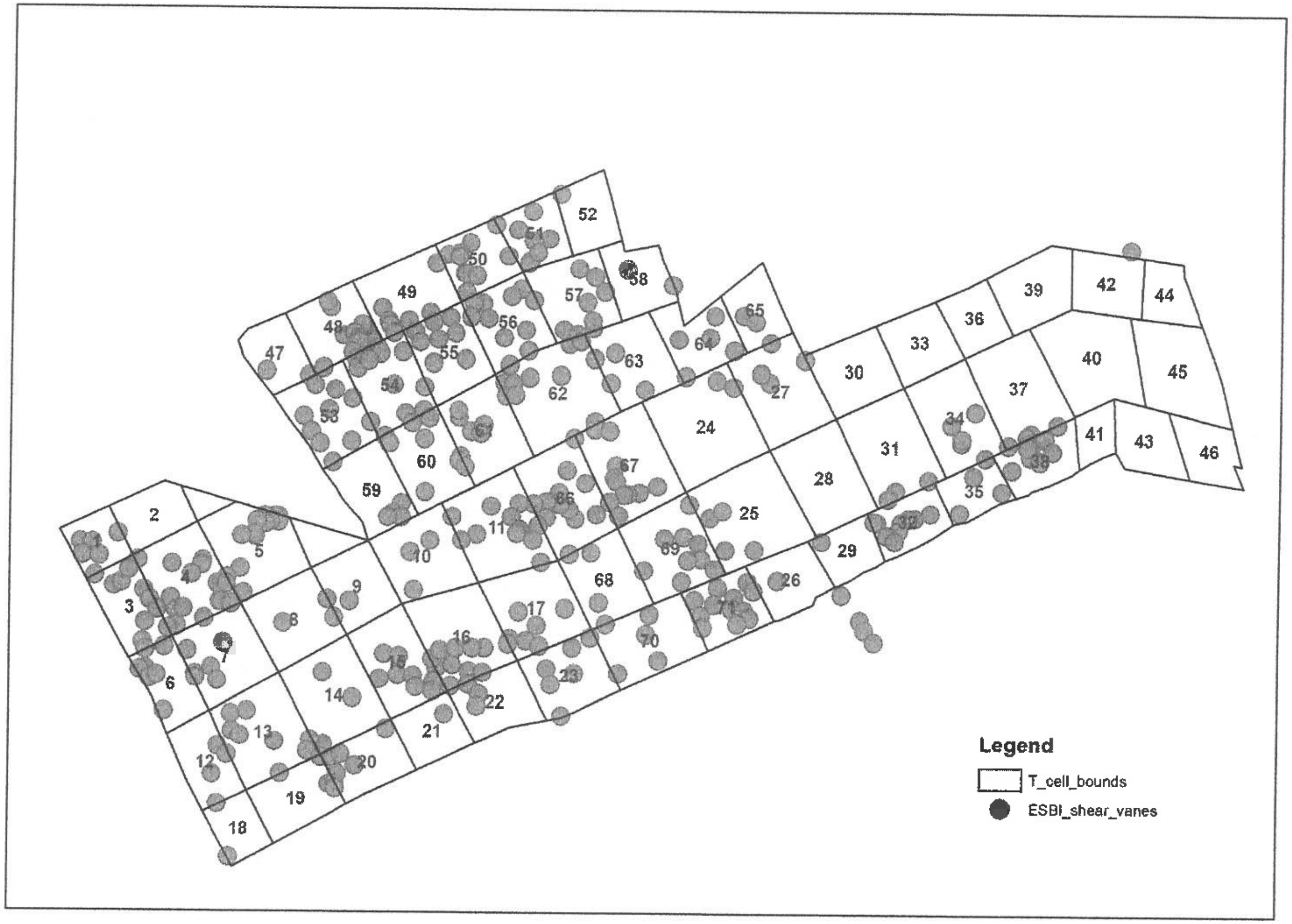

Figure 7. Distribution of ESBI (2005) shear vane tests across the T-cells of the windfarm site (from '*Figure 2, Appendix XIV of Appendix D of Appendix B*'). There is little coverage in the eastern part of the site, while certain T-cells in critical areas (e.g. T-cells 2, 18, 47 and 52) have only one or two testing locations.

6.2 Assessing adverse consequences and determining risk

6.2.1 SGG-2017 – risk assessment

The SGG-2017 guidance acknowledges that there is no single agreed method for assessing hazard and risk associated with peat landslides. Instead it highlights certain key issues that any method must address. It states:

"The probability of a peat landslide reflects the combined influences of *preconditions, preparatory factors and triggering factors, or collective 'controls', on the stability of a peat deposit.*

The addition of man-made controls (such as construction activities, alterations to peat drainage) reflects the potential destabilising effects of human activity on peatlands, and evidence from well-publicised peat landslide events that human activity may exert a significant control on peat stability (e.g. Lindsay & Bragg, 2005; Dykes and Warburton, 2007a).

As part of the EIA submission, it is expected that the [Peat Landslide Hazard Risk Assessment] provides sufficient estimates of risks to enable infrastructure layout (e.g. turbines, hard standings, compounds, tracks) to avoid areas of medium or high risk, while also making full and detailed recommendations for mitigation of low and medium risks where exposure remains."

