Appendix 1

Comments on (LWP 2006) Addendum to the Environmental Statement

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1. Introduction

The LWP (2006) Addendum represents a modified form of the application originally submitted as LWP 2004 to erect 234 wind turbines and their associated infrastructure on the Isle of Lewis. The present author provided two commentaries on the original proposal – one as a briefing note to the RSPB about certain aspects of the proposal, and a second more lengthy critical assessment, again for the RSPB, looking in detail at several aspects of the 2004 Environmental Statement. This second document has been available for public scrutiny on the RSPB website (Lindsay, R.A. 2005. *Lewis Wind Farm Proposals : observations on the official Environmental Impact Statement*.)
See : http://www.rspb.org.uk/scotland/action/lewis/index.asp (downloads)

The LWP (2006) Addendum proposes a reduction in the number of turbines from the original 234 down to 181 turbines, and provides an Environmental Statement that attempts to assess the potential impact of this smaller number of turbines. In addition, the 2006 ES examines a number of issues that were raised in Lindsay (2005) and endeavours to address these by providing more detail or by undertaking further analysis.

This present report therefore provides a critical overview in summary form of the revised proposal and the additional work undertaken to address issues raised in Lindsay (2005). A more detailed critical examination of these issues, based on fieldwork undertaken in 2006 and on further analysis of available evidence, is currently being assembled by the Environmental Research Group, University of East London.

This present summary will therefore consider the potential implications of this reduced development proposal for the peatland habitat, and will also look at the extent to which updated information provided by the LWP 2006 ES adequately addresses issues of concern originally raised in Lindsay (2005).

2. Nature of the revised development proposal and supporting documents

2.1 The revised proposal reduces the number of turbines by some 23%, but for the peatland habitat the *number* of turbines is not the main issue. What is far more important is the infrastructure associated with the turbines – particularly the road system linking the turbines. Each turbine base undoubtedly has the potential to disrupt the peatland habitat around it, but the impact is a point-source impact in the sense that impacts radiate from a single point.

2.2 Roads are linear and continuous impacts in the sense that they extend as an unbroken line across the peatland ecosystem. Unless they run exactly parallel with the flow-lines of water seeping through the peat, these roads form relatively continuous barriers to the natural hydrological pattern of the ecosystem. This will be explored in more detail later, but for the moment it is sufficient to note that the revised development involves only around 15% reduction in completely new constructed road length. Consequently although issues to do with bird collision and visual impact may (or may not) be reduced by up to 23% with this new proposal, the revised application makes only a relatively small difference in terms of the main development impact on the peatland habitat itself.

2.3 The development follows essentially the same routes as before (see Figure 1), albeit over a reduced total area (see Figure 2), with the result that 'floating roads' are still proposed for some 70% of the total road length. This is an enormous proportion of road infrastructure to be using for a construction technique that is relatively untested. Indeed not only is evidence available to show that such roads do not behave as predicted by the developers, but the construction technique described in the ES makes no reference to normal engineering practice on such soils, as will be discussed later.

2.4 Despite this, an Environmental Management Plan (EMP) is presented with the reported intention of demonstrating commitment to best practice in working methods. It is supported by a series of Outline Briefing Notes and Outline Construction Method Statements. The EMP also contains a draft Habitat Management Plan (HMP) that sets out a series of actions in relation to a number of habitat creation proposals linked, for example, to the use of excess peat excavated during the construction phase. The HMP suggests that additional habitat can be restored through this process, thereby compensating at least to some extent for any biodiversity lost through construction and operation of the windfarm.

2.5 However, the approaches adopted in both the EMP and the HMP fail to take into account the reality of prevailing conditions. They propose actions that may on the face of it appear reasonable or even desirable, but closer consideration shows that key issues are not addressed and that reality is likely to prove a great deal more complicated. The potentially substantial implications of these mitigation and compensation actions are by no means always positive, and are certainly not reviewed adequately by this Addendum to the Environmental Statement.

2.6 In addition, and in the light of the revised size and geographical scope of the development proposal, a similarly revised set of potential impact assessments is provided for the new layout. These impact evaluations are supported by a variety of new information which is used to justify this revised assessment exercise. A considerable amount of additional work has, for example, been undertaken to review the classification of vegetation and identification of 'active' bog, while a major hydrological study is reported on, specifically to support the stated position that drainage in blanket bog has minimal impact.

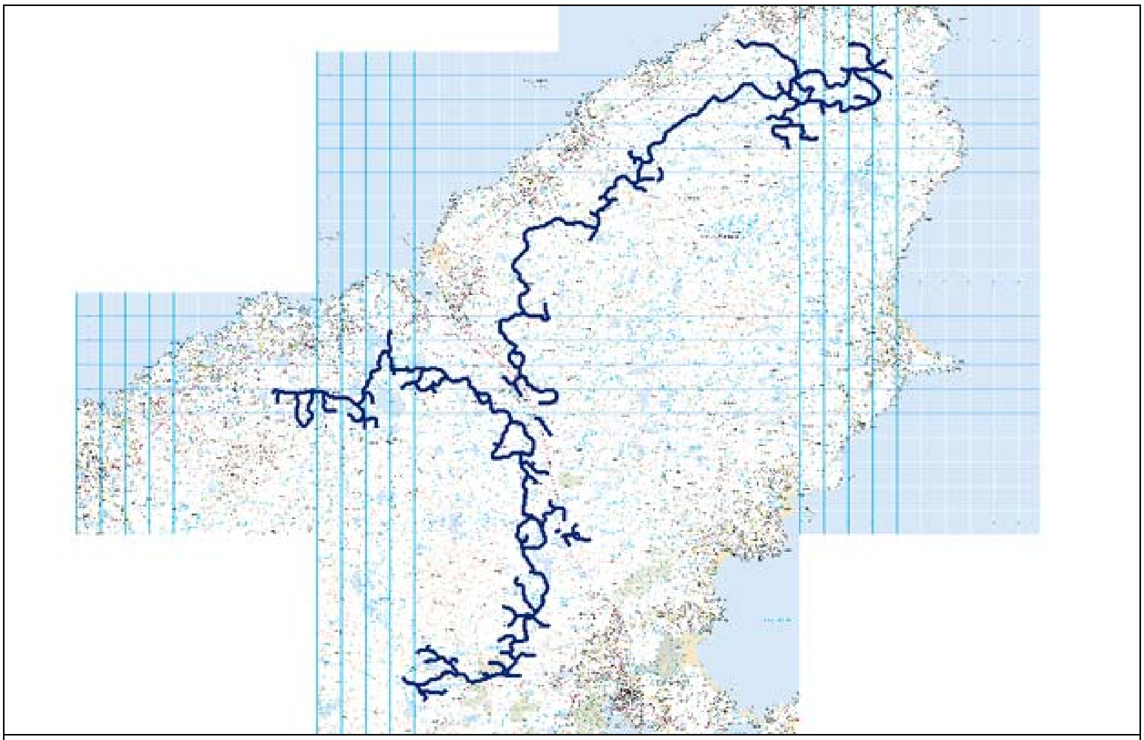

Figure 1. Map of the new site-roads for the revised Lewis wind farm proposal.

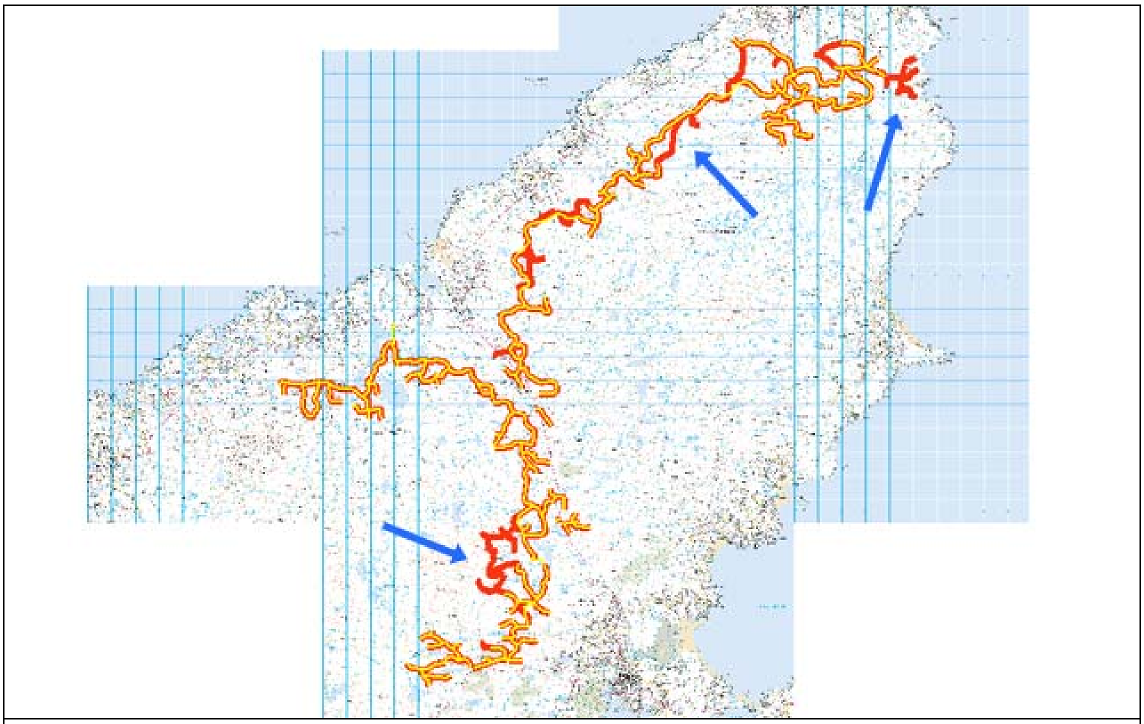

Figure 2. The new proposed site-roads (yellow) displayed over the route of the original development proposal (red). Blue arrows highlight significant areas of originally proposed site-road layout that are no longer required for the revised development proposal.

