11. ORNITHOLOGY

11.1 INTRODUCTION

This chapter evaluates the effects of the proposed Viking windfarm ('the Development') on birds. It complements the evaluation of other ecological effects set out in Chapter 10: Ecology. The methods used to establish the bird interest within and around the proposed windfarm are described, together with the process used to determine the nature conservation importance of the bird populations present. The ways in which birds might be affected by the development are explained and the magnitude of the probable effects of the Development is considered. Finally, possible mitigation is identified and the significance of any likely residual effects is assessed. The evaluation was undertaken by Natural Research Projects (NRP) Limited.

Potentially significant adverse effects on birds comprise:

- Direct loss of habitat to wind turbine bases, access tracks, site substation, converter station and ancillary infrastructure;
- modification of habitats that support bird populations, due to hydrological change resulting from the construction of access tracks, cable trenches, etc.;
- indirect loss of habitat due to the displacement of birds by construction works and operation of the windfarm; and
- mortality due to collision with wind turbine blades, overhead wires, guy lines and fencing.

As well as potential adverse effects, the Development would make a beneficial contribution towards countering climate change. Climate change is widely perceived to be the single most important long-term threat to the global environment, particularly to biodiversity and to birds. Thus, the continued rise in mean global temperatures is predicted to affect the size, distribution, survival and breeding productivity of many British bird species (Leech 2007). For example, Zockler and Lysenko (2000) predicted a reduction in the breeding range of Arctic species of between 5% and 93%, dependent on the species. High altitude species found in Scotland, such as dotterel and snow bunting, may also experience loss of habitat as temperatures increase. Moreover, sea-level rises may lead to the loss of areas of lowland coastal habitat, including salt marshes and mudflats (Norris & Atkinson 2000). It has been estimated that 84% of migratory species face some threat from climate change (Robinson et al. 2005). Despite the overwhelming evidence, uncertainties regarding climate change predictions mean that it is not possible at present to carry out a quantitative assessment of the beneficial effects of the Development on birds.

11.2 POLICY CONTEXT

Planning policies of relevance to this assessment are outlined in Chapter 7: Renewable Energy and Planning Policy Context.

11.3 SITE DESIGNATIONS

The proposed development site is not designated for its international ornithological interest, for example as a Special Protection Area (SPA) or Ramsar site. Three designated sites of national importance (Sites of Special Scientific Interest; SSSIs) are located near to the Development:

- Dales Voe Site of Special Scientific Interest (SSSI), an area of saltmarsh and intertidal sand and mud that supports locally important populations of feeding shorebirds, and breeding ringed plover and arctic tern. It is approximately 1,200 m from the nearest proposed wind turbine.
- Kergord plantations SSSI, an area of mixed coniferous and deciduous woodland that provides a locally important habitat for feeding and breeding birds, including woodpigeon, blackcap, chaffinch and song thrush, and supports most of Shetland's breeding rook population. Greenlea Plantation, the nearest part, is approximately 850 m from the nearest proposed wind turbine.
- Sandwater SSSI, a shallow mesotrophic loch surrounded by dwarf shrub and acidic moorland that supports locally important populations breeding waterfowl, including common and black-headed gulls, and passage and wintering whooper swans and other wildfowl. It is approximately 910 m from the nearest proposed wind turbine.

Other SSSIs in the area include Laxo Burn SSSI and Burn of Lunklet SSSI. However, neither of these sites is designated for their ornithological interest.

A part of Petta Dale is included in a composite Important Bird Area (IBA). The IBA is not well defined geographically, but includes the Ward of Cullswick which supports a small number of whimbrel. Although IBAs are not statutory designations, they represent areas that meet the qualifications for SPA designation. As such, they are designed to help decision makers discharge their obligations under the EC Directive on the Conservation of Wild Birds.

11.4 CONSULTATION

There was regular liaison between NRP and the following organisations during baseline surveys:

- Royal Society for the Protection of Birds (RSPB).
- Scottish Natural Heritage (SNH).

11.5 ASSESSMENT METHODS

11.5.1 Pre-baseline Survey Data Sources

The evaluation was undertaken by Natural Research Projects (NRP) Limited based on the following information sources:

- Shetland Biological Records Centre (SBRC). SBRC is the custodian of bird records gathered by RSPB, SNH and local and visiting ornithologists. Data were first obtained in April 2003.
- The Wetland Bird Survey database (WeBS). Data were obtained in August 2003.
- A long-term study of breeding red-throated divers in Shetland undertaken by D. Okill.
- Studies of breeding merlin in Shetland undertaken by P. Ellis, D. Okill and N. Dymond.

These sources indicated that the main species likely to be potentially affected by the development were:

- Breeding red-throated diver, merlin, golden plover, dunlin (C. *a. schinzii*) and arctic tern (species listed in Annex 1 of the EU Birds Directive [79/409/EEC] on the Conservation of Wild Birds 1979 ['the Birds Directive']).
- Breeding whimbrel (listed in Schedule 1 of the Wildlife and Countryside Act (WCA) 1981, as amended).
- Breeding snipe, curlew, arctic skua and great skua (important breeding species in a regional and, in some cases potentially national, context).
- Migratory and wintering whooper swan (listed in Annex 1 of the Birds Directive).

No other important populations of breeding, migratory or wintering birds were reported.

11.5.2 Baseline Surveys

A review of the main bird sensitivities associated with the Development identified a range of field survey requirements with the following aims:

- Determine the distribution and abundance of moorland breeding birds, in particular merlins, waders (shorebirds), skuas and terns.
- Investigate the level of bird flight activity across the development site throughout the year, with emphasis on the breeding period (April-August) and migration periods (March-May and September-November).
- Identify freshwater bodies used by breeding and non-breeding red-throated divers and determine their relative importance in terms of maintaining the diver population.
- Quantify spatial and temporal patterns of flight activity by breeding and non-breeding red-throated divers across the site.
- Determine the distribution and abundance of migrant and wintering birds, in particular whooper swans.

Ornithological surveys to address these requirements were initiated in April 2003. The chronology of these surveys was as follows:

April 2003 to March 2004. Breeding bird, flight activity and autumn/winter bird surveys in eastern parts of the development site.

April 2005 to May 2006. Surveys of breeding red-throated diver and merlin within, and adjacent to, all parts of the development site. Surveys of other breeding birds, flight activity, migratory bird movements and wintering birds in western parts of the development site. Systematic counts of whooper swans at potential feeding and staging sites within, and adjacent to, all parts of the development site. Monitoring of hen harriers using a communal roost site adjacent to the Development.

April 2006 to March 2007. Repeat surveys of breeding red-throated diver and merlin within, and adjacent to, all parts of the development site. Repeat surveys of other breeding birds, flight activity, migratory bird movements and wintering birds in eastern parts of the development site.

April to August 2007. Repeat surveys of breeding red-throated diver and merlin within, and adjacent to, all parts of the development site. Breeding bird surveys of eight small additional areas peripheral to the development site, made necessary by design modifications. Surveys to quantify the detection likelihood, flying height and diurnal variation in flight activity of selected species of conservation concern.

April to August 2008. Repeat surveys of breeding red-throated diver and merlin within, and adjacent to, all parts of the development site. Breeding bird surveys of a further eight small additional areas peripheral to the site access tracks, made necessary by design modifications.

Survey methods and results are comprehensively reported in the Birds Technical Report (Technical Appendix 11.1). Findings relevant to the current assessment are summarised in section 11.7.

11.6 EVALUATION OF SIGNIFICANCE

11.6.1 Overview

The evaluation follows the process set out in the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 1989 ("the EIA Regulations") and guidance on the implementation of the Birds and Habitats Directive (SERAD 2000). The process of evaluating the effects of the proposals on birds ensures that the planning authority has sufficient information to determine whether the proposal (either alone or in combination with other plans or projects) is likely to have a significant effect on bird interests.

Effects are evaluated against the expectation that the development would not have a significant adverse effect on the population, range or distribution of a species; and that it would not interfere significantly with the flight paths of migratory birds. In assessing the effects, emphasis is given to the national and regional populations of species.

The evaluation first identifies the potential effects of the development and considers the likelihood of their occurrence. A judgement is then made as to whether or not they are significant with respect to the EIA Regulations. In judging whether a potential effect is significant or not, two principal factors are taken into account:

- The nature conservation importance of the bird populations present; and
- The magnitude of the likely effect.

11.6.2 Methods used to Evaluate Nature Conservation Importance

The nature conservation importance of the bird species potentially affected by development is defined according to Table 11.1. The classification is hierarchical; therefore species that would qualify under more than one category are defined according to the highest class.

Table 11.1 Determining factors for Nature Conservation Importance

Importance	Definition
High	Species listed in Annex 1 of the Birds Directive. Breeding species listed in Schedule 1 of the WCA. Species present in nationally important numbers (>1% of UK population).
Moderate	Species listed in the UK Biodiversity Action Plan (BAP). 'Red' listed Birds of Conservation Concern (BOCC; Gregory et al. 2002). Species present in regionally important numbers (>10% of Shetland population)[1] Regularly occurring migratory species, which are either rare or vulnerable, or warrant special consideration on account of the proximity to the Development of migration routes or breeding, moulting, wintering or staging areas.
Low	All other species not covered above.

11.6.3 Methods used to Evaluate the Magnitude of Effects

Effect is defined as change in the assemblage of bird species present as a result of the development. Change can occur either during or beyond the life of the development. Where the response of a population has varying degrees of likelihood, the probability of these differing outcomes is considered. Note that effects can be adverse, neutral or favourable.

In determining the magnitude of effects the behavioural sensitivity and ability to recover from temporary adverse conditions is considered in respect of each potentially affected population. Behavioural sensitivity is determined according to each species' ecological function and behaviour, using the broad criteria set out in Table 11.2. The judgement takes account of information available on the responses of birds to various stimuli (e.g. predators, noise and disturbance by humans). Behavioural sensitivity can differ even between similar species (Schueck et al. 2001) and within a particular species some populations and individuals may be more sensitive than others, and sensitivity may change over time. Therefore the behavioural responses of birds are likely to vary with both the nature and context of the stimulus and the experience and 'personality' of the bird. Sensitivity also depends on the activity of the bird. For example, a species is likely to be less tolerant of disturbance whilst breeding than at other times, and tolerance is likely to increase as breeding progresses (Holthuijzen 1985). As a result of these ambiguities species sometimes span more than one category of sensitivity.

[1] This apparently arbitrary value was chosen because the Development occupies an area approximately 10% the size of the Shetland Isles.

Table 11.2: Determining Factors for Behavioural Sensitivity

Sensitivity	Definition
High	Species or populations occupying habitats remote from human activities, or that exhibit strong and long-lasting reactions to disturbance events. Species that for reasons of morphology and/or behaviour are relatively vulnerable to collision.
Moderate	Species or populations that appear to be warily tolerant of human activities, or exhibit short-term reactions to disturbance events. Species that are moderately vulnerable to collision.
Low	Species or populations occupying areas subject to frequent human activity and exhibiting mild and brief reaction (including flushing behaviour) to disturbance events. Species that are at low risk of collision.

Effects on each bird species present are judged in terms of magnitude in space and time (Regini 2000). There are five levels of spatial effect (Table 11.3) and four levels of temporal effect (Table 11.4).

Table 11.3: Scales of Spatial Magnitude on Receptor Species

Magnitude	Definition
Very high	Total/near total loss of a bird population due to mortality or displacement. Total/near total loss of breeding productivity in a bird population due to disturbance. Guide: >80% of regional population affected; 21-80% of national population affected
High	Major reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: 21-80% of regional population affected; 6-20% of national population affected
Moderate	Partial reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: 6-20% of regional population affected; 1-5% of national population affected
Low	Small but discernable reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: 1-5% of regional population affected; < 1% of national population affected
Negligible	Very slight reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the “no change” situation. Guide: < 1% regional population affected; no discernable effect on national population

Note: guidelines assume that effects are adverse.

Table 11.4: Scales of Temporal Magnitude

Magnitude	Definition
Permanent	Effects continuing indefinitely beyond the span of one human generation (taken as approximately 25 years), except where there is likely to be substantial

	improvement after this period (e.g. the replacement of mature trees by young trees which need >25 years to reach maturity, or restoration of ground after removal of a development. Such exceptions can be termed long term effects).
Long-term	Approximately 15 - 25 years or longer (see above)
Medium-term	Approximately 5 – 15 years
Short-term	Up to approximately 5 years

The Development is not located within, or in close proximity to, areas of designated European importance for birds (SPAs). Moreover, there is no expectation that birds forming part of the qualifying interest of SPAs visit the development site on a regular basis. Therefore it is not considered likely that the Development would have a significant effect on SPA interests.

In view of the above, the magnitude of likely effects on the Wider Countryside ornithological interest is assessed. These effects are evaluated at the regional scale using an appropriate ecological unit, taken to be the Shetland Natural Heritage Zone (NHZ), as defined by SNH (2000). Exceptionally, the number of birds present within the region may represent most or all of the national or world populations. In these cases, magnitude is judged at the regional and appropriate higher scales. For example, predicted effects on 1% of the national population of a species would be deemed of moderate magnitude, whilst a similar level of effect on its global population would be deemed high magnitude. In making judgements on effects magnitude, consideration is given to the population status, trends and distribution of the potentially affected species, following the principals set out in SNH guidance (SNH 2006). Crucial to this evaluation is whether or not the conservation status of a species is favourable (in terms of the robustness or fragility of its population and the adequacy of its supporting habitats), and whether the proposal would add substantially to the difficulty of taking action to reverse any decline and enable the species to achieve favourable conservation status.

11.6.4 Methods used to Determine Significance of Effects

In accordance with the EIA Regulations, each possible effect is evaluated and classified as either significant or not significant. The significance of potential effects is determined by integrating the scales of *nature conservation importance* and *effects magnitude* in a reasoned way. In making judgements on significance, consideration is given to national and regional trends within potentially affected populations. Detectable changes in regional populations of nature conservation importance are automatically considered to be fundamental effects and therefore significant under the EIA Regulations (i.e. no distinction is made between differing levels of significance). Non-significant effects include all those which are likely to result in non-detectable changes in regional (and therefore national) bird populations.

If a potential effect is determined to be significant, measures to avoid, reduce or remedy the effect are suggested wherever possible.

