Construction Environmental Management Plan (CEMP)

Strathy South Wind Farm

This CEMP has been prepared to support the

Strathy South Wind Farm Environmental Statement

(Project Ref. LN 000019)

CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

STRATHY SOUTH

CONTENTS

DOCUMENT CONTROL SHEETS

SECTIONS

PART 1 – CONSTRUCTION ENVIRONMENTAL MANAGEMENT 1
1 INTRODUCTION 1
1.1 Construction Environmental Management: Aims & Objectives 1
1.2 Roles, Responsibilities and Structure of the CEMP 1
2 PROJECT ENVIRONMENTAL CONSTRAINTS 3
2.1 Schedule of Mitigation, Commitments Register and Planning Conditions 3
2.2 Planning Conditions 3
3 CORRESPONDENCE & GENERAL COMMUNICATION 6
3.1 Correspondence, Records & Reports 6
3.2 Environmental Audits 6
3.3 Risk Assessments and Method Statements 6
4 SITE INDUCTION AND TRAINING 7
5 POLLUTION PREVENTION & MITIGATION 8
5.1 Responsibility 8
5.2 Site Specific Requirements and Documentation 8
5.3 General Pollution Prevention Measures 8
5.4 Noise and Dust 9
5.5 COSHH 9
5.6 Pollution Monitoring & Controls 9
6 WASTE MANAGEMENT 10
6.1 Site Waste Management Plan (SWMP) Implementation and Records 10
6.2 SWMP Monitoring and Auditing 10
6.3 Anticipated Construction Waste Streams 10
7 DRAINAGE 11

7.1 Scope and Minimum Requirements 11
7.2 Clean Water Diversion 11
7.3 Silt Mitigation and Settlement Ponds 11
7.4 Borrow Pit Drainage 12
7.5 Turbine Foundations and Crane Hardstandings 12
7.6 Construction Compounds, Substation and Control Buildings 12
7.7 Access Track Drainage 13
7.8 Peat and Soil Storage Drainage 14
8 WATER QUALITY MONITORING 15
8.1 General Requirements 15
8.2 Monitoring Frequency and Analytical Parameters 15
8.3 Surface Water Quality Monitoring Reports 16
8.4 *Contractor's* Visual and Field Water Quality Monitoring 17
8.5 Private Water Supplies (PWS) 17
9 WATERCOURSE CROSSINGS 18
9.1 General 18
9.2 Design Philosophy 18
10 ECOLOGICAL PROTECTION 20
10.1 Scope and Objectives of the Habitat and Species Protection Plan 20
10.2 Definitions, coverage and scope 20
10.3 Habitats Protection Plan 20
10.4 Species Protection Plan 21
10.5 The Ecological / Environmental Clerk of Works (ECoW) 24
11 ARCHAEOLOGICAL PROTECTION 28
12 EXCAVATED MATERIALS 29
12.1 Contractor Requirements 29
12.2 Excavations 29
12.3 Handling and Temporary Storage of Excavated Material 29
13 FORESTRY & AGRICULTURAL LAND 31
13.1 Forestry 31
13.2 Agricultural Land 32

14 REINSTATEMENT AND RESTORATION 34
15 ENVIRONMENTAL INCIDENT & EMERGENCY RESPONSE 36
15.1 General Requirements 36
15.2 SEARS and Environmental Auditing 36
15.3 Summary Sheet for Machinery / Plant Operators 36
16 REFERENCE DOCUMENTATION 37
17 CHECKLIST – Required *Contractor's* Information 39
PART 2 – CONSTRUCTION METHODS 40
18 INTRODUCTION 40
18.1 General 40
18.2 Working Hours and Noise 40
18.3 Plant and Equipment 40
19 SITE ACCESS CONSTRUCTION 40
19.1 Signage 40
20 ENABLING WORKS 41
21 ONSITE PREPARATORY CONSTRUCTION 41
21.1 Introduction 41
21.2 Temporary Construction Compound Preparation 42
22 BORROW PITS 43
22.1 General Method of Work 43
22.2 Borrow Pit Establishment 44
22.3 Borrow Pit Working 45
22.4 Reinstatement 46
23 WTG & ANEMOMETER MAST FOUNDATION CONSTRUCTION 46
23.1 Construction of Turbine Foundations 47
24 ACCESS TRACK CONSTRUCTION 49
24.1 Introduction 49
24.2 General Construction Criteria 49
24.3 Unstable Ground 50
24.4 Track Construction 50

Drawings

Drawing 1: Typical Schematic of Settlement Ponds and Silt Mitigation Measures
Drawing 2: Schematic Drainage Arrangements for Tracks and Watercourse Crossings
Drawing 3: Schematic Section of Typical Cut and Fill Track Drainage Arrangements
Drawing 4: Schematic Borrow Pit Drainage Arrangements
Drawing 5: Schematic Drainage Arrangements for Turbine Bases and Crane Pad Hardstandings
Drawing 6: Schematic Drainage Arrangements for Substation and Control Room

DOCUMENT VERSION			
Version No.: V1.0			**Date: June 2013**
	Name	**Position**	**Signature**
Prepared by :	Michelle Morton	Environmental Officer	
Checked by :	Jane MacDonald	Environmental Manager	
Reviewed by :			
Comments:	*Version 1.0 supports the Strathy South Wind Farm Environmental Statement.*		

DOCUMENT REVISIONS			
Revision No:	**Description:**		**Date:**
Revision Details:			
	Name :	**Position :**	**Signature :**
Revised by :			
Checked by :			
Reviewed by :			

DOCUMENT DISTRIBUTION RECORD			
Version and Revision No. :	**Document**	**Date of Issue**	**Recipient**
V1.0, Rev 0.0	ES CEMP	June 2013	1. Scottish Parliament

PART 1 – CONSTRUCTION ENVIRONMENTAL MANAGEMENT

1 INTRODUCTION

1.1 Construction Environmental Management: Aims & Objectives

1.1.1 This document provides information on Environmental Management and details on Construction Methods (Part 2 of this CEMP) for the wind farm project. This document has been prepared for the Planning Authority and statutory consultees and outlines the proposed management methodology to be employed during the construction of the consented wind farm.

1.1.2 The principal objective of this document is to provide information on the proposed infrastructure and information on how SSER intend to avoid (where possible), minimise and control adverse environmental impacts associated with the development. Furthermore, this document aims to define good practice as well as specific actions to be implemented following receipt of a planning consent.

1.1.3 The information contained within the CEMP will form part of the Civils Works Contract. The methods and principles contained herein, as well as within referenced legislative instruments and published guidance documents, are adhered to by the *Contractor* in developing the detailed design, construction method statements and other plans relating to environmental management as required by the Contract.

1.1.4 The *Contractor* submits all relevant information as detailed in this document to the *Employer* for acceptance in according with the contract provisions. No works commence prior to the *Employer's* acceptance.

1.1.5 The *Employer* provides the *Contractor* with an electronic copy of the CEMP which the *Contractor* developments and maintains for the duration of the works (CEMP Version 2.0).

1.1.6 This document is read and implemented on site in conjunction with industry best practice, published guidance documents, and other documents referred to within the CEMP (see Section 16).

1.2 Roles, Responsibilities and Structure of the CEMP

1.2.1 The *Contractor* appoints an appropriately competent person or persons to undertake relevant environmental tasks as detailed in this document prior to and during the construction works. This person will be the *Contractor's* **Site Environmental Representative**. The relevant person will be based on site for the duration of the construction works.

1.2.2 The *Contractor* is responsible for obtaining all necessary consents, licences and permissions[1] for his activities as required by current legislation governing the protection of the environment.

1.2.3 The *Contractor* considers all of the mitigation measures and best practice construction methods

[1] For example, discharge consents, abstraction licenses, Waste Management License (WML) Exemption, Permission, notification or consent for road closure, opening or diversion.

detailed within this document in his design and in any detailed environmental plans as required by the Contract. Where any mitigation measures or construction methods described in other documents deviate in any way from those contained within this document, the *Contractor* abides by whichever is the most onerous and stringent in terms of environmental protection (whilst complying with H&S and civil engineering requirements), and identifies this to the *Employer* for acceptance.

1.2.4 A copy of this document and related files and documents will be kept in the site offices for the duration of the site works and will be made available for review at any time. Upon completion of the construction works, the *Contractor* submits a complete CD copy of the final set of information to the *Employer* for their records. This information will include electronic scans of all relevant hard copy reports, data, field records and correspondence which are gathered over the course of the construction works, as detailed in Section 3.

1.2.5 Where the *Contractor* has standard documents within his own company / corporate Environmental Management Plan which might cover a particular requirement of this CEMP, these will either be inserted or cross referenced within the relevant Section of the detailed CEMP.

1.2.6 A **Checklist** has been included in Section 17, providing the *Contractor* with a summary of the minimum information to be provided to the *Employer* pre- during and post-construction. The information / documents listed in the Checklist represent the minimum information to be provided to the *Employer* / Planning Authority at the stages indicated in the Checklist.

2 PROJECT ENVIRONMENTAL CONSTRAINTS

2.1 Schedule of Mitigation, Commitments Register and Planning Conditions

2.1.1 Mitigation measures are described in the relevant chapters of the Environmental Statement (ES). If not already provided in the ES, a Schedule of Mitigation will be prepared post-consent and will be provided as part of a revised and updated CEMP (V1.1) in Table 1 below. Table 1 will be updated following receipt of planning consent to include any additional commitments made following submission of the planning application of the ES Addendum.

TABLE 1.0
SCHEDULE OF MITIGATION

ES Section	Mitigation Specified within the ES and Subsequent Documentation* (*as applicable, e.g. Further Information, Pre-construction surveys, etc)
	To be provided post-consent (CEMP version V1.1)

2.1.2 Following receipt of planning consent, the Mitigation Schedule will be updated and incorporated into a Commitments Register which will detail all mitigation measures referred to in the ES, any ES Addendum and additional documentation provided to, and approved by the Planning Authority.

2.2 Planning Conditions

2.2.1 Table 2.0 below **will be updated** to include details of relevant planning conditions attached to any consent to be received, and will detail which section(s) of the updated CEMP documentation covers specific planning conditions.

TABLE 2.0
RELEVANT PLANNING CONDITIONS AND RELATED DOCUMENTATION

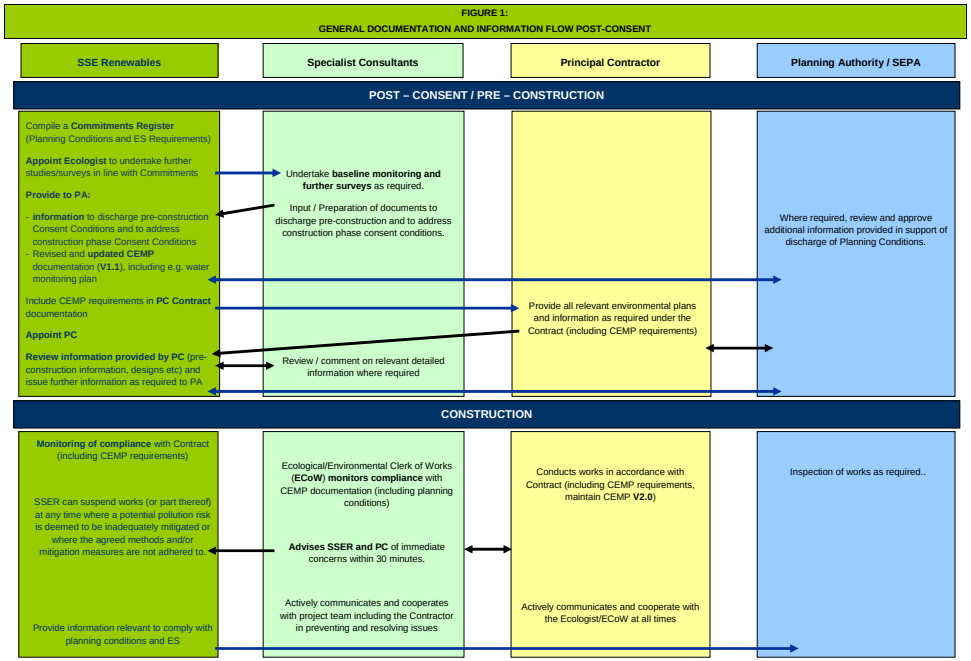
	Planning Condition	Related CEMP Section / other document

TABLE 2.0
RELEVANT PLANNING CONDITIONS AND RELATED DOCUMENTATION

	Planning Condition	Related CEMP Section / other document

2.2.2 The Commitments Register and Planning Conditions will be included in a revised and updated CEMP (V1.1) document for review by the Planning Authority prior to commencement of any construction works.

2.2.3 Figure 1 illustrates the general parties and their responsibilities for obtaining, reviewing, issuing and accepting documentation in regard to environmental management post-consent.



3 CORRESPONDENCE & GENERAL COMMUNICATION

3.1 Correspondence, Records & Reports

3.1.1 The Contractor provides a Communication Plan specifically for environmental management during the works. This will include information on roles and responsibilities as well as communication routes and requirements. The Communication Plan will also provide information on communication during an environmental emergency or incident (specific communication routes and requirements in the case of an emergency or incident are covered in Section 15).

3.1.2 The *Contractor* provides a complete record of all relevant communication and reports associated with all aspects of environmental management and implementation of this document. As a guide, the following records will be maintained:

A) Minutes and attendance record of start up meeting (on-site meeting prior to commencement of construction works).

B) Weekly rolling **Environmental Risk Log** including look ahead activities with required mitigation (section 5.1.6). This will include a supporting **Environmental Risk Map** (section 4.1.2)

C) Communication Plan (section 3.1.1 above).