6.2.2 rEIAS – risk assessment

The risk assessment process employed by the rEIAS is not described at all in '*rEIAS, Section 10.2.4. – Baseline Peat Stability Risk Assessment*'. Only the final resulting assessments are presented there, with assessments for three time-periods spanning the life of the development. Details of the assessment process are instead given in '*Sections 1, 2.5, 3.4 and 5.6 Appendix B*', where various relevant factors are considered and evaluated in '*Tables 2-2, 3-5 and 5-4, Appendix B*'.

The following factors are considered in '*Tables 2-2, 3-5 and 5-4, Appendix B*':

- Condition of the peat and/or sub-soil;
- Topography;
- Hydrology
- FoS;
- Contributory factors.

These factors are given numerical values between 5 and 20 in steps of 5 for each T-cell, though some factors are in effect allocated a 'Present' (20) – 'Absent' (5) option.

Although never specifically referred to, it seems that '*Tables B1 to B5, Appendix B of Appendix B*' are the source of these values.

The decision to allocate four categories to some of these factors but to allocate a simple 'Present' – 'Absent' option to others is a matter of expert judgement, as is the decision concerning which aspects of each factor are used to assign a particular condition to a particular category. Thus, for example, in '*Table B1*' the factor '*Stability of peat in trial pits*' allocates '*Collapse at >3m depth*' as '*Medium*' (Score 15), but '*Collapse at <3m depth*' as '*High*' (Score 20). However, collapse at any depth should be cause for serious concern, so the logic of separation is not clear.

In similar vein, '*Table B3*' allocates only those Factor of Safety values less than 1 to the highest category. It allows FoS values below the AGEC threshold of 1.4 to be allocated to a '*Low*' rating. The issues of poor shear vane recording and consequent impact on FoS values has been discussed earlier in the present document, and the rEIAS must surely be aware of the widespread concerns about such field data (given that the rEIAS states that it is using the SGG-2017 as its guidance). The categorisation of values even at the AGEC threshold of 1.4 as 'Low' would appear to be an inappropriate decision and not one guided by the required degree of caution.

Impact

At least in terms of 'Impact', given that the 2003 peatslide caused very considerable impact (and indeed continues to do so in terms of financial consequences) it is appropriate that *Tables 2-2, 3-5 and 5-4, Appendix B*' have allocated the maximum possible Impact value to every T-cell.

Risk assessment mapping

Based on these data and decision-steps, three scenarios are then presented in '*Appendix B*' and repeated in '*Section 10.2.4.4*' of the rEIAS:

- the risk in 1998 prior to commencing windfarm construction ('*Section 2.5 with Figure 2-17 and Table 2-2, Appendix B*');
- the risk following mitigation and improved site conditions for the period 2005 to 2020 ('*Section 3.4 with Figure 3-39 and Table 3-5, Appendix B*'); and
- the risk following mitigation and improved site conditions from 2020 to decommissioning in 2040 ('*Section 5.6 with Figure 5-8 and Table 5-4, Appendix B*').

The first scenario, presented as the 'baseline' condition in 1998, generates a peatslide risk map which identifies a considerable number of T-cells having

significant risk of instability and consequent impact (see Figure 8). The distribution of shear vane tests in relation to this assessment can be seen in Figure 9, while correspondence with the original 'worst-case' map generated by AGEC (2004) can be seen in Figure 10.

What is most striking about the areas identified as being at risk in by AGL (2020) is the clear concentration of T-cells at risk in the northern sector of the site, mirroring the already-failed area of the 2003 slide to the south. This region remained largely un-surveyed by AGEC (2004) so the main records for peat condition come from ESBI (2005). Even after this survey, however, some critical T-cells remain largely un-tested, as can be seen from Figure 9. They still emerge as being significantly at risk because of other risk factors. Concentration of high-risk areas in the northern and western parts of the site is reinforced by the findings of the AGEC (2004) report, as can be seen in Figure 10.

There are, nevertheless, doubts about the underlying data, as well as about the calculations and the classifications used in assembling the risk assessment presented in the rEIAS. The list of aspects that do not conform to, or adequately respond to, the various guidance steps set out in SGG-2017 includes:

- incomplete survey of the site;
- reliance on shear vane data;
- no adjustment for, or consideration of, shear vane blade size;
- inconsistent or incomplete mapping of surface and sub-surface seepage zones;
- little evidence for attempts to map sub-surface piping;
- failure to map forestry plough lines;
- failure to map fissures associated with forestry plough lines.

There is also a degree of uncertainty about several of the key data items recorded on the T-cell field sheets presented in '*Appendix B of Appendix B*' because they consistently have asterisks beside them, together with an asterisk key stating: *"Assumed, no information available, therefore, data conservatively assumed based on general on-site experience."* Precisely which data items this comment refers to is not made clear but the comment appears on every record form. It is to be hoped that all these asterisked items have not been universally *"...assumed based on general on-site experience"* as this would represent a very large component of the data reportedly collected.

Figure 8. Peat Stability Assessment by AGL (2020) for baseline conditions in 1998 for each T-cell. Highest risk rating is '5'. Note the concentration of high risk cells in the northern section of the site, and also the high risk value along the western margin of the site.

Figure 9. Peat Stability Assessment by AGL (2020) for baseline conditions in 1998 for each T-cell (highest risk rating is '5'), together with locations of shear vane sampling by ESBI in 2004/2005. Note the limited number of samples in high-risk cells 47 and 52, as well as the limited sampling in the SW corner of the site, and the absence of sampling for T-cell 46.

