VIKING WIND FARM

HABITAT MANAGEMENT PLAN 2010

Produced by the Viking Energy Partnership, 2010

EXECUTIVE SUMMARY

The Viking Energy Partnership (VEP) submitted a Section 36 application to Scottish Ministers for a 150 turbine, 540 MW wind farm on central and northern Mainland Shetland (known simply as the 'Viking' Wind Farm). An Environmental Impact Assessment has been carried out to inform the planning process, part of which is known as an Environmental Statement (ES). During the application process the proposed scheme has been revised in light of comments received from statutory and non-statutory consultees. As a result of these revisions the proposed scheme now consists of 127 turbines (457.2MW). VEP has prepared an addendum to the original ES to capture all of the changes resulting from the revised scheme. Within the Viking ES and addendum, avian and non-avian ecology chapters assess the ecological effects and predicted impacts of the proposed wind farm.

The purpose of this Habitat Management Plan (HMP) is to provide both the context and the planned actions to offset and compensate for potential remaining adverse effects (following avoidance and minimisation) of the construction, operation and decommissioning of the Viking Wind Farm. A secondary objective of the HMP is to alleviate the ecological impacts arising from past and present land management practices with the intention of conserving, enhancing and restoring native habitats within the vicinity of the Viking Wind Farm in such a way that the Viking Wind Farm development will provide a net long-term ecological gain both during and beyond the life of the wind farm.

The HMP is primarily concerned with habitat management and ensuring that predicted wind farm impacts are reduced to such an extent that Favourable Conservation Status is not significantly affected for the species and habitats under consideration (as per SNH 2006 guidance). Blanket bog is widespread across the Viking study area, and much of it has been classified as 'active' according to the EU Habitats Directive definition, although arguably much of this would not be considered to be under Favourable Conservation Status. Given the predicted impacts of the Viking Wind Farm outlined in the revised ES, the HMP has four main foci: red-throated diver, merlin, whimbrel and blanket bog.. It also includes a number of measures which extend beyond the offsetting of predicted wind farm impacts that are aimed to further the conservation of these three priority bird species and one priority habitat.

This document outlines planned actions, an initial work programme that summarises the steps that need to be taken, appropriate partners and suitable funding, and monitoring mechanisms for the life of the wind farm. This HMP has been developed as an evolving plan that will be responsive to changes in circumstance, new information, best practice guidance and the results of its actions. It is planned that periodic progress reviews will be undertaken and that these will inform future work programmes and the techniques employed. Whilst the primary responsibility of the VEP, the implementation of the HMP will draw upon a diverse range of expertise and knowledge and will be overseen by an independent advisory and monitoring group, the Shetland Windfarm Environmental Advisory Group (SWEAG).

The VEP is fully committed to providing best practice mitigation and this explicitly includes a commitment to establish, initiate and fund ongoing programmes of mitigation and enhancement work around the proposed wind farm. This commitment extends for the life of the project; a period of at least 20 years. Over time, the techniques used and the intentions of the HMP will inevitably change and evolve to reflect increased knowledge and experience arising from the project itself or from elsewhere. Regardless of how the HMP's techniques, intentions and stakeholders may evolve, VEP will provide the initiative, drive and support to work towards delivering the aims and objectives of this plan.

1. INTRODUCTION

1.1 Introduction

This Habitat Management Plan (HMP) forms an appendix to the ES addendum submitted by the Viking Energy Partnership (VEP) in support of its S36 application for consent for the Viking Wind Farm, central and northern Mainland, Shetland. The HMP is designed to (i) offset and provide compensation for predicted significant impacts on habitats and species associated with the construction and operation of the Viking Wind Farm, and (ii) alleviate the ecological impacts arising from past and present land management practices with the intention of conserving, enhancing and restoring the natural and native habitats within the vicinity of the Viking Wind Farm. The intention of mitigation is to avoid, reduce and if possible remedy significant adverse effects (Schedule 4 Part II, PAN 58). The mitigation of ecological impacts directly associated with the construction, operation and decommissioning of the Viking Wind Farm are addressed in the Ornithology and Non-avian Ecology ES addendum Chapters (Chapters A11 and A10 respectively). However, there will be links between defined mitigation works in the ES (particularly impact reduction) and the HMP, so integration will occur as and when necessary.

The proposed approach to mitigation follows the best practice standard defined by PAN 58 and IEEM (2006). This also follows SNH's 2006 standard guidance '*Assessing significance of impacts from onshore windfarms on birds outwith designated areas*'. This standard hierarchic approach to mitigation is widely accepted across industry and with regulators and incorporates: (i) avoiding or preventing effects, (ii) reducing effects, and (iii) offsetting effects. The first two elements of mitigation, avoidance and reduction, are described within the revised ES chapters. Large reductions to the size and the scale of the proposed wind farm have been made (Chapter A4), with many changes driven by ornithology and the desire to avoid and reduce impacts on priority species and habitats. This HMP focuses on the third element of mitigation, namely actions that are planned to offset and compensate for predicted potentially significant adverse impacts that cannot be avoided or reduced if a wind farm is to go ahead. PAN 58 states that, "*when* (adverse) *effects remain that cannot be prevented or reduced, they may be offset by remedial or compensatory action such as provision of environmental improvements and creation of alternative habitats*". PAN 58 adds that offsetting measures can be difficult to deliver successfully and a sensitive approach will be needed by those using such measures.

This HMP explicitly includes a commitment by VEP to establish, initiate and fund ongoing programmes of mitigation and enhancement work around the proposed wind farm. This commitment extends for the life of the project; a period of at least 20 years. Over time, the techniques used and the intentions of the HMP will inevitably change and evolve to reflect increased knowledge and experience arising from the project itself or from elsewhere. Regardless of how the exact HMP's techniques, intentions and stakeholders may evolve, VEP will provide the initiative, drive and support to work towards delivering this plan.

An important consideration in realising the habitat management objectives in practice is the question of appropriate agricultural payments and trying to ensure its compatibility with existing and future, agricultural compensation arrangements e.g. ESA, LFASS and SFP. It is envisaged that Scottish Agricultural College and/or a similar body will be engaged to draft, and possibly help to implement, the scheme(s) of compensation. It is expected to contain elements which include a Viking Habitat Management (VHM) grant programme to support positive habitat management work by land users and financed by VEP, perhaps modelled on SNH's Peatland Management Scheme for the Caithness and Sutherland Flow Country http://www.snh.org.uk/pdfs/about/FinalPMS202.pdf, Land Management Contracts and ESA arrangements. It has already been discussed with key stakeholders.

1.2 Aim and objectives

The aim of this management plan is to outline methods to conserve, enhance and/or restore populations of target priority species (especially birds) and degraded priority habitats (especially blanket bog) with the potential to be significantly impacted upon by the Viking Wind Farm. It also reduces further likely negligible (and not significant) effects on birds through enhancement. All work outlined in this HMP will give due consideration to any existing localised features of high nature conservation value. That is to say that baseline ecological surveys of all candidate sites for management will be undertaken prior to any management work commencing in order to take account of their existing biodiversity. In some cases the presence of sensitive species may mean that part or all of a proposed candidate site must be excluded from the HMP. The HMP will:

- Introduce and describe the current nature of the habitats, and the priority species associated with them;
- Identify the ecological impacts that are associated with past and present land management practices and the wind farm;
- Introduce and describe the management techniques that may be employed to reduce the negative effects and promote the positive effects of these impacts;
- Outline the criteria that should be used to determine the suitability of areas for management;
- Describe the proposed management of large areas (as compensation for direct habitat losses caused by the construction and operation of the Viking Wind Farm); and
- Outline the monitoring necessary to determine the success or otherwise of the initial habitat restoration and enhancement trials and other works.

The Viking HMP directly supports SNH's strategic aims and objectives for Shetland (i.e. SNH Natural Heritage Future 2002; amended 2009). Of particular relevance to ecology, SNH want:

- To increase awareness and understanding of Shetland's natural heritage.
- To maintain diversity of habitats and species on in-bye land.
- To maintain and restore upland habitats, in particular:
    - Reducing stock numbers on the hill to sustainable levels;
    - Restoration (where possible) of heather moorland;
    - Halting further reseeding of unimproved heath;
    - Restoration of blanket bog; and
    - Research measures for restoring damaged upland habitats where natural recovery is unlikely, and develop demonstration schemes.
- To maintain freshwater habitats for important plant, fish and wildfowl populations.
- To restore locally endangered habitats and species, in particular:
    - Implement action for critical plant species, including native trees; and
    - Record locations of plant species of limited distributions and use them to inform development plans.

1.3 Scope of the management plan

The HMP considers the enhancement, restoration and conservation of priority habitats and species over the expected life of the project. Its scope covers the habitats contained within the Viking study area. Areas outside of this study area boundary are also considered for management on account of their contiguity with habitat inside it, presence of important priority species, their potential role as buffer zones, or for their own inherent value. Marine habitats are excluded although some of the priority species identified within the plan, most notably the red-throated diver, salmon and sea trout are dependent upon them for feeding.

Management of the blanket bog habitat is especially prominent within the plan because it is so widespread within the application boundary, is in poor condition in many areas and because it supports a high proportion of priority bird species. In their written responses to the 2009 (150 turbine) ES, SNH, "*suggest the actual footprint of the wind farm is likely to be significantly greater than is indicated in the ES and recommends a more accurate estimate* needs *to be calculated by the applicant*". The RSPB went further and said that, "*the HMP must be significantly increased. It must seek to offset adverse impacts on all key species and habitats*". Details of the significant reduction in the wind farm size and scale are provided elsewhere (Chapter A4) and this new design layout has been used to reappraise impact significance, which in turn has been used to revise this HMP.

The HMP aims towards offsetting predicted significant impacts (as required under the EIA Regulations), which means it focuses efforts on benefiting three priority species of bird, namely red-throated diver, merlin and whimbrel and one priority habitat, blanket bog. Design changes associated with the new 127 turbine layout have now reduced the likely impacts on red-throated divers to such an extent that these are no longer considered likely to be significant. Consequently, it could be argued that this HMP should no longer focus emphasis on red-throated diver. However, the HMP goes further than simple EIA Regulations compliance and in particular it seeks to reduce likely (but not significant) adverse effects on birds (as per RSPB comments) through enhancement, and therefore it maintains this emphasis on red-throated diver action. It also aims to support SNH's Natural Heritage Futures (2002; 2009) objectives and so considers the management and restoration of other locally endangered habitats not significantly affected by the wind farm e.g. grassland, woodland and freshwater habitats in combination with the requirements of a range of associated priority species. Therefore, numerous other species are also predicted to benefit from the Viking HMP.

2. SITE DESCRIPTION

2.1 Physical environment

The topography within the application boundary for the Viking Wind Farm is generally gentle and undulating. It ranges in altitude from sea level to 281m on Scalla Field. At Lerwick (approximately 10km south of the application site boundary), monthly average temperatures vary from 3.3°C in February to 11.9°C in July and August and the mean rainfall ranges from 53mm in June to 117mm in November. These relatively benign but wet conditions are enlivened by the strength and persistence of the wind which averages 'Force 4' on the Beaufort scale and there are gales ($\geq$ Force 8) on an average of 58 days per year. Hill and sea fogs are also frequent (Berry and Johnston, 1980).

As a result of the wet, oceanic climate, the Viking study area is dominated by blanket peatland, which is drained by frequent small burns and contains several hundred standing water bodies ranging in size from small pools of a few square metres to sizeable lochs over 1km^2 in area. These are important features within the habitat matrix and valuable habitats in their own right. The 24 largest water bodies (>3ha) are referred to in the HMP as lochs, and all are flooded rock basins. These tend to have rocky shorelines, are several metres deep and often have inflow and outflow burns. The remainder are lochans and pools (simple holes in the peat) with water depths rarely more than 1.5m. These lochans are largely confined to summits and saddles within the peatland and usually have vegetated shorelines.

2.2 Vegetation

The information contained within this section of the HMP is summarised from the Phase 1 Habitat and Phase 2 National Vegetation Classification surveys in the Addendum Non-avian Ecology Chapter which should be referred to for further details.

Blanket bog is the predominant vegetation type throughout the Viking study area and the most frequent or constant vascular species are heather *Calluna vulgaris*, cross-leaved heath *Erica tetralix*, deer grass *Trichophorum caespitosum* and common and hare's tail cotton-grass *Eriophorum angustifolium* and *E. vaginatum*. Bog moss *Sphagnum* species are frequently present and may form extensive carpets in the wettest areas but they are replaced by the woolly-fringe moss *Racomitrium lanuginosum* in more exposed and better-drained locations. Previous research has shown that the vegetation over much of the blanket bog in Shetland (including the Viking study area) has been modified, primarily through long-term effects of sheep grazing (Hulme 1985; Birnie and Hulme 1990; Birnie 1993; Hulme and Birnie 1997). Erosion and damage of the blanket bog is widespread and has resulted in the complete removal of peat to expose the mineral ground beneath in many areas. This is generally believed to be a consequence of over-grazing (Spence, 1979; Berry and Johnson, 1980).

Heath (vegetation dominated by sub-shrubs, especially heather) is present on well-drained, shallow peat and mineral soils. As well as forming extensive stands on the steeper slopes, it is commonly found as a mosaic within areas of eroding or fragmented blanket bog and on mineral or bedrock mounds protruding through the bog. As a consequence of historical and current grazing levels, the heath vegetation frequently includes a high proportion of grass species and may then form a mosaic with stands of acid grassland.

Acid grassland is widespread but sporadic in its occurrence and typically forms a mosaic with dwarf shrub heath or, more rarely, within areas of eroding blanket bog. More continuous swards are occasionally present on steep, well-drained slopes that have been intensively grazed. It is also found in enclosed fields on lower-lying ground, where it has been modified by varying degrees of agricultural improvement. Acid flushes, although limited in extent, are frequent throughout the area and have a relatively indistinctive flora of common blanket bog and semi-aquatic species. Base-rich flushes, which are much less common, have a more distinctive suite of species. Marshy grassland and calcareous grassland are rare habitats within the planning application boundary and trees and shrubs are also present but very rare.

2.3 Existing management

The whole area has been extensively grazed by livestock for at least four millennia and this has combined with the effect of the wind to create an open, generally treeless landscape. Within the application boundary, other land uses are limited to the enclosure and improvement of grassland for pasture around settlements. Hand cutting of peat for fuel within the Viking study area is currently limited in extent and restricted to accessible low-lying areas, where there is also evidence of more widespread peat cutting from the past.

3. THE PRIORITY SPECIES AND HABITATS

3.1 Priority bird species

Based on the legal protection, abundance and distribution of the species present, and predicted impacts, the birds species of highest priority are considered to be red-throated diver, merlin, whimbrel and, to a lesser extent, Arctic skua. The HMP measures are designed to primarily benefit these species, however, the HMP will also benefit a number of other species of conservation importance; these include golden plover, dunlin, curlew, lapwing, black-tailed godwit and passerines (Table 1).

Table 1: Important bird species - their conservation listing, significance of their populations within the application boundary and habitat management objectives.

Species	Conservation listings[1]	Viking population importance	Habitat	Habitat management objectives
Red-throated diver	A1, S1	National	Peatland lochans & lochs.	Safeguard, restore & enhance lochans. Stabilise & restore erosion of surrounding peatlands.
Merlin	A1, S1, LBAP	Regional	Rank heather for nesting, passerine-rich moorland & croftland for hunting.	Encourage rank heather in (former) breeding territories. Manage moorland, blanket bog & pastures in ways that encourage passerines.
Whimbrel	S1, Red list	National	Short sward moorland & bog.	Various. Crow control.
Curlew	UKBAP	Regional	Moorland, blanket bog & pasture.	Stabilise & restore erosion of peatlands. Crow control.
Golden plover	A1	Regional	Blanket bog.	Stabilise & restore erosion of peatlands. Crow control.
Lapwing	UKBAP	Regional	Pasture and wet moorland.	Appropriately grazed pasture & moorland. Crow control.
Dunlin	A1	National	Blanket bog with pools. Loch fringes	Stabilise & restore erosion of peatlands. Safeguard lochans & pool systems. Crow control.
Black-tailed godwit	S1, UKBAP, Red list	National (intermittent)	Rank wet grassland.	Appropriately grazed wet grassland. Crow control.
Arctic skua	Red list	National	Blanket bog.	Stabilise & restore erosion of peatlands. Encourage Arctic tern. Crow control.
Skylark	Red list	Regional	Blanket bog & rough pasture.	Stabilise & restore erosion of peatlands. Crow control.
Twite	UK & LBAP, Red list	Low	Moorland & croftland & scrub.	Create deep heather & flower rich meadows. Create scrub habitat.
Fieldfare	S1	Irregularly breeding rare UK breeding species.	Scrub & pasture.	Create woodland/scrub habitat.
Redwing	S1	Irregularly breeding rare UK breeding species.	Scrub & pasture.	Create woodland/scrub habitat.

[1] Species conservation listings are as follows: A1, EU Birds Directive Annex 1; S1, Wildlife and Countryside Act Schedule 1; EPS, European Protected Species; LBAP, Local Biodiversity Action Plan; Red List, Birds of Conservation Concern UK red list; UKBAP, UK Biodiversity Action Plan Priority Species.

3.2 Other priority species

The Viking fish survey (see Appendix 10.6 of the ES) identified three priority species within the study area: Eurasian eel *Anguilla anguilla*, brown/sea trout *Salmo trutta* and Atlantic salmon *S. salar*. Brown/sea trout are present in all 11 Viking study area catchments, whereas salmon were only recorded in 2 catchments: Burrafirth and Laxo (Table 2).

Table 2: Priority fish species - their conservation listing, significance of their populations within the application boundary, and habitat and habitat management objectives.

Species	Conservation listings[2]	Viking population importance	Habitat	Habitat management objectives
Atlantic salmon	UKBAP, A2	Regional	Low altitude streams & rivers, lochs & the coast.	Remove impasses & improve riparian habitat.
Sea/brown trout	UKBAP	Regional	Low altitude streams & rivers, lochs & the coast.	Remove impasses & improve riparian habitat.
European eel	UKBAP	Regional	Low altitude streams & rivers, lochs & the coast.	Remove impasses & improve riparian habitat.

The European eel was recorded as present in 8 of the 11 Viking catchments surveyed. This species, which has undergone a catastrophic decline, has recently been added to the UK BAP Priority Species list. In September 2007 the EU issued regulations (Council Regulation (EC) No 1100/2007) intended to underpin recovery of eel stocks. These require member states to produce Eel Management Plans to reduce anthropogenic mortality of eels. Although not specifically identified in the 2009 Viking ES at the time of writing, it is likely that the proposed HMP habitat management objectives for salmon and sea/brown trout would directly benefit eels, especially removal or improvement of impasses/barriers.

A small number of rare plants species, primarily hawkweeds (in the genus *Hieracium*) also occur within the boundary of the Viking study area (in particular within the Burn of Lunklet SSSI). However, their location on steep slopes above watercourses means that they are not directly affected by the proposed development or proposed HMP actions.

3.3 Priority habitat: blanket bog

Blanket bog is included in Annex I of the EC Habitats Directive, which highlights its international significance. Blanket bog characteristically has low floristic diversity, and its particular biodiversity value lies in the way that its few plant species can interact with the relief to form a highly structured but richly varied mosaic of vegetated and open water surfaces that cloaks the landscape. The cool, wet conditions that support blanket bog are globally limited, and as a consequence of this, blanket bog too has a limited global distribution. It has been estimated by Natural England that 10–15% (1.4 million ha) of the global resource occurs within Britain, and most (1 million ha) of this is in Scotland (Lindsay 1995 a;b). In Shetland, there are 56,645ha of active blanket bog[3] (Quarmby *et al*, 1999), representing ca 5.6% of the Scottish total (ca 3.8% of the UK total; *cf.* Quarmby *et al*, 1999).

<u>Peatland function</u>

Active blanket bog accumulates dead plant remains beneath the living vegetation because the ground is so wet that the decomposition process, which requires air, is limited. The partially-decomposed organic

[2] UKBAP, UK Biodiversity Action Plan Priority Species; A2, EU Habitats and Species Directive Annex II.

[3] Defined according to the EC Habitats Directive definition which is: "*blanket bog still supporting a significant area of vegetation that is normally peat forming*."

material, or peat, gradually builds up as a waterlogged layer which continues to support blanket bog vegetation at the surface, transforming the landscape into peatland. As the name suggests, blanket peatland forms a continuous mantle over the whole landscape, apart from the steepest slopes and although it is made up of layers of vegetation and peat, more than 90% of its volume consists of water.

Certain characteristics of the peatland vegetation have a role to play in the accumulation of peat. For example, the litter of many of the flowering plant species (especially deer-grass and the cotton-grasses) is resistant to bacterial and fungal decomposers. However, one group of plants in particular stands out for its ability to engineer the conditions under which peat accumulates - the bog-mosses *Sphagnum* species. The bog-mosses are able to increase waterlogging because they store large amounts of water in specially-adapted water-holding cells and because the spaces around the leaves, and between individual plants, both hold water and control its flow. In addition, their mode of nutrition reduces the nutrient supply and increases the acidity of the water (to a pH level approaching that of vinegar) which creates conditions that are conducive to the preservation of plant material and the accumulation of peat.