D) Waste Management Records (section 6).

E) Drainage Maintenance Register (section 7.1.1).

F) Water and / or Dust Quality Monitoring Records as required (section 8).

G) *Employers* and *Contractor* Audit Reports (according to respective corporate procedures).

H) Ground Risk, including a Geotechnical / Peat Risk Register as required.

I) Licensing and Consents: Copies of all permissions, consents, licenses and permits.

3.2 Environmental Audits

3.2.1 Audits may be completed at any time by the *Employer,* but at least one per quarter. All completed audit forms (and records of corrective action and close outs) must be filed.

3.2.2 The *Contractor* undertakes a programme of environmental audits of his implemented CEMP, including audits of his sub-contractors, on a monthly basis.

3.3 Risk Assessments and Method Statements

3.3.1 The *Contractor* provides risk assessments and method statements for all works and tasks prior to these being undertaken. These documents will take into account and address all of the environmental aspects of the planned works and will include proposed mitigation measures.

3.3.2 The *Contractor's* risk assessments and method statements require acceptance by the *Employer* prior to commencement of the relevant works/tasks.

4 SITE INDUCTION AND TRAINING

4.1.1 The *Contractor* ensures that all contractor employees, sub-contractors, suppliers, and other visitors to the site are made aware of the specific environmental issues relating to their work. Accordingly, environmental specific induction training will be prepared and presented to all categories of personnel working and visiting the site

4.1.2 As a minimum, the *Contractor* provides inductees with the following information:

- Identification of specific environmental risks associated with the work to be undertaken on site by the inductee (e.g. exclusion zones, fuel handling, spill kit locations, sensitive habitats, drainage control/mitigation, spill control, silt pollution control, waste minimisation and recycling, reporting of environmental observations).
- Environmental Incident and Emergency Response Procedures (including specific Environmental Communication Plan requirements – refer to Section 17 for further information).

4.1.3 The *Contractor* provides a convenient sized copy of an **Environmental Risk Map** to all inductees showing sensitive areas, exclusion zones, wash out areas, watercourses, refuelling exclusion areas, location of skips, etc. The map shall be updated and re-issued as required. Any update will trigger a tool box talk –see below- to comment and stress on necessary change.

4.1.4 The *Contractor* submits a **tool box talk schedule** at least 1 week prior to commencement of works. The proposed schedule –to be considered as a live document- shall be consistent with the programme of works. Additional tool box talks shall be added as required based on circumstances such as unforeseen risks, repeated observation of bad practices, perceived lack of awareness, pollution event, etc.

4.1.5 The *Contractor* provides as a minimum one environmental related tool box talk or other environmental related training session per month on the above topics, along with any other environmental issues which arise on site. Additional tool box talks shall be added as required based on circumstances such as unforeseen risks, repeated observation of bad practices, perceived lack of awareness, pollution event, etc.

4.1.6 Where necessary, the *Contractor* requests the assistance of specialist personnel on site (e.g. ECoW, other geotechnical, hydrological or archaeological specialists, *Contractor's* Site Environmental Representative, etc.) to undertake specific toolbox talks or parts thereof as required.

4.1.7 The *Contractor* provides, as a minimum, training on the use of spill kits (on ground and in surface waters), to be provided on a regular basis (to account for staff/subcontractor changes etc).

4.1.8 The *Contractor* maintains a record of all toolbox talks or other environmental related training sessions delivered, their content and the attendees.

5 POLLUTION PREVENTION & MITIGATION

5.1 Responsibility

5.1.1 The *Contractor* is responsible for pollution prevention for the duration of the contract and until such time as permanent measures, such as permanent drainage and silt mitigation controls, are deemed to be adequate and appropriately constructed. This responsibility will include the actions of any third party who is sub-contracted by the *Contractor* or otherwise involved in the project.

5.1.2 It is the responsibility of the *Contractor* to contact SEPA, other statutory and non-statutory bodies in the vicinity of and downstream of the proposed project so that the requirements and interests of these parties are adhered to and protected throughout the duration of the Contract.

5.2 Site Specific Requirements and Documentation

5.2.1 The *Contractor* is familiar with and executes works in accordance with the guidance provided in the SEPA Pollution Prevention Guidelines, in particular PPG6, PPG21 and PPG22, and other guideline documents as detailed in Section 16.

5.2.2 Prior to construction works commencing the *Contractor* provides information identifying all potential environmental risks that may arise during construction works and specify required mitigation for each risk, e.g. in form of an **Environmental Risk Log** (section 3.1.2) and accompanying **Environmental Risk Map**.

5.2.3 The Environmental Risk Log will be accompanied by site specific procedures detailing how the *Contractor* intends to avoid and/or manage risks associated with e.g. silt pollution, chemical and fuel storage and handling, concrete wash out areas, dust management waste management and any other potential risks associated with particular engineering methods required at the site (e.g. soil stabilisation techniques, piling etc).

5.2.4 These risks are discussed and updated at scheduled weekly construction meetings, covering all environmental sensitivities, including ecology, archaeology and water quality.

5.3 General Pollution Prevention Measures

5.3.1 Pollution prevention measures will be applied in accordance with the relevant guidance documents referenced in Section 16 and the Environmental Statement. The following points (not exhaustive) indicate some of the additional specific measures to be undertaken / adhered to during the works:

i. Any material or substance which could cause pollution will be prevented from entering groundwater, surface water drains or watercourses by the appropriate use of and appropriate placement of (temporary) silt fences, cut-off drains, silt traps and drainage to vegetated areas where appropriate.

ii. Any silty water generated on site will ideally be settled out as much as possible through drainage mitigation measures (silt traps, etc.) and channelled into vegetated (not blanket bog or similarly protected) areas at least 50m from watercourses.

iii. Fuel storage and handling will be undertaken in line with PPG2, PPG6 and PPG26. External fuel delivery lorries will only be allowed as far as the site compound where there will be a

bunded refuelling area constructed on an impermeable base. The onsite fuelling / fuel transfer will only be undertaken or supervised by trained personnel.

iv. **Spill kits** will be available within each plant on site and also located close to identified pollution sources or sensitive receptors (fuel storage areas, water course crossings, etc).

v. **Interceptor drip trays** (or similar, e.g. plant nappies, – open metal drip trays are not acceptable) will be positioned under any stationary mobile plant to prevent oil contamination of the ground surface or water. .

vi. Areas of waste oil / fuel / chemical storage and permanent refuelling will be located **50m** away from watercourses or drainage paths. All refuelling will be carried out at least 50m from watercourses.

vii. All stockpiled materials will be stored in designated areas and isolated from any surface drains and a minimum of **50 metres away** from watercourses. **Aggregate or fine materials storage will be enclosed and screened/sheeted.**

5.4 Noise and Dust

5.4.1 The Contractor complies with all planning consent conditions and legal limits relating to construction noise.

5.4.2 The Contractor implements all required dust suppression measures as required throughout the duration of the construction works. These measures may include wheel washes, dampening of track surfaces during dry weather, covering of stockpiles etc.

5.5 COSHH

5.5.1 The *Contractor* is responsible for ensuring that all materials ordered or brought to site listed as hazardous under the Control of Substances Hazardous to Health (COSHH) Regulations are accompanied with a hazardous information sheet. The *Contractor* complies with the COSHH Regulations.

5.6 Pollution Monitoring & Controls

5.6.1 The *Contractor* carries out regular inspections of oil/fuel storage areas and plant, to confirm the appropriate use of mitigation measures as identified within the *Contractor's* **Environmental Risk Log** and **Drainage Maintenance Register** (section 7.1.1). The frequency and responsibility for undertaking these inspections will be detailed within the Environmental Risk Log prior to commencement of construction works.

5.6.2 To ensure compliance of the works with this documents and pollution prevention requirements, the *Employer* regularly monitors the *Contractor's* works. **Should the *Employer* identify any failure to comply with the requirements of this document or the *Contractors* own method statements the *Employer* may stop the associated works until such time as the failure is rectified**. Any associated cost or time delay incurred will be borne by the *Contractor.*

5.6.3 The Planning Monitoring Officer (PMO) may inspect the works as part of an overall construction works inspection programme as required on behalf of the Planning Authority.

6 WASTE MANAGEMENT

6.1 Site Waste Management Plan (SWMP) Implementation and Records

6.1.1 In accordance with best practice the *Employer* requires a Site Waste Management Plan (SWMP) for all their construction sites[2]. The *Contractor* utilises one of the available WMP templates e.g. Smart Waste or WRAP waste management plans[3], or similar.

6.1.2 The SWMP provides details on how waste reduction is to be implemented at the site and also how this is to be monitored throughout the construction phase. The *Contractor* nominates a site representative who takes responsibility for implementation and monitoring of the SWMP.

6.1.3 The *Contractor* provides details of their proposed waste contractors (carriers, transfer station, waste recipient etc) to the *Employer* as part of the SWMP, according to the provisions of the contract.

6.1.4 The requirements of the SWMP are communicated to all site operatives during their induction. Furthermore, all operatives on site attend waste reduction toolbox talks on a monthly basis to increase awareness of recycling/waste reduction.

6.1.5 The Contractor provides adequate numbers of separate bins (e.g. for paper, cans/plastic, kitchen waste etc) and skips / waste containers (e.g. for wood, metal, hazardous waste, general waste) to facilitate waste segregation and recycling.

6.1.6 The Contractor provides a site plan showing all waste disposal and recycling locations.

6.2 SWMP Monitoring and Auditing

6.2.1 The *Contractor's* **Environmental Site Representative** checks the contents of the site waste and recycling skips on a weekly basis. Non-compliance will be highlighted at the weekly progress meeting and appropriate actions taken e.g. a toolbox talk to all site operatives.

6.2.2 Waste management will be an agenda item on all regular meetings as required by this document. The *Contractor's* Environmental Site Representative provides an update on the achieved percentage of recycling and any actions that are required to be implemented.

6.3 Anticipated Construction Waste Streams

6.3.1 A number of difference waste streams are likely to arise during construction of the wind farm. The *Contractor* identifies all waste streams[4] and provides an estimate of expected waste volumes for each waste type generated within the waste stream.

6.3.2 The *Contractor* ensures all relevant information is taken into account in preparing his SWMP (for example intrusive ground investigation data, supply chain assessments, options appraisals etc).

---

[2] SWMP are already a legal requirement for certain projects in England and Wales. For projects in E&W where a SWMP is legally required, the Employer provides a draft SWMP prior to works commencing.

[3] Information on WRAP and SMART SWMPs can be found on http://www.wrap.org.uk/content/site-waste-management-plans-1 and http://www.smartwaste.co.uk/page.jsp?id=97

[4] For example food waste, paper, plastics, glass and other typically domestic refuse and sewage, concrete, waste chemicals, fuel and oils, packaging, e.g. paper, plastics and wood, waste metals, polluted water from plant, vehicle and wheel washes.

7 DRAINAGE

7.1 Scope and Minimum Requirements

7.1.1 The *Contractor* submits all temporary drainage designs and drawings at least 4 weeks prior to the start of the works. Where approval of these designs is required by Local Planning Authority and their Consultees, the *Contractor* allows 4 weeks for these approvals.

7.1.2 All onsite drainage proposals and designs, for temporary and permanent drainage solutions, will be reviewed by the onsite ECoW for acceptance by the *Project Manager* four weeks prior to any on site construction.

7.1.3 The *Contractor* undertakes maintenance of all temporary and permanent drainage solutions as and when required at a frequency at least weekly whilst Principal Contractor, the *Contractor* creates and manages a **Drainage Maintenance Register** and issues this to the *Project Manager* on a weekly basis.

7.1.4 The *Contractor* designs and constructs a drainage system including all silt mitigation measures necessary to prevent the pollution of existing drainage systems and watercourses for construction and post construction activities

7.1.5 As a minimum all temporary drainage is installed as the track is constructed, where possible the permanent drainage is installed as the *works* progress. In the event that temporary drainage is installed at the time of construction the permanent drainage is installed within 3 months of that section of track being completed

7.1.6 The *Contractor* designs all new drainage to accommodate a 1:200 year + climate change storm event, as a minimum.

7.1.7 All drainage associated with the *works*, with the exception of that carrying purely Greenfield run-off, is not permitted to discharge directly into any existing drainage or watercourse without at least 2 treatment volumes.

7.1.8 Except where necessary to facilitate the crossing of a watercourse, no works will be undertaken within 50m of any watercourse identified on the 1:50,000 OS map, or 25m of any other watercourse (except where an element of infrastructure may be downslope of a watercourse).

7.2 Clean Water Diversion

7.2.1 Where possible, green field run-off will be kept separate from silty water or other potentially contaminated water. Where appropriate, interceptor ditches and other drainage diversion measures will be installed – in advance of any excavation works – in order to collect and divert green field run-off away from construction disturbed areas.

7.2.2 Green field run-off will be discharged into an area of vegetation for dispersion or infiltration. Discharge points (for green filed run-off) will be located at sufficient distance (minimum of 50m) from any watercourses to allow adequate infiltration or settlement of suspended solids.

7.3 Silt Mitigation and Settlement Ponds

7.3.1 Silt laden run off should be expected from any areas of recently exposed soil or rock. This silt laden run-off will be captured and directed via berms or ditches towards specially constructed

sediment control structures.

7.3.2 Details of typical settlement ponds and silt mitigation measures are indicated on Drawing 1 as included in this CEMP. Additional filtration measures may include flow attenuation measures such as weirs, rock bars and / or anchored and embedded straw bales within settling ponds or between series of ponds.