2.7 Both these reported studies, and other additional work presented, provide much valuable information and data. As such, they are very helpful additions to the body of knowledge about these issues and will doubtless help to inform further debate and scientific investigation. However, at both a fundamental and pragmatic level the information does not, in the final analysis, provide the degree of justification suggested for the environmental evaluations and impact assessments presented in this (2006) Addendum to the ES.

2.8 Consequently the resulting values given for potential impacts are in some cases inappropriate, in others they represent only one potential scenario when in fact there are other scenarios that could equally and evidently be invoked, while in other cases there is clear evidence available to suggest that important relevant aspects have been ignored or overlooked. Furthermore, certain other important aspects identified as deficient in the original LWP ES (2004) remain so in this Addendum, to the detriment of the evaluation process.

2.9 These various issues will be addressed in more detail below, but can be listed here as:

- hydromorphological classification of blanket mire systems
- blanket bog vegetation types
- condition of eroding bog (and peat cuttings)
- hydromorphological dynamics of the Lewis blanket bogs
- existing impacts on the Lewis blanket bogs
- identification of ‘active blanket bog’
- blanket mire hydrology and identification of potential zone of impact (PZI)
- delineation of infrastructure (roads, etc.) buffer zones
- construction of floating roads (OCMS 4)
- hydrogeology, geology and construction (OBN 6)
- peat stability analysis
- the Habitat Management Plan (HMP)

3. Hydromorphological classification of blanket mire systems

3.1 The ES (2006) Addendum continues to be at variance with the officially recognised system for defining and classifying units of peatland within a blanket mire landscape. Appendix 11B makes little reference to the hydromorphological system set out in the JNCC guidance (*Guidelines for Selection of Biological SSSIs : Bogs*) despite the acknowledged requirement (Appendix 11B, Para 1) that the Scottish Executive explicitly requested information about habitats and peat hydrology as part of the scoping guidance. The hydromorphological classification recommended by the JNCC provides an internationally-recognised integrated hydrological framework that describes the hydrological functioning of such mires at all scales.

3.2 It should be emphasised that the hydromorphological classification system recommended by the JNCC is not, as is claimed in the ES, developed for use in, and only suitable for, the Flow Country of Caithness and Sutherland. It has been embraced, and recommended for international use, by the Ramsar

Convention through the *Wise Use Guidelines for Mires and Peatlands* (a publication whose authors are Irish and Dutch/German). The classification system has been so endorsed precisely because it provides a functional, hydrological, multi-level framework for peatland habitats, which is precisely why it would be of considerable value to the Lewis Windfarm Assessment process.

3.3 In the absence of the JNCC system, the ES (2006) Addendum focuses instead on a classification system describing degree of erosion within the various mire systems of the Habitat Survey Area (HSA). While this categorisation is useful for certain purposes, it is a descriptive system that overlies the more fundamental hydromorphological character of each bog unit – thus a saddle mire remains a saddle mire whether it is eroded or not; however, the hydromorphology of the saddle mire will determine the likely orientation of the erosion pattern.

3.4 The ES (2006) Addendum appears confused about this point, as it suggests that the hydromorphological classification system 'lacks eroded bog types' and is thus not capable of describing the Lewis peatlands because they are some special 'eroded bog' type. Such an observation suggests a failure to grasp the basis of the hydromorphological system, and also suggests a failure to understand the nature of the blanket mire hydrological processes at the macro-, meso- and possibly the micro-scale within the landscape. The more detailed report from the UEL Environmental Research Group, referred to in Section 1 above, will illustrate the way in which the classification system can be used within the Lewis peatland systems.

3.5 In the meantime, the ES (2006) Addendum continues to rely upon an assessment of the peatland habitat that fails to provide the appropriate ecosystem focus and is thus inadequate for the purposes intended. The approach adopted so far is perhaps best likened to describing a showroom full of various cars but only using their colour scheme to distinguish them – useful for certain purposes, but incapable of providing any meaningful insight into the primary function of these cars as vehicles.

4. Blanket bog vegetation types

4.1 A considerable amount of work is described in Appendix11B of the LWP (2006) Addendum in terms of verifying the nature of NVC vegetation classes recorded from the Lewis blanket mires. This work was undertaken in response to comments made in Lindsay (2005) about certain NVC assignments, particularly to H10b, described in the LWP (2004) ES. In particular, Lindsay (2005) questioned the validity of the decision in the LWP (2004) ES to assign vegetation growing on deep peat to dry heath NVC types such as H10b.

4.2 A description is given in Appendix11B, Para 43 (LWP 2006 Addendum) further work subsequently carried out to address this question. The new work consists of species and vegetation analysis using Ellenberg values – a set of scores assigned to individual species based on various environmental characteristics of those species (Hill *et al*. 1999). This analysis shows that the species composition found on the Lewis peatlands demonstrates a clear gradient of wetness to dryness. In so doing, the study provides some interesting ecological insight into the hydrological stresses experienced within the haggs of these eroding bog systems. However, the decision then to assign these drier communities to H10b dry heath is still acknowledged as a unilateral decision. Appendix11B (LWP 2006 Addendum) is only able to cite supporting evidence from other published literature for this unilateral decision with the observation that “what seem to be dry heath analogues” appear in previously-published accounts of the Lewis peatlands or blanket bogs in Britain as a whole. Dayton (2003) barely recorded any H10b during her vegetation survey of the SAC, despite the fact that Plate 9 of Lindsay (2005) illustrates by no means the worst state of erosion to be found within the SAC. The LWP (2006) Addendum merely notes that Dayton (2003) did not record any H10b in the adjoining SAC, and states that: “A decision was made early in the HSA survey to isolate dry heath conditions with *Racomitrium lanuginosum* as H10b records...”, a decision clearly at variance with Dayton’s (2003) interpretation, but no attempt is made to explore this difference in interpretation. The evidence presented in the LWP (2006) Addendum merely states that (contrary to all previous published survey information) significant areas of the blanket bog surface should be classified as a dry heath H10b vegetation, and that this and other dry NVC types dominate the vegetation of the Lewis peatlands.

4.3 In the light of this unilateral decision, it is worth noting the opinion of Ben and Alison Averis, both highly experienced and respected botanical surveyors of Scottish vegetation. In surveys of south Lewis and North Harris (Averis & Averis 1995), they explicitly state that H10b never occurs on peat soils, and that M15c is almost wholly restricted to shallow peat soils. There is extensive deep-peat erosion in south Lewis, but there is no suggestion from either individual that the vegetation found on dry haggs could or should be classed as H10b.

4.4 Furthermore, the Upland Specialist of Natural England (Alistair Crowle, *pers. comm.*) has confirmed to the present author that relatively dry vegetation found on hagg tops in England would always be assigned to an M (mire) class of the NVC, rather than to an H (dry heath) NVC type. This is because drier versions of blanket bog vegetation continue to be regarded by Natural England as modified blanket bog types rather than as vegetation types of completely different ecosystem types.

4.5 A closer look at the species composition of hagg tops in the erosion complexes of Lewis reveals why it is appropriate to continue to classify the vegetation as still essentially a mire community, albeit a species-poor example where there has been severe erosion. Figure 3 shows an area defined in the LWP (2004) ES as heavily eroded H10b dry heath. It can be seen From Figure 3 that the ground is indeed eroded blanket bog, but also that there is a substantial proportion of common cotton grass (*Eriophorum angustifolium*) within the vegetation, providing a characteristic chestnut tint.

4.6 Common cotton grass is one of the key species differentiating bog peat systems from other habitat types. Dry heath is characterised by the absence of cotton grass (see Rodwell 1991). The extent of cotton grass in Figure 3 makes it quite clear that, even on most of the hagg tops, the vegetation is still essentially a mire (peatland) vegetation rather than a heath community. Widespread use of H10b on deep peat, as used by the mapping process of the LWP (2004) ES, would therefore still seem to be unjustified and inappropriate despite the extra justification put forward by the LWP (2006) Addendum. The assignment of blanket bog habitat to a dry heath vegetation type does not fit with the nature of the species assemblage, and distorts the conservation value-process, suggesting that the area under threat is of relatively low conservation value .

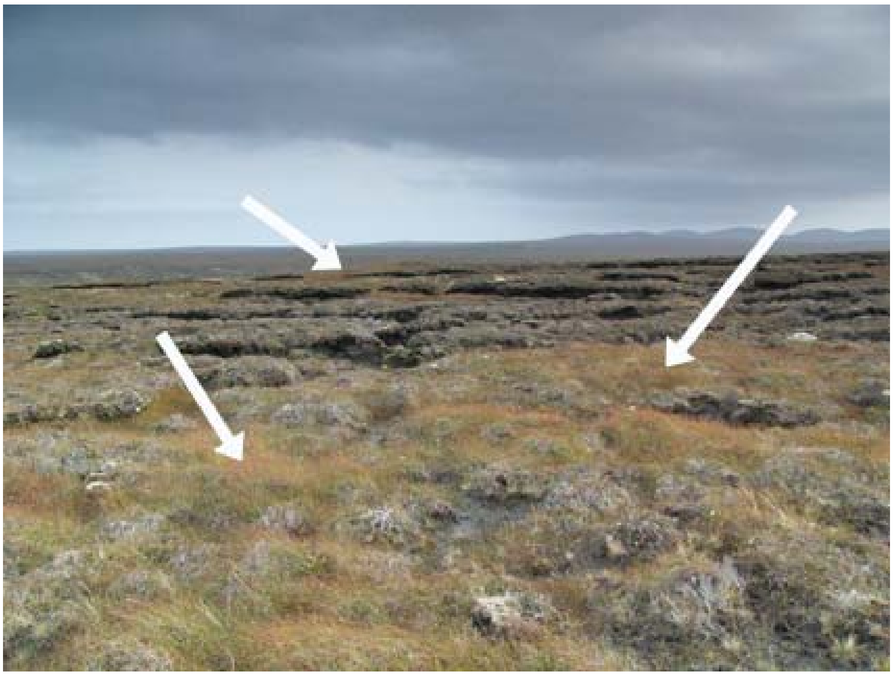

Figure 3. Area indicated by LWP (2004) ES as NVC type H10b (dry heath). Arrows point to the abundance of common cotton grass (*Eriophorum angustifolium*) – a defining species for bog, rather than heath, communities - within the hagg-top vegetation.

