
LIMEKILN WIND FARM

PROTECTED SPECIES REPORT

INFINERGY



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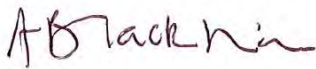
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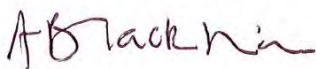
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Executive Summary

Contents	Summary
Site Location	The site is located within Limekiln Estate, to the south of the village of Reay, Caithness, Highland.
Proposals	Revision of consented Limekiln Wind Farm; includes new access routes, increase in tip height for each of the 21 turbines to 149.9 m and removal of one borrow pit from the scheme.
Survey Scope	<p>The objectives of the report are to carry out:</p> <ul style="list-style-type: none"> ✔ A desk study, to obtain existing information on statutory and non-statutory sites of nature conservation interest and relevant records of protected/notable species within the site and its zone of influence; ✔ A survey of the site to map the distribution of key protected species, namely otter, water vole and pine marten. Any signs of other protected or notable species were recorded, such as reptiles badgers and bats. ✔ An assessment of the potential ecological features present, any constraints they pose to development of the site and any recommendations for further surveys, avoidance, mitigation or compensation
Results	<p>Otter</p> <p>Spraints found on both the Reay and Achvarasdal Burns suggesting otter are using the site. Excellent foraging habitat within the catchment of both burns and suitable resting sites, however none confirmed during survey.</p> <p>Water Vole</p> <p>Reduction in number of active colonies since 2011 survey. Main activity found on Meur an Fhuarain Ghill, a tributary of the Reay Burn, approximately 80 m from construction footprint.</p> <p>Pine Marten</p> <p>Pine marten activity noted (scats) throughout the site. No dens confirmed, although suitable habitat for denning present in log piles which are found throughout the site and wider forest area.</p> <p>Reptiles</p> <p>Two common lizard observed during surveys along the suitable riparian habitats and edge habitats (woodland rides).</p> <p>Other Species</p> <p>No potential roost sites were recorded within the survey area and no signs of badger were noted.</p> <p>No NatureScot Licences are required at this Stage</p>
Recommendations	<p>Further Surveys</p> <p>Pre-construction survey for otter, water vole and pine marten at least six weeks prior to commencement on site.</p> <p>Mitigation</p> <ul style="list-style-type: none"> ✔ Species Protection Plan to be completed for; otter, water vole & reptiles. ✔ Open excavations should be covered or provision of 'ladders' to allow access for mammals to escape. ✔ Any lighting (temporary or permanent) should be directed away from watercourses and woodland edges to prevent disturbance to nocturnal species (e.g. bats).

1 Introduction

1.1 Introduction

Nevis Environmental Ltd (Nevis) was commissioned by Infinergy Ltd in February 2021, to carry out an updated ecological assessment of Limekiln Wind Farm as part of Limekiln Wind Farm Section 36C variation application , hereafter referred to as the 'Revised Consented Development' or ' the site'.

This report has been prepared by Nevis Ecology Project Manager, Karen Aldridge, MCIEEM.

1.2 Site Location

The site is located at the Limekiln Estate, Caithness; approximately 1.5km to the south of the village of Reay and is centred on Ordnance Survey (OS) grid reference (NG 98270 60620). The site is shown on Figure 1 and the habitats on site are predominantly commercial coniferous plantation of Sitka spruce *Picea sitchensis* and Lodgepole pine *Pinus contorta*. The habitats surrounding the site include undulating open moorland to the east and agricultural land to the north-east of the site.

1.3 Development Proposals

The consented development includes the construction and operation of 21 turbines. The key infrastructure for this development included;

- ✔ 21 wind turbines (with a maximum blade tip height between 139 m and 126 m) and associated foundations and hardstandings;
- ✔ network of underground cables for the grid connection;
- ✔ access tracks connecting each turbine location;
- ✔ onsite substation and control/maintenance buildings;
- ✔ two borrow pits;
- ✔ new access to link site to the A836 at Bridge of Isauld;
- ✔ temporary access and compound areas; and
- ✔ a permanent anemometer mast to measure wind speed and direction.

Works completed on site under the consented development include; access track from A836 to the control building, hardstanding for the control building and works at borrow pit (including blasting and crushing). Additionally Ground Investigation (GI) works were undertaken in Spring/Summer 2020, which included felling of 50 m corridors through proposed access routes to undertake GI works in vicinity of wind turbine hardstanding's. None of the felled material has been removed from site and has been left stacked along each of the corridors and around turbine locations.

The revised proposals include;

- ✔ no change in the number of turbines;
- ✔ redesigned access tracks to minimise disturbance to the core path within Limekiln Forest;
- ✔ removal of one borrow pit; and

- ▼ increase of tip height for each turbine to 149.9 m

1.4 Purpose of the Report

This report seeks to document the present distribution of otter *Lutra lutra*, water vole *Arvicola amphibious*, pine marten *Martes martes*, within the site. In addition, any observations as to the suitability of the site for reptiles, bats or badger *Meles meles* were also undertaken.

2 Methods

2.1 Desk Study

2.1.1 Previous Reports

Limekiln Wind Farm has undergone a number of surveys since the original Environmental Statement was completed in 2012 (Infinergy, 2012).

During 2011/2012, a full suite of surveys was undertaken to inform the environmental assessment;

- ✓ phase 1 Habitat & National Vegetation Classification Surveys (NVC);
- ✓ water vole survey;
- ✓ pine marten survey;
- ✓ bat surveys;
- ✓ freshwater macroinvertebrates; and
- ✓ electrofishing.

As part of the consented development, pre-construction surveys were undertaken during 2019 (EnviroCentre, 2019) – 2020 (Nevis Environmental Ltd, 2020), these included;

- ✓ water vole survey of suitable habitat within 200 m of water crossing locations and of suitable habitat around turbine locations;
- ✓ otter survey of suitable habitat within 250 m of any proposed infrastructure;
- ✓ bat surveys of any suitable structures within 30 m of any proposed works;
- ✓ pine marten survey of all suitable habitats within 200 m, prior to any felling works (or any other works associated with the development); and
- ✓ electrofishing surveys on Sandside Burn Reay Burn and Achvarasdal Burn.

An extension to the site was proposed in 2020; Limekiln Wind Farm Extension (Planning Ref 20/01905/S36). The proposed extension site, is located to the west of the site on Broubster and Achaveilan North Estates. The Environmental Impact Assessment (EIA) for this proposal included vegetation surveys, protected species surveys, including static bat recordings at proposed turbine locations (Infinergy Ltd, 2020).

2.1.2 Online Resources

The following web-based databases were also accessed:

- ✓ NatureScot SiteLink (NatureScot, 2021) for information on statutory designated sites for otter, water vole or bats.

2.2 Field Survey

The ecological survey work was undertaken on the site on in May 2021 (6th – 7th & 10th – 12th) by Nevis Ecology Project Manager, Karen Aldridge, MCIEEM. The weather conditions were predominantly overcast throughout the survey days with periods of heavy showers on the 11th May. Air temperatures varied between 8°C to 12°C throughout the survey period.

The following methodologies were used to inform the assessment of habitat types and protected and notable species during the Ecology Survey.

2.2.1 Protected and Notable Species

The site was assessed for the possible presence of, and the likely importance of its habitats for, protected or notable species, especially those listed under the Schedule 2 of the Habitat Regulations 1994 (as amended), Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) (W&CA) and The Protection of Badgers Act 1992.

Any Species of Principal Importance (SPI) for the conservation of biodiversity in Scotland (as listed on the Scottish Biodiversity List) and/or local priority species, included in the Highland Biodiversity Action Plan that were present on or adjacent to the site were also recorded during the survey.

The site was assessed for the possible presence of, and the likely importance of its habitats for, protected or notable species, especially those listed under the Schedule 2 of the Habitat Regulations 2017, Schedule 5 of the Wildlife and Countryside Act 1981 (W&CA), the Countryside and Rights of Way (CROW) Act 2000, those given extra protection under the Nature Conservation Act 2004, and species included in the Highland BAP.

Otter

The site was surveyed for its suitability for otter, based on guidance outlined in *Monitoring the otter* (Chanin, 2003) and *Protected Species Development Guide: Otter* (NatureScot, 2020). The survey concentrated on looking for field signs along riparian corridors and in suitable terrestrial habitats. Field signs included:

- ✔ spraints;
- ✔ footprints;
- ✔ slides;
- ✔ couches/lay-ups/hovers; and
- ✔ holts

Water Vole

Freshwater habitats within 50 m of any proposed infrastructure, such as the Reay and Achvarasdal Burns and their associated tributaries, were assessed for suitability for water voles based on guidance outlined in *Water Vole Mitigation Handbook* (Dean, Strachan, Gow, & Andrews, 2016) Signs of water vole included:

- ✔ latrines;
- ✔ burrows;
- ✔ feeding signs; and
- ✔ runways.

Pine Marten

Suitable habitat within 200 m of any proposed infrastructure was assessed for suitability for pine marten *Martes martes*. The survey methods followed guidance outlined in UK BAP Mammals (W.J Cresswell, 2012) and guidance based on *Species Planning Advice: Pine Marten* (NatureScot, 2020). The surveys entailed the looking for signs of

pine marten throughout the site, walking transects within accessible areas of the woodland pockets or assessing woodland from accessible woodland rides. Field signs included:

- ✓ footprints;
- ✓ Scats; and
- ✓ potential den structures (either in trees or other suitable locations).

Reptiles

The site was appraised for its suitability to support reptiles, including common lizard *Zootoca vivipara* and slow worm *Anguis fragilis*. The assessment was based on Guidance outlined in the *Herpetofauna Workers' Manual* (Gent, 2003)

Bats

Roosting Bats

Buildings, structures and trees on site and within 30 m of the site boundary were assessed from the ground for their suitability to support breeding, resting and hibernating bats, with reference to the methods outlined in *Bat Surveys for Professional Ecologists: Good Practice Guidelines 3rd ed* (Collins, 2016); hereafter referred to as the 'BCT Guidelines'. The following system has therefore been used to categorise the bat roost suitability of any features found:

Table 1 Bat Roost Suitability Categories

Suitability	Description of Potential Roosting Habitats
Negligible	Negligible habitat features on site likely to be used by roosting bats.
Low	A structure with one or more potential roost sites that could be used by individual bats opportunistically. However, these potential roost sites do not provide enough space, shelter, protection, appropriate conditions and/or suitable surrounding habitat to be used on a regular basis or by larger numbers of bats (i.e. unlikely to be suitable for maternity or hibernation). A tree of sufficient size and age to contain potential roost features (PRFs) but with none seen from the ground or features seen with only very limited roosting potential.
Moderate	A structure or tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only – the assessments in this table are made irrespective of species conservation status, which is established after presence is confirmed).
High	A structure or tree with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis & potentially for longer periods of time due to their size, shelter, protection, conditions & surrounding habitat.

Foraging/commuting bats

In accordance with the BCT Guidelines, the following criteria have been used to categorise the potential value of site habitats and features for use by foraging and commuting bats (Table 2)

Table 2 Bat Foraging Habitat Categories

Suitability	Description of Potential Foraging Habitats
Negligible	Negligible habitat features on site likely to be used by commuting or foraging bats.
Low	Habitat that could be used by small numbers of commuting bats such as a gappy hedgerow or unvegetated stream, but isolated, i.e. not very well connected to the surrounding landscape by other habitat. Suitable, but isolated habitat that could be used by small numbers of foraging bats such as a lone tree (not in a parkland situation) or a patch of scrub.
Moderate	Continuous habitat connected to the wider landscape that could be used by bats for commuting such as lines of trees and scrub or linked back gardens. Habitat that is connected to the wider landscape that could be used by bats for foraging such as trees, scrub, grassland or water.
High	Continuous high-quality habitat that is well connected to the wider landscape that is likely to be used regularly by commuting bats such as river valleys, streams, hedgerows, lines of trees and woodland edge. High-quality habitat that is well connected to the wider landscape that is likely to be used regularly by foraging bats such as broadleaved woodland, tree-lined watercourses and grazed parkland. Site is close to and connected to known roosts.

Badgers

The site was surveyed for evidence of badger setts or other badger activity such as paths, latrines or signs of foraging. Any setts recorded were classified according to the criteria outlined in *Surveying Badgers* (Harris, Creswell, & Jefferies, 1989).

Other Species

The site was also appraised for its suitability to support other protected or notable fauna including mammals, amphibians, and invertebrates with regard to CIEEM’s *Guidelines for Preliminary Ecological Appraisal* (CIEEM, 2017). Evidence of any current or historical presence of such species was recorded.

2.3 Limitations

The ecology surveys were undertaken within the optimum survey window for each of the species, and it is therefore considered that there were no seasonal constraints to the survey.

Heavy showers were experienced on 11th May, it is therefore possibly that signs of water vole or otter may have been missed due to the heavy rain, however the habitat could still be suitably assessed, and it is unlikely that the short period of rain during the survey period would have a significant limitation on the results.

3 Baseline Conditions

All relevant ecological data provided by the desk study was reviewed and the results from these investigations are summarised below. Relevant site photos are presented in Appendix A and details of the legislation relating to the species discussed are presented in Appendix B.

3.1 Designated Sites

The search of NatureScot Site Link returned one internationally important conservation site within 5 km of the site, with a protected species (otter) as a designated feature (Table 3; Figure 1).

Table 3: Summary of Internationally Important Nature Conservation Sites within 5km of the Site.

Site Name and Designation	Proximity and Direction to the Site	Designated Features
Caithness and Sutherland Peatlands Special Area of Conservation (SAC)	0 km - Adjacent to south west boundary of the site.	<p>Annex I habitats that are a primary reason for selection of the site:</p> <p>3130 - Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or the Isoëto-Nanojuncetea</p> <p>3160 - Natural dystrophic lakes and ponds Acid peat-stained lakes and ponds</p> <p>7130 - Blanket bog</p> <p>Annex I habitats present as a qualifying feature, but not a primary reason for selection of the site:</p> <p>4010 - Northern Atlantic wet heaths with <i>Erica tetralix</i></p> <p>7140 - Transition mires and quaking bogs</p> <p>7150 - Depressions on peat substrates of the <i>Rhynchosporion</i></p> <p>Annex II species that are a primary reason for selection of this site:</p> <p>1355 - Otter</p> <p>1528 - Marsh saxifrage <i>Saxifraga hirculus</i></p>

A further two internationally important sites and five nationally important sites (Sites of Special Scientific Interest) were recorded within 5 km of the site, however none of these sites are designated for any terrestrial species. These sites are:

- ✔ Broubster Leans SAC / SSSI.
- ✔ Caithness and Sutherland Peatlands Ramsar.
- ✔ East Halladale SSSI.
- ✔ Loch Caluim Flows SSSI.
- ✔ Red Point Coast SSSI.
- ✔ Sandside Bay SSSI.

3.2 Protected and Notable Species

The results of the protected species survey is found in Figure 2. The reports for water vole and pine marten from 2011 are in Appendix C.

3.2.1 Otter

The otter survey found signs of otter activity along both the Reay and Achvarasdal Burns. No resting places were confirmed during the survey but both Achvarasdal and Reay Burn provide suitable habitat for resting sites (such as lay-ups or couches) along the entirety of the survey area. Within the survey area, both burns lack the typical habitat associated with holts (e.g. cavities within rocky banks or under tree roots), however it is likely that both offer suitable holt and/or hover habitats downstream, where they become wider and are surrounded by dense shrubs and trees.

3.2.2 Water Vole

During the 2011 surveys 14 active water vole colonies were recorded (Waterside Ecology, 2012). However, the recent survey, recorded very limited water vole signs within the survey area.

Reay Burn & Catchment

Signs of water vole activity were recorded on Meur an Fhuarain Ghill (Appendix A, Photo 1) at NC 97670 60866, with two burrows (Appendix A, Photo 2), and several obvious 'runs' in the bankside vegetation. A water vole latrine was recorded within 1 m of the burrows on raised vegetation within the bed of the burn.

A further burrow was identified at NC 97643 60390 on Meur a' Chrochain Ghill. It was assessed as being a suspected water vole burrow (appropriate size and location), however in the absence of obvious water vole signs (droppings or feeding signs) it could not be confirmed. It is likely an old burrow; historical records had confirmed water vole presence on this tributary in 2011. The burrow is within habitat that is considered good for water vole, with an abundance of suitable bank side vegetation (grasses and rushes), gently sloping banks and slow flowing water (Appendix A, Photo 3).

Achvarasdal Burn & Catchment

Water vole activity was recorded along the Achvarasdal Burn, at the edge of the survey boundary. Three burrows and two latrines were recorded at NC 99420 61190. The area immediately downstream of the survey area, appeared to offer good habitat for water vole, with gently sloping banks, slow flowing water and abundant bank side grasses.

Areas of unsuitable habitat within the survey area were mapped. Unsuitable habitats included; areas which offer limited burrow creation, such as rocky substrate, flat-sided areas (Photo 4) or steep sided slopes (<35° angle) (Photo 5). Watercourses which are particularly shaded by trees or other shrubs were also ruled as unsuitable. As the shade tends to limit bankside vegetation these sites are not favoured by water vole.

3.2.3 Pine Marten

Similar evidence of pine marten was recorded during the 2021 survey as during the previous surveys in 2011 and 2020, with pine marten scats, both old and fresh being recorded throughout much of the site.

No dens were recorded within the survey area, however there is an increase in denning potential within the site, compared to previous surveys, with the recent forestry activities creating numerous log piles (around turbine locations and access routes) (Appendix A, Photo 6). The rocky outcrops of Cnocan nan Eun (NC 98316 61457) also offer excellent denning habitat although no signs of occupation were recorded during the survey.

3.2.4 Reptiles

Two incidental records of common lizard were recorded during the survey at NC 97784 60777 and NC 97688 60408. Both these observations occurred in wet heath vegetation within riparian corridors.

3.2.5 Bats

Roosting Bats

No suitable bat roosting trees or structures were recorded within 30 m of any proposed infrastructure.

Foraging/Commuting Bats

The site offers low to moderate foraging suitability as classified in Table 2. Although the site has two main watercourses offering linear foraging/commuting features, the woodland area is isolated from other suitable foraging or commuting routes, with the west of the site comprising of open moorland and the east, mainly agricultural fields.

3.2.6 Badger

No signs of badger were recorded during the survey and the site is largely considered unsuitable for sett creation due to the dominance of water-logged substrate. However the coniferous plantation and connectivity to suitable habitats in the west of the site offer suitable foraging habitats for badger.

3.2.7 Other Notable Species

No observations of notable invertebrates or other notable species were recorded during the survey and the habitats (predominately coniferous plantation) on site are unlikely to support a large community of invertebrate species.

4 Discussion

4.1 Protected and Notable Species

4.1.1 Otter

Otter is a European Protected Species (EPS) and is protected by the Conservation (Natural Habitats &c.) Regulations 1994 (as amended).

The site is well connected to the wider landscape through the Reay and Achvarasdal Burns, which offer excellent foraging potential for otter. The survey results show that both these catchments are used by otter. Both catchments also offer suitable habitat for opportunistic resting of otter, with the Achvarasdal Burn and Reay Burn offering suitable habitat for more permanent resting e.g. holts downstream of the survey area.

The survey results do not indicate the requirement for a NatureScot Otters & Development Licence.

A pre-construction survey for otter, within 200 m of infrastructure is recommended at least six weeks prior to works commencing on site to update the baseline surveys.

Water Vole

Water vole are partially protected under Schedule 5 of Wildlife and Countryside Act 1981 (as amended) (WACA).

The water vole recorded at Meur an Fhuarain Ghill are approximately 80 m from the construction footprint. The colony on the Achvarasdal are over 100 m from the nearest construction and are not considered at risk from any construction activities.

The construction plans exclude work within riparian habitat except for at watercourse crossings, where there are currently no signs of water vole. As no works are expected within riparian habitats and there is no risk of damage to the water vole habitat. Due to the distance from the works, it is unlikely that site activity will lead to disturbance of water vole.

It should be noted that the 2011 survey area encompassed a larger survey boundary, as a design had not been fixed by the time it was carried out. Several of the colonies which were recorded during this survey, were located outside of the 200 m survey area. It is possible that these colonies survive and could therefore repopulate areas within the site. However, it is not uncommon for small populations of water vole to become extinct, especially in areas prone to flooding, such as the tributaries found within the Reay and Achvarasdal catchments (Rob Strachan, 2011).