Figure 10. Peat Stability Assessment by AGL (2020) for baseline conditions in 1998 for each T-cell (highest risk rating is '5'), together with 'hypothetical' risk assessment by AGEC (2004). Note correspondence of the two assessments for western T-cells 2, 3 and18, and northern T-cells 47, 50, 51, 55 and 56.

Notwithstanding this uncertainty about the field sheets, it is possible to assemble a set of criteria from these sheets which arguably more closely reflect the guidance provided in SGG-2017 as well as those features highlighted by Dykes (2008) and presented in Table 1 earlier. This revised working of the ESBI T-cell field sheets is shown in Table 3.

Figure 11 compares the distribution of T-cells at risk based on the data in Table 3 with the distribution of at-risk T-cells presented by the rIEAS (and shown in Figure 8 above). From this it can be seen that there is good correspondence across all those T-cells identified in the rEIAS, but the revised assessment based on the data in Table 3 highlights a number of additional T-cells.

While the foregoing is all based on data from which predictions are made, it is also possible to correlate actual examples of failure with these values of risk assessment. Most evidently, the area of the 2003 peatslide features prominently in all these predicted assessments not because of the slide but because the character of the ground points to potential instability. Similarly, T-cell 31 within the turbary plots features consistently within these assessments and this is the location of the peat failure illustrated in '*rEIAS, Section 10.4.5.2.3, Plate 10-8*'.

Furthermore, in a very recent development, the developers have erected a 'Hazard' sign at the entrance to the turbary area stating that there is a risk of instability if peat extraction operations are undertaken. Although '*rEIAS, Section 10.4.5.2.3*' states "*The peat slide was not caused by site activities related to the construction or operation of the windfarm,*" the rEIAS and indeed field sheets presented as 'rEIAS, Appendix B of Appendix B' highlight the presence of sub-surface seepage running through the turbary area to the head of the turbary peatslide.

The start of this sub-surface seepage sits at a confluence of windfarm and forestry drainage infrastructure at Turbine 27, as can be seen from '*rEIAS, Drawing No. 11-147-03, Appendix B of Appendix B*', from where water is fed SE into the drainage system that runs alongside the road between Turbine 25 and Turbine 40 to the east. Interconnection with the very obvious seepage zone running from Turbine T27 to the peat slide, either directly at T27 or where the road drainage crosses the seepage zone immediately to the east of Turbine 34, could quite conceivably led a build-up of hydrostatic pressure within the seepage zone, causing failure. This possibility is discounted by the rEIAS without evidence, yet if pietzometers had been spread along the turbary zone rather than being clustered round a single turbine, and had those piezometers been maintained rather than being decommissioned, perhaps such dismissal of possibilities would have been tenable – or may have revealed a developing issue. As it is, the appearance of a 'Hazard' sign suggests that stability conditions on the site in 2020 are not as suggested by '*rEIAS, Figure 10-36*'.

In addition, deterioration or failure of the roadway in various locations has necessitated remedial action. In the case of the roadway between Turbines 15 and 17 a decision was even made to abandon the road because ground conditions were so unstable.

By overlaying the map of road sections which by 2014 required remedial action shows close correspondence with the high-risk T-cells consistently identified by the risk assessments. The northern section of the site has required remedial action along substantial sections of roadway, while in addition to the section in the south-west which has been abandoned (and for which data are not supplied as part of the rEIAS) it can be seen that several other significant portions of road in the western part of the site have required remedial action.

Furthermore, '*Figure 3-7, Appendix B*' indicates several areas where forestry will be left in place despite the general requirement for forestry to be removed when a windfarm is constructed. No reason is given for the retention of these forest blocks but their somewhat irregular edges suggest that they have been left in place because of local ground conditions rather than being planned forest coups. Their concentration in the northern part of the site, across areas consistently indicated as being at risk, would lend weight to the conclusion that this ground has shown sufficient signs of instability to abandon forest operations.

Sufficient evidence thus exists of ongoing instability in those areas consistently highlighted as being at risk to make a compelling case for a re-survey of the site, similar to that undertaken in 2004/2005. There has been ample opportunity to acknowledge the need for, and to undertake, further survey, given that all current risk assessments are based on data obtained as much as 20 years ago. However, no such fresh survey data, particularly for those areas potentially at risk, are presented within the rEIAS.

Recent survey has instead focused on the area of the 2003 peatslide or the peat repository areas. Given that much of the original peat has already been lost from the peatslide area, the main threat from this ground is most likely to be the formation of peat 'plates (like mud-cracks) on areas of bare peat. These plates form during dry weather but are then are lifted and transported downstream during periods of heavy rainfall (Hulme & Blyth, 1985). Consequent increases in levels of particulate organic carbon (POC) and dissolved organic carbon (DOC) will have a negative impact on downstream water quality whenever this occurs.

The peat repository areas, meanwhile, are held within constructed barrages which have been subject to recent geotechnical testing – unlike the remainder of the site.

Table 3. T-cells ordered according to the number of criteria met, based on peatslope risk assessment criteria recommended in SGG-2017.