<u>Peatland ecosystem services</u>

The natural accumulation of healthy peat results in the long-term storage of carbon captured from the greenhouse gas carbon dioxide in the atmosphere. The carbon is 'fixed' into the living tissues of the plants at the peatland surface and about 10–15% of the fixed carbon is eventually incorporated into the peat where most of it will be stored almost indefinitely if the peat remains waterlogged. This carbon capture by peatlands is arguably of much greater significance than that undertaken by the more frequently publicised trees and forests (by around 50%: *cf.* Bohn, 1976; Botch *et al.*, 1995; Gorham, 1991 and Shvidenko *et al.* 2005).

As well as being important carbon stores, peatlands can also become sources of carbon dioxide and other greenhouse gas emissions when they dry out and/or lose their vegetation so that the rate of decomposition exceeds the rate at which new peat is being formed. If erosion then ensues, the peatland begins to release peat sediment which can be washed into streams and lochs to their detriment. Peatlands also store water that is then available during periods of drought to sustain the bog vegetation and water supply to streams. When the water store has been depleted by drought, peatlands can also help to hold back heavy rainfall that may otherwise cause flooding. This role in water regulation can be drastically altered by drainage and/or erosion.

A number of more direct benefits to Shetland's socio-economic environment are provided by peatlands and the most prominent of these is the use of the blanket bog for grazing. However, the peatland pasture is generally poor in quality and the methods used to make it more productive (such as drainage or fertiliser application) are rarely sustainable in the long term because they degrade the habitat. Peat has also been an important source of fuel in the past, and continues to be in some parts of Shetland.

3.4 Priority habitat: blanket bog lochans

The waterbodies in the Viking study area can be divided into two categories: lochs and lochans. Lochs tend to be large, occur on mineral-based substrates and have inflow and outflow burns. Lochans are small holes in peat that contain water. The lochs and lochans on the Viking site have particular importance for red-throated divers as they provide breeding sites for around 6% of the UK population of this EU Birds Directive Annex 1 species. Some other breeding birds are also associated with these waterbodies, most notably whooper swans and dunlin. In addition, greylag geese use lochs, particularly those with islands, as a safe place for rearing goslings; and waders, terns, gulls and skua species use shorelines for loafing and bathing.

Whether or not a waterbody is suitable for breeding divers is largely determined by its physical characteristics. The key requirements for nesting divers are a waterbody length of at least 15m, and ideally more than 25m (too short and the birds cannot take off), but less than 200m; a depth of at least 0.5m so that the birds can dive for cover; and vegetated shorelines close to the water level for nesting. Most of the water bodies with these requirements are lochans that have formed within the peatland. Although the largest lochs on the site are all used by divers, they are mainly used by non-breeding birds and are seldom used for nesting. For this reason they merit lower priority within the HMP.

Widespread peat erosion is affecting a high proportion of the lochans within and outwith the Viking study area. Peat erosion has completely destroyed some lochans, or at least has caused water levels to drop. As a result, many lochans that were once suitable for nesting divers are now less suitable or totally unsuitable. Furthermore, there is strong evidence to suggest that if peat erosion continues unchecked, the suitability of many lochans will continue to reduce. It is also likely that the waterbodies damaged by peat erosion are of lower value to the other high priority bird species. For all these reasons, the main objective of the HMP with regard to lochans is to address the problem of peat erosion.

Three types of management action on lochans are proposed, depending on the current condition status and extent of surrounding peat erosion. These are: (i) safeguarding lochans that are currently in a favourable condition; (ii) restoring lochans that are no longer in a favourable condition; and (iii) enhancing lochans that, irrespective of their condition, do not have the appropriate characteristics for breeding divers. A build-up of organic sediment is apparent in many of the lochs and this is at least partly due to the loss of peat from eroding areas. This factor is also of relevance to the burns discussed in the following section but the scale and significance of this is not known.

3.5 Priority habitat: rivers and streams

Riparian habitats throughout the Viking study area have been significantly affected by centuries of grazing, mainly by sheep. In the few fenced areas where livestock are completely excluded e.g. the exclosures in lower reaches of the Burn of Lunklet and Burn of Crookadale, the regeneration of riparian trees, shrubs and herbs is striking. Regeneration of riparian vegetation is of benefit to fish populations through the provision of food and cover in the form of draped vegetation, roots and debris. Stream productivity including invertebrate abundance may also increase through inputs of organic material originating from riparian vegetation. Regeneration of the riparian strip may be of greatest benefit to trout in the lower reaches of Shetland's burns, since cover in upper reaches is generally plentiful in the form of undercut peat turf. In contrast, the lower reaches of stream such as the Burn of Grunnafirth, South Burn of Burrafirth, Laxo, Seggie and Laxobigging are rather open and lacking in both cover and shade.

The removal/modification of artificial barriers to the movement of fish within these waters is also important, especially in relation to the migratory salmon, sea trout and eel populations and perhaps otters. If undertaken, this will benefit brown trout as well as the juvenile sea trout and salmon that form the basis of the sport-fishing in Shetland.

3.6 Priority habitat: woodland

Shetland is noted for the rarity of native trees and shrubs in the present landscape. However, the presence of such species in gardens and in isolated, natural settings demonstrates the potential for their growth in Shetland, from sea level up to a predicted altitude of around 200m (Spence, 1960). Studies of the Islands' ecological history based on pollen grains and wood recovered from peat and loch sediments also demonstrate the previous existence of widespread woodland on Shetland. However, this woodland would always have been naturally restricted in extent and altitude because of its exposure to high wind speeds.

The beginnings of woodland clearance on north Mainland have been dated to around 4,500 years ago with the arrival of agriculture. The woodland at this time contained a diverse assemblage of native species e.g. alder *Alnus glutinosa,* aspen *Populus tremula,* crab apple *Malus sylvestris,* downy birch *Betula pubescens,* downy willow *Salix lapponum,* eared willow *S. aurita,* glaucous dog rose *Rosa caesia,* grey/rusty willow *S. cinerea,* hazel *Corylus avellana,* juniper *Juniperus communis,* rowan *Sorbus aucuparia,* and oak *Quercus* spp.

Following clearance, woodland regeneration was largely prevented by livestock and burning and the habitat therefore became restricted to relatively inaccessible sites such as islands, ledges in gullies and cliffs. At present there are very few sites where woodland vegetation persists. The Shetland Woodland Strategy (Shetland Amenity Trust, 2000), lists only 17 'selected' relict sites, which are primarily located in the north-west of the Shetland Islands. These extant areas of woodland habitat (sometimes represented by only a few isolated shrubs or trees) are generally too small to support particularly distinctive floral or faunal communities.

The scarcity of woodland habitat means that it is of relatively little importance to the priority bird species that currently occur in the Viking area. However, restoring native woodland is likely to increase the numbers of priority species, including small passerine species such as twite, greenfinch, woodland passerines and passage migrants and in turn provide additional small-bird prey for merlins. The densities of song-bird prey in scrub woodland areas are much greater than open hill habitats. The restoration of woodland is also likely to benefit two nationally rare breeding thrush species, fieldfare and redwing, both of which are have bred locally in recent years, and possibly attract in new (perhaps former historical) breeding woodland species also.

The woodland-associated herbs and ferns that have been restricted to inaccessible ledges and islands by grazing pressure are relatively widespread but uncommon in Shetland e.g. beech fern *Phegopteris connectilis,* broad buckler fern *Dryopteris dilatata,* greater woodrush *Luzula sylvatica,* honeysuckle *Lonicera periclymenum,* lady fern *Athyrium filix-femina,* male fern *Dryopteris filix-mas,* oak fern *Gymnocarpium dryopteris,* polypody *Polypodium vulgare,* primrose *Primula vulgaris,* red campion *Silene dioica,* tufted hair-grass *Deschampsia caespitosa,* water avens *Geum rivale,* wavy hair-grass *Deschampsia flexuosa* and wild angelica *Angelica sylvestris,* except for royal fern *Osmunda regalis* which is confined to five sites on islands in freshwater lochs in the west of Mainland. The original composition and distribution of the woodland on Shetland is not known definitively but it may be assumed that aspen, downy birch, hazel, rowan and the willows would be present at higher altitudes (up to *ca*. 200m) where they would form a sub-alpine scrub extending close to sea level in the most exposed situations. More sheltered areas at the lower altitudes would be expected to support the formation of woodland including some of the foregoing species as well as alder, crab apple and oak.

A number of relict woodland sites in the vicinity of the Viking study area have already been identified by the Shetland Amenity Trust (2002): e.g. near Brae; on Fora Ness, and at Catfirth. It is proposed that the current woodland resource at these three sites will be safeguarded and enhanced, where possible, in partnership with the relevant land managers and the Shetland Amenity Trust. Ongoing safeguarding and management of relict woodland and the possible creation of a selected number of new areas for planting will be encouraged and resourced as deemed appropriate by SWEAG. It is expected that, where possible, actual implementation would be channelled through existing groups such as the Shetland Amenity Trust.

3.7 Priority habitat: wet grassland

The wet grassland habitats considered by the HMP are located in valley bottoms where they may be used as extensive pasture and/or for hay or silage production. As well as hosting a range of vegetation types and plant species they also provide nesting and chick-rearing habitat for a number of wader species, potentially including black-tailed godwit, lapwing, curlew, redshank and snipe. In the past, this habitat would also have held corncrakes, a species that may return if sufficient areas were managed sympathetically. Wet grassland is also used by wildfowl, most notably by whooper swans, wigeon and geese species.

The floristic variation of these grasslands is described by Roper-Lindsay and Say (1986) in relation to the soil moisture content. The drier areas support a tall herb community in which black sedge *Carex nigra*, meadow buttercup *Ranunculus acri*, common sorrel *Rumex acetosa*, sweet vernal grass *Anthoxanthum odoratum* and Yorkshire fog *Holcus lanatus* are abundant. In wetter situations, stands of yellow flag iris *Iris pseudacorus* predominate in association with a range of small grass and herb species such as creeping bent *Agrostis stolonifera*, ragged robin *Lychnis flos-cuculi*, marsh marigold *Caltha palustris*, northern marsh orchid *Dactylorhiza purpurella*, heath spotted orchid *D. maculata*, meadow grasses *Poa* spp. and white clover *Trifolium repens*.

Grazing within these communities is usually light and they are often used only intermittently for pasture or hay production. Nonetheless, the grazing and mowing are important to prevent tufted hair grass and juncus species from becoming dominant, thus maintaining biodiversity as well as the suitability of the vegetation cover for ground-nesting birds. Also, poaching of the ground by livestock creates small openings in which annual plant species may become established. More heavily managed grasslands are uncommon within the application boundary of the wind farm and are restricted to altitudes below 30m a.s.l. These grasslands have usually been re-seeded with perennial rye-grass *Lolium perenne*, are fertilised with chemicals or manure, and are typically cut for silage. Given their economic importance, they are not included within the management plan although they could become important for nature conservation if they were managed in ways that benefit biodiversity.

4. MANAGEMENT TECHNIQUES

4.1 Approach

This section of the HMP outlines the proposed practical management techniques that are necessary to safeguard and enhance targeted priority species and habitats. The techniques presented aim to:

- Prevent significant wind farm-related damage to the habitats;
- Restore the natural functions of the habitats; and
- Manage human activity to ensure the long-term persistence of priority habitats and species.

The Viking ES (Chapter A11) assesses the likely impact of the proposed wind farm on all important avian receptors. The main priorities identified within the HMP have been selected based on the significance of their impacts. The likely magnitudes of these effects are important and has been used to quantify or set the levels at which mitigation must be delivered to offset predicted impacts. This in turn directly affects the choice of management techniques to use in the HMP.

Impact prediction varies depending upon a range of parameters. For some elements e.g. direct habitat loss, it is relatively straightforward to assess and quantify the area of habitat that will likely be lost through land-take and from this it is possible to quantify the amount of offset required to compensate for any significant impacts. However, other impacts are less certain and a range of best case/worse case scenarios exists. The EIA Regulations state that the 'likely' scenario should be used to quantify impacts and therefore levels of offset. For each of the main priority species in the HMP the likely impact scenario is used to quantify the scale of offset mitigation necessary. In practice, effort will be applied to considerably exceed the calculated minimum offset mitigation required.

4.2 Baseline surveys

It is necessary to establish baseline conditions for the candidate HMP sites at least one year ahead of any habitat management changes that are proposed. Assuming the Viking Wind Farm proposal goes ahead as planned, then the earliest construction work would likely begin is in 2012. For this reason, baseline surveys of potential HMP sites commenced in 2010 and will continue in 2011.

There are three main reasons for undertaking baseline surveys. Firstly, the need to understand and consider the existing biodiversity value of candidate HMP sites. Secondly, so it can be demonstrated that any subsequent ecological changes are likely to be linked to HMP management rather than something else (including chance). This is a well-established and standard best-practice approach when monitoring and subsequently reporting on ecological changes associated with management actions, and encompasses the use of control sites (where no management changes are planned). Thirdly, baseline surveys provide information to inform aspects of the proposed management actions where there is uncertainty about how best to proceed. For example, a better understanding of whimbrel ecology is necessary in order to develop and implement effective site-specific management prescriptions.

4.3 Priority bird species management

4.3.1. Targets/goals

The protection/restoration/enhancement components of this HMP can be divided into the four main priorities: (i) red-throated diver, (ii) merlin, (iii) whimbrel (and by association Arctic skua) and (iv) peatland management actions to restore, enhance and protect blanket bog and thereby benefit birds and other taxa that depend on this habitat. It is important to note that although the blanket bog management element will benefit birds such as golden plover and dunlin (by reducing habitat loss), the aim is to benefit all aspects of peatland biodiversity and so, in contrast to the red-throated diver, merlin and whimbrel elements, blanket bog management is not driven by a single ornithological aim. Therefore, the actual restoration approach adopted in different areas will shift, sometimes being habitat-led and sometimes being species-led, depending upon interests in the vicinity of planned management. However, there are obvious synergies e.g. red-throated diver lochan management will directly benefit blanket bog restoration as these issues are inextricably linked.

4.3.2. Red-throated diver

Important factors

Shetland Central Mainland has long been known to be an important area for breeding red-throated divers. From the outset of the Viking studies it was appreciated that this species was likely to be one of the birds of greatest concern in relation to the proposed wind farm. For this reason the species was singled out for detailed studies. As a result, much more is known about the breeding requirements of this Viking priority species than any other. In particular, all important breeding sites have been identified and the key habitat features that make water bodies attractive to breeding birds determined (Appendix A11.1). During the course of these studies it became apparent that many breeding lochans used by divers are detrimentally affected by existing peatland erosion processes. Indeed, several lochans appear to have been destroyed or rendered unsuitable through erosion in the relatively recent past. Furthermore, at many sites the erosion processes are clearly active and ongoing, leading to a strong expectation that the condition of some lochans, including some that are currently rated as high and medium importance to breeding divers, will deteriorate relatively quickly to a point when they are of little or no value to divers.

There is no doubt about the seriousness of the threat to Central Mainland divers from existing peat erosion and this issue is therefore seen as the most important factor for divers that the HMP should address. Although there is some uncertainty regarding the rate of erosion, and therefore the timescale over which lochan suitability will change, there is good reason to believe that there will be significant losses or deterioration of lochans over the lifespan of the wind farm. For example, the monitoring of divers on Central Mainland since 2003 has revealed that over this period erosion has led to two breeding lochans becoming unsuitable (and no longer used) and noticeable deterioration at several others. Irrespective of any potential adverse effects caused by the proposed wind farm itself, peat erosion if left unchecked is expected to lead to a decline in the numbers of breeding divers in Central Mainland over the life span of the wind farm as well as large scale releases of CO_2.

Breeding red-throated divers are relatively sensitive to human disturbance and this is also potentially an important factor affecting site occupancy and breeding success. Divers are sensitive to people approaching breeding lochans too closely (typically <300m, but sometimes further) and this may cause divers to temporarily leave their breeding lochan. Very little has been published on distances at which red-throated divers show signs of disturbance to humans. However, in a review of disturbance distances for SNH, Ruddock and Whitfield (2007) quote the VEP work in Shetland and discuss the greater likelihood of divers to take flight and show signs of active disturbance on smaller breeding lochans. They also highlight that some birds showed no signs of disturbance from humans even when in full view and at close range (50-100m). Divers using lochs (i.e. larger water bodies of at least several hectares) are generally less sensitive to disturbance caused by the near presence of people however some of the more accessible lochs are frequently visited by anglers and other people. Unfortunately within Central Mainland most of these relatively disturbed lochs lack any islands suitable for nesting divers and have relatively unsuitable shores for nesting anyway. The combination of human disturbance coupled with poor potential nest sites is probably the reason why these lochs are currently rarely used as breeding sites. The provision of small artificial floating islands for divers to nest on is likely to be an effective way to overcome these problems.

Fences that are very close to breeding lochans pose a collision risk to flying divers as they take off; a time when, because of their poor ability to gain height, they can be flying very close to ground level. In Central Mainland four breeding lochans are known where livestock fences intersect the shores and there are several others with fences passing less than 20m away. The risks posed by these sections of fences were proven to be real during baseline survey fieldwork in 2006 when an adult diver was found recently dead by a fence that passed along the shores of a breeding loch.

Red-throated divers breeding in Shetland rely on the surrounding sea for their food resource. Looking after their marine habitats is clearly therefore no less important for their conservation than looking after their terrestrial habitats. There is currently little evidence that breeding divers in Central Mainland have any particular problems with their marine environment and the potential effects on divers of the wind farm are all limited to terrestrial areas. Therefore, the measures put forward in the HMP to benefit divers are all essentially aimed at terrestrial issues.

The 2010 ES (Chapter A11) predicts that the windfarm will likely have long-term adverse effects of negligible magnitude on red-throated diver and it is judged that these effects would be not significant under the terms of the EIA Regulations. Nevertheless, a range of conservation actions to benefit red-throated diver are considered necessary and desirable.

<u>Red-throated diver HMP goals</u>

- Regular breeding by divers on at least five 'new' sites, i.e. sites with no recent history of regular breeding;

- In so far as is possible, all existing regularly used breeding sites to continue to be so;

- Threats from erosion to all high and medium importance diver breeding lochans in Central Mainland significantly reduced and where possible removed;

- Reduce to negligible the potential for ground-based wind farm activities to adversely disturb divers on breeding lochans;

- Reduce the potential for human disturbance and nest site availability to constrain breeding by divers at six selected sites in Central Mainland through the provision of floating islands (nesting rafts);

- Minimise existing collision risks to flying divers throughout Central Mainland; and

- Promote in general the greater appreciation and conservation requirements of divers breeding in Central Mainland.

<u>Planned red-throated diver HMP actions</u>

- Breeding lochan protection/enhancement/restoration measures;

- Provision of nesting rafts at selected lochs;

- Earth bank screening of tracks and turbine bases that are potentially visible from and within 500m of breeding diver lochans. The need for and final design of any screening measures will be decided in consultation with SNH. Note, in the first instance tracks and turbines will be micro-sited to minimise their visibility from diver breeding lochs;

- Minimise existing collision risks to flying divers throughout Central Mainland by the realignment of all stock fences in the immediate vicinity of breeding lochans; and

- There is a possibility of providing a carefully selected public viewing facility for breeding divers in Central Mainland along the lines that RSPB have used in Orkney. Whether this is realised will depend on circumstances and consultation with SNH and RSPB.

It is recognised that during the initial stages of executing the HMP many lessons on lochan protection/enhancement/restoration will be learned. The experience and knowledge initially gained will help direct future delivery of targets and be fed back into restoration measures at other lochans. It is likely, given uncertainties, that not all restoration work will achieve diver gains. For this reason, we have not proposed to offset a minimum like for like loss and gain in relation to potential wind farm impacts. The proposed scale of diver works highlighted above and numbers of lochans so far selected exceed those required to offset (not significant) wind farm impacts and so will begin to tackle the main conservation issue for divers in Shetland of blanket bog erosion destroying nesting lochans. Therefore, in this context, planned red-throated diver HMP actions are a part of, and not separate from, wider blanket bog/peatland restoration work and will deliver benefits for the Viking blanket bog resource and its associated species also.

Breeding lochan protection/enhancement/restoration

The primary aim of planned HMP work is relatively straightforward: create conditions on lochans conducive to the protection/enhancement/restoration of breeding red-throated divers.

As part of the baseline diver studies an audit of diver lochs and lochans in Central Mainland was undertaken. This assessed the extent to which lochs and lochans have been affected by erosion and the apparent threat from likely future erosion. Lochans with the potential, through active management, to become more suitable for breeding divers have also been identified. Therefore, the information required on lochan condition and future threats already exists and this was used to draw up a short list of 30 candidate lochans (at medium, high or severe risk) for HMP work. Before management work can start it is necessary to assess each candidate lochan for what practical measures need to take place and how best to achieve these.