There is currently no requirement for a NatureScot Water Vole & Development Licence.

A pre-construction survey for water vole within 50 m, around the water crossing locations and infrastructure with suitable habitat, is recommended at least six weeks prior to works commencing on site.

Pine Marten

Pine marten are protected under Schedule 5 of WACA 1981 (as amended) and are also partially protected under Conservation (Natural Habitats &c.) Regulations 1994 (as amended).

The survey results were similar to those obtained through surveys conducted in 2011 (Waterside Ecology, 2012) and 2020 and showed pine marten are active throughout the site, but elevated denning habitats are limited to Cnocan nan Eun and the log piles which are present throughout the site.

The survey did not confirm any dens; therefore a NatureScot Pine Marten & Development Licence is not required currently.

A pre-construction survey for pine marten should be conducted prior to any further forestry works or development, including a survey/inspection of the log piles and the rocky outcrop at Cnocan nan Eun at least 6 weeks prior to works.

Reptiles

It is likely that the site supports common lizard, but the population is likely to be sparsely distributed, with much of the site covered with dense plantation and therefore considered unsuitable for reptiles.

No further surveys for reptiles are recommended.

4.2 General Mitigation

The following good practice mitigation measures are recommended during construction;

- ✔ A Species Protection Plan to cover otter, water vole, pine marten, reptiles and bats.
- ✔ Site inductions and toolbox talks to cover the potential for otter, water vole, pine marten, reptiles and bats.
- ✔ All open trenches must be either covered at night or fitted with a mammal escape ramp (installed at an angle of less than 45°). These excavations should be checked daily, prior to works commencing.
- ✔ Any temporary or permanent lighting should be directed towards working areas and avoid illuminating the surrounding habitats, especially along watercourses, to prevent disturbance to nocturnal activity by mammals.

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Figures

Figure No.	Title
Figure 1	Designated Sites
Figure 2	Protected Species Results

LIMEKILN WIND FARM S 36C APPLICATION

Legend

- Site Boundary
- Special Conservation Area
- Site Infrastructure**
- Wind Turbines
- Wind Farm Access Tracks



Figure 1: Designated Sites



Scale: 1:25000

Drawn by: KA
 Checked by: AB
 Approved by: AB
 Ref Number: ENVd1240A
 Project Number: 16320
 Issue Date: 20/05/2021
 Projection: OSGB 1936/British National Grid - EPSG 27700
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LIMEKILN WIND FARM S 36C APPLICATION

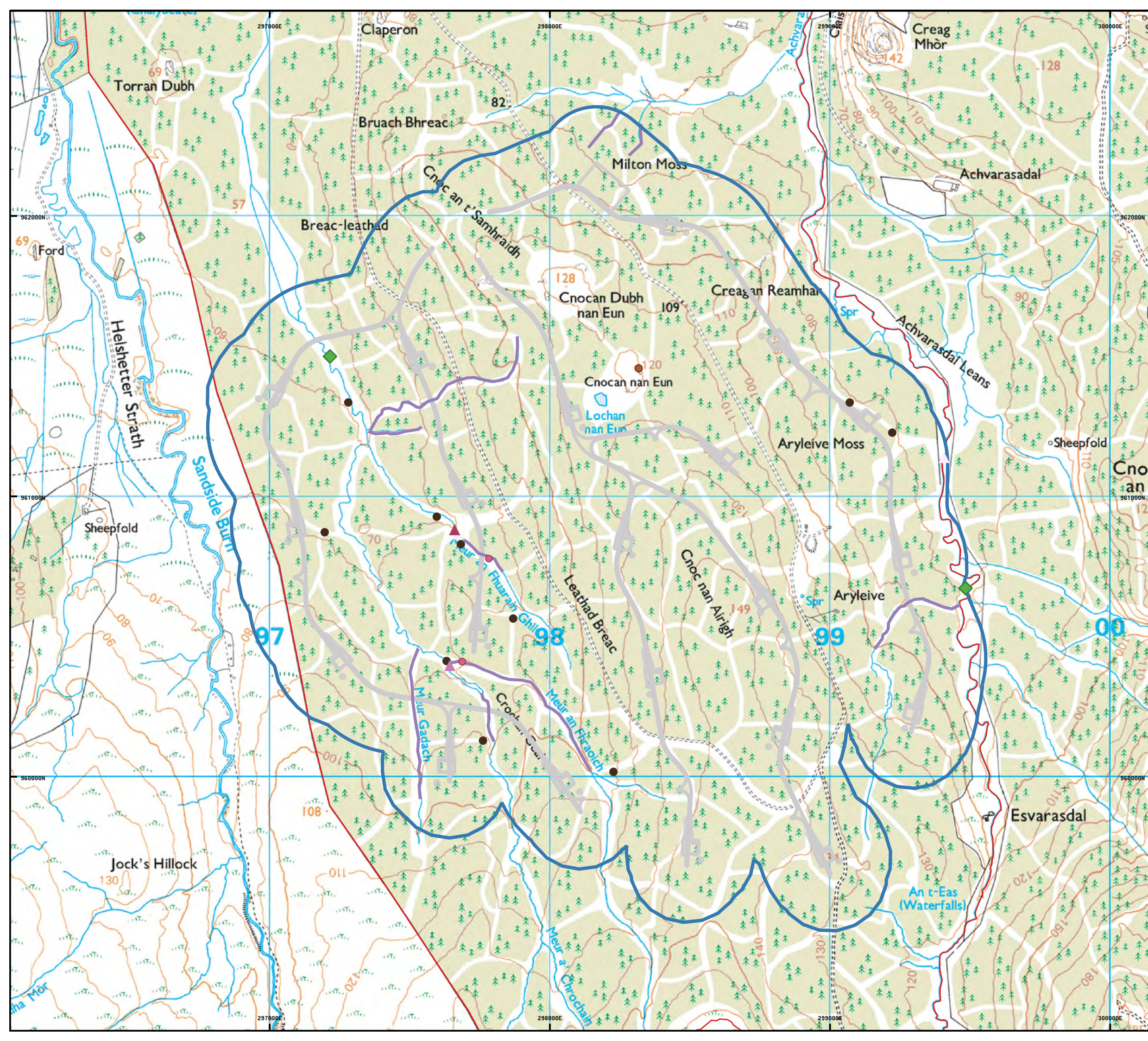
- Legend**
- Site Boundary
 - 200 m Survey Buffer
 - Wind Turbines
 - Wind Farm Access Tracks
- Protected Species Signs**
- Otter**
- ◆ Spraint
- Pine Marten**
- Potential Den
 - Scat
- Water Vole**
- ▲ Burrow (Old)
 - ▲ Burrows & Latrine
 - ▲ Old
 - Water Vole - Unsuitable Habitat
- Reptile**
- Common Lizard

Figure 2: Protected Species Survey Results



Scale: 1:12500

Drawn by: KA
 Checked by: AB
 Approved by: AB
 Ref Number: ENVd1241A
 Project Number: 16320
 Issue Date: 20/05/2021
 Projection: OSGB 1936/British National Grid - EPSG 27700
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Appendix A: Site Photographs



Photo 1: Meur an Fhuarain Ghill – stretch of watercourse where water vole signs were found.



Photo 2: Water vole burrow – large mouth, narrowing to approx. 6 cm inside.



Photo 3: Stretch of water course where old burrow was recorded. Showing suitable banks and vegetation.



Photo 4: Flat sided burn, just upstream of water crossing at east of site.



Photo 5: Typical steep sided watercourse which is considered unsuitable for water vole.



Photo 6: Example of log piles found around site and around most turbine locations.

Appendix B

General Legislation

The following presents accounts present a summary of the legislation relevant to the site and proposals. It is recommended that the reader also refer to the original legislation for definitive interpretation.

The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)

The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), henceforth referred to as the Habitats Regulations are the principal means by which the European Union's ECC Directive 92/43 (The Habitats Directive) as amended is transposed into English and Welsh law.

The Habitats Regulations place duty upon the relevant authority of government to identify sites which are of importance to the habitats and species listed in Annexes I and II of the Habitats Directive. Those sites which meet the criteria are, in conjunction with the European Commission, designated as Sites of Community Importance, which are subsequently identified as Special Areas of Conservation (SAC) by the European Union member states. The regulations also place a duty upon the government to maintain a register of European protected sites designated as a result of EC Directive 79/409/EEC on the Conservation of Wild Birds (The Birds Directive). These sites are termed Special Protection Areas (SPA) and, in conjunction with SACs, form the Natura 2000 network of sites. The Habitats Directive introduces for the first time for protected areas, the precautionary principle; that is that projects can only be permitted having ascertained no adverse effect on the integrity of the site. Projects may still be permitted if there are no alternatives, and there are imperative reasons of overriding public interest.

The Habitats Regulations also provide for the protection of individual species of fauna and flora of European conservation concern listed in Schedules 2 and 5 respectively. These are commonly referred to as European Protected Species. Schedule 2 includes species such as otter, great crested newt and most recently beaver for which the Scottish population represents a significant proportion of the total European population. It is an offence to deliberately kill, injure, disturb or trade these species. Schedule 5 plant species are protected from unlawful destruction, uprooting or trade under the regulations.

It is also an offence under the Habitats Regulations for any person to have in their possession or control, to transport, to sell or exchange, or to offer for sale, any live or dead protected species, part of a protected species or anything derived from a protected species, which has been unlawfully taken from the wild.

The Wildlife and Countryside Act (WCA) 1981

The WCA, as amended, consolidates and amends pre-existing national wildlife legislation in order to implement the Bern Convention and the Birds Directive. It complements the Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2012, offering protection to a wider range of species. The Act also provides for the designation and protection of national conservation sites of value for their floral, faunal or geological features, termed Sites of Special Scientific Interest (SSSIs).

Schedules of the act provide lists of protected species, both flora and fauna, and detail the possible offences that apply to these species. All relevant species-specific legislation is detailed later in this Appendix.

Nature Conservation (Scotland) Act 2004

The Nature Conservation (Scotland) Act 2004 places a duty on all public authorities, including local planning authorities, to consider biodiversity in their work. The legislation also requires government departments to have regard to the Convention on Biological Diversity. As a result of the Act, Scottish ministers were required to produce a biodiversity strategy for Scotland (the Scottish Biodiversity Strategy) and a list of species and habitats of principal importance for biodiversity conservation in Scotland (the Scottish Biodiversity List) and to take or promote steps to further their conservation. This legislation also strengthens the protection given to SSSIs and amends rules on protecting certain birds, animals and plants.

Wildlife and Natural Environment (Scotland) Act 2011

The Wildlife and Natural Environment (Scotland) Act 2011 or WANE Act amends the Wildlife and Countryside Act, to create more far reaching legislation in respect of invasive species. In relation to the spread of invasive species, The Act makes it an offence to:

- ✔ plant, or otherwise causes to grow, any plant in the wild at a place outwith its native range.
- or
- ✔ release, or allow to escape from captivity, any animal
 - to a place outwith its native range; or
 - of a type the Scottish Ministers, by order, specify; or
- ✔ otherwise causes any animal outwith the control of any person to be at a place outwith its native range.

This does not apply to animals that are released or allowed to escape from captivity for the purpose of being subsequently killed by shooting, which are at present: common pheasant and red-legged partridge.

The Act also introduced new offences in relation to keeping invasive species and made it an offence for any person to:

- ✔ keep, have in their possession, or have under their control
 - any invasive animal of a type which the Scottish Ministers, by order, specify; or
 - any invasive plant of a type so specified.

The Act also makes provision for the prohibition of keeping invasive animal and plant species and for requiring notification about the presence of such species in a particular area.

In addition to the strengthening of invasive species legislation, the Act also introduced tougher powers against wildlife crimes.

Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR Regulations)

The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR Regulations) provide the regulator environment covering the impacts of certain activities on water abstractions and Ground Water

Dependent Terrestrial Ecosystems (GWDTE) which member states are obliged to protect from significant damage, under the EU Water Framework Directive. SEPA have developed guidance on the identification, assessment and protection of GWDTE.

Wild Mammals Protection Act 1996

This Act offers protects a form of protection to all wild species of mammals, irrespective of other legislation, and focussed on animal welfare, rather than conservation.

Unless covered by one of the exceptions, a person is guilty of an offence if he mutilates, kicks, beats, nails or otherwise impales, stabs, burns, stones, crushes, drowns, drags or asphyxiates any wild mammal with intent to inflict unnecessary suffering.

Its application is typically restricted to preventing deliberate harm to wildlife (in general) during construction works etc.

Specific Legislation

Herpetofauna (reptiles and amphibians)

All the UK's native reptiles and amphibians are protected by law, although their level of protection differs.

Both reptiles (adder, grass snake, common lizard and slow worm) and amphibians (common frog, common toad, smooth newt, palmate newt) are protected via part of Section 9(5) of the Wildlife & Countryside Act 1981 (as amended) against:

- ✔ selling, offering or exposing for sale, or having in possession or transporting for the purpose of sale, any live or dead wild animal or any part of, or anything derived from, such an animal; or
- ✔ publishing or causing to be published any advertisement likely to be understood as conveying buying or selling, or in or selling, or intending to buy or sell, any of those things.

Four species of reptile excluding sea turtles (slow worm, sand lizard, adder and common lizard) and three species of amphibian (common toad, natterjack toad, pool frog and great crested newt) are listed as are listed as SPI on the Scottish Biodiversity List and therefore are a material consideration for Local Planning Authorities (LPAs) during the planning process.

Bats

Bats and the places they use for shelter or protection (i.e. roosts) receive European protection under the Habitats Regulations 1994. They receive further legal protection under the Wildlife and Countryside Act (WCA) 1981, as amended. This protection means that bats, and the places they use for shelter or protection, are capable of being a material consideration in the planning process.

Regulation 41 of the Habitats Regulations (as amended), states that a person commits an offence if they:

- ✔ deliberately capture, injure or kill a bat;
- ✔ deliberately disturb bats; or

- ✔ damage or destroy a bat roost (breeding site or resting place).

Disturbance of animals includes in particular any disturbance which is likely to impair their ability to survive, to breed or reproduce, or to rear or nurture their young, or in the case of animals of a hibernating or migratory species, to hibernate or migrate; or to affect significantly the local distribution or abundance of the species to which they belong.

It is an offence under the Habitats Regulations (as amended) for any person to have in their possession or control, to transport, to sell or exchange or to offer for sale, any live or dead bats, part of a bat or anything derived from bats, which has been unlawfully taken from the wild.

Whilst broadly similar to the above legislation, the WCA 1981 (as amended) differs in the following ways:

- ✔ Section 9(1) of the WCA makes it an offence to intentionally kill, injure or take any protected species.
- ✔ Section 9(4)(a) of the WCA makes it an offence to intentionally or recklessly damage or destroy, or obstruct access to, any structure or place which a protected species uses for shelter or protection.
- ✔ Section 9(4)(b) of the WCA makes it an offence to intentionally or recklessly* disturb any protected species while it is occupying a structure or place which it uses for shelter or protection.

As bats re-use the same roosts (breeding site or resting place) after periods of vacancy, legal opinion is that roosts are protected whether or not bats are present.

Nine bat species are listed as 'SPI' as SPI on the Scottish Biodiversity List. These are:

- ✔ Barbastelle bat *Barbastella barbastellus*.
- ✔ Bechstein's bat *Myotis bechsteinii*.
- ✔ Noctule *Nyctalus noctule*.
- ✔ Soprano pipistrelle *Pipistrellus pygmaeus*.
- ✔ Brown long-eared bat *Plecotus auritus*.
- ✔ Greater horseshoe bat *Rhinolophus ferrumequinum*.
- ✔ Lesser horseshoe bat *Rhinolophus hipposideros*.

Otter

Otters are protected under sections 9 and 11 of the Wildlife and Countryside Act 1981 and also under the Habitats Regulations, making them a European protected species. Under this legislation, it's an offence to:

- ✔ capture, kill, disturb or injure otters (on purpose or by not taking enough care);
- ✔ damage or destroy a breeding or resting place (deliberately or by not taking enough care);
- ✔ obstruct access to their resting or sheltering places (deliberately or by not taking enough care); or
- ✔ possess, sell, control or transport live or dead otters, or parts of otters.

Otters are listed as SPI in are listed as SPI on the Scottish Biodiversity List and therefore are a material consideration for Local Planning Authorities (LPAs) during the planning process.

Water Vole

The water vole is fully protected under Schedule 5 of the Wildlife and Countryside Act 1981 and is a priority conservation species. Under this legislation, it's an offence to:

- ✔ intentionally capture, kill or injure water voles;
- ✔ damage, destroy or block access to their places of shelter or protection (on purpose or by not taking enough care);
- ✔ disturb them in a place of shelter or protection (on purpose or by not taking enough care); or
- ✔ possess, sell, control or transport live or dead water voles or parts of them (not water voles bred in captivity).

Water vole are listed as SPI on the Scottish Biodiversity List and therefore are a material consideration for Local Planning Authorities (LPAs) during the planning process.

Pine Marten

Pine marten are protected species, listed under Schedules 5 and 6 of the Wildlife and Countryside Act 1981 (as amended). Under this legislation it is an offence to intentionally or recklessly:

- ✔ kill or injure a pine marten;
- ✔ damage or destroy any structure or place a pine marten uses for shelter or protection; or
- ✔ disturb a pine marten while it is occupying a structure or place for shelter or protection (except when this is inside a dwelling house).

It is also an offence to:

- ✔ possess or control, sell, offer for sale or possess or transport for the purpose of sale any living or dead pine marten or any derivative of such an animal.

Pine marten are listed as SPI on the Scottish Biodiversity List and therefore are a material consideration for Local Planning Authorities (LPAs) during the planning process.

Appendix C: 2011 Water Vole and Pine Marten Survey Reports

Appendix 11.E

Water Vole Survey Report

**Limekiln Wind Farm:
Survey of water vole *Arvicola amphibius***

Report to Infinergy Ltd

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1 Summary

1.1 Background

A survey of water voles *Arvicola amphibius* was commissioned to inform the Environmental Impact Assessment for the proposed Limekiln Wind Farm in Caithness. The proposed wind farm is anticipated to have 30 to 50 turbines and would be constructed to the south of the village of Reay. The site extends to approximately 11 km² and is currently used mainly for commercial forestry.

Two experienced surveyors carried out the survey during summer 2011. The survey involved careful searches for water voles signs along all watercourses in the proposed wind farm site.

1.2 Main findings

- Active water vole colonies were widespread in the study area.
- Six active colonies were identified in the Reay Burn catchment. These were on the Reay Burn (two colonies), an unnamed stream near Borag Knowe (one colony), Meur a' Chrochain Ghill (one colony) and Meur an Fhraoich (one colony). One further colony extended from the Reay Burn for approximately 1 km up the Meur an Fhuarain Ghil.
- Eight active colonies were identified on the Achvarasdal Burn catchment. Five of these were on the Achvarasdal Burn, one on the stream draining Milton Moss, one on a small tributary at Achvarasdal Leans and one on the Allt Cnoc an Fhraoich. The site on Allt Cnoc an Fhraoich was just outside the wind farm perimeter but linked to it by suitable water vole habitat.
- Several further sites were identified where there was evidence of previous occupancy by water voles. These were mainly in the upper reaches of the Reay Burn catchment.
- Both the Reay Burn and Achvarasdal Burn have long reaches of suitable habitat for water voles. These habitats provide for good linkage and easy dispersal between adjacent colonies. Maps of habitat distribution are provided.
- Large areas of suitable water vole habitat are present outside the proposed wind farm boundary and records suggest water voles are likely to be widespread in these areas, providing a potential source of immigrants to the Limekiln site. Barring any catastrophic events, it is expected that the water vole population at Limekiln will persist.
- No signs of water voles were identified other than along the watercourses. Minor ditches beneath the plantation canopy did not provide suitable habitat.

1.3 Implications

The design of the proposed wind farm has taken account of the distribution of water vole colonies and water vole habitats in order to avoid negative impacts on the species. The riparian strip will be avoided during enabling works and construction. All proposed stream crossings are to be located away from water vole colonies and optimal water vole habitat.

Water vole colonies are not entirely static and they may expand or shrink over time. Some colonies may become extinct and new colonies may be created. Therefore stream crossings and any other infrastructure that may encroach onto potentially suitable water vole habitats, including sub-optimal habitat, should be re-surveyed prior to enabling works and/or construction.