5. Condition of Lewis blanket bogs

5.1 One of the most striking features about the blanket bogs of Lewis, as became very evident during fieldwork undertaken by UEL during autumn 2006, was *not* how eroded the bogs were within the SPA, but how vigorously these eroded bogs were *regenerating*. Compared to the expanses of bare peat that separate the hagg tops of Kinder Scout or the Monadhliaths, the erosion patterns of Lewis were almost invariably found to have well-vegetated gullies at various stages of re-colonisation. It was relatively rare to find erosion gullies lacking any signs of recovery, or even still showing signs of active erosion. The main examples of active erosion noted in the field were encountered within the SAC rather than the SPA.

5.2 In many places the recovery of vegetation within the gullies has ponded water back through the erosion complex and led to the development of extensive pools. The combination of ponded water and thickening peat-forming vegetation within the gullies results in a general raising of the water table in adjacent haggs, which now show signs of becoming increasingly paludified. This is expressed as a greater proportion of cotton grass and *Sphagnum* within the vegetation of the hagg top and sides.

5.3 The scale of recovery can perhaps best be appreciated with reference to colour aerial photographs (see Figure 4), where the pale chestnut of cotton grass and paler shades of *Sphagnum* can be seen to dominate the network of erosion gullies.

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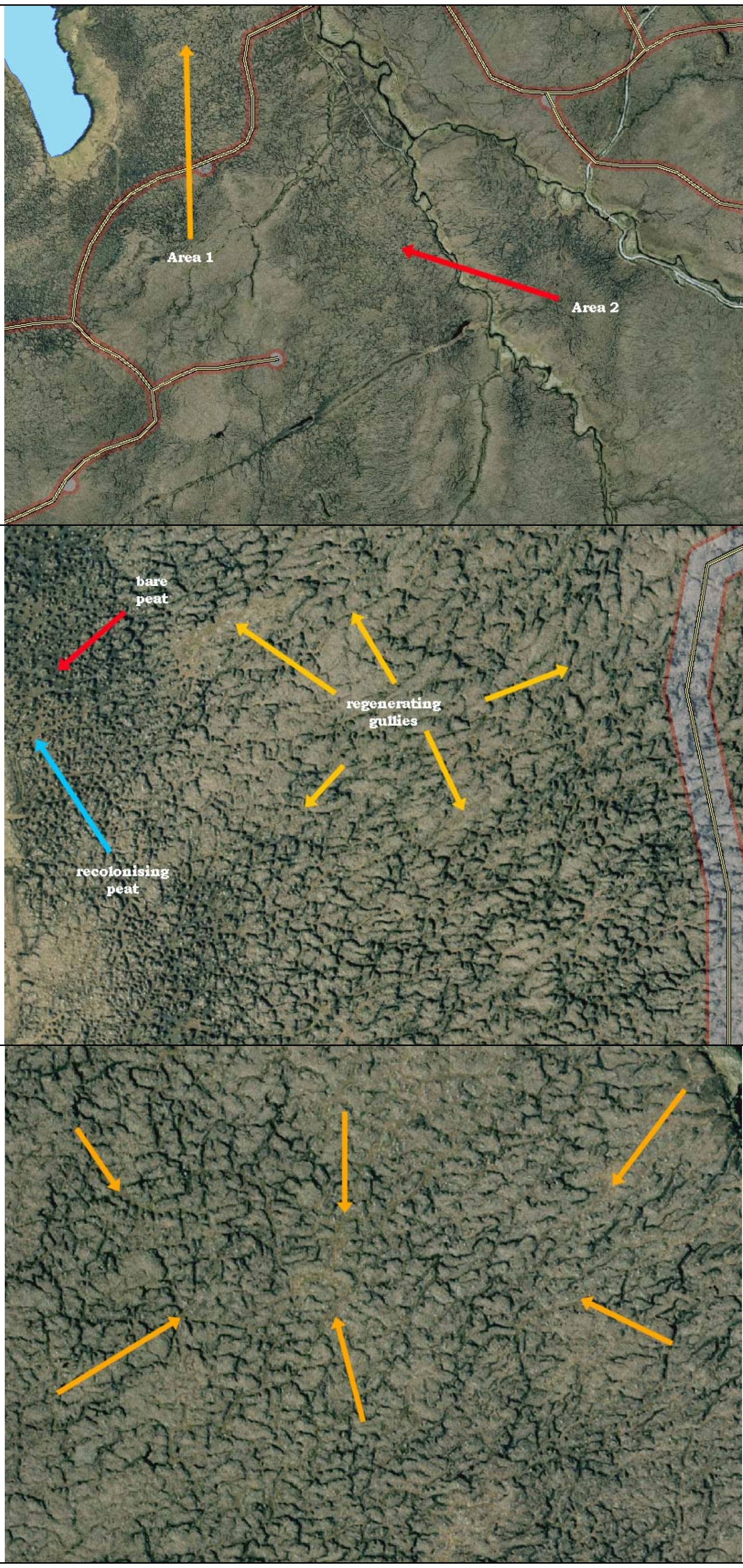

Figure 4 (a, b, c) (a) A typical area of peat erosion within the Lewis Peatlands SPA. Arrows indicate the two areas for which more detailed views are provided. (b) Area 1 detail, with orange arrows showing re-vegetated gullies, a blue arrow indicating re-vegetating sheet erosion, and red for bare peat erosion. (c) Area 2, with orange arrows highlighting some of the many re-vegetated erosion gullies.

5.4 Interestingly, the scale of recovery noted by the UEL survey is aactually corroborated by the definitions and extent of the various erosion classes given in the LWP (2004) ES. That picture of recovery is not, however, reflected in the many descriptions of the vegetation provided throughout the LWP (2004) ES and the LWP (2006) Addendum, nor in the quadrat data provided by the LWP (2004) ES. In these documents, emphasis is consistently placed on the dry nature of the hagg tops in descriptions of the vegetation, with relatively little mention of the vigorous recovery evident throughout the gully systems.

5.5 Indeed the quadrat data listed in the LWP (2004) ES are strangely at odds with the data obtained by the UEL team during 2006. The UEL data contain much more *Sphagnum* cover and a greater range of *Sphagnum* species than are recorded for the LWP (2004) ES. It looks as though the survey team for the LWP (2004) ES has tended to focus on the highest points of the hagg *tops* only, and not combined this in any way with data from lower parts of the microtopography, when describing the vegetation for an area as a whole. By so doing, the resulting account tends to suggest a much drier vegetation type than is perhaps the true picture.

5.6 Such a sampling and descriptive approach in part reflects the failure of the LWP (2004) ES to work within the framework of the hydromorphological hierarchy recommended by the JNCC. This framework explicitly encourages the description of vegetation based firstly on specific sampling of separate microtopographic elements, then subsequently on the integration of these components into a comprehensive vegetation description.

5.7 The contrast between the data obtained by the LWP (2004) ES and the data gathered by the UEL team will be explored further in the more detailed UEL report to follow. For the present, it is sufficient to observe that the emphasis placed by both the LWP (2004) ES and the LWP (2006) Addendum on the dry nature of the Lewis peatlands within the SPA does not appear to be a fair reflection of conditions on the ground. It is clear that, in the past, the Lewis peatlands have been relatively dry and subject to vigorous erosion. That phase appears to have ended some time ago, and now the general pattern is quite clearly one of recovery.

5.8 One further point worth making now, although it will be referred to again later, is that the domestic peat cuttings so widespread along the roadsides in Lewis, also generally have a good vegetation cover. In many cases this vegetation is clearly forming peat. It is quite unusual to find a peat bank where there is extensive bare peat. In part, this is probably due to the practice of laying the top-spit of living vegetation down onto the cut surface as part of the peat-cutting practice. It is therefore unwise to regard these old peat-cuttings as degraded habitat in need of major intervention.

6. Hydromorphological dynamics of the Lewis peatlands

6.1 It was noted in the previous section that there is heavy emphasis, within both the LWP (2004) ES and the LWP (2006) Addendum, on the dry nature of the Lewis peatlands. This perception of the peatlands is then strengthened and built on in the LWP (2004) ES and Appendix 11B of the LWP (2006)

Addendum. The title of Section 11B.3.4.1, LWP (2006) Addendum is "*Dry and possibly atypical peatlands*", suggesting that the peatlands of the Lewis SPA are unusual in their dry and eroded nature.

6.2 Having stated that the peatlands are dry, the subsequent sections between Paras 68 and 76 construct a hypothesis that the peatlands of the Lewis SPA are degrading through the natural action of peat pipes, with the implication that this is an inevitable and unstoppable degradation process. The text acknowledges that there is no robust evidence for this theory, and no research evidence is offered in relation to the Lewis peatlands, although reference is made to the increasing body of published literature now coming available about various forms of peat pipe.

6.3 As we have seen, however, the general picture of the Lewis peatlands is not in fact one of steady degradation but is instead appears to be one of relatively vigorous recovery. This picture of recovery does not fit easily with the vision of the Lewis peatlands as a landscape in terminal decline because it is riddled with peat pipes. Indeed several lines of evidence suggest that this is not a tenable theory.