11.7 BASELINE DESCRIPTION

Baseline ornithological studies commenced in April 2003 and are ongoing. Full details of the surveys are given in Technical Appendix 11.1. A summary of findings relevant to the Development is set out below. The development site comprises four discrete quadrants: Collafirth (NE), Nesting (SE), Kergord (SW) and Delting (NW) (see Figure 1.1). For the purposes of this description the bird interest in the northern and southern parts of the Nesting quadrant is reported separately.

11.7.1 Red-throated Diver

Allowing for inter-annual variation, approximately 30 pairs of red-throated diver breed within 1 km of the proposed turbines, tracks and other features of site infrastructure[1] (Confidential Fig. 11.1). This represents 2.4% of the UK breeding population and 7.4% of the Shetland breeding population. The 41 freshwater lochs used by these pairs for breeding (nesting and chick-rearing) in 2003-08 are located mostly in the Nesting, Kergord and Delting quadrants:

Quadrant	Breeding lochs
Delting	10
Collafirth	4
Kergord	10
Nesting (N)	7
Nesting (S)	10
Total	41

Divers bred as close as 265 m to the nearest proposed turbine (Fig. 11.1), although most were located further away as a result of design iterations to reduce disturbance effects (refer to Chapter 4: Development Description); six breeding lochs were located within 350 m and 12 within 450 m (Confidential Fig. 11.1; also, refer to Technical Appendix 11.1: Confidential Annex Map C3).

Breeding red-throated divers flew to coastal waters to feed, generally using the most direct route possible. Breeding pairs were estimated to make 13.3 flights per day (outbound / inbound foraging flights and other flights) during the incubation period, rising to 24.4 flights per day during the chick rearing period (refer to Appendix 11.1: Table 50). Some flights crossed the Development, although design modifications sought to ensure that the proposed turbines were not located in areas of predicted heavy use.

The development site and immediate surrounding area also supports a strong population of non-breeding red-throated divers, estimated to comprise approximately one third of the adult-plumage individuals present in spring and summer. Seven freshwater lochs within 1 km of the Development, additional to those used for breeding, were identified as important gathering sites for non-breeding divers (Fig. 11.2: also, refer to Technical Appendix 11.1: Confidential Annex Map C4). Flight activity levels by non-breeding birds were high, typically exceeding those of breeding birds in the immediate vicinity (<500 m) of breeding lochs. In addition to feeding flights between gathering lochs and coastal waters,

[1] Including temporary features such as construction compounds and borrow pits

non-breeding birds frequently visited breeding lochs, typically circling repeatedly around the loch.

Overall, flying red-throated divers were recorded 573 times during 1424 hours of generic vantage point (VP) observation[1], and a further 1899 times during 1560 hours of observation focussed on freshwater lochs (945 hours overlooking breeding lochs; 615 hours overlooking non-breeding lochs and other selected locations). Flight intensity varied across the site, with the greatest concentration in the Delting quadrant and selected parts of Collafirth, Nesting and Kergord (Fig. 11.3). Data from generic VP watches indicated that approximately 67% of flight activity was 30 m to 150 m above the ground, corresponding to the Rotor Swept Height (RSH) of the proposed turbines (refer to Appendix 11.1: Table 26).

11.7.2 Whooper Swan

A pair of whooper swan breeds, less than annually, at a freshwater loch approximately 750 m from the proposed turbines, tracks and other features of site infrastructure (see Technical Appendix 11.1: Confidential Annex). The pair represents approximately 20% of the UK breeding population and one third of the Shetland population.

No whooper swans flights were recorded during 1374 hours of generic VP observation covering the calendar year.[2]

The site does not appear to lie on a route used regularly by migratory swans, or wintering swans making local movements. Thus, only one flight, involving four whooper swans, was recorded during 524 hours of migratory VP observations in spring and autumn 2005-06 (362 hrs overlooking the western part of the development site and 162 hrs covering the eastern part). The swans flew at 15-40 m above the ground, i.e. for the most part were below the RSH of the proposed turbines.

Small numbers of migrant and wintering whooper swan use various lochs and pasture fields adjacent to the proposed Development. These birds are present from October to April, with peak numbers in March and April when up to 12 birds are present. Potential whooper swan sites were surveyed on 34 dates stratified across the winter of 2005-06 (refer to Technical Appendix 11.1: Tables 11 and 32). This showed that six sites within 750 m of the proposed turbines, tracks and other features of site infrastructure were used by swans. The monthly maxima for this sub-set of lochs ranged from 0-12 birds (mean = 5.9). With the exception of Mill Loch (Delting quadrant), the sites are broadly located along Pettadale, i.e. between the Kergord and Nesting quadrants. All except one site are within 200 m of regularly used public roads.

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[1] Note that the number of hours of generic VP observation quoted for red-throated diver is greater than for other species. This is because data for a larger area (and therefore greater number of VPs) were used in the case of divers. For all other species only data for VPs overlooking the development site were included. It is recognised that the summary statistics for diver flight activity given in the Baseline Description will differ slightly from values that would have been obtained employing a more restricted area, covering just the development site. However, this difference is unimportant since, unlike almost all of the other potentially affected species present, divers do not forage in flight and therefore the only relevance of flight activity metrics is to inform the assessment of collision risk. In the current evaluation, diver collision risk was determined from measures of flight activity within the development site at a resolution of 200 x 200 m, in preference to using conventional (and less precise) values representing the mean flight activity recorded from each VP.

[2] Data for VPs overlooking the development site.

11.7.3 Greylag Goose

Greylag geese are resident breeders, passage migrants and winter visitors. However, few birds are present within the development site during the winter. Approximately 49 pairs of greylag geese breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.4). This represents 0.1% of the UK breeding population and 39% of the Shetland breeding population. However, the apparent regional importance of this species is almost certainly an artefact of the greater level of survey effort within the development site compared with other parts of Shetland. An island wide survey in 1999 (Pennington 2000) indicated that Central Mainland (including the development site) held about 11% of Shetland total. This is almost certainly a more reliable indication of their relative abundance. Breeding greylag geese on Shetland are colonists from Iceland, as opposed to birds belonging to the native Scottish population (Pennington et al 2004).

The breeding territories are located mostly in the Delting quadrant:

Quadrant	Territories
Delting	20
Collafirth	5
Kergord	11
Nesting (N)	8
Nesting (S)	5
Total	49

Eighteen territory centres were located within 250 m of the proposed turbines, including some as close as 60 m.

During 1374 hours of generic VP observation flying greylag geese were recorded for 1.0% of the time (0.9% after correction for monthly variation in observation effort).[1] The recorded activity varied seasonally, from a low of less than 0.5% in winter (September-February), to a approximately 1.2% during the period March-August. Approximately 60% of flight activity was at the RSH of the proposed turbines. Detection trials indicated that less than half of flights by greylag geese beyond 1 km were detected by observers (refer to Technical Appendix 11.1). Allowing for this bias, the mean annual flight activity at RSH was estimated to be 468 bird secs/ha/yr.

During an additional 524 hours of VP observation to detect movements by migratory wildfowl and waders, 18 greylag goose flights (7 in spring, 11 in autumn), involving a total of 217 birds, were seen (refer to Technical Appendix 11.1: Tables 27 and 28). No regular flight corridors were apparent. Half of the recorded flights were estimated to be at the RSH of the proposed turbines. It was unclear if the greylags seen during these watches were local breeders or migrants from further north, or a mixture of both.

11.7.4 Hen Harrier

Hen harriers are scarce migrants and rare (less than annual) winter visitors. Exceptionally, in the winter of 2005-06 at least three hen harriers roosted communally adjacent to the development site, with a maximum of two harriers present on any one date. The roost site is approximately 375 m from the A970 trunk road and nearest proposed access track, and over 1 km from the nearest proposed turbine (see Technical Appendix 11.1: Confidential Annex). Intensive observations focussed on the roost indicated that the birds did not arrive from, or disperse towards, areas occupied by the proposed turbines. Birds typically flew less than 10 m above the ground when foraging, although in the vicinity of the roost a small number of flights were at the RSH of the proposed turbines.

Hen harriers were observed just eight times during generic VP observations (refer to Technical Appendix 11.1: Table 22b). Flying birds were recorded for 0.05% of the time. All records were during the non-breeding period.

11.7.5 Merlin

Merlins are mostly breeding visitors and passage migrants. A small number use the development site in winter. In recent years (2005-08), up to nine pairs of merlin have bred within 2 km of the proposed turbines, tracks and other features of site infrastructure (Confidential Fig. 2). This represents 0.7% of the UK breeding population and 45% of the Shetland breeding population. Ten discrete breeding territories have been used during this time, located in the Delting, Kergord and Nesting quadrants:

Quadrant	Territories
Delting	5
Collafirth	0
Kergord	2
Nesting (N)	0
Nesting (S)	3
Total	10

Most of these territories are peripheral to the development site (see Technical Appendix 11.1: Confidential Annex), perhaps because merlins favour locations close to the interface between moorland and farmland habitats. Previous to baseline survey work, merlins are reported to have bred in six additional territories within the 2 km buffer since the mid-1980s. One, perhaps two, of these territories was apparently occupied by a single adult each year, 2005-08.

Baseline surveys indicate that two pairs of merlin, located in Territories C and K, routinely breed within 500 m of the proposed turbines. The nest sites used by these pairs varied between years, such that they were located 201-300 m and 322-430 m, respectively, from the nearest proposed turbine (mean distances: Territory C = 237 m; Territory K = 358 m). Other merlin territories are located further away from the Development, partly as a result of design iterations to reduce possible adverse effects (refer to Chapter 4: Development Description).

The annual breeding success of pairs within the 2005-08 survey area varied from 2.3 to 3.6 well-grown chicks per breeding pair (refer to Technical Appendix 11.1: Table 57). Mean breeding success in Territories C and K over this period was 4.3 and 3.5 chicks per pair (n = 4), respectively.

Merlins were recorded in flight 30 times for a total of 1527 seconds during 1374 hours of generic VP observation overlooking the development site. Approximately 31% of this activity was at the RSH of the proposed turbines. Merlins are particularly difficult to detect due to their relatively small size, fast flight and low elevation above the ground (Madders & Whitfield 2006). Unsurprisingly, therefore, the results of distance detection trials indicated that less than 40% of the merlin flight activity that occurred further than 750 m from an observer was detected, and that it was unusual for any activity beyond

1250 m away to be detected (refer to Technical Appendix 11.1: Table 25). Allowing for this bias, mean annual flight activity at RSH was estimated to be 16 bird secs/ha/yr. A further 68 flights totalling 2857 seconds were recorded during 33 hours of additional observation focussed on six breeding attempts (refer to Technical Appendix 11.1: Table 54). These data indicated that much greater levels of flight activity occurred close to the nest, with an estimated 1263 adult secs/ha/yr at RSH within 200m of the nest.

Flight activity within the development site varied spatially between years, according to the occupancy and success of breeding territories. Overall, the data indicate that, away from their nest sites, merlins were not particularly active within areas occupied by the proposed turbines (Fig. 11.5). This is probably because merlins spend most time foraging in low-lying moorland and farmland habitats peripheral to the Development.

11.7.6 Red Grouse

Red grouse are resident breeders, present within the development site all year. Approximately 18 pairs of red grouse breed within 250 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.6). This represents less than 0.1% of the UK breeding population but approximately 20% of the Shetland breeding population. However, the apparent regional importance of this species is almost certainly an artefact of the greater level of survey effort within the development site compared with other parts of Shetland. The breeding territories are located mostly in the Kergord and Delting quadrants:

Quadrant	Territories
Delting	4
Collafirth	1
Kergord	7
Nesting (N)	3
Nesting (S)	3
Total	18

Nine territory centres were located within 250 m of the proposed turbines. Flying red grouse were recorded for approximately 0.1% of generic VP observation time.

11.7.7 Golden Plover

Most golden plovers are either breeding visitors or passage migrants and few birds, if any, are present within the development site during the winter (a few remain on the moors until November and small numbers are present again from February).

Approximately 90 pairs of golden plover breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.7). This represents 0.4% of the UK breeding population and 6.2% of the Shetland breeding population. The breeding territories are located mostly in the Delting and Kergord quadrants:

Quadrant	Territories
Delting	29
Collafirth	2
Kergord	35
Nesting (N)	12
Nesting (S)	12

Total	90

Twenty-four territory centres were located within 250 m of the proposed turbines, with the nearest as close as 50 m.

During 1374 hours of generic VP observation overlooking the development site flying golden plover were recorded for 3.9% of the time (2.4% after correction for monthly variation in observation effort). The recorded activity varied seasonally, from a low of less than 0.1% in winter (September-February), to 3.4% in migratory periods (March-April and August) and a peak of 6.3% during the main breeding period (May-July). Approximately 62% of flight activity was at the RSH of the proposed turbines (refer to Technical Appendix 11.1: Table 26). Detection trials indicated that less than one third of flights by golden plovers beyond 500 m were detected by observers (refer to Technical Appendix 11.1: Table 25). Allowing for this bias, the mean annual flight activity at RSH was estimated to be 3496 bird secs/ha/yr.

11.7.8 Lapwing

Lapwings are mostly breeding visitors to the development site, present during the period February-October. Approximately 65 pairs of lapwing breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.8). This represents less than 1% of the UK breeding population and 3.7% of the Shetland breeding population. The breeding territories are located mostly in the Kergord, Nesting and Delting quadrants:

Quadrant	Territories
Delting	11
Collafirth	6
Kergord	25
Nesting (N)	9
Nesting (S)	14
Total	65

Five territory centres were located within 250 m of the proposed turbines, with the nearest as close as 140 m.

Flying lapwings were recorded for 4.8% of generic VP observation time (3.6% after correction for monthly variation in observation effort)[1], mainly during the period May-July.

11.7.9 Dunlin

Most dunlins are breeding visitors and few birds, if any, are present within the development site outside the period May-July. Approximately 57 pairs of dunlin breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.9). This represents 0.6% of the UK breeding population and 3.4% of the Shetland breeding population. The breeding territories are located mostly in the Kergord and Nesting quadrants:

Quadrant	Territories
Delting	9
Collafirth	2
Kergord	19

Nesting (N)	13
Nesting (S)	14
Total	57

Twenty-five territory centres were located within 250 m of the proposed turbines, with the nearest as close as 50 m.