2 Introduction

2.1 Proposed scheme

A survey of water voles *Arvicola amphibius* (previously *A. terrestris*) was commissioned to inform the Environmental Impact Assessment for the proposed Limekiln Wind Farm in Caithness. The proposed wind farm is anticipated to have 30 to 50 turbines and would be constructed to the south of the village of Reay. The site extends to approximately 11 km² and is currently used mainly for commercial forestry. The trees are at a 'thicket' stage and there is little development of a field layer except at the perimeter. The land has been ploughed for planting and the trees are planted on ridges; the habitat remnants in the firebreaks indicate the trees were mainly planted on blanket bog.

Two main watercourses the Achvarasdal Burn and Reay Burn drain the site, both running south to north. The Achvarasdal Burn runs along the eastern site boundary and the Reay Burn runs close to its western edge. Both of these streams are fed by a number of small tributaries that drain the site. These waterbodies provide potential habitat for water voles, which are widespread in Caithness (Strachan & Jefferies 1993; Fraser *et al.* 2005). The proposed development has potential to impact on water voles through damage to habitats, resting sites or the voles themselves.

2.2 Water vole legal status

Since 1998 the water vole has received legal protection through its inclusion on Schedule 5 of the Wildlife & Countryside Act 1981 (as amended), in respect of Section 9(4) only. This means that the water vole's places of shelter or protection are protected, but not the animals themselves. Recently the Nature Conservation (Scotland) Act 2004 enhanced this protection by inclusion of the term 'recklessly' in the offences quoted below. The current partial protection afforded this species is under wider review and may be extended in future. At present it is an offence to intentionally or recklessly:

- Damage, destroy or obstruct access to any structure or place which water voles use for shelter or protection, and;
- Disturb water voles while they are using such a place.

The implementation of the Act differs somewhat between Scotland and the rest of the UK, where it is also an offence to intentionally or recklessly kill, injure or take a water vole from the wild.

Water voles are listed as a 'Priority Species' in the UK Biodiversity Action Plan. Scottish Planning Policy (2010) requires all public bodies, including planning authorities, to further the conservation of biodiversity under the Nature Conservation (Scotland) Act, and to reflect this duty in development management decisions.

2.3 Water vole ecology

The water vole is found living along waterway edges in a variety of habitats from upland streams to wide rivers and agricultural ditches (Aars *et al.* 2001; Lambin *et al.* 2004; Strachan *et al.* 2011). Water voles are almost wholly vegetarian, feeding on a wide range of plants. They favour riparian habitats affording luxurious bank-side vegetation, particularly grasses and sedges, to provide food and cover from predators. They may tolerate brackish water and feed on halophytic plants, but do not generally inhabit areas that dry out twice daily, and so are largely absent from estuaries and salt marshes.

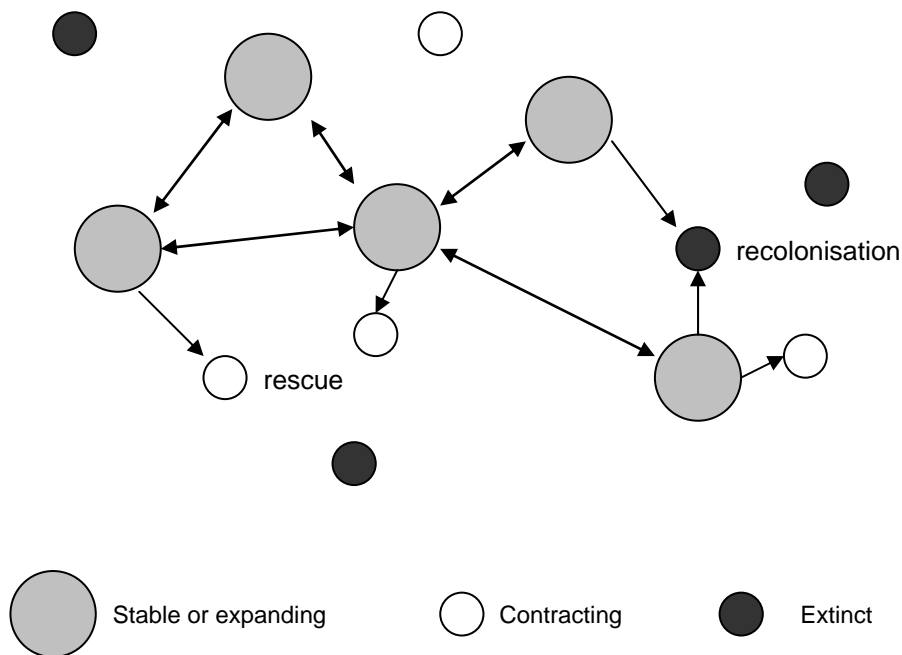
Water voles create extensive systems of burrows with interconnecting tunnels and entrances both above and below the water surface. Steep banks with a slope of 35 degrees or more allow burrowing and, importantly, provide refuge during flood events. However, vertical or overhanging banks may be difficult for water voles to access for burrowing, unless there are access ledges at water level. Rocky banks are avoided due to the difficulty of excavation.

Fragmentation of suitable habitat has caused a fragmentation of water vole populations and a consequent reduction in population size. Each small colony is defined by an area of suitable habitat and

is separated from other such areas by unsuitable habitat. These small populations are vulnerable to extinction but can be preserved through dispersal of individuals between them. Water voles are effective dispersers and travel an average distance of 2 km to find a mate and appropriate habitat (Lambin *et al.* 2004). In upland Scotland, dispersal distances are even greater and water voles travel an average distance of 3.5 km (and up to 23.9 km) to find a mate and appropriate habitat (Lambin *et al.* 2011).

The highly localised distribution of habitat leads to a population structure where a large regional population comprises many smaller sub-populations or colonies. Colonies vary in size, but where suitable habitat is present as small patches a colony may consist of only one female and her progeny. Many adults do not survive to breed in two successive years and as the juveniles do not reproduce within the year of their birth small colonies are vulnerable to extinction. However they can be sustained through dispersal from other colonies. As a result the overall population, likened by Macdonald and Strachan (1999) to “a constellation of twinkling stars blinking on and off”, may remain relatively stable while individual sub-populations come and go. This phenomenon of many small sub-populations within an overall patchy distribution functioning independently but interacting via movements of individuals is known as a metapopulation (Figure 1).

Figure 1 Metapopulation structure.



Circles represent colonies and connecting arrows dispersal. Re-colonisation occurs when an animal disperses from a stable or expanding population to an extinct one. Rescue occurs with dispersal from a stable or expanding population to one that is decreasing in numbers.

2.4 Water voles, regional and local status

The water vole is one of Britain's most threatened mammal species. Over the last fifty years its population is estimated to have declined by 94% (Strachan & Jefferies 1993; Strachan *et al.* 2000), one of the most rapid and serious declines of any UK mammal. Habitat loss and degradation, fluctuations in water levels and pollution have all contributed to this decline, which has been greatly exacerbated by the spread of the American mink *Neovison vison*, an introduced and very efficient generalist predator (Strachan *et al.* 2011). Mink were brought to fur farms in the UK in the 1920s and 1930s. Following escapes and intentional releases mink are now widespread in Britain (Dunstone & Macdonald 2008;

Harrington *et al.* 2008). Once mink have colonised a waterway their impact on water voles is usually catastrophic leading to localised water vole extinction as well as fragmentation of remaining populations, threatening their long-term viability.

Mink populations are expanding in Scotland but there is, as yet, no evidence that they have reached Caithness (Harrington *et al.* 2008). Caithness and east Sutherland contain large expanses of peatland and, to a lesser extent crofting, habitats that are suitable for water voles (Fraser *et al.* 2005). As a result, water voles remain widespread in this part of Scotland. The Caithness and east Sutherland area has been identified by Scottish Natural Heritage as a Priority Area for water vole conservation, under the Species Action Framework, part of the Scottish Biodiversity Strategy. NBN lists one record of water voles on the Achvarasdal Burn, at NC 996 582. It also includes records on the Sandside Burn and at Loch Thormaidd, a short distance to the west and east of the proposed wind farm site respectively.

3 Aims and objectives

The aim of this study was to identify water vole colonies and habitats within the study area, in order that the potential impact of the proposed wind farm can be assessed. Field surveys were conducted to:

- (i) Establish presence and distribution of water voles along watercourses in the survey area;
- (ii) Assess the distribution of suitable water vole habitats along the same watercourses.

4 Survey areas and methods

4.1 Survey extent and survey conditions

The area shown in Figure 2 was searched for signs of water voles by a team of two experienced surveyors (Drs Lorna Brown and Jon Watt of Waterside Ecology). The surveys were carried out during July and August 2011. Water level at the time of survey was low.

4.2 Survey methods

Water voles leave a number of distinctive field signs including burrows, runways through vegetation, piles of feeding remains and, most significantly, mark their home ranges with faecal latrines. The presence of latrines and burrows are the most reliable field signs of water vole presence, as feeding signs may be indistinguishable from those left by field voles *Microtus agrestis* or bank voles *Myodes glareolus* (Ryland & Kemp 2009). Grazed lawns may be found at the entrance of some burrows. These are often created by breeding females, keen not to venture far from their burrow to feed (Strachan *et al.* 2011).

Survey methods were based on the standard water vole survey described by Strachan and Moorhouse (2006) and Strachan *et al.* (2011). The banks of each watercourse were surveyed and signs of water vole activity were noted. Where access and water depth allowed, the search was conducted from the channel itself. During surveying, copies of 1:10,000 scale maps were used in conjunction with a GPS to accurately establish the upstream and downstream limits of each water vole colony. Water vole signs separated by less than 200 m within one watercourse were considered to be within one colony, as adult males are known to have a home range of up to 200 m (Capreolus 2005; Sah 1998). The detailed habitat data listed in Table 1 were recorded within each colony.

Data on wider habitat suitability throughout the Limekiln site were maintained along the full length of each watercourse. Habitats ranks presented in text are based on Lawton and Woodroffe (1991) as follows:

Optimal habitat

Ideally with a slow-flowing watercourse less than 5 m wide and about 1 m deep and without extreme fluctuations in water level. Shore type should be predominantly earth or peat with a stepped or steep incline (35 degrees or more), into which the voles can burrow and create nest chambers above the

water table. There should be an abundance of bankside vegetation, with 70% or more of grasses and high foliage height diversity.

Sub-optimal habitat

Slow flowing watercourse with adequate covering of vegetation and the potential for burrowing in banks. Sub-optimal habitat was further divided into two categories as follows. Sub-optimal class 1 habitat was judged adequate to hold water vole colonies, with long stretches or numerous patches of bank that would allow burrowing. Sub-optimal class 2 habitat was generally poor and unlikely to support water vole colonies due to unsuitable bank substrate or potential for flooding, but included small patches that may allow individuals to create temporary shelter burrows during migration.

Unsuitable habitat

Unsuitable sites have low potential for cover or food, such as banks that are heavily grazed or trampled by livestock. The channel may be flat-sided, providing no refuge against fluctuating water levels or may be dry. Sites that are excessively shaded, rocky or engineered are also less favoured, because this has a limiting effect on growth of suitable bankside vegetation. Rocky or engineered banks may also prevent burrowing.

Table 1 Detailed habitat data collected at water vole colonies

Water vole signs data	Habitat data
Number of latrines	Habitat type (e.g. running, loch, ditch, marsh)
Number of active burrows	Bank substrate type, profile and height
Number of old inactive burrows	Soil softness
Number of burrows with lawns	Stream bed substrate
Number of sightings	Abundance of vegetation types
Presence of runs	Vegetation height
Presence of tracks	Water width, depth and current speed
Presence of feeding remains.	Land use and sources of disturbance

5 Results

5.1 Reay Burn catchment

5.1.1 Water vole signs

Water vole signs were widespread in Reay Burn and its feeder streams (Figure 2). A total of five active colonies were identified (Table 3), some of which were extensive with many burrows and latrines. The most downstream active colony was RV1, at NC968 622. This was a small colony where only two active burrows and a single latrine could be found. A short distance further upstream the larger colony RV2 stretches along both banks of a straightened stretch of stream. Two main areas of activity were identified, separated by a gap of about 120 m where runs were found but no burrows or latrines. The distance from RV1 to RV2 is only a little over 200 m and while they may represent a single colony this seems unlikely as no runs or other signs were found in between.

The largest colony found was RV3, which starts at NC 972 614 on the Reay Burn and extends for over one kilometre up the Meur an Fhuarain Ghil. Over 30 latrines and 40 active burrows were identified in this colony. These figures are likely to be under-estimates, as it was difficult to obtain a full count of signs. The stream is narrow and overgrown, making many of the latrines at the water's edge difficult to see even when on hands and knees. The colony is slightly fragmented at its northern end and there is also a break of 120 m at NC 977 608, where the hard banks are largely unsuitable for burrowing. No active holes were found in this reach, but runs and latrines were present suggesting a single colony.

Colony RV4 consisted of only three burrows and three latrines. This colony is in the small stream to the north of Borag Knowe and, in the context of the wind farm site, is a little isolated. Colony RV5 on the upper reaches of the Meur an Fhraoich is quite extensive but signs were rather scattered and the overall density was low with only two active latrines and 10 active holes spread through several hundred metres of stream.

The final colony, RV6, was on the upper reaches of the Meur a' Chrochain Ghill at NC 980 593. Two active holes, both with grazed lawns at the entrances, were found along with a single, large latrine and a number of runs.

Old burrows and runs were identified at several further locations in the Reay Burn catchment (Figure 2 and Table 2). Most of these were along the lower reaches of the Meur a' Chrochain Ghill and the Meur Gadach. Despite intensive searching no active burrows, latrines or droppings could be found at these locations that would have indicated current occupancy.

5.1.2 Habitat quality and distribution

Habitat classifications are listed fully in Appendix 3 and summarised in Table 2. Of the 12.6 km of stream that was surveyed some 61% was classified as providing suitable habitat for water vole colonies i.e. either optimal or class 1 sub-optimal. A further 30% was classified as class 2 sub-optimal, where small patches were present that would provide limited opportunity for foraging and burrowing. Only about 9% of habitat was classified as entirely unsuitable.

Table 2 Habitat quality and distribution, Reay Burn catchment

Watercourse	Total length (m)	Linear length of habitat (m)			
		Optimal	Sub-optimal 1	Sub-optimal 2	Unsuitable
Reay Burn	4240	132	2542	1084	493
Meur an Fhuarain Ghil	1250	276	839	134	0
Meur an Fhraoich	2230	84	1062	742	343
Meur a' Chrochain Ghill	2700	62	1661	726	251
Meur Gadach	720	0	520	170	30
Unnamed (Borag Knowe)	610	0	420	190	0
Unnamed	700	0	0	700	0
Lochan nan Eun	160	0	160	0	0
<i>Total</i>	<i>12610</i>	<i>554</i>	<i>7202</i>	<i>3746</i>	<i>1117</i>

Habitat distribution is shown on Figures 3 and 4. The longest reaches of optimal habitat are on the Reay Burn and the Meur an Fhuarain Ghil. These habitats generally coincided with the presence of the most active water vole colonies.

5.2 Achvarasdal Burn catchment

5.2.1 Water vole signs

Eight active water vole colonies were identified (Table 4). The largest of these was colony AV1, on the Achvarasdal Burn at Achvarasdal Leans. This colony extended from NC 994 612 upstream for over 1 km to NC 996 602. Activity was highest at the north end of the site, where 23 active burrows were identified. Further upstream the signs were more widely dispersed and there were several gaps of up to 170 m where no signs were recorded (Figure 2).

A second large colony, AV2, was located approximately 200 m upstream from the An t-Eas waterfalls. This colony was on the mainstem of the Achvarasdal Burn and also extended up two tiny, unnamed tributary streams entering on the left bank. The majority of the 29 latrines and 25 active burrows were in the tributary streams.

Table 3 Reay Burn catchment, water vole signs

Active colonies

Watercourse	Code	Downstream NGR	Upstream NGR	Latrines (n)	Active burrows (n)	Notes
Reay Burn	RV1	NC 9691 6225	NC 9691 6225	1	2	On left bank
Reay Burn	RV2	NC 9701 6178	NC 9696 6199	4	2	Continuation from previous section, most signs at start of section
Reay Burn	RV2	NC 9705 6168	NC 9701 6178	7	4	Small voles signs are more towards wet areas behind stream
Reay Burn	RV3	NC 9725 6140	NC 9720 6143	1	1	Also 1 possible drop hole to stream and many small vole signs
Reay Burn	RV3	NC 9732 6128	NC 9732 6128	1	0	Burrow at NC 9733 6124 looks like small vole but check if to be disturbed
Meur an Fhuarain Ghil	RV3	NC 9736 6116	NC 9741 6107	2	5	Burrows spread down stretch
Meur an Fhuarain Ghil	RV3	NC 9741 6107	NC 9757 6092	4	12	Latrines may be under estimated, signs throughout section
Meur an Fhuarain Ghil	RV3	NC 9757 6092	NC 9770 6081	7	10	Burrows start at NC 97696 60808
Meur an Fhuarain Ghil	RV3	NC 9772 6081	NC 9781 6074	1	0	Habitat not good for burrows but possibly more latrines in stream
Meur an Fhuarain Ghil	RV3	NC 9781 6074	NC 9786 6064	2	4	Continuation of same colony
Meur an Fhuarain Ghil	RV3	NC 9786 6064	NC 9793 6056	4	4	Continuation of colony but habitat changed
Meur an Fhuarain Ghil	RV3	NC 9793 6056	NC 9802 6050	10	8	Small voles signs also present
Unnamed	RV4	NC 9765 6295	NC 9761 6292	0	3	Fresh droppings on runs. Latrines could be missed in tiny stream.
Unnamed	RV4	NC 9755 6304	NC 9753 6306	3	3	1 drop hole. All droppings fresh in small latrines.
Meur an Fhraoich	RV5	NC 9820 5974	NC 9819 5966	1	3	3 drop holes to stream
Meur an Fhraoich	RV5	NC 9820 5954	NC 9829 5947	0	3	Two further holes possibly active
Meur an Fhraoich	RV5	NC 9836 5931	NC 9835 5906	1	4	Very fresh droppings, 4 drop holes to stream
Meur a Chrochain Ghill	RV6	NC 9802 5929	NC 9802 5930	1	2	Latrine large and well used

Other signs

Watercourse	Code	Downstream NGR	Upstream NGR	Latrines (n)	Active burrows (n)	Old burrows (n)	Notes
Meur an Fhraoich	-	NC 9728 6097	NC 9728 6097	0	0	2	Also two drop holes.
Meur an Fhraoich	-	NC 9781 6035	NC 9781 6035	0	0	1	Old burrows. No further signs.
Meur an Fhraoich	-	NC 9811 6005	NC 9813 6003	0	0	2	Some drop holes and old burrows but no water vole droppings.
Meur a Chrochain Ghill	-	NC 9776 6028	NC 9776 6028	0	0	1	Water vole runs but no latrines or active burrows found.
Meur a Chrochain Ghill	-	NC 9785 5996	NC 9785 5996	0	0	1	Water vole runs. Possible burrow .
Meur a Chrochain Ghill	-	NC 9777 6018	NC 9777 6018	0	0	1	Possible burrow in poor habitat on bank.
Meur a Chrochain Ghill	-	NC 9792 5962	NC 9792 5962	0	0	4	Old burrows. Some runs. No latrines found.
Meur a Chrochain Ghill	-	NC 9786 5983	NC 9786 5983	0	0	3	Old burrows.
Meur a Chrochain Ghill	-	NC 9796 5945	NC 9796 5945	0	0	1	Old burrow and runs.
Meur a Chrochain Ghill	-	NC 9815 5880	NC 9815 5882	0	0	1	1 drop hole, burrow very old.
Meur Gadach	-	NC 9750 6037	NC 9750 6037	0	0	2	1 drop hole to stream.
Meur Gadach	-	NC 9753 6004	NC 9753 6004	0	0	1	Old burrow and runs.
Meur Gadach	-	NC 9754 5982	NC 9754 5982	0	0	1	Old burrow and runs.