Lochan management under the HMP (protecting/enhancing/restoring) would likely offset any of the negligible wind farm impacts, provided sufficient lochans are treated. Unlike some other parts of Shetland, it is believed that the availability of suitable diver lochans (rather than food) are limiting in Central Mainland and so provision of extra breeding lochans would be beneficial for breeding red-throated divers. In order to achieve this, the 30 candidate lochans in Central Mainland have been identified from existing Viking data sources (see Section 5). This is a relatively large candidate list as it is suspected that some sites will drop out of selection for a range of logistical reasons. To protect nest site locations, this list of lochans will remain confidential.

A range of management techniques will be required to achieve the HMP lochan management aims. The probability of achieving long-term success with this management is crucially dependent on the hydrology of the surrounding peatland. The lochan management objectives therefore require a two-pronged approach: indirect measures aimed at the wider surrounding hydrology (potentially up to several hundred metres away) and direct measures primarily aimed at the integrity of the lochan banks and maintaining water levels. If the hydrology is not properly taken into account then it is unlikely that lochans subject to management will be sustainable in the long term or posses the special characteristics required by breeding divers, in particular water levels close to the bog surface.

The management techniques used on lochans to benefit divers will include:

- Preventing erosion of surrounding peatlands;
- Damming small drainage channels;
- Strengthening or repairing lochan banks;
- Reducing detrimental levels of stock grazing on the surrounding vegetation; and
- Expansion of existing pools.

Artificial floating islands at selected lochs

The provision of small artificial floating islands or rafts covered in natural moorland vegetation has been widely and successfully used as a conservation tool for breeding divers. For example, the RSPB state raft provision probably improved the chick production of the Scottish black-throated diver population by 44% (Hancock 2000). The use of rafts can be highly effective in the right circumstances, in particular at larger water bodies without natural islands that experience one or more of the following: inappropriate shorelines for nesting, large water level fluctuations, shoreline disturbance from people and their dogs and the presence of terrestrial ground predators. These factors do not all apply to the vast majority of potential breeding diver sites in Central Mainland, (e.g. the peatland lochans) and thus the provision of rafts is a lower priority than the conservation measures aimed at safeguarding and improving the condition of peatland lochans. However, six sites have been identified where several of the conditions listed above prevail. Providing these sites with rafts is likely to be beneficial and lead to either these sites being used for breeding, or where this is already the case, improved breeding performance. Five of the sites identified are moderate-sized lochs regularly used by anglers but which lack any natural islands and in most case have largely unsuitable shores; none of these lochs have supported regular breeding in recent years. The sixth is a small regularly occupied lochan very close to a public highway which experiences low breeding success, probably linked to human disturbance.

The techniques for constructing and anchoring floating islands are well developed and tested and could be easily applied to the Shetland sites. The initial effort, technical expertise and costs associated with making and installing rafts are modest and are unlikely to present any great difficulties. They need to have at least annual maintenance to ensure that they remain in an attractive and safe condition for divers. The biggest potential problems are wave action and possibly winter ice. However, the extensive experience of providing rafts for divers on much larger and ice prone lochs on mainland Scotland has shown that these potential problems can be averted provided rafts and anchor system are built to withstand the worst plausible weather conditions and maintained properly. One member of the Viking Natural Research ornithology team (D Jackson) was closely involved in former employment with the highly successful RSPB led initiative to put rafts out on over 40 black-throated diver lochs on mainland Scotland and so has considerable experience in the practical aspects of rafts. Furthermore, SSE (as part of VEP) has considerable experience planning, funding and installing diver rafts associated with several of their mainland Scotland hydro-electric power projects.

Rafts measuring approximately 2m x 2m would be ideal for red-throated divers and these would require at least three anchors. Where possible, rafts would be positioned in relatively sheltered and undisturbed locations in relatively deep water about 30m from the shore. Modifications may be required to standard designs to suit the circumstances of individual lochs but these are unlikely to present any serious difficulties.

Experience on mainland Scotland shows that some raft-nesting pairs of black-throated divers can become habituated to benign human disturbance. Road-side lochs with rafts can present very good opportunities for people to watch divers at relatively close distances without causing disturbance. Two of the Viking lochs identified as a strong candidate for rafts are by main roads and could therefore potentially provide ideal sites for birdwatchers/tourists to watch red-throated divers, thus reducing pressures at breeding sites where divers are more sensitive to disturbance. While the setting up of some sort of promoted public viewing facility for divers is not an aim of the HMP, such a facility would be an asset that could be taken advantage of if developed carefully and if circumstances allow.

Screening of wind farm tracks/infrastructure

Within the 2010 ES, an analysis of the potential wind farm activities along tracks and at turbine bases likely to cause disturbance to breeding divers showed that five lochans and one loch that are used by divers for breeding are likely to visible from tracks and turbine bases within 500m (and vice-versa). These six sites are therefore considered most likely to be at potential risk of disturbance from ground-based wind farm related activities. This assessment, based on a 500m distance threshold, is highly precautionary as experience from survey work shows that the majority of breeding red-throated divers on the Viking site show no signs of disturbance by human activity at distances of 250m away, suggesting a degree of habituation and tolerance, and therefore such disturbance is unlikely to be significant (Chapter A11, Section A11.8.5 considers potential red-throated diver disturbance impacts in detail). The 500m distance threshold was recommended by RSPB, although they acknowledged this was an arbitrary threshold.

The first choice for mitigating the potential disturbance to breeding divers by wind farm activities is to reduce it, as far as possible, by making small modest changes (i.e. micro-siting) to the routes of tracks and turbine locations so that divers can no longer see activities along the track and around turbine bases. This is being done by taking full advantage of the natural topography at each site to reduce the visibility of the tracks and turbine bases from breeding lochs. Digital terrain data examined with GIS software indicates that such changes could reduce track and turbine base visibility for divers on the lochans to zero at two of the five lochans and reduce it by approximately a half at the other sites (Appendix A11.1). Any residual potential disturbance affects at these sites would be further mitigated through screening works carried out as part of the HMP programme. Ruddock and Whitfield (2007) reported that it is not uncommon for both pair members to be absent from the breeding loch for several hours at a time during chick rearing, thus reducing the time adults may be 'disturbed'. Pre-fledged chicks often respond to human presence/disturbance by remaining concealed at the shoreline or in emergent vegetation.

The GIS digital terrain analysis indicates that in total up to 600m of screening of 0.5 to 1.5m high (depending on local topography) may be required to reduce track and turbine base visibility at these sites to zero. It is expected that considerably less than this is required as most of the track stretches of concern are over 350m from lochs and are therefore in practice are unlikely to result in actual disturbance. Therefore, before decisions are taken site visits should be made to refine what is actually most sensible, in consultation with SNH. The screening could take the form of a raised bank of earth (or peat) close to the relevant length of track or turbine base. The use of earth-bank screening to hide human activity from breeding divers has been successfully used by RSPB at Burgar Hill, where an embankment of approximately 50m length and 2m height screens the approach of visitors to a diver observation hide. All screening banks would be profiled to blend in with the natural topography and designed with due sensitivity to the local hydrology and ecology. The banks would be vegetated with living turfs of moorland vegetation retained from track cutting. SNH and SEPA would be consulted over the detailed design and location of any screening. Alternatively RSPB have suggested that there may be a role for the use of temporary screening to reduce disturbance to breeding birds during the construction periods, or possibly during emergency maintenance, and note that permanent fencing as screening is likely to be susceptible to damage by strong winds.

Three lochans where screening is recommended are identified in the confidential birds appendix. One other breeding site has a visible turbine <500m away however screening here is unlikely to be beneficial. This is because the birds here are already habituated to potential disturbance from a public road passing only 360m from the traditional nest site (a small island), considerably closer than the proposed turbine base (480m). Also visits to the site in June 2010 showed that the birds using the loch showed no response to an observer at the position of the proposed turbine base, indeed the birds showed no reaction until the observer was only 250m away.

Red-throated diver HMP work timetable

The following actions are being undertaken in 2010:

- Compile a short-list of approximately 30 candidate lochans for further investigation and begin landowner liaison/negotiation – *completed*
- Visit each site, identify extent of area to be managed (largely based on hydrology) and determine what specific management work is required. Produce an outline management work plan for each site – *underway*;
- Continue baseline monitoring of diver use and physical characteristics (all sites have already been monitored for several years) – *underway*;
- Begin baseline monitoring of aquatic vegetation, invertebrates and physical characteristics – *underway*;
- Secure long-term landowner agreement for planned site management – negotiations and agreements for lochan management - *underway*; and

In 2011 and beyond:

- At selected lochans, begin management through carefully planned trials of different methods including;
  - Management of erosion-damaged sites through restoration measures of the surrounding peatlands and lochan banks,
  - Stock fence realignment where existing diver collision risk is considered high, and
  - Creation/expansion of existing pools.
- Establish regular monitoring of changes caused by management;
- Progress diver work plan in liaison with SWEAG and in light of information from trials, new guidance and any changes in circumstances; and

- Liaise with SNH and SEPA as required.

4.3.3. Merlin

Important factors

Since 1987, the number of merlin pairs has apparently declined in Shetland and the breeding population is now considered to be 15-20 pairs (Etheridge *et al*, 2008). The loss of breeding merlin from several historical sites in Shetland has coincided with significant habitat degradation. Notably patches of deep heather required for nesting have been lost through reseeding for agricultural purposes, over-grazing by sheep and defoliation by insect larvae (Pennington *et al* 2004). Merlins typically nest on the ground in heather moorland, often in deep heather on a slope of a hill or on the side of a valley. Importantly, merlins show high site fidelity returning in successive years to nest in the same suitable area.

Planned merlin HMP action

The planned HMP work is relatively straightforward and simple: create conditions conducive to the restoration of deep heather at (former) traditional merlin nesting sites. The revised ES predicts a small risk of low likelihood of negative impacts (displacement due to close proximity of a turbine) to one merlin pair, which constitutes *ca.*5% of the regional population (Chapter A11). However, it is considered that the magnitude of the residual effects on merlin due to the Viking Wind Farm construction and operational activities is most likely to be negligible and the likely residual effects after mitigation are judged to be not significant under the terms of the EIA Regulations.

Discussions with the RSPB suggest that in practice this turbine is unlikely to pose a major risk to this single pair. Nevertheless, re-establishing regularly successful breeding merlins in just one former site would be sufficient to offset the predicted potential (negligible) negative impacts on merlin. In order to have a high probability of success of achieving this, the HMP works will take place in five traditional nesting sites in Central Mainland where there is evidence of a lack of suitable nesting cover. Candidate site selection has been confined to Central Mainland as this area has the best information on previous site use (from monitoring by VEP and before then by RSPB). Therefore, searches have been undertaken in 2010 throughout Central Mainland and candidate sites selected. Section 5 provides further details of merlin HMP site selection.

Specific management measures are likely to be centred on stock exclusion fencing to allow heather regeneration to occur over sufficiently large areas (at least a few hectares at each territory) to be attractive to nesting merlin. Assuming heather restoration occurs within a few years (and there is anecdotal evidence from Shetland that this is a reasonable assumption e.g. ESA management prescriptions), subsequent grazing management within the fenced areas is likely to be required to keep heather at the optimal height and structure for nesting merlins, i.e. not too tall and dense but not too short either.

Merlin HMP goal

- Regular breeding by merlins on at least one formerly occupied traditional site.

Merlin HMP work timetable

The following HMP actions for merlin are being undertaken in 2010:

- Identify and compile a list of traditional sites in Central Mainland – *completed*;
- Begin landowner liaison/negotiation for selected sites – *completed*;
- Visit merlin sites and assess quality and extent of existing heather and determine which five sites would benefit most from HMP work – *underway*;
- Visit the five short-listed merlin sites to assess and map the areas to be stock fenced – *underway*;
- Undertake monitoring of merlin occupancy and breeding success at all sites in Central Mainland – *ongoing* (continuing the annual monitoring VEP has undertaken since 2005);
- Secure long-term landowner agreement for site management (stock fencing and initial stock removal) negotiations and agreements for merlin management - *underway*;
- Undertake surveys of vegetation at the five selected sites – *underway*.

The following HMP actions for merlin are planned for 2011 and beyond:

- Where possible, erect stock-proof fencing and remove stock. To be discussed and agreed with land managers once baseline monitoring is completed and assessed.
- Complete erection of stock-proof fencing and remove stock;
- Annual monitoring of vegetation caused by stock removal and fencing;
- Annual monitoring of merlin occupancy and breeding success;
- Progress merlin work plan in liaison with SWEAG and in light of information from trials, new guidance and any changes in circumstances; and
- Adjust grazing regime as appropriate.

4.3.4. Whimbrel

Important factors

Shetland is the most important area in the UK for breeding whimbrel holding at least 95% of the UK population (Richardson 1990; NRP data), which has been declining in recent years down to an estimated 300 pairs (Appendix A11.1). The causes of the decline are unknown, but several possible causes have been speculated, including predation of nest and chicks (by great skua, gulls and corvids), changes in habitat suitability linked to land management and climate change. The 2009-2010 whimbrel survey (combined with previous data) has provided good up to date information on whimbrel occurrence across Shetland and the Viking study area. In particular, the location of the majority of existing good whimbrel habitat is known. Areas used by whimbrel tend to fall into two categories: (i) regularly used high density locations where more than one pair is typically present in relatively close proximity, referred to as 'whimbrel hot spots' (specifically defined as polygons buffered to 200m around clusters of at least two territories within 600m of each other), and (ii) areas where a single pair occur and which typically are not occupied each year. The hot spots identify the parts of the landscape of greatest value to whimbrel.

The habitat requirements of whimbrel on Mainland Shetland are relatively poorly understood. To address this information gap a study was commenced in 2010 aimed at understanding the species habitat and management requirements. Initial results show three features appear to be important. First, whimbrel typically select locations in wide flat-bottomed valleys and on adjacent gentle slopes. Second, they show a preference for short and relatively dry blanket bog vegetation, especially with a high component of moss (*Raccomitrium* and *Sphagnum* species) and lichen (*Cladonia sp.),* interspersed with small patches of wet bog vegetation. Third, many pairs show a tendency to nest in association with other breeding species (e.g. Arctic skua, common gull and other waders), probably because the mobbing behaviour of these species affords them some protection from aerial predators such as crows and large gull species.

Studies of whimbrel habitat use on the island of Unst in Shetland in the mid 1980s (Grant 1991; 1992; Grant *et al* 1992a and b, see summary characteristics below) and more recently on Central Mainland by Natural Research Ltd provide a broad understanding of which habitat characteristics are negatively and which are positively correlated for whimbrel. This information, together with ongoing targeted whimbrel habitat research will inform the objectives and methods proposed for whimbrel management in the HMP.

Habitat preferences for whimbrel

- Whimbrel are widely distributed in Shetland and use a variety of moorland types. Nevertheless the best sites appear to share a number of common features and it is likely that providing these will be the key to successful habitat management.
- Extensive areas of relatively short moorland vegetation but ideally with some with some wetland areas (pools and wet hollows) appear to be the preferred breeding habitat (89% of all nests studied). 'Good' whimbrel moorland typically has a closed (little bare ground) short sward comprising a mixture of sparse heather, cotton grass and deer grass, together with woolly hair moss (*Raccomitrium sp.*) and reindeer moss lichen (*Cladonia sp.),* and, in blanket bog situations, sphagnum mosses also. Such communities can develop in a range of situations including, intact deep peat blanket bog, maritime heath (highly exposed to sea gales) and on free draining base-rich serpentine soils (as found on parts of Unst). Whimbrel in Shetland also make some use of the very extensive areas of blanket bog moorland with a medium sward length, but this by itself appears not to be attractive. The vegetation of such areas consists of the same species but heather or cotton grass typically dominate (or co-dominate) and woolly hair moss and reindeer moss lichen are uncommon. In reality there exists a continuum from short to medium height sward moorland vegetation (and longer) and at any one location there is usually a degree of heterogeneity of sward lengths. Habitat suitability for whimbrel is currently being systematically investigated and assessed as part of HMP base-line monitoring.
- Whimbrel hot spots on Shetland Mainland are found around the edge of breeding colonies or groups of other bird species, typically black-headed gull, common gull, Arctic skua and other waders.
- Flat or gently sloping gradients particularly in the concave parts of the landscape, but not exclusively so. Relatively low altitudes appear to be preferred, especially areas below 100m.
- Grazing appears to be important but this has to be at an appropriate intensity. Grazing can help create a low sward height (which whimbrel like), however if grazing is too intensive it can

initiate and exacerbate existing peat erosion (which whimbrel appear to dislike), particularly at higher elevations.

- Steep ground (more than *ca.* 5 degree gradient), deep rank vegetation, extensive peat erosion and the presence of nesting great skuas all appear to be features negatively associated with breeding whimbrel. 'Improved' and 'semi-improved' pasture land is also unattractive for breeding whimbrel though may be used by feeding adults. Unlike curlew, breeding adult whimbrel appear to make little or no use of marine or freshwater littoral habitats.
- 'Improved' and 'semi-improved' pasture close to moorland is sometimes used by adults for feeding, especially in the early part of the breeding season. Worms and crane-fly larvae (tipulids) are the main constituent of adult diet. The highest biomass of these prey items were found in the preferred feeding habitats. But this can be provided by small areas also.
- Scale is important to whimbrel which like big habitat patches so that chicks can move and territories can be large. Whimbrel appear to require sites which have several km sq of broadly suitable habitat.
- Whimbrel select nest sites on hummocks (80% of nests) and/or heather (75% of nests). All chicks monitored on Unst (where high densities of birds may have restricted movements) remained within 1km of nest sites until fledging (most within 400m).

<u>Planned whimbrel HMP actions</u>

The overall effects of wind farm construction and operation (without mitigation) are predicted to have long-term adverse effects of low magnitude on whimbrel and it is judged that these effects would possibly be significant under the terms of the EIA Regulations (Chapter A11). Consequently, it is an objective that the HMP should implement beneficial habitat management on a high proportion of the Mainland Shetland whimbrel hot spots (both within and outside Viking study area). As these are potentially large areas, monitoring work has commenced at some, but not all sites in 2010. From the relatively large list of candidate hot spots it is suspected some potential areas or parts of areas will drop out of selection for a range of logistical reasons (see Section 5 for further details of whimbrel HMP site section).

In particular it is likely that targeted management of sufficiently extensive areas will more than offset the potentially negative effects of the wind farm on whimbrel (Chapter A11). The amount of whimbrel mitigation far exceeds predicted impacts and is aimed at bringing a significant proportion of the Shetland (and hence UK) population under favourable conservation management.

There is a long history of successful habitat management projects to benefit breeding wader species in the UK, in particular projects undertaken by the RSPB. Many of these initiatives have not only stemmed population declines but have led to local population increases. For example, the various projects aimed at lapwing, snipe and other species on numerous wet-meadow reserves and the Stone Curlew Project. Successful projects are based on sound science, adequate scale and resources. Therefore, there is good reason to believe that the right habitat management prescriptions (carried out over a sufficiently large area) will benefit whimbrel and lead to an improvement in their species conservation status.

Using the parameters identified to date it is possible to develop a series of site specific management prescriptions for whimbrel hot spots in Shetland. Waders show high site fidelity, so focussing efforts around the existing hot spots is most likely to bring birds back to adjacent restored habitats. Monitoring in 2009 and 2010 indicates that hot spots maintain their attractiveness to whimbrel between years.

At the moment it is not clear to what extent Shetland whimbrel declines are linked to either habitat change, if at all, or the spread and increase in predators such as breeding great skuas or hooded crows. Nor is it clear where the balance lies between site abandonment (local range loss) as opposed to reduction in whimbrel density. It is likely that converting back reseeded moorland to native vegetation would be difficult and take a long time. Furthermore great skuas cannot be legally controlled and therefore managed to help whimbrel. For these reasons the HMP will primarily attempt to increase densities at existing occupied sites (away from great skua colonies) rather than attempt to attract birds into new areas by large scale habitat creation.

Predator control

Crows are adaptable and opportunistic feeders with a broad diet including invertebrates, grain, small vertebrates, birds' eggs, carrion and scraps (Snow and Perrins (eds) 1998). For several centuries they have been considered a significant predator/pest of game birds and young lambs and so have been subject to high levels of persecution/control, though with little apparent long-term impact on the population (Holloway 2002). Indications are that persecution has declined in some areas due to a reduction in game-keeping activities (Forrester, Andrews *et al* 2007) and perhaps stock reduction in the uplands.