7.3.3 Siting of settlement ponds will take into consideration access requirements for reinstatement and maintenance (for example: periodic silt removal, expansion of ponds or incorporation of additional silt mitigation measures, etc.).

7.3.4 Final discharge from any settlement pond will be over vegetated ground (with exceptions, e.g. blanket bogs) and away from surface water bodies (minimum distance 50m).

7.3.5 The *Contractor* discusses and agrees the location of lagoons and other drainage mitigation measures with the ECoW prior to associated works taking place.

7.4 Borrow Pit Drainage

7.4.1 Schematic representation of a typical borrow pit drainage arrangement is provided on Drawing 4 included in this CEMP.

7.4.2 The *Contractor* incorporates interceptor (cut-off) drains to prevent water ingress to the area of *works* from the surrounding topography and a toe drain to control water ingress and flow around the base of the excavation.

7.4.3 The *Contractor* channels borrow pit drainage to settlement ponds, a minimum of 50m from any watercourse.

7.5 Turbine Foundations and Crane Hardstandings

7.5.1 Schematic representation of a typical turbine base and crane hardstanding drainage arrangement is provided on Drawing 5. Further details on relevant construction methods are provided in Part 2 of this CEMP.

7.5.2 Foundation excavations for turbines are generally below the level of the surrounding ground and hence surface water ingress from up slope or groundwater seepage may occur, leading to standing water within the base of the excavation. A **'permit to pump'** procedure will be in place prior to water being pumped from an excavation. The *Contractor* seeks the ECoWs approval prior to granting a 'permit to pump'.

7.6 Construction Compounds, Substation and Control Buildings

7.6.1 Schematic representation of a typical drainage arrangements around construction compounds and welfare/ control building excavations are provided on Figure 6. Further details on relevant construction methods are provided in Part 2 of this CEMP.

7.6.2 As with tracks and borrow pits, green field run-off and development run-off will be kept separate and appropriate silt mitigation measures will be deployed. Pumping of water from excavations are subject to a 'permit to pump' (see 7.5.2).

7.7 Access Track Drainage

7.7.1 The *Contractor* designs all new drainage to be installed alongside the access tracks, where appropriate. The dimensions of the ditches will be sized to accommodate the development run-off from site infrastructure and green field run-off from adjacent ground resulting from a 1:200 year + climate change storm event.

7.7.2 The *Contractor* designs the frequency of relief drains crossing the access tracks to ensure the longitudinal track drainage ditches do not surcharge during the 1:200 year + climate change storm event.

7.7.3 The *Contractor* installs all permanent drainage concurrently with all adjacent infrastructure, in particular the *Contractor* installs the permanent drainage in tandem with the access track construction such that no section of access track is trafficked until the associated drainage is complete.

7.7.4 If the *Contractor* constructs any parts of the *works* without its designated drainage system in place, or a sufficient temporary alternative, the *Project Manager* may instruct the *Contractor* to exclude all non essential traffic from that area until the drainage system is in place.

7.7.5 The *Contractor* provides pipe culverts for cross drainage. Pipe culverts extend beyond the edge of access track construction materials by at least 1m. Check dams are installed immediately above a cross drain inlet.

7.7.6 The *Contractor* provides silt traps / catch pits at the inlet of all cross drains to prevent the pipes becoming blocked and prevent erosion at the inlet points. Silt traps / catch pits are designed to allow access by gully suckers to remove silt during the operational phase of the wind farm, and are designed to present no risk to livestock and animals, whilst permitting unrestricted water flow into the catch pit.

7.7.7 The *Contractor* provides erosion protection at all inlets and outlets to protect against the erosive force of flow during high rainfall events. The type of erosion protection may vary and will be influenced principally by the flow capacity of the culvert / relief drain, velocity and turbulence of flow and sensitivity of the outfall environment.

7.7.8 The *Contractor* erects and maintains silt fences to protect all watercourses, which may be affected, within 50m of any element of the *works* or drainage outfall. The *Contractor* maintains these.

7.7.9 All drainage channels are sufficiently wide as is practicable to allow wildlife to safely enter/exit the channel. Slope angles are a minimum of 1(v):3(h), except where the *Contractor* can demonstrate a more efficient design.

7.7.10 The *Contractor* provides scour / erosion protection to slow the flow of water.

7.7.11 The *Contractor* provides permanent check dams / water bars (flow barriers or dams constructed across the drainage channel) at regular intervals within drainage ditches. Check dams are required in order to reduce the velocity of water and therefore allow settlement of coarser sediment particles, as well as silt at low flow conditions. Reduction in velocity will also prevent scouring of the drainage channel itself.

7.7.12 Check dams are constructed of clean aggregate graded 50mm – 300mm and are embedded into the side walls and invert of the excavation by at least 100mm.

7.7.13 The number and location of check dams will be dependent on the slope gradient, flow and volume of water thoughthe minimum frequency of check dams 1 per 75m length of ditch.

7.7.14 Green field run-off and development run-off will be kept separate where possible and will be channelled separately to suitably vegetated areas at least 50 metres from watercourses to allow the settlement of solids on site. Schematic arrangements for tracks and watercourse crossings are illustrated on Drawing 2 included in this CEMP, a schematic section of a typical cut and fill track drainage is provided on Drawing 3.

7.8 Peat and Soil Storage Drainage

7.8.1 The *Contractor* considers the location of any temporary peat or soil storage areas such that erosion and run-off is limited, leachate from the stored material is controlled and stability of the existing ground, particularly in peatland areas, is not affected. The *Contractor* also gives consideration to the impacts of poor drainage control in any areas where peat is used in reinstatement (see sections 12 and 14).

7.8.2 Interceptor ditches, down slope drainage collection systems, containment berms (embedded where appropriate), and appropriate drainage mitigation measures will be required as with other infrastructure described above.

7.8.3 The *Contractor* carefully selects the locations and design the peat and other spoil storage requirements including methods for reinstatement works and incorporated drainage elements. Such design will be prepared in consultation with the ECoW and *Employer* prior to works commencing.

8 WATER QUALITY MONITORING

8.1 General Requirements

8.1.1 In line with best practice, the *Employer* undertakes surface water quality monitoring where an impact on surface water bodies cannot be ruled out. The *Employer* considers it best practice to obtain baseline surface water quality data prior to commencement of the works, and to monitor water quality during the works, in order to identify any significant changes of water quality which may be attributed to the construction works.

8.1.2 The surface water monitoring programme is implemented and maintained by the *Employer* and either undertaken by the *Employer's* environmental staff or by an environmental consultant appointed by the *Employer.*

8.1.3 **Where a decrease in water quality resulting from construction works is observed the *Contractor* will undertake remedial measures and will bear the costs of all associated sampling and investigation**. The *Contractor* may wish to undertake confirmatory sampling and analysis at any point during the works at his own cost.

8.1.4 A Surface Water Quality Monitoring Plan (WQMP) has been prepared as part of the ES submission. The proposed plan details the proposed monitoring locations, monitoring frequency and analytical parameters and other water quality monitoring data that has been made available in the area.

8.2 Monitoring Frequency and Analytical Parameters

8.2.1 Surface water quality monitoring will usually be undertaken at the following intervals:

Pre-construction (baseline) monitoring:	Monthly, commencing six - 12 months prior to any construction works taking place.
During construction:	Monthly, commencing within 2 weeks of start of works, and ad-hoc if deemed necessary, e.g. following a pollution incident
Post construction:	Monthly, for three months following completion of construction works.

8.2.2 Monitoring of specific locations may cease within 3 months of works ceasing in this area, following consultation with SEPA where necessary.

8.2.3 The surface water quality monitoring will include the monitoring of field parameters at each location prior to the collection of water samples at each location for analysis at a UKAS accredited laboratory.

8.2.4 The field parameters monitored during each monitoring round and obtained via use of a hand-held monitoring device, are pH, electrical conductivity, temperature, and dissolved oxygen. Monitoring results will be recorded in the field.

8.2.5 Water samples at each location will be obtained and submitted to a UKAS accredited laboratory. As a guide, analysis for the following parameters may be undertaken:

Table 4.0
PROPOSED LABORATORY ANALYTICAL PARAMETERS

Analytical test	Rationale
Electrical conductivity	Useful indicator of the overall salinity of surface or spring water
pH	Overall water quality parameter which could indicate effects on water acidity due to changes in land use and disturbance of peatlands.
Temperature	General physical indicator
Dissolved oxygen	Likely to be high in all streams but needs determining as an important indicator of water quality.
Turbidity	Measurable on site, and the most noticeable indicator of impact to a water course
Total suspended solids (TSS)	TSS: measure of water quality for construction developments and hence a TSS limit is generally specified for discharges from construction sites.
Biochemical oxygen demand (BOD)	A measure of the biologically degradable substances in water and a standard surface water quality parameter.
Chemical Oxygen Demand (COD)	Measure of possible releases from disturbed peat turf and peat.
Dissolved organic carbon (DOC)	Key component of carbon cycle and known to be sensitive to development on peatland. Organic carbon can help to reduce metal toxicities. May correlate closely with colour.
Soluble iron	Solubility can be affected by pH. High iron concentrations may precipitate out if physical conditions change.
Ammoniacal Nitrogen	Nutrient, known to occur as pulse after ecosystem disruption.
Total reactive phosphorus (orthophosphate)	Standard nutrient parameter, known to occur as pulse after ecosystem disruption and may lead to eutrophication (algal blooms).
Nitrate	End product of nitrogen pollution. Principal nutrient and standard nutrient parameter. Indicator of background pollution and needed for assessing any impact of ground disturbance during construction.
Chloride as Cl	Indicator of rainfall inputs and site weathering, often related to geology of catchments, partly controls electrical conductivity readings.
Total Petroleum Hydrocarbons (TPH) (CWG by GC-FID)	Monitor impact from potential hydrocarbon releases on site during construction works.

8.3 Surface Water Quality Monitoring Reports

8.3.1 A monthly monitoring report on the findings of the monitoring exercises will be prepared and provided to the *Employer* and the *Contractor* within 1 week of receipt of analytical results.

8.3.2 The pre-construction monitoring results will inform baseline values (average and maximum baseline levels), and the monthly monitoring reports for the period covering the construction and post-construction works will highlight any results exceeding the baseline conditions.

8.4 *Contractor's* Visual and Field Water Quality Monitoring

8.4.1 The *Contractor* ensures that all personnel and visitors on site are encouraged (at site inductions) to report visual indications of changes in water quality (e.g. discolouration or other evidence of contamination) in any watercourses on site.

8.4.2 **The *Contractor* undertakes visual inspections of the watercourses on site**, including the monitoring locations referred to in section 8.2 above, at least once a week. The *Contractor's* monitoring records will include the following minimum information:

- Antecedent and current weather conditions;
- Current construction activities within the vicinity and in particular up stream or up gradient of the observation point;
- Visual assessment of water colour, turbidity and flow rate;
- Evidence of chemical contamination;
- Visual evidence of silt or sediment pollution within the water column or on the bed of the watercourse/standing water body.
- Details on any communication, corrective action and / or mitigation undertaken as a result of any water quality issues observed during the monitoring visit.

8.4.3 Where evidence of pollution is observed to the water environment, emergency response procedures will be implemented and the incident will be reported to the *Employer* within 30minutes (section 15). Remedial measures will be implemented immediately and details of action taken will be recorded.

8.5 Private Water Supplies (PWS)

8.5.1 Where the ES has identified potential impacts on PWS from the proposed works, mitigation measures as specified in the ES will be implemented. Monitoring requirements of any PWS will be assessed by the *Employer* post-consent, and information on any mitigation / monitoring measures proposed additionally to those included in the ES will be submitted to the Planning Authority pre-commencement of works (CEMP V1.1).

9 WATERCOURSE CROSSINGS

9.1 General

9.1.1 The *Contractor* provides detailed designs for any new or upgrades to existing watercourse crossings.

9.1.2 The Controlled Activities (Scotland) Regulations 2011 regulate activities in or in the vicinity of rivers, lochs and wetlands, including engineering activities like river crossings and culverting. Works may require (depending on the nature of the works) Registration with, or a Licence from, SEPA.

9.1.3 The *Contractor* produces a detailed Water Course Crossing Plan prior to commencement of the works, i.e. detailed plans for each of upgrades or new built structures. The *Contractor* submits these plans to the *Employer* and SEPA (via the Planning Authority) for acceptance.

9.1.4 The *Contractor* obtains all necessary permissions prior to the execution of any works affecting a watercourse.

9.1.5 The Ecological Clerk of Works (ECoW) will be consulted with regard to all Watercourse Crossing works. The ECoW carries out surveys immediately prior to construction or upgrading to identify areas of mammal activity in watercourses.

9.2 Design Philosophy

9.2.1 The *Contractor* adheres to general good practice in Watercourse Crossing design in line with relevant guidance, in particular CIRIA and Scottish Government publications (section 16), taking into account various requirements summarised below:

i) All watercourses over which the access roads cross will be routed through culverts or under bridges appropriately sized and designed not to impede the flow of water and allowing safe passage for wildlife;

ii) Culvert design will be over-engineered so that it can be sunk into the bed of the watercourse allowing riverine substrate to stabilise on the floor of the culvert (i.e. leaves the watercourse in as natural condition as possible);

iii) Low maintenance; and

iv) Visually in keeping with the surroundings.

9.2.2 All river crossings will be designed to convey a minimum 1:200 year + climate change storm event., and individually sized and designed to suit the specific requirements and constraints of its location.

Culverts

9.2.1 The design of all culverts is in accordance with CIRIA Report 689. Inlet and outlet will be as 'Headwall' design type as stated in the Report for all watercourse crossings. Multiple pipe culverts are not permitted.