Table 4 Achvarasdal Burn catchment, water vole signs

Active colonies

Watercourse	Code	Downstream NGR	Upstream NGR	Latrines (n)	Active burrows (n)	Notes
Achvarasdal Burn	AV1	NC 9942 6119	NC 9939 6092	5	23	Most activity at NC 9939 6111. One water vole skull found.
Achvarasdal Burn	AV1	NC 9939 6092	NC 9948 6069	4	4	Also 2 drop holes to stream.
Achvarasdal Burn	AV1	NC 9948 6069	NC 9945 6059	1	1	
Achvarasdal Burn	AV1	NC 9948 6046	NC 9949 6046	1	3	Latrine is large and well used in rushes.
Achvarasdal Burn	AV1	NC 9950 6037	NC 9951 6035	2	1	Other vole species also present.
Achvarasdal Burn	AV1	NC 9952 6031	NC 9951 6030	2	1	1 drop hole to water, more signs on opposite bank.
Achvarasdal Burn	AV1	NC 9955 6017	NC 9955 6017	1	0	Also 2 possible very old holes and runs on bend of pool.
Achvarasdal Burn	AV2	NC 9939 5936	NC 9939 5925	4	3	
Achvarasdal Burn	AV2	NC 9938 5920	NC 9937 5917	3	2	
Unnamed	AV2	NC 9939 5936	NC 9939 5937	Tiny side tributary - signs included in row below		
Unnamed	AV2	NC 9939 5936	NC 9930 5935	17	15	
Unnamed	AV2	NC 9923 5932	NC 9938 5929	5	5	
Achvarasdal Burn	AV3	NC 9950 5889	NC 9950 5889	0	4	Large holes, fresh clippings.
Achvarasdal Burn	AV3	NC 9951 5882	NC 9948 5879	1	0	Active latrine.
Achvarasdal Burn	AV4	NC 9949 5849	NC 9949 5846	7	8	Active holes and latrines.
Achvarasdal Burn	AV5	NC 9951 5832	NC 9955 5826	1	1	Plugged with moss containing water vole faeces
Milton Moss	AV6	NC 9883 6257	NC 9888 6263	2	4	Active holes and latrines in high quality habitat.
Unnamed	AV7	NC 9914 6156	NC 9919 6159	1	2	Latrine well used. Runs in secondary tributary but no burrows.
Allt Cnoc an Fhraoich	AV8	NC 9900 5811	NC 99045820	Present	Present	Colony is outside wind farm perimeter.

Other signs

Watercourse	Code	Downstream NGR	Upstream NGR	Latrines (n)	Active burrows (n)	Old burrows (n)	Notes
Achvarasdal Burn	-	NC 9901 6176	NC 9901 6176	0	0	1	One possible old burrow and drop hole into stream.
Achvarasdal Burn	-	NC 9950 5895	NC 9950 5895	0	0	1	Water vole hole. Only current activity is from smaller vole species.
Achvarasdal Burn	-	NC 9961 5796	NC 9961 5796	0	0	1	Possible old burrow in wet flush and one drop hole.
Milton Moss	-	NC 9823 6243	NC 9823 6243	0	0	2	Two old holes, one of which is collapsed.

Colony AV3 consisted of four active holes at NC 995 589. There were no latrines immediately adjacent to these but fresh grass clippings were present and an active water vole latrine was identified 100 m further upstream. Colony AV4 showed greater activity, with eight active burrows and seven latrines. Grazed lawns were present at the entrances to three of the burrows. Only one active burrow and one latrine were found at colony AV5, which is a little over 200 m upstream from AV4. A grazed lawn was present at the entrance of the burrow, which at the time of survey had been plugged with moss.

Three further colonies were identified on tributary streams. Within the wind farm site, the most active of these was AV6 at NC 988 626 in the lower reaches of the stream draining Milton Moss. Another colony, AV7 was in the lowermost reaches of a tiny tributary stream at NC 991 616 on the Achvarasdal Leans. The final colony, AV8, was just outside the perimeter of the proposed wind farm in the upper reaches of the Allt Cnoc an Fhraoich at NC 990 581. No counts of signs were made at AV8 but burrows and active latrines were present. Suitable habitat extends downstream from this site offering opportunities for colony expansion inside the wind farm perimeter.

Only four locations were identified where old signs were present without any sign of recent activity (Table 4). Three of these were along the Achvarasdal Burn and all consisted of single disused burrows. A further two old burrows were identified in the upper reaches of the stream draining Milton Moss (see Figure 1).

5.2.2 Habitat quality and distribution

Some 46% of the survey reaches in the Achvarasdal Burn catchment were suitable for creation of water vole colonies (Table 5). The majority of the optimal and class 1 sub-optimal habitat is distributed along the mainstem of the Achvarasdal Burn, in the low gradient reaches of Achvarasdal Leans and also upstream from the waterfalls. It is also in these reaches that the largest active colonies were identified.

Table 5 Habitat quality and distribution, Achvarasdal Burn catchment

Watercourse	Total length (m)	Linear length of habitat (m)			
		Optimal	Sub-optimal 1	Sub-optimal 2	Unsuitable
Achvarasdal Burn	7860	259	4512	927	2162
Milton Moss	2490	75	435	1755	225
Aryleive	850	0	0	850	0
Allt Cnoc an Fhraoich	1150	0	590	560	0
Unnamed	1230	30	323	677	200
<i>Total</i>	<i>13580</i>	<i>364</i>	<i>5860</i>	<i>4769</i>	<i>2587</i>

The majority of unsuitable habitat was in the lower reaches of the Achvarasdal Burn downstream from Milton Moss, where the hard, stony banks do not permit burrowing. Further upstream the longest reach of unsuitable habitat is around the An t-Eas waterfalls (NC 995 596) but this extends for only a few hundred metres and is well within the dispersal capability of water voles.

The network of watercourses draining Milton Moss provides some suitable foraging opportunities but in the main the stream banks are low, wet and unsuitable for burrowing. The exception is the lower 0.5 km, some of which was classified as optimal. This habitat was occupied by colony AV6.

6 Evaluation

6.1 Water vole use of the site

The low gradients and predominance of peat substrates in the stream banks makes many of the watercourses within the proposed wind farm site suitable for colonisation by water voles. In addition, the site is bounded to the west, south and east by further peatland habitats that are also likely to support water vole colonies. As such, the widespread distribution of water voles within the proposed wind farm perimeter is unsurprising and in keeping with the view that Caithness is a priority area for water vole conservation.

It is apparent from Figures 3 to 5 that most of the more extensive reaches of suitable habitat showed some signs of occupancy by water voles. The main exceptions were the lower reaches of the Meur a' Chrochain Ghill and Meur Gadach. Even here, there were signs of previous occupancy at several locations and there is every possibility that these habitats may be recolonised in future.

A number of previous water vole studies have used mark and recapture techniques to attempt to calibrate the relationship between the number of water voles present and signs, particularly latrine counts. The relationship has been found to vary greatly from site to site and is thought to be influenced by several factors including season, population density, population structure, availability of suitable latrine sites and the variation in latrine detection rates in different habitat types. The SNH upland water vole study (Capreolus 2005) used six different regression relationships (taken from five different studies) to calculate water vole population density for a hypothetical site. The analysis produced estimates of anywhere between 3 and 20 voles per 100 m of river. It was concluded that the use of latrines to estimate population was imprecise and may be insensitive in detecting statistically significant changes in population size over time. Whilst acknowledging the uncertainty of latrine counts as a measure of vole numbers, WildCRU (2002) consider that such counts do at least provide a useful index of water vole activity, with the larger and more robust populations showing a larger number of closely packed latrines. This being the case, the Limekiln data would suggest that colonies RV2, RV3, AV1, AV2 and AV4 are the most important core areas for water voles within the wind farm perimeter. Of these, RV3 and AV2 had the largest numbers of active latrines with totals of 32 and 29 respectively. Sign density was particularly high at AV2, where the colony extent was only about 350 m.

Extinction of water vole colonies is influenced by both colony size and extinction rates within neighbouring colonies, i.e. a colony is more likely to become extinct if there are few individuals present and neighbouring colonies are also suffering extinction events. Thus the colonies in close proximity to one another within large areas of suitable habitat are more likely to continue to be re-colonised than smaller geographically isolated populations. At Limekiln, all of the colonies that were identified were relatively close to other colonies and none were separated by long reaches of unsuitable habitat. The longest reach of unsuitable habitat separating two colonies was a mere 350 m, between AV1 and AV2. Fisher *et al.* (2009) showed that water voles are capable of travelling hundreds of metres in one day and water voles would be expected easily to pass along most reaches of stream in the survey area.

The main reach of unsuitable habitat is the northern end of the Achvarasdal Burn, where there over 1 km of stream with hard stony banks and coarse bankside vegetation. This may partially isolate the Achvarasdal colonies from immigration from the north. However, with plentiful suitable peatland habitats to the east, south and west it is very likely that water voles have quite easy dispersal routes between the Limekiln study site and colonies in the wider peatland habitats. Barring catastrophic events such as mink introduction or disease, it is likely that water voles will continue to persist at Limekiln for the foreseeable future.

6.2 Areas not surveyed

Much of the Limekiln site is currently beneath thicket conifer. A number of small drainage ditches are present in these thickets but these could not be surveyed due to the density of low-growing trees. This dense thicket greatly reduces the presence of ground vegetation, due to lack of light, making these woodland drains unsuitable for water voles. Indeed, the standard water vole survey methods described by Strachan *et al.* (2011) suggest that streams running through mature conifer woodland should be omitted from survey for this reason. It is therefore highly improbable that any of the drains under thicket conifer would be suitable for water voles.

7 Potential impacts

7.1 Water vole habitats

A key principle of metapopulation dynamics is that loss of unoccupied habitat may be as important as loss of occupied habitat, since any suitable habitat may become occupied over time, maintaining the connectivity and overall stability of the wider population. Therefore, loss of good quality (optimal or class 1 sub-optimal) habitat should be avoided. The streams that were surveyed had broad buffer zones, generally conforming to the Forest and Water Guidelines (Forestry Commission 2011), and all water vole signs identified were within these unplanted riparian strips. If turbines, roads, hard stands and other infrastructure are kept off these buffer zones it might be expected that direct loss of water vole habitat would be minimal. Similarly care will be required during any tree felling operations that precede construction to avoid loss or damage to suitable habitats. If significant loss of habitat is predicted, it may be necessary to enhance existing habitats or implement compensation through creation of new habitats.

Four stream crossings have been proposed along the track network (Table 6; Figures 3 to 5). All are in sub-optimal water vole habitat (class 1 or 2). Minor losses of these habitat types would not be expected to have any negative impact on water voles at the site so long as no barriers to migration are created. Bridges or box culverts would be expected to maintain better connectivity below tracks than would pipe culverts and would be the preferred option for stream crossings.

Table 6 Water vole habitats and signs at proposed stream crossings.

Crossing	NGR	Survey section	Habitat quality	Water vole signs
1	9693 6251	R2	Sub-optimal 1	No current activity. 1 old burrow present.
2	9752 6021	G1	Sub-optimal 1	None
3	9811 6007	MF3	Sub-optimal 2	None
4	9919 6019	AT4b	Sub-optimal 2	None

7.2 Resting sites and licensing

Water vole resting sites are legally protected and it will be necessary to avoid damage to them during enabling works and construction of the wind farm. Keeping all infrastructure back from watercourses and riparian buffer zones will ensure that burrows are not damaged. It cannot be assumed that simply avoiding the colonies identified during the current survey will achieve this, since new colonies may become established or old ones become recolonised. Therefore it would be prudent to carry out a brief pre-construction survey at proposed stream crossings to ensure that water vole burrows are still absent. If vole burrows are present it may be necessary to implement further mitigation, such as relocation of water voles e.g. by displacement. This could only be done with the appropriate licence from SNH, who can only grant such a licence if satisfied that: a) the proposed action will give rise to, or contribute towards the achievement of a significant social, economic or environmental benefit; and b) there is no other satisfactory solution.

7.3 Recommendations

- Avoid damage to riparian habitats during enabling works and construction. In particular, avoid or minimise impacts on optimal and class 1 sub-optimal water vole habitats.
- Maintain maximum habitat linkage at stream crossings, particularly those in class 1 sub-optimal habitat.
- Conduct pre-construction surveys for water vole burrows at crossing locations.

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Figure 2 Survey area and water vole signs distribution.

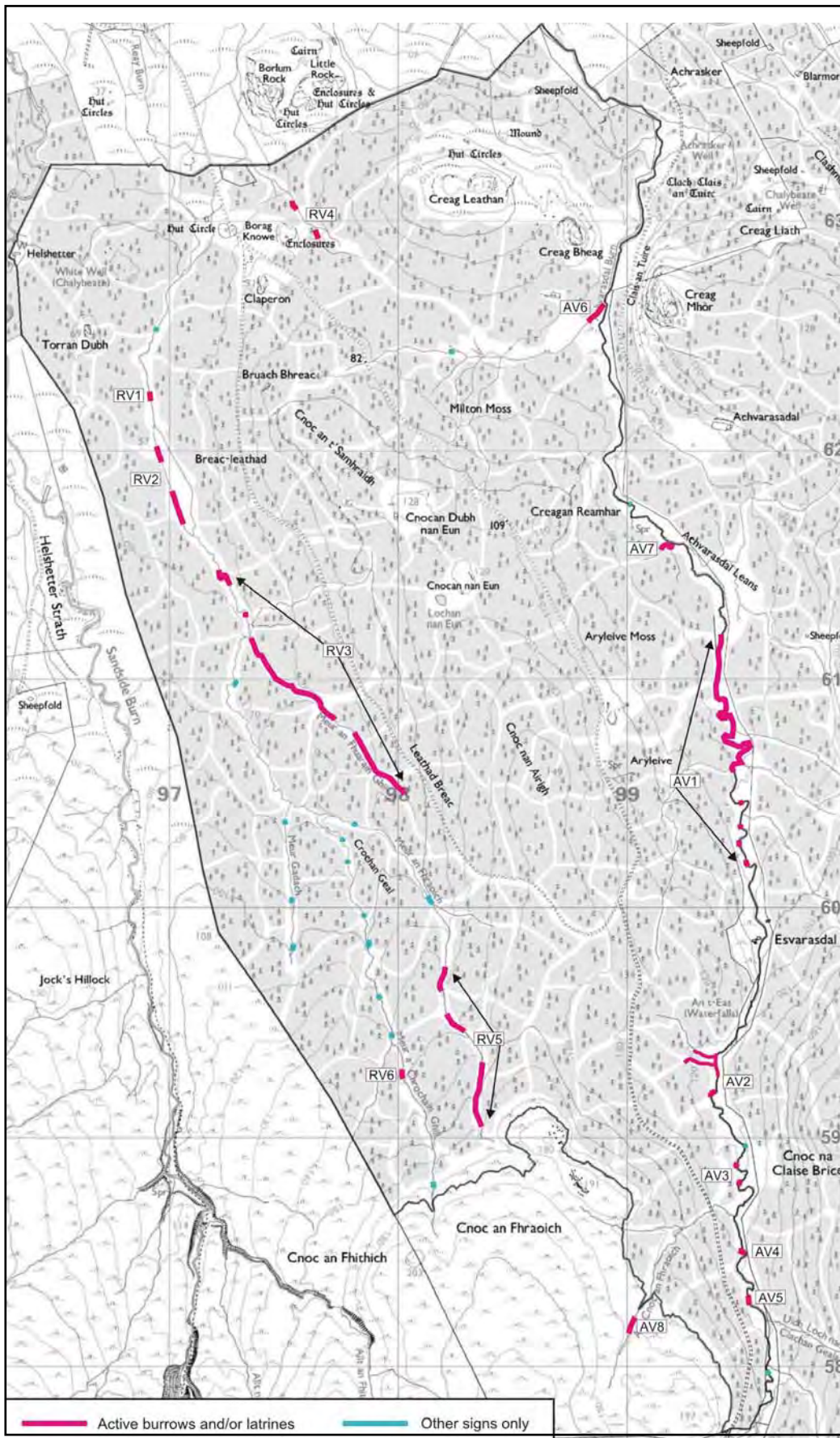


Figure 3 Water vole habitat quality and distribution, NW sector, with active colonies marked.

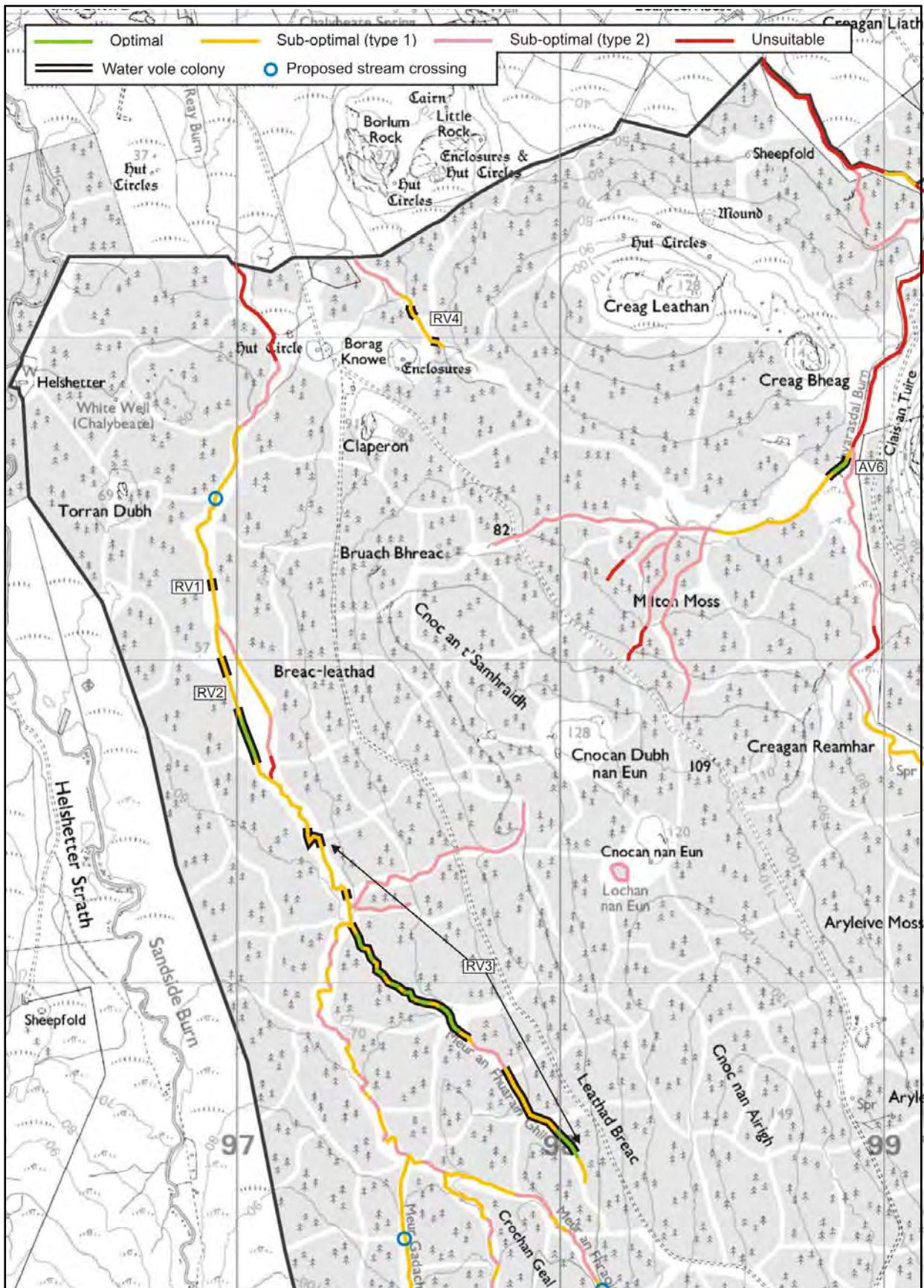


Figure 4 Water vole habitat quality and distribution, SW sector, with active colonies marked.