6.4 Firstly, to invoke peat pipes as the driving force behind the almost universal picture of peatland erosion observed across Lewis would require that every example of erosion must be associated with a peat pipe. In fact, although sink holes and evident peat pipes are fairly frequent throughout the Lewis peatlands, there is nowhere near enough evidence to suggest that every erosion complex has been caused by this agent. If, on the other hand, it is suggested that not every erosion complex must have a peat pipe but that one degrading bog system can bring about the erosion of an adjoining system, then we are faced with a model where hydrological impacts can extend for a kilometre or more across peatland units – not a possibility explored by either the LWP (2004) ES or the LWP (2006) Addendum.

6.5 Secondly, the vision that peat pipes result in collapse of the peat and that the resulting sink holes bring about the breakdown of adjacent pool systems is not supported by the evidence. Lines of sink holes are generally found in areas displaying a relatively smooth bog surface (see Figure 5). If they were the cause of pool-system collapse by drawing water into these sink holes, the lines of erosion gullies would tend to lead towards such sink holes. If anything, erosion patterns tend to flow anywhere other than towards any sink holes in the vicinity.

6.6 Thirdly, evident sink holes and peat pipes would presumably be associated with evident collapse and drying out of bog pool complexes, and yet several systems that have very evident sink holes and peat pipes also have generally high water levels in their pools.

6.7 Indeed Figure 5 shows the same site as Plate 11B.24 of the LWP (2004) ES (referred to again in the LWP 2006 Addendum). In that document it is captioned as illustrating "Collapsed subterranean pipes as shallow depression lines and circular hollows, probably draining extensive watershed pool system (NB4255)". It is actually located at NB4355, but what is evident even in Plate 11B.24 (and Figure 5) is that many of the large pools have high water levels – despite the immediate presence of this large peat pipe.

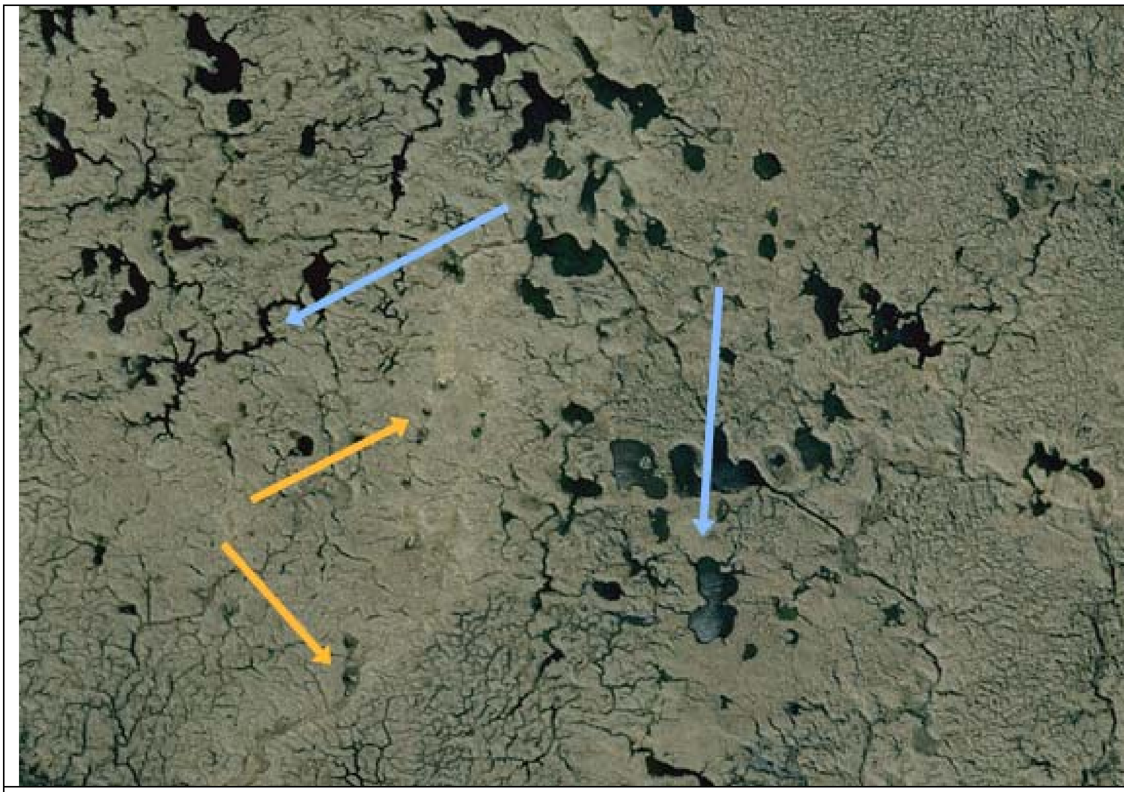

Figure 5. Line of sink holes (and thus presumed peat pipe) within pool system at NB4355. This same system is illustrated in Plate 11B.24 in the LWP (2004)ES. Note the relatively smooth ground associated with the sink holes (orange arrows), and the high water table in the pools arrowed blue on the right. Blue arrows point to water-filled pools evident in Plate 11B.24 of the LWP (2004) ES.

6.8 More extensive examination of sink holes and peat pipes in the Lewis peatlands both on the ground and using aerial photography reveals that, in general, sink holes form in lines (along the presumed peat pipe) and that they lie in natural lines of drainage within the landscape. Figure 6 emphasises this very clearly, and suggests that sink holes and peat pipes may often be *constructive* features formed where an established stream-course becomes overgrown by vigorous peat growth, leaving a few pockets where the stream is still exposed. The lines of the established streams are evident, and it is possible to distinguish various stages of overgrowth at different places along their lengths.

6.9 Eventually the line of the stream-course may become almost completely masked by the depth of peat above it. This appears to be the case in Figure 7, where the two small arrowed sink holes are very clearly (when examined on the ground) remnant pockets where the stream can still be seen flowing along its mineral bed before vanishing again beneath the peat. The other line of sink holes in Figure 7 can be seen to be associated with an evident and apparently long-established confluence with the larger main stream.

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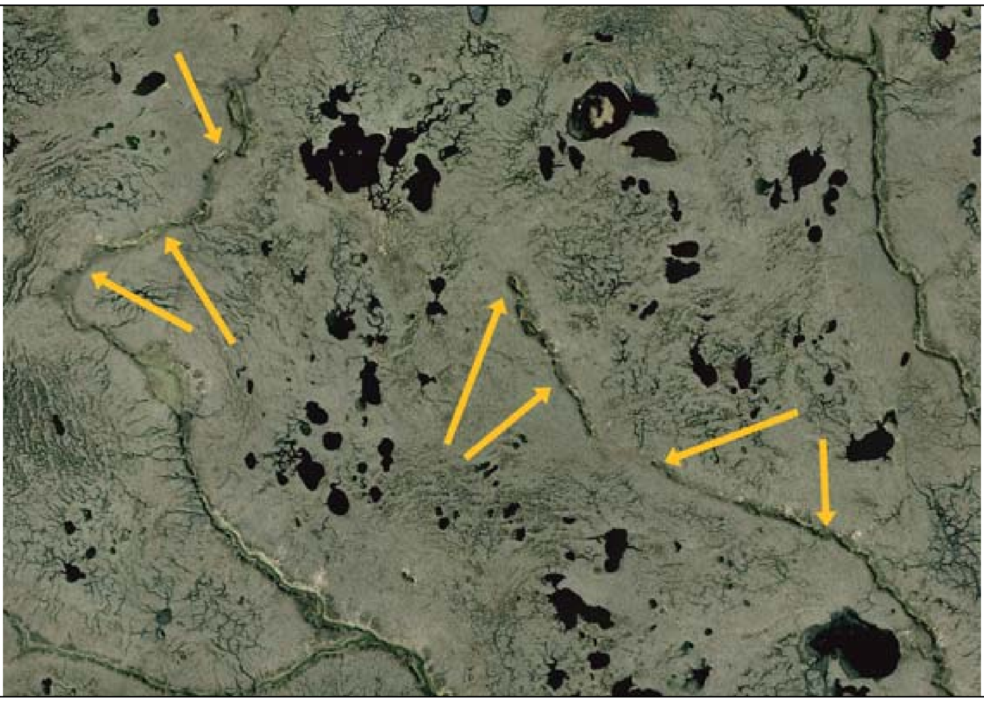


Figure 6. Lines of sink holes within the central part of the Lewis Peatlands SAC. The association of sink holes and peat pipes with established stream-courses is very evident. Various stages of overgrowth by peat can be observed.

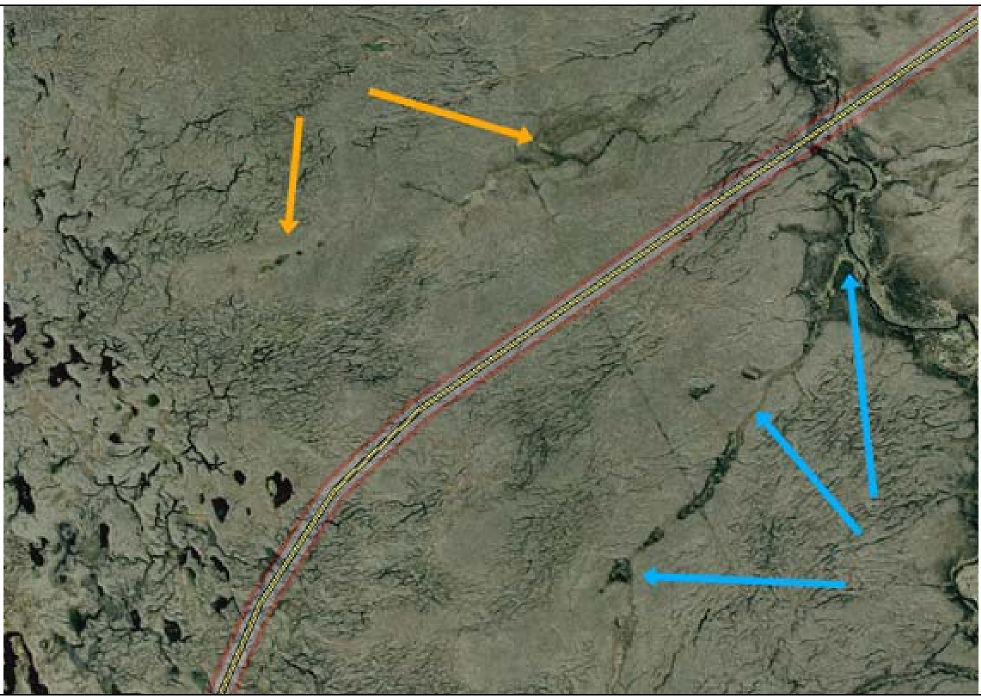


Figure 7. Two sets of sink holes, one arrowed orange, the other blue. On the ground the location of the orange sink holes to the left of the picture within a topographic line of natural drainage is faint but still detectable. The evident confluence with the main stream at the outflow of the blue sink-hole line suggests that this is a long-established feature. The pale red and yellow line is the line of the site road for the proposed windfarm.