9.2.2 The natural bed and banks of any existing watercourse will remain unaffected by any new structure.

Bridges

9.2.1 The *Contractor* consults and complies with the requirements of the relevant Statutory Authorities, Utilities and Service Providers, including the onsite ECoW and the *Employer* for the construction of any culverts or bridges.

9.2.2 The *Contractor* provides watercourse crossing structures (i.e. bridges) with sufficient clear span as to ensure no *works* are required within the one metre of the watercourse, unless accepted in writing by the *Project Manager.*

9.2.3 The *Contractor* designs all new and upgrades any existing structures spanning watercourses to accommodate the flow resulting from the **1:200 year + climate change storm event**. The *Contractor* designs these structures to ensure they do not to affect any existing floodplain or the downstream flow characteristics of the watercourse.

9.2.4 Where the *Contractor* demonstrates the passing of the unrestricted flow from the 1:200 year + climate change storm event negatively affects the downstream catchment the *Contractor* designs the access track and associate drainage to ensure any surcharging during the 1:200 year + climate change storm event does not jeopardise the structural integrity of any assets while protecting the downstream catchment.

Erosion Protection

9.2.5 Erosion protection is generally required at the outlet of the culvert (and to a lesser extent at the inlet). However by appropriately sizing and designing the structure erosion can be minimised reducing the need for any engineered protection.

9.2.6 Where possible the design will avoid using artificial bank reinforcement, and the watercourse kept as natural as possible. Bank protection measures will have to be justified to SEPA regardless of the required level of authorisation (under the Controlled Activities Regulations).

10 ECOLOGICAL PROTECTION

10.1 Scope and Objectives of the Habitat and Species Protection Plan

10.1.1 Implementation and monitoring of a Habitat and Species Protection Plan will be the responsibility of the Ecological Clerk of Works (ECoW). The ECoW will be a qualified ecologist and a Member of the Institute of Ecology and Environmental Management (IEEM).

10.1.2 The ECoW is appointed and employed by the *Employer*, the appointment being subject to approval by the Planning Authority after submission of details of qualifications and experience. The role and duties of the ECoW are further detailed in Section 10.5 below.

10.1.3 The Habitat and Species Protection Plan applies to the immediate pre-construction and the construction period of the development.

10.2 Definitions, coverage and scope

10.2.1 Species protection may be defined as the set of measures used to minimise the risk of disturbance, injury or death to species of nature conservation interest. Particular attention is paid to species protected under EC and/or UK legislation.

10.2.2 Habitat protection may be defined as the set of measures used to minimise the risk of damage or destruction to the terrestrial and aquatic habitats of the site and downstream ecosystems.

10.2.3 The generally applicable and best practice protection and mitigation measures to be applied at the site are summarised below. **Following receipt of Planning Consent the habitat and species protection plans will be revised and updated to incorporate any site specific requirements as detailed in the ES and stipulated in relevant planning conditions, if applicable**.

10.3 Habitats Protection Plan

Aquatic Habitats:

10.3.1 The purpose of the aquatic habitat protection plan is to maintain a high water quality to support aquatic habitats used by any existing aquatic species like otters, water voles and fish and associated eco systems, both within the development site and downstream of the site, including salmon spawning grounds.

Terrestrial Habitats:

10.3.2 Protection of terrestrial habitats (through avoidance and minimisation of damage and loss) like active blanket bogs, groundwater dependent terrestrial ecosystems (GWDTE) is required as these habitats are recognised as important under the EC Directives.

10.3.3 All site working practices need to consider their possible effects on sensitive habitats and soils and mitigate significant negative effects as far as is reasonably possible.

Habitat Protection Measures:

10.3.4 Proposed measures for both aquatic and terrestrial habitat protection are generally as follows:

- A **50m buffer** will be maintained between working areas, machinery and watercourses in all areas except at watercourse crossing points (any buffer zones less than 50m have to be

authorised by the ECoW, the minimum buffer zone is 20m). Buffer zones will be demarcated, where necessary, by the ECoW. The *Contractor* will discuss and agree the requirement for demarcation with the ECoW and the *Employer* prior to commencement of any works.

- Details on watercourse crossings design and work, taking into account habitat and species protection are provided in Section 9 of this CEMP;
- A Water Quality monitoring programme, to be implemented prior to commencement of the construction works and undertaken in the pre, during and post construction phase of the development is detailed in Section 8 of this CEMP;
- Construction activities around watercourses will adhere to general good practice measures and Pollution Prevention Guidance produced by SEPA. Relevant guidance documents are referenced in Section 16 of this CEMP;
- Pollution prevention measures will be installed and maintained as appropriate, Sections 5 and 7 provide details on pollution control and drainage mitigation measures;
- Any forestry felling works, if applicable, in the vicinity of watercourses will adhere to general good practice measures as outlined in Section 13 of this CEMP;

10.3.5 The ***Contractor*** ensures the protection of habitats as detailed in this CEMP. The *Contractor*

- Includes information on habitat and species protection and legal requirements in the daily inductions and toolbox talks, in consultation with the ECoW (see Section 10.5).
- Ensures that all staff, contractors subcontractors and visitors are aware of the emergency response procedures to be followed in the event of a pollution incident.
- Microsites development infrastructure to reduce the damage to sensitive habitats, in consultation with the ECoW and the GCoW and ACoW, as necessary.
- Makes best use of excavated live turf and peat as part of reinstatement procedures (see Sections 12 and 14 (Excavated Materials and Reinstatement).
- Adheres to buffer distances relating to watercourses / lochs / springs and species as detailed in this CEMP.
- Prevents discharge or run-off of silty or polluted water to ground / habitat / watercourses.
- Consults the ECoW ahead of any clean water discharge to ground / habitat / watercourses.

10.4 Species Protection Plan

Birds

10.4.1 All bird species are protected by law[5]. All breeding birds encountered within the development

[5] Under the Wildlife and Countryside Act 1981 (Appendix 1) it is an offence to kill them or damage their nests and eggs. Species listed in Schedule 1 of the Act are specially protected, so that it is an offence merely to disturb them while nesting. Other specially protected species are listed on Annex 1 of the EC Birds Directive, which also prohibits willful disturbance at the nest. However, if disturbance to the nest of any other bird species without special protection

area access site or at pinch points are protected.

10.4.2 If construction commences before the end of the breeding season the ***Contractor*** provides bird deterrence measures prior to the start of the breeding season. If works do not begin until the end of the bird breeding season, the *Contractor* undertakes those checks required e.g. for species such as crossbills if any forestry felling is occurring.

Mammals

Otters and Water Voles - Pre-Construction measures

10.4.3 Within 2 months prior to commencement of the development on site, a pre-construction otter and water vole survey will be carried out by the *Employer*. This will be conducted by a suitably qualified and experienced ecologist. Surveys will not be undertaken during, or after heavy rain or periods of flood.

10.4.4 If required, the ECoW will make relevant licence applications (e.g. licence to disturb) to SNH on behalf of the Employer and will oversee and/or undertake related mitigation measures in accordance with any licence obtained.

10.4.5 Prior to works commencing, the ECoW marks buffers around all known otter shelters (and water vole burrows, if applicable) using a marking method and distance approved by the planning authority in consultation with SNH.

Otters and Water Voles - Measures during construction

10.4.6 The *Contractor* informs the ECoW at least one week ahead of works commencing in or near watercourses, and consults the ECoW on any mitigation measures required as part of the works.

10.4.7 The *Contractor* does not commence construction activities and blasting within 100m from a watercourse used by otters until two hours after sunrise, ceasing two hours before sunset; machinery lights will be directed away from watercourses. Sunrise and sunset time can be obtained from the internet (www.timeanddate.com);

10.4.8 The *Contractor* ensures that

- all open excavations are ramped to enable easy exit by otter and other species;
- culvert pipes stored on site are capped, or if caps are not available, pipes are stored vertically, to prevent otter entrapment;
- design of any permanent or temporary lighting is such that it is directed away from watercourses and that an unlit corridor of 30m either side of watercourses is maintained.

10.4.9 During the construction period, the ECoW carries out further checks, including checks ahead of the construction front.

10.4.10 The ECoW maintains a mapped record of checked areas and a log of otter and water vole surveys and informs the *Contractor* and *Employer* as soon as possible of any potential restrictions and limitations to the planned works as a result of the checks/survey findings.

were sufficient to prevent parent birds from incubating their eggs or feeding their nestlings, so that the brood died, this could be regarded as an offence under the 1981 Act.

10.4.11 The ECoW notes key areas of otter and water vole activity and any potential shelters outwith a licensable distance from construction and monitors activity at these areas and shelters regularly during construction.

10.4.12 All site personnel report any sightings of otters and water voles and any potential otter shelters / water vole burrows encountered on site to the ECoW as soon as possible.

Badgers - Pre-Construction measures

10.4.13 Within 2 months prior to commencement of site works pre-construction checks for badgers will be undertaken by a suitably qualified ecologist. Checks will be undertaken within 150m of any proposed construction works.

10.4.14 Ahead of construction works, the ECoW marks out exclusion zones around any badger setts. These exclusion zones will extend to 200m from any sett. No construction activity is permitted within 150 m of any badger sett.

10.4.15 If required, the ECoW will make relevant licence applications (e.g. licence to disturb) to SNH on behalf of the Employer and will oversee and/or undertake related mitigation measures in accordance with any licence obtained.

10.4.16 The ECoW maintains a mapped record of checked areas and a log of badger surveys.

10.4.17 The ECoW provides induction material and tool box talks ensuring all staff and visitors on site are aware of the legal obligations, restrictions on site and applicable protection measures / behaviour in relation to badgers.

Wildcat- Pre-Construction measures

10.4.18 Ongoing pre-construction checks ahead of tree felling and construction works for Wildcat will take place by a suitably qualified ecologist. Checks will be undertaken within 250m of any proposed construction works. The ECoW will mark out a 200m exclusion zone for a potential wildcat den.

10.4.19 Additional checks of all wildcat denning sites (identified during baseline surveys will take place 14 days or less before scheduled commencement of construction in those areas by the ECoW. These checks will ascertain the level of usage of all potential denning sites, allowing an accurate assessment of potential impact to be made.

10.4.20 No works will take place within 200m buffer zones around a known or suspected wildcat denning site. Distances greater than 200m may be required for natal dens. SNH will be consulted before any works proceed within this exclusion zone. It may be necessary to obtain a 'Licence to Disturb wildcat before any works can proceed within this zone. Where natal dens are identified, a cessation of works within the exclusion zone for up to 5-8 weeks may be necessary until kittens are mobile.

10.4.21 The ECoW maintains a mapped record of checked areas and informs the *Contractor* and *Employer* as soon as possible of any potential restrictions and limitations to the planned works as a result of the checks/survey findings.

Pine Marten-Pre-Construction measures

10.4.22 Ongoing pre-construction checks ahead of tree felling and construction works for pine marten will continue by a suitably qualified ecologist.

10.4.23 Additional checks of all potential pine marten den sites will take place 14 days or less before scheduled commencement of construction by the ECoW. These checks will ascertain the level of usage of all potential denning sites, allowing an accurate assessment of potential impact to be made.

10.4.24 All confirmed pine marten dens will have a minimum 30m exclusion zone demarcated around them. Suspected natal or maternal dens will have a minimum exclusion zone of 60m. A distance of greater than 100m may be required for some activities, with the nature of the den taken together with the type of activities strongly influencing the safety distance required. A cessation of works within the exclusion zone for up to 12 weeks may be necessary until young are mobile.

Other Species (Red Squirrels, Bats, Reptiles, Fish etc) - Pre-Construction measures

10.4.25 Within 2 months prior to commencement of the development on site (or in relevant suitable species survey season, prior to commencement of works) pre-construction species surveys relevant to those species identified in the ES will be carried out by a suitably qualified and experienced ecologist on behalf of the *Employer*.

10.4.26 If required, the ECoW will make relevant licence applications to SNH on behalf of the *Employer* and will oversee and/or undertake related mitigation measures in accordance with any licence obtained.

10.4.27 Pre-works survey findings will further inform any additional mitigation measures deemed necessary for the construction works phase. This information will be included in the updated CEMP (V1.1).

10.5 The Ecological / Environmental Clerk of Works (ECoW)

Background and Term of Appointment

10.5.1 The *Employer* considers it best practice to provide an ECoW for the duration of the construction works, irrespective of whether or not this role is required as part of a Planning Consent.

10.5.2 The ECoW will generally be appointed be 2-3 months prior to work commencing on site. The role will be full-time for the duration of the main construction period (construction of infrastructure and associated facilities) and may be reduced to a part time role (2-4 days/week) thereafter (turbine deliveries, electrical works etc) subject to Contractor performance and general consensus between ECoW, Employer and the Planning Authority (where required).

10.5.3 *The ECoW will be a* member of the Institute of Ecology and Environmental Management (IEEM) with suitable experience.

ECoW tasks

Overview

10.5.4 The ECoW advises and assists the *Contractor* in avoiding, minimising and mitigating adverse effects. The *Contractor* consults with the ECoW prior to undertaking specific works as detailed below, and considers the ECoWs advice at all times.

10.5.5 Where the ECoW disagrees with works being undertaken by the *Contractor,* resulting in a breach

of planning conditions or measures detailed in the ES and this CEMP, the ECoW informs the *Employer* immediately. On advice of the ECoW the *Project Manager / Employer* may halt the works.

10.5.6 The following are anticipated to represent the main tasks which translate these aspects of the role into action. This list is not intended to be exhaustive, and will require modification during the construction period as and when circumstances dictate.