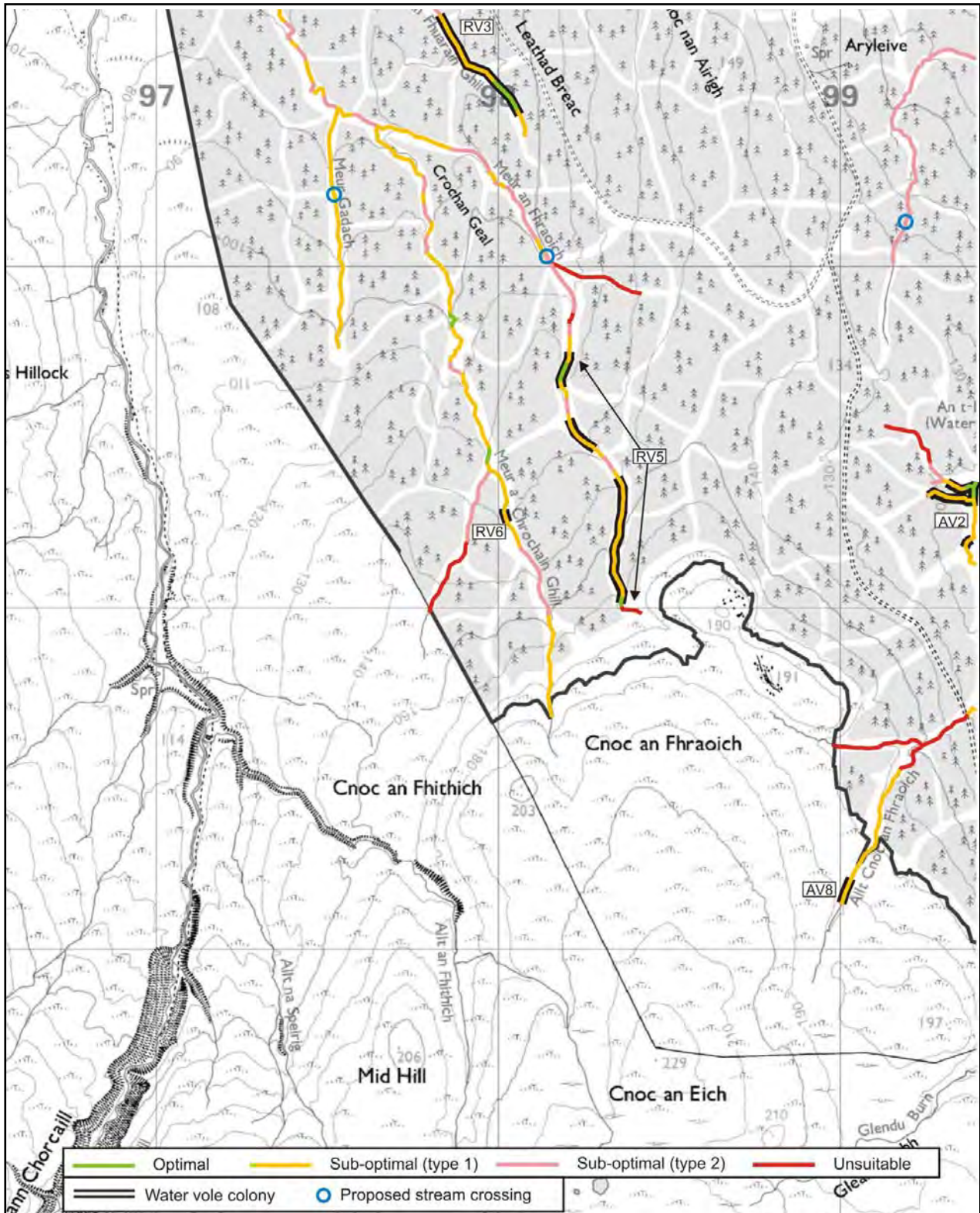
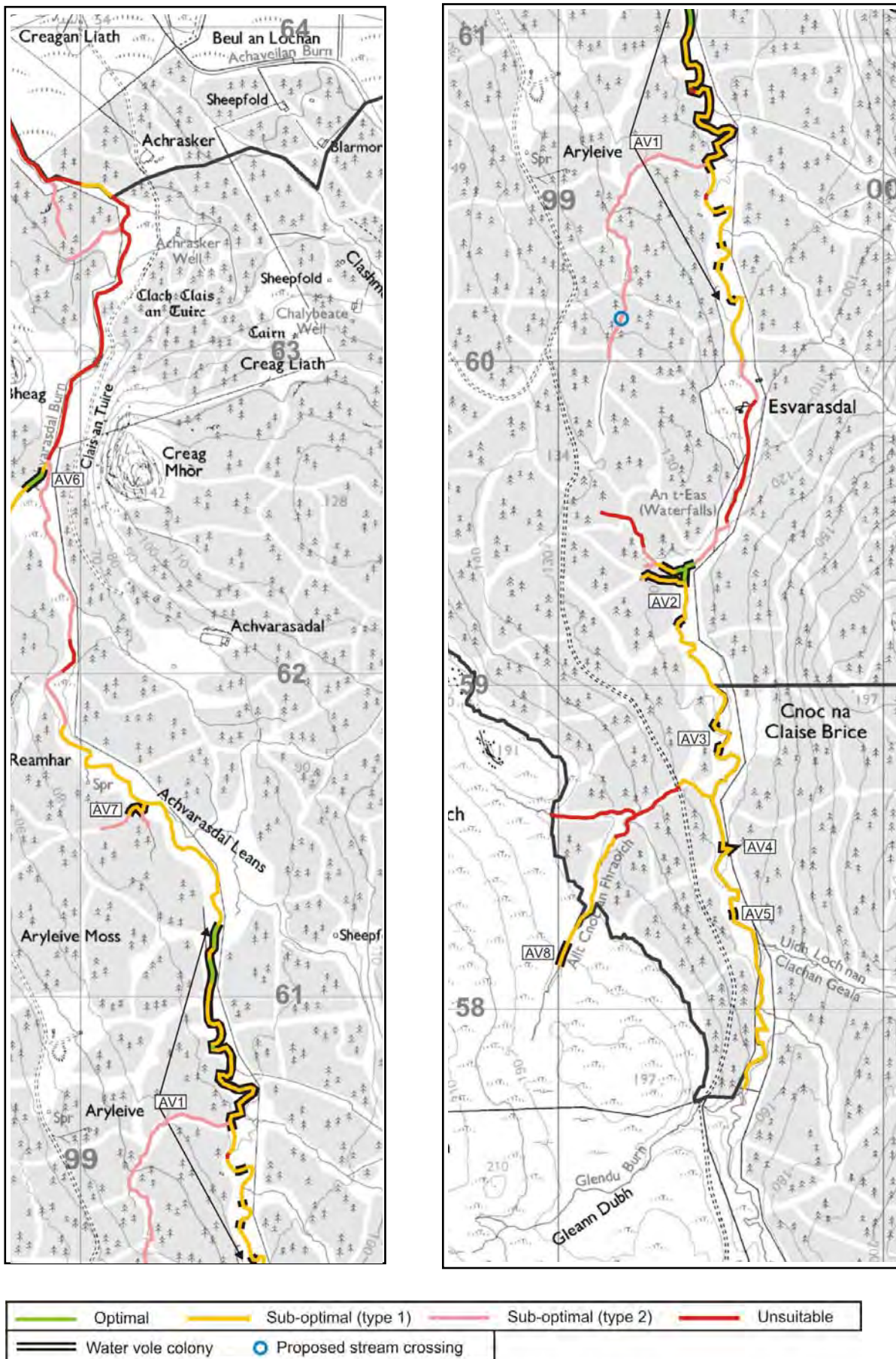


Figure 5 Water vole habitat quality and distribution, NE and SE, with active colonies marked.



Appendix 1. Water vole signs

Catchment	Colony	NGR downstream	NGR upstream	Latrines	Active burrows	Inactive burrows	Prints	Runs	Feeding remains	Grazed lawns	Sightings	Notes
Reay	na	NC 9693 6251	NC 9693 6251	0	0	1	0	yes	0	0	0	1 old burrow, much small vole signs (some with enlarged entrances)
Reay	RV1	NC 9691 6225	NC 9691 6225	1	2	0	y	yes	Grasses	0	0	On left bank
Reay	RV2	NC 9696 6199	NC 9701 6178	4	2	3	0	yes	0	0	0	Continuation from previous section, most signs at start of section
Reay	RV2	NC 9701 6178	NC 9705 6168	7	4	1	0	yes	0	0	0	Small voles signs are more towards wet areas behind stream
Reay	RV3	NC 9720 6143	NC 9725 6140	1	1	3		?	0	0	0	1 possible drop hole to stream, many small vole signs
Reay	RV3	NC 9732 6128	NC 9732 6128	1	0	0	0	0	0	0	0	Burrow at NC 9733 6124 looks like small vole but check if to be disturbed
Meur an Fhuarain Ghil	RV3	NC 9736 6116	NC 9741 6107	2	5	3	0	yes	0	1	0	Burrows spread down stretch
Meur an Fhuarain Ghil	RV3	NC 9741 6107	NC 9757 6092	4	12	0	0	yes	y	0	0	Latrines may be under estimated, signs throughout section
Meur an Fhuarain Ghil	RV3	NC 9757 6092	NC 9770 6081	7	10	0	0	yes	yes	0	0	Burrows start at NC 97696 60808
Meur an Fhuarain Ghil	RV3	NC 9772 6081	NC 9781 6074	1	0	0	0	yes	0	0	0	Habitat not good for burrows but possibly more latrines in stream
Meur an Fhuarain Ghil	RV3	NC 9781 6074	NC 9786 6064	2	4	0	0	yes	0	0	0	Continuation of same colony but higher level of small vole activity
Meur an Fhuarain Ghil	RV3	NC 9786 6064	NC 9793 6056	4	4	0	0	yes	0	0	0	Continuation of colony but habitat changed
Meur an Fhuarain Ghil	RV3	NC 9793 6056	NC 9802 6050	10	8	3	0	yes	0	0	0	Small voles signs both upper and lower
Unnamed (E of Borag Knowe)	RV4	NC 9765 6295	NC 9761 6292	0	3	2	0	yes	<i>Molinia</i> & rush	0	0	3 drop holes. Fresh droppings on runs. Latrines could be missed in tiny overgrown stream.
Unnamed (E of Borag Knowe)	RV4	NC 9755 6304	NC 9753 6306	3	3	0	0	yes	<i>Molinia</i> & rush	0	0	1 drop hole. All droppings fresh in small latrines.
Meur an Fhraoich	na	NC 9728 6097	NC 9728 6097	0	0	2	0	yes	0	0	0	2 possible old burrows and two drop holes
Meur an Fhraoich	na	NC 9781 6035	NC 9781 6035	0	0	1	0	yes	0	0	0	
Meur an Fhraoich	na	NC 9811 6005	NC 9813 6003	0	0	2	0	yes	0	0	0	Some drop holes and old burrows but no water vole faeces
Meur an Fhraoich	RV5	NC 9820 5974	NC 9819 5966	1	3	3	0	yes	yes	0	0	3 drop holes to stream
Meur an Fhraoich	RV5	NC 9820 5954	NC 9829 5947	0	3	0	0	yes	yes	0	0	Two further holes possibly active
Meur an Fhraoich	RV5	NC 9836 5931	NC 9835 5906	1	4	3	0	yes	0	0	0	Very fresh faeces, 4 drop holes to stream
Meur a Chrochain Ghill	na	NC 9776 6028	NC 9776 6028	0	0	1	0	yes	0	0	0	
Meur a Chrochain Ghill	na	NC 9785 5996	NC 9785 5996	0	0	1	0	yes	0	0	0	Possible burrow
Meur a Chrochain Ghill	na	NC 9777 6018	NC 9777 6018	0	0	1	0	yes	0	0	0	Possible burrow in poor habitat on bank
Meur a Chrochain Ghill	na	NC 9792 5962	NC 9792 5962	0	0	4	0	yes	0	0	0	
Meur a Chrochain Ghill	na	NC 9786 5983	NC 9786 5983	0	0	3	0	yes	0	0	0	
Meur a Chrochain Ghill	RV6	NC 9802 5930	NC 9802 5929	1	2	1	0	yes	0	2	0	Latrine large and well used
Meur a Chrochain Ghill	na	NC 9796 5945	NC 9796 5945	0	0	1	0	yes	0	0	0	

Appendix 1 contd.

Catchment	Colony	NGR downstream	NGR upstream	Latrines	Active burrows	Inactive burrows	Prints	Runs	Feeding remains	Grazed lawns	Sightings	Notes	
Meur a Chrochain Ghill	na	NC 9815 5882	NC 9815 5880	0	0	1	0	yes	0	0	0	1 Drop hole, burrow very old	
Meur Gadach	na	NC 9750 6037	NC 9750 6037	0	0	2	0	yes	0	0	0	1 drop hole to stream	
Meur Gadach	na	NC 9753 6004	NC 9753 6004	0	0	1	0	yes	0	0	0		
Meur Gadach	na	NC 9754 5982	NC 9754 5982	0	0	1	0	y	0	0	0		
Achvarasdal Burn	na	NC 9901 6176	NC 9901 6176	0	0	1	0	0	0	0	0	1 possible burrow and 1 possible drop hole into stream	
Achvarasdal Burn	AV1	NC 9942 6119	NC 9939 6092	5	23	6	y	yes	yes	0	0	One water vole skull. Most activity at NC 9939 6111	
Achvarasdal Burn	AV1	NC 9939 6092	NC 9948 6069	4	4	2	0	yes	0	0	0	2 drop holes to stream	
Achvarasdal Burn	AV1	NC 9948 6069	NC 9945 6059	1	1	0	0	yes	0	0	0		
Achvarasdal Burn	AV1	NC 9948 6046	NC 9949 6046	1	3	0	0	yes	0	0	0	Latrine is large and well used in rushes	
Achvarasdal Burn	AV1	NC 9950 6037	NC 9951 6035	2	1	0	0	yes	0	0	0	Burrow entrance large but both kinds of faeces present	
Achvarasdal Burn	AV1	NC 9952 6031	NC 9951 6030	2	1	0	0	yes	0	0	0	1 drop hole to water, more signs on opposite bank	
Achvarasdal Burn	AV1	NC 9955 6017	NC 9955 6017	1	0	2	0	yes	0	0	0	2 possible very old holes with runs between them on bend of pool	
Achvarasdal Burn	AV2	NC 9939 5936	NC 9939 5925	4	3	0	0	yes	yes	0	0	Last four lines of data constitute one colony using 4 sections of stream	
Achvarasdal Burn	AV2	NC 9938 5920	NC 9937 5917	3	2	0	0	yes	0	0	0		
Achvarasdal Burn	na	NC 9950 5895	NC 9950 5895	0	0	1		yes				Large hole but much small vole activity	
Achvarasdal Burn	AV3	NC 9950 5889	NC 9950 5889	0	4	0	0	yes	yes	0	0	Large holes, fresh clippings but small vole faeces	
Achvarasdal Burn	AV3	NC 9951 5882	NC 9948 5879	1	0	1	0	yes	0	0	0		
Achvarasdal Burn	AV4	NC 9949 5849	NC 9949 5846	7	8	0	0	yes	yes	3	0		
Achvarasdal Burn	AV5	NC 9951 5832	NC 9955 5826	1	1	0	0	yes	0	1	0	Plugged with moss containing water vole faeces	
Achvarasdal Burn	na	NC 9961 5796	NC 9961 5796	0	0	1	0	yes	0	0	0	Possible burrow in wet flush and one drop hole, small vole faeces	
Milton Moss	na	NC 9823 6243	NC 9823 6243	0	0	2	0	0	0	0	0	Small vole faeces and runs. Two old water vole holes, one of which is collapsed.	
Milton Moss	AV6	NC 9883 6257	NC 9888 6263	2	4	1	y	yes	0	0	0	Small voles signs also start to appear at downstream end near mainstem.	
Unnamed	AV7	NC 9914 6156	NC 9919 6159	1	2	1	0	yes	yes	0	0	Latrine well used, few drop holes, runs in side tributary but no burrows	
Unnamed	AV2	NC 9939 5936	NC 9939 5937	Tiny side tributary - signs included in data below									
Unnamed	AV2	NC 9939 5936	NC 9930 5935	17	15	0	0	many	many	0	0		
Unnamed	AV2	NC 9923 5932	NC 9938 5929	5	5	0	0	yes	yes	0	0	Approximately 9 drop holes to stream	
Allt Cnoc an Fhraoich	AV8	NC 9900 5811	NC 99045820	present	present	present	present	yes	yes		0	Vole signs are outside development area but suitable habitat extends downstream into development.	

Appendix 2. Water vole habitat at active colonies (code provided) or where other signs were identified (colony code = na)

Section code	Colony	Habitat rank	Habitat	Bank				Bed substrate	Vegetation (DAFORN)							Vegetation height (m)	Watercourse		
				Substrate	Profile	Height (m)	Softness		Trees	Shrubs	Reeds, sedges,	Tall grass	Short grass	Herbs	Sub-merged		Width (m)	Depth (m)	Speed
A7	na	S1	R	E/S	>45	0.5	S	G/S	N	N	O	O	O	R	N	0.2-0.5	2-5	0.5	Slow
A11	AV1	S/O	R	E	>45	0.5-1	S	G/S	N	N	F	F	O	O	N	0.2-0.5	2-5	0.5-1	Sluggish
A12	AV1	S1	R	E	>45	0.5-1	S	S/G	N	N	F	O	F	O	R	0.1-0.2	2-5	<0.5	Slow
A13	AV1	S1	R	E	>45	0.5-1	S	S/G	N	N	F	O	F	O	R	0.1-0.2	2-5	<0.5	Slow
A14	AV1	S1	R	E	V/U	0.5-1	S	S/G	N	N	F	F	O	O	R	0.2-0.5	2-5	<0.5	Slow
A14	AV1	S1	R	E	V/U	0.5-1	S	S/G	N	N	F	F	O	F	R	0.2-0.5	2-5	<0.5	Slow
A14	AV1	S1	R	E	>45	<0.5	S	S/G	N	N	F	F	O	O	R	0.2-0.5	2-5	0.5-1	Sluggish
A15	AV1	S1	R	E	Varied	0.5-1	S	G	N	N	F	O	O	F	R	0.2-0.5	2-5	<0.5	Sluggish
A19	AV2	S1	R	E	>45	1-2	S	G/ST	N	N	F	F	O	O	R	0.2-0.5	2-5	<0.5	Slow
A20	AV2	S1	R	E	>45	1-2	S	G/ST	N	N	O	O	O	O	N	0.2-0.5	2-5	<0.5	Slow
A21	na	S1	R	E	>45	1-2	S	G/ST	N	N	O	O	O	O	N	0.2-0.5	2-5	<0.5	Slow
A21	AV3	S1	R	E	>45	1-2	S	G/ST	N	N	O	O	O	O	N	0.2-0.5	2-5	<0.5	Slow
A22	AV3	S1	R	E	>45	1-2	S	G/ST	N	N	O	O	O	O	N	0.2-0.5	1-2	<0.5	Slow
A23	AV4	S1	R	E	45	<0.5	S	S	N	N	F	O	O	R	N	0.2-0.5	1-2	<0.5	Slow
A24	AV5	S1	R	E	45	<0.5	S	S	N	N	F	O	O	R	N	0.2-0.5	1-2	<0.5	Slow
A25	na	S	R	E	45	<0.5	S	S	N	N	F	O	O	R	N	0.2-0.5	1-2	<0.5	Slow
M2	na	S2	B	E	<45	<0.5	S	S	N	N	F	R	O	O	O	0.1-0.5	0.5-1	<0.5	Static
M1	AV6	S	R	E	<45	<0.5	S	G	N	N	F	O	O	O	N	0.2-0.5	<0.5	<0.5	Slow
AT3	AV7	S1	R	E	>45	0.5-1	S	G/P	N	N	O	O	F	O	N	0.2-0.5	<0.5	<0.5	Slow
AT5	AV2	O	R	E	45	0.5	S	G/P	N	N	F	F	O	O	R	0.2-0.5	<0.5	<0.5	Slow
AT6	AV2	S1	R	E	Varied	Varied	S	G/P	N	N	F	O	O	O	R	0.2-0.5	<0.5	<0.5	Slow
R2	na	S1	R	E	>45	0.5	S	G/P	N	N	F	F	O	R	N	0.2-0.5	<0.5	<0.5	Slow
R4	RV1	S1	R	E	>45	0.5	S	G/P	N	N	F	F	O	R	N	0.5	<0.5	<0.5	Slow
R5	RV2	S1	R	E	>45	0.5	S	G/P	N	N	F	F	O	R	N	0.5	<0.5	<0.5	Slow
R6	RV2	S1	R	E	>45	0.5	S	G/P	N	N	O	F	O	R	N	0.5	<0.5	<0.5	Slow
R7	RV3	S1	R	E	>45	<0.5	S	G	N	N	O	O	O	R	N	0.1-2	0.5-1	<0.5	Slow
R8	RV3	S1	R	E/S	>45	0.5-1	H	G	N	N	O	O	F	R	N	0.1-0.2	0.5-1	<0.5	Slow
R10	na	S1	R	E	>45	0.5-1	S	ST	N	N	F	O	O	R	N	0.2-0.5	1-2	<0.5	Slow
RT1b	RV4	S1	R	E	>45	<0.5	S	P/E	N	N	F	F	R	R	N	0.2-0.5	<0.5	<0.5	Sluggish
RT1b	RV4	S1	R	E	<45	<0.5	S	P/E	N	N	F	F	R	R	N	0.2-0.5	<0.5	<0.5	Sluggish
F1	RV3	S	R	E	>45	<0.5	S	G	N	N	O	F	F	O	N	0.1-0.2	<0.5	<0.5	Slow
F2	RV3	S	R	E	>45	<0.5	S	G	N	N	F	F	O	O	N	0.2-0.5	<0.5	<0.5	Slow

Appendix 2 contd.