6.10 Indeed, although the Target Notes from the LWP (2004) ES frequently refer to sink holes as obvious ‘collapse’ features, we have not yet encountered in the field any sink hole within the Lewis peatlands, possessing a structure which has obviously resulted from collapse of the peat. All examples so far examined have appeared to demonstrate steady constructive growth to overwhelm an established streamcourse.

6.11 While this alternative view of sink holes and peat pipes is supported by little more solid research evidence than the model of peat-pipe degradation advanced by the LWP (2004) ES and (2006) Addendum, it is proposed that this ‘constructive’ view of many sink holes and peat pipes is an equally valid interpretation of the visible evidence. This alternative ‘constructive’ model was put to the developers by Lindsay (2005). The LWP (2006) Addendum does not acknowledge this possibility at all, instead continuing to advance the model of peatland degradation to the exclusion of other possibilities. Consequently the LWP (2006) Addendum constrains its assessment of potential impacts, and the significance of these impacts, to a view in which the blanket bog landscape is inexorably decaying and degrading.

7. Existing impacts on the Lewis peatlands

7.1 The LWP (2004) ES and LWP (2006) Addendum both conclude that “drying as a result of natural hydrological de-watering is by far the most significant factor affecting habitat condition” (LWP 2006 Addendum : Appendix 11B.3.5.1, Para 84). Given that the same document admits that degradation through peat pipes is no more than a hypothesis, the statement quoted above seems remarkably confident and definitive in what is claimed. As will hopefully have been made clear in Section 6 above, there is at least one other possible interpretation of sink-hole dynamics.

7.2 The LWP (2004) ES and (2006) Addendum are both adamant that there is little evidence for significant burning impacts in the Lewis peatlands to explain the currently eroded state of these peatlands. The large fire that occurred on Barvas Moor in 2003 is acknowledged, but it is then observed that “even here there had been rapid re-growth of vegetation [by] late June.” Neither report states what form this re-growth had taken – was it species characteristic of fire damage such as abundant deer-hair grass (*Trichophorum cespitosum*), or perhaps purple moor grass (*Molinia caerulea*)?

7.3 The confident assertion that fire is not a major factor influencing the nature of the vegetation and the bog surface is at variance with at least three information sources. Firstly, SNH’s own condition assessment of the Lewis Peatlands SAC identifies it as “unfavourable”, due *particularly* to burning, “but recovering”. Secondly, it is possible to identify several examples of fire damage from aerial photography; some of these were subsequently confirmed in the field. Figure 8 shows one such area of evident burning. The frequency of these patches, and the facts that they can still be seen on aerial photographs, indicates that regular fire has left, and continues to leave, a substantial mark on the landscape. Finally, an extensive area of very recent burning was encountered in November 2006 within the SAC (see Figure 9). This collection of evidence for regular fire damage, combined with the large fire in 2003, indicates that fire may be a far more regular occurrence than is suggested by the LWP ES documents, and field evidence indicates that it has a substantial effect on the vegetation assemblage.

7.4 Interestingly, the LWP (2004) ES and (2006) Addendum cite the investigation by Moores and Stevenson. This research which indicates that very severe burning in the late Mesolithic/early Neolithic (5,500 BP) appears to have triggered extensive development of woolly-hair moss (*Racomitrium lanuginosum*), which is one of the major components of eroding bog vegetation. Such evidence, and a number of other features which will be explored further in the larger subsequent UEL report, may indicate that in fact the blanket bogs of Lewis have been in an eroded state, and maintained in that way, for almost 6,000 years. The fact that there now seems to be vigorous regeneration within the erosion complexes is thus of particular interest.

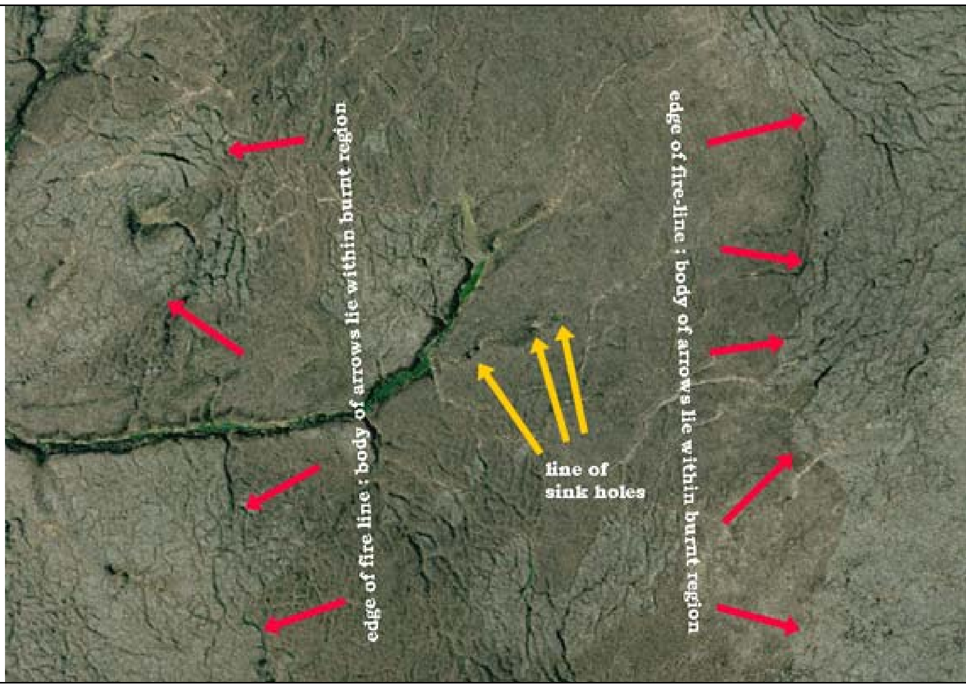


Figure 8. Line of sink holes (orange arrows) and evident boundary of fire damage (red arrows).

Aerial photo (c) Getmapping.com 2206

Figure 9. Blanket bog damaged by very recent fire within the SAC. Photo taken in November 2006.

8. Identification of 'active bog'

8.1 A considerable amount of additional analysis and discussion in the LWP (2006) Addendum is devoted to the question of how best to define 'active blanket bog'. The questionnaire instigated by John Tallis, University of Manchester, exploring concepts of damaged, modified and degraded bog, is considered in some detail, but the final approach adopted by the LWP (2006) Addendum for definition of active and non-active blanket mire involves the simple calculation of % *Sphagnum* cover.

8.2 As is acknowledged by the LWP (2006) Addendum, just such a reliance on % *Sphagnum* cover was abandoned by the JNCC Guidelines for SSSI selection some years ago, while the EU Habitats Interpertation Manual for the Habitats Directive, and associated JNCC guidance, makes no mention of any specific threshold of *Sphagnum* cover as the deciding factor between 'active' or 'non-active' bog. The JNCC guidance in relation to active blanket bog remains clear, however:

> "*...Thus sites, particularly those at higher altitude, characterised by extensive erosion features, may still be classed as 'active' if they otherwise support extensive areas of typical bog vegetation, and especially if the erosion gullies show signs of re-colonisation*."

Note that this definition does *not* require there to be re-colonisation by *Sphagnum*, nor indeed for any re-colonisation to be taking place in the gullies.

8.3 Despite this guidance, the decision is made by the LWP (2006) Addendum to use a *Sphagnum* cover of 10% as the threshold between 'active' and 'non-active' blanket bog. This figure is justified on the basis that it reflects the boundary between the *Sphagnum* cover found in Erosion Classes 1-3 and that found in Erosion Classes 4-6. In fact Erosion Classes 4 and 6 are described earlier in the LWP (2006) Addendum as having evident regeneration in the gullies and thus should very comfortably fit the JNCC definition of 'active blanket bog'.

8.4 Not all blanket peat is laid down by *Sphagnum*. That is, in part, why the JNCC guidance does not rely on any specific cover of *Sphagnum*. Furthermore, there are already concerns mentioned earlier about the species-recording process presented in the LWP (2004) ES. By taking this simple 10% figure based on one genus of plant, the LWP (2006) Addendum proceeds to define unilaterally what it considers to be 'active blanket bog' and calculate the degree of environmental impact on this basis.

8.5 Such a unilateral decision, if in accord with the various guidance available, might be considered an acceptable pragmatic first step in working towards a provisional estimate of the resource, but the approach adopted here does not accurately reflect the existing guidance. Consequently until such time as the EU Habitats Committee, and Member States, agree to change the extant wording of the published definition for active blanket bog, and the JNCC provides accompanying guidance for the UK, the unilateral calculation of extent of 'active blanket bog' provided by the (2006) Addendum is not an acceptable approach when undertaking a formal Impact Assessment.