Flying dunlins were recorded for 0.3% of generic VP observation time (0.1% after correction for monthly variation in observation effort)[1], almost all of which was recorded during the main breeding period (May-July). Approximately 22% of flight activity was at the RSH of the proposed turbines (refer to Technical Appendix 11.1: Table 26). Detection trials indicated that less than one fifth of flights beyond 125 m were detected by observers (refer to Technical Appendix 11.1: Table 25). Allowing for this bias, the mean annual flight activity at RSH was estimated to be 837 bird secs/ha/yr.

11.7.10 Curlew

Most curlews are breeding visitors to the development site and few birds, if any, are present outside the period March-August. Approximately 227 pairs of curlew breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.10). This represents 0.2% of the UK breeding population and 6.6% of the Shetland breeding population. However, the apparent importance of these species within a regional context may be an artefact of greater survey effort within the development site compared with other parts of Shetland. The breeding territories are located mostly in the Delting, Kergord and Nesting quadrants:

Quadrant	**Territories**
Delting	68
Collafirth	18
Kergord	83
Nesting (N)	15
Nesting (S)	43
Total	227

Seventy-one territory centres were located within 250 m of the proposed turbines, with the nearest as close as 50 m.

Flying curlew were recorded for 16.8% of generic VP observation time (10.7% after correction for monthly variation in observation effort)[1], almost wholly recorded during the breeding period March-August. Based on a small sample of observations from detection trials it was estimated that less than 3% of flights beyond 1 km were detected by observers (refer to Technical Appendix 11.1). Assuming this is an accurate reflection of bias, mean annual flight activity at RSH is approximately 1475 bird secs/ha/yr.

11.7.11 Whimbrel

Whimbrels are breeding visitors and passage migrants, present within the development site during the period April-August. Approximately 40 pairs of whimbrel breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.11). This represents approximately 7.5% of the UK breeding population and 8.4% of the Shetland breeding population, based on the most recent comprehensive survey data. However, whimbrel numbers appear to have declined rapidly in some parts of Shetland since the last comprehensive surveys in the late 1980s and early 1990s (M. Grant, pers. comm.). Consequently, the development site probably supports a greater proportion of the regional and national breeding populations than these figures suggest and therefore caution is required when evaluating the magnitude of any population impacts.

The breeding territories are located mostly in the Kergord and Nesting quadrants:

Quadrant	Territories
Delting	8
Collafirth	2
Kergord	16
Nesting (N)	3
Nesting (S)	11
Total	40

Thirteen territory centres were located within 250 m of the proposed turbines, with the nearest as close as 60 m.

Flying whimbrels were recorded for 1.2% of generic VP observation time (0.7% after correction for monthly variation in observation effort)[1]. The recorded activity varied from 0.2% in migratory periods (March-April and August) to 2.6% during the breeding period (May-July). Approximately 41% of flight activity was at the RSH of the proposed turbines (refer to Technical Appendix: Table 26). Detection trials indicated that less than one quarter of flights beyond 500 m were detected by observers (refer to Technical Appendix 11.1: Table 25). Allowing for this bias, the mean annual flight activity at RSH was estimated to be 583 bird secs/ha/yr.

11.7.12 Black-tailed Godwit

Black-tailed godwit is a rare breeding summer visitor to the development site. A pair probably bred in the Nesting quadrant in 2007 and 2008, at locations approximately 590 m and 1.3 km, respectively, from the nearest proposed turbine, track or other feature of site infrastructure. One pair represents approximately 2% of the UK breeding population and one third of the Shetland breeding population. No flight activity by this species was recorded during the timed VP watches.

11.7.13 Arctic Tern

Arctic terns are breeding visitors, present within the development site during the period May-August. During baseline surveys, 12 pairs of arctic tern bred in three colonies within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.12). This represents less than 0.1% of the UK and Shetland breeding populations. The breeding territories are located mostly in one coastal colony in the Delting quadrant:

Quadrant	Territories
Delting	11
Collafirth	0
Kergord	0
Nesting (N)	1
Nesting (S)	0
Total	12

Arctic terns nested as close as 490 m to the nearest proposed turbine.

Flying arctic terns were recorded for 0.6% of generic VP observation time (0.3% after correction for monthly variation in observation effort)[1]. Almost all recorded activity was during the period May-July.

11.7.14 Arctic Skua

Arctic skuas are breeding visitors, present within the development site during the period April-August. Approximately 30 pairs of arctic skua breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.13). This represents 1.4% of the UK breeding population and 2.7% of the Shetland breeding population. The breeding territories are located mostly in the Kergord and Nesting quadrants:

Quadrant	Territories
Delting	3
Collafirth	3
Kergord	12
Nesting (N)	2
Nesting (S)	10
Total	30

Twelve territory centres were located within 250 m of the proposed turbines, with the nearest as close as 80 m.

Flying arctic skuas were recorded for 3.0% of generic VP observation time (1.7% after correction for monthly variation in observation effort)[1]. The recorded activity varied from 1.0% during March-April and August to 6.0% during the main breeding months (May-July). Approximately 32% of flight activity was at the RSH of the proposed turbines (refer to Technical Appendix 11.1: Table 26). Detection trials indicated that less than one half of flights beyond 750 m were detected by observers (refer to Technical Appendix 11.1: Table 25). Allowing for this bias, the mean annual flight activity at RSH was estimated to be 452 bird secs/ha/yr.

11.7.15 Great Skua

Great skuas are breeding visitors, present within the development site during the period March-September. Approximately 53 pairs of great skua breed within 500 m of the proposed turbines, tracks and other features of site infrastructure (Fig. 11.14). This represents 0.6% of the UK breeding population and 0.8% of the Shetland breeding population. Shetland supports 43% of the world's breeding great skua, meaning that the development site holds 0.3 % of the global population.

The breeding territories are located mostly in the Delting, Kergord and Nesting quadrants:

Quadrant	Territories
Delting	11
Collafirth	2
Kergord	15
Nesting (N)	8
Nesting (S)	17
Total	53

Twenty-three territory centres were located within 250 m of the proposed turbines, with the nearest as close as 80 m.

Flying great skuas were recorded for 12.8% of generic VP observation time (8.6% after correction for monthly variation in observation effort)[1]. Approximately 54% of flight activity was at the RSH of the proposed turbines (refer to Technical Appendix 11.1: Table 26). Detection trials indicated that less than half of flights beyond 1000 m were detected by observers (refer to Technical Appendix 11.1: Table 25). Allowing for this bias, the mean annual flight activity at RSH was estimated to be 3266 bird secs/ha/yr.

11.7.16 Other Species

Approximately 750 pairs of skylark breed within 250 m of the proposed turbines, tracks and other features of site infrastructure. This represents less than 0.1% of the UK breeding population and approximately 3.6% of the Shetland breeding population. The breeding territories are located mostly in the Nesting, Kergord and Delting quadrants.

Approximately 195 pairs of snipe breed within 500 m of the proposed turbines, tracks and other features of site infrastructure. This represents less than 0.3% of the UK breeding population and approximately 5.7% of the Shetland breeding population. The breeding territories are located mostly in the Delting and Kergord quadrants.

The site does not appear to lie on an important flyway for migratory geese. Barnacle geese occasionally pass over the site, e.g. two birds in March 2005. Three small flocks of pink-footed geese, totalling 53 birds, flew over the site during 524 hours of VP observation focussed on migratory wildfowl and waders. All flights were in the autumn and none was at the RSH of the proposed turbines

Very small numbers of scarce migrants occur annually, for example a little egret in October 2003, marsh harrier in May 2006, honey buzzard in September 2005, hobby in August 2005 and June 2007, red-footed falcon in June 2006, gyr falcon in March 2005 and short-eared owl in May 2006. Osprey, peregrine and short-eared owls probably occur annually, for short periods. These occurrences are remarkable but have little ecological consequence.

11.7.17 Information Gaps

There are no significant information gaps in respect of the baseline data. However, intensive surveys of selected areas (in this case the development site) inevitably expose gaps in our knowledge of the wider area, where survey work is generally less complete and/or contemporary. Without care this can result in spurious importance being attached to the site populations of some populations (e.g. greylag geese). The most obvious deficiency of this type is the lack of contemporary information relating to the size of the UK and Shetland whimbrel population.

11.8 PRE-COMMENCEMENT SURVEYS

Surveys to locate breeding attempts and winter roosts[1] of birds listed on Schedule 1 of the WCA would be undertaken prior to the start of construction work. If it is judged that construction activities are likely to disturb the nesting / roosting routines, or chick

[1] Applicable to hen harrier only

survival, of these birds, then appropriate exclusion zones or other mitigation procedures would be agreed with SNH.

11.9 PROJECT ASSUMPTIONS AND OPERATIONAL CONSTRAINTS

Construction of the site access tracks, turbine hard standings, site compound and control station(s), and erection of the turbines is predicted to commence in late spring and last five years. The construction programme requires some winter working, when conditions allow.

Prior to construction works commencing, sections of the site access routes adjacent to non-breeding lochs used by red-throated divers would be defined as sensitive zones in which no pedestrian access would be permitted and vehicular traffic would be prohibited from stopping. Signage to demarcate these sensitive zones would be established immediately following construction of the relevant section of track. All construction personnel would be instructed in the importance of complying with this measure, which would be supervised by the Ecological Clerk of Works (ECoW).

All electrical cabling between the proposed turbines and the site substations would be underground and follow existing roads and tracks. Connection between the substations and the converter station in Upper Kergord would be mainly underground except for a proposed wooden pole mounted section of cable which follows an existing pole mounted cable route along the A970 in Petta Dale. The connection between the converter station and the electrical grid is the subject of a separate planning application with an associated Environmental Statement. Please see Chapter 4: Development Description for further details.

Eleven permanent meteorological masts would be constructed. These would be of lattice tower construction with diagonal struts to discourage perching birds (see Chapter 4 and Figure 4.7). In the event that temporary masts require the use of supporting guys these would be fitted with bird diverters of standard industry design[1] to reduce the likelihood of bird collisions.

A programme of habitat management would be undertaken as described in the Habitat Management Plan (refer to Appendix 10.9). The Habitat Management Plan is aimed at restoring blanket bog and other habitats, initially restricted to a 10 km^2 area in the north east of the Nesting quadrant.

11.10 IMPACT ASSESSMENT

11.10.1 Evaluation of Nature Conservation Importance

The nature conservation importance of species potentially affected by the proposals was determined using criteria set out in Table 11.1. These include 20 species of high importance and six of moderate importance (Table 11.5).

[1] In recognition of the extremely high wind speeds in Shetland, diverters would be attached to the guy wires using the most robust method practicable.

Table 11.5: Nature Conservation Importance of Potentially Affected Species

Species	Reason for classification	Importance
Red-throated diver	Anne11.1	High
Little egret		
Whooper swan		
Barnacle goose		
Hen harrier		
Marsh harrier		
Honey buzzard		
Osprey		
Hobby		
Merlin		
Red-footed falcon		
Gyr falcon		
Peregrine		
Golden plover		
Dunlin (*schinzii*)		
Arctic tern		
Short-eared owl		
Whimbrel	Schedule 1	
Black-tailed godwit		
Arctic skua	Nationally important breeding population	
Red grouse	UK BAP	Moderate
Lapwing		
Curlew		
Skylark		
Great skua	Restricted global distribution	
Greylag goose	Regionally important breeding population	
All other species		Low

11.10.2 Behavioural Sensitivity

Little egret, barnacle goose, marsh harrier, honey buzzard, osprey, hobby, red-footed falcon, gyr falcon, peregrine and short-eared owl visit the area very infrequently and it is highly unlikely that the proposed Development could have a material effect on their populations. Similarly, black-tailed godwits breed too far from the Development for adverse effects to be plausible. In view of the above, potentially adverse effects on these species are not considered further.

Skylarks are widespread and numerous throughout suitable habitat in Shetland and the numbers present within the proposed development area are not considered to be regionally important. Moreover, there is no evidence to suggest a decline in numbers or change in distribution of breeding birds following windfarm construction (Shepherd 2002, 2003). Therefore potential effects on this species are not considered further.

Greylag geese are numerous throughout suitable habitat in Shetland, and increasing in number (Pennington et al 2004). Therefore potential effects on this species are not considered further.

The behavioural sensitivity of the remaining species listed in the baseline description was determined using criteria set out in Table 11.2. Four species were judged to have high sensitivity, eight to have moderate sensitivity and one to have low sensitivity (Table 11.6).

Table 11.6: Behavioural Sensitivity of key species at proposed Viking Windfarm

Species	Nature of sensitivity	Sensitivity level
Red-throated diver	Birds potentially vulnerable to collision with turbines when making flights between freshwater lochs and the sea (all birds), and between/around freshwater lochs (non-breeding birds). Breeding birds sensitive to human activity, visual disturbance and sudden noise events over large distances (~400 m).	High
Whooper swan	Birds potentially vulnerable to collision with turbines when migrating or making short distance movements between feeding sites. Breeding birds sensitive to human activity, visual disturbance and sudden noise events over moderate distances (~250 m).	
Merlin	Breeding birds potentially vulnerable to collision with turbines when displaying and mobbing avian intruders. Breeding birds sensitive to human activity, visual disturbance and sudden noise events over large distances (~500 m). However, individuals appear to tolerate moderate levels of disturbance in some situations.	
Hen harrier	Roosting birds potentially vulnerable to collision with turbines when gathering / interacting prior to roosting. Roosting birds sensitive to human activity, visual disturbance and sudden noise events over large distances (~500 m).	
Golden plover Lapwing Dunlin Curlew Whimbrel Arctic tern Arctic skua Great skua	Birds potentially vulnerable to collision with turbines when displaying, mobbing avian intruders, commuting between breeding and feeding areas and migrating. Breeding birds sensitive to human activity, visual disturbance and sudden noise events over moderate distances (~250 m).	Moderate
Red grouse	Birds at little risk of collision due to low flying habits. Breeding birds sensitive to human activity, visual disturbance and sudden noise events over short distances (~100 m).	Low

11.10.3 Potentially Significant Effects

Potentially significant effects are evaluated in respect of species of high and moderate nature conservation importance.

With the exception of hen harrier, effects on these species are likely to be greatest during the breeding period (typically, April – August). Potentially significant effects on passage migrants are likely in the case of whooper swan and golden plover only. Potentially significant effects on wintering birds are likely in the case of whooper swan and hen harrier only.