Section code	Colony	Habitat rank	Habitat	Bank				Bed substrate	Vegetation (DAFORN)							Vegetation height (m)	Watercourse		
				Substrate	Profile	Height (m)	Softness		Trees	Shrubs	Reeds, sedges,	Tall grass	Short grass	Herbs	Sub-merged		Width (m)	Depth (m)	Speed
F3	RV3	S/O	R	E	>45	<0.5	S	G	N	R	O	O	F	R	N	0.2-0.5	<0.5	<0.5	Slow
F4	RV3	S2	R	E	V	1M	S	P/G	N	R	O	R	F	R	N	0.2-0.5	<0.5	<0.5	Slow
F5	RV3	S	R	E	V	0.5-1	S	P/G	N	R	O	F	O	R	N	0.2-0.5	<0.5	<0.5	Slow
F6	RV3	S	R	E	V	0.5-1	S	P/G	N	F	O	O	O	O	N	0.2-0.5	<0.5	<0.5	Slow
F7	RV3	S	R	E	V	<0.5	S	P/G	N	R	F	O	O	O	N	0.1-0.2	<0.5	<0.5	Slow
MF2	na	S1	R	E	>45	<0.5	S	G/P	N	N	O	O	R	R	N	0.2-0.5	<0.5	<0.5	Slow
MF3	na	S1	R	E	V	0.5-1	S	G/P	N	N	O	F	O	R	N	0.2-0.5	<0.5	<0.5	Slow
MF5	RV5	S/O	R	E	V	0.5-1	S	G/P	N	R	O	O	O	O	N	0.2-0.5	<0.5	<0.5	Slow
MF6	RV5	S1	R	E	V	0.5-1	S	G/P	N	N	F	O	O	O	N	0.2-0.5	<0.5	<0.5	Slow
MF7	RV5	S1	R	E	Varied	Varied	S	G/P	N	N	O	O	F	O	N	0.2-0.5	<0.5	<0.5	Slow
C1	na	S	R	E	V	0.5-1	S	G/ST	N	N	F	O	O	R	N	0.2-0.5	<0.5	<0.5	Slow
C2	na	S	R	E	V	0.5-1	S	G/ST	N	N	F	O	O	R	N	0.2-0.5	<0.5	<0.5	Slow
C2	na	S	R	E	V	0.5-1	S	G/ST	N	N	F	O	O	R	N	0.2-0.5	<0.5	<0.5	Slow
C3	na	S	R	E	V	0.5-1	S	G/ST	N	N	A	O	O	R	N	0.2-0.5	<0.5	<0.5	Slow
C3	na	S	R	E	V	0.5-1	S	G/ST	N	N	A	O	O	R	N	0.2-0.5	<0.5	<0.5	Slow
C4	RV6	S	R	E	<45	<0.5	S	G/P	N	R	F	O	O	R	N	Varied	<0.5	<0.5	Slow
C4	na	S	R	E	<45	<0.5	S	G/P	N	R	F	O	O	R	N	Varied	<0.5	<0.5	Slow
C6	na	S	R/B	E	Varied	Varied	S	G/P	N	N	F	O	O	O	N	Varied	<0.5	<0.5	Slow
G1	na	S1	R	E	>45	0.5	S	G/P	N	N	F	R	O	R	N	Varied	<0.5	<0.5	Slow
G1	na	S1	R	E	>45	0.5	S	G/P	N	N	F	R	O	R	N	Varied	<0.5	<0.5	Slow
G1	na	S1	R	E	>45	0.5	S	G/P	N	N	F	R	O	R	N	Varied	<0.5	<0.5	Slow

Key

Habitat rank: O=optimal, S1=class 1 sub-optimal, S2=class 2 sub-optimal, U=unsuitable

Habitat: R=running water, B=bog

Bank substrate: E=peat/earth, S=stony

Bank profile: V=vertical (or slope in degrees)

Softness: S=soft, H=hard

Substrate: S=sand, G=gravel, P=pebbles, ST=stones (cobble)

DAFORN: D=dominant 81-100%, A=abundant 61-80%, F=frequent 41-60%, O=occasional 21-40%, R=rare 1-20%, N=none 0%

Appendix 3. Water vole survey sections.

Section code	Watercourse	NGR downstream	NGR upstream	Quality	Notes
A1	Achvarasdal Burn	NC 9862 6386	NC 9891 6366	U	Banks vertical or overhanging. Hard with boulder or bracken root
A2	Achvarasdal Burn	NC 9900 6349	NC 9907 6347	S1	Banks are less steep than A1, sloping and grassy with soft bank faces and signs of small voles
A3	Achvarasdal Burn	NC 9908 6347	NC 9890 6263	U	Banks steep often rocky or have very dense root systems from bracken on top, some high undercuts
A4	Achvarasdal Burn	NC 9890 6263	NC 9892 6233	S2	Banks vertical or undercut, bank tops mainly dense bracken, some grass and banks slope to water upstream
A5	Achvarasdal Burn	NC 9892 6233	NC 9896 6210	S2/U	Much rock and boulder in banks or slumping, no small vole signs
A6	Achvarasdal Burn	NC 9896 6210	NC 9894 6183	S2/U	Downstream unsuitable rocky banks, upper very short grass and banks still quite hard
A7	Achvarasdal Burn	NC 9894 6183	NC 9909 6170	S1	More varied grass heights than downstream, some sloping but still much boulder in banks
A8	Achvarasdal Burn	NC 9909 6170	NC 9924 6159	S1	Banks high but some collapse creates steps, mixed grass and iris on bank tops
A9	Achvarasdal Burn	NC 9924 6159	NC 9935 6140	S1	Slightly faster flow with erosion on bends, banks bit unstable, mixed grass/Juncus /iris on bank tops
A10	Achvarasdal Burn	NC 9935 6140	NC 9942 6119	S1	Downstream end of section similar to A9 but upper is start of large pool with mixed grass, Juncus, iris on banks.
A11	Achvarasdal Burn	NC 9942 6119	NC 9939 6092	O/S1	Deep pool, good banks, mixed vegetation provides good cover in lower section, upper faster, water shallow
A12	Achvarasdal Burn	NC 9939 6092	NC 9948 6069	S1	Some small patches of nearly optimal where burrows and water vole latrines are, rest of section is slightly steep banks or less grassy
A13	Achvarasdal Burn	NC 9948 6069	NC 9946 6059	S1	Some nice patches where there is plenty of cover close to water's edge, some slumping, some high dry with very short grass
A14	Achvarasdal Burn	NC 9946 6059	NC 9951 6032	S1	Burrows in good patches, most of rest is fast flowing or very short grass, bracken appears at upstream end of section
A15	Achvarasdal Burn	NC 9951 6032	NC 9952 6009	S1	Downstream end of section has some, much is shallow glide/run with steep or vertical bracken clad banks
A16	Achvarasdal Burn	NC 9952 6009	NC 9960 5989	S2	Much is now fast with dense bracken banks, occasional slow areas are rarer
A17	Achvarasdal Burn	NC 9960 5989	NC 9951 5949	U	Steep, fast, bedrock falls, pools have hard bedrock banks and short grass
A18	Achvarasdal Burn	NC 9951 5949	NC 9939 5937	S2	Slightly steep but lower gradient than section 17, most high bracken banks along shallow glide but occasional sloping grass
A19	Achvarasdal Burn	NC 9939 5937	NC 9939 5225	S1	Good mix of long and short grass with rushes, good sloping or stepped bank, slow flow along much of section
A20	Achvarasdal Burn	NC 9939 5225	NC 9944 5904	S1	Latrines tucked in the back of some broken down banks. Patchy long grass and Juncus or stretches of short grass. Some bank faces high and scoured bare
A21	Achvarasdal Burn	NC 9944 5904	NC 9951 5882	S1	Stretches of very short grass banks interspersed with wetter tussock areas with some long grass, all vole signs in the wetter areas
A22	Achvarasdal Burn	NC 9951 5882	NC 9946 5864	S1	Very similar to section 21, not possible to tell if runs are water vole, no faeces
A23	Achvarasdal Burn	NC 9946 5864	NC 9952 5834	S1	Slightly poorer than 21 and 22, faster flowing with some boulder in banks, although good grass cover. Voles in wet flush tussock area where stream has sharp bend and wet flush runs across bend
A24	Achvarasdal Burn	NC 9952 5834	NC 9956 5774	S2	Similar to section 23, many small vole runs and holes in the patches of Juncus
AT1	Unnamed north	NC 9891 6352	NC 9893 6341	S2	Wet flush with some bracken and heather banks
AT2	Unnamed north	NC 9913 6337	NC 9898 6328	S2	Wet flush with irises and some bracken banks
M1	Milton Moss	NC 9890 6263	NC 9851 6238	S1	Small slow flowing ditch, banks have good burrowing potential, mixed grass at downstream end

Appendix 3 contd.

M2	Milton Moss	NC 9851 6238	NC 9780 6236	S2	Mostly unsuitable. Low lying and floodable. Tussocks, small patches of higher drier poor suboptimal
MT1A	Milton tributary	NC 9832 6213	NC 9833 6181	U/S2	Heathery downstream, upstream wet flush with no underground flow, ditch in trees
MT1B	Milton tributary	NC 9846 6240	NC 9845 6222	S2/U	Upstream wet flush (no underground flow), downstream banks low and floodable with oily deposits
MT2	Milton tributary	NC 9835 6241	NC 9825 6201	U/S2	Upstream grass with no channel, downstream oily/iron deposits
AT3	Unnamed	NC 9918 6158	NC 9899 6147	S1/S2	Downstream end of section tussocks with underground stream, upper deep forestry ditch with heather or thick grass
AT3a	Side tributary of unnamed	NC 9919 6156	NC 9919 6154	S1	Wet flush with no underground flow, tussocks
AT4a	Unnamed	NC 9946 6059	NC 9922 6058	S2/U	Ditch with high vertical bank (over 1m) on both or one side, not flowing with occasional pools standing water
AT4b	Unnamed	NC 9922 6058	NC 9915 6004	S2/U	Wet mossy flushes or dry ditch with heather clad overhanging banks, standing water in occasional pools
AT5a	Unnamed	NC 9939 5936	NC 9930 5937	O/S1	Short stretch of good optimal habitat with good mixture of vegetation, middle of section underground with tussocks. Upstream is ditch with one side high heather clad bank, other bank low and wet.
AT5b	Unnamed	NC 9930 5937	NC 9921 5935	S2/U	Plantation ditch with grass on one bank and vertical heather clad bank on other, towards upstream is low open moss ditch
AT6	Unnamed	NC 9938 5930	NC 9924 5931	S1	Lower and upper section is wet flush with Juncus and mixed grass, mid of site is underground. Most burrows towards top where habitat is good suboptimal bordering on optimal
ACF1	Allt Cnoc an Fhraoich	NC 9948 5864	NC 9937 5867	S1	Some soft banks would permit burrowing. Grasses and rushes. Stony with bracken near top of section.
ACF2	Allt Cnoc an Fhraoich	NC 9937 5867	NC 9917 5850	U	Steep stony stream.
ACF3	Allt Cnoc an Fhraoich	NC 9917 5850	NC 9900 5810	S1	Rushes and sphagnum. Much of bank low lying but some drier areas. All good foraging habitat. Burrows present at top of section, outside of site boundary.
ACF4	Allt Cnoc an Fhraoich trib.	NC 9925 5860	NC 9896 5862	U	Steep, stony stream. Near-dry at time of survey.
R1	Reay Burn	NC 9699 6323	NC 9701 6272	S2/U	Poor, short grass and high banks, banks harder downstream with increased gradient/speed of stream
R2	Reay Burn	NC 9701 6272	NC 9693 6249	S1	Okay suboptimal with good stream access, mixed grass and some very slow flows
R3	Reay Burn	NC 9693 6249	NC 9689 6233	S1	Similar to R4, some nice sloping areas on both sides with mixed grass, many small vole signs
R4	Reay Burn	NC 9689 6233	NC 9696 6199	S1	Left bank is good with mixed grasses, right bank bit steep and more heather clad
R5	Reay Burn	NC 9693 6210	NC 9701 6178	S1	Upstream has long grass and good banks, downstream banks are vertical and grass is short
R6	Reay Burn	NC 9701 6178	NC 9716 6154	S1	Banks grassy with steps, good suboptimal habitat right at bank but between channels too wet
R7	Reay Burn	NC 9716 6154	NC 9728 6135	S1	Long grass and Juncus by stream, many small voles signs, possible water vole activity
R8	Reay Burn	NC 9728 6135	NC 9736 6116	S1	Very short grass with some tussock behind, some stepped banks but much is vertical and rocky
R9	Reay Burn	NC 9736 6116	NC 9728 6099	S2	Very little cover from short grass, right bank is undercut and left is collapsing due to erosion, shallow and fast in places
R10	Reay Burn	NC 9728 6099	NC 9743 6060	S2	Much is very poor, either shallow fast runs with steep undercut bracken clad banks or very short grass, possible signs are at slow deep pool with tussocks on bend
R11	Reay Burn	NC 9743 6060	NC 9763 6039	S2	Some bends are slow with mixed grass and Juncus but mostly shallow And fast flowing or hard banks with very short grass
RS1	Reay side channel	NC 9710 6182	NC 9692 6209	S1	Downstream had some good banks with mixed grass but much is low banks likely to flood. Often dry channel of still pools
RS2	Reay side channel	NC 9710 6161	NC 9710 6182	S2	Channel disappears into bog with occasional pools, whole area is very prone to flooding and channel is unclear
RT1a	Unnamed (E of Borag Knowe)	NC 9765 6293	NC 9774 6287	S1	Tussock and bog myrtle. Banks low lying at top of section but steeper and suited to burrowing downstream. Little water - wet flush.
RT1b	Unnamed (E of Borag Knowe)	NC 9750 6311	NC 9765 6295	S1	More grasses than U1. Steep dry banks suited to burrowing in 25% of section. Rest low lying and boggy. Tiny channel/wet flush.

Appendix 3 contd.

RT1c	Unnamed (E of Borag Knowe)	NC 9735 6323	NC 9750 6311	S2	40% grass and much heather. Channel <0.2 m wide.
RT2b	Unnamed tributary	NC 9766 6138	NC 9786 6141	S2	Mainly dry but grasses provided some foraging. A few sections of soft, steep bank would permit burrowing. Signs of smaller voles present.
RT2a	Unnamed tributary	NC 9735 6124	NC 9766 6138	S2	Some patches at downstream end where banks are high but mostly low floodable wet flush
RT4	Unnamed tributary	NC 9734 6122	NC 9751 6119	S1/S2	Slight section underground at downstream end, wet flush with tussocks and grass becomes drier upstream
C1	Meur a' Chrochain Ghill	NC 9763 6040	NC 9776 6018	S1	Upstream is poor - fast flowing with heather and bracken on banks, slow flowing meanders with Juncus banks downstream
C2	Meur a' Chrochain Ghill	NC 9776 6018	NC 9787 5984	S1/S2	Some good bends with Juncus covering in upstream half of section, downstream it is steeper, narrow with bracken clad banks
C3	Meur a' Chrochain Ghill	NC 9787 5984	NC 9793 5953	S1	Many low gradient bends on stream with good Juncus and grass areas on the outside of the bends, also some stretches too steep
C4	Meur a' Chrochain Ghill	NC 9793 5953	NC 9801 5927	S1	Some Juncus covered channel with occasional dry grassy banks suitable for burrows, some steep fast flowing stretches
C5	Meur a' Chrochain Ghill	NC 9801 5927	NC 9815 5896	S2	Much is very deep (1m) steep sided narrow channel making access difficult, only a few Juncus flushes with accessible banks
C6	Meur a' Chrochain Ghill	NC 9815 5896	NC 9815 5858	S1	Upstream very poor with wet flush, lower better suboptimal with much Juncus and little grasses
CT1	Meur a' Chrochain Ghill	NC 9815 5896	NC 9824 5887	S1	Wet flush with Juncus and moss, grass on drier banks, many small voles signs
F1	Meur an Fhuarain Ghil	NC 9736 6116	NC 9741 6107	S1	Similar to FG6 but more short cropped grass
F2	Meur an Fhuarain Ghil	NC 9741 6107	NC 9757 6092	S1	Slightly faster than upstream but still stepped/sloping, often overgrown or under turf
F3	Meur an Fhuarain Ghil	NC 9757 6092	NC 9772 6082	S1/O	Lots of stepped or sloping banks, good grass mix, slow flow, optimal habitat on bend
F4	Meur an Fhuarain Ghil	NC 9772 6082	NC 9781 6074	S2	Mostly all unsuitable vertical high banks with very few collapsed areas, only small vole holes
F5	Meur an Fhuarain Ghil	NC 9781 6074	NC 9786 6064	S1	Mix of grass or heather banks, mostly vertical but some broken down (small stretches of unsuitable)
F6	Meur an Fhuarain Ghil	NC 9786 6064	NC9793 6056	S1	Banks steeper than F7 and more heather clad, broken down in places and some grass
F7	Meur an Fhuarain Ghil	NC 9793 6056	NC 9808 6039	S1/O	Upstream moss/Juncus wet flush into underground flow through Juncus and grass
G1	Meur Gadach	NC 9752 6045	NC 9755 5971	S1	Stream occasionally flows completely underground, some bends and open areas with Juncus/grass mix, becomes wet flush upstream
MF1	Meur an Fhraoich	NC 9763 6039	NC 9781 6035	S1	Very small stream goes underground in places, much is fast and steep with heather banks but a few slower areas with Juncus
MF2	Meur an Fhraoich	NC 9781 6035	NC 9799 6022	S2	Very narrow shallow stream, mostly steep with stony, heather and bracken clad banks flatter areas is common than downstream
MF3	Meur an Fhraoich	NC 9799 6022	NC 9818 5996	S2	One good flat, underground, grassy patch at confluence but most is small with moderate flow, slightly steep, and bracken on banks
MF4	Meur an Fhraoich	NC 9818 5996	NC 9820 5982	S2/U	Much is fast and steep with Juncus and grass quite thick
MF5	Meur an Fhraoich	NC 9820 5982	NC 9819 5966	S1	Runs underground with some stretches open, good mix of long and short grass and Juncus
MF6	Meur an Fhraoich	NC 9819 5966	NC 9833 5940	S1	Often completely underground at downstream end of section, often one bank higher and drier, upstream becomes poorer
MF7	Meur an Fhraoich	NC 9833 5940	NC 9843 5899	S1	Some stretches of wet flush and some of underground with stepped banks and mixture of Juncus and grasses, top of channel is dry with heather clad banks
MFT1	Meur an Fhraoich tributary	NC 9818 5996	NC 9852 5989	S2/U	Downstream no dry banks with bog/wet flush, upstream has dry bracken or grass
LE1	Lochan nan Eun	NC 9816 6136	NC 9816 6136	U	Heather and short sedges. Low lying and unsuitable for burrows.

Appendix 4. Selected photographs.



Optimal water vole habitat. Parts of colony AV1 were in this reach.



Class 1 sub-optimal water vole habitat in section C1 on the Meur a' Chrochain Ghill.



Class 2 sub-optimal in section MT1 on Milton Moss. Foraging potential is present but the low lying, wet banks are prone to flooding and are mainly unsuitable for burrowing.



Unsuitable habitat for water voles at section A17 on the Achvarasdal Burn. The hard, stony banks do not allow burrowing.



Water vole burrow in colony AV1.



Water vole latrine with droppings of varying ages present.