T-cell	von Post	Pit stability	Convex break	Cu 2.5 kPa	Cu 2.5 class	Surface water	Forestry	Seepage	Pipes	Cracks	Valley	No. of criteria met
68	H8-H10	Local collapse	Yes	1	4	Y	Y	Y	Y	Y	Y	9
2	H8-H10	Spalling	Yes	<1 to <1.3	3	Y	Y	Y	Y	N	Y	8
4	H8-H10	Local collapse	Yes	<1	5	Y	Y	Y	N	N	Y	8
14	H8-H10	Collapse	Yes	<1	5	Y	Y	Y	N	N	Y	8
17	H8-H10	Collapse	Yes	>1.3	1	Y	Y	Y	Y	Y	Y	8
49	H5-H10	Collapse	Yes	<1	5	Y	Y	Y	N	N	Y	8
50	H6	Collapse	Yes	<1	5	Y	Y	Y	N	N	Y	8
53	H5-H10	Local collapse	Yes	<1	5	Y	Y	Y	Y	N	N	8
60	H5-H10	Collapse	Yes	<1	5	Y	Y	Y	N	N	Y	8
61	H5-H10	Local collapse	Yes	1	4	Y	Y	Y	N	Y	Y	8
62	H8-H10	Local collapse	Yes	<1	5	Y	Y	Y	N	N	Y	8
69	H8-H10	Local collapse	Yes	<1	5	Y	Y	Y	N	N	Y	8
3	H8-H10	Local collapse	Yes	<1	5	Y	Y	Y	N	N	N	7
5	H5-H10	Local collapse	Yes	<1 to <1.3	3	Y	Y	Y	N	N	Y	7
13	H8-H10	Collapse	Yes	1	4	Y	Y	Y	N	N	Y	7
15	H8-H10	Collapse	Yes	1	4	Y	Y	Y	N	N	Y	7
19	H6	Local collapse	Yes	<1 to <1.3	3	Y	Y	Y	N	N	Y	7

T-cell	von Post	Pit stability	Convex break	Cu 2.5 kPa	Cu 2.5 class	Surface water	Forestry	Seepage	Pipes	Cracks	Valley	No. of criteria met
20	H5-H10	Spalling	Yes	<1 to <1.3	3	Y	Y	Y	Y	N	N	7
21	H5-H10	Spalling	Yes	<1 to <1.3	3	Y	Y	Y	Y	N	N	7
31	H9	Local collapse	Yes	<1	5	Y	N	Y	Y	N	N	7
47	H9	Spalling	Yes	1	4	Y	Y	Y	N	N	Y	7
51	H5-H10	Local collapse	Yes	<1	5	Y	N	Y	N	N	Y	7
54	H9	Collapse	Yes	<1	5	Y	Y	Y	N	N	N	7
55	H9	Local collapse	Yes	<1	5	Y	Y	Y	N	N	N	7
59	H9	Spalling	Yes	<1 to <1.3	3	Y	Y	Y	Y	N	N	7
63	H5-H7	Spalling	Yes	<1	5	Y	Y	Y	N	N	N	7
64	H5-H10	Local collapse	Yes	<1	5	Y	Y	Y	N	N	N	7
1	H8-H10	Spalling	Yes	<1 to <1.3	3	Y	Y	Y	N	N	N	6
8	H8-H10	Collapse	Yes	<1 to <1.3	3	Y	Y	Y	N	N	N	6
12	H5-H10	Local collapse	Yes	<1 to <1.3	3	Y	Y	Y	N	N	N	6
22	H5-H10	Spalling	No	<1	5	N	Y	N	Y	N	Y	6
27	H8-H10	Collapse	No	<1	5	Y	N	Y	Y	N	N	6
33	H9	Collapse	No	<1	5	Y	N	Y	Y	N	N	6
34	H5-H7	OK	Yes	1	4	Y	N	Y	Y	N	Y	6
36	H5-H10	Local collapse	Yes	1	4	Y	N	Y	Y	N	N	6

T-cell	von Post	Pit stability	Convex break	Cu 2.5 kPa	Cu 2.5 class	Surface water	Forestry	Seepage	Pipes	Cracks	Valley	No. of criteria met
48	H5-H10	Local collapse	Yes	<1 to <1.3	3	Y	Y	Y	N	N	N	6
65	H8-H10	Spalling	Yes	1	4	Y	Y	Y	N	N	N	6
66	H8-H10	Spalling	No	1	4	Y	Y	Y	N	N	Y	6
70	H5-H10	OK	No	>1.3	1	N	Y	N	Y	Y	Y	6
6	H5-H10		Yes	<1 to <1.3	3	Y	Y	Y	N	N	N	5
7	H8-H10	Collapse	No	<1 to <1.3	3	Y	Y	Y	N	N	N	5
9	H8-H10	Collapse	Yes	>1	2	Y	Y	Y	N	N	N	5
18	H6	Spalling	Yes	>1.3	1	Y	Y	Y	N	N	N	5
44	H8-H10	Spalling	Yes	1	4	Y	N	Y	N	N	N	5
56	H6	Spalling	No	<1	5	Y	N	Y	N	N	N	5
67	h5-h10	OK	Yes	>1.3	1	Y	Y	Y	N	N	Y	5
11	H5-H10	Spalling	No	>1.3	1	N	Y	N	Y	N	Y	4
24	H6	OK	Yes	>1.3	1	Y	Y	Y	N	N	N	4
30	H5-H10	Local collapse	No	>1.3	1	Y	N	Y	Y	N	N	4
45	H6	OK	Yes	>1.3	1	Y	N	N	Y	N	N	4
57	H6	OK	Yes	>1.3	1	Y	Y	Y	N	N	N	4
23	H6	OK	No	>1.3	1	N	Y	N	Y	N	Y	3
28	H6	OK	Yes	1	4	N	N	N	Y	N	N	3