9. Blanket mire hydrology and the identification of the PZI (potential zone of impact)

9.1 The very considerable amount of work which the LWP (2006) Addendum presents in relation to monitoring of bog water levels at the Farr windfarm provide a great deal of data about conditions and responses at that particular site. However, the lengthy paper that provides this information, and several other places in the (2006) Addendum, acknowledge firstly that relatively little is known about the hydrology of peat and water-table draw-down in relation to drainage. Those studies generally cited have tended to be fairly coarse-grained investigations, and as more detailed work is undertaken it is becoming increasingly clear that it is the fine-grain detail that is probably most important if the link between peat, water and species composition is to be understood.

9.2 Secondly, the LWP (2004) ES and (2006) Addendum acknowledge repeatedly that local ground conditions on blanket bog can vary enormously within relatively short distances, never mind from site to site. The data obtained from Farr provide some valuable insights into small-scale water-level behaviour at that site, but it is a very great leap from beginning to unravel the small-scale hydrology of that one site in Ross-shire to the potential small- and large-scale hydrological responses of the blanket bogs of the Lewis peatlands.

9.3 Given the very detailed nature of the information provided from this study, a more detailed analysis of the work will be provided in the UEL report to follow. For the moment, a few observations will suffice.

9.4 Firstly, the work so far undertaken has only been running for a short time. The evaluation of potential impacts should consider what impacts may develop over a period of some 25 years. Had the studies at Farr been able to present data spanning 15 or 20 years, then more confidence could have been placed on the results in relation to their relevance to the Lewis windfarm development. Some peat responses are very rapid, even catastrophic, as in the bogslide at Derrybrien, Co. Galway. Others, such as the steady loss of peat to oxidative wastage, may proceed at a rate of no more than a few millimetres per year. The hydrological work at Farr has been running for around 18 months, while the Causeymire development was only completed in 2004.

9.5 Secondly, much emphasis is placed on the micro-eroded nature of the impacted bog surface, and it is acknowledged that less eroded ground or softer bog may show a markedly different response to that described in Appendix 11E. Referring back to an earlier point, blanket bog tends to vary considerably even over short distances, and a bog that is broadly described as dominated by 'micro-erosion' may have pockets where the natural pattern remains relatively intact. Thus it is not advisable, when attempting to assess the potential impact of a development, to generalise and assume that all parts likely to be affected are in a micro-eroded state. As vividly demonstrated by the Derrybrien bogslide, one small area of weakness can lead to large-scale impacts.

9.6 Two of the key factors in assessing potential impacts on a blanket bog site, and which do not appear to be addressed explicitly either in the Farr studies or in the more general discussion about impact evaluation, are, firstly, the loss of peat thickness through oxidative wastage, and secondly the potential for initiating or rejuvinating erosion. Changes in bulk density of peat, cracking through shrinkage and wastage, loss of water through such cracking, the potential for catastrophic breakdown of pool patterning should there be a breach in hydrological integrity, and indeed the dangers of constructing on peat which has a significant density of peat pipes – these are all issues that are not addressed by the LWP (2004) ES or the (2006) Addendum, and yet they should be addressed if only to make clear how such issues relate to the development, if at all, and how they will be managed, mitigated against, or avoided.

9.7 Indeed there is a consistent tendency in the approach adopted to the assessment of potential impacts, particularly in the light of results such as those obtained from the Farr hydrological investigations, to generalise and propose average responses to potential problems. The identification of a potential impact zone should be based on the specific conditions across each part of a development and the zone adjusted accordingly in response to these varying conditions. 'One size fits all' is not an appropriate approach to the identification of potential impacts. The next section addresses this issue with some real-life scenarios which are not adequately catered for in the (2006) Addendum.

10. Delineation of buffer zones for infrastructure (roads, etc.)

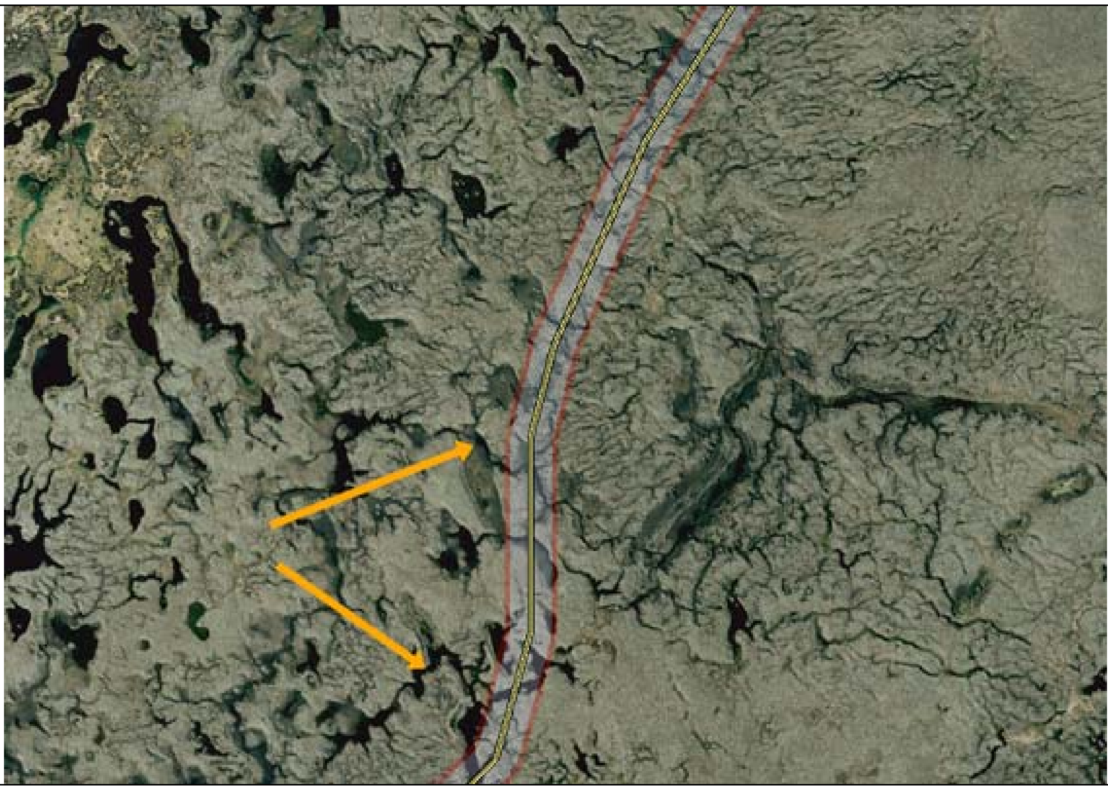
10.1 It is proposed by the (2006) Addendum that a potential impact zone of 10m be adopted along the length of the site roads, whether or not these roads will be 'floating' roads or not. This figure is arrived at on the basis of the results obtained from the Farr Windfarm hydrological monitoring. On this basis, a total impact of the roads and turbine bases on ‘active’ and ‘non-active’ bog (see earlier discussion about the validity of the definition used for these) is calculated to be 181 ha of ‘active’ bog, 593 ha of all blanket bog, and 906 ha of all habitats.

10.2 However, when the actual route of the roads is examined in relation to ground conditions, it can be seen that this estimate of potential impacts is a relatively meaningless set of figures based on theoretical or notional averages. For example, Figure 10 shows the proposed road and prevailing ground conditions north of Turbine G36. From this aerial photograph it is evident that the road crosses at least two major pool structures (arrowed), one of which extends for 60m and the other for more than 100m. Over what sort of distance is it reasonable to say that the constructed road would have an influence in this case? Will the road have no impact on the pools? Unlikely. Will it have some impact on the pools? Likely, but if it does, then what impact will changes to the pools have on the surrounding ground?

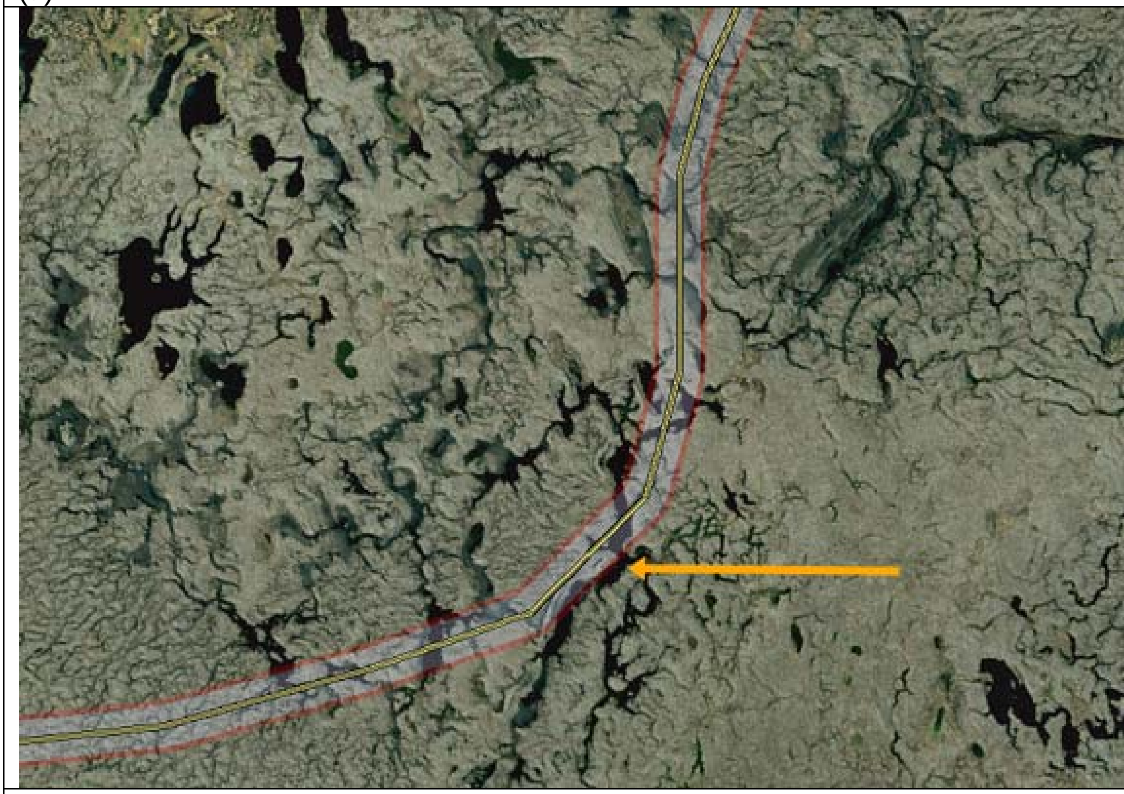
10.3. There is explicit acknowledgement in the LWP (2006) Addendum, Appendix 11E, that road construction tends to cause ponding upslope from a road (unless a drain is also added upslope), and that there is drying of the bog downslope from the road. Given that the erosion gullies downslope (to the right) of the road in Figure 10 are evidently brown and vegetated with peat-forming vegetation (a fact confirmed by field survey), what will be the effect on this re-colonising vegetation if the road cuts off a significant proportion of the water supply that maintains wet conditions through downslope seepage along the erosion gullies? Over what sort of distance would such drying result in significant change to these gully communities?