Micrositing

10.5.7 The ECoW (in consultation with the Archaeological Clerk of Works and the Geotechnical Clerk of Works, if applicable and required) advises on micro-siting, where required. The *Contractor* consults the ECoW prior to micro-siting being undertaken.

Drainage Management and Watercourses

10.5.8 The ECoW maintains a **Pollution Prevention Measures Register (PPMR)** of the weekly inspections, to include an inventory of all measures on the site, their effectiveness, as well as any advice provided. A template will be provided by the *Employer*.

10.5.9 The ECoW conducts weekly inspection of site pollution prevention measures (silt fences, settlement ponds, check dams etc) and visually assesses their effectiveness. This includes inspection of water management measures installed by contractors such as excavation pumping and diversion channels. The ECoW

- Assesses, in advance of works, habitats and species on ground that may be affected by drainage management.
- Reviews drainage management proposals associated with temporary peat storage and reinstatement works in advance of such works commencing.
- Surveys in advance of any works near or crossing a ditch or watercourse, the condition of the watercourse and for protected terrestrial and aquatic species, using an established specialist if necessary.

Excavated materials and reinstatement

- Reviews working areas and route corridors, in consultation with the Archaeological Clerk of works (ACoW) as necessary.
- Agrees proposals for side casting and temporary storage areas as development proceeds.
- Agrees timing of reinstatement of track sides.
- Monitors the condition of stored turf.
- Agrees any required hydroseeding specification, including seed mix and fertiliser quantities, if required, in liaison with SNH.

Ecological Protection Tasks

- Erects and maintains markers and notices for limits around watercourses, exclusion zones and other areas with protected species or habitats.
- Considers requests and granting of permission to enter within habitat and protected species exclusion zones.

- Conducts weekly checks for protected species and sensitive habitat (peatland, watercourses) within and adjacent to construction areas, and maintains a register of all habitat inspections carried out.
- Implements species protection plans, if ground checks suggest this is necessary for the protected species detailed in Section 10.4 above.
- Implements the Terrestrial Habitat Protection Plan and Aquatic Habitat Protection Plan, including surveys and checks specific to those plans.
- Executes the terms of any Licence to Disturb, aquatic species and birds, or disturb/destroy their places of shelter, which might be required as a result of future surveys and searches.

On-site communication and liaison with Consultees

10.5.10 The EcoW will always inform the *Employer*'s Project Manager of areas of particular concern, who will then make a decision as to the subsequent action.

10.5.11 The ECoW is involved in the delivery of biodiversity-related Toolbox Talks as part of the site induction process. All staff will know of the circumstances when the ECoW should be contacted, and the relevant phone numbers.

10.5.12 The ECoW liaises with the statutory consultees as required and agreed with the *Employer* in line with any Planning Authority requirements (if applicable).

Meetings and Recording

10.5.13 The ECoW attends a weekly (or fortnightly, if agreed) meeting which will include representatives from the *Employer*, *Contractor*, sub-contractors and consultees as required and/or requested by e.g. consultees. The purpose of these meetings is to:

- review the effectiveness of the ecological and environmental mitigation;
- review the construction progress on site in the context of ecological and environmental mitigation;
- discuss construction programme for the following week, and fortnight look-ahead; and
- agree actions on these matters.

10.5.14 The ECoW keeps a record of the following:

- animal sightings and signs (including birds, in addition to other site ornithological monitoring), particularly those noted in searches one or two days in advance of construction;
- the **Pollution Prevention Measures Register** (as detailed above);
- the habitats of ground to be developed via survey at least a week in advance of construction work;
- record of tasks carried out and written record of all verbal advice given.

10.5.15 The ECoW maintains a **GIS database** of key recordings made during the construction period. Field records will use, if necessary, differential GPS technology captured into a field GIS system.

10.5.16 The ECoW assists the *Employer* with the supply of relevant information for compliance assessment.

10.5.17 The ECoW provides monthly reports (template will be provided by the *Employer*).

10.5.18 The ECoW produces a final report to the *Employer* documenting the environmental and ecological effects of the construction period. The evidence for effects will be based on findings included in the minutes of weekly/fortnightly meetings, together with other recording information maintained by the ECoW. The report will relate results to residual effects predicted in the site's ES documents. The report will be made available to the *Contractor* and the Planning Authority.

11 ARCHAEOLOGICAL PROTECTION

11.1.1 Any construction works involving ground disturbance will pay due attention to the potential presence of unknown and recorded archaeological subsurface features or structures. To ensure this, the following measures will be put in place:

11.1.2 **Archaeological support will be provided by an Archaeological Consultant appointed by the *Employer***. The consultant will prepare a methodology for the identification, preservation and recording of archaeological remains at the site (Written Scheme of Investigation'). The contents of the WSI will generally be agreed with the Planning Authority's archaeologist.

11.1.3 A 'Contractors Guidelines' document will be prepared by the consultant, which provides brief and clear guidelines for all construction contractors undertaking any ground works including topsoil and overburden stripping, cable laying, turbine base foundations or access track construction. The guidelines contain details of arrangements for calling upon professional archaeological support (the Archaeological Consultant) in the event that buried remains of potential archaeological interest are discovered during the absence of a watching brief.

11.1.4 As part of the WSI / Contractors' Guidelines' a call-out procedure will be put in place which should ensure the presence of an archaeologist on site, generally within 24 hours of a call-out.

11.1.5 The *Contractor* familiarises themselves with the contents of the above documents and ensures that their contents is communicated to relevant staff, subcontractors and plant operators via the induction and toolbox talks prior to commencement of any ground works.

12 EXCAVATED MATERIALS

12.1 Contractor Requirements

12.1.1 **In advance of each main phase of works**, the *Contractor (*in consultation with ECoW, and other specialists where required), provides a **method statement detailing expected volumes, material classification, storage and reuse procedures for the excavated materials anticipated from that particular work area**.

12.1.2 The *Contractor* liaises with SEPA on all aspects of waste management, if required, to ensure compliance with all appropriate regulatory controls prior to and during construction works.

12.1.3 The ES contains information on expected soil types and volumes requiring excavation and reuse as part of the construction works. The *Contractor* utilises this information and any additional investigation findings post-consent when planning the works.

12.1.4 Any material that is not immediately suitable for a predetermined use without the requirement for treatment (e.g. dewatering) is classed as waste and requires to be dealt with in accordance with the *Contractor's* developed Site Waste Management Plan.

12.2 Excavations

12.2.1 The *Contractor's* attention is drawn in particular to the risk of slope instability and peat slides at wind farm Sites. The *Contractor* ensures that under all conditions, the ground surface stability is fully maintained both during investigation and construction of the wind farm.

12.2.2 The *Contractor* undertakes sufficient additional studies and intrusive Site Investigations, where required, to establish the prevailing ground conditions at the Site and the likely ground conditions following completion of the construction and installation *works*. This includes geotechnical and geo-environmental investigations, hydro-geological and hydrological investigations or other investigations to ensure that the ground conditions are fully understood. Particular attention should be paid to peat or similar organic deposits, <u>even on shallow slopes</u>.

12.2.3 The *Contractor's* construction methodology incorporates best practices for construction in a peat environment.

12.2.4 The *Contractor* employs a construction management team and plant operators of proven experience of working in a peat environment for all peat drainage, excavation (including cable trenches), track construction and reinstatement & restoration *works*

12.3 Handling and Temporary Storage of Excavated Material

12.3.1 Where material is not required for immediate reinstatement, temporary storage may be required. To minimise handling and haulage distances, where possible excavated material will be stored local to the site of excavation and/or local to the end–use site where it is required for re-profiling, landscaping or structural purposes. The *Contractor* agrees storage location(s) with the ECoW prior to commencement of excavations.

12.3.2 Where the *Contractor* excavates topsoil, peat vegetation, or other organic soil the turfs are stored separately, with vegetation facing upward. The *Contractor* waters the turfs to maintain them as suitable for reinstatement and restoration. The *Contractor* stores turfs for a maximum period of 3 months.

12.3.3 Where the *Contractor* excavates peat soils these are segregated by material type and stored separately in stockpiles. Peat soils are stockpiled no higher than 1m.

12.3.4 Where practical the *Contractor* reuses topsoil/peat immediately, however, where this is not possible it is stockpiled for a maximum period of 6 months.

12.3.5 Where the *Contractor* makes stockpiles these are located in non trafficked areas. The *Contractor* only handles topsoil or peat twice: once from the excavated area to a stockpile and secondly from the stockpile to its final position unless agreed, in advance, with the *Project Manager* and the ECoW.

12.3.6 Stockpiles will be isolated from any surface drains and a minimum of 50 m away from watercourses, unless otherwise agreed with the ECoW. Stockpiles will include appropriate bunding to minimise any pollution risks where required.

12.3.7 The *Contractor* does not stockpile any material for longer than 6 months, handle it more than twice or unnecessarily surcharge it. Material stockpiled for longer than 6 months is removed from site and replaced with imported material.

13 FORESTRY & AGRICULTURAL LAND

13.1 Forestry

13.1.1 This Section applies only where the *Employer* has control over the forestry works, i.e. where works are carried out on behalf of the *Employer* / under a contract with the *Employer*.

13.1.2 Forestry works have the potential to affect protected species, e.g. nesting birds, and sensitive, including surface waters for fish (salmonids), otters, water voles, badgers, possibly red squirrels and bats.

13.1.3 Works on agricultural land poses a potential risk to the water environment, livestock and crops.

General Control Requirements

13.1.4 Forestry operations are undertaken in accordance with the UK Forest Standard published by Forestry Commission, revised in 2011, as appropriate. These include guides on General Forest Practice but specifically Forests and Water.

13.1.5 Cognisance is given to SEPA Guidance "Management of Forestry Waste" February 2013 and the approach for planning alternative genuine suitable uses off site is being actively pursued.

13.1.6 Tree felling operations will be undertaken by a qualified tree felling/forestry contractor and their subcontractors (if applicable).

13.1.7 The forestry contractor will liaise with the *Employer* to ensure that any protected species and/or sensitive habitats have been considered prior to commencement of the works, and appropriate mitigation measures have been agreed.

13.1.8 All access and egress points for the forestry contractor will be as agreed with the *Contractor*. For all road vehicles all normal highway rules will apply on all routes, at all times. Traffic management will normally be under the control of the *Contractor*. Where there are localised site traffic risks associated with tree felling operations, traffic management will be set up by the forestry contractor in consultation with the *Contractor*.

13.1.9 The forestry contractor provide details of the harvesting and extraction subcontractor and the timber haulage subcontractor (if applicable) prior to commencement of forestry works to the *Contractor* and the *Employer*.

13.1.10 The tree felling contractor and their subcontractors will be familiar and comply with the Pollution Prevention and the Environmental Incident and Emergency Response measures as detailed in the CEMP. The Principal *Contractor* will ensure that subcontractors are familiar with the contents of the relevant CEMP sections.

13.1.11 Large scale machinery will not operate within 20m of sensitive watercourses or watercourses feeding important mire and bryophyte areas without specific guidance from the Ecological Clerk of Works (ECoW). Within these areas if felling is required, it will be carried out under the direction of the ECoW and may include motor-manual methods or with small scale machinery to minimise disturbance to watercourses or water dependent habitats. Cable extraction methods may also be

used to minimize soil disturbance. To reduce the likelihood of soil and water contamination biodegradable chain oil will be used in harvesting machinery over the whole site. All forestry machines on site will carry an oil spill kit specially compiled for forestry operations.

13.1.12 Fuel will be delivered to site by tanker lorry which will fill double bunded grab tanks, one for each forest machine in use. Re-fuelling of tanks shall be undertaken on the site track or timber stacking area, remote from watercourses at a designated point and supervised by the forestry contractor. The forestry contractor provides spill kits and drip tanks which will be set up to prevent pollution from fuelling operations. All plant will be regularly checked for fuel and oil leaks, at least once a day. Re-fuelling activities will comply with the Pollution Prevention and the Environmental Incident and Emergency Response measures.

Specific Tree Removal Objectives and Methods

Objectives

1. Tree removal for infrastructure site investigation and construction
2. Tree removal for habitat management and peatland restoration

Methods

13.1.13 **Objective 1.** trees will be cleared by conventional shortwood harvesting with forwarder extraction utilising brash mats to support machinery. Stemwood will be despatched off site to the appropriate end users. Where tree size is below utilisable level (approximately 10m in height or 15cms dbh) trees will be mulched in situ.

13.1.14 **Objective 2.** by definition the peat restoration areas are predominantly saturated and sustain poor tree growth. Whole tree mulching of small trees, as above, is expected to be the appropriate technique but where 'utilisable' timber is accessible the conventional shortwood harvesting and extraction will take place. Where this occurs brash mats and tree stumps will be mulched.

13.1.15 Whole tree harvesting opportunities which utilise all forest tree material and end users which accept both stemwood and brash are under constant development. However at this stage they do not currently exist in significant scale in the North of Scotland. Such processes being pursued by SSER for Strathy South include a consented local biomass plant and on site processing as woodfuel.

13.2 Agricultural Land

13.2.1 The *Contractor* will identify relevant landowners (if not already identified by SSE) and liaise with relevant landowners prior to commencement of works. The *Contractor* will undertake a site walk-over of relevant areas with the landowner (and *Employer* as appropriate).

13.2.2 The *Contractor* will provide a risk assessment for all works on agricultural land, identifying potential hazards/sensitive areas and proposed mitigation measures, as identified in liaison with the landowner.