Crows have recently been split into two species: carrion crow *Corvus corone* and hooded crow *C. cornix*. Both occur on Shetland, but carrion crow is a scarce passage migrant and hooded crow is a fairly common breeding resident and scarce passage migrant and winter visitor (Pennington *et al* 2004). The breeding population of hooded crow on Shetland has not been estimated and there are no reliable datasets on populations or trends of crows in Shetland. Non-breeders use communal roosts throughout the year and often remain in flocks throughout the day (Forrester, Andrews *et al* 2007). Most roosts contain less than 250 birds, but there were 800 at Kergord in December 1981 and little is known about how far such birds move to roost. Breeding territories in Shetland are occupied from March, with eggs laid in May and the first fledged young are evident in late June or early July. Immediately after fledging, family groups tend to move to the coast, where they become secretive, possibly to avoid being shot (Pennington *et al* 2004).

Shetland's mammal fauna is dominated by introduced non-native species, including ground predators such as stoat, ferret polecat and hedgehog (Laughton Johnston 1999). During several years of study, one single (dead) stoat has been recorded in the Viking study area and only a handful of ferret polecats have been recorded. There is no direct physical or anecdotal evidence that mammalian ground predators are impacting significantly on any nesting waders in the Viking study area and none was found during whimbrel studies on Unst (Grant 1991).

The main avian predators of birds' eggs and young in Shetland are raven, hooded crow, common gull, herring gull, greater black-backed gull, Arctic skua and great skua. Any of these species could in theory predate nests of whimbrel and other waders. To date, there have been no specific studies in Shetland on the impacts of either ground or avian predators on waders. However, work on whimbrel in Unst and Fetlar found avian predation was responsible for most losses of whimbrel eggs between laying and hatching accounting for 45% of the 126 known losses. Actual successful predation on nests was only observed on only one occasion, and this involved hooded crow and Arctic skua. Addling and embryo death accounted for a further 23% and 12% of egg losses, whilst smaller losses were due to trampling by livestock, desertion and predation by great skua. Causes of chick mortality could not usually be ascertained, but predation was observed once by Arctic skua and twice by herring gulls (Grant 1991).

Detailed survey work has focussed on whimbrel in 2010 and many crow/whimbrel interactions have occurred. This is unsurprising as the latest Shetland Breeding Bird Survey shows record numbers of hooded crows breeding (more than in any other previous year) (Shetland Bird Report 2009). The HMP measures are aimed at increasing whimbrel productivity by enhancing egg survival through lethal crow control and enhancing chick survival through promoting habitat conditions that provide good and safe feeding areas. This is likely to benefit many other ground nesting waders too.

Habitat management and crow control measures to benefit whimbrel are proposed for sixteen sites in Central and West Mainland. Between them these sites contain approximately 100 whimbrel territories (based on survey work in 2009 and 2010), i.e. about one third of the population total. Negotiations with landowners and tenants over agreements to implement the HMP measures have met with a favourable response. Agreement in principal has been reached for areas containing at least 75 whimbrel pairs and possibly as many as 100 pairs.

Recent experimental studies in the UK and Sweden have shown the importance of predation on the breeding success of a suite of wader species (e.g. Wallander *et al* 2006; Fletcher *et al* 2010). In the Fletcher *et al.* 2010 a nine year upland study was conducted which showed that the breeding success of curlew, golden plover and lapwing was significantly improved by legally controlling the numbers of some of their predators, in particular carrion crow, fox and stoat (Fletcher *et al* 2010). Waders were more than three times as likely to raise a chick on an area with predator control than on an area without.

Breeding numbers of lapwing, golden plover and curlew increased in years following predator control, but declined in other years, but snipe numbers seemed unaffected by predator control (although it was acknowledged that detection of snipe nests and broods, and therefore evaluation of effects, was problematic). The study concluded that agri-environment schemes on their own, without legal predator control, seem unable to give rise to an abundance of breeding waders or even bring about a significant improvement in sparse populations. The low breeding success on North Pennine areas without predator control suggests that predation is likely to be contributing to population declines of waders elsewhere and the authors went on to propose that the contraction in breeding range of some waders, like lapwing and curlew may be being caused by, or at least aggravated by, predation during the breeding season.

Parallel to this, the recovery of raven populations in the UK has led to some conflict with land managers over their concerns for both the protection of livestock and possible detrimental impacts on some upland bird species, particularly ground nesting waders. As a consequence, detailed studies have recently been published which investigated the impacts of raven on breeding upland wader species (Amar *et al* 2010) in the UK (but not Shetland). No significant spatial or temporal relationships between ravens and any species of five upland waders investigated were found. However, weak negative relationships between raven abundance and trends of curlew and lapwing may warrant further study. The study found no significant negative associations between raven abundance and population changes in upland waders and so the authors concluded that requests for control of ravens in the interest of population level conservation of upland waders was not justified. However, a study in southern Norway found that ravens were responsible for most June losses of golden plover clutches (Byrkjedal 1987). Nevertheless, the recent balance of evidence does not suggest that raven have been responsible for significant declines in UK upland wader populations and therefore, there is no justification for the control of ravens in Shetland to protect upland wader populations.

Given the above findings, in particular the work demonstrating that upland waders are three times as likely to raise a chick when legal predator control is carried out, it is likely that the single most important action that can be done to increase whimbrel breeding success and thereby return the species to Favourable Conservation Status is to control the likely main nest predator, hooded crow, over sufficiently large areas during the breeding season. It is recognised that a different suite of predators occurs on Shetland (e.g. fox is absent) and so simply extrapolating the results of legal predator control from the Pennines to Shetland is not straight forward. Nevertheless, proper peer-reviewed studies such as Fletcher *et al* (2010) provide compelling evidence of the impacts of predation on upland waders, and highlights the beneficial role legal predator management could have in a Viking and Shetland context. It will be important to measure the effectiveness of this in a rigorous and transparent manner (including experimental 'control' sites where no crow control takes place).

The legal control of hooded crows is covered by a 'General licence' which covers authorised persons to take measures to control certain species in a number of situations, including where there is a need to protect other wild birds. The licensing authority is the Scottish Government and they provide further information on: http://www.scotland.gov.uk/Topics/Environment/Wildlife-Habitats/16330/general-licences

Section 16(1)(c) of the Wildlife and Countryside Act 1981 allows licences to be obtained for a range of reasons including:

a) for scientific, research or educational purposes;
b) for the purpose of ringing or marking, or examining any ring or mark on wild birds;
c) for the purpose of conserving wild birds;
d) for the purposes of the re-population of an area with, or the re-introduction into an area of, wild birds, including any breeding necessary for those purposes;
e) for the purpose of conserving flora or fauna;
f) for the purpose of protecting any collection of wild birds;

The control of crows for the purpose of conserving and enhancing whimbrel populations clearly falls within this conservation remit, which has been used in other circumstances such as control of crows at RSPB reserves e.g. Abernethy. It is proposed to carry out legal crow control using conventional methods e.g. Larsen and crow cage traps over sufficiently large areas to cover targeted whimbrel hot spots and hinterlands around these. If deemed acceptable, this legal crow control could be extended to the entire Viking study area (*ca.* 90km^2), so that other wader species directly benefit from crow control during the breeding season. Given the lack of knowledge of crow dispersal distances and large numbers of nonterritorial crows present in Shetland throughout the year, it is predicted that crow control in the breeding season would likely create vacuum that would readily be filled, so an annual breeding season control programme is likely to be needed for the life of the Viking Wind Farm.

Whimbrel HMP goals

The primary focus will be to protect whimbrel hot spots and manage these in ways that will benefit whimbrel. It is predicted that the HMP measures will lead to:

- Improved whimbrel breeding success across Viking study area;
- Increased whimbrel breeding densities across Viking study area; and
- Protection and recognition of the importance of these sites for whimbrel and thereby lessen the likelihood that insensitive incidental management (e.g. through agricultural change) will be deleterious to whimbrel.

Of particular importance is the scale of the proposed HMP whimbrel actions. The intention is that the magnitude of management is not only sufficient to offset any adverse effects from the wind farm but to also make a significant improvement to the regional/national conservation status of the species, i.e. management will take place in areas where *ca.* 20% of existing Shetland/UK whimbrel population occurs. Modelling work on whimbrel population dynamics suggests that a relatively small increase in breeding success could reverse the recent population decline (Chapter A11; Appendix A11.1).

Not enough is known about the precise details of whimbrel ecology (yet) to say which elements of the planned management measures are likely to be most successful. Therefore, an integral element of the HMP is research aimed at understanding whimbrel habitat requirements and how to, through management, achieve conditions that promote increased breeding success. The research programme will be developed in consultation with other organisations, in particular SNH and RSPB. The results of the research will feed into management prescriptions, which in turn would be monitored when implemented. Moreover, regardless of the proposed Viking Wind Farm, understanding whimbrel ecology and reasons for their decline in Shetland are valuable in their own right in establishing the groundwork for much needed wider conservation measures.

The management techniques used to benefit whimbrel will include:

- Grazing intensity management of extensive moorland areas;
- Wetting up small areas (e.g. barriers across erosion and drainage features);
- Widespread crow control;
- Protection and sensitive management of important areas e.g. no fertiliser, new reseeding etc; and
- Creation of large shallow pools and marshy edges for waders in general, which creates the 'many eyes' and 'protective umbrella' conditions that result from multi-species vigilance and anti-predator mobbing behaviours.

Whimbrel HMP work timetable

The following summary HMP action is considered necessary in 2010:

- Identify whimbrel potential HMP hot spot sites (both within and outside Viking study area) and begin landowner liaison/negotiation – *completed*;
- Visit potential sites and identify extent of area to be managed – *completed*;
- For each potential site undertake a provisional assessment of gross management requirements, identifying those parts to remain unchanged (i.e. the first priority 'best' parts) and which are to be restored or enhanced (i.e. the second priority poorer parts) – *underway*;
- Select sites for inclusion in HMP based on results from first 3 bullet points above– *underway*;
- Undertake baseline monitoring (birds, predators, invertebrates and vegetation) – *completed*;
- Secure long-term landowner agreement for site management – negotiations and agreements for whimbrel management - *underway*; and
- Identify and agree management regime for each site (complex task which may need to be reviewed annually) – to be discussed with land managers once baseline monitoring is completed and assessed.
- Investigate licensing issues around crow control and discuss with relevant authorities - *underway*.

2011 and beyond:

- Commence practical actions of management as agreed for each site. For example this may include:
  - Grazing management/manipulation focussing on short heathland vegetation;
  - Restoration of suitable habitat features;
  - Reduction on predation on nests and during crucial 14 day post fledging period (when 80% of chick losses occur). Suitable habitat management may reduce predation, but so may control of hooded crows during the key nesting period; and
- Establish regular monitoring of vegetation, invertebrates and birds at HMP sites and controls.

4.4 Priority habitat management: blanket bog

Grazing

The grazing of blanket bog habitat by livestock and wild mammals (in Shetland, principally sheep and mountain hare respectively) at low to moderate levels (the precise rates are location-specific) can be beneficial and help maintain and enhance vegetation diversity and productivity. However, high levels of grazing intensity are damaging to blanket bog habitat in many areas, leading to severe vegetation degradation and extensive peat erosion in Shetland (SNH 2002). Consequently, managing appropriate grazing levels is a crucial element to achieving many blanket bog biodiversity goals.

Grazing affects vegetation structure which can be a key determinant of the value of the habitat to many species of breeding bird. Priority bird species on the Viking site that are known to be sensitive to grazing-induced changes to vegetation structure include merlin, whimbrel and golden plover. Furthermore all the high priority birds associated with blanket bog habitat are likely to be deleteriously affected by large scale peatland erosion precipitated by over-grazing. At very high levels of grazing, serious damage occurs when the vegetation cover is broken by hooves or excessive vegetation removal, exposing the underlying peat. The combination of high wind speeds and rainfall in Shetland then results in the mobilisation of peat so that the initial 'cut' into the blanket bog surface (the 'acrotelm') rapidly develops into a large 'scar' that is most evident in the gullies that further can proliferate up and down a slope, through the movement of water and sediment. Exposed peat is also vulnerable to wind erosion, especially at higher levels where wind speeds are greater. As a consequence existing severe erosion is most pronounced on hill tops and plateaux areas in the Viking study area.

Spontaneous recovery of blanket bog vegetation is occurring in some areas, and as sheep stocking levels are predicted to fall in the future, this may become more widespread. However, it is by no means clear that recovery of the blanket peatland as a fully functional and self-sustaining ecosystem will automatically ensue because there is still active erosion downslope from re-vegetating patches, and grazing units that are still heavily used adjoin recovering ones. Moreover, in the case of some peat lochans, it appears that advancing erosion will cause water levels to fall (and thus reduce or destroy the suitability for breeding red-throated divers) before any spontaneous recovery of blanket bog vegetation will commence. Therefore, a co-ordinated landscape-level approach to grazing management, combined with active intervention at specific locations, will be needed and is therefore planned. The presence of introduced lagomorphs (rabbits and mountain hares) on Central Mainland and across the Viking study area means grazing management will have to consider the effects of all grazing species, not just sheep. For example, their control will be considered when constructing fences and regular monitoring of the fence integrity will be undertaken.

Due to the natural variability in the productivity of the common grazings it is not possible to define exact figures for the stocking density which should be adjusted according to the condition of the vegetation and substrate rather than to a rigid figure. However, as an *approximate* guideline, stock figures should not exceed 0.5 sheep per hectare during the summer months and 0.25 sheep per hectare during the winter months. In winter, complete removal of the sheep is a desirable management option for many areas. Winter and summer grazing patterns are delimited by the time of tupping (in November, when the sheep should be taken off the hill) and lambing (in April, when the sheep can be returned to the hill).

Hydrology

The management of drainage is integral to the success of the aims of blanket bog protection/restoration as this habitat requires permanently waterlogged conditions to function properly. Eroding peat develops a clear structure that radiates out from the damaged and degraded central area. In eroding peatland, the management of peat sediment is closely related to the management of drainage. This involves the installation of structures to slow the movement of water and sediment along ditches and erosion gullies, for which various techniques are described below. However, because of the way that water moves across and through the peat, not all of these techniques are suitable for all locations. For example, structures placed in the path of high-intensity storm flows are at risk of being washed away and may exacerbate the existing peat instability.

Although the EIA process separates offset 'mitigation' for infrastructure from general habitat management, there are a number of hills where infrastructure will be present on only one side, making co-ordination of 'mitigation' with 'habitat management' beneficial. Therefore, some brief comment on peatland management in areas with turbines is appropriate here. It is calculated in the 2010 ES (Chapter A10) that 170.88ha of blanket bog (of all activity and condition) will be directly affected by predicted construction impacts reducing to 88.99ha directly affected by predicted operational impacts. This 170.88ha figure is crucial in terms of the amount of offsetting that must be achieved.

The wind farm roads were designed in the original 2009 ES so as to minimise the disturbance to peat however it is acknowledged that the construction of these tracks can also be advantageous for hydrological management. Further details of the road design and addendum changes are described in Chapter A4 Development description and are also available in A14.6 Site Environmental Management Plan. Many of the road sections will intercept water, and perhaps also sediment, moving across and through the peat blanket and erosion gullies, and it will therefore be beneficial to integrate their detailed design with management requirements for the surrounding blanket mire. A related issue is that the routes of streams ('blue lines') shown on published 1:50,000 Ordnance Survey maps do not accurately distinguish watercourses from erosion gullies everywhere on the Viking area, so that the 'rule of thumb' planning requirement to allow unimpeded water movement along these may be counter-productive for peatland restoration.

Another hydrological feature of the blanket peatland landscape is that the intensity of drainage (the volume of water drained per unit area) is least on summits and flatter areas such as spurs, saddles and platforms protruding from the hillsides in the higher parts of the relief. These are the areas from which flow lines diverge, and the places where small lochans (those without connecting streams - many of which are attractive to red-throated divers) typically form. Moving downslope, both the drainage intensity and the slope generally increase so that it becomes increasingly less practical to fully block up the erosion gullies.

The sediment load will increase until the draining water approaches the foot of the hill and begins to slow down, at which stage there is a tendency for sediment to be re-deposited. It has been shown that the quantity of particulate material entering watercourses is much reduced if there is a good cover of vegetation (notably common bog-cotton) to trap sediment in this part of the landscape; thus management intervention may be beneficial for denuded streamsides and in the lowermost parts of erosion gullies, as well as near the tops of the hills.

Damming small drainage channels

Drains that have been installed to facilitate the flow of water from areas of bog are relatively uncommon in the vicinity of the Viking Wind Farm. They generally serve to drain an area of bog for the purpose of improving pasture and they tend to be small (less than 1m x 1m in cross-section) and simple in structure (typically forming a single, linear feature or a localised 'herringbone' pattern, rather than an extensive network). Much more frequent are small (<2m x 2m) erosion gullies and the early treatment of these will hopefully prevent their development into a larger and more complex gully system that will prove considerably more difficult to repair.

A range of established techniques will be used to reduce and reverse the impacts of small drainage channels (ditches and small erosion gullies). Where these involve installing a series of dams to retard flow and hold water within the channel, the intention is to promote the development of pool vegetation in the open water areas between the dams which, over time, will accrue peat that itself reduces the flow of water and reverses the impact of the drain in the medium to long term.

The placement of the dams will be determined by a levelling survey prior to the commencement of works. This is to ensure that the water table is restored to as close to the vegetation surface as possible and that water flow is effectively reduced to prevent erosion and to promote the colonisation of plants that would otherwise be flushed from the drain. The dams will be constructed from a variety of materials depending upon the size of the drain, access, labour and availability (with some potential for the recycling of materials). These materials will be discussed in turn below and they include:

- Peat;
- Composite dams of peat combined with other impervious materials such as plastic sheeting;
- Plywood, plastic and metal sheeting; and
- Plastic piling.

During consultation, concerns were raised (particularly by RSPB) about the use of peat in the HMP. To address these concerns we have included more prescription on the proposed bog restoration and ditch blocking methods (using RSPB guidance from peat restoration experience at their Forsinard Reserve i.e. Robinson – no date; Wilke and Thompson – no date) and clarified our use of peat. In particular:

- The existing literature on best practice peatland restoration techniques being followed in this HMP relates to restoration of degraded blanket bogs using a range of restoration techniques concerned with the stabilisation of bare peat surfaces using, for example geo-textiles and mulches, others are concerned with re-establishing peat hydrology by drain blocking and encouraging sphagnum regrowth.
- The use of peat for HMP work excavated during the construction works in the HMP areas is pre-determined and the most suitable source for peat rather than imported or foreign material;
- Only the required amount of peat will be used;
- Only material suitable for the intended HMP use will be selected and used;
- The material will be derived from construction excavations as local to the point of use as is possible - to minimise disturbance (through haulage, storage, double handling etc);
- The works will be undertaken at a similar time to construction works (so that the material is not stored for long periods);
- The works will be completed in the least intrusive manner possible (i.e. use of mechanical plant to be avoided unless other constraints preclude manual labour etc); and
- Monitoring of water quality and impacts on habitats is planned and therefore any concerns relating to pollution impacts will be addressed.

Peat is the most widely available material in the vicinity of the drains and it is suitable for use on its own only over low gradients because of its propensity to erode when subjected to water flows and its inability to provide a reliable spillway. It is also suitable only where permanent waterlogging is expected because peat dams are not completely impervious to water (unless used in association with a membrane) and they disintegrate if they dry out.

The best result is obtained by completely filling relatively level ditches with re-located peat and surface turfs so that the original arrangement of peat and vegetation layers in the surroundings is reinstated. However, it will be necessary to strike a balance between potential benefit from using this technique and the disturbance that will be caused by transporting large quantities of material across the site to locations that are remote from construction areas.

Where less peat is available, dams will be built from well-humified cohesive peat (classified as H6–H8 on the von Post humification scale; see Appendix A) as this is relatively impervious to water flow. This peat will be removed in large blocks and handled as little as possible in order to maintain its cohesiveness. At the site of the proposed dam, the sides of the drain will be cut back to leave a clean face that will form a good seal with the peat blocks and vegetated turfs will be placed on the top of the dam in order to protect it from erosion. Drains larger than *ca.* 1m x 1m will require the peat to be cut by machine and potentially, the use of additional strengthening materials (as specified below) to form a composite dam. The completed peat dams will stand proud of the adjacent surface (by around 30cm) in order to compensate for slumping and shrinkage.

Where suitably cohesive peat is not available, erosion-resistant dams will be constructed from stacks of sand bags filled with the non-cohesive peat available at the site. Where suitable access is possible, this method could also make modest use of some of the peat excavated during the construction of the wind farm, thereby reducing the need to locally remove intact peat. If large quantities of ‘peatbags’ can be produced and transported, they may also be used, topped with turves, to completely fill ditches and/or the spaces between other types of dams.

Plywood, plastic and metal sheeting or panels

Sheeting made of suitable plastic or plywood (usually marine ply) will be used as a means of damming the smaller drains and gullies. Metal sheeting might be considered if readily available, but alloys and coatings likely to leach metal ions that are toxic to bog plants will be avoided (e.g. galvanised metal leaches zinc, which is highly toxic to bog moss), and if mild steel is used it will be coated with waterproof paint to prevent corrosion where medium-term serviceability is required. Panels of these materials will block the width of the drain allowing for additional width to anchor them into the adjacent peat at the sides and bottom of the drain (*ca.* 20–50% of the drain width or depth). Sheets of the appropriate dimensions will be hammered into vertical slits cut into the base and the sides of the drain until they are just proud (2–3cm) of the adjacent vegetation surface. A shallow spillway will be cut into the mid-point of the dam face with the lowest point just below the level of the vegetation surface. Some form of strengthening (horizontal struts or supporting wall of turfs) may be required if upstream water pressure causes sheets to bow.