T-cell	von Post	Pit stability	Convex break	Cu 2.5 kPa	Cu 2.5 class	Surface water	Forestry	Seepage	Pipes	Cracks	Valley	No. of criteria met
39	H5-H10	Spalling	Yes	1	4	N	N	N	N	N	N	3
42	H8-H10	Spalling	Yes	>1.3	1	N	N	N	Y	N	N	3
25	H6	OK	Yes	>1.3	1	N	Y	N	N	N	N	2
26	H5-H10	OK	No	<1 to <1.3	3	N	Y	N	N	N	N	2
29	H6	OK	No	>1.3	1	N	Y	N	N	N	Y	2
32	H6	OK	No	>1.3	1	N	Y	N	Y	N	N	2
37	H6	OK	Yes	>1.3	1	N	N	N	Y	N	N	2
38	H6	OK	No	>1.3	1	N	Y	N	Y	N	N	2
41	H6	OK	No	>1.3	1	N	Y	N	Y	N	N	2
71	H5-H10	OK	No	1	4	N	Y	N	N	N	N	2
10	H5-H7	OK	No	>1.3	1	N	Y	N	N	N	N	1
35	H5-H7	OK	No	>1.3	1	N	N	N	Y	N	N	1
40	H6	OK	Yes	>1.3	1	N	N	N	N	N	N	1
43	H6	OK	Yes	>1.3	1	N	N	N	N	N	N	1
46	H6	OK	Yes	>1.3	1	N	N	N	N	N	N	1
58	H6	OK	No	>1.3	1	N	Y	N	N	N	N	1
52	H6	OK	No	>1.3	1	N	N	N	N	N	N	0

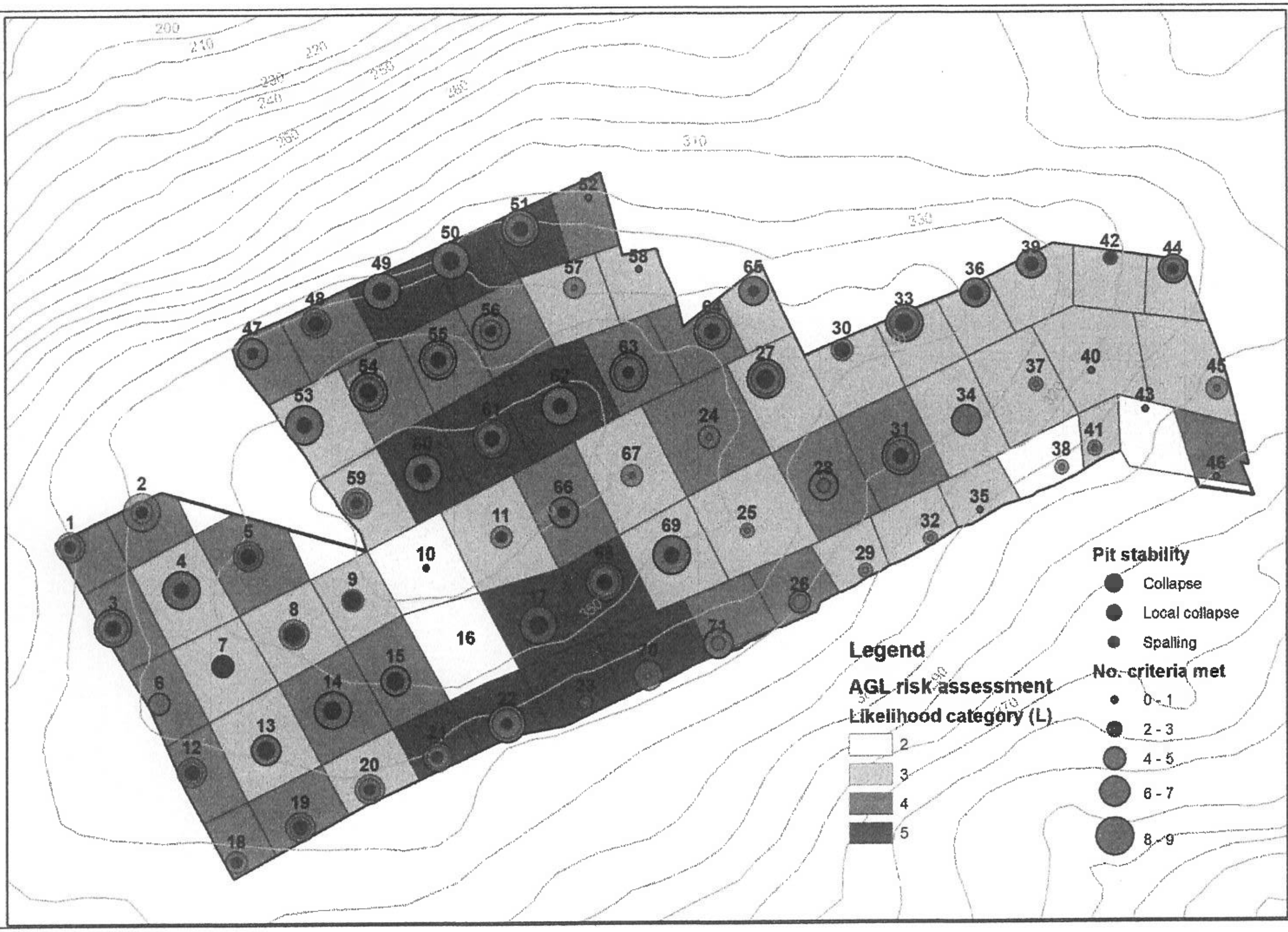

Figure 11. Correspondence between criteria set out in Table 3 and AGL risk assessment. Note in particular the consistent emphasis on the northern and western sectorsr of the site. Note that T-cells 14 and 15 represent the most extensive area of deep peat on the site, and this SW corner of the site slopes in the direction of the village of Derrybrien.