13.2.3 The risk assessment, method statements and mitigation measures will address the following potential issues (this is not an exhaustive list and the *Contractor* will amend as applicable):

- General access restrictions (gates, fences, unstable ground);

- Stock movement (type of stock, numbers, location of stock and requirements/timetable for movement, access restrictions, specific risks e.g. cattle/bulls etc);
- Season-depending risks/restrictions (lambing season, crop harvesting etc);
- Cattle grids and gates (proper use, repair and installation of cattle grids, gates etc);
- Fencing (requirement for removal/replacement/repair of fencing, location of electrical fencing etc);
- Surface water (drainage, surface water bodies, livestock drinking water supplies and routes)

14 REINSTATEMENT AND RESTORATION

14.1.1 The *Contractor* undertakes reinstatement. Reinstatement works are those undertaken during construction and aim to address any damage inflicted on the landscape as part of the construction *works*. Reinstatement is undertaken in parallel with, or as soon as possible following, the construction *works* in each area, such as the re-dressing of road and track verges and turbine bases (and other areas that may be disturbed as a result of the construction process). Where redressing proves unsuccessful re-seeding and hydro-seeding may be part of reinstatement measures. Reinstatement is primarily undertaken using in-situ and Site-sourced materials (turfs and topsoils).

14.1.2 The *Contractor* provides proposed methods for reinstatement of materials in landscaping and re-profiling of: track verges; turbine bases; construction compounds; borrow pits; cable trenches; other disturbed areas and redundant construction features (such as drainage ditches, settlement ponds or other sediment control measures, concrete wash out pits and other features which may not be required as part of the permanent works). Reinstatement proposals will provide details on methods proposed for replacement of turves and re-seeding where appropriate. If reseeding is required, this will e undertaken, where possible, using native species of local provenance.

14.1.3 Excavated peat from cut and fill sections of access tracks will be used for dressing the side slopes of floating track sections. No mineral soil will be used for dressing the side slopes of tracks to prevent silt run off.

14.1.4 Where practicable, reinstatement and re-profiling of, and around, infrastructure and borrow pits will be carried out as the work front progresses, or as soon as is practical after the substantial completion of the works themselves in a particular area. Early reinstatement and re-profiling is required to minimise visual impact and temporary storage / stockpiling of soils and to promote vegetation and habitat reinstatement as early as possible.

14.1.5 Where feasible, to prevent scour and run off and facilitate vegetation re-establishment, any down-slope embankments will be graded such that the slope angles are not too steep and there is a gradual transition with the surrounding / existing ground profile.

14.1.6 Outline design proposals for borrow pit re-profiling, including details on reinstatement material origin and classification, placement method, final ground profiles and surface dressing will be submitted by the *Contractor*, signed off by their GCoW and agreed by the ECoW prior to commencement of re-instatement

14.1.7 The *Contractor* maintains comprehensive records of the location, depth and volumes of all materials used in restoration of the borrow pit.

14.1.8 Reinstatement of vegetation will be focused on natural regeneration utilising peat or other vegetated turves or soils stripped and stored with their intrinsic seed bank. To encourage stabilisation and early establishment of vegetation cover, where available, peat turves or other topsoil and vegetation turves in keeping with the surrounding vegetation type will be used to provide a dressing for the final surface.

14.1.9 Following completion of the access tracks the side-cast topsoil and vegetated material will be

used to dress off the batters of the new track as part of an ongoing reinstatement process. The turves should be re-instated as soon as is practicable

14.1.10 The *Contractor* undertakes restoration. Restoration works are long-term measures aimed t o restore (and in some instances improve/enhance) the ecological status of the Site with regard to species and/or habitat management. Re-seeding and hydro-seeding may be part of restoration *works* where reinstatement works are found to have been unsuccessful with regard to establishing plant growth. Restoration is undertaken using Site-won, or imported, materials(seed mixes, turfs and topsoil's).

14.1.11 The *Contractor* undertakes full Site restoration including access tracks, borrow pits, temporary hardstanding areas and the construction compound(s), as a minimum.

14.1.12 The *Contractor* undertakes all works in such a way as to allow restoration of disturbed areas to proceed as early as possible and in a progressive and sustainable manner.

14.1.13 Where the *Contractor* re-seeds, or hydro-seeds, as part of his restoration, the seed mix to be used is first agreed with the *Employer* and relevant environmental / landscape authorities. The *Contractor* proposes seed mix(es) for acceptance, and in the time to suit procurement of the seed mix(es).

14.1.14 Any accidental damage or other impacts caused during the works are repaired and reinstated or restored by the *Contractor* to the *Employer's* satisfaction and in accordance with the Planning Consent and any agreements with the landowners, all prior to taking over by the *Employer*.

15 ENVIRONMENTAL INCIDENT & EMERGENCY RESPONSE

15.1 General Requirements

15.1.1 The *Contractor* prepares a detailed Environmental Incident and Emergency Response Plan (EIERP) in line with PPG21, in particular sections 2.1.-2.4 and PPG22.

15.2 SEARS and Environmental Auditing

15.2.1 A SSE Safety and Environmental Awareness Report (SEAR) is required to be completed for any potential or actual environmental incident or emergency which occurs or is noted on site. Blank SEAR forms will be provided by SSE Renewables.

15.3 Summary Sheet for Machinery / Plant Operators

15.3.1 The *Contractor* provides a 1 page Summary Sheet containing the key information for incidents response to be used as a quick reference for any on-site personnel witnessing an incident. A laminate copy of this Summary Sheet will be located with all plant / machinery / on-site vehicles. A Communication Plan (to be followed in the event of a spillage) will be provided by the *Contactor*, in liaison with relevant stakeholders and will be provide to the *Employer*, according to the Contract provisions, prior to commencement of the site works.

Key Information to be provided in a clear and concise manner (as soon as possible, but within 30 minutes of incident):

- What substance was spilled;
- Approximate volume and time of spillage;
- Accurate Location of spill (GPS or grid reference if possible, or bridge ID/number referenced on map etc);
- All measures taken;
- Help required i.e. manpower, machinery, expert advice, disposal, etc; and,
- Whether the spill has reached a watercourse.

16 REFERENCE DOCUMENTATION

- **SEPA/EA Pollution Prevention Guidelines (PPGs):**
  - PPG01 (2001) General guide to the prevention of pollution
  - PPG02 (2011) Above ground oil storage tanks
  - PPG03 (2006) Use and design of oil separators in surface water drainage systems
  - PPG04 (2006) Treatment and disposal of sewage where no foul sewer is available
  - PPG05 (2007) Works and maintenance in or near water
  - PPG06 (2012) Working at construction and demolition sites
  - PPG07 (2011) Refuelling facilities
  - PPG08 (2004) Safe storage and disposal of used oils
  - PPG13 (2007) Vehicle washing and cleaning
  - PPG21(2009) Pollution incident response planning
  - PPG22 (2012) Dealing with Spills
  - PPG26 (2011) Storage and handling of drums and intermediate bulk containers
- *Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste*, a joint publication by Scottish Renewables and the Scottish Environment Protection Agency, Version 1 January 2012.
- *Good Practice During Wind Farm Construction*, A joint publication by Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland, Version 1, October 2010;
- SEPA Regulatory Position Statement, Developments on Peat, National Waste Policy Unit, 9 February 2010.
- Engineering in the Water Environment, Good Practice Guide, Construction of River Crossings, First edition, SEPA, April 2008.
- *Prevention of Pollution from Civil Engineering Contracts: Special Requirements* publication (SEPA, 2006)
- The Waste Hierarchy, National Waste Strategy: Scotland. **SEPA**, September 2006. (http://www.sepa.org.uk/waste/moving_towards_zero_waste/waste_hierarchy.aspx).
- **Scottish Natural Heritage (SNH):**
  - Floating Roads on Peat, Forestry Civil Engineering and SNH, August 2010.
  - Constructed tracks in the Scottish Uplands, March 2005.
- **British Standards Institute (BSI):**
  - Code of Practice for Earth Works, BS6031:2009
  - Code of practice for noise and vibration control on construction and open sites. Noise, BS5228-1: 2009.
- **Forestry Commission**:

  - Forests and Water UK Forestry Standard Guidelines, 5th Edition 2011
- **CIRIA Publications:**
  - Control of Water Pollution from Construction Sites – Guide to Good Practice (SP156)
  - Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (C532)
  - Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648)
  - Control of Water Pollution from Linear Construction Projects – Site Guide (C649)
  - Culvert Design Guide, C689, CIRIA, 2010;
  - Environmental Good Practice – Site Guide (C650)
  - The SUDS Manual (C697)
  - Site Handbook for the Construction of SUDS (C698)
- **Institute of Environmental Management and Assessment (IEMA):**
  - Practitioner Series No.11: Waste Management: A Guide for Business in the UK, September 2008.
- **Scottish Government:**
  - River Crossings and Migratory Fish: Design Guidance, Scottish Government, April 2000.

Regulations

1. The Water Environment (Controlled Activities) (Scotland) Regulations 2011 ("CARs").
2. The Water Environment (Controlled Activities) (Scotland) Regulations 2011, A Practical Guide, SEPA, Version 6, August 2011.

17 CHECKLIST – Required *Contractor's* Information

The information listed in the table below provides a guide to the information which will be provided by the *Contractor* to the *Employer*.

Pre-commencement of works:	Yes/No
Name and CV of nominated and appropriately qualified person for site based single point of contact for all environmental matters (Section 1)	
Communication Plan (Section 3)	
Schedule of toolbox talks (Section 4)	
Environmental Risk Log, Procedures and Environmental Risk Map (Section 5)	
A Site Waste Management Plan (SWMP, Section 6)	
Drainage Maintenance Register (Section 7)	
Watercourse crossing plans and CAR licences/authorisations(Section 9)	
Excavated materials and reinstatement plans (Section 12)	
Forestry works information (, Section 13)	
Environmental Incident and Emergency Response Plan (Section 15)	
Proposed Borrow pit working plans (Section 21)	
During and post-completion of works:	**Yes/No**
Records of relevant communication, meetings and reports (Section 3)	
Records of site inductions and tool box talks (Section 3)	
Records of communication with SEPA, SNH, PMO (Section 3 and 5)	
Records of all environmental checks/inspections (Section 5)	
Site Waste Management Plan and related information (Section 6)	
Drainage Maintenance Register (Section 7)	
Records of water quality monitoring (Section 8)	
Excavated materials and reinstatement plans (Section 12)	
Records of borrow pit restoration (Section 14 and 20.5)	

Note: The above list only relates to requirements of this CEMP. As part of the Contract, other information provisions will be required from the *Contractor*.

PART 2 – CONSTRUCTION METHODS

18 INTRODUCTION

18.1 General

18.1.1 The following sections describe the general methods of construction which are stipulated in the Employer's Civil Technical Requirements generally included in the Civils Work Contract forming the basis for the Contractor's detailed design.

18.2 Working Hours and Noise

18.2.1 Construction activities will generally be stipulated as part of a planning consent, normally limited between 07.00 and 19.0 hours Mondays to Fridays, and 07.00 to 13.00 hours on Saturdays, with no working activities on Sundays. In the event of work being required outwith these hours, e.g. abnormal load deliveries, commissioning works or emergency mitigation works, the Planning Authority will be notified prior to these works taking place, wherever possible.

18.2.2 Operation of crushing equipment located within / next to borrow pits will generally be limited to 08.00 to 18.00 hours Mondays to Fridays and 08.00 to 12.00 hours Saturdays, with no operation on Sundays.

18.3 Plant and Equipment

18.3.1 The works shall be undertaken in strict accordance with the Provision and Use of Work Equipment Regulations "PUWER" (as amended) covering all types of plant and equipment found on construction sites.

18.3.2 All site operatives will be appropriately trained and experienced and hold certification of training achievement issued by CITB or other construction industry approved schemes.

18.3.3 All site plant and equipment shall be fitted with effective silencers / insulation. Regular noise monitoring will be undertaken by the *Contractor* at specific areas around the site to monitor noise effecting nearby properties.

18.3.4 A non-exhaustive list of plant that may be utilised during the construction activities detailed in this Construction Method Statement is as follows; 360° tracked excavators, tipper trucks, dumper trucks, tractor dozers, vibratory rollers, ground ripping plant, mobile crushers and screeners.

19 SITE ACCESS CONSTRUCTION

19.1 Signage

19.1.1 Sufficient signage will be employed on site, for both site personnel and the public, to clearly define the boundary of the works where they coincide with areas accessible to the public.

19.1.2 Ecological awareness signs (e.g. potential otter crossing) are also required at speed limit signs in certain areas of the site.

20 ENABLING WORKS

20.1.1 Initial enabling works consist of the construction of the new access track linking the consented Strathy North Wind Farm to the Strathy South Wind Farm and the associated new bridge across the river Strathy.

20.1.2 In undertaking these works a temporary Construction Compound will be established at or adjacent to the proposed Strathy North Construction Compound or Operations Building with a secondary welfare unit being located closer to the bridge crossing.

20.1.3 The existing forestry will be felled/mulched along the line of the proposed access and the track formed from imported material in accordance with the Civil Technical Requirements.

20.1.4 The foundation for the new bridge will then be constructed using precast concrete sections on the northern bank of the River Strathy. Access will then be taken to the south of the River Strathy by fording the river either at the location of the proposed bridge or at another location on the existing access to Strathy South. The foundations will then be excavated and again formed using pre-cast concrete sections. All works on the Bridge will be in accordance with CAR and in consultation with SEPA.

20.1.5 Once the foundations have been created the bridge section with either be launched or lifted into position from the north bank of the river.

20.1.6 Once the bridge crossing is place the remainder of the access track to Strathy South will be formed from imported material until it is suitable for the trafficking of Plant and material for the main preparatory works

21 ONSITE PREPARATORY CONSTRUCTION

21.1 Introduction

21.1.1 Onsite preparatory construction concerns the formation of the Temporary Construction Compound (TCC), laydown areas and associated works required to establish the site offices, welfare facilities and storage arrangements for materials, plant and equipment in connection with the wind farm construction phase.