Plastic piling

Plastic piling is very strong, lightweight and long-lasting (up to 150 years). The piles are normally 30cm wide, come in lengths of up to 8m, and they join together using integral interlocking edges that are designed to be water-tight. Their installation will be undertaken in a manner similar to that described above for the sheeting dams but each pile is installed separately, from the centre of the gully, towards the edges. Plastic piling should not be strengthened by rigid cross braces as it must bend in order to maintain its strength and water-tightness.

<u>Damming large erosion gullies</u>

In comparison to the approaches described above, which completely block the cross-section of the drain, the methods adopted for the larger and/or unstable gullies will focus only on the lowermost part of the cross-section in which any water and eroded materials are transported. The materials used here will be both resistant to erosion and securely anchored in order to resist the energetic water flows that may occur during or following storm events, slowing it down to encourage re-deposition of sediment as high as possible in the gully system. Should revegetation and peat accumulation prove to be successful, the gullies might be re-dammed to raise the water level further if appropriate. However, in many instances, the intention will be to reproduce and assist the process of sediment accumulation and re-stabilisation that is occurring naturally in gullies across the site (Crowe *et al.* 2008), any artificial obstructions being designed for compatibility with natural blocks upslope and downslope.

Materials that have been used successfully in the pioneering work already undertaken by the Moors for the Future Partnership and other groups in the English Peak District[4] include:

- Stones;
- Sand bags filled with peat;
- 'Sausages' of rolled coir matting anchored with metal pins;
- Conifer brash;
- 'Hay bales' that may be formed from rushes; and
- Corrugated plastic piling.

The potential also exists to use other materials naturally present on the site or generated by the construction of the wind farm. These include:

- Vegetated turfs; and
- Local excavated peat where its retention can be assured, e.g. upstream of wind farm road crossings.

The creation of the dams will aim to retard water and sediment flow and achieve as much storage as possible within the confines of the gully in order to help support the associated water table in the

[4] See http://www.moorsforthefuture.org.uk for further details.

adjacent, upstanding areas of peat. However, the height and extent to which water and sediment may be stored is dependent upon:

- Steepness of the slope;
- Complexity of the surrounding topography;
- Nature of the upslope catchment;
- Hydrological interconnections;
- Relative widths of gullies and upstanding peat; and
- Conformation and complexity of the gullies' drainage network.

The feasibility of the action and the desired height, location and number of dams will be determined by survey work beforehand because an *ad hoc* approach that does not take account of these factors is likely to result in failure. In the case of gently sloping gullies, the use of natural, readily accessible materials (such as peat, stones or dislodged turfs) to form low dams may be appropriate. Whereas, in the case of steeper gullies where complete damming is required, it will be necessary to use stronger, erosion resistant structures such as the sheeting and plastic piling methods described above. In many instances, fully restoring the water table in the larger gullies to the level of the surrounding vegetation surface will not be feasible or advisable, especially where this will involve impounding substantial depths of water between banks of degraded peat on sloping ground. In such cases, the intention will be to promote the natural recovery process, in which peat sediment is captured, retained and re-vegetated in the gullies so that their floors gradually rise towards the level of the surrounding peatland surface. For this, the same materials may be used to create low dams and/or baffles (not extending across the full width of the gully).

Capture of the water and sediment flow behind the dams will create small pockets of stabilised peat which will act as nuclei for the re-establishment of plants such as common bog-cotton and heath rush *Juncus squarrosus* that will spread and consolidate the peat with their rhizomes and roots. This process will be facilitated by introducing individual plants or turfs of these species that have:

- Become detached from the bank of the gully;
- Been cut selectively from small, discontinuous areas of the neighbouring, undisturbed vegetation; or
- Been specifically grown for the purpose within a nursery.

It is also possible to introduce suitable native species to bind the peat such as wavy hair-grass and bents. These grasses are introduced to the bare peat as turf or as seed and they rapidly grow to form a sward that resists erosion. Seed collection of the native grasses that are likely to persist can be undertaken locally and this will require the purchase and hire of machinery and the training and seasonal employment of suitable locally based staff.

Given the especially nutritious nature of these grasses, especially if their establishment is accompanied by fertilisation and/or liming, the success of this approach is dependent upon the exclusion or severe reduction of grazing in the area. This is because the sheep will concentrate their attentions on the consumption of these 'grasslands' that are more palatable than the surrounding blanket bog vegetation. The potential effects of grazing by lagomorphs will also be considered on a site by site basis.

Where it is necessary to stabilise peat as rapidly as possible, biodegradable erosion and sediment control textiles (e.g. coir mesh) will be used to assist the process of revegetation. These will be rolled out over areas subject to erosion (i.e. where the dominant process is sediment removal rather than re-deposition), e.g. on level plateau areas and at the *tops* of eroding gully sections, and may be seeded or planted with appropriate species where these are not expected to colonise naturally.

All the measures outlined in Section 4.4 are based around current best practice (e.g. Brooks and Stoneman 1997; Robinson; Wilke and Thompson) gained from a wide variety of mainly UK sources and sites from the Peak District to the Flow Country. As and when new best practice guidance becomes available, it will be adopted and planned methods changed accordingly. The partners involved in overseeing the Viking HMP implementation (Section 8.0) will input into guidance and methodologies used. Given the scale of proposed works and the existing threat to Shetlands blanket bog, the HMP will likely develop best practice guidance applicable to windy, wet maritime sites. The VEP are fully committed to sharing and disseminating this information and, where possible, publishing its findings.

4.5 Priority habitat management: lochan restoration and enhancement

A range of techniques will be required to achieve the three objectives (safeguarding, restoration and enhancement) of the HMP aimed at lochans. The probability of achieving long-term success with these management objectives is crucially dependent on the hydrology of the surrounding peatland. The lochan management objectives therefore require a two-pronged approach, indirect measures aimed at the wider hydrology and direct measures aimed at the lochans and their banks. If the hydrology is not properly taken into account then it is unlikely that lochans subject to management will be sustainable in the long term or possesses the special characteristics required by breeding divers, in particular water levels close to the bog surface. Indeed, to a very large extent, the challenge of tackling the consequences and threats posed by peat erosion to lochans is primarily a question of managing the surrounding part of the blanket peatland, possibly up to several hundred metres from a lochan. For this reason, the major part of the work associated with managing lochans would involve the various techniques aimed at promoting a healthy peatland system that have already been discussed in Section 4.4.

A lochan that has developed in a summit position, and so has no upslope catchment, is full of water because the surrounding blanket peat slows the rate at which water is lost by seepage to below the rate at which new water arrives as rain (minus evaporation and overflow). Lochans of this type on the Viking site are vulnerable to erosion in two ways. Firstly, when erosion gullies develop on the surrounding slopes, they begin to drain the peat layer around the lochan. The result on some summits is that the peat has disappeared (through a combination of shrinkage, vegetation loss, drying-out, decomposition and wind erosion) from around the shoulder of the hill, leaving the lochan in a separate, hydrologically unstable 'upstanding' block of peat that continues to erode at its outer edges. Secondly, once formed on the slopes, gullies can cut back through the peat blanket towards the summit, and eventually breach the bank of the lochan itself. The lochan can then drain into the gully system. The water level in the lochan may only be lowered initially but once a gully has connected with it, there is a tendency for the connection to grow in width and depth through continued erosion until the lochan is completely empty. Once such a process has begun, observations indicate that there does not appear to be any natural mechanism to arrest it.

Accordingly, appropriate measures to safeguard a summit lochan or to reinstate a recently drained one will include damming techniques – essentially blocking up a breach in the bank of the lochan or an erosion gully that is approaching it. However, the approach of a gully is a sign that the ability of the peat blanket to sustain the hydrological equilibrium of the lochan is becoming marginal, so that artificially restoring the water level may actually destabilise the system further. Therefore, simultaneous action should be taken to re-establish vegetation and peat formation on the surrounding areas. This would involve working outwards from the lochan, applying appropriate measures to stabilise and re-vegetate with appropriate plant species any bare peat, mineral ground and/or gullies. Ideally, the area treated should extend to the next stream, reversal of slope or other line of hydrological discontinuity in the landscape. In some cases, however, the distance may be so large or the boundary so indistinct that a closer range for intensive remedial work might be set following a detailed assessment of the individual situation.

Lochans and lochs in valley locations receive water from upslope and discharge it *via* a distinct outlet. Here, the principal adverse effect of erosion is the delivery of peat sediment which tends to fill up the basin. The two effects are combined in lochans that have so far survived on 'islands' of bog vegetation in saddles between eroding summits, which can be simultaneously receiving sediment from two upslope directions and under threat of drainage by gullies advancing from downslope. Where lochans of this type are to be safeguarded or restored, the peatland on both of the flanking summits will need to be returned to 'healthier' condition as part of the management prescription, in order to curtail the sediment supply.

Lochan stabilisation and repair techniques

The direct measures necessary to address the objectives of safeguarding lochans and restoring the damage already caused by erosion described in this section are concerned with the lochan banks. These aim to arrest the advance of erosion gullies towards vulnerable lochans, and to rebuild and strengthen banks where gullies have already been penetrated; in both cases promoting the development of peat forming vegetation around the lochan where this has been lost. Depending upon the nature of the problems at a particular lochan, measures could range from large scale blocking up of gullies (which can be up to 2m deep and several metres wide) with a mix of hard (rock or timber) and soft defences (compacted peat) to small scale surface measures aimed at raising the water table and promoting colonisation by *Sphagnum* moss, e.g. infilling or damming small gullies. The depth of water to be retained is typically 0.5 to 1m so the potential pressure on the banks is not especially high. However it is essential that the repairs do not leak significantly more than the remainder of the bank, which is likely to consist of fairly well humified (i.e. low permeability) peat. Whereas the use of membrane liners (e.g. 'butly' rubber) would undoubtedly produce a watertight basin, their use is probably not necessary and would in any case be very expensive. Nevertheless, there may be merit in incorporating some form of membrane patch across severe bank breaches to simulate the function of the impervious, well-humified peat that forms the remainder of the bank, since peat that is formed from recently established vegetation will probably take a very long time to reach the same degree of humification. The upper edge of the patch should, however, be level with the base of any vegetation layer on the bank and new vegetation should be re-established above to complete the surrounding, more-permeable living surface layer that is important in regulating the water level of the lochan.

Where the restoration of former water levels is an objective, the works may need to be phased over several years so that vegetation can recolonise and reinforce banks as they are gradually built up and strengthened. Restoring 'empty' lochans that retain most of their original shorelines is an attractive option for creating new water bodies because there is a ready-made basin and so relatively little if any excavation is required. However, it remains to be seen if large sections of destroyed bank can be economically repaired to successfully impound water. These measures would also need complementing by measures to tackle erosion of the surrounding peatland, which is often particularly severe around empty lochans.

Lochan enhancement techniques

Lochan enhancement is distinct from restoration, though some lochs may benefit from a combination of both. The aim of enhancement would be to change the characteristics of an existing lochan or pool that, irrespective of any erosion, does not meet the requirements of nesting divers into those of a lochan that does. In addition, it may be possible to create lochans in places with no existing water body by digging out a completely new basin, though this has the obvious disadvantage that the amount of work involved is potentially greater. The aim of the lochan enhancement work would be to create lochans that comfortably exceed the minimum dimensions required by nesting divers. In practice, to be reasonably attractive to divers, a lochan should measure at least 20m x 15m and have a depth of at least 0.5m, though a lochan of twice this size may be more than twice as likely to be occupied and would still be well below the optimum dimensions for divers.

As discussed in Section 4.3.2 new potential diver breeding lochans could be created in several ways. Existing lochans that are either too small or too shallow could be enlarged or deepened. In some cases it may be possible to amalgamate two small existing pools. It may also be possible to impound water in certain existing erosion features (such as large horizontal gullies) to form suitable pools using small dams of mineral till, peat or plastic piling.

Each of these approaches has pros and cons. Enlargement of existing deep-peat lochans that are currently too small for divers is attractive as a watertight basin clearly already exists and in some cases relatively little excavation would be needed to create a water body that would meet the requirements of breeding divers. However any excavation in such areas runs the risk of upsetting the local hydrology and will therefore need to be subject to expert hydrological scrutiny. In practice, this method will work best at sites surrounded by extensive level ground, as these are most likely to have the hydrological capacity to successfully impound relatively large lochans. Deepening a shallow-peat lochan may be a particularly effective and relatively easy to achieve because the resultant lochan would not be dependent on the hydrological integrity of the surrounding blanket bog to impound water. However the practicalities of this approach will depend on the proximity of bedrock. Summits and/or spurs that have completely lost their peat cover may be potential sites for this type of intervention since, if a suitable waterproof basin could be created by excavation and new peat formation initiated on the surrounding area, diver breeding habitat would be created in the short term whilst the long-term result could closely resemble a natural summit.

The amount of material that would need to be excavated to achieve such lochan enhancement works is likely to range from about 25m^3 to 250m^3 of peat and/or mineral drift per lochan. There should be no difficulty in using the material locally - for example, it could be used as part of the wider blanket bog restoration programme. It will be necessary to have SEPA's support and this would only be progressed once such discussions and agreements had been reached. The work would probably require the use of a tracked excavator and mini-dumper. Vehicles with tracks specifically designed to exert low ground pressure are available and this would help to prevent vegetation damage caused by driving machinery over blanket bog. The vegetation from any excavated areas would be carefully saved as turfs and re-used to help stabilise banks and treat any nearby erosion.

Much of the planned lochan enhancement and restoration work follows general best practice blanket bog guidance, but has not been used specifically with the express aim of increasing use by breeding red-throated divers. Given the scale of proposed works and the existing threat to the diver's habitat, the HMP will likely develop best practice guidance for the management of red-throated diver lochans. The VEP are fully committed to sharing and disseminating this information and, where possible, publishing its findings.

4.6 Priority habitat management: rivers and streams

The Viking Wind Farm poses no significant threat to watercourses and so no offsetting or compensation is required within the HMP. The proposed management work on this habitat is identified as beneficial enhancement action. Man made barriers to the passage of migratory fish are present on three watercourses within or close to the Viking study area. These may be removed in some instances or alternatively, modified in order to facilitate the passage of fish. The habitat for these fish species will be enhanced further by the restoration of riparian vegetation which will provide cover and an additional source of food.

Where streams and rivers are responsible for the conduction of large quantities of eroding peat, sediment traps may be employed to reduce the impact of this on the lochs and lochans receiving the sediment and potentially, on the spawning areas within the streams and rivers used by migratory and resident fish species. The sediment traps should be situated where they will not block passage to the spawning grounds and where they are accessible to the means necessary to empty them.

4.7 Priority habitat management: woodland

The Viking Wind Farm poses no significant threat to woodland and so no offsetting or compensation is required within the HMP. The proposed management work on this habitat is identified as beneficial habitat enhancement that will be present well beyond the life of the Viking Wind Farm. There are two potential ways to deliver this:

- The facilitation of natural regeneration around existing woodland remnants; and
- Creation of a new native woodland area.

Grazing control may be necessary to prevent the loss of reproductive structures, individuals and whole areas of regeneration. In these cases it may be necessary to protect (with fencing) and then supplement the existing vegetation with the transplantation of suitable saplings once a mature canopy has started to develop, appropriate native herb species will also be introduced as seed or transplants. The restoration of the woodland ground flora will also benefit bumble bees (an LBAP priority) and other insects through the provision of a range of nectar-bearing flowers, as well as a broad range of other species.

In certain instances, it may be possible to incorporate a degree of grazing within the restoration areas. This can be achieved by protecting specific areas of regeneration with mobile or re-usable fencing, or well-supported growth tubes, which can be removed once the trees have established to a size where they will not be affected by grazing. Such fencing can then be relocated to encourage regeneration within an adjacent area. This is a long-term approach that should be supplemented by the creation of core areas in which only very limited grazing at most is permitted.

The support of existing local nurseries (and the Shetland Amenity Trust) may be required to facilitate the woodland regeneration and preferably, locally-sourced and prepared seeds and/or cuttings will be used to establish the required species. Appropriate seed for the establishment of the herbaceous species may also be gathered by hand, or by machine, depending upon the nature and size of the sources.

Finally, an important consideration in woodland restoration is its potential to spread onto important adjacent areas of blanket bog. For this reason, as with all HMP site selection, careful consideration of existing baseline site biodiversity will undertaken prior to any management work commencing.

4.8 Priority habitat management: wet grassland

The Viking Wind Farm poses no significant threat to wet grassland and so no offsetting is required within the HMP. Nevertheless, the proposed management work on this habitat is identified as beneficial enhancement action. Due to the variation in their vegetation, substrates, past and present management and in some cases, the selectivity of the stock that will be used to graze them, it is not possible to prescribe a specific management regime to satisfy all requirements at all grassland sites. However, the management of the sites should ensure that the vegetation does not all become overgrown or rank or be so heavily grazed that it becomes a short, homogenous sward. The management of the grassland habitats will be undertaken by grazing or through their usage as hay meadows. The latter is especially appropriate where this land use has been practised previously (or continues to be so) because a significant proportion of the fauna and flora will be adapted to the pressures that this land management imposes. Leaving a proportion of the field uncut (such as its margins) will promote the creation of greater structural diversity that will benefit insects, amongst other species, and supply cover when the hay is mown.

Management by light and/or seasonal grazing will be adopted where appropriate. Cattle will be favoured rather than sheep because they create a less even sward and break up the ground more effectively, thereby increasing the range of niches available for plants and invertebrates. Cow pats also create a valuable habitat for fungi and invertebrates and the latter will then supply foraging birds with a food resource. Seasonal grazing is preferred to a continuous regime as this allows flowering species to set seed and is generally preferable for ground-nesting birds as well.

The preferred implementation option is:

- Adoption of grazing and/or mowing regimes described above through providing financial incentives to existing land managers. It is likely that expertise within SWEAG can prioritise the best use of resources made available for this element.

4.9 Trials

Wherever possible, management techniques identified in the HMP follow evidence-based best practice (e.g. Robinson; Wilke and Thompson). However, it is recognised that some of the management techniques described are relatively novel and unproven in the Shetland environment. This applies especially to the methods proposed for stabilising and re-vegetating bare peat surfaces, and for safeguarding and restoring/enhancing lochans. For these techniques, trials are needed in order to determine the most satisfactory techniques to use in the Viking area and potentially for other degraded sites in Shetland.

The approach suggested for bare peat surfaces (and possibly also for bare mineral ground) is for a trial to be carried out on an extensive area of bare peat from which sheep are excluded. The trial would be designed to test the following factors:

- Colonising vascular species – initially heath rush and/or common bog cotton, resorting to ‘exotic’ nurse grasses only if the bog species cannot be persuaded to grow;

- Planting method – sowing seed or planting nursery-grown seedlings;
- With or without fertiliser application;
- With or without coir matting or other textile laid over surface;
- With or without the addition of bog moss propagules (e.g. macerated material); and
- No treatment apart from exclusion of grazing.

All of the techniques proposed for lochan management require trialling, preferably in a relatively confined area that is readily accessible from public roads. The techniques are:

- Safeguarding, which involves arresting erosion that is a threatening an existing valuable lochan, using peatland restoration techniques that are appropriate to the individual situation;
- Deepening shallow-peat lochans may be a particularly effective; and
- Damming up the banks of a drained lochan.

5. SELECTION OF HABITAT MANAGEMENT AREAS

This section outlines the criteria used to identify and prioritise candidate areas for HMP sites.

5.1 Selection criteria for red-throated diver lochans

The large number of candidate lochans and pools within the Viking area makes it unlikely that all those that would benefit from practical management could be treated, at least to begin with. A two-stage selection process has been carried out that uses the information on the *ca.* 200 water bodies examined in the Viking lochs and lochans survey together with other information to prioritise sites for habitat management. The aim of this process is to maximise the conservation benefit of whatever level of habitat management work is agreed.

The first stage considers each lochan as a candidate for the three management objectives, namely safeguarding, restoration and enhancement. Matrices were used to classify lochans as 'very high', 'high', 'medium' or 'low' priority for each of these management objectives on the basis of measures of current and potential suitability for nesting divers and the apparent threat from future erosion (Tables 3 to 4). The prioritisation matrix for safeguarding lochans from erosion (Table 3) is based on a combination of apparent erosion threat and the likely medium-term change in suitability for breeding divers. The prioritisation matrix for restoration work to reverse the impacts of existing erosion (Table 4) is based on a combination of current and estimated pre-erosion suitability. The prioritisation scoring for work to enhance lochans for divers, irrespective of any erosion, was restricted to small lochans (less than *ca.* 25m long) and pools, i.e. those that are currently below or close to the minimum acceptable size. Clearly the potential increase in suitability of a particular lochan will depend on the amount of enhancement work undertaken. Therefore, the prioritisation matrix (Table 5) is based on the expected change in suitability for divers that would result from a defined level of enhancement effort. This was arbitrarily set at increasing length by 10m and depth by 0.3m. The measures of lochan condition and erosion threat; and the current, potential and expected future changes in suitability are all based on value to divers.