Appendix 11.F

Pine Marten Survey Report

**Limekiln Wind Farm:
Survey of pine marten *Martes martes* L.**

Draft report to Infinergy Ltd

July 2012

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1 Summary

1.1 Background

A survey of pine martens (*Martes martes* L.) was commissioned to inform the Environmental Impact Assessment for the proposed Limekiln Wind Farm in Caithness. The proposed wind farm is anticipated to have 30 to 50 turbines and would be constructed to the south of the village of Reay. The site extends to approximately 11 km² and is currently used mainly for commercial forestry.

A limited scat survey was carried out during summer 2011, in order to identify whether pine martens were present at the Limekiln site. The presence of pine martens was confirmed. Subsequently, a survey of signs and den locations around the proposed turbine and track network was carried out in May 2012. Marten signs were recorded during this survey to determine the extent of marten use of the site. A desk study of published sources was used alongside data on habitats at Limekiln to make an assessment of the site's potential for pine martens, including likely use of habitat and key foraging resources.

1.2 Main findings

- Twenty-six pine marten scats were positively identified using DNA analysis during 2011.
- Surveyors correctly identified 81 % of scats that were collected.
- The wider survey during 2012 found numerous signs of pine marten and it is clear that the species ranges throughout the Limekiln site.
- The thicket stage conifer at Limekiln has minimal field layer and provides poor foraging habitat for pine martens. It does provide cover but was too dense to survey effectively for dens. Few snags or root plates providing cover for martens were observed along the edges of the rides and those that were found showed no signs of marten use.
- The riparian buffer zones and some of the woodland rides provide good habitat for field voles *Microtus agrestis*, an important prey item for pine martens. These habitats are likely to represent the favoured foraging areas for pine martens at Limekiln.
- Fourteen potential sites for marten dens, mainly among rocks and boulders, were identified within the open areas of habitat. No signs were present at any of these and none was considered to be a marten den.
- As den locations may change over time, a pre-construction survey should be undertaken. This should include checks of the potential sites that were identified during the current survey.

2 Introduction

2.1 Proposed scheme

A survey of pine martens *Martes martes* was commissioned to inform the Environmental Impact Assessment for the proposed Limekiln Wind Farm in Caithness. The proposed wind farm is anticipated to have 30 to 50 turbines and would be constructed to the south of the village of Reay (Figure 1). The site extends to approximately 11 km² and is currently used mainly for commercial forestry. The trees are at a 'thicket' stage and there is little development of a field layer except at the perimeter (Headley 2012). The land has been ploughed for planting and the trees are planted on ridges; the habitat remnants in the firebreaks indicate the trees were mainly planted on blanket bog.

The proposed development has potential to impact on pine martens both directly e.g. through damage to resting sites or indirectly by changes to woodland and other habitats that may be used by the species.

2.2 *Pine marten legal status*

Pine martens are listed on Schedules 6 of the Wildlife and Countryside Act 1981 (as amended in Scotland). Various methods of capturing or killing pine martens are also listed in the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Under the Wildlife and Countryside Act 1981 (as amended) it is an offence to intentionally or recklessly:

- Kill, injure or take a wild pine marten;
- Damage, destroy or obstruct access to any structure or place which such an animal uses for shelter or protection (a nest or den);
- Disturb such an animal when it is occupying a structure or place for that purpose;
- Possess or control, sell, offer for sale or possess or transport for the purpose of sale any live or dead wild pine marten or any derivative of such an animal.

Knowingly causing or permitting any of the above acts to be carried out is also an offence. In addition to the above protections, pine martens were added to the UK Biodiversity Action Plan as a priority species requiring conservation action. Scottish Planning Policy (2010) requires all public bodies, including planning authorities, to further the conservation of biodiversity under the Nature Conservation (Scotland) Act, and to reflect this duty in management and planning decisions.

2.3 *Relevant aspects of pine marten ecology*

Pine martens are small carnivores of the family Mustelidae, which also includes stoats, weasels, otters and badgers. They are associated primarily with woodland and other structurally complex habitats, but will occasionally forage in open areas especially if rocky terrain is present offering cover (Birks 2002). Martens live in intrasexual territories, males excluding other males and adult females excluding other adult females. Male home ranges may overlap with more than one female home range. Pine martens generally have smaller core areas within the overall home range where they habitually forage or rest.

Although pine martens are carnivores, their diet is broad and includes a variety of foods, including small mammals, birds, eggs, carrion, invertebrates, fruits and nuts (Balharry *et al.* 2008). Microtine rodents (principally voles) are the most important prey species for martens throughout their European range. In most countries voles of the genus *Myodes* appear to be the preferred prey, but in Scotland the short-tailed field vole *Microtus agrestis* is more important and is the dominant prey in most studies (e.g. Lockie 1961; Gurnell *et al.* 1994; Putman 2000; Caryl 2008). Other important food includes carrion in winter and berries in late summer (Balharry *et al.* 2008; Caryl 2008). Martens mainly forage on the ground but they are excellent climbers and will readily take birds or squirrels in the canopy. Their ankle joints are highly adapted to arboreal life and they can grip with their rear feet while the rest of their body can be turned in any direction.

Generally, female pine martens first breed in their third year. Pine marten young are born in the spring and litter size varies from one to five (typically three). The young martens remain in the natal den for around 2 months before they are relocated. Dispersal normally takes place in the first autumn.

Pine martens do not generally excavate their own dens, preferring existing cavities. In Scotland, the majority of dens that have been described are in trees or amongst rocks, although a significant minority of those found have been in buildings, burrows or various man made structures (Birks *et al.* 2005). This diversity of den site differs to mainland Europe where martens mainly use tree cavities. Birks *et al.* (ibid.) suggest that the difference may be due to the lack of tree holes in many Scottish woodlands, which tend to be dominated by younger trees in which cavities are rare. Marten dens are often sited in elevated positions. This provides some protection from red foxes *Vulpes vulpes*, which may be a significant predator of pine martens (Lindstrom *et al.* 1995).

2.4 *Pine martens, national, regional and local status*

It is thought that in Mesolithic times the pine marten was very common in Britain. Declines are likely to have been well advanced by the Middle Ages, due to woodland clearance and hunting for pelts (Strachan *et al.* 1996; Yalden 1998). Predator control on sporting estates further hastened declines and led to local and regional extinctions until by the early 1900s pine martens were confined to a few remote areas. Its modern distribution reflects expansion from these refuges. Today the pine marten's stronghold is in northern Scotland and its range is continuing to expand south and east. Recent distribution maps (Birks 2002; Balharry *et al.* 2008) suggest that it is widespread in Caithness and Sutherland. The National Biodiversity Network Gateway shows three records of pine marten less than 1 km north of the Limekiln Wind Farm site. These records include one of a female with a juvenile at NC 948 648 during 2009. There are also recent records from the Broubster and Shebster woodlands, immediately to the east of Limekiln.

3 Rationale, aims and objectives

Recent studies have shown that pine marten scats cannot always be reliably identified, even by experienced surveyors (Birks *et al.* 2004; Davison *et al.* 2002). Therefore the aim of the initial survey (July to September 2011) was to identify the presence of pine martens within the site and ensure surveyors were correctly identifying the majority of pine marten scats. The aim of the May 2012 study was to identify the distribution of marten activity and dens within the Limekiln site, concentrating on turbine perimeters and the proposed track layout. A secondary aim of this study was to provide an assessment of the site's potential for pine martens, including key resources and likely habitat use. This information will be used to:

- (i) Identify the potential impact of the proposed wind farm on pine martens if present and;
- (ii) Assist in the development of mitigation proposals, including any pre-construction survey needs.

4 Survey areas and methods

Possible pine marten scats were collected for DNA analysis by experienced mammal surveyors (Jon Watt, PhD, Lorna Brown, PhD, Shirley Lynch MSc and Steve Austin BSc) during late summer 2011. Scats judged to potentially be from pine martens were individually bagged and their location recorded using hand held GPS. Pine marten scats are very variable in their appearance and there is overlap in size and morphology with the faeces of other species (Davison *et al.* 2002). DNA typing is now considered essential to confirm pine marten presence (Cresswell *et al.* 2012). The scats were frozen as soon as possible after collection. Scats were then sent to the Waterford Institute of Technology where the DNA typing was conducted. The DNA analysis of the September samples was carried out using real time polymerase chain reaction (rt-PCR) methods to determine whether or not they were from pine martens. A control sample of known origin was also tested to ensure reliability of results.

Following on from the DNA study, a survey of potential den locations was undertaken by Jon Watt and Lorna Brown in May 2012. Most of the Limekiln forest is at thicket stage and very dense. As a result much of the site is inaccessible for survey and an extensive search for dens within the stands of trees was impractical at this time. The search was therefore limited largely to open areas, such as riparian zones and woodland rides. All open areas within a 250 m radius of proposed infrastructure, including potential turbine locations, compounds and indicative laydown areas were searched. Fifty-meter wide corridors on both sides of all access tracks were also searched where they passed through open areas. Searching focused on areas providing the greatest potential for marten dens such as boulder outcrops, rock piles, and raised uneven ground. Damaged trees where snags or root plates could provide cover were also searched. During the survey all marten scats or other signs seen were also recorded (NGR)

and counted. Ten scats from a possible den site were collected in May 2012 and sent for DNA analysis using sequencing to identify species.

The location of each sign was recorded on 1:10,000 scale maps in the field and additional information was recorded on a field form. Locations were confirmed using GPS in order that accurate spatial information could be provided and the distance from sources of potential damage or disturbance could be determined. This is particularly important in the case of resting sites, as distance from sources of damage or disturbance will guide any licensing requirements.

5 Results

5.1 *Pine marten presence*

Thirty-two scats were collected during the initial survey in 2011 (Appendix 1) of which 26 (81 %) were positively identified as pine marten (Appendix 2). The provenance of the other scats is unknown. Some may be from other carnivores or negative results may have resulted from degradation of DNA in scats that were from martens. The minimum level of accuracy of scat identification is therefore 81% (26/32), similar to that found in other studies (Davison *et al.* 2002; Birks *et al.* 2004). The distribution of pine marten scats identified by rt-PCR is shown on Figure 1. It should be noted that this initial scat survey was not intended to be comprehensive and that it did not, therefore, cover the entire site. Pine marten presence was however confirmed and, when the proposed layout became available in May 2012, a more wide-ranging survey of marten signs and marten dens was carried out.

5.2 *Distribution of signs*

During the May 2012 survey the only marten signs identified were scats (see Appendix 3). Scats were found throughout the Limekiln site and also along the proposed route of the access track (Figure 2). Many of the scats were deposited along the various woodland rides where they were often found on deer paths.

5.3 *Resting sites*

In total 14 potential den locations were identified during the May 2012 survey (Appendix 4). However of these, only one was considered potentially to be in use as a marten den.

The site that was identified as possibly an active den was at NC 9891 6080, in the west face of the old quarry near the limekiln (Figure 2). The quarry face at this location appears to consist of boulders (presumably old quarried material) that have become covered in earth and turf. Several entrance holes lead into the old quarry face. A number of these entrance holes are small, some 10 to 20 cm wide and too small to allow fox access. All of them lead back into the rocky bank. Many small scats were present around the various entrances and on nearby paths. The appearance of the scats was consistent with pine marten i.e. mainly 1 cm diameter (approx.), sometimes twisted and generally full of hair and mammal remains. No large, fox-like scats were present around the entrance holes at the quarry site, although fox scats were present near the building on top of the bank on the north side of the quarry. Ten of the smallest scats were collected and sent for DNA analysis. The DNA sequencing identified all of the scats as fox (see Appendix 5), suggesting that the site is a fox den and that cubs were present.

None of the other locations identified as potentially suitable for use as resting sites had any associated scats or other signs of use by martens or other carnivores. The majority of these sites were associated with scattered rocky outcrops and consisted of tunnels or caves under boulders. One, also near the limekiln, consisted of a tunnel into old masonry. Some of these sites appeared to have some good potential for longer-term marten use, with small, narrow entrances that would provide protection from foxes. Two locations examined were in high, dry peat banks; one may have been an old rabbit warren while the other may have been created by water erosion. Only one location examined was in the form of a wind blown tree. In general extremely few snaggings, root plates or tree cavities were present in the

thicket stands of the plantation. Throughout the site the majority of the trees are between 7 and 15 m in height with simple growth forms and lacking holes or other features that would create suitable den sites for martens.

Figure 1 Locations of pine marten scats positively identified using *rt*-PCR (September 2011)

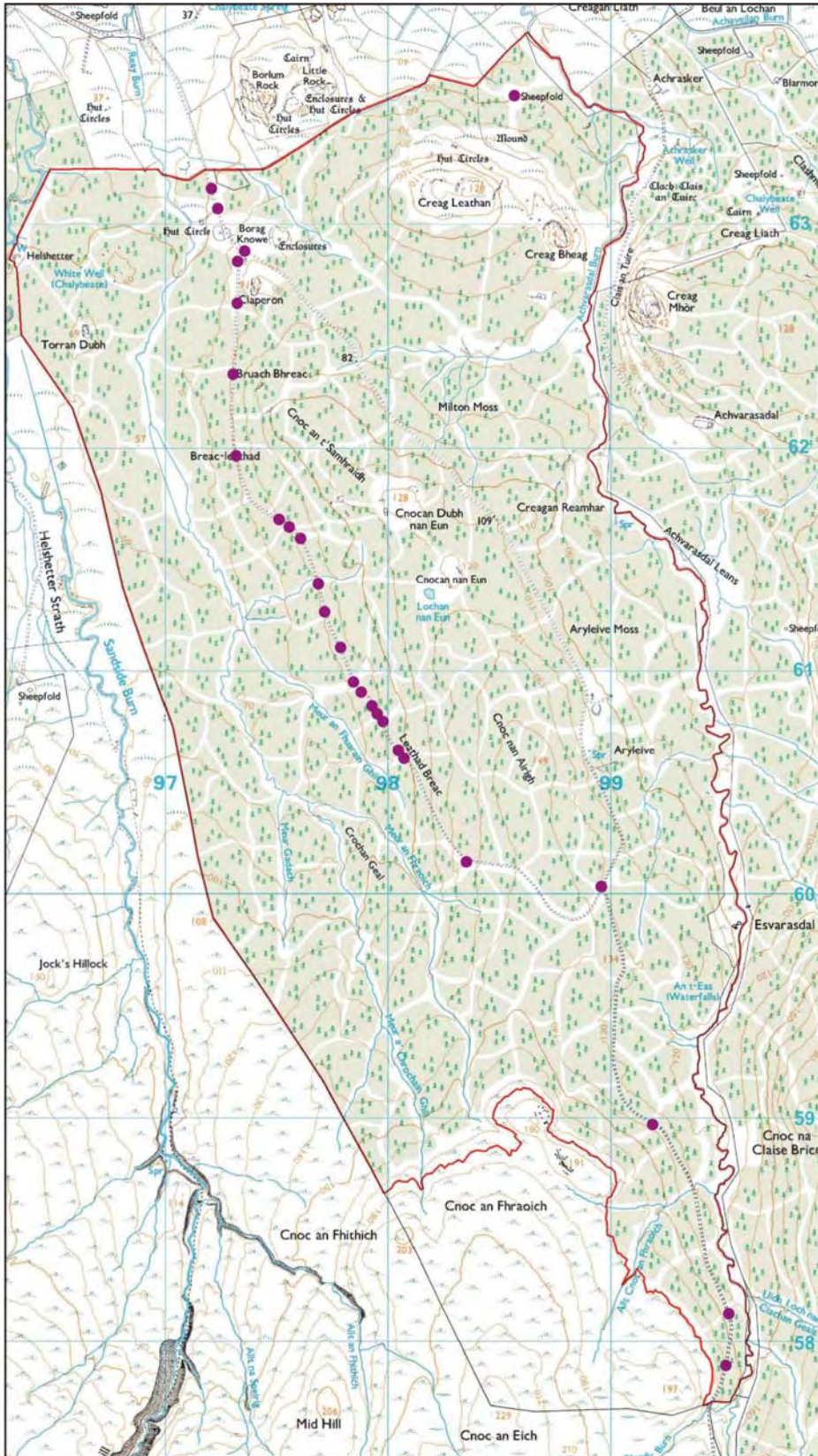
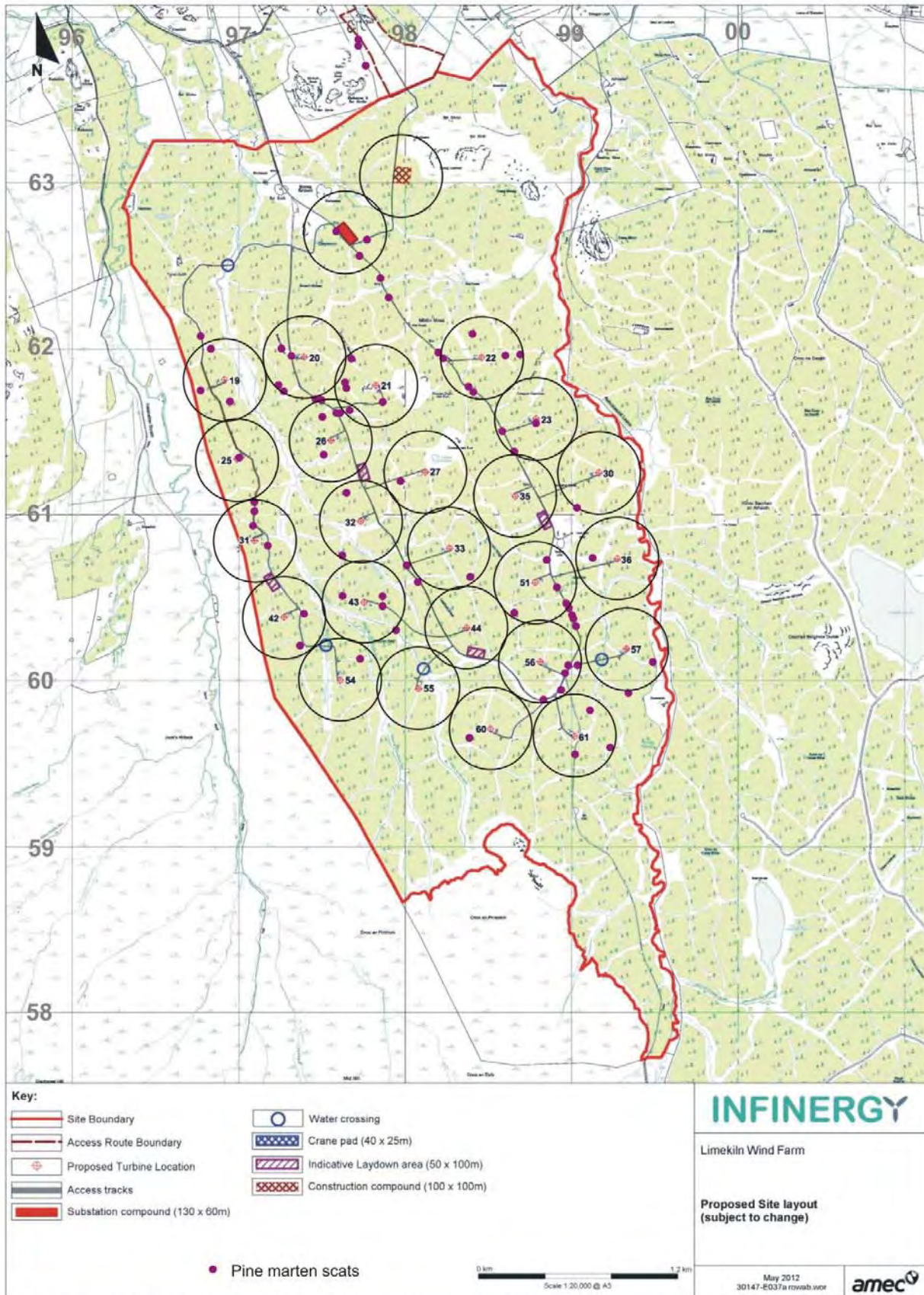


Figure 2 Locations of pine marten signs identified during May 2012 survey. 250 m search perimeters are shown around turbines and other proposed infrastructure.



Based upon Ordnance Survey Map with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright. 100001776

6 Interpretation

6.1 *Habitat suitability*

Very early, or very mature and well-thinned conifer forests generally have a diversity of sub-canopy vegetation cover. In contrast, due to lack of light penetration, thicket stage conifer forests generally lack a field layer of grasses and herbs and this is the case at Limekiln (Headley 2012). Pine martens do not favour thicket stage conifer forests and use it less than more open canopy forest (Caryl 2008). Habitat use of conifer forest is influenced in large part by prey availability (Birks 2002) and in Scotland the most important prey is the field vole. Field voles are strongly associated with rough, often damp, ungrazed grassland such as that found in open mature or pre-thicket conifer forest.