Based on the abundance and distribution of the species present, the principal sensitive receptors are considered to be: red-throated diver, merlin, golden plover, dunlin, curlew, whimbrel, arctic skua and great skua.

11.10.4 Land Take Effects

The total land-take by the wind turbine bases, access tracks, site substation, converter station and ancillary infrastructure would result in the permanent loss of a very small proportion of the overall site's habitat (less than 1.5%; see Chapter 4: Development Description). Based on the mean densities of birds within 500 m of the proposed site infrastructure, direct habitat loss is predicted to result in the loss of approximately three pairs of golden plover, two pairs of dunlin, one pair of whimbrel, six pairs of curlew, one pair of arctic skua and two pairs of great skua. No pairs of red-throated diver or merlin are predicted to be lost. The magnitude of effects on birds due to these relatively small losses is considered to be **low**. Even in the case of the species present that are of highest nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

The loss of blanket bog and moorland habitat to windfarm infrastructure is unavoidable. Although the consequences of this loss on birds are unlikely to be significant (see above), it is considered highly desirable, and consistent with best practice, to ameliorate any adverse effects by managing habitat in the immediate vicinity (within 0.5 km) of the development and further afield (up to several kilometres) (see Chapter 10: Ecology, and Appendix 10.9: Habitat Management Plan). Much of the blanket bog and other moorland habitats are currently in poor condition due to heavy grazing and extensive peat erosion. As a result, the development site almost certainly supports smaller populations of 'specialist' moorland birds than would be the case if the habitats were in better condition. Moreover, the current populations of some species (e.g. red-throated diver and dunlin) are likely to be unsustainable if habitat quality deteriorates further due to continuing peat erosion. Drawing on the considerable practical expertise from elsewhere in the UK with respects to peatland restoration, the proposed management seeks to reduce the effects of habitat loss by restoring, and sustaining in good condition, nearby areas of peatland. This, in turn, would enable higher densities of key bird species to be supported. It is envisaged that the area of restored habitat would be several times the size of the area lost to development infrastructure.

11.10.5 Habitat Modification

Construction of the Development, in particular the access tracks, is predicted to result in localised hydrological change in the peatland habitats that support breeding populations of merlin, golden plover, dunlin, whimbrel and curlew.

The tracks servicing the development have been designed to have neutral or beneficial effects[1] on the site hydrology where possible (refer to Chapter 14: Soil and Water). However, recognising the potential for some adverse effects to occur, it was assumed for the purposes of this analysis that up to 50% of the route traversed by the tracks would be affected due to the drying out of peatland (blanket bog) habitat (see Chapter 10: Ecology). Potential effects are predicted to extend to a maximum of 20 m either side of the affected sections of track, i.e. a total of approximately 236 ha, representing <1.5% of the development site. Habitat management would be implemented to limit the likelihood of peat erosion in these areas (see Chapter 14). The effects on birds would be ameliorated by management to enhance the value of approximately 1000 ha of habitat (refer to Appendix 10.9: Habitat Management Plan), including 'wetting-up' areas of blanket bog to counteract existing trends towards peat erosion. These changes would increase the capacity of the area to support dunlin and other breeding waders (shorebirds).

(a) Red-throated Diver

The development is not predicted to change the physical characteristics of lochs used by red-throated divers. There is a small risk of increased sediment loads in running waters (refer to Chapter 14: Soil and Water), which could result in additional sediment being deposited in the larger lochs, including some used by non-breeding divers. However, this is unlikely to materially affect their use by divers and the magnitude of any adverse effect would be **negligible**.

(b) Merlin

Merlins prefer to nest in tall (>0.4 m) heather. The availability of tall heather appears to have declined over much of Central Shetland, including some merlin territories that have been unoccupied in recent years, presumably due to heavy grazing by sheep. Management that seeks to reverse this decline would be undertaken as part of the development (see Chapter 10: Ecology, and Appendix 10.9: Habitat Management Plan) and therefore any effects on breeding merlins are likely to be positive. Breeding merlins have large foraging territories and the proportion potentially affected by habitat modification is negligible. Furthermore, merlins prey on small song bird species (principally meadow pipit and skylark), which are likely to be unaffected by habitat modification as a result of the development. Overall, the magnitude of any adverse effects on merlin due to habitat modification would be **negligible**.

(c) Golden Plover

Golden plover do not appear to be particularly sensitive to localised reductions in the water table, or even moderate peat erosion. Indeed, breeding golden plover use many types of moorland habitat including dry areas and show a preference for short vegetation

[1] Benefical effects include measures to impede drainage.

(Whittingham et al 2000, Pearce-Higgins and Grant 2006) Therefore the magnitude of any adverse effects on golden plover due to habitat modification would be **negligible**.

(d) **Dunlin**

Breeding dunlins are closely associated with areas of wet blanket bog containing pools, typically found on the flat summits and saddles of the hills. Such conditions develop where the water table is high, and the habitat is therefore highly sensitive to changes that result in increased drainage. Based on the mean density of breeding birds within 250 m of the proposed site infrastructure, it is estimated that habitat modification would result in the potential loss of two pairs of dunlin, at most. These potential losses would be more than offset by a combination of measures aimed at impeding surface drainage, i.e. those incorporated in the design construction of the access tracks (see 14: Soil and Water), and restorative habitat management measures to 're-wet' areas of surrounding eroded blanket bog (see Appendix 10.9: Habitat Management Plan). Dunlins have relatively small territories (typically ~.0.3 km^2) therefore relatively small patches of enhanced habitat would potentially support many breeding pairs. Overall, the magnitude of likely adverse effects on dunlin due to habitat modification would be **negligible**.

(e) **Whimbrel and Arctic Skua**

Breeding whimbrel and arctic skua in the Central Mainland of Shetland appear to prefer moderately elevated locations in valleys and adjacent slopes. The habitat preferences of these species are as yet poorly understood; studies of whimbrel on Shetland showed that whereas heather clad hummocks on heathland were preferred for nesting, wetter mire habitat were more often used during the chick rearing stage (Grant 1992, Grant et al 1992). Based on the mean density of breeding within 500 m of the proposed site infrastructure, it is estimated that habitat modification would result in the potential loss of approximately one pair each of whimbrel and arctic skua. Overall, it seems reasonable to assume that the magnitude of likely adverse effects on whimbrel and arctic skua due to habitat modification would be **negligible**.

(f) **Curlew**

Curlews are a common and widespread breeding species in Central Mainland. Localised drying of peatland habitats close to the proposed access roads would potentially affect six breeding pairs. However, these effects would be limited by habitat management aimed at preventing the drying process leading to peat erosion. Curlew would benefit from more widespread measures to 're-wet' eroded peatland habitats, described in Appendix 10.9: Habitat Management Plan. Overall, it is considered that the magnitude of likely adverse effects on curlew due to habitat modification would be **low**.

(g) **Great Skua**

Great skuas are evenly distributed across the higher parts of the development site, apparently irrespective of peatland condition. This species is not expected to be sensitive to the effects of localised habitat drying. Therefore, it is considered that the magnitude of likely adverse effects on great skua due to habitat modification would be **negligible.**

(h) **Other Species**

It is considered that habitat modification would have permanent adverse effects of **negligible** magnitude on all other species.

(i) **Summary**

In view of the above, it is considered that habitat modification would have permanent adverse effects of **low** or **negligible** magnitude on birds. Even in the case of the species present that are of highest nature conservation importance (red-throated diver, merlin, golden plover, dunlin, whimbrel, arctic skua; see Table 11.5) it is judged that the predicted effects would be **not significant** under the terms of the EIA Regulations.

11.10.6 Construction Disturbance

It is likely that noise and visual disturbance associated with construction activities would temporarily displace some breeding and foraging birds and disrupt the routines of others. Effects would be confined to areas in the locality of borrow pits, turbines, tracks and other site infrastructure. The consequences of construction disturbance are likely to be greatest during the period when birds breed. Birds that are disturbed at breeding sites are vulnerable to a variety of potential effects, including the chilling or predation of exposed eggs and chicks, damage or loss of eggs and chicks caused by panicked adults and the premature fledging of young. Disturbed birds may also feed less efficiently and therefore breed less successfully. These effects may lead to a reduction in the productivity and survival of bird populations.

Few attempts have been made to quantify the disturbance of birds due to activities of this type and much of the available information is contradictory. However, larger bird species, those higher up on the food chain, and those that feed in flocks in the open tend to be more vulnerable to disturbance than small birds living in structurally complex or closed habitats such as woodland (Hill et al. 1997).

(a) **Red-throated Diver**

Appropriate measures would be undertaken to avoid disturbance of nesting red-throated divers present at the time of construction works (see Pre-commencement Surveys). Therefore it is assumed that no breeding divers would be directly affected by construction activities. Disturbance at construction sites would potentially displace breeding divers from energetically efficient flyways to and from feeding areas. However, there is no evidence for such effects occurring, as evidenced by divers commonly passing directly over observers engaged in baseline surveys, and traffic using Shetland's trunk roads. Similarly, a pair that bred within 350 m of Scatsta airport was observed to make regular flights to and from the breeding loch, regardless of human and aircraft activity (D. B. Jackson, pers. obs.).

Construction works are likely to displace red-throated divers from non-breeding lochs. For the purposes of this assessment it is assumed that red-throated divers would be displaced from non-breeding lochs within 500 m of construction work sites. Baseline surveys indicate that nine non-breeding lochs within the assumed construction displacement zone are regularly used by divers, all in the Nesting and Kergord quadrants (refer to Fig. 11.2). Construction works would proceed in a phased manner across the development site and, therefore, it is unlikely that many non-breeding lochs within the assumed zone would be subject to disturbance in more than one year. Vehicular movements along the constructed tracks are likely to have few if any adverse effects on non-breeding divers due to 'soft' measures to minimise disturbance in sensitive zones (see Project Assumptions and Operational Constraints). In view of the above it is assumed that up to four non-breeding lochs would be affected in any one year. This is greater than a simple proportionate calculation (number of lochs divided by number of years) would suggest and is therefore likely to overestimate the actual number affected. Continuing on a precautionary basis, it is assumed that affected non-breeding lochs would not be used by divers during the year of disturbance. No longer-term consequences are anticipated. Non-breeding divers appear to wander widely, with most apparently showing little affinity to particular lochs (D. B. Jackson, pers. obs.). Several alternative large lochs are located in the Nesting and Kergord quadrants, more than 500 m from the proposed construction sites. Therefore, the temporary loss of up to four lochs due to construction works is unlikely to have a material effect on the non-breeding diver population.

Summarising, it is considered that construction works would have short-term adverse effects of **negligible** magnitude on red-throated diver. Although red-throated diver is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(b) **Whooper Swan**

Appropriate measures would be undertaken to avoid disturbance of nesting whooper swans present at the time of construction works (see Pre-commencement Surveys). Therefore it is assumed that no breeding whooper swans would be directly affected by construction activities.

Wintering whooper swans, and migrant birds that 'stage' on freshwater lochs and/or feed close to the proposed Development would be potentially at risk of disturbance by construction works. Wintering and migrant whooper swans frequently occupy sites within 200 m of busy public roads (see Baseline Description, above) and are therefore not obviously affected by noise of vehicular traffic. In view of this apparent habituation, it seems reasonable to assume that potentially adverse effects on whooper swans would be limited to birds occupying sites within 250 m, at most, from construction work sites. One site (Sand Water) is just within this distance. Baseline surveys indicated that up to five swans use Sand Water during winter and therefore might plausibly be affected. However, it seems reasonable to assume that disturbance caused by construction works would be secondary to that caused by traffic using the A970 and B9075 roads, which are located much closer to the loch and run along the northern and eastern shores. Even in the event that swans were displaced, it is unlikely this would have a material effect on the Shetland populations of wintering or migratory whooper swans.

In view of the above, it is considered that construction works would have short-term adverse effects of **negligible** magnitude on whooper swan. Although whooper swan is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(c) **Hen Harrier**

Appropriate measures would be undertaken to avoid disturbance of hen harrier roosts present at the time of construction works (see Pre-commencement Surveys). Therefore it is assumed that no roosting hen harriers would be directly affected by construction activities.

Wintering hen harriers would be potentially displaced from foraging areas in the vicinity of construction sites. However, few harriers winter in Shetland and the development site supports few prey species likely to attract them at this time of year. Furthermore, construction works would mostly occur in the months that harriers are absent (refer to Chapter 4) .Therefore, it seems reasonable to assume that displacement of hen harriers (if any) as a result of construction works would have little or no effect on the birds' foraging efficiency.

In view of the above, it is considered that construction works would have short-term adverse effects of **negligible** magnitude on hen harrier. Although this species is of high Nature Conservation Importance, these effects are judged to be **not significant** under the terms of the EIA Regulations.

(d) **Merlin**

Appropriate measures would be undertaken to avoid disturbance of nesting merlin present at the time of construction works (see Pre-commencement Surveys). Therefore it is assumed that no breeding merlin would be directly affected by construction activities.

Breeding merlins would be potentially displaced from foraging areas in the vicinity of construction work sites. Although alternative foraging areas exist these are likely to be energetically less efficient for merlins that nest in the vicinity of the Development, since they are more distant. The ranging behaviour of breeding merlins has not been studied in detail in the UK. Radio-tracking of urban Canadian merlins indicates that birds use areas that are inversely proportionate in size to the abundance of prey, as might be expected: merlin with more prey around their nest use smaller areas than those with less prey, which have to travel further to catch their needs (Sodhi 1993). An indication of the extent of merlin hunting ranges in the UK may be given by the distances between nest sites of neighbouring pairs, which is typically 3 – 4 km in the highest density areas (Parr 1991), meaning a crude estimate of range area may be given by a circle of 2 km around the nest (the criterion used by SNH in drawing up SPA boundaries involving a merlin interest). Hunting ranges of neighbouring birds, however, can have a large degree of overlap (Sodhi & Oliphant 1992) so even a 2 km radius around a nest site is probably a conservative measure of the extent to which birds may travel in search of prey. This is confirmed by the only quantified measures of the distance travelled by breeding merlins in Scotland, presented by Rebecca et al. (1990) which were a minimum distance of 3.8 km from the nest. This paper also reported on an unpublished radio telemetry study in Wales in which merlins hunted up to at least 4 km from the nest.