Table 3: Matrix for prioritising lochans for management aimed at safeguarding them from future erosion, according to the apparent risk of future peat erosion and the likely change in suitability for breeding red-throated divers.

Apparent erosion risk	Medium term future change in suitability			
	High > Unsuit.	**High > Low Med. > Unsuit.**	**High > Med. Med. > Low**	**Low > Unsuit.**
High - severe	very high	High	medium	low
Medium	high	Medium	low	low
Low	medium	Low	low	low

Table 4: Matrix for prioritising lochans for habitat restoration measures according to their pre-erosion and current suitability for breeding red-throated divers.

Pre-erosion suitability	Current suitability			
	High	**Medium**	**Low**	**Unsuitable**
High	low	Medium	high	high
Medium	N/A	Low	medium	high
Low	N/A	N/A	low	medium

Table 5: Matrix for prioritising small and pools for habitat enhancement measures according to their current and predicted post-enhancement suitability for breeding red-throated divers.

Current suitability	Potential post-enhancement suitability			
	High	**Medium**	**Low**	**Unsuitable**
Medium	medium	Low	N/A	N/A
Low	high	Medium	low	N/A
Unsuitable	high	Medium	low	N/A

The second stage takes the 'very high' and 'high' priority sites identified in stage one and examines them against potential constraints that would affect the practicality and desirability of management work at that site. The potential constraints that need to be considered are local hydrology, distance from vehicular access, predicted amount of work involved (equates to likely costs) and the proximity to any proposed wind turbines. These factors are each scored on a nominal 0, 1, 2, 3, 4 scale and that the product of the scores is used as a single practicality score to consider alongside the priority ratings from stage one. The zero score would be reserved for what are considered to be absolute constraints. Thus, a site that scores zero for any constraint would also achieve an overall practicality score of zero, indicating that management work at that site was impractical. This scoring exercise resulted in 30 lochans out of 200 being prioritised for HMP work. Initial agreement has been obtained from 15 different land managers and/or grazings committees. These agreements cover up to 53 different lochans (including all 30 priority lochans). There was a 100% commitment, in principle, to implement the HMP from those approached. Figure A10.9.1 shows the distribution of lochs and lochans provisionally identified as most suitable for diver habitat management measures.

5.2 Selection criteria for merlin sites

- Sites that have a history of merlin breeding use but that have had low occupancy in recent years;

- Sites where there is a lack of high quality deep heather vegetation but where heather is nevertheless extensively present in the vegetation. i.e. the management work will be aimed at improving the condition of existing heather rather than attempting to establish heather cover in place of some other vegetation type;

- Sites where it is feasible to erect fence exclosures, both practically and in terms of reaching agreement with landowners and grazing tenants;

- Sites that are at least 500m away from any proposed turbine location; and

- Initial agreement has been reached with 12 different land managers and/or grazings committees. These agreements cover up to 19 different possible merlin locations (within which 5 priority areas will be selected). There was 100% commitment to implement the HMP in principle from those approached. The candidate territories are A, D, F (2 sites 1.5 km apart), N and S (see figure A11.4).

5.3 Selection criteria for whimbrel sites

<u>Site selection</u>

There are insufficient areas within Central Mainland that meet the whimbrel habitat preference criteria identified in Section 4.3.4, so sites away from Central Mainland have been assessed and considered to ensure a sufficiently large area can be beneficially managed for a large number of whimbrel.

Habitat restoration and predator control will be undertaken at carefully selected sites that meet the following criteria:

- Existing regular breeding whimbrel;

- Landscape characteristics that are attractive to whimbrel (low gradients, low altitude, wet elements, away from human settlements; other groups of breeding birds etc);

- Largely covered in native vegetation;

- Extensive (at least $1km^2$) areas; and

- Landowner consent.

Focussing habitat restoration (creating some of the positive habitat features) and predator control in these adjacent areas is the second priority. New habitat creation away from these areas is not considered a high priority due to the length of time management changes would occur at and the uncertainty of success. Finally, targeted research into whimbrel ecology is a high priority because important questions on whimbrel ecology need to be answered and fed into the iterative HMP process.

The whimbrel beneficial characteristics identified in Section 4.3.4 were used to identify ten areas, within which whimbrel hot spots occur. Based on 2009-2010 data, these ten candidate areas include at least 75 pairs of whimbrel, ca. 25% of the Shetland and UK population (see Figure A10.9.2).

Initial agreement has been reached with 30 different land managers and/or grazings committees to implement the HMP and/or participate in predator control covering up to 87 different parcels of land. There was a 100% commitment to implement the HMP in principle from those approached.

5.4 Selection criteria for rivers and streams

The need for criteria to be developed in relation to riverine habitat is negated largely by the ready identification of a series of clearly defined impediments to the passage of migratory fish species. The dam on the Burn of Laxobigging at HU417727 apparently serves no known purpose. Its removal, modification or the installation of a fish pass, with landowner and SEPA consent, would open up approximately 1km of habitat upstream, most of which is good juvenile salmonid habitat with spawning potential. Should the waterfalls at HU411720 be passable by sea trout, the removal of the dam would permit access all the way into the upper reaches of the catchment. The fish pass on the lower Kirkhouse Burn where the stream flows below the B9071 (HU402627) could be modified in agreement with the current landowner. The drop from the lower pool of the fish pass is onto shallow rock, with no suitable pool from which fish can make the jump to the pass. Access would be improved by deepening the pool below the fish pass.

A further man-made obstacle, the weir at Weisdale Mill (HU396531) should be fully assessed. While the weir is passable, it clearly impedes fish passage at certain flows and fish trapped below the weir may be vulnerable to predation. Indeed, this was a favoured poaching area in past years (Paul Featherstone, *pers. comm.*). Furthermore, it should be noted that artificial impediments to the passage of migratory fish are now being targeted for improvement by legislative important drivers e.g. Salmon (fish passes and screens) Scotland Regulations 1994; and Water Framework Directive. The fish pass on the lower Sandwater (HU408511) was not inspected during Viking ES surveys. However during consultation concerns about it were expressed by members of the Shetland Angling Association, who felt that its efficacy should be assessed.

5.5 Selection criteria for woodland

By supporting efforts around existing woodland patches and utilising local expertise, at least 3 existing remnant sites have already been identified. As regarding establishing new woodland, consideration and survey will be required to establish the areas' most suitable for the regeneration of woodland (as well as avoiding important blanket bog and wet grassland habitats) with activities expected to be channelled through existing local groups and initiatives. It is expected that this will take place primarily along stream valley sides where the steepness of the ground will facilitate natural drainage and relict woodland vegetation may already be present that will provide a natural seed source. In such circumstances however, cognisance must be paid the potential presence of rare or otherwise notable plant species whose persistence may be threatened by the exclusion of grazing animals and/or the establishment of woodland.

Islands in lochs, isolated rock outcrops and mineral mounds protruding through areas of high quality blanket peat may also be targeted to enhance the connectivity between valleys (subject to the provisos above). The borrow pits created during the construction of the wind farm also hold potential for the establishment of woodland within a sheltered, well drained situation. The following criteria will be used to determine the suitability of areas for woodland regeneration:

- Altitude less than 100m a.s.l.;
- The presence of relict trees or shrubs that may be capable of naturally regenerating woodland habitat with the exclusion of grazing;
- A wind exposure that is compatible with tree establishment (wind exposure has been modelled and mapped across the site for the purposes of turbine location);

- The presence of a mineral soil suitable for shrub/tree establishment;
- The absence of adjacent, blanket peatland in poor condition that will be susceptible to widespread woodland regeneration to its detriment;
- The absence of high densities of priority bird species that require open ground (such as whimbrel, golden plover, dunlin and Arctic skua); and
- The potential for stock management (through stock reductions or the erection of exclosures).

5.6 Selection criteria for wet grassland

Appropriate sites will be identified by survey and agreement with the relevant land owner/manager and prominence will be given to:

- The enhancement and/or conservation of those sites that are already especially rich in distinctive faunal or floral species (e.g. black-tailed godwit); and
- The restoration of those wet grasslands that have fallen into dereliction.

5.7 Selection criteria for blanket bog

Blanket bog vegetation is widespread across the Viking study area, and much of it has been classified as 'active' according to the EU Habitats Directive definition, although arguably much of this would not be considered to be under Favourable Conservation Status. The principal attribute that is lacking is its landscape-level continuity, which is severely compromised by peatland erosion. The HMP aims to promote the recovery of active blanket bog over a large part of Viking study area. However, given the size of the site and the extent of the peatland, it will be impractical to apply this type of management everywhere at once and it will be necessary to prioritise between candidate areas for active intervention. Nevertheless, the recovery of large areas is the most biologically robust way forward in terms of enhancing Favourable Conservation Status (as per SNH 2006 guidance). During consultation the RSPB highlighted that larger, rounder areas (with less edge) are better habitats biologically.

Criteria that are relevant to determining priorities and practicalities are listed below.

1. In terms of direct blanket bog habitat loss offset, a minimum of 170.88ha must be restored to compensate for (like for like) predicted construction wind farm impacts (operational losses are calculated at 88.99ha);

2. Each area to be managed (compartment) should be chosen with consideration for its ability to support a self-sustaining section of blanket peatland, and its management should take into account any functional connections to adjacent sections.

3. Priority might then be afforded to:

    - Compartments which are actively eroding (e.g. have extensive areas of bare peat and mineral ground and/or actively eroding gully systems) as opposed to those which have begun to re-vegetate, and thus apparently to recover spontaneously;
    - Compartments where there are signs of direct human disturbance such as ditches, grazing lines, ploughing, tracks etc., especially where impacts could be reversed by active intervention;
    - Compartments that support additional important peatland habitats and species;
    - Compartments where specific and imminent threats to the additional important habitats and species have been identified;
    - Compartments where opportunities have been identified for enhancing specific habitat features (e.g. increasing the number of lochans suitable for red-throated diver breeding); and

- Compartments where continued erosion would detract from the quality of the stream and loch habitats receiving water from them (e.g. the silting up of salmonid spawning gravels with fine-grained, organic sediment).

4. Two principal logistical constraints on management can be identified:

 - Planned wind farm infrastructure which, although designed for minimal interruption of the hydrological continuity of the recovering peat blanket, may nonetheless restrict the range of habitat elements that it would be appropriate to create during the projected lifetime of the wind farm (e.g. it would be unwise to create areas of open water that may attract breeding red-throated divers close to turbines); and
 - Practical and financial compatibility of habitat management work with existing land use, especially in view of the complex pattern of land ownership and occupancy associated with the long-established crofting economy, combined with recent and continuing changes in agri-environment subsidy mechanisms.

The RSPB highlighted (and VEP recognise) that the revegetation of bare peat within existing degraded blanket bog areas is difficult to achieve but it is very good from a carbon dioxide (CO_2) savings perspective. Whist this HMP is largely focussed on mitigation in terms of priority species and habitats, it is recognised that huge CO_2 savings could be made alongside revegetating significant areas of degraded blanket bog habitat. At this stage it is not possible to accurately quantify what CO_2 savings blanket bog restoration would achieve, due to uncertainties over the speed and success of efforts to revegetate the large areas of bare peat in the Viking study area. However, once pilot restoration work in Nesting has been undertaken (see Section 6) and monitored it should be possible to assess and measure CO_2 savings accrued. This could then form the basis of predictive assessments of carbon saving planned for other areas, such as Collafirth. Further information on greenhouse gasses, peat and the Viking Wind Farm are provided in Chapter 16 Climate Change.

The following section examines in detail proposed large-scale blanket bog work in one example compartment where land manager co-operation has been secured.

6. PILOT BLANKET BOG MANAGEMENT AREA

It is anticipated that blanket bog management will be undertaken in stages over a significant part of the Viking site during the lifetime of the wind farm, and that the criteria developed will be applied at a range of levels during this time. In order to illustrate how they may be applied, an example for Nesting quadrant is summarised here. The following section describes in detail, the application of the techniques in Section 4 to a proposed pilot blanket bog management area.

Areas within the Nesting quadrant were chosen because a qualitative assessment of peatland condition based on available field observations and air photographs indicates that this is the quadrant with the most widespread, active erosion at the present time. In other quadrants, post-erosion bog moss carpets have developed on at least some summits, whereas in Nesting all of the summits appear still to be losing peat. This is reflected by the presence of six red-throated diver lochans prioritised for safeguarding and thirteen candidates for restoration/enhancement.

The principal convex and concave landform units (hills and valleys) in the Nesting quadrant are distinguished in Figure 1 as indicative management compartments. Table 6 summarises, for each landform unit, the available information relating to peatland condition, nature conservation features requiring safeguarding, opportunities for habitat enhancement and the wind farm constraints. For wind farm constraints, the approximate fraction of the unit that will lie within turbine clusters (i.e. the approximate area from which birds may be displaced) is estimated. For land use constraints, the approximate fraction that lies on common grazings (as opposed to enclosed parcels) is given, as a first indication of the number of land users involved.

An outline of management considerations and potential indicated by this exercise for hills in Nesting is given below.

Riven Hill is the closest of the Nesting hills to being separate from the remaining convex landforms, although it is connected by a low saddle to Muckle Hill. It is completely covered by peatland and its two eroding summits appear to be re-vegetating with heath rush and heather, with limited recolonisation by bog moss. A nationally rare moth has been recorded and there is a non-priority lochan (seldom used by red-throated divers). There is also some degraded spur peatland which appears to retain elements of what may be typical blanket bog for Shetland. The small areas of croft apportionments (possibly three land users) and planned wind farm construction, and its proximity to a public road make this a strong candidate area for peatland restoration including the establishment of trials (re-vegetation, hydrology and lochans).

Muckle Hill has some old ditches and its principal summit is eroding quite severely. Two apportionments occupy around half of the compartment, and wind farm infrastructure is confined to one corner of the hill. There are three lochans, two of which have been identified as priorities, with potential for enhancement at three more (all on the priority list) for safeguarding. Access to these will be improved when the wind farm tracks are in place.

A second separate area (in the Collafirth quadrant and which consists of the northern section of the Sandwick, Sweening and Laxo Common Grazings and the Camperdown Common Grazings) has been identified for possible blanket bog restoration work and landowner liaison has occurred. This second area will be considered and plans developed in a similar way as the Nesting area once successful trials have taken place, so that lessons learned can inform management techniques. The combined areas of the Nesting and Collafirth blanket bog pilot management areas alone far exceed like for like offset for predicted wind farm effects.

Table 6: Summary of peatland condition, safeguarding requirements, opportunities for habitat enhancement, and management constraints identified for each indicative landform unit within Nesting quadrant. Attributes are grouped according to:

(a) condition of peatland in terms of erosion (E: eroding summits, R: revegetating summits, S: sediment issues apparent, C: erosion in catchment) and signs of human impacts (D: ditches, P: plough lines, G: grazing lines, T: tracks, M: improved pasture, Q: quarry, S: shelter belt;

(b) nature conservation features requiring safeguarding (number of lochans and *priority lochans for safeguarding, record of nationally rare or other priority species e.g. moths, vascular plants, fungi, 's' indicates important for salmonid spawning);

(c) opportunities for habitat enhancement (RTD: number of restorable or enhanceable lochans and * priority lochans, W: woodland, WP: wet pasture); and

(d) constraints (estimated fraction of compartment occupied by wind farm infrastructure and thus potentially unavailable to birds; estimated fraction of compartment on common grazing as a first indication of types of land use constraints).

	Condition		**Safeguard**		**Opportunities**			**Constraints**	
Unit	Erosion	Human Impacts	RTD lochans	Rare or priority species	RTD	W	WP	(%)	Common grazing (%)
Sae Water/ Laxo Burn	C	D				√	√	0	*ca*. 60
Riven Hill	E (R?)	G	1	✓	√			*ca*. 25	*ca*. 75
Atler Burn	C	D		✓				0	0
Gossa Water and burns	S			✓ s				<1	100
Muckle Hill	E	DG	3*	✓	2*+1			*ca*. 30	*ca*. 50
Burn of Grunnafirth	C	DGM		✓ s		?	?	*ca*. 30	*ca*. 60
Skellister	E	GTPMS	4	✓		?	?	*ca*. 25	*ca*. 50
Burns of Quoys and Flamister	C	DGM		s		?	?	*ca*. 40	<20
Flamister	E	GTMS		✓			?	*ca*. 60	*ca*. 80
Burn of Crookadale	C	D		s	3*+1			*ca*. 10	*ca*. 90
East Kame	E	Q	1		1*	?		*ca*. 10	*ca*. 50
Hoo Kame / Mossy Hill	E	M	3*+1		3*+2		?	*ca*. 60	*ca*. 95
Wester Filla Burn	C							<1	100

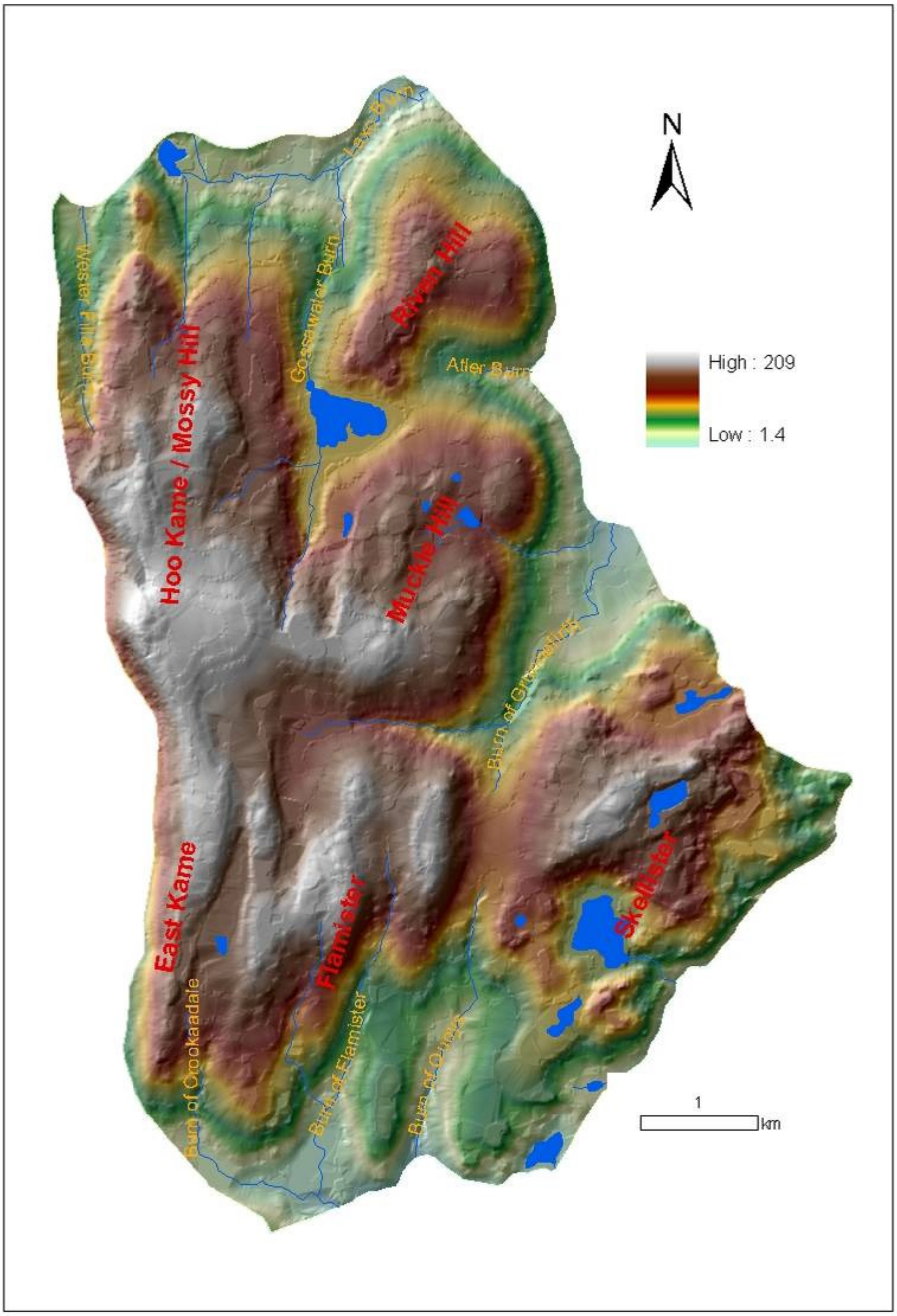


Figure 1: Relief map of Nesting quadrant, indicating the major landform units (convex with red labels, concave with orange labels) listed in Table 7. Altitude scale is in metres above Ordnance Datum. Derived from © Ordnance Survey data, licence no. EL273236.