21.1.2 The TCC is a temporary work for the duration of the construction phase of the project. Following commissioning, the TCC shall be dismantled and all plant, welfare facilities and equipment removed from the site. Reinstatement of this area shall be in line with the requirements stated within the main CEMP document.

21.1.3 The main TCC will comprise of site offices for the Principle Contractor, the Wind Turbine Supplier (WTS), any other sub-contractors, project support staff (i.e. the ECoW and ACoW) and *Employer*, together with all the necessary welfare facilities for the workforce.

21.1.4 Imported crushed rock will be used to construct the temporary construction compound to allow a

safe compound (with working welfare) to be established prior to any major borrow pit works.

21.1.5 The *Contractor* and any subcontractors will be familiar with, and take account of, the planning conditions relevant to the construction works and the requirements of the CEMP prior to construction work commencing.

21.1.6 Prior to the works commencing at site, a pre-condition survey of the existing tracks and associated field boundary features (fences, walls and gates) will be undertaken by the *Contractor* in conjunction with the *Employer* and landowners, where appropriate, to visually record the existing conditions. This will entail the preparation of a Pre-condition Survey Report, which will include text, diagrams and photographs clearly referenced to the locations at site.

21.2 Temporary Construction Compound Preparation

21.2.1 The *Contractor* designs and constructs an area of hardstanding, as specified in the Civil Works Information, of sufficient load bearing capacity, as the construction compound(s). Where appropriate a geo-textile layer is used to maximise the effectiveness of stone removal when the compound is removed.

21.2.2 The compound(s) include all Site accommodation and welfare facilities, bunded fuel tanks and other liquid storage areas with segregation, bunded refuelling areas, general and protected storage areas, vehicle parking, security, lighting and services, communications and laboratory/testing or holding facilities, signage, pedestrian and vehicular circulation routes, and safety barriers. The *Contractor* provides recycling facilities at the Site compound and professional collection thereof.

21.2.3 The compound(s) are free draining with oil interceptors and contain a bunded area for maintaining vehicles and plant, or other pollution control measures, as appropriate / required to protect existing water courses and private water supplies.

21.2.4 The typical construction activities associated with the TCC are detailed below:

- Stripping of any topsoil / peat and careful stockpiling of this material as per CEMP requirements.
- Excavating the remaining superficial soil materials and stockpiling of this material on the surrounding undisturbed area in accordance with CEMP requirements.
- Installation / construction of temporary surface water drainage in accordance with CEMP requirements.
- Laying and compacting crushed rock in layers to form a hardstanding. Crushed rock material will be site won from local excavations and have a low fines content to reduce the risk of sediment contamination.
- Delivery of offices, mess area, toilets and associated infrastructure on flat bed lorries.
- Erection of offices, mess area, toilets, and installation of all bunded areas to contain generator and fuel stores.
- Erection of fencing around the perimeter of the main TCC.
- Following the completion of all construction activities, the TCC shall be reinstated according to

the methods set out in the CEMP.

21.2.5 Welfare facilities will be provided for site operatives under the Construction and Design Management Regulations 2007 including sanitary conveniences, washing facilities, drinking water, changing rooms and accommodation for clothing not worn during working hours and rest facilities.

21.2.6 Toilets during the construction phase will be chemical toilets or soakway, depending on ground suitability and discussion with SEPA. The waste will be emptied on a regular basis by a registered waste disposal contractor. Toilets will be located within the TCC areas.

21.2.7 Potable water will be supplied via a borehole or surface water extraction subject to licences/authorisations obtained from SEPA under CAR. The water will be used for messing purposes during the construction phase.

21.2.8 If additional water is required to be impounded and / or abstracted from site water bodies for site based activities (i.e. dust suppression, etc), the CAR Regulations apply and advice will be sought from SEPA prior to any abstraction.

21.2.9 The duration of the works may extend into winter months. If required, external lighting will be required to be provided at the TCCs. Lighting columns will be erected in proximity to security gates and any site offices / welfare facilities and stores. Compound lighting shall face inwards to reduce light pollution and environmental impact effects.

21.2.10 All areas of the site including accommodation areas shall be kept clean and tidy with a regime of good housekeeping established to facilitate mobility of personnel and plant/equipment around the site and eliminate potential hazards and environmental pollution.

22 BORROW PITS

22.1 General Method of Work

22.1.1 To construct the access tracks (including passing bays) and formation of new hardstanding areas for the crane pads, site construction compounds and laydown areas crushed rock is required. It is proposed to source this material, where possible, from on-Site borrow pits, to reduce the need to import materials. In addition, and where suitable, some rock types may be utilised as a source of aggregate for concrete batching for the turbine foundations.

22.1.2 Site surveys of each borrow pit location have been undertaken and details of the estimated position, size, potential yield and restoration proposals have been developed. “Areas of Search” have been developed for each borrow pit location within which the maximum extents of the borrow pit shall be situated.

22.1.3 Subject to consent each borrow pit will be further investigated to determine, the precise location and details of the borrow pits, including maximum size and depth, a fully detailed plan incorporating contours and a programme of implementation will be submitted for approval by the Planning Authority.

22.1.4 The rock will be extracted using recognised quarrying techniques and crushed to provide the required properties (material size or “grade”). The rock extraction method will vary from location to location, and is dependent upon the nature of the material encountered, depth of weathering

and level of fracturing. A combination of digging, ripping and blasting shall be utilised, followed by crushing, as appropriate.

22.1.5 The borrow pit works will be subject to significant health, safety and environmental constraints, including:

- Segregation and fencing off of processing plant with only authorised personnel permitted to enter. These works will be carried out on a level working platform.
- Bunding and fencing of borrow pit high wall to prevent plant / personnel falling into the void.
- Surface water / drainage mitigation to prevent pollution, silt run off and inundation into the void.
- Exclusion zones implemented during blasting works.
- Fitting of spray bars to the processing plant to keep dust down during dry / windy periods.

22.2 Borrow Pit Establishment

Demarcation

22.2.1 Prior to any borrow pit works beginning at each location is shall be surveyed and the “Area of Search” pegged out. In areas of recently cleared forestry consideration shall be given to the freshly exposed ground profile / topography.

22.2.2 Once the extent of the borrow pit is established a temporary fence shall be erected to this boundary with appropriate warning signs. Where necessary a Rylock sheep fence shall be erected to protect grazing livestock from entering the working area. All fencing and warning signs will be checked on a regular basis and repaired/replaced as necessary.

22.2.3 Once a proposed borrow pit location has been surveyed and pegged-out, the Ecological Clerk of Works (ECoW) and Archaeological Clerk of Works (ACoW) shall be consulted prior to any further development of the location. Once the ECoW and ACoW have given their approval for the demarked location, borrow pit preparation may commence.

Borrow Pit Preparation

22.2.4 Surface vegetation (turves) shall be cut and placed to one-side. This material shall be monitored, and watered (as appropriate) to be retained for reinstatement purposes once the borrow pit workings are completed.

22.2.5 The removal of the existing superficial soil materials (“overburden”) would typically be undertaken using a combination of crawler tractor dozers and backtrackers with the material loaded by mechanical loading shovel onto 30 tonne articulated dump trucks and transported (within the “Area of Search” of the individual borrow pit) to designated stockpile locations adjacent to the worked area and retained for restoration purposes. Where different overburden materials are present these will be stored according to type. Overburden shall be stockpiled carefully, with consideration given to slope gradient, proximity to watercourses or other sensitive receptors, and shall avoid loading areas of deeper (> 1m deep) peat. This excavated overburden will be lightly tracked to seal the windrows to prevent erosion.

22.2.6 Care will be taken not to traffic undisturbed soils unnecessarily and to limit the working area as far as possible to avoid unnecessary ground excavation and disturbance.

Drainage

22.2.7 Borrow pit drainage requirements are detailed within the drainage section 7 of this CEMP.

Programme of Implementation

22.2.8 Borrow pits will not be opened up until rock extraction is required and each borrow pit will be restored as quickly as possible following completion of extraction works. Borrow pits shall be established as the works progress in accordance with their proximity to the active areas of work.

22.2.9 Where it is necessary to cease production in borrow pits and return later in the works to extract rock for a particular product, the borrow pit will be securely fenced off during this period of inactivity.

22.2.10 Borrow pits will be reinstated as soon after cessation of production as possible. However, in some instances borrow pits may be required to be kept open for longer, for example where they may be suitable for the situation of an on-site batching plant, or where there is a need for additional laydown areas. These would be agreed with the ECoW in advance.

22.3 Borrow Pit Working

22.3.1 Following the exposure of the rock head, the material will be dealt with either by digging, ripping or blasting, or a combination of techniques. A combined approach may be required due to variability in the strength and integrity of the rock within individual pits and from pit to pit.

22.3.2 Ripping will be carried out with large tractor dozers, typically a CAT D9 fitted with a towed ripper. Following passes by this ripper, a 360° excavator will load the broken material into dump trucks for transportation to the pre-crusher stockpile. Where the gradients are to steep or heights of faces inappropriate for ripping, a 360° excavator located at the bottom of the working face may be utilised to “pick” the rock face. In both cases where any pieces are too large for the crusher, they will be broken with a 360° excavator fitted with a hydraulic breaker.

22.3.3 A maximum of 5m high benches would be worked in accordance with standard construction practice. Where the rock is prohibitively resistant to allow digging or ripping, blasting will be undertaken. This would be undertaken by a competent specialist sub contractor utilising good blasting practice and would be in compliance with the relevant health and safety regulations (The Quarries Regulations 1999) and other relevant provisions. The blasted rock will subsequently be ripped/dug as required and treated as described above. Blasting operations will be kept to an absolute minimum and only utilised where in-situ rock material cannot feasibly be removed by mechanical equipment.

22.3.4 Mobile crushing and screening plant will be established within each borrow pit and all crushing and grading and stockpiling of material will take place within the confines of the identified borrow pits.

22.3.5 Stone excavation will be carried out using a 45 tonne or 65 tonne excavator loading dump trucks for haulage to the processing plant. The processing plant will be located adjacent to the extraction area with an area cleared to stockpile the processed material. The processing

operation will comprise of:

- Initial screening to segregate the oversize material requiring crushing
- Secondary breaking of large rocks using a hydraulic breaker attached to a tracked excavator.
- Crushing of oversize rock using a mobile tracked crusher and secondary screening if required using a 3 way split screen.

22.3.6 A number of products will be produced in this operation including:

- Track base material (nominally 125mm down product)
- Track topping material (nominally 50mm down product)
- Belt end fines for cable sand
- Clean single size product for aggregates if the rock type permits

22.3.7 Each product will be separately stockpiled. Due to the limited available space at most of these locations it is intended to match as closely as possible processing productions with the capacity to incorporate the product into the works whilst maintaining a cushion to allow for plant down time etc.

22.3.8 The stockpiled material won within each borrow pit will be transported to its location of use, with the broad spread of borrow pits ensuring that travel distances are minimised.

22.4 Reinstatement

22.4.1 The borrow pit areas will be backfilled in accordance with reinstatement plans to be provided by the *Contractor*.

22.4.2 On completion of the backfilling with construction spoil, surface profile restoration will be undertaken using the stockpiled overburden materials dozed back into place and finished off with turves.

22.4.3 The *Contractor* will provide records of the borrow pits reinstatement works (original levels, reinstated levels, material utilised) to the *Employer*.

22.4.4 All borrow pits (unless specifically requested by the ECoW) shall be reinstated as soon as possible after the working of them is complete. Once reinstated a borrow pit shall be inspected periodically to monitor for any settlement or surface erosion that may occur, or deterioration of the surface vegetation.

22.4.5 Consideration shall be given to the need for watering a restored area during prolonged dry periods, to encourage re-establishment of vegetation. Should the ECoW identify any unacceptable degradation to a reinstated borrow pit then further restoration management techniques shall be considered, including re-profiling of the surface or reseeding of vegetation, as appropriate.

23 WTG & ANEMOMETER MAST FOUNDATION CONSTRUCTION

23.1 Construction of Turbine Foundations

23.1.1 The Wind Turbine Generators (WTG's) will be erected on reinforced concrete gravity foundations.

23.1.2 Proposed turbine foundation locations are inspected by the *Contractor* to ensure that all potential ecological and archaeological constraints have been identified, demarcated and/or mitigated for prior to the on-set of construction in that area. The final location of the turbines will be within approved micrositing allowances of the consented positions in accordance with Planning Conditions. The turbine coordinates are supplied by the *Employer* and any proposed micrositing by the C*ontractor* must be first agreed with the *Employer*. The regularity of inspections (hourly, daily, weekly, as appropriate) during construction shall be determined in advance for each particular section, based on anticipated ground conditions, known ecological or archaeological sensitive receptors, prevailing weather conditions, and anticipated rate of progress.

23.1.3 Construction of the turbine foundations shall be the responsibility of the *Contractor*.

23.1.4 The limits of each of the foundation excavations will be surveyed and pegged out at least two weeks in advance of any proposed works, and the ECoW and ACoW shall be consulted to ensure all necessary pre-construction checks have been completed.

23.1.5 The depth of concrete will vary across the base, depending on its shape and dimensions, tapering from around 0.5m at the outer edges to around 2m where it meets the central plinth, the plinth will then be approximately a further 2m in depth. All concrete works shall implement pollution prevention controls in line with this CEMP.

23.1.6 The turbine foundation design will minimise the excavation requirement where appropriate.

23.1.7 The position of each turbine will be clearly marked on co-ordinates provided by the *Employer* and agreed with the Planning Authority.