Figure 12. Map of road system indicating (in red) sections requiring remedial action in 2014. Correspondence between identified peatslide risk. The need for remedial action (in addition to the zone of the 2003 peatslide) is particularly marked in northern and western sections of the site. Road upgrade map from '*Drawing P378015-C-0003, Appendix A of Appendix B*'.

7. Mitigation

In some ways this is the most critical aspect of the rEIAS because, as the foregoing demonstrates, within its risk assessment the rEIAS recognises that a good proportion of the T-cells within the windfarm development are potentially at risk. The proposed mitigation measures are then claimed to alter conditions to such an extent that all at-risk T-cells are converted to a negligible-risk rating by 2020.

7.1 Mitigating actions

7.1.1 SGG-2017 – Mitigation

The SGG-2017 guidance provides four main actions and four sub-theme actions which can be used to reduce the likelihood of peat-slope failure:

- Avoidance;
- Engineering measures to minimise landslide risk;
- Engineering measures to control landslide impacts;
- Monitoring and review.

7.1.1.1 Avoidance

SGG-2017 guidance states that areas displaying Medium or High risk levels should be avoided. Infrastructure should be relocated to areas of lower risk. If avoidance is not possible, engineering measures should be put in place to minimise or control any risk.

7.1.1.2 Engineering measures to minimise risk

Although the SGG-2017 guidance identifies **drainage** measures as one approach to minimising risk, it employs drainage in a very specific way – namely as a means of re-routing surface and sub-surface water flows away from high-risk areas. The SGG-2017 guidance does *not* encourage the use of drainage as a general means of drying out the peat matrix in order to increase its shear strength.

In terms of **construction management**, the SGG-2017 guidance makes clear the importance of establishing rigorous procedures for managing actions in at-risk areas. It also emphasises the need to avoid loading excavated peat onto intact peat wherever possible.

7.1.1.3 Engineering measures to control landslide impacts

The SGG-2017 guidance does not seek to be prescriptive about measures which might be used to control the impact of any slope failure which might occur. This is because new approaches are constantly being explored and developed, particularly within the field of peatland habitat restoration where

such measures may be useful for restoration but may also have a role to play in controlling impact should slope failure occur.

The guidance does, however, identify two measures which are already well-established, namely **catch-wall fences** and **catch ditches**. Both are designed to slow or halt any run-out that may occur, with the former engineered into the peat substrate whereas the latter should be cut into non-peat soils rather than into the peat itself.

7.1.1.4 **Monitoring and review**

The SGG-2017 guidance states that factors affecting "*...the likelihood of peat landslides and their consequences may change with time. Thus, ongoing review of the peat hazard management plan is essential.*"

7.1.2 rEIAS – Mitigation and monitoring

7.1.2.1 **Scope of rEIAS mitigation measures**

Although '*rEIAS, Section 10.5*' is titled '*Remedial (Mitigation) Measures and Monitoring*', the majority of the section is devoted to measures designed to minimise further impact. It provides relatively little information about remedial actions designed to reduce *existing* risk. The focus is almost entirely devoted to direct impacts caused by site infrastructure or by removal of forest blocks. This restricted focus does not therefore tally with the approach adopted to risk assessment whereby the *entire* site is divided into contiguous T-cells with a risk assessment then generated for each of these cells.

Careful reading of '*rEIAS, Section 10.5*' reveals that actual mitigation measures undertaken to reduce existing risk created by the presence of the windfarm or risk inherent in site conditions, consist of just three actions or processes:

- Consolidation of peat beneath the roads, thereby increasing shear strength of the peat directly under the roads through compression;
- Abandonment of Turbine 16 and its section of access road;
- Improving and maintaining drainage across the site.

Two of these steps (consolidation of the peat beneath roads, and abandonment of T16) do indeed represent actions that almost certainly have reduced existing risk. The last action, that of site-wide drainage, creates more long-term challenges than it solves.

7.1.2.2 Engineering measures to minimise risk

The claimed and predicted mitigation improvement in conditions shown in the sequence '*rEIAS, Figures 10-34, 10-35 and 10-36*' is derived from the risk assessment set out in '*rEIAS, Appendix B*'. Of particular relevance are '*Tables 3-3, 3-5, 4-3 and 5-4 of Appendix B*'. These tables contain revised 'Hazard likelihood' values which are then used together with 'Impact' to derive new 'Risk Ratings'. '*Table 3-5 of Appendix B*' gives expert-judgement values for factors influencing site conditions *prior* to 2003 and these values are then used to calculate a 'Total Hazard Rating' then used to derive a 'Hazard Likelihood' value. No such expert judgement values for these factors are provided in '*Table 3-5 of Appendix B*' for the predicted post-mitigation conditions in 2004-2005. A 'Hazard Likelihood' value is simply presented and appears to be based on the decision that any 'Hazard Likelihood' value of greater than 3 in 1998 now reduces universally to a 'Hazard Likelihood' value of 2, while values originally set at 3 or less can be universally reduced to a 'Hazard Likelihood' value of 1.