For the purpose of this assessment, hypothetical 'core' foraging ranges, assumed to contain food resources critical to successful breeding, were represented by circles of 2 km radius defined around each territory centre (i.e. the mid-point of each cluster of nest locations identified in 2005-08). Thus, each core range measured 12.6 km^2. This indicated that the development site might provide <u>some</u> critical foraging for merlin breeding in 10 territories. Using a strongly precautionary approach, it is assumed that foraging merlins would be displaced from areas within 250 m of construction work sites. The overlap between the assumed displacement zone and hypothetical core foraging ranges varies between territories, from 2% to 52% (mean 24%). Six territories (C, F, G, K, L and O; refer to Technical Appendix 11.1: Confidential Annex) have cores that overlap the displacement zone by more than 20%, taken to be a reasonable threshold at which to expect material effects on nest provisioning. Two territories (C and K) overlap by more than 40%.

Construction works would proceed in a phased manner across the development site. Therefore, with the possible exception of vehicular movements along the new tracks, it is unlikely that merlin within the assumed construction disturbance zone would be affected in more than one year. Vehicular traffic appears to have little or no effect on merlin nest placement (Fig. 11.5) and therefore it seems reasonable to assume that it would have a similarly slight effect on foraging behaviour. In view of the above, it is considered likely that foraging efficiency in two merlin territories, at most, would be materially affected in any one year. This is greater than a simple proportionate calculation (number of territories divided by number of years) would suggest and is therefore likely to overestimate the actual number affected. Continuing on a precautionary basis, it is assumed that affected territories would be prevented from rearing young during the year of disturbance. On the basis of this analysis, construction works would, at worst, result in a loss of breeding in two out of the nine pairs (22%) that constitute the site population, representing 10% of the regional (Shetland) total, for a period of five years. No longer-term consequences are anticipated. Again, this is precautionary because it is unlikely that all breeding attempts abandoned or aborted due to construction works would have been otherwise successful.

Outside the breeding period merlins would continue to be potentially displaced from foraging areas localised around construction sites. Most merlins leave their breeding haunts for lower ground, and the wintering population is supplemented by birds from Iceland (Wernham et al. 2002). There are no studies of non-breeding range use in merlins in the UK, although even on simple considerations (e.g. the absence of a nest site to constrain activity to a focal point, lower prey supplies) non-breeding birds are liable to range over a considerably greater area than breeding birds. Research on merlins in Canada confirms that range area in non-breeding birds is much larger (Sodhi & Oliphant 1992, Warkentin & Oliphant 1990). Many studies of other raptors which are resident and so easier to obtain comparable seasonal measures of range size invariably confirm that non-breeding ranges are larger (e.g. Marquiss & Newton 1981, Marzluff et al. 1997). In view of the above it seems reasonable to assume that any displacement of non-breeding merlins due to construction disturbance is highly unlikely to have a material effect on migratory or wintering populations at the regional scale.

Summarising, it is considered that construction works would have short-term adverse effects of **moderate** magnitude on merlin. Merlin is a species of high nature conservation importance (see Table 11.5) and therefore it is judged that these effects would be **significant** under the terms of the EIA Regulations.

(e) **Golden Plover**

Golden plovers are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore construction works would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that golden plovers would be displaced from areas within 500 m of construction work sites. Baseline surveys indicate that 90 pairs typically breed within this assumed displacement zone (refer to Fig. 11.7). Construction works are expected to proceed in a phased manner across the development site. Therefore, with the possible exception of vehicular movements along the new tracks, it is unlikely that golden plover within the assumed construction disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that ~30 pairs would be affected in any one year. This is greater than a simple proportionate calculation (number of territories divided by number of years) would suggest and is therefore likely to overestimate the actual number affected. Continuing on a precautionary basis, it is assumed that affected territories would be prevented from rearing young during the year of disturbance. This analysis suggests that construction works would result in a reduction of approximately 2% in the regional (Shetland) breeding population, for a period of five years. Again, this is precautionary because it is unlikely that all the affected territories would have produced young in the absence of construction works. No longer-term consequences are anticipated. In view of the above, it is considered unlikely that construction disturbance would have a material effect on the regional population of breeding golden plover.

Migrant foraging and roosting birds would be potentially displaced from localised areas around construction work sites during the spring and autumn. The potential indirect loss of habitat due to construction disturbance is substantial. However, the characteristics of the development site are typical of many upland areas in Shetland and it is reasonable to expect that migrant golden plovers would find alternative foraging and roosting habitat, free from disturbance, elsewhere in the Shetland NHZ. Moreover, most migrant golden plovers are likely to use lower elevation pasture habitats, peripheral to the development site. In view of the above, it is considered unlikely that construction disturbance would have a material effect on the welfare of migrating golden plover.

Summarising, it is considered that construction works would have short-term adverse effects of **low** magnitude on golden plover. Although golden plover is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(f) **Lapwing**

Breeding lapwings are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore construction works would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that lapwings would be displaced from areas within 500 m of construction work sites. Baseline surveys indicate that 64 pairs typically breed within this assumed displacement zone (refer to 11.8). Construction works would proceed in a phased manner across the development site. Therefore, with the possible exception of vehicular movements along constructed tracks, it is unlikely that lapwing territories within the assumed construction disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that ~20 pairs would be affected in any one year and that affected territories rear no young. This analysis suggests that construction works would result in a reduction of approximately 1% in the regional (Shetland) population of breeding lapwing, for a period of five years. No longer-term consequences are anticipated.

In view of the above, it is considered that construction works would have short-term adverse effects of **low** magnitude on lapwing. Although lapwing is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(g) **Dunlin**

Breeding dunlins are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore construction works would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that dunlins would be displaced from areas within 250 m of construction work sites. Baseline surveys indicate that 42 pairs typically breed within this assumed displacement zone (refer to Fig. 11.9). Following the example of golden plover (see above) it is unlikely that dunlin territories within the disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that ~14 pairs would be affected in any one year and that affected territories rear no young. This analysis suggests that construction works would result in a reduction of less than 1% in the regional (Shetland) population of breeding dunlin, for a period of five years. No longer-term consequences are anticipated.

In view of the above, it is considered that construction works would have short-term adverse effects of **negligible** magnitude on dunlin. Although dunlin is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(h) **Curlew**

Breeding curlews are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore construction works would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that curlews would be displaced from areas within 500 m of construction work sites. Baseline surveys indicate that 225 pairs typically breed within this assumed displacement zone (refer to Fig. 11.10). Following the example of golden plover (see above) it is unlikely that curlew territories within the disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that ~75 pairs would be affected in any one year and that affected territories rear no young. No longer-term consequences are anticipated. This analysis suggests that construction works would result in a reduction of just over 2% in the regional (Shetland) population of breeding curlew, for a period of five years.

In view of the above, it is considered that construction works would have short-term adverse effects of **low** magnitude on curlew. Although curlew is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(i) **Whimbrel**

Appropriate measures would be undertaken to avoid disturbance of breeding whimbrel present at the time of construction works (see Pre-commencement Surveys). Therefore it is assumed that no breeding whimbrel would be directly affected by construction activities.

For the purposes of this assessment it is assumed that whimbrel would be displaced from areas within 500 m of construction work sites. Baseline surveys indicate that 40 pairs typically breed within this assumed displacement zone (refer to Fig. 11.11). Following the example of golden plover (see above) it is unlikely that whimbrel territories within the disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that ~15 pairs would be affected in any one year and that affected territories rear no young. No longer-term consequences are anticipated. This analysis suggests that construction works would result in a reduction of just over 3% in the regional (Shetland) population of breeding whimbrel, for a period of five years. However, as noted previously (see Baseline Description), numbers of whimbrel appear to have declined since the last full survey of the Shetland population. As a result, it is possible that 5% or more of the regional breeding population would be affected.

In view of the above, it is considered that construction works would have short-term adverse effects of **moderate** magnitude on whimbrel (based on the current *probable* reduced population size). Although whimbrel is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **significant** under the terms of the EIA Regulations.

(j) **Arctic Tern**

Breeding arctic terns are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore construction works would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that arctic terns would be displaced from areas within 500 m of construction work sites. Baseline surveys indicate that 14 pairs typically breed within this assumed displacement zone (refer to Fig. 11.12). Following the example of golden plover (see above) it is unlikely that breeding arctic terns within the disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that approximately five pairs would be affected in any one year and that affected pairs rear no young. No longer-term consequences are anticipated. This analysis suggests that construction works would result in a reduction of less than 0.1% in the regional (Shetland) population of breeding arctic tern, for a period of five years.

In view of the above, it is considered that construction works would have short-term adverse effects of **negligible** magnitude on arctic tern. Although arctic tern is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(k) **Arctic Skua**

Breeding arctic skuas are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore construction works would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that arctic skua would be displaced from areas within 500 m of construction work sites. Baseline surveys indicate that 30 pairs of arctic skua typically breed within this assumed displacement zone (refer to Fig. 11.13). Following the example of golden plover (see above) it is unlikely that arctic skua territories within the disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that ~10 pairs would be affected in any one year and that affected territories rear no young. No longer-term consequences are anticipated. This analysis suggests that construction works would result in a reduction of approximately 0.1% in the regional (Shetland) population of breeding arctic skua, for a period of five years.

In view of the above, it is considered that construction works would have short-term adverse effects of **negligible** magnitude on arctic skua. Although arctic skua is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(l) **Great Skua**

Breeding great skuas are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore construction works would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that great skua would be displaced from areas within 500 m of construction work sites. Baseline surveys indicate that 53 pairs of great skua typically breed within this assumed displacement zone (refer to Fig. 11.14). Following the example of golden plover (see above) it is unlikely that great skua territories within the disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that ~18 pairs would be affected in any one year and that affected territories rear no young. No longer-term consequences are anticipated. This analysis suggests that construction works would result in a reduction of less than 0.3% in the regional (Shetland) population of breeding great skua, for a period of five years.

In view of the above, it is considered that construction works would have short-term adverse effects of **negligible** magnitude on great skua. Although great skua is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(m) **Red Grouse**

Breeding red grouse are judged to have low sensitivity to disturbance (Table 11.6). Nonetheless, it is possible that construction works would displace some birds from suitable nesting areas, potentially resulting in reduced site productivity.

For the purposes of this assessment it is assumed that red grouse would be displaced from areas within 250 m of construction work sites. Baseline surveys indicate that 19 pairs typically breed within this assumed displacement zone (refer to Fig. 11.6). Following the example of golden plover (see above) it is unlikely that red grouse territories within the disturbance zone would be affected in more than one year. For the purposes of this assessment it is assumed that approximately six pairs would be affected in any one year and that affected territories rear no young. No longer-term consequences are anticipated. This analysis suggests that construction works would result in a reduction of approximately 4% in the regional (Shetland) population of breeding red grouse, for a period of five years.

In view of the above, it is considered that construction works would have short-term adverse effects of **low** magnitude on red grouse. Although red grouse is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

11.10.7 Operational Disturbance

The presence and operation of wind turbines would potentially displace birds from nesting and foraging areas. These effects require further study, although existing information (e.g. Vauk 1990, Phillips 1994, Leddy et al. 1999, Madders and Whitfield 2006) and reviews of impacts (e.g. Crockford 1992, Benner et al. 1993, Winkelman 1994) suggest that most birds are affected only slightly. For example, breeding birds have not been found to be displaced at distances greater than 300 m from a turbine (Gill et al. 1996, Percival 1998). However, wind turbines might displace birds from larger areas if they act as a barrier to bird movements, or if the availability of suitable habitat is restricted. Also, displacement effects may vary over time, as birds habituate to the operation of the turbines or site faithful individuals are lost from the population.

There is potential for some disruption of feeding and nesting behaviours as a result of increased human activity due to maintenance work and easier access for agricultural and recreational activities. However, this would be relatively infrequent, and involve low levels of temporary and localised disturbance, restricted to areas of the site accessible by tracks. Therefore the overriding source of disturbance is considered to be turbine operation.

(a) Red-throated Diver

Red-throated divers are judged to have high sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some divers from breeding lochs, possibly resulting in a reduced and less productive site population. Observations on Shetland and Orkney (Natural Research, unpublished data) strongly suggest that breeding divers tolerate vehicular traffic, and most types of human activity, to within a few hundred metres of their nests. However, it is not known if all individuals are able to tolerate such disturbance, what role the breeding site (in particular loch size) might play in this process, or how long it takes birds to habituate. At Burgar Hill Windfarm, Orkney, red-throated divers regularly breed, without any obvious behavioural anomalies, on a loch situated within 300 m of two wind turbines and within 100 m of a public viewing station. However, the birds respond anxiously if people closely approach the loch shore. The apparently relaxed behaviour towards humans shown by the Burgar Hill birds contrasts markedly with the wary responses exhibited by divers breeding on the Viking site, where people are rare visitors.

For the purposes of this assessment, and using a strongly precautionary approach, it is assumed that breeding red-throated divers would be displaced from lochs within 500 m of operating turbines and from areas within 250 m of tracks. It is further assumed that displaced birds would not breed on alternative (and equally suitable) lochs. Baseline surveys indicate that 15 breeding lochs are located within the assumed operational displacement zone, of which ten are typically occupied in any one year (refer to Confidential Fig. 1 and Technical Appendix 11.1). This analysis indicates that operational displacement could result in a long-term reduction in the size of the site breeding population by ten pairs. This represents a loss of 2.5% in the regional (Shetland) breeding population. Breeding data gathered during 2003-08 indicate that the breeding lochs potentially affected have below average productivity, and that the envisaged effect would result in approximately 6.5 fewer young reared per year (Table 11.7). This represents a reduction of 2% in the productivity of the regional (Shetland) population.[1]

Table 11.7: Red-throated diver productivity 2003-2008 on potentially affected lochs

Breeding loch	Nearest turbine (m)	Mean young per year
NB	234	0.00
AY	265	0.00
BE	295	0.83
LBE	310	0.00
HM	340	0.33
DU / LGW	342	0.60
BX	363	0.00
BA	365	1.17
BB	365	0.50
BD	380	1.50
AX	409	0.80
CO	415	0.60
LPW	473	0.00
BF	500	0.17
	Total	6.50

In view of the above, it is considered unlikely that operational disturbance would have a material effect on the regional breeding population of red-throated diver.