23.1.8 The typical construction activities associated with the turbine foundation are detailed below:

- Stripping of surface vegetation (turves) and careful stockpiling of this material as per CEMP requirements.
- Excavating the remaining superficial soil and rock materials and stockpiling of this material as per CEMP requirements.
- The stockpiled materials are to be retained for restoration purposes.
- Soil will be excavated to a depth of approximately 4 metres. Where rock is encountered at a shallower depth this will most likely be removed by mechanical excavation to the required depth and material stockpiled as described above. The potential impacts associated with the use of hydraulic breakers or other such vibratory equipment in the vicinity of sensitive ecological receptors or watercourses shall be assessed and appropriate mitigation measures implemented where required in consultation with the ECoW. If the ground conditions at 4m depth does not provide the required bearing the Contractor shall excavate further to a suitable bearing strata and bring the level back up using suitable crushed rock.
- The foundation design is based on the most efficient use of materials and local ground conditions.

- Temporary fencing shall be erected at locations where there are safety implications for any persons likely to be present on the site e.g. around open excavations. Signage will be displayed clearly to indicate deep excavations and any other relevant hazards associated with the foundation excavation works.
- Following excavation, levels will be set to allow the blinding concrete to be placed and finished to the required line and level as per the WTS requirements.
- The formwork will be pre-fabricated of sufficient quality and robustness to allow repeated use. Formwork will be cleaned after each use and re-sprayed or painted with mould oil within the blinded foundation excavation prior to being fixed in place. The placement of containers with mould oil will be strictly monitored to ensure that storage is only in bunded areas (i.e. in the TCC) on sealed hardstanding as required by this CEMP. Spraying of mould oil and storage of such sprayed materials will be undertaken in such as way as to avoid pollution.
- Sulphate resistant concrete or other suitable concrete, as appropriate for the prevailing ground conditions, will be used in the turbine base. Prior to pouring the base concrete, the overall quality of the steel fixing will be checked to ensure there is sufficient rigidity to cope with the weight of personnel and small plant during the pour. The quantity, size and spacing of the reinforcement bars will be checked against the construction drawings to ensure compliance with the design detail. The position of the foundation insert, or other appropriately designed foundation mechanism supplied by the turbine manufacturer will be checked to ensure that the level is within the prescribed tolerances. A check will also be carried out to make sure the correct cover from edge of reinforcement to edge of concrete is maintained throughout the structure. A splay will be formed on all external corners.
- The line of ducts will be checked so as not to leave sharp corners that will cause cable snagging and that all bend radius comply with the design illustrated on the construction drawing. All earthing cable or strip connections will also be examined to prove their adequacy to withstand the rigors of the concrete placing process.
- The concrete pour will commence after the blinding concrete has been cleaned of debris and other loose material. Vibrating pokers will have been checked to ensure they are fuelled by compressed air and in good working order. The pour will proceed under the control of the *Contractor*. Personal Protective Equipment (PPE) will be worn by the site operatives and as detailed in the Construction Phase Health & Safety Plan. Pouring will follow best working practice procedures and fresh concrete will be protected from hot and cold weather as required. All concrete works shall implement pollution prevention controls in line with CEMP requirements
- Shutters will be carefully loosened, removed and cleaned no earlier than 24 hours from the finish of the pour.
- Backfilling to the turbine base will proceed in layers of approximately 0.3 metres with compaction as necessary.

23.1.9 A checklist for each foundation will be prepared to show compliance with the documents of each step of the installation process. These lists, once completed, will be stored in the contractor's QA file along with relevant cube test results, and be available for inspection at all times.

23.1.10 Following the completion of all construction activities, the area surrounding the base shall be reinstated according to CEMP requirements.

24 ACCESS TRACK CONSTRUCTION

24.1 Introduction

24.1.1 The overall site design has been developed in accordance with recommendations adopted from the Environmental Statement(s) and to reflect the requirements and specifications for transporting wind turbine components to the consented turbine locations.

24.1.2 The extent of construction disturbance will be limited to around the perimeter of, and adjacent to, access track alignments, including associated earthworks, and shall be monitored by the ECoW and ACoW as required.

24.1.3 Proposed access track alignments will be inspected by the *Contractor*, ECoW and ACoW prior to the on-set of construction in that area. The regularity of inspections (hourly, daily, weekly, as appropriate) during the construction period shall be determined in advance for each particular stretch, based on anticipated ground conditions, known ecological or archaeological sensitive receptors, prevailing weather conditions, and anticipated rate of progress.

24.1.4 In general, as part of the design mitigation wherever practicable all proposed site infrastructure has been sited at least 50m from any watercourse.

24.2 General Construction Criteria

24.2.1 It is anticipated that all access tracks will be constructed from aggregate won from local excavations and constructed to the best practices for wind farm access tracks. If site won material does not conform to required engineering specification for the final running surface then imported crushed rock material may be required.

24.2.2 In general, the internal site track layouts have been designed to reflect the contours and design criteria established by the WTS. The internal track length at site will be kept to a minimum to follow the existing topography and tie-in with existing infrastructure.

24.2.3 Access tracks shall be constructed to a minimum running width of 5m, plus shoulders of approximately 0.5m on either side, to accommodate the maximum transport requirements and specifications of the WTS. Track shoulders may be up to a width of 2m to accommodate cabling along the access track alignment,

24.2.4 Passing places will be located to ensure inter-visibility between passing places on sections of track which cannot accommodate 2 way traffic movements. All passing places will be appropriately signed such that they are clearly visable to approaching drivers. Access tracks will be formed from a sub-base of general fill won from local excavations, and finished off with a cap-stone / wearing course of graded crushed rock, to provide suitable delivery of the WTG components. Wearing course stone shall be of a suitable material that is not susceptible to breaking down / weathering to a high fines content material.

24.2.5 Maintenance of the running surface will be carried out on a regular basis, as required, to prevent undue deterioration. Loose track material generated during the use of access tracks will be

prevented from reaching watercourses by maintaining an adequate cross fall on the tracks. Periodic maintenance of tracks by way of brushing or scraping will be carried out to minimise the generation of wheel ruts. In dry weather, dust suppression methods may be required for track and hardstanding areas. The site access tracks, hardstandings and trackside drains will be inspected on a daily basis by the *Contractor*. Records of such inspections will be held on site for review by the ECoW / Planning Authority (PMO) / *Employer*.

24.2.6 Where floating roads are installed, the contractor will denote this on the site's 'as builts' and issue to the Planning Authority.

24.3 Unstable Ground

24.3.1 Unstable ground is herein considered to be any ground conditions encountered along the proposed alignment, or within the immediate vicinity and influence, of the access tracks that has insufficient strength in its existing state to support the proposed load conditions or to remain in-situ for the duration of the construction works, or that has experienced natural failure (i.e. not as a consequence of the wind farm construction works) prior to, but along the alignment of, or within the immediate vicinity and influence of, the proposed access track alignment such as to require re-alignment of the works, or major civil engineering solution to maintain the proposed alignment.

24.3.2 If any unstable ground is encountered during access track construction, the following procedure shall be adopted:

- Access track construction in the immediate area of the unstable ground shall cease with immediate effect;
- The *Contractor* immediately consults a suitably qualified and experienced geotechnical engineer; and
- If relocation within approved micro-siting allowances of the proposed access track alignment is possible and acceptable to the ECoW/ACoW (as appropriate), without potential for further ground instability to occur, then construction may recommence along the newly agreed alignment, and any stabilisation / mitigation measures that may be required of the unstable ground shall occur in parallel.

24.4 Track Construction

24.4.1 Access tracks will be formed on suitable underlying material (soil or rock with sufficient bearing capacity) in the following manner:

- Stripping of surface vegetation (turves) and careful stockpiling of this material as per CEMP requirements.
- Excavating the remaining superficial soil materials (overburden) and stockpiling this material as per CEMP requirements.
- Where different overburden materials are present these will be stored according to type. This material will be monitored and watered (as appropriate) to be retained for reinstatement purposes.
- The exposed suitable track formation shall have rock fill material tipped from dumper trucks directly onto the proposed access track alignment; and

- This material will then be either spread by a dozer or placed by a hydraulic excavator and compacted in layers, typically using vibratory rollers.

24.4.2 Turning areas will be formed to facilitate the turning of dumper trucks. These turning areas can serve as passing places during the construction period before being reinstated at the end of the works using subsoil/topsoil.

TECHNICAL APPENDIX A4.2: DESIGN STATEMENT

Introduction

This Design Statement describes the design principles that have informed the development of the Modified 2013 Scheme. The design statement is informed by Planning Advice Note 68, although it is noted that the emphasis of that guidance is on urban development (e.g. housing, retail development).

Site Details

The site is situated in north Sutherland, approximately 15 km to the south of the village of Strathy, on the North Atlantic coast of Scotland. The nearest town is Thurso, approximately 25 km to the east and the nearest regional centre is the village of Bettyhill, approximately 10 km to the west. Running southwards from Strathy is the shallow valley of the River Strathy. The site occupies an area of commercial forestry, roughly "U"-shaped on plan, which wraps around the headwaters of the River Strathy, it's tributary, the Yellowbog Burn and the Yellow Bog. The two limbs of the site occupy the two low ridges which enclose the Yellow Bog, with higher land bordering the southern end of the site. This higher land to the south comprises the foothills of Ben Griam Mor, Beinn a Mhadaidh and Ben Griam Beg. To the north are two areas of forestry, known as Strathy Forest and Strathy Wood. To the east and west of the site are extensive raised plateaux characterised by bog and small lochans. These plateaux are defined to the north by the rocky coastline, which is interspersed with small bays and crofting villages. The site is in private ownership. The main wind farm site is not subject to any designations; however, the main access track between Strathy North wind farm and site together with the link road across Yellow Bog both cross the Caithness and Sutherland Peatlands (SPA, SAC and Ramsar).

Design Principles

The underlying design principle was to design a wind farm that achieved an appropriate balance between identified technical and environmental constraints and requirements.

(a) Technical Requirements

The wind farm design was constrained by the following technical requirements or aspirations:

- To maximise energy output by locating turbines in exposed positions with the greatest wind speed; minimising array effects between turbines and maximising the capacity of the site;
- To minimise areas of difficult ground conditions;
- To meet manufacturers specified surface gradients and turbine separations;
- To facilitate construction efficiency;
- To minimise infrastructure costs;
- To retain a degree of flexibility for a 'design and build' contract; and
- To accommodate transportation access constraints.

(b) Environmental Requirements

Baseline studies were completed to identify any significant environmental constraints, and this identified that the design should specifically consider:

- effects on the Caithness and Sutherland Peatlands SPA, SAC and Ramsar site which surrounds the site;
- effects on birds
- effects on peat

Other factors which have guided the design for the Modified 2013 Scheme include: consideration of landscape and visual impacts from sensitive receptors; avoidance of impacts on sensitive watercourses; and avoidance/minimisation of impacts to cultural heritage receptors.

Ornithology

The Modified 2013 Scheme could interact with bird species directly due to disturbance or removal of habitat, through barrier effects, or collision with rotor blades or turbine structures; or indirectly by causing changes to habitat characteristics, in particular by introducing noise and movement.

As discussed in Chapter A11: Birds, a significant amount of bird survey work has been undertaken between 2003 – 2012. The survey data has been collated, combined with desk study results and analysed, and the combined insights used to inform the layout of the Modified 2013 Scheme. As well as detailed knowledge of the site's bird interests, off-site fieldwork completed for the consented Strathy North wind farm, together with a range of post-construction monitoring results has generated insights into predicted effects that can be anticipated, including once forest removal has taken place.

The following design considerations have been incorporated into the Modified 2013 Scheme, specifically in relation to bird interests:

- the site access for the Original 2007 Scheme has been removed; this was known as the Cnoc Meala route. A preferred and an alternative access route are now proposed, both through Strathy Wood, following for the most part the existing Strathy South access track (which would be partially widened) (Figure A4.1). This revised route significantly reduces the amount of land take by reusing existing track through the Caithness and Sutherland Peatlands SPA, SAC and Ramsar site;
- the re-routing of most of the grid connection. The transmission connection no longer crosses the Caithness and Sutherland Peatlands SPA, SAC and Ramsar site from the east of Strathy South, but instead is proposed, under a separate Section 37 application, to connect to Strathy North, north of the designated site.
- The Modified 2013 Scheme proposes to connect Strathy South wind farm to the substation in Strathy North wind farm via underground cabling. The underground cabling between Strathy North and South would follow the preferred or alternative access routes and be integrated with the existing access track into Strathy North (Figure A4.1);
- a review of ornithological constraints was considered in the revisions to the site layout. This review included a consideration of the predicted displacement effects on key qualifying birds from the Caithness and Sutherland Peatlands SPA, SAC and Ramsar site as a result of turbine locations, taking into account consultation responses, notably from SNH. The results of this review informed the design revisions and led to the removal of turbines and the creation of a habitat corridor in the northwestern part of the site;
- the reduction in number of turbines, from 77 to 47, has led to a reduction in the wind farm's physical footprint (helping to reduce the extent of habitat effects, and increasing the area available for habitat restoration); and
- the rotor of the turbine has a greater ground clearance than the Original 2007 Scheme thereby reducing collision risk with the lower flying bird species.

Ecology

Following the submission of the Section 36 application for the proposed Strathy South wind farm in 2007, there has been ongoing dialogue with various consultees, in relation to certain aspects of the proposals. One particular area of concern related to the proposed access route, known as the Cnoc

Meala track (mentioned above), on account of the surrounding ecological designations including the Caithness and Sutherlands SPA