The quantified logic behind this change in 'Hazard Likelihood' values is not explained. Given that, for example, the condition-factors 'Peat' or 'Topography' cannot readily be altered by mitigation other than by wholesale movement of windfarm infrastructure, such wholesale transformation is also difficult to understand. It might be argued that '*Table 3-3, Appendix B*' provides a basis for revision of the condition-factor values but there is no attempt to relate what is in '*Table 3-3, Appendix B*' either to the individual site-condition factors (such as Topography) used in '*Table 3-5, Appendix B*' for baseline 1998 conditions, nor indeed even directly to the new 'Hazard Likelihood' value given (without calculated explanation) for conditions after 2004-2005 mitigation works.

Drainage consolidates but also dislocates

The perception that mitigation actions applicable to mineral soils are equally applicable to peat soils is captured very clearly in the belief repeatedly expressed in '*rEIAS, Section 10.5*' that drainage will be wholly positive and inevitably increase slope stability. Unfortunately this is not the case, as has been described and illustrated earlier in the present document. The degree of shrinkage in peat soils following drainage can be an order of magnitude greater than that normally encountered in a mineral soil. This means that the unconfined peat matrix (i.e. peat not confined beneath a 'floating road') *must* crack and fissure under such drainage forces because it cannot occupy the same volume as it did when much of its volume consisted of stored water.

As discussed and illustrated earlier in the present document, while individual blocks of peat may gain in shear strength if they lose water to drainage systems, the drains themselves represent lines of zero cohesion, and as cracks develop in the peat these multiply the regions having zero cohesion.

Where deformation due to drying also results in separation along a line of weakness within the peat or separation of the peat from the mineral sub-soil, this provides avenues for water to increase hydrostatic pressure within or beneath the peat and also to lubricate the junction between these layers.

Drainage and maintenance of the peat in a robustly drained state throughout the life of the windfarm is regarded as a consistently positive mitigation measure by the rEIAS. This is based solely on the belief that the critical features for risk assessment are the roads and other infrastructure. While it is true that a waterlogged road is a danger to the stability of heavy vehicles and a waterlogged turbine base is a danger to turbine stability, almost no thought appears to have been given to the long-term consequences of drainage on the peat surrounding this infrastructure.

7.1.2.3 Engineering measures to control impact

Although the AGEC (2004) report recommends that a Contingency Plan be drawn up to control the impacts of any subsequent slope failure (following the 2003 failure), there is no evidence from the rEIAS or associated documents that such measures have been drawn up for the four catchments identified in '*Drawing No. QS-000192-01-D451-018, Appendix A of Appendix B*'.

7.1.2.4 Monitoring

It has already been pointed out in Section 5.4.2 above that the only continuous monitoring devices installed on the site (piezometers and tilt-meters) were decommissioned in 2014. Since then, the sole monitoring devices have been a set of 'sighting poles' located in the 2003 peatslide area which are checked intermittently by eye for signs of movement.

'*Section 10.5.4.2*' of the rEIAS and '*Table 3.2, Appendix C*' list a set of Periodic Inspection Reports undertaken by ESB, while *Table 4-2, Appendix B*' list a set of Geotechnical Inspection Reports undertaken by ESBI, together covering the period 2006 to 201, no example of these reports is provided as part of the rEIAS submission. The only description of what is monitored for these inspections is found in '*Section 3.2, Appendix C*' which notes that a report produced by ESB (2006) makes recommendations for a monitoring programme. '*Section 3.2, Appendix C*' simply lists the following as aspects which are the focus of such inspections:

- Peat slide source area;
- Repository areas;
- Containment barrages;
- Drainage network;
- Site access roads;

- Drainage local to turbines and associated hardstands;
- Borrow pits;
- Sighting posts and remote monitoring instrumentation (now decommissioned).

No details of what is monitored nor how it is monitored are provided.

However, a 2005 draft copy of the ESBI (2006) report – not supplied as part of the rEIAS submission – recommends the following inspection methodology:

Weekly

- Weekly check of remote monitoring instrumentation (now of course decommissioned);

Monthly – to confirm

- that the drainage network is operating freely;
- that there is no standing water adjacent to roads or turbine bases;
- that silt traps are not choked;
- no evidence of unusual road movement or of cracking;
- no un-intentional loading of the peat;
- no movement in the peat repository areas;
- the barrages are permitting free flow of the watercourse;
- the peatslide debris is stable
- any relevant off-site activities.

Yearly – by a geotechnical engineer and surveyor

- review effectiveness of drainage network;
- review shallow valleys on site for signs of movement;
- review 'restricted areas' (e.g.. areas where trees were not removed) for signs of movement;
- review the main slide area to check for movement and re-vegetation;
- review stability of borrow pits;
- review the barrages;
- review the remote monitoring instrumentation (now decommissioned).

Assuming that this monitoring regime was adopted and has been continuing since 2006 (and there is no way of knowing from the rEIAS submission whether this does now represent the regular monitoring programme), it is evident that monitoring since 2006 has relied on periodic inspection by eye

alone, and only the annual inspection requires the eye of a qualified specialist.

No formal testing of ground conditions is required in this regime, and the only monitoring instrumentation referred to has been decommissioned since 2014. Given that 16 years have passed since collection of the data on which the AGL (2020) risk assessment was based, and three years since publication of SGG-2017, there has been ample time for additional data to have been gathered both to confirm the changes in site condition assumed in the AGL (2020) risk assessment and also gather data which are more appropriate to a risk assessment claiming to conform to the requirements of SGG-2017. It appears from the rEIAS that the site operators have not made use of this opportunity.