It is possible that divers would be displaced from the most efficient flyways between breeding and feeding areas. However, observations at Burgar Hill indicate that, whilst divers exhibit avoidance towards individual turbines, they continue to fly between turbines (Jackson et al, submitted). Although the proposed Development comprises many more turbines than are present at Burgar Hill, the spacing between the turbines is similar. Furthermore, the maintenance of unobstructed flyways to and from diver breeding lochs was an important constraint in the design of the Development, in order to reduce collision likelihood (refer to Chapter 4: Development Description). In view of the above, it seems reasonable to assume that the turbines would not materially impede diver movements.

Operation of the Development would also potentially displace divers from non-breeding lochs. For the purposes of this assessment it is assumed that divers would be displaced from non-breeding lochs within 250 m of operating turbines and from areas within 100 m of tracks. It was further assumed that displaced divers would not move to alternative (and equally suitable) non-breeding lochs. Baseline surveys indicate that two non-breeding lochs within the assumed operational displacement zone are regularly used by divers (refer to Fig. 2). Without a greater understanding of the importance of non-breeding lochs to red-throated diver ecology it is not possible to evaluate the likely consequence of this effect with any certainty. However, no direct effects on productivity or survival are likely and it seems reasonable to assume that any indirect effects would be subtle. On this basis, and in view of the very small number of potentially affected lochs, it is considered that operational disturbance of non-breeding lochs is unlikely to have a material adverse effect on red-throated divers.

[1] Assuming that productivity within the development site is representative of Shetland as a whole

Summarising, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **low** magnitude on red-throated diver. Although red-throated diver is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(b) **Whooper Swan**

Breeding whooper swans are judged to have high sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting sites, possibly resulting in reduced site productivity.

For the purposes of this assessment, and using a strongly precautionary approach, it is assumed that whooper swans would be displaced from breeding / feeding sites within 500 m of operating turbines and from areas within 250 m of tracks. Baseline surveys indicate that whooper swans are unlikely to breed within these assumed displacement zones (refer to Technical Appendix 11.1: Confidential Annex). Operation of the Development would also potentially displace whooper swans from lochs used by migratory and wintering whooper swans. One loch used by such birds (Sand Water) is just within 250 m of the access track network. However, as discussed previously (see Construction Disturbance, above), Sand Water is flanked by two busy public roads and therefore the relatively small volume of additional traffic using one of the access tracks is unlikely to contribute materially to overall disturbance,

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **negligible** magnitude on whooper swan. Although whooper swan is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(c) **Merlin**

Operation of the Development would potentially displace nesting and foraging merlin. Merlins have not been studied with respect to their sensitivity to displacement by windfarms. However, several other raptor species have been studied, including other falcons, and these results (Madders & Whitfield 2006) suggest that it is highly unlikely that merlins will be displaced by operational windfarms. However, in view of the limited information on displacement available to date, and in keeping with the established precautionary practice, it is assumed for the purpose of this assessment that nesting birds would be displaced from areas within 500 m of operating turbines and foraging birds from areas within 100 m.

Baseline surveys indicate that two pairs of merlin typically nest within the assumed operational displacement zone (Territories C and K; refer to Confidential Fig. 2). If it is assumed, on a precautionary basis, that these pairs do not relocate and nest elsewhere, then this suggests there would be a reduction of approximately 10% in the regional (Shetland) breeding population. Based on data for the period 2005-2008, mean annual productivity in the territories potentially affected was 3.9 young, substantially greater than the mean for all territories associated with the development site (= 2.2; Table 11.8). This difference is largely explained by the high annual occupancy rate (100%) of territories C and K in recent years. Annual monitoring results for the entire Shetland merlin population over a period of 25 years have been compiled by P. Ellis. These data indicate that, although some territories are more likely to be occupied than others, long-term occupancy cannot be reliably predicted from short runs of data, e.g. covering four consecutive years. Thus, it cannot be assumed that the relatively high productivity observed in territories C and K during baseline surveys will be sustained in the future.

Table 11.8: Merlin productivity 2005-2008 in territories associated with the Development

Territory	Mean young per year
C	4.3
D	2.5
E	0
F	1.3
G	3.3
K	3.5
L	2.8
M	2.5
O	1.3
R	0.8
Average	2.2

To conclude, using precautionary assumptions, it is predicted that operational disturbance would result in a 10% decline in the regional breeding merlin population. If it is further assumed that the relatively high breeding success observed in the affected territories is representative of the longer term, then adverse effects on productivity may exceed 10%. In view of the above, it is considered that operational disturbance would have a material effect on the regional merlin breeding population.

As noted previously, the Development probably provides some critical foraging habitat for ten pairs of breeding merlin. Plausible displacement effects were calculated using the same approach followed under Construction Disturbance (see above). A displacement zone extending 100 m around the operational turbines was assumed. This analysis indicates that nine territories would be potentially affected. However, the overlap between core foraging and assumed displacement did not exceed 5% in any territory (range 0.2% to 4.1%; mean = 1.9%). Thus, under the envisaged scenario, it is unlikely that reductions in core foraging would be sufficient to have a material effect on any territory.

In view of the possibility of displacement of breeding birds, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **moderate** magnitude on merlin. Merlin is a species of high nature conservation importance (see Table 11.5) and therefore it is judged that these effects would be **significant** under the terms of the EIA Regulations.

(d) **Hen Harrier**

Roosting hen harriers are judged to have high sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable roost sites, possibly resulting in reduced winter survival.

For the purposes of this assessment it is assumed that hen harriers would be displaced from roost sites within 500 m of operating turbines and from areas within 250 m of tracks. Baseline surveys indicate that no hen harriers roost within the assumed displacement zone (refer to Technical Appendix 11.1: Confidential Annex). Therefore, it is highly unlikely that operational disturbance would have a measurable effect on roost occupancy or behaviour.

Foraging birds would be potentially displaced from localised areas around operational wind turbines. Hen harriers are present in the non-breeding period only. However, the level of foraging effort during the non-breeding period does not suggest that the habitat occupied by the proposed turbines is critical to harriers. Moreover, as noted previously birds are not constrained by nest site location at this time and therefore it is reasonable to expect that they would be able to accommodate any displacement by more intensively exploiting areas further from the influence of the turbines. Thus it is highly unlikely that the operational disturbance would have a measurable effect on the foraging efficiency of the non-breeding population.

Summarising, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **negligible** magnitude on hen harrier. Although hen harrier is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(e) **Golden Plover**

Golden plovers are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore it is possible that some breeding birds would be displaced by the operation of the Development. Pearce-Higgins et al (2008) found that the density of breeding golden plover was apparently lower at operational windfarms than at similar sites without windfarms, and that habitat within 200 m of operational turbines was used significantly less than comparable habitat further away. There was additional evidence for avoidance of tracks, although this effect was less strong.

For the purposes of this assessment it is assumed that nesting and foraging golden plovers would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that 35 pairs of golden plover typically breed within the assumed displacement zone (refer to Fig. 7). If it is assumed, on a precautionary basis, that the pairs occupying these territories do not relocate and breed elsewhere then this suggests that operational disturbance would result in a reduction of approximately 2.5% in the regional (Shetland) breeding population.

The breeding success of golden plover nesting outside the assumed displacement zone would be potentially affected if birds were displaced from critical foraging / chick rearing habitat. However, no aggregations of feeding golden plover were located within the development site during baseline surveys, and chick rearing areas are likely to be close to the identified territory centres. Therefore, it seems reasonable to assume that the magnitude of this displacement effect is likely to be negligible.

Foraging and roosting migrant golden plover would be potentially displaced from localised areas during the spring and autumn. The indirect loss of habitat due to operational disturbance would be less than that during the construction period (see above). Studies at operational windfarms indicate that migrant golden plover are little affected by operational turbines. Indeed, at Penrhyddlan and Llidiartywaun (central Wales) migrant golden plovers occupied the southern part of the windfarm, apparently in preference to the surrounding moorland and grazed pastureland (ScottishPower, 2008). Similarly, at Hare Hill Windfarm, Ayrshire, activity by up to 230 migrant golden plover was found to be focussed on the operational windfarm, with groups of up to 40 birds roosting at the base of the operating turbines (ScottishPower, 2007a). Moreover, as noted previously, most migrant golden plovers are likely to occupy pasture habitats, peripheral to the development site. Overall, it is considered highly unlikely that operation of the Development would have a material effect on migrant golden plovers passing through Shetland.

The proposed access tracks would potentially result in greater agricultural and recreational activity within the development site. Human disturbance has been shown to have a negative effect on golden plovers. For example, Finney et al (2005) found evidence of avoidance extending up to 200 m from heavily used footpaths. However, any additional agricultural use is likely to involve infrequent vehicular traffic, and this is unlikely to have a material effect on golden plovers. Similarly, it is not envisaged that the currently low levels of recreational use would increase appreciably as result of the Development.

Summarising, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **low** magnitude on golden plover. Although golden plover is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(f) **Lapwing**

Breeding lapwings are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that nesting and foraging lapwing would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that 13 pairs of lapwing typically breed within the assumed displacement zone (refer to Fig. 8). Following the example of golden plover (see above) this suggests that operational disturbance would result in a reduction of approximately 0.7% in the regional (Shetland) breeding population.

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **negligible** magnitude on lapwing. Although lapwing is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(g) **Dunlin**

Breeding dunlins are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that nesting and foraging dunlins would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that 32 pairs of dunlin typically breed within the assumed displacement zone (refer to Fig. 9). Following the example of golden plover (see above) this suggests that operational disturbance would result in a reduction of approximately 2% in the regional (Shetland) breeding population.

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **low** magnitude on dunlin. Although dunlin is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(h) **Curlew**

Breeding curlews are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity. However, studies of curlew at operational windfarms elsewhere in the UK (Green et al., in prep) suggest that displacement of breeding curlew, if it occurs at all, is unlikely to be a serious issue. For example, at Hadyard Hill Windfarm, Ayrshire, curlew territory centres ranged from 20 m to 710 m from operational turbines, including a nest site 190 m from a turbine. At Dun Law Windfarm in the Scottish Borders 18 nests were located during the period of study, at distances ranging from 100 m to 450 m (mean = 260 m) from the turbines. A study of breeding wader densities before and after construction of Black Law Windfarm, Lanarkshire, showed evidence of curlew declines in some habitat-types and increases in others (ScottishPower 2007b). However, there was no obvious correspondence between these changes and the presence of turbines (thus only two out of five survey areas where declines were apparent contained turbines). Moreover, Breeding Bird Survey data obtained from the BTO showed that curlew numbers declined steadily across Scotland as a whole over the period of study. Since construction, four pairs of curlew have bred within approximately 500 m of the operational turbines at Black Law, including one pair approximately 160 m from a turbine base. A recurrent finding of the studies undertaken to date is that curlews frequently breed within 250 m or so of operational turbines.

Despite the above, for the purposes of this assessment it is assumed that nesting and foraging curlews would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that 93 pairs of curlew typically breed within the assumed displacement zone (refer to Fig. 10). Following the example of golden plover (see above) this suggests that operational disturbance would result in a reduction of less than 3% in the regional (Shetland) breeding population.

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **low** magnitude on curlew. Although curlew is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(i) **Whimbrel**

Breeding whimbrels are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that nesting and foraging whimbrels would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that 16 pairs of whimbrel typically breed within the assumed displacement zone (refer to Fig. 11). Following the example of golden plover (see above) this suggests that operational disturbance would result in a reduction of just over 3% in the regional (Shetland) breeding population. As noted previously (see Baseline Description), numbers of breeding whimbrel have apparently declined in recent years, meaning that the 16 pairs within the assumed displacement zone may now represent 5% or more of the regional breeding population. Note that none of the whimbrel predicted to be affected are located within the composite IBA (see 11.3 Site Designations).

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **moderate** magnitude on whimbrel (based on the current *probable* reduced population size). Whimbrel is a species of high nature conservation importance (see Table 11.5) and therefore it is judged that these effects would be **significant** under the terms of the EIA Regulations.

(j) **Arctic Tern**

Breeding arctic terns are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting sites, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that nesting and foraging terns would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that no pairs of arctic tern typically nest within the assumed displacement zone (refer to Fig. 12).

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **negligible** magnitude on arctic tern. Although arctic tern is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(k) **Arctic Skua**

Breeding arctic skuas are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that nesting and foraging skuas would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that 13 pairs of arctic skua typically breed within the assumed displacement zone (refer to Fig. 13). Following the example of golden plover (see above) this suggests that operational disturbance would result in a reduction of just over 1% in the regional (Shetland) breeding population.

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **low** magnitude on arctic skua. Although arctic skua is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(l) **Great Skua**

Breeding great skuas are judged to have moderate sensitivity to disturbance (Table 11.6) and therefore operation of the Development would potentially displace some birds from suitable nesting areas, possibly resulting in reduced site productivity.

For the purposes of this assessment it is assumed that nesting and foraging skuas would be displaced from areas within 250 m of operating turbines and from areas within 100 m of tracks. Baseline surveys indicate that 27 pairs of great skua typically breed within the assumed displacement zone (refer to Fig 14). Following the example of golden plover (see above) this suggests that operational disturbance would result in a reduction of just over 0.4% in the regional (Shetland) breeding population.

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **negligible** magnitude on great skua. Although great skua is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(m) **Red Grouse**

Breeding red grouse are judged to have low sensitivity to disturbance (Table 11.6). Nonetheless, it is possible that operation of the Development would displace some birds from suitable nesting areas, potentially resulting in reduced site productivity.

For the purposes of this assessment it is assumed that nesting and foraging red grouse would be displaced from areas within 100 m of operating turbines. No displacement from tracks is assumed, on the basis that grouse are likely to be attracted to them to pick up grit. Baseline surveys indicate that one pair of red grouse typically breed within the assumed displacement zone (refer to Fig. 6). Following the example of golden plover (see above) this suggests that operational disturbance would result in a reduction of approximately 0.7% in the regional (Shetland) breeding population.