10.4 Taking another example of potentially complex impact interactions, Figure 11 shows a section of road near Turbines G40 and G42. The route of the road runs directly across what is obviously a sink hole/peat pipe complex. Where do the potential impacts extend to in this case? If the road is a floating road and progressively sinks (LWP 2006 Addendum, Appendix 11E indicates that this is likely) then what will be the hydrological implication for the peat associated with the length of this sink hole system? This system extends some 100m upslope into the pool system, and for several hundred metres downslope. What would be an appropriate zone of impact to define in this case? The 10m zone proposed by the (2006) Addendum is unlikely to be appropriate in this case.

10.5 In fact, given the evidently complicated ground conditions, it is meaningless for the impact assessment of such a development to use a standard buffer width to indicate the potential impact zone. Local conditions can mean that some sections of road would have virtually no impact on the surrounding ground, while other sections may give rise to potentially very extensive impacts. A realistic attempt to identify the potential zone of impact for such a development should show that the evaluation system has been responsive to local conditions and has produced an appropriate assessment of impact for each section or region. An impact zone based simply on a uniform measurement applied throughout displays a lack of attention to real-life detail and, frankly, a lazy approach to the impact assessment process.



(a)



(b)

Figure 10. Two overlapping scenes from part of the proposed site roads located to the north of Turbine G36. Major pools that cross the track of the proposed road are arrowed orange. Note also the pale brown colour of the erosion gullies downslope (to the upper right) of the road; these are re-vegetating vigorously with peat-forming communties (i.e. this is 'active' blanket bog).

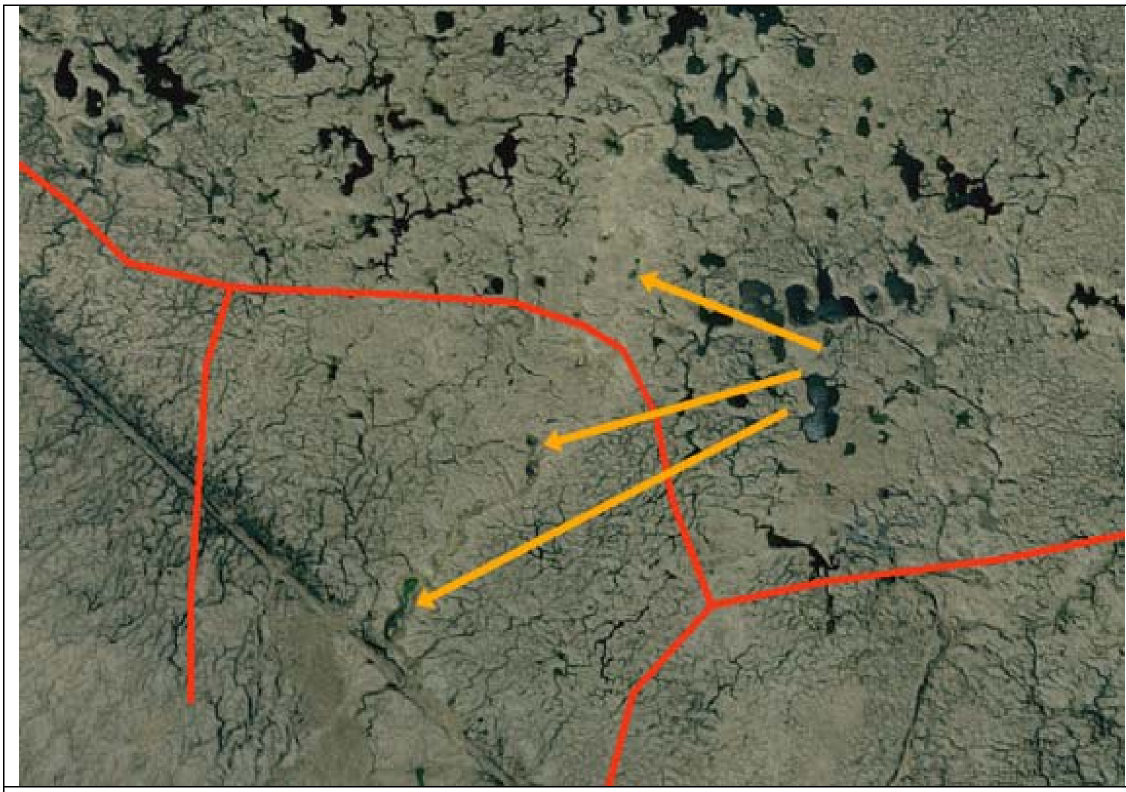


Figure 11. Line of proposed road (in red) close to Turbines G40 and G42. The road crosses an obvious line of sink holes (arrowed orange) and thus may compromise the associated peat pipe. The distance upslope (to top right) along the line of sink holes from the road to the large pools is 150m.

10.6 An example of the way in which the potential impact zone should be tailored to local conditions can be seen in Figure 12. This firstly shows the standard uniform impact zone applied by LWP (2006) Addendum. This uniform approach is then contrasted with an impact zone tailored to local ground conditions. The tailored boundary has been drawn up as an example only, and has thus been created by deciding specifically which areas of the erosion complex are most likely to be obviously and *directly* affected by the presence of the road. If the road passes through a bog pool, for example, it should be reasonable for even the most sceptical observer to accept that the pool will be in some way affected by this. Thus the tailored impact zone restricts itself to only the most obvious effects such as direct breach of a pool or cutting off the water supply to regenerating gullies. The tailored boundary, being only an example, does not attempt to incorporate possible indirect or secondary impacts.

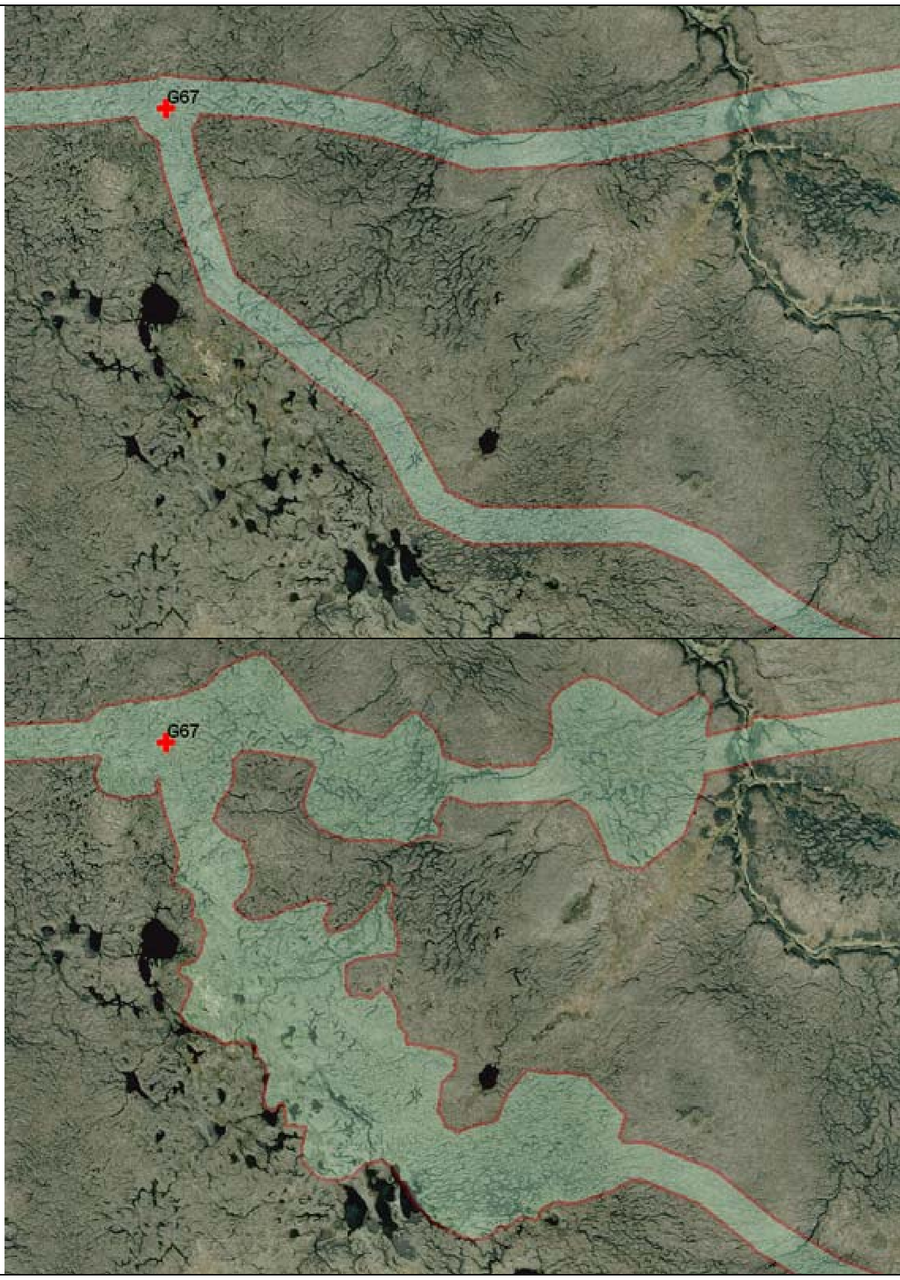


Figure 12. (a) Upper image shows the standard uniform application of an impact zone, irrespective of ground conditions. The pale turquoise shading indicates the predicted zone of impact. (b) Lower image shows the application of an impact-zone assessment where local ground conditions are taken into consideration. The Turbine G67 is indicated by a red cross.