8. Post-construction and restoration works

8.1 SGG-17 – Post-construction work

The SGG-2017 guidance emphasises that risk exists throughout the lifetime of the development and beyond. Restoration works bring their own risks if undertaken inappropriately. Equally, further risks to stability can also arise through the absence of restoration work at the end of the development lifetime, with the site simply left to respond to the long-term impacts of the development.

The SGG-2017 guidance highlights the importance of considerations and actions during the post-construction and restoration phase of the development. It states: *"Restoration proposals should aim to restore the water table of the peatland to ensure that the peatland becomes active again and therefore stores carbon. Otherwise, potentially significant changes to the hydrology of the peat bog may result in irreversible changes to the physical characteristics and structure of the peat that could both increase the likelihood of peat landslides and lead to long term degradation of the peat resource."*

8.2 rEIAS – Post construction work

The description of decommissioning provided by the rEIAS ('*Section 10.3.2.3.2*' and '*Section 10.7*') makes clear that the drainage system will be left to choke up after the above-ground infrastructure is removed: *"The improved drainage network on the wind farm site will be maintained up to decommissioning so that it will continue to have a positive impact with a moderately significant impact on the peat relative to the baseline conditions prior to construction. However, over time the drains will become clogged with vegetation which will result in partial restoration of groundwater levels on the site. In the long term this will reduce the effect on the stability of the peat to slightly significant."* (p.'*10-337*')

This statement appears remarkably sanguine about such an eventuality, given that the whole preceding document has repeatedly emphasised the dangers of ponded water and the undesirability of the drainage system choking up.

Damage to peatland systems through drainage cannot be simply undone by 'walking away'. A very considerable sum of money is spent every year across the European Union undoing the damage caused by peatland drainage because re-wetting drained peatland is not simply (or safely) a case of just 'walking away'. As the rEIAS (and a great many specialist geo-engineering authors) repeatedly acknowledge, the failure of an established drainage system on a hill summit characterised by many convex slopes represents a very significant risk of slope failure. Some examples of such failure have resulted from drains or peat cuttings created a great many years prior to the eventual slope-failure event.

Undoing the effects of peatland drainage is generally a more complex challenge than installing drainage in the first place – precisely because of shrinkage, cracking and deformation within the peat. The challenges are increased substantially where forestry has been involved because the tree roots add further complexity while forestry ploughing furrows (with their inevitable cracks) are generally placed at much closer intervals than when draining open landscapes. Research (e.g. Holden et al., 2007) has shown that drains with gradients of more than 4° tend to remain open and erode their bases over time. The general assumption of the rEIAS that all drains will choke up over time is therefore also not valid and not based on available scientific evidence.

Restoration of a blanket bog habitat on a landform such as the Cashlaundrumlahan summit required very careful and well-informed intervention, particularly as the blanket bog is demonstrably riven with fissures resulting from its historical land use for forestry, now combined with the drainage necessary for windfarm construction and maintenance.

The developers cannot on the one hand state that maintenance of a robust drainage system is vital for site stability then state that they intend to walk away from the site and permit the drainage system to fail having undertaken no mitigating management to stabilise such a future scenario. It is absolutely essential for the long-term stability of the site that suitable measures are tested and the best of these measures implemented by the developers *before* they leave the site.

The proposal to leave roads in place means that the excavated roads across thinner areas of peat will represent sharp breaks in cohesion of the peat mantle until such time as they are overgrown and a strong, fibrous mantle of peat has re-established over the carriageway. 'Floating roads', on the other hand, will continue to sink into the peat and form both a band of dense peat running across the line of sub-surface seepage (thus tending to pond water at depth) while also intercepting surface water flow and directing it along the roadway, thereby depriving the peat mantle of surface water downslope from the road. This will continue until the peat beneath the

roadway becomes so compressed that it cannot compress further, but if the peat is deep this may take many decades or even longer. Eventually, if compression ceases, the carriageway can become overgrown by peat-forming vegetation and can begin to re-accumulate sufficient peat to such an extent that accumulation can fill the trench formed by the road, but this is far into the future and far beyond what is currently known about the long-term behaviour of 'floating roads'.

Drains, fissures and road-lines will therefore continue to represent breaks in the cohesion of the peat-covered landscape and thus form points and lines of weakness until such time as a strong, deep surface layer of peat-forming vegetation can re-establish across them

A range of best-practice methods can inform whatever measures might be tested within the windfarm site and its environs. The recently-updated *'Conserving Bogs – The Management Handbook'* (Thom et al. (2020) is a valuable compendium of information. Moors for the Future and the Yorkshire Peat Partnership in England also have very considerable experience in restoration methods appropriate to intensively drained blanket bog, while the RSPB in Scotland now have much experience in the restoration of forested blanket bog. In particular, given the frequency of peatslides in Shetland, Scotland's Peatland Action team has found that old salmon-farm netting can be extremely useful in helping to stabilise otherwise unstable bare peat. This, combined with the standard engineering use of soil nails, might prove a fruitful area of testing for the Derrybrien site operators over the coming 20 years before decommissioning commences.

What is absolutely clear, given the repeated evidence of slope failure both on the site itself, in the surrounding landscape, and across Ireland as a whole, is that some form of suitable restoration intervention will be required on the Derrybrien site prior to completion of decommissioning to ensure long-term stability of the area. Simply walking away is not an option.

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