In view of the above, it is considered that disturbance due to operation of the Development would have long-term adverse effects of **negligible** magnitude on red grouse. Although red grouse is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

11.10.8 Collision

Birds that collide with a turbine rotor are likely to be killed or fatally injured. This may in turn affect the maintenance of bird populations. Further studies are required to establish the extent to which birds are able to avoid collision with wind turbines. The indications from studies so far are that collisions are rare events and occur mainly at sites where there are unusual concentrations of birds and turbines, or where the behaviour of the birds concerned leads to high-risk situations (Winkelman 1994, Gill et al. 1996, Percival 1998). Examples include migration flyways, other situations where large numbers of birds may be flying at night or in poor visibility (e.g. tidal feeding movements) and areas where the food resource, and therefore level of bird activity, is exceptional.

Collision risk is assumed to be dependent on the amount of flight activity within the Development; specifically, flights through the airspace within which the rotors of the proposed turbines would operate. Observations made during timed VP watches undertaken as part of the pre-construction baseline studies can give useful insight into the level of 'at risk' flight activity. However, in reality, the reliability of these data depends on:

- The ability of observers to detect flying birds;
- the extent to which birds are displaced by the Development; and
- the ability of birds to take evasive action to avoid collision with the turbine rotor blades.

Care was taken to ensure, as far as practicable, the accuracy of measures of bird flight activity determined from the baseline surveys. For example, species-specific detection functions were used in estimates of activity per unit time and area (refer to Technical Appendix 11.1 for details). For collision assessment purposes, it is assumed there would be no displacement of birds from the windfarm. Finally, in the absence of detailed information, precautionary and species-specific measures of turbine avoidance were assumed.

The baseline studies demonstrated conspicuous aerial activity by nine species of high /moderate nature conservation importance (red-throated diver, greylag goose, merlin, golden plover, dunlin, curlew, whimbrel, arctic skua and great skua). The Band collision risk model (CRM; Band et al. 2007) was used to determine quantitative estimates of collision risk for these species (see Technical Appendix 11.2: Estimation of Collision Risk). Models were based on recorded flight activity levels and flight behaviour, proposed turbine numbers and specifications, and species' biometrics and flight characteristics. Modelling collision risk under the Band CRM is a two-stage process. Stage 1 estimates the number of birds that fly through the rotor swept disc. Stage 2 predicts the proportion of these birds that would be hit by a rotor blade. Combining both stages produces an estimate of collision fatality in the absence of any avoiding action by birds. In practice, as noted previously, birds do avoid flying through rotating blades, and avoidance rates appear to be very high (e.g. Gill et al. 1996). Both stages are prone to bias due the inclusion of relatively simplistic assumptions about bird behaviour.

An appraisal of the Band model (Chamberlain et al. 2005, 2006) noted that whilst it appears generally robust there is a strong influence of avoidance rates on estimated collision risk and that information on avoidance rates is scant, confirming Band et al.'s conclusions. Chamberlain et al. (2005) rightly express concern about this issue, as relatively little is known about avoidance rates, and suggest that until more is known about avoidance, collision risk modelling has limited value. However, they offer no suggestions as to alternative approaches to the problem, perhaps because alternative methods to assess collision risk provide even less comfort than collision risk modelling but are subject to the same or more potential biases (Madders & Whitfield 2006).

(a) **Red-throated Diver**

Red-throated divers are potentially vulnerable to collision with turbines when making flights between freshwater lochs and the sea, moving between freshwater lochs, and circling around freshwater lochs. The latter two behaviours are especially relevant to non-breeding birds. Studies at Burgar Hill Windfarm, Orkney, demonstrated that red-throated divers can exhibit a high level of avoidance (98% or more) of collision with turbines located between breeding and feeding sites (Jackson et al., submitted). Two of the Burgar Hill turbines are located less than 300 m from the loch centre, yet, with in a two year study period at least, there was no evidence of collisions by breeding or non-breeding birds. However, the studies at Burgar Hill were conducted more than 20 years after the windfarm was built and divers may have become accustomed the presence of the turbines. It is not known whether divers without previous experience of turbines would show more or less avoidance.

CRM models for red-throated diver were constructed for each turbine, using measures of flight activity calculated for an array of 200x200 m grid cells covering the development site and wider area (Fig 3). The size of cell was chosen as a compromise between the conflicting requirements to maximise spatial resolution and minimise potential errors in flight recording accuracy due to the effects of parallax. Within each grid cell, separate flight activity values (expressed as kilometres flown per year) were available for breeding and non-breeding divers. In order to make the data as relevant as possible, values were determined for new 200x200 m cells centred on each proposed turbine. This was done by calculating a mean value for each 'turbine cell', weighted according to the contribution of each original cell overlapped.

Flight activity values for each turbine cell were then adjusted to represent the amount of time spent at RSH using flight height data (i.e. values for total flying time were multiplied by 61.7%, refer to Appendix 11.1: Table 26).[1]

Turbines were assumed to be inoperative for 15% of the time due to wind speed and maintenance activities. Red-throated diver biometrics were averaged across the sexes, and a flight speed of 17.5 m/s was used (mean of values given in Provan & Whitfield 2006). Based on the findings of post-construction studies at Burgar Hill, Orkney, an avoidance rate of 98% was used in red-throated diver CRM.

The Stage 2 (Band) calculation for the probability of collision gave a value of 6.8% for the proposed turbines (see Technical Appendix 11.2). These results applied across all runs of the red-throated diver CRM. The combined Stage 1 and Stage 2 calculations gave two sets of mortality rates, one for breeding birds and one for non-breeding birds. Combined breeding and non-breeding annual mortality ranged from zero to 0.36 per turbine. Overall, mortality estimates were 2.6 breeding birds per year and 3.5 non-breeding birds per year. The predicted number of breeding birds killed represents 0.3% of the regional (Shetland) breeding population.

These potential losses should be viewed in the context of likely levels of background mortality in red-throated divers. Data presented by Hemmingsson and Eriksson (2002) suggests that annual survival rates are in the order of 61% for birds aged less than two years old, and 84% thereafter. In Shetland it is estimated that most divers commence breeding at five years of age (D. Okill, pers. comm.). Therefore, plausible annual survival rates in Shetland would be 84% for breeding birds and 75% for non-breeding birds. Thus, out of a breeding population of 407 pairs, approximately 130 divers (814 x 0.16) would be expected to die annually. This suggests that the proposed Development would potentially elevate the existing mortality of breeding divers by about 2% (or, expressed another way, annual survival would decline by 0.3% to 83.7%). A similar calculation can be done for non-breeding divers; a UK-wide survey (RSPB 2007) found that approximately 40% of the summering population did not breed. If this metric is applied to Shetland this suggests there is a summering population of ~1356 birds, including 542 non-breeders. Out of this non-breeding population approximately 135 divers (542 x 0.25) would be expected to die annually. This suggests that the proposed Development would potentially elevate the existing mortality of non-breeding divers by about 2.6%, i.e. annual survival would decline by 0.5% to 74.5%.

Summarising, it is considered that collisions with the turbine rotors would have long-term adverse effects of **low** magnitude on red-throated diver. Although red-throated diver is a species of high nature conservation importance (see Table 11.5) it is judged that these

[1] Flying time estimated to occur within the 10-50 m, 51-100 m and 101-150 m recording bands was used to determine the period that red-throated divers were at risk of collision with the turbine rotors. The RSH of the proposed turbines is 35-145 m. Therefore data for the 10-50 m recording band was adjusted by allocating flight time equally into 10 m height bins and summing data for bins representing 30-50 m height. Overall, therefore, data for flights 30-150 m above the ground were used in the models.

effects would be **not significant** under the terms of the EIA Regulations. However, the potential loss of more than 150 divers over the lifetime of the windfarm is considered highly undesirable. With this in mind, and recognising the uncertainties inherent in the CRM process, precautionary measures would be implemented to reduce the likelihood of collisions by red-throated divers (see 11.11 Mitigation).

(b) **Merlin**

Merlins have not been studied with regard to collision vulnerability at operational wind farms. Detailed observations of foraging merlins in the UK uplands are scarce, but most anecdotal observations refer to merlins flying low over the ground, well below turbine RSH. Prey (mainly small songbirds) is captured after fast aerial chases close to the ground or surprised in the ground vegetation at close range. Less commonly, merlin stoop on their prey from greater heights with a fast direct flight, or 'ring up' after prey (typically, skylark). When 'ringing up' the prey attempts to gain height by climbing in circles above the merlin, which follows. The merlin may give up the chase at any stage, but if not, and after up to several hundred metres of conjoined skyward flight, the lark descends earthwards rapidly with the merlin following closely and making repeated short stoops on the lark. While such spectacular hunts have been recorded commonly (Cresswell 1994), it would appear that they are rare relative to other hunting techniques. Thus, aerial pursuits at the RSH of the proposed turbines are likely to be quite rare; indeed, none was observed during baseline surveys (refer to Technical Appendix 11.1).

Other exceptions to merlins' characteristically low flying elevation occur during territorial displays, 'mobbing' flights to drive away potential avian nest predators, and practice flights by juveniles (Rae 2006). However, these behaviours are typically restricted to within 500 m or so of the nest (Rae 2006). Two territories identified in baseline surveys are located within this distance of the proposed turbines (Territories C and K; refer to Technical Appendix 11.1: Confidential Annex).

CRM models for merlin were constructed employing flight data gathered during baseline generic flight activity studies, covering the entire development site, corrected for detection bias (see Baseline Description). Separate models were run for each quadrant of the development site. Merlin biometrics were averaged across the sexes, and a flight speed of 14 m/s was used (Provan & Whitfield 2006). In the absence of any guiding empirical data an avoidance rate of 98% was used in merlin CRM. The Stage 2 (Band) calculation for the probability of collision gave a value of 5.3% for the proposed turbines. These analyses estimated that one merlin would be killed every 2.8 years (refer to Technical Appendix 11.2). Predicted collisions per turbine were greatest in the Delting quadrant (0.23 per year) and least in Collafirth (0.01 per year).

CRM models were also constructed for 'core' areas of merlin breeding territories, using flight data gathered during focal watches of nesting areas (refer to Technical Appendix 11.1: Part 2, Merlin). These analyses demonstrated that, unsurprisingly, collision likelihood would decline with nest distance. It was estimated that if an operational turbine was located 200-300m from a nest it would result in one of the breeding pair being killed every nine years. Similarly, if the turbine was located 300-400m away it would result in the loss of a bird every 13 years.

It is unlikely that merlin flight activity (and therefore collision risk) would increase as a result of changed habitat conditions due to construction of the Development. Similarly, the habitat management and mitigation (see Chapter 10: Ecology and Appendix 10.9: Habitat Management Plan) proposed as part of the Development do not aim to shift the distribution of suitable nesting habitat closer to the turbines. This is important because, as noted previously, collision likelihood is greatest in the vicinity of nest sites.

Based on the current favourable conservation status of merlin in Shetland, it is concluded that the predicted level of collisions would not have a material effect on the regional merlin population.

In view of the above, it is considered that collisions with the turbine rotors would have long-term adverse effects of **low** magnitude on merlin. Although merlin is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations. However, the potential loss of almost nine merlins over the lifetime of the windfarm is considered highly undesirable. With this in mind, and recognising the uncertainties inherent in the CRM process, precautionary measures would be implemented to reduce the likelihood of collisions by merlins (see **11.11 Mitigation**).

(c) **Whooper Swan**

As noted previously (see 11.7 Baseline Description), the site does not appear to lie on a regularly-used flight route. Thus, only one flight, involving four whooper swans, was recorded during baseline surveys. This flight was, for the most part, below the RSH of the proposed turbines. A quantitative estimate of collision mortality was not attempted because it was obvious that CRM would have inevitably concluded the level of risk was very low, probably less than one bird during the lifetime of the Development.

In view of the above, it is considered that collisions with the turbine rotors would have long-term adverse effects of **negligible** magnitude on whooper swan. Although whooper swan is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(d) **Greylag Goose**

Employing data collected during timed VP observations (corrected for detection bias, see Baseline Description) and assuming 99% avoidance, CRM estimated that 6.4 greylag geese per year would be killed (Technical Appendix 11.2). This represents 2.6%, at most, of the regional breeding population. Predicted collisions per turbine were on average three times greater in the Delting quadrant (0.09 per year) than other quadrants (mean for Collafirth, Kergord and Nesting = 0.03 per year).

Summarising, it is considered that collisions with the turbine rotors would have long-term adverse effects of **low** magnitude on greylag goose. Although greylag goose is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(e) **Hen Harrier**

Examination of previous studies of hen harrier mortality at operational windfarms indicates that lethal strikes are rare, even at a windfarm where mortality rates of some raptors are renowned for being particularly high (Altamont) (Whitfield & Madders 2006). It is worth noting with respect to this finding that observed harrier activity levels at the proposed

Viking windfarm were several orders of magnitude lower than has been documented at those operational windfarms where collision mortality has been studied and illustrated to be negligible or absent (Whitfield & Madders 2006).

Hen harriers were recorded flying at 10-50 m elevation above the ground for a total of 161 secs during 1374 hours (<0.01%) of generic VP observation in 2003-07, and for a total of 159 secs during 43 hours (0.1%) of winter roost observation in 2005-06 (Technical Appendix 11.2). No flight activity was recorded at higher elevations. Most of the recorded activity would have occurred below the RSH of the proposed turbines (see Whitfield & Madders 2006; Fig. 2). The winter roost observations did not indicate that the proposed windfarm was used as a gathering site for harriers to interact with one another (when they are more likely to fly at RSH) prior to roosting.

In conclusion, taking into account the low vulnerability of hen harriers to turbine collision apparent from previous studies and the small amount of time that birds would be potentially at risk from the proposed Development, it is considered that collisions would have long-term adverse effects of **negligible** magnitude on hen harrier. Although hen harrier is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(f) **Golden Plover**

Employing data collected during timed VP observations (corrected for detection bias, see Baseline Description) and assuming 98% avoidance, CRM estimated that 62.5 golden plover per year would be killed (Technical Appendix 11.2). This represents just over 2% of the regional breeding population. Predicted collisions per turbine were substantially greater in the Nesting quadrant (mean = 0.48 per year) than other quadrants (mean for Delting, Collafirth and Kergord = 0.34 per year).

The conservation status of golden plover is judged to be favourable, both nationally and regionally, on the basis that (1) the species appears to be maintaining itself in the long-term as a viable component of its habitats, and (2) the natural range of the species does not appear to be contracting, nor is it likely to contract in the foreseeable future. Moreover, there is reason to expect that sufficient habitat will exist to maintain the population in the long-term.