10.7 Thus in Figure 12, a number of features are taken to have some potential for fairly obvious and potentially significant impacts - impacts on which all parties can probably agree: specifically, re-vegetating gullies immediately downslope from the road, pool areas directly affected, flat expanses of wet, regenerating bog vegetation. Elsewhere, on peat that is relatively smooth and gently sloping, the obvious and fairly immediate impacts are assumed to be no more than is suggested by the hydrological studies at Farr Windfarm. It should be fairly obvious that the resulting boundary begins to give a much more realistic picture of the areas likely to be very obviously and rapidly affected by the development proposal.

10.8 In some cases the potential impact boundary for even such obvious impacts may extend for several hundred meters (as in the case of the sink hole system in Figure 11), but in other sections the impact zone may be very narrow. If it is known that, for example, there are sink holes fairly frequently distributed throughout the impacted landscape, or there are areas where extensive erosion complexes are recognised as likely to be *initiated* by the development, then an impact zone map which is tailored to local ground conditions will embrace a very different area compared to the extent identified by a potential impact assessment using a standard uniform width of impact zone throughout. If the uniform width used is very small (*e.g.* a few metres), the tailored impact zone would almost certainly be very much larger than this, whereas if the uniform distance is very large (*e.g.* 1 km), then the tailored impact zone might prove to be significantly smaller in total area.

10.9 Thus, for example, it is possible to re-examine the basis of the contrasting and contested impact zones cited by the LWP (2004) ES and by Lindsay (2005), but using figures for the new development. Taking the revised area of development proposed in the LWP (2006) Addendum, and then:

- removing areas on thin peat from the Habitat Survey Area (HSA) - as for the purposes of this illustration we are considering only the potential impacts on the peatland habitat,
- limiting the area of interest to those parts within the HSA defined as 'active mire' [*sensu* LWP (2006) ES],
- then further limiting the area of interest to a combination of the full road width (15m) and a 10m buffer either side of the road, together with an average radius of direct impact for the turbines and hardstanding as 21.6m*

then the total affected area of "active bog on peat within the zone of the road with its 10m buffer and the turbines and hardstanding" amounts to 344 ha. If, on the other hand, concern for issues such as peat pipes and dewatering of pool complexes is used to define a uniform impact zone and a worst-case scenario of potential direct impact is adopted, then a buffer of 250m around all roads and turbines on deep peat might be adopted. Uniform application of such a width results in a total potential impact zone of 4,390 ha.

10.10 From such calculations it is evident that significantly increasing the width of a uniform impact distance results in a dramatic increase in the estimated zone of potential impact – in this case a more than 10-fold increase. In other words, if using a uniform zone of impact throughout, the total area of potential impact is enormously dependent upon the uniform width adopted. Every metre added to the width of the impact zone of the roads alone (*i.e.* a metre either side of the road) adds approximately 30 ha to the total area of the impact zone associated with the roads.

10.11 The true size of the impact zone almost certainly lies somewhere between 344 ha and 4,390 ha, and would more closely reflect the area obtained if the exercise in Figure 12 were to be applied throughout the site. However, it should be clearly understood that in certain locations within the development, impacts may be felt over distances of 300m or even 1km, depending on the particular local circumstances (for example, some peat pipes are known to run for more than a kilometre).

10.12 It is important to clarify one final point at this stage. The procedures used to identify the boundary in Figure 12b could not be used to define the boundary of the SAC. The discussion in the preceding paragraphs is concerned with illustrating the effect of taking into account those impacts that are obvious, reasonably immediate, and on which all parties can fairly readily agree. Constructing a road through a pool, especially if the road is accompanied by a drain, would seem to be an evident example of such an impact.

10.13 The question of whether impacts would eventually be felt beyond the boundary shown in Figure 12b remains the subject of dispute and will be explored further in the forthcoming UEL report. Suffice it to say here that JNCC guidance on bogland boundary definition states clearly that, in order to be secure, such boundaries should be based on the mesotope and macrotope concepts of the hydromorphological classification system – an approach already illustrated for the Lewis peatlands in Lindsay (2005). The LWP (2004) ES, and subsequent LWP (2006) Addendum, do not use this classification system and are thus unable to define boundaries in such a way.

10.14 It is worth noting here, however, that even the LWP (2006) Addendum to the ES does refer to amendments in the original scheme in order to ensure a 'safe' distance between the development and the SAC. This action is described as having been taken "to avoid any risk of impact on SAC hydrology extending over a few hundred metres" (Section 2, Chapter 11, 11.5.1). Such actions demonstrate that even the developer acknowledges the *potential* for hydrological impacts over considerable distances under certain circumstances, despite the evidence obtained from the Farr Windfarm studies.

The remaining four issues will be dealt with briefly here, but will be addressed in more depth in the subsequent UEL report about the area and the development.

11. Construction of floating roads

11.1 Floating roads have in the recent past been promoted by developers as an environmentally benign way of constructing roads over deep peat, because it has been asserted that such roads do not need associated drainage. The LWP (2004) ES stated that the extensive floating road network necessary for this development would not require drainage, and thus over a substantial part of the road network, road drainage was not a major impact issue for the ES to address.

11.2 In fact floating roads do affect the hydrology of the bog, both by blocking surface water flow – as acknowledged in Appendix 11E of the LWP (2006) Addendum – and because such roads tend to sink with time and thus either need drainage along their margins to prevent flooding, or require regular rockfill addition to raise the surface back to a height above the surrounding bog surface. In general, it is usual to find that such floating roads are eventually provided with a drainage system, even if they begin life without one. Consequently, drainage and water management from such drains along floating road lengths *is* an issue to be addressed by the ES, but is currently only addressed very briefly and inadequately in LWP (2006) Addendum, Outline Briefing Note 6.

11.3 Normal engineering practice for semi-permanent structures on such soft deposits as peat involves a process of ‘pre-loading’ the peat, which in effect squeezes some of the water from the peat and begins to re-align the peat fibres. Pre-loading means that when the final load (the structure) is applied, the rate of peat compression and water release is much reduced. However, pre-loading only affects the initial rapid compression; as long as there is a load applied to the peat, secondary compression will continue to occur, meaning that the peat surface, and its load, will continue to sink but at a slower rate. If this process is to be prevented, the construction must be supported on piles that reach through the peat to more solid sub-base.

11.4 Pre-loading is not common practice in the construction of floating roads, while piling is not an economic option. Consequently floating roads inevitably sink, and some sink more rapidly than others. Natural England reports a floating road on peat in the Pennines that has sunk more than 0.5m since the 10 years since it was installed. LWP (2006) Addendum, Appendix 11E also mentions records of rapidly-sinking roads.

11.5 Floating roads that sink are a significant operational issue, because the EMF states that all roads must be in a suitable condition, or capable of being brought into suitable condition, for use by heavy machinery such as cranes. A road that has a tendency to sink, especially if it sinks unevenly, is an operational problem which may have environmental consequences either through accidents that result, or because of the pre-emptive actions required. These issues are not adequately addressed by the LWP (2006) Addendum.

12. Hydrogeology and construction

12.1 Various statements regarding intended construction and working practices set out in, for example, Outline Briefing Note 6 are of real concern. These will be detailed in the subsequent UEL report about the area and the development.

13. Peat stability analysis

13.1 It appears that, although the cohesion of the sub-soil at the peat/sub-soil interface has been tested at regular intervals, there has been little testing with shear-vanes of the peat profile itself. This would seem to be a significant gap in the information-set required to create a meaningful stability analysis. Given the obviously variable and complex nature of the peat systems present here (as displayed in Figures 9-11), a detailed set of shear-vane tests would seem to be essential for production of an accurate slope-stability model and calculation of Factors of Safety (FoS) across the site.

14. Habitat Management Plan

14.1 The two primary objectives of this plan with regard to peatland habitats involve the ‘restoration’ of blanket bog in abandoned domestic peat cuttings, and the felling of forestry on peat to restore open blanket mire. The restoration of the peat cuttings will be achieved using infill peat obtained from excavating the site infrastructure (roads, etc.).

14.2 The assumption behind the restoration process for the peat cuttings is that these areas need assistance to return to 'active blanket bog' and cannot do so without the replacement of peat that has been removed.

14.3 In fact these old cuttings are generally in an advanced state of regeneration and many support what can be classed as an 'active bog vegetation'. Figure 13 shows part of the area explicitly identified for restoration of peat cuttings. It can be seen from this aerial photograph that virtually all the cuttings are well-vegetated, and field survey has shown that much of this is both *Sphagnum*-rich and supports a wide range of typical blanket bog species.

14.4 Replacement of this actively-growing community with a series of translocated peat blocks that may, or may not, eventually develop a community as active as the one replaced, appears to be an action with little environmental merit and indeed may do positive harm.

Figure 13. Aerial photograph of peat cuttings along the road running north from Stornoway, and identified as suitable locations for restoration proposals involving translocation of peat blocks from the development site to these cuttings. It can be seen that the majority of the cuttings are extremely well vegetated (blue arrows), with only small patches of bare peat (orange arrow).

Appendix 1

References

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