At Limekiln, suitable habitat for field voles is confined to the forest rides and other open areas, particularly the buffer zones along the various watercourses where tussock forming grasses such as *Molinia caerulea* are abundant (Headley 2012). Field vole signs were abundant in these habitats (Waterside Ecology 2012; J. Watt pers.obs.) and small mammal remains and hair were present in marten scats identified during the 2012 survey (see Appendix 3). Caryl (2008) found that martens living in conifer forest selected to forage in areas where tussock grasses and rushes were abundant and demonstrated that this was a reflection of diet and prey availability. It is very probable, therefore, that the primary food resources for pine martens at Limekiln are the vole populations in forest rides and riparian buffer strips and these areas, not the thicket conifer, represent the species' core foraging areas.

Although field voles are generally considered the most important prey of Scottish pine martens, the species is a trophic generalist and other food items may be important. Martens are efficient predators of birds and berries are frequently eaten during the autumn (Putman 2000). Feather and berries were present in presumed marten scats at Limekiln during 2011.

Thicket stage trees such as those at Limekiln provide little potential for arboreal dens or for dens in large complex root masses. Few fallen trees are present and the trunks are too young and small to have developed holes that would provide potential dens. However, the trees do provide dense cover, which may allow martens to conceal den sites in nests or under root plates. In the summer, martens may simply rest up on tree branches (Cresswell *et al.* 2012). Elsewhere, cover such as rock falls appeared to be lacking, although clearly it was impossible to fully survey the extensive thickets. Those that are present are generally of a poor quality, other than those discussed in 6.3 below. Some areas of dense scrub, mainly gorse, present near the northern perimeter of the site may also offer suitable cover for resting sites.

6.2 *Use of the site by pine martens*

Overall, the habitat at Limekiln can be considered sub-optimal for pine martens due to the predominance of thicket stage conifer, providing limited food resources or den sites. The most important marten habitats on the site are likely to be the riparian zones and some of the woodland rides where tussock-forming grasses provide habitat for field voles, the favoured prey of Scottish pine martens.

Pine martens have large home ranges. Published home range size of breeding females (reviewed by Balharry *et al.* 2008; Caryl 2008) varies between 0.7 km² in lowland mixed conifer forest in Easter Ross to 9.8 km² in upland spruce forest in Galloway. Given the great variation in range size, it is difficult to assess how many breeding martens might be present at Limekiln. The smallest home ranges were identified by Caryl (2008) at Morangie Forest. These were obtained from martens living in more diverse habitats than are present at Limekiln and with less thicket stage conifer. These very small ranges are unusual and all other Scottish studies have suggested home ranges of >2 km². It seems probable that marten range size at Limekiln would be greater than that at Morangie Forest due to the abundance of less-favoured habitats. As such, it might be suggested that the Limekiln site might support five or fewer breeding females, although any such estimate must be treated with extreme caution.

It has already been noted that breeding pine martens have been recorded immediately to the north of Limekiln. The forest habitats to the east, at Broubster, also appear to provide suitable habitat for pine martens and it is probable that the home ranges of some individuals using Limekiln Forest extend outside the site. Some vole rich habitats are also likely to be present along the Sandside Burn, a short distance to the west and also easily accessible for pine martens at Limekiln.

6.3 Resting site identification and sensitivity

The survey identified no pine marten dens. Thirteen ground level sites were considered sufficiently suitable to warrant a check during any pre-construction survey. Most of these are simple cave-like structures in rock outcrops, but as they are at ground level these sites offer limited protection from foxes and are unsuitable as breeding sites. Birks *et al.* (2005) found that 28% of dens found by radio-tracking and/or chance were associated with rocks. Use of dens within trees was far lower than in continental Europe and those structures that were found tended to offer only limited protection against severe weather. They suggest that a lack of old trees and their associated cavities forces martens to use ground-level dens that may be subject to fox predation. Placing the dens within rock cavities may give some protection against predation but compromise thermal regulation. Birks *et al.* (2005) conclude that breeding success is likely to be limited in commercial forestry due to the limited availability of den sites.

6.4 Areas not surveyed

The dense stands of conifer that dominate the proposed wind farm site could not be fully surveyed. No suitable tree den locations were observed along the edges of the stands but clearly it would not be possible to state categorically that no resting sites were missed.

Very dense patches of gorse are present on the stream banks in the lower reaches of the Reay Burn around NC 970 631 and the lower Achvarasdal Burn around NC 987 636. Gorse was also present along the main track within the development zone and along the proposed access route into the development area. Searches were made for paths leading into these dense stands and by kneeling and crawling it was sometimes possible to determine that no holes or marten scats were present. However, as with the plantations, it cannot be stated categorically that no marten signs were missed in this area.

Four of the survey zones around turbines in the west of the site (19, 25, 31 and 42) extend a short distance beyond the site boundary (see Figure 2) and no access permissions could be gained for these areas. Observations from the forest edge suggested that the great majority of this unsurveyed area comprised flat, featureless heather moor without suitable cover for dens. Only the ground beyond the fence to the west of turbine 31 had some undulations and a few boulders. Those boulders seen from the fence line appeared to be well bedded in but this could not be confirmed.

7 Potential impacts

7.1 Prey populations

Potential impacts on pine martens resulting from the development of a wind farm at Limekiln may result from changes in habitat use, as some areas of conifer will be felled for erection of turbines and construction of a track network. At the time of writing, no felling plan is available so the extent of felling and other habitat changes are unknown.

In general, the thicket stage conifer at Limekiln is likely to be used by martens mainly as cover since it will not support significant prey resources except perhaps at the edges where birds may be more abundant. Felling of conifers is likely to result in a proliferation of ground cover species, particularly grasses such as *Molinia caerulea*, and would be expected to result in increases in habitat availability for voles (Lambin *et al.* 2000) and ground nesting birds such as meadow pipits. This in turn might be expected to enhance prey resources for pine martens at Limekiln. Pine martens do not favour very open habitats but would be expected to exploit vole rich habitats where some cover is available. Caryl's

(2008) study in Easter Ross found that pine martens used scrub cover for travel between favoured foraging areas and also for resting sites. Brash and other woody debris provides similar cover and the retention of these types of three-dimensional structure in clear felled areas would be expected to ensure continued use by pine martens. It is worth noting, however, that positive site management requirements for pine martens may run counter to those for raptors. Scottish Natural Heritage guidance for post-construction management of wind farm sites near SPAs (SNH 2010) aims to reduce vole and ground nesting bird numbers in order to make the sites unattractive to raptors, minimising collision risk. Clearly, an integrated plan for the site will have to balance the needs of the various species of conservation concern that are present.

7.2 *Resting sites*

No pine marten resting sites were identified during the survey.

7.3 *Licensing*

It is possible to licence activities that could affect pine martens for social, economic or environmental reasons. This could cover a range of activities including wind farm developments. However, it is important to note that SNH may only issue licences for such purposes provided that:

- The activity authorised by the licence will contribute to significant social, economic or environmental benefit; and,
- There is no other satisfactory solution.

Alterations to habitats are unlikely to require a licence. However, disturbance or damage to pine marten dens would. We suggest that a pre-construction survey for marten dens should be carried out.

7.4 *Recommendations*

- A pre-construction pine marten den survey should be carried out resurveying accessible habitats around proposed infrastructure and the potential sites identified in Appendix 4. This should take place no more than ten weeks pre-construction/felling and will determine any licensing needs.
- In areas that will be felled or otherwise disturbed, but where the trees were too dense to permit survey, further mitigation may be required to minimise the risk to pine marten dens. This might, for instance, include additional checks of any areas that provide good potential for den sites as these become exposed by felling. If necessary, risk to young pine martens still in the natal den might be further reduced by seasonal restriction of felling in any sensitive areas that are identified by pre-construction/pre-felling survey.
- Pine marten should be considered in any post-development habitat management plans, although it is acknowledged that there may be conflicts between optimum management for pine martens and for raptors.

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Appendix 1. Scats collected during 2011 survey for DNA analysis

Collector	Date	NGR	Result
JW	26/07/2011	NC 9951 5814	Pine marten
JW	26/07/2011	NC 9952 5796	Pine marten
JW	26/07/2011	NC 9892 6190	Not pine marten
JW	26/07/2011	NC 9730 6294	Pine marten
JW	26/07/2011	NC 9828 6020	Pine marten
LB	26/07/2011	NC 9720 6224	Pine marten
LB	26/07/2011	NC 9722 6244	Pine marten
SA	06/07/2011	NC 97190 63185	Pine marten
SA	25/09/2011	NC 98977 60044	Not pine marten
SA	25/09/2011	NC 98974 60047	Pine marten
SA	25/09/2011	NC 98976 60053	Pine marten
SA	25/09/2011	NC 97328 62903	Pine marten
SA	25/09/2011	NC 97203 63154	Pine marten
SA	20/06/2011	NC 98620 63585	Pine marten
SL	05/07/2011	NC 97534 62935	Not pine marten
SL	31/07/2011	NC 97974 60731	Pine marten
SL	31/07/2011	NC 97979 60731	Pine marten
SL	31/07/2011	NC 98076 60598	Pine marten
SL	01/09/2011	NC 99217 58940	Pine marten
SL	26/09/2011	NC 98318 60363	Not pine marten
SL	26/09/2011	NC 98072 60603	Pine marten
SL	26/09/2011	NC 97980 60736	Not pine marten
SL	26/09/2011	NC 97900 60881	Pine marten
SL	26/09/2011	NC 97840 60944	Pine marten
SL	26/09/2011	NC 97757 61149	Pine marten
SL	26/09/2011	NC 97705 61274	Pine marten
SL	26/09/2011	NC 97670 61330	Pine marten
SL	26/09/2011	NC 97603 61573	Pine marten
SL	26/09/2011	NC 97568 61618	Pine marten
SL	26/09/2011	NC 97505 61663	Pine marten
SL	26/09/2011	NC 97310 61948	Pine marten
SL	26/09/2011	NC 98639 60036	Not pine marten

Surveyors:

JW: Jon Watt, BSc, PhD, Waterside Ecology

LB: Lorna Brown, BSc, PhD, Waterside Ecology

SA: Steve Austin, MSc, independent consultant

SL: Shirley Lynch, MSc, independent consultant.

Appendix 2. Analytical data for rt-PCR as supplied by Waterford Institute of Technology.

Sample		DNA Extraction		Real time PCR Data				Results
Code	Suspect species	Code	DNA conc. (ng/μl)	Probe	Total cycles	Cycles to amplify (Ct)	Data file	Species
SEL 539	<i>Martes martes</i>	CP 141111 1	4.5	PM3	40	22.05	151111	<i>Martes martes</i>
SEL 540	<i>Martes martes</i>	CP 141111 2	6.1	PM3	40	21.32	151111	<i>Martes martes</i>
SEL 541	<i>Martes martes</i>	CP 141111 3	6.4	PM3	40	nd	151111	<i>Not Martes martes</i>
SEL 542	<i>Martes martes</i>	CP 141111 4	5.7	PM3	40	23.27	151111	<i>Martes martes</i>
SEL 543	<i>Martes martes</i>	CP 141111 5	5.8	PM3	40	22.14	151111	<i>Martes martes</i>
SEL 544	<i>Martes martes</i>	CP 141111 6	4.9	PM3	40	25.73	151111	<i>Martes martes</i>
SEL 545	<i>Martes martes</i>	CP 141111 7	8.7	PM3	40	27.12	151111	<i>Martes martes</i>
SEL 546	<i>Martes martes</i>	CP 141111 8	4.8	PM3	40	21.32	151111	<i>Martes martes</i>
SEL 547	<i>Martes martes</i>	CP 141111 9	9.1	PM3	40	ND	151111	<i>Not Martes martes</i>
SEL 548	<i>Martes martes</i>	CP 141111 10	4.9	PM3	40	25.26	151111	<i>Martes martes</i>
SEL 549	<i>Martes martes</i>	CP 141111 11	7.7	PM3	40	22.73	151111	<i>Martes martes</i>
SEL 550	<i>Martes martes</i>	CP 141111 12	5.6	PM3	40	18.54	151111	<i>Martes martes</i>
SEL 551	<i>Martes martes</i>	CP 141111 13	6.8	PM3	40	17.41	151111	<i>Martes martes</i>
SEL 552	<i>Martes martes</i>	CP 141111 14	6.6	PM3	40	22.15	151111	<i>Martes martes</i>
SEL 553	<i>Martes martes</i>	CP 141111 15	8.5	PM3	40	nd	151111	<i>Not Martes martes</i>
SEL 554	<i>Martes martes</i>	CP 141111 16	9.3	PM3	40	24.41	151111	<i>Martes martes</i>
SEL 555	<i>Martes martes</i>	CP 141111 17	7.4	PM3	40	22.9	151111	<i>Martes martes</i>
SEL 556	<i>Martes martes</i>	CP 141111 18	5.3	PM3	40	22.61	151111	<i>Martes martes</i>
SEL 557	<i>Martes martes</i>	CP 141111 19	6.2	PM3	40	21.47	151111	<i>Martes martes</i>
SEL 558	<i>Martes martes</i>	CP 141111 20	7.8	PM3	40	nd	151111	<i>Not Martes martes</i>
SEL 559	<i>Martes martes</i>	CP 141111 21	2.7	PM3	40	26.45	151111	<i>Martes martes</i>
SEL 560	<i>Martes martes</i>	CP 141111 22	5.9	PM3	40	nd	151111	<i>Not Martes martes</i>
SEL S61	<i>Martes martes</i>	CP 141111 23	5.9	PM3	40	23.34	151111	<i>Martes martes</i>
SEL 562	<i>Martes martes</i>	CP 141111 24	4.7	PM3	40	21.99	151111	<i>Martes martes</i>
SEL 563	<i>Martes martes</i>	CP 141111 25	7.9	PM3	40	25.05	151111	<i>Martes martes</i>
SEL 564	<i>Martes martes</i>	CP 141111 28	9.7	PM3	40	23.19	151111	<i>Martes martes</i>
SEL 565	<i>Martes martes</i>	CP 141111 29	6.8	PM3	40	20.58	151111	<i>Martes martes</i>
SEL 566	<i>Martes martes</i>	CP 141111 30	7.8	PM3	40	23.8	151111	<i>Martes martes</i>
SEL 567	<i>Martes martes</i>	CP 141111 31	6.6	PM3	40	24.5	151111	<i>Martes martes</i>
SEL 568	<i>Martes martes</i>	CP 141111 32	7.1	PM3	40	24.11	151111	<i>Martes martes</i>
SEL 569	<i>Martes martes</i>	CP 141111 33	5.8	PM3	40	24.71	151111	<i>Martes martes</i>
SEL 570	<i>Martes martes</i>	CP 141111 34	8.6	PM3	40	nd	151111	<i>Not Martes martes</i>

Positive control sample	Source	Result
	<i>Martes martes</i>	Ct=21.99 cycles

Appendix 3. Pine marten signs distribution, May 2012.

Date	Surveyor	NGR	Notes
22/05/2012	LB	NC 9768 6191	1 recent, 1m from path
22/05/2012	LB	NC 9727 6174	1 recent 1 old
22/05/2012	LB	NC 9724 6178	1 old scat
22/05/2012	LB	NC 9725 6200	1 old scat
23/05/2011	LB	NC 9677 6208	Pile of old scats
23/05/2011	LB	NC 9683 6200	3 piles of scats within 3 m on deer path with 1 old, 1 old and two recent/1 old
23/05/2011	LB	NC 9677 6173	2 piles of scats within 2 m on deer path - one old marten, one fox and marten
23/05/2011	LB	NC 9694 6167	2 old scats
23/05/2011	LB	NC 9707 6133	1 old scat on path from ride into ditch under thick canopy
23/05/2011	LB	NC 9710 6107	2 piles of old
23/05/2011	LB	NC 9709 6103	1 old scat
23/05/2011	LB	NC 9705 6096	1 old scat
23/05/2011	LB	NC 9717 6080	1 old scat
23/05/2011	LB	NC 9740 6039	1 recent
23/05/2011	LB	NC 9737 6020	2 piles 20 m apart on deer path
23/05/2011	LB	NC 9772 6012	2 piles of mixed species scats 2 m apart
23/05/2011	LB	NC 9838 5962	1 fox, one possible old pine marten
23/05/2011	LB	NC 9795 6031	1 possible old marten scat
23/05/2012	LB	NC 9787 6043	3 old and second pile of two old 2 m apart
23/05/2012	LB	NC 9787 6050	2 recent 2 old
23/05/2012	LB	NC 9761 6051	1 old scat
23/05/2012	LB	NC 9762 6078	1 possible old marten scat
23/05/2012	LB	NC 9776 6114	Pile of old scats
23/05/2012	LB	NC 9747 6169	1 recent and pile of old
23/05/2012	LB	NC 9777 6265	1 old scat
23/05/2012	LB	NC 9759 6270	1 old scat
24/05/2012	LB	NC 9902 6107	1 fresh scat
24/05/2012	LB	NC 9912 6074	1 recent scat
24/05/2012	LB	NC 9864 6137	1 old scat
24/05/2012	LB	NC 9857 6150	Pile of old scats
24/05/2012	LB	NC 9849 6165	1 old scat
24/05/2012	LB	NC 9772 6387	1 old on fallen section of wall
24/05/2012	LB	NC 9772 6385	2 old on fallen section of wall
24/05/2012	LB	NC 9779 6368	1 old on fallen section of wall
22/05/2012	JW	NC 9731 6197	On track
22/05/2012	JW	NC 9786 6167	Path on ride - small mammal remains
22/05/2012	JW	NC 9764 6177	Contains feather
22/05/2012	JW	NC 9763 6177	4 scats containing small mammal
22/05/2012	JW	NC 9763 6178	3 scats
22/05/2012	JW	NC 9764 6163	2 scats
22/05/2012	JW	NC 9758 6162	Near road
22/05/2012	JW	NC 9759 6159	Road - old fox scat also present
22/05/2012	JW	NC 9751 6160	3 to 4 scats
22/05/2012	JW	NC 9751 6137	1 scat small mammal remains
22/05/2012	JW	NC 9747 6168	1 scat on road
23/05/2012	JW	NC 9797 6119	Six scats at crossroads with dead grass- established scent marking location
23/05/2012	JW	NC 9840 6057	2 scats - small mammal remains
23/05/2012	JW	NC 9838 6217	1 scat
23/05/2012	JW	NC 9859 6197	1 scat
23/05/2012	JW	NC 9868 6195	3 to 4 scats - dry and moist

Appendix 3 contd.

Date	Surveyor	NGR	Notes
23/05/2012	JW	NC 9876 6152	4 marten scats and 3 fox on bare ground scent marking area
23/05/2012	JW	NC 9864 6041	1 scat
23/05/2012	JW	NC 9910 5982	1 scat on multi species path into wood
23/05/2012	JW	NC 9924 5959	2 scats
23/05/2012	JW	NC 9902 5955	1 scat
23/05/2012	JW	NC 9892 5994	1 scat
23/05/2012	JW	NC 9882 5987	1 scat
23/05/2012	JW	NC 9808 6059	1 scat
23/05/2012	JW	NC 9801 6067	4 scats
24/05/2012	JW	NC 9948 6009	4 scats on path to stream
24/05/2012	JW	NC 9934 5993	1 scat
24/05/2012	JW	NC 9897 6003	1 scat
24/05/2012	JW	NC 9898 6006	1 scat
24/05/2012	JW	NC 9902 6030	1 scat
24/05/2012	JW	NC 9902 6031	4 scats
24/05/2012	JW	NC 9900 6035	4 scats
24/05/2012	JW	NC 9899 6036	1 scat
24/05/2012	JW	NC 9896 6045	2 scats
24/05/2012	JW	NC 9890 6056	3 scats
24/05/2012	JW	NC 9886 6071	1 scat
24/05/2012	JW	NC 9837 6175	3 and 2 scats
24/05/2012	JW	NC 9832 6178	1 scat
24/05/2012	JW	NC 9821 6193	1 scat
24/05/2012	JW	NC 9819 6195	2 scats
24/05/2012	JW	NC 9788 6231	3 scats
24/05/2012	JW	NC 9765 6243	1 scat
24/05/2012	JW	NC 9772 6255	1 scat