Summarising, it is considered that collisions with the turbine rotors would have long-term adverse effects of **low** magnitude on golden plover. Although golden plover is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(g) **Dunlin**

Employing data collected during timed VP observations (corrected for detection bias, see Baseline Description) and assuming 98% avoidance, CRM estimated that 13.4 dunlin per year would be killed (Technical Appendix 11.2). This represents 0.4% of the regional breeding population. Predicted collisions per turbine were on average twice as high in the Nesting quadrant (mean = 0.13 per year) than other quadrants (mean for Delting, Collafirth and Kergord = 0.06 per year).

In view of the above, it is considered that collisions with the turbine rotors would have long-term adverse effects of **negligible** magnitude on dunlin. Although dunlin is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(h) **Curlew**

Employing data collected during timed VP observations (corrected for detection bias, see Baseline Description) and assuming 98% avoidance, CRM estimated that 58.4 curlew per year would be killed (Technical Appendix 11.2). This represents approximately 0.9% of the regional breeding population. Predicted collisions per turbine were substantially greater in the Kergord quadrant (mean = 0.53 per year) than other quadrants (mean for Delting, Collafirth and Nesting = 0.31 per year).

In view of the above, it is considered that collisions with the turbine rotors would have long-term adverse effects of **low** magnitude on curlew. Although curlew is a species of moderate nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(i) **Whimbrel**

Employing data collected during timed VP observations (corrected for detection bias, see Baseline Description) and assuming 98% avoidance, CRM estimated that 10.5 whimbrel per year would be killed (Technical Appendix 11.2). Analysis of whimbrel flight data gathered in six sample areas (refer to Technical Appendix 11.1) showed that activity was not random with respect to landform. When this was taken into consideration the predicted collision risk declined to approximately 9.6 birds per year. This represents approximately 1% of the published regional and national breeding populations; and therefore greater than 1% of the current, apparently diminished, populations (see Baseline Description). Predicted collisions per turbine were similar in all quadrants (range 0.06 to 0.09 per year). It is possible that a very small number of the pairs potentially affected in the Kergord quadrant are located within the composite IBA (see 11.3 Site Designations). However, it is not possible to determine this in the absence of clarity regarding the areas included in the IBA designation.

In view of the above, it is considered that collisions with the turbine rotors would have long-term adverse effects of **moderate** magnitude on whimbrel (based on the current *probable* reduced population size and using thresholds appropriate to national populations, see Table 11.3). Whimbrel is a species of high nature conservation importance (see Table 11.5) and therefore it is judged that this effect would be **significant** under the terms of the EIA Regulations.

(j) **Arctic Skua**

Employing data collected during timed VP observations (corrected for detection bias, see Baseline Description) and assuming 98% avoidance, CRM estimated that 10.1 arctic skua per year would be killed (Technical Appendix 11.2). This represents 0.4% of the regional breeding population. Predicted collisions per turbine were on average twice as high in the Nesting quadrant (mean = 0.10 per year) than other quadrants (mean for Delting, Collafirth and Kergord = 0.05 per year).

In view of the above, it is considered that collisions with the turbine rotors would have long-term adverse effects of **negligible** magnitude on arctic skua. Although arctic skua is a species of high nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(k) **Great Skua**

Employing data collected during timed VP observations (corrected for detection bias, see Baseline Description) and assuming 98% avoidance, CRM estimated that 60.2 great skua per year would be killed (Technical Appendix 11.2). This represents 0.4% of the regional breeding population. Predicted collisions per turbine were substantially greater in the Kergord quadrant (mean = 0.56 per year) than other quadrants (mean for Delting, Collafirth and Nesting = 0.34 per year).

In view of the above, it is considered that collisions with the turbine rotors would have long-term adverse effects of **negligible** magnitude on great skua. Even in the case of the species of highest nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

(l) **Other Species**

It is considered that collisions with the turbine rotors by all other species would have long-term adverse effects of **negligible** magnitude. Even in the case of the species of highest nature conservation importance (see Table 11.5) it is judged that these effects would be **not significant** under the terms of the EIA Regulations.

11.10.9 Decommissioning

Habitat reinstatement would be decided in consultation with the statutory authorities at the time of decommissioning, and activities would be subject to the prevailing best practice at that time. It is assumed that disturbance effects due to decommissioning would be of shorter duration than the construction period. Apart from the shorter duration the effects on birds would be similar to those during construction.

The magnitude of decommissioning effects on merlin and whimbrel is considered to be **moderate**. These effects are judged to be **significant** under the terms of the EIA Regulations. The magnitude of decommissioning effects on all other species is considered to be **negligible** or **low**. These effects are judged to be **not significant** under the terms of the EIA Regulations.

11.10.10 Future Situation Without the Scheme

More than 50% of the blanket bog habitat within the development site is classified as ‘modified bog’ or ‘bare peat’, indicating that the blanket mire ecosystem is in poor condition (refer to Chapter 10: Ecology, Chapter 14: Soil & Water and Appendix 10.9: Habitat Management Plan). Evidence of recent extensive and apparently progressive erosion, such as cracked peat, soil piping and emptying of pools strongly suggest that the hydrological processes supporting the moorland system are unstable and deteriorating. Without intervention, it is likely that much of the remaining peat will, sooner or later, be lost, exposing any vulnerable substratum to erosive forces. This trend has important implications for many of the bird populations that are currently supported.

It is not possible to predict the effects of insidious change in peatland hydrology with much precision. However, some trends are both inevitable and obvious. For example, long-term declines in the number of breeding red-throated diver, dunlin, whimbrel and curlew are virtually certain. Conversely, the drying of peatland habitats is likely to benefit species such as golden plover, in the short to medium term at least, and may attract others to colonise the area.

Overall, it is predicted that further deterioration in blanket bog habitats would adversely affect bio-diversity. Over a 30 year period (i.e. equivalent to the construction and operational phases of the proposed Development) it is plausible that losses in many bird populations would be broadly similar to those predicted to result from the proposed Development. For example, based on the evident near-collapse of retaining peat walls, it is predicted that at least nine red-throated diver breeding lochs are in imminent danger of being lost. In the absence of the proposed Development, it is highly unlikely that action would be taken to prevent this situation, or to instigate remedial work to reverse any declines that occur.

Many of the species predicted to be adversely affected by the proposed Development are potentially highly vulnerable to the effects of climatic change. For example, simulations by Huntley et al (2007) suggest that the distribution of red-throated diver is likely to shift dramatically northwards, such that by the late 21st century they are likely to be absent from most of Scotland, including Shetland. Similarly, whimbrel would no longer be present as a breeding species and conditions would be considerably less suitable for golden plover and dunlin. Whilst these predictions have no immediate application in evaluating the effects of the proposed Development, they nevertheless have contextual relevance.

11.11 MITIGATION AND ENHANCEMENT

(a) Construction Disturbance

It is predicted that construction works would have a significant adverse effect on breeding merlins as a result of disturbance to foraging birds; see section 11.10.6 (d). The baseline data suggest that two pairs of merlin would be affected, in territories C and K. In order to reduce the magnitude of this effect, measures would be implemented to ensure that the overlap between predicted displacement zones around construction works (extending to 250 m from each work site) and the hypothetical core foraging range of individual merlin territories (extending to 2 km from the nest) does not exceed 20%. This degree of overlap is assumed to be the threshold at which material effects on nest provisioning might occur. Reduction in the size of the overlapped area would be achieved by restricting construction works in some parts to the months of September to March, i.e. outside the merlin breeding period. All practicable measures would be taken to ensure that works permitted to continue within the overlap were near the periphery of the core foraging areas. Similar procedures would be adopted in respect of decommissioning activities.

It is predicted that construction works would have a significant adverse effect on whimbrel due to the displacement of adults and young from critical foraging habitat. The baseline data suggest that ~15 pairs would be affected each year of construction. In order to reduce the magnitude of construction effects, a three-visit Brown and Shepherd (1993) survey would be undertaken and construction work rescheduled, if necessary, to ensure that a maximum of five whimbrel territories recorded in the previous visit were located within the hypothetical displacement zone (i.e. extending 500 m around each work site). All practicable measures would be taken to ensure that works permitted to continue were near the periphery of the displacement zone. Similar procedures would be adopted in respect of decommissioning activities.

(b) **Operational Disturbance**

It is predicted that operation of the windfarm would have a significant adverse effect on breeding merlins as a result of disturbance to birds nesting in territories C and K. Remedial habitat management over a 10 km^2 area in the north-east of the Nesting quadrant merlin (refer to Appendix 10.9: Habitat Management Plan) would potentially enhance merlin nesting habitat by creating stands of tall heather (>0.4 m) in an area that no longer supports breeding. The proposed habitat management would potentially offset some of the adverse effects that are predicted to occur as a result of the disturbance caused by operation of the windfarm, although uncertainty in the responses of merlins mean that the strength of this compensatory effect cannot be reliably quantified. Moreover, although heather management would be implemented as quickly as possible following consenting of the Development, there could be a delay of several years before suitable heather develops. Finally, the proposed habitat management area is probably sufficient to support only one additional breeding pair. In view of the above it is considered that, despite the potentially beneficial effects of the proposed habitat management, disturbance due to operation of the Development would continue to have long-term adverse effects on at least one pair of merlin, representing 5% or more of the regional population.

It is predicted that operation of the windfarm would have a significant adverse effect on whimbrels as a result of disturbance to nesting birds. Applying precautionary assumptions to the baseline survey data suggests that 16 pairs of whimbrel would be displaced. Remedial habitat management is proposed to restore 10 km^2 of the moorland in the north-east of the Nesting quadrant to more favourable condition (refer to Appendix 10.9: Habitat Management Plan). This would potentially offset some of the predicted adverse effects due to operational disturbance. For example, a reasonable and realistic aim of habitat management would be to increase the site population of whimbrel by five pairs. If this can be achieved, then habitat management would reduce the *effective* losses to approximately 11 pairs. Based on the most up to date information on the whimbrel population trajectory, this would represent around 5% of the regional (Shetland) and national (UK) populations. However, in practice the precise number of additional whimbrel that would result from habitat management cannot be quantified with certainty and therefore this measure, on its own, would not provide a reliable means of mitigating the predicted displacement effect.

The cause(s) of the current apparent decline in whimbrel numbers, and the measures needed to reverse it, are not fully understood. Therefore, as a precursor to any necessary remedial action, it is proposed that the Development funds research aimed at better understanding the requirements of whimbrel in Shetland. The eventual goal of this research is to devise and implement a programme of practical measures aimed at maintaining the whimbrel population. Both the research and conservation projects would be designed in consultation with SNH and RSPB.

(c) **Collision Mortality**

It is predicted that operation of the windfarm would have a significant adverse effect on whimbrels as a result of collisions with the turbine rotors. Remedial habitat management in the north-east part of the Nesting Quadrant (see Appendix 10.9: Habitat Management Plan) would potentially compensate for some losses by creating habitat likely to support additional breeding pairs. However, there is insufficient certainty concerning the number and productivity of the new territories to reliably estimate the effects of these measures on the whimbrel population. Furthermore, in the event that the population increased, it is possible that collision rates would rise in accordance with the greater number of birds 'available' to collide.

It is predicted that operation of the windfarm would have undesirable but non-significant adverse effects on red-throated divers and merlins as a result of collisions with turbine rotors. Remedial habitat management in the north-east part of the Nesting Quadrant (see Appendix 10.9: Habitat Management Plan) would potentially compensate for some losses by enhancing habitat likely to support up to two additional pairs of red-throated divers and up to one additional breeding pair of merlin.

11.12 SUMMARY OF RESIDUAL EFFECTS AFTER MITIGATION

It is considered that the magnitude of the residual effects on merlin and whimbrel due to construction works and decommissioning is likely to be **low**. Therefore, although these species are of high Nature Conservation Importance, the residual effects after mitigation are judged to be **not significant** under the terms of the EIA Regulations.

It is considered that the magnitude of the residual effects on merlin due to operational disturbance is likely to be **moderate**. Therefore, given that merlin is a species of high Nature Conservation Importance, the residual effects after mitigation are judged to be **significant** under the terms of the EIA Regulations.

It is considered that the magnitude of the residual effects on whimbrel due to operational disturbance is likely to be **moderate**. Therefore, given that whimbrel is a species of high Nature Conservation Importance, the residual effect after mitigation is judged to be **significant** under the terms of the EIA Regulations.

It is considered that the magnitude of the residual effects on whimbrel due to collision mortality is likely to be **moderate**. Therefore, given that whimbrel is a species of high Nature Conservation Importance, the residual effects after mitigation are judged to be **significant** under the terms of the EIA Regulations.

11.13 SUMMARY OF EFFECTS

Potential Effect	**Mitigation**	**Residual Significance**
Land Take		
All species		Not significant
Habitat Modification		
All species		Not significant
Construction Disturbance		
Merlin	Restrictions on the timing and location of	Not significant

Whimbrel	construction works	
All other species		Not significant
Operational disturbance		
Merlin	Management to enhance the value of habitat in part of the Nesting quadrant	Significant
Whimbrel		
All other species		Not significant
Collision		
Whimbrel	Management to enhance the value of habitat in part of the Nesting quadrant	Significant
All other species		Not significant
Decommissioning		
Merlin	Restrictions on the timing and location of construction works	Not significant
All other species		Not significant

11.14 MONITORING

The effects of the proposals on birds would be monitored during windfarm construction and in years 1-3 following final commissioning. Thereafter, dependent on the results of monitoring, it is proposed to undertake surveys at 5-yearly intervals.

The following aspects would be covered:

- The location and success of red-throated diver and merlin breeding attempts;
- The distribution of breeding whimbrel territories;
- Focal vantage point watches to quantify flight activity by red-throated divers, merlin and whimbrel at selected turbines;
- Searches around selected turbines to quantify collisions by red-throated divers, merlin and whimbrel;

In addition, a ‘one-off’ study to measure bias in collision mortality searches due to detection error and carcass removal by scavengers would be undertaken in the year following final commissioning of the windfarm .

The bird monitoring programme would be agreed with SNH and RSPB prior to construction commencing. A report would be sent to the Scottish Executive, SNH and RSPB after each year of monitoring, together with details of any proposed changes to the monitoring programme as a result of survey findings.

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