Flamister has no special interest for rare or priority species, but some flush vegetation has been noted and the number and extent of the turbines on the summit makes it a non-favoured area for lochan creation. There is a borrow pit search area on the boundary between the catchments of the Burns of Flamister and Quoys, for which sediment issues will be important as these burns contain important salmonid spawning habitat. The improved pasture around the house at Flamister may offer potential for management as wet meadow (although the possibility of re-integrating this land into the main expanse of blanket bog should be eliminated first).

East Kame is close to a public road, although separated from it by a steep ascent. The principal interest lies in two lochans, one of which requires (non-priority) safeguarding and the other of which is a priority site for enhancement; both are on land apportioned to a single user. Existing and proposed borrow pits along the A970 public road offer sites for woodland patches which would contribute to the connectivity of this habitat.

Hoo Kame/Mossy Hill. One very high value diver lochan is situated here that merits highest priority for safeguarding. Unless conditions at this lochan deteriorate further, any management work is probably best postponed until practical experience is gained at other lochans of lower value. There is also a second diver lochan that would benefit from safeguarding measures but the relatively close proximity of several of the proposed turbines lowers the priority for management. Two large borrow pit search areas offer potential for creating woodland.

One of the valleys (that contains the Burn of Crookadale) warrants special mention because its upper reaches contain some potentially restorable lochans. As this is one of the important salmonid spawning streams, peatland management here will potentially benefit both red-throated divers and fish. This is also an area where management to restore stands of deep heather would benefit breeding merlins.

6.1 Selection and management of the pilot area

At the planning stage, the need to demonstrate that tangible arrangements were in place to develop and trial the practical restoration methods themselves was identified. For this reason, a pilot area was required with the following attributes:

- A high-priority area for active management intervention;
- Potential for restoration of a self-sustaining section of blanket peatland incorporating a representative range of landforms;
- Area at least sufficient to compensate for the direct impact on peatland of infrastructure associated with the whole Viking Wind Farm (i.e. at least 170.88ha during construction reducing to 88.99ha during operation after recovery of disturbed vegetation);
- Presents opportunities to trial most or all of the management techniques proposed;
- Avoids risk to the highest quality habitat elements (e.g. lochans where divers breed with consistent success) until techniques are proven;
- Accessible from public roads; and
- Location enabling management work to commence and proceed largely independently of wind farm construction work.

The area identified for this purpose is assembled from the first five of the landscape units listed in Table 6. The pilot area for peatland is bounded to the east by the B9075 public road, to the north by the Laxo Burn, to the west by the Gossawater Burn, Gossa Water itself, Burn of the Dale and the Stour Burn, probably with a functional connection in this area to the Hoo Kame peat blanket; and by the Burns of Forse and Gunnafirth to the south and south-east. Its total area is 1,051ha (see Figure 2). This area could be increased slightly so that boundaries would be set back from burns, to allow both banks on streams to re-establish and for practical reasons to allow stock exclusion fencing if necessary.

There is potentially continuous peatland over the whole of this area, but 51 ha of peripheral improved pasture which may prove impractical to re-integrate into the peat blanket (subject to inspection and landowner preferences) are deducted from the area calculation. Thus, the total area of potentially restored blanket peatland is 1,000 ha (10km^2). The area of improved-quality habitat is estimated as 10km^2. Some bird species may not fully benefit from all parts of the pilot area due to displacement effects close to turbines and roads (as described in the ES). Nevertheless, at worst, the species concerned are unlikely to be displaced from no more than approximately 25% of managed pilot area; much less if very recent evidence on lack of wind farm displacement effects on waders is considered.

Figure 3 summarises the condition of peatland within the pilot area. The map of blanket bog 'activity' prepared in conjunction with the ground-based Phase 1 habitat/vegetation survey indicates that more than half (*ca.* 500ha) of the pilot area peatland has an activity score less than 5 and thus could potentially be improved as compensation for the calculated 170.88ha constructional and 88.99ha operational 'direct take' of blanket bog at all activity levels beneath the entire footprint of the wind farm.

Air photography broadly confirms the relative proportions of vegetated and bare ground in different parts of the pilot area, although peat thickness is obviously not taken into account. Both maps show abrupt discontinuities in peatland condition coinciding with some of the fence lines in Figure 2, which can be attributed to differences in historical and/or current management between land holdings (grazing lines). Thus co-ordination of management across the different land holdings is needed in order to recover the peatland's landscape-level continuity. The presence of securely fenced areas offers potential for conducting comparative manipulations of grazing regimes. Figures 4 to 7 illustrate some examples of locations where management intervention involving combinations of the techniques described in Section 4 could be applied.

The peatland pilot area offers limited opportunities for introducing the other 'biodiversity' habitats (woodland and wet grassland). Nevertheless, along the burns forming the west boundary appears potentially suitable for woodland, and the croft field on the mid east boundary seems to have grassland opportunities e.g. the 'peripheral 51ha of grassland'. As previously suggested, boundaries would be best set back from burns, to allow both banks to re-establish and for practical reasons to allow stock exclusion fencing if necessary.

In the area north of the Laxo Burn, the B9071 road has permanently isolated a strip of the edge of the Collafirth peatland which could potentially be developed as a 'biodiversity corridor' connecting the coast at Voe with that at Laxo (Figure 2). Here, a series of woodland and wet pasture patches might be introduced to facilitate movement of birds, Lepidoptera *etc.* between the two sides of the island. The drained land around the eastern side of Sae Water may be suitable for management as wet grassland. Including this northern part expands the pilot area, allowing significant opportunities for woodland and wet grassland habitats that are not readily available elsewhere in the pilot area.

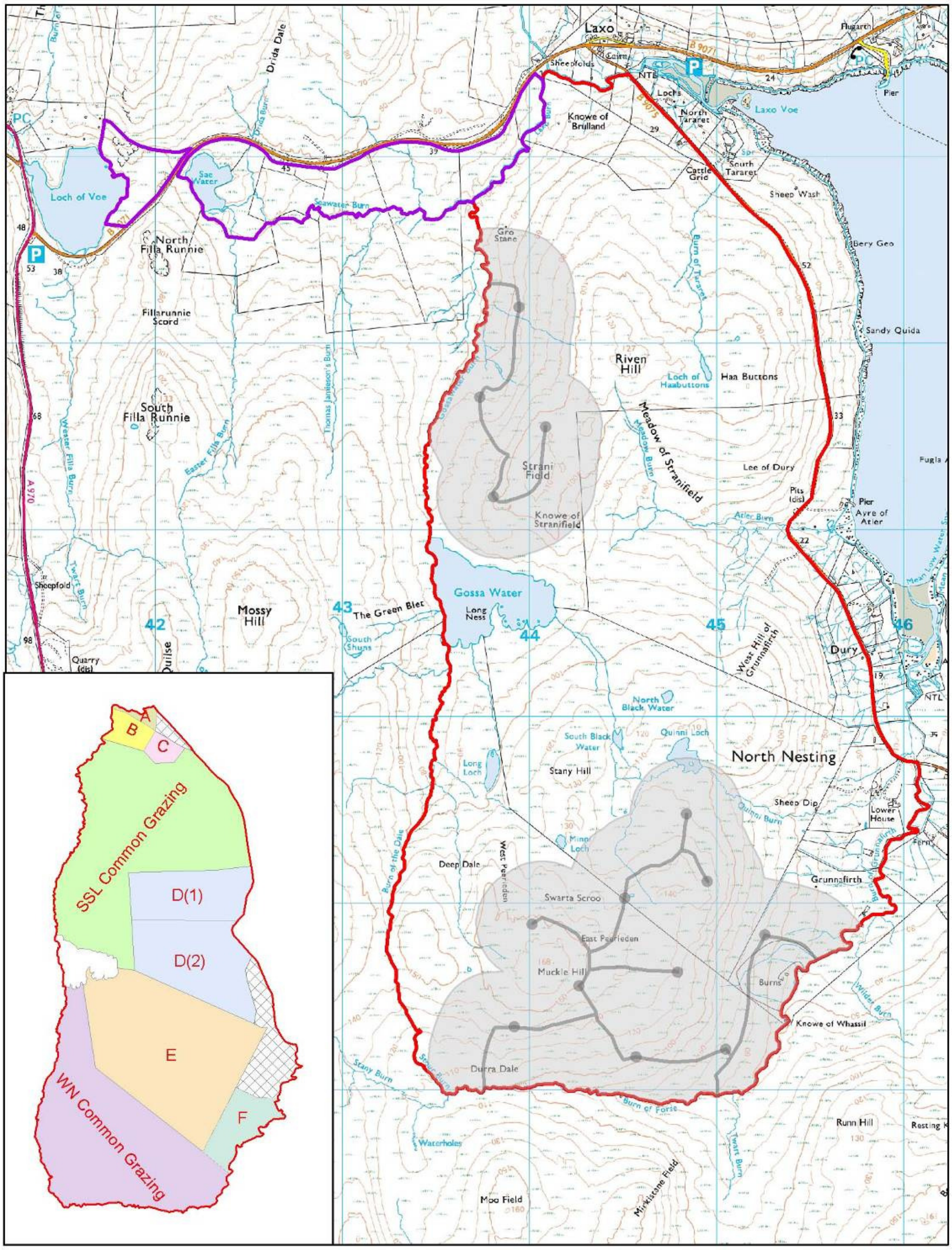


Figure 2: Map showing outlines of the proposed pilot areas for peatland management (red) and development of woodland and wet grassland habitats (purple). The positions of proposed turbines and tracks are also shown, surrounded by a 300 m 'bird exclusion' buffer (grey). The inset shows, for the peatland area only, fenced land holdings (A–F), areas of improved pasture (cross-hatched), and the areas that lie within common grazings (SSL: Sandwick, Sweening & Laxo; WN: West Nesting). There may be no fence separating holdings D(1) and D(2). Base map © Ordnance Survey, licence no. EL273236.

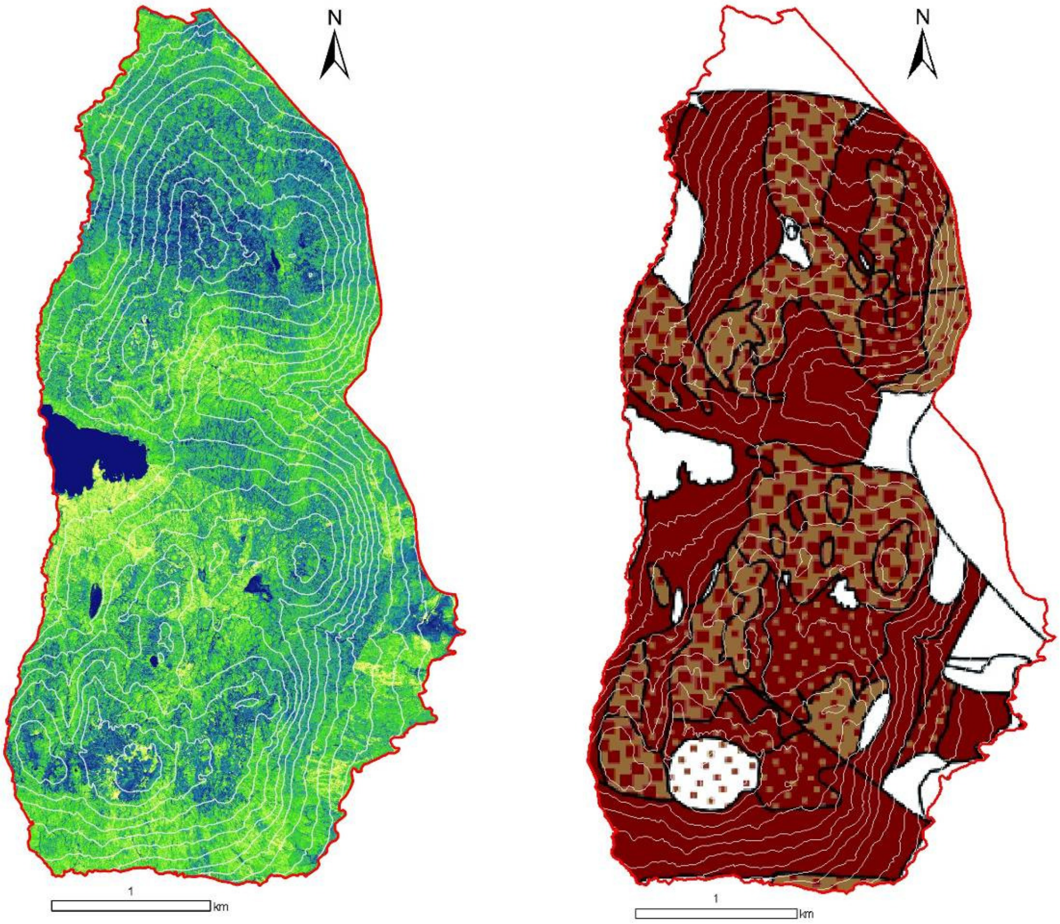
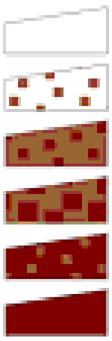


Figure 3: Left: false-colour air photograph of the peatland pilot area with contours (10 m interval) superposed. The lightest tones from the air photograph are coloured yellow, and the darkest navy blue; thus, bare mineral ground appears yellow and open water lochs/lochans as solid dark blue shapes. Between these extremes, blue generally indicates bare peat and green tones vegetated areas. **Right: map showing different levels of blanket bog activity**, estimated during the Phase 1 vegetation survey (key below), for the same area.

Key to assessments of blanket bog activity (from ground-based Phase 1 survey).



0: Inactive blanket bog, open water and areas not surveyed.

1: More or less totally inactive, poor condition, 80–100% bare peat (or vegetated shallow peat).

2: Largely inactive, 50–80% bare peat (or vegetated shallow peat).

3: Intermediate, widespread larger scale peat erosion, 20–50% bare peat (or vegetated shallow peat).

4: Areas of broadly intact bog with smaller scale but frequent bare peat erosion, 5–20% bare peat (or vegetated shallow peat).

5: More or less fully active, good, stable condition blanket bog, <5% bare peat.

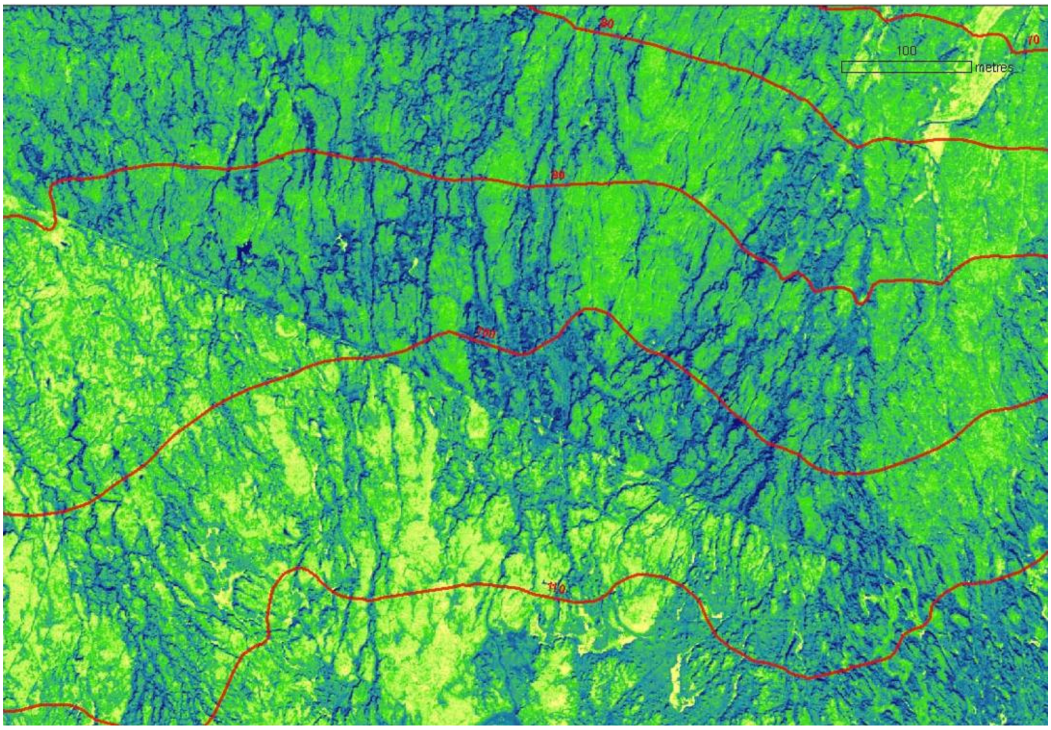


Figure 4: Example of the apparent effect of differences in grazing intensity on the two sides of a sheep-proof fence separating a pair of adjacent land holdings. Contours (red) are at 10m intervals and labelled with altitude in metres a.s.l.

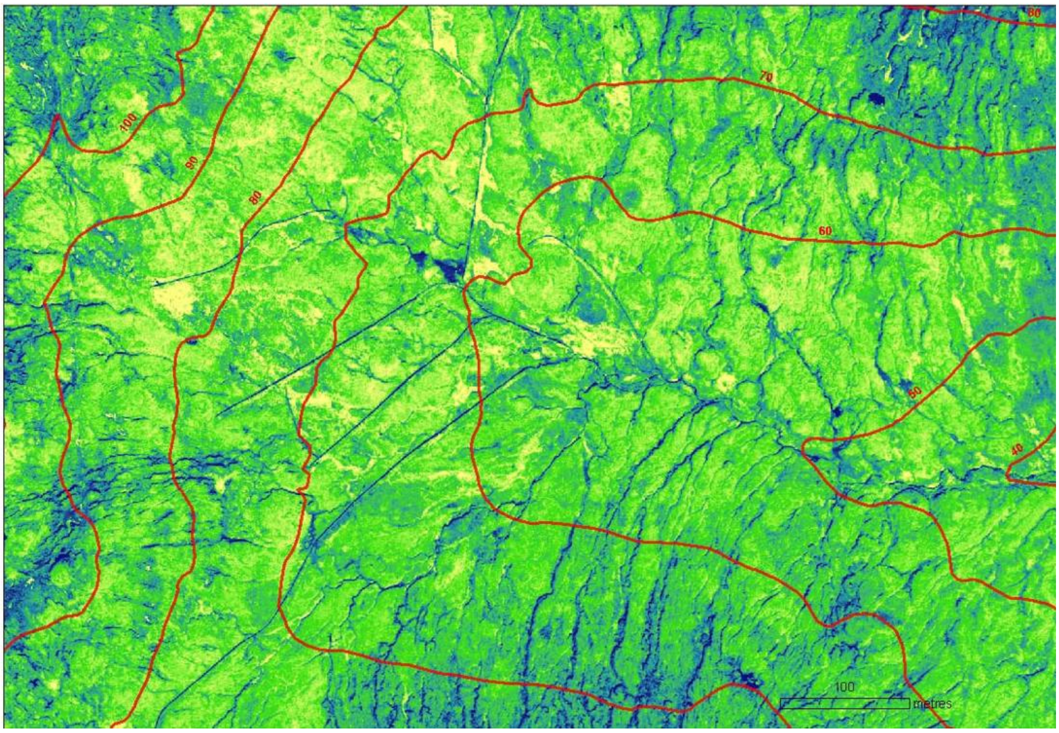


Figure 5: Head of the Atler Burn, showing ditches running at an angle to erosion gullies through 'level 5 active blanket bog'. There are associated areas of altered vegetation or possible bare mineral ground (yellow). Contours as in Figure 4.

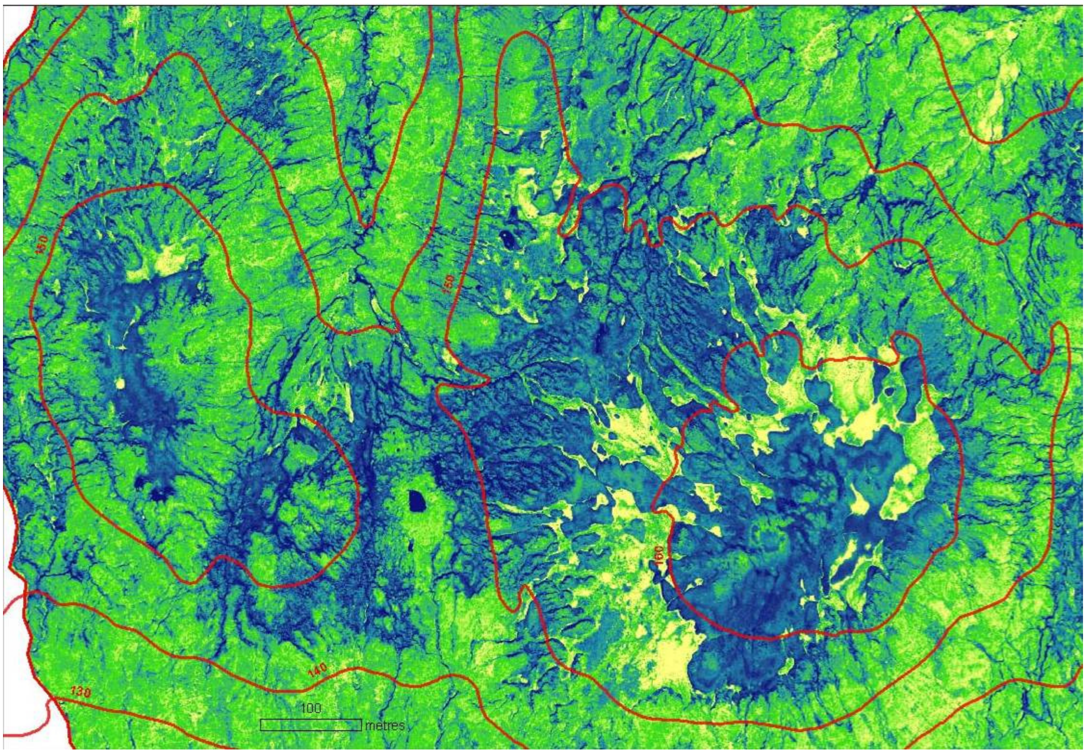


Figure 6: Poor condition (activity class 1) blanket bog on the main summit of Muckle Hill, showing extensive bare peat - a candidate area for re-vegetation trials - eroding to mineral (yellow) and re-vegetating, probably with heath rush. The small dark patch in the saddle slightly below and to the left of centre frame is the lochan that features in Figure 7. Contours as in Figure 4.

Figure 7: Lochan due west of the principal summit of Muckle Hill. Although this diver nesting lochan has so far survived, it is threatened by severe erosion advancing from both upslope and downslope. Re-vegetation of the hill behind would contribute to safeguarding the lochan, and also improve the quality of grazing for stock.

6.2 Outline of management approach for pilot area

Although the ultimate objective of peatland management is to reinstate its landscape-level continuity, management will in practice be applied at the level of individual land holdings. The individual holdings within the pilot area are shown in the inset map in Figure 2. Table 7 gives a preliminary list of proposed management objectives and techniques for each holding, derived from currently available information. Ground inspection and baseline surveys will, however, be required before details can be finalised.

Table 7: Preliminary list of management objectives and techniques for each of the land holdings within the Nesting pilot area.

Land holding (Fig. 5.2)	**Peatland area (ha) within pilot area**		**Specific objectives & techniques**
	holding	Cumulative	
A	4.7	4.7	Reduce fragmentation of peatland; re-incorporate marginal areas into peat blanket.
B	14.6	19.3	
C	9.4	28.7	
SSL CG	289.6	318.3	Relate peatland condition to grazing history. Safeguard (1) lochan. Excavate lochan & re-establish peat formation in an area where mineral ground has been exposed by erosion. Improve *Sphagnum* recolonisation on summits. Encourage recovery of patterned spur peatland. Encourage re-vegetation of gullies on slopes. Reduce fragmentation of peatland. Integrate wind farm infrastructure into peatland system (minimise hydrological discontinuity). Optimise stocking regime. Monitoring of vegetation & surface patterns.
D(1)	70.3	388.6	Ditch & gully repair. Relate peatland condition to grazing history. Encourage re-vegetation of gullies on slopes. Reduce fragmentation of peatland. Comparative stocking manipulations (e.g. sheep density, sheep plus cattle) to determine optimal grazing regime(s). Monitoring of vegetation & surface patterns. Construct pilot catchment carbon budget.
D(2)	101.1	489.7	
E	227.1	716.8	Rehabilitate (2) saddle lochans & 1 loch subject to sedimentation. Safeguard 1 lochan (only part of relevant peatland lies within this holding). Stabilise bare peat (factorial trials?). Re-vegetation of bare mineral. Ditch (and possibly gully) repair. Reduce fragmentation of peatland. Relate peatland condition to grazing history. Encourage re-vegetation of gullies on slopes. Integrate wind farm infrastructure into peatland system (minimise hydrological discontinuity). Optimise stocking regime. Monitoring of vegetation & surface patterns.
F	36.4	753.2	Reduce fragmentation of peatland; re-incorporate marginal area into peat blanket.
WN CG	247.1	1000.3	Safeguard (2.5) lochans. Stabilise bare peat (factorial trials?). Re-vegetation of bare mineral ground. Gully repair? Reduce fragmentation of peatland. Relate peatland condition to grazing history. Encourage re-vegetation of gullies on slopes. Integrate wind farm infrastructure into peatland system (minimise hydrological discontinuity). Optimise stocking regime. Monitoring of vegetation & surface patterns.

6.3 Monitoring of the blanket bog habitat

For the peatland, management will aim to:

- Reduce the extent of bare peat;
- Reinstate continuous 'active' blanket bog vegetation;
- Replace erosion patterns with the typical surface patterning for healthy blanket bog in Shetland;
- Achieve a more or less neutral carbon budget; and ultimately
- Establish grazing at a level that is compatible with maintenance of these features of the peatland.

In order to monitor progress towards the first three of these targets, it will be necessary to make repeat assessments, perhaps at intervals of five years, of the surface condition of the peatland. There are drawbacks to both of the methods illustrated in Figure 3. Ground-based vegetation survey of such a large area is time consuming and inevitably involves scanning substantial areas of ground obliquely from a low viewpoint, which prevents accurate assessment of the extent of erosion gullies. High-resolution vertical air photographs sample the whole surface and give a much clearer indication of surface patterns; but tonal inconsistencies between frames mean that automated analysis of the data (e.g. to calculate the extent of bare peat) is problematic. Satellite imagery captures the whole scene almost instantaneously so that tonal variations do not cause problems, but resolution is relatively low (pixels typically some tens of metres across). On the other hand, sophisticated analysis techniques are available and archive images can be obtained so that it would be possible to make retrospective condition assessments for comparison with trends emerging in the future. Thus, it is proposed that the possibility of basing repeat monitoring of peatland condition primarily on satellite imagery (supported by vegetation survey for ground-truthing purposes) should be explored.

The response to peat restoration measures by most of the priority breeding bird species will be measured periodically (approximately every three years) using standard moorland bird survey methods. It is likely that this survey work will be instigated as part of the wider programme of ornithological monitoring across the wind farm site, however it will be important that it is integrated (through careful design) with the specific needs of monitoring the habitat restoration work. Stands of heather managed for nesting merlin will be monitored by annually measuring vegetation height and density. These areas will also be incorporated into areas checked during routine annual breeding merlin surveys.

Given the condition of the peatland, the Viking site is currently losing large amounts of CO_2 at present. As previously stated huge CO_2 savings could be made by revegetating significant areas of degraded blanket bog. Once pilot restoration work in Nesting has been undertaken and monitored it should be possible to assess and measure CO_2 savings accrued and relate this to work planned for other areas.

Finally, in order to determine sustainable long-term stocking levels for the Viking peatland, accurate measures of grazing management will be made.

7. INTERPRETATION

The unique culture of Shetland and its distinctive land forms, flora and fauna already attract a wide range of visitors to the islands including: archaeologists, botanists, geologists, ornithologists and general visitors. Some of these visitor groups as well a local people may be interested in the implementation and outcomes of the Viking HMP in terms of:

- Changes in the composition and diversity of the native flora and fauna;
- The restoration of degraded habitats;
- The sustainability of farming and other land management practices; and
- The potential recreation of an extinct landscape.

A number of opportunities for interpretation are consequently available to inform and educate widely and to encourage local involvement. The most desirable approach is the restoration and conservation of all of the habitats in one demonstration area wherein the full range of approaches to managing blanket bog, woodland and freshwater bodies can be demonstrated in combination with sustainable farming practices, or in their absence, in order to demonstrate how the pre-agricultural landscape of Shetland may have looked. This could be taken forward through an interpretation programme linked to panels, leaflets, guided walks etc.

Opportunities also exist for local groups (such as schools and youth groups) to become involved through the adoption of a specific area and helping with some of the management and monitoring. This may include damming gullies, propagating (at home or at school) and transplanting plants, and survey/monitoring work.

As already highlighted, two of the Viking lochs have been identified as a strong candidate for rafts are by main roads and could therefore potentially provide ideal sites for birdwatchers and visitors to watch red-throated divers, thus reducing pressures at breeding sites where divers are more sensitive to disturbance. While the setting up of some sort of promoted public viewing facility for divers is not yet an aim of the HMP, such a facility would be an asset that could be taken advantage of if developed carefully and if circumstances allow. The possible development of such a viewing facility (hide) would demonstrate practically the value of the significant mitigation work undertaken by VEP.

Finally, the implementation of this HMP is likely to result in significant discoveries in terms of the efficacy of planned habitat management measures in a Shetland context. The VEP are fully committed to sharing and disseminating these discoveries and, where suitable, publishing relevant findings.

8. IMPLEMENTATION

8.1 Management

Implementation of the HMP will be the responsibility of the VEP, aided and advised by the proposed independent Shetland Windfarm Environmental Advisory Group (SWEAG) modelled on, but distinct from, the Shetland Oil Terminal Environmental Advisory Group (SOTEAG).

Implementation will be via an appropriately qualified project officer. The project officer will be responsible to Viking Energy Partnership, SWEAG and the Monitoring Committee for day-to-day implementation of the HMP, and will be supported in this role by partners, additional staff and consultants as necessary.

An initial work programme that outlines the necessary steps to be taken and that summarises the management prescriptions above will be developed if and when planning consent is granted. The terms of reference will be agreed post consent, but VEP is expected to co-ordinate, deliver and drive the implementation on the HMP aided by SWEAG or a similar group.

8.2 Partnership working

VEP will implement the HMP with the help of the a number of potential partners such as those listed in Table 8. VEP would envisage that these partners will be involved from the earliest stages in order to ensure the effective delivery of the plan.

Table 8: Potential partners identified as relevant to the delivery of the HMP.

Partner	Roles
Academic institutes and environmental consultancies.	• Research & monitoring of the HMP outcomes. • Independent peer review.
Highland Birchwoods/Shetland Amenity Trust	• Advice, information & technical input on woodland regeneration.
Moors for the Future Partnership	• Advice, information & technical input on blanket bog restoration.
Royal Society for the Protection of Birds	• Advice, information & technical input on habitat restoration & species requirements.
Scottish Environment Protection Agency	• Advice, information, monitoring & technical input. Licensing.
Scotland's Environmental and Rural Services (SEARS)/Scottish Agricultural College	• Assistance developing a land management scheme to fund the modifications to agricultural practice.
Scottish Natural Heritage	• Advice, information, monitoring & technical input. Licensing.
Shetland Amenity Trust	• Provision of nursery facilities. • Advice, information & technical input.
Scottish Agriculture College or Shetland Crofting, Farming & Wildlife Advisory Group or similar	• Assessment of grazing levels. • Negotiations with crofters. • Calculation of appropriate compensation. • Production of grazing management plans.
Shetland Islands Council	• Advice, information & technical input. • Integration of management plan outputs with LBAP.
Shetland Oil Terminal Environmental Advisory Group	• Advice, information & technical input in developing SWEAG.

8.3 Funding

The implementation of the management plan will be funded by VEP with supplementary or match funding being sought where available. The funding commitment by VEP will span the life of the project; a period of at least 20 years and may include:

- The salary and other expenses associated with the project officer (including office space and equipment);
- Set up and ongoing administration costs for SWEAG;
- Costs to devise and manage agricultural compensation arrangements (eg. through SAC)
- Consultancy, research and labour fees;
- Stock management compensation;
- Materials, (fencing, matting, dam materials, etc);
- The collection and propagation of plant species for blanket bog and woodland regeneration;
- The hire or purchase and maintenance of necessary equipment and premises; and
- Development and delivery of the interpretive programme.

8.4 Duration

The HMP will only be implemented if and when planning permission for the wind farm is agreed and it will incorporate two phases. Phase 1 will extend over the first five years and it includes the establishment of the necessary baseline survey and monitoring programmes; instigation of the blanket bog restoration trials; and restoration/conservation of the other habitats in the proposed Nesting Pilot Area. Phase 2 will extend over the following twenty years and will incorporate the wider application of the blanket bog restoration techniques and management of the other habitats across the Viking study area.

8.5 Monitoring and review

The work undertaken to fulfil the habitat management plan will be monitored periodically to ensure it delivers the aims. This will be achieved by a programme of survey work that quantifies the changes to the extent and condition of priority habitats and changes in the abundance and distribution of priority species. For those aspects of the management plan where field trials will determine the most efficacious methods, a further aim of the monitoring will be to provide timely quantitative assessment of various alternative methods and combination or methods tested. For example, the results of trials undertaken in the Pilot Area of the HMP will be needed to inform the works to be undertaken in later work phases. All work phases will be monitored and the results will feedback into the process of review and implementation.

In all cases it will be necessary to have adequate measures of baseline conditions made before management work commences. Many of these baseline surveys are being undertaken in 2010 and 2011, so that HMP works can commence as quickly as possible if and when planning consent is granted. In some cases data already collected for the purposes of the ES may be adequate for this, in other cases new survey work will be required to establish baseline conditions.

9. REFERENCES

Amar, A., Redpath, S., Sim, I. and Buchanan, G. 2010. Spatial and temporal associations between recovering populations of common raven *Corvus corax* and British upland wader populations. Journal of animal Ecology **47**: 253-262.

Birnie, R.V. 1993. Erosion rates on bare peat surfaces in Shetland. Scottish Geographical Magazine, **108**: 12-17.

Birnie, R.V. and Hulme, P.D. 1990. Overgrazing of peatland vegetation in Shetland. Scottish Geographical Magazine, **106**: 28-36.

Berry, R.J. and Johnston, J.L. 1980. The natural history of Shetland. Collins.

Bohn, H. L. 1976. Estimate of organic carbon in world soils. Soil Society of America Journal **40**: 468-470.

Botch, M.S., Kobak, K.I., Vinson, T.S. and Kolchugina, T.P. 1995. Carbon pools and accumulation in peatlands of the former Soviet Union. Global Biogeochemical Cycles **9**: 37-46.

Brooks, S. and Stoneman, R. 1997. Conserving bogs: the management handbook. The Stationery Office.

Byrkedal, I. 1987. Antipredator behaviour and breeding success in Greater Golden Plover and Eurasian Dotterel. Condor **89**: 40-47.

Crowe, S.K., Evans, M.G. and Allott, T.E.H. 2008. Geomorphological controls on the re-vegetation of erosion gullies in blanket peat: implications for bog restoration. Mires and Peat **3**: 1–14.

Etheridge, B., Holling, M., Riley, H., Wernham, C. and Thompson, D. 2008. Scottish Raptor Monitoring Scheme Report 2007.

Fletcher K., Aebischer N. J., Baines D., Foster R. and Hoodless A N. 2010. Changes in breeding success and abundance of ground-nesting moorland birds in relation to the experimental deployment of legal predator control. *Journal of Applied Ecology*. In press.

Forrester, R.W, Andrews, I.J, McInerny, C.J, Murray, R.D, McGowan, R.Y, Zonfrillo, B, Betts, M.W, Jardine, D.C, and Grundy, D.S (eds) 2007. The Birds of Scotland. The Scottish Ornithologists Club.

Gorham, E. 1991. Northern peatlands: role in the carbon cycle and probable responses to climatic warming. Ecological Applications **1**: 182-195.

Grant, M. 1991. Nesting densities, productivity and survival of breeding whimbrel in Shetland. Bird Study **38**: 160-169.

Grant, M. 1992. The effects of re-seeding heathland on breeding whimbrel in Shetland. I. Nest distributions. Journal of Animal Ecology. **29**:501-508.

Grant, M., Chambers, R. and Evans, P. 1992a. The effects of re-seeding heathland on breeding whimbrel in Shetland. II. Habitat use by adults during pre-laying period. Journal of Animal Ecology **29**: 509-515.

Grant, M., Chambers, R. and Evans, P. 1992b. The effects of re-seeding heathland on breeding whimbrel in Shetland. III. Habitat use by broods. Journal of Animal Ecology **29**: 516-523.

Hancock, M. 2000. Artificial floating islands for nesting black-throated divers *Gavia arctica* in Scotland: construction, use and effect on breeding success. Bird Study **47**: 165-175.

Holloway, S. 2002. The Historical Atlas of Breeding Birds in Great Britain and Ireland 1875-1900. Poyser.

Hulme, P.D. 1985. The peatland vegetation of the Isle of Lewis and Harris and the Shetland Islands. Aquilo Seria Botanico, **21**: 81-85

Hulme, P.D. and Birnie, R.V. 1997. Grazing induced degradation of blanket mire: its measurement and management. In: proceedings of conference on "Blanket mire degradation: causes, consequences and challenges" (ed. by J.H. Tallis, R. Meade, and P.D. Hulme), University of Manchester, 9-11 April. Mires Research Group, British Ecological Society,163-173.

IEEM 2006. Guidelines for Ecological Impact Assessment in the UK. IEEM.

Laughton Johnston, J. 1999. A Naturalist's Shetland. Academic Press.

Lindsay, R.A. 1995a. Peatlands. In: The natural heritage of Scotland: an overview. E.C. Mackey (ed.). Perth, Scottish Natural Heritage.

Lindsay, R.A. 1995b. Bogs: The Ecology, Classification and Conservation of Ombrotrophic Mires. Scottish Natural Heritage, Battleby, 120 pp.

Planning Advisory Note (PAN 58). 1999 (modified 2005). Environmental Impact Assessment.

Pennington, M., Osborn, K., Harvey, P., Riddington, R., Okill, D., Ellis, P. and Heubeck, M. The Birds of Shetland. Helm.

Quarmby N.A., Johnson. G. and Morris. J.M. 1999. Scottish Blanket Bog Inventory: The Shetland Islands - characterisation of blanket bogs using Landsat Thematic Mapper. Scottish Natural Heritage. Unpublished report.

Richardson, M. 1990. The distribution and status of whimbrel in Shetland and Britain. Bird Study **37**: 61-68.

Robinson, K. (no date). Restoring Active Blanket Bog of European Importance in North Scotland. Monitoring effectiveness of habitat restoration works completed on RSPB land. LIFE00NAT/UK/7075.

Roper-Lindsay J. and Say, A.M. 1986. Plant communities of the Shetland Islands. Journal of Ecology. **74**(4).

Ruddock, M. and Whitfield, D.P. 2007. A review of disturbance distances in selected bird species. SNH report.

Scottish Natural Heritage. 2002. Natural Heritage Futures: Shetland (amended 2009).

Scottish Natural Heritage. 2006. Assessing significance of impacts from onshore windfarms on birds outwith designated areas. SNH On-line guidance.

Shetland Amenity Trust. 2002. Shetland Woodland Strategy. Unpublished Report.

Shetland Bird Club 2009. Shetland Bird Report 2008.

Shvidenko, A., Barber, C.V., Persson, R., McCallum, I., Nilsson, *et al.*, 2005. Forest and woodland systems. Chapter 21 in the 3rd Millennium Ecosystem Assessments Ecosystems and Human Well-being: Conditions and Trends, pp. 583-617.

Snow, D.W and Perrins, C.M (eds) 1998. The Birds of the Western Palearctic. Oxford University Press.

Spence, D.H.N. 1960 Studies on the vegetation of Shetland III. Scrub in Shetland and South Uist, Outer Hebrides. Journal of Ecology **48**: 73-95.

Spence, D.H.N. 1979. Shetland's living landscape. A study in plant ecology. Thule Press.

Wallander, J. Isaksson, D. and Lenerg, T. 2006. Wader nest distribution and predation in relation to man-made structures on coastal pastures. Biological Conservation **132**: 343-350.

Wilkie, N.M and Thompson, P.S. (no date). Identification and restoration of damaged blanket bog: a guide to restoring drained and afforested peatland. LIFE Peatlands Project.

APPENDIX A

VON POST HUMIFICATION SCALE

H	Description	Proportion of dy*	Plant structure	Expressed fluid	Peat lost through fingers	Peat retained in the hand
H1	Completely unhumified	None	Evident	Colourless, clear	None	Not porridgey
H2	Virtually unhumified	None	Evident	Yellow-brown, clear	None	Not porridgey
H3	Little humified	Small	Evident	Noticeably turbid	None	Not porridgey
H4	Poorly humified	Modest	Evident	Very turbid	None	Somewhat porridgey
H5	Fairly humified, structure distinct	Fair	Evident but somewhat obscured	Strongly turbid	Some	Very porridgey
H6	Fairly humified, structure less distinct	Fair	Indistinct but still clear	Strongly turbid	Up to 1/3	Very porridgey
H7	Quite well humified	Consider-able	Much still visible	Strongly turbid	Up to 1/2	Gruel-like
H8	Well-humified	Large	Vague	Strongly turbid	2/3	Only fibrous matter & roots remain
H9	Almost completely humified	Most	Almost none visible	Very strongly turbid	Almost all	Homogeneous
H10	Completely humified	All	None visible	Very strongly turbid	All	Porridge

* Highly decomposed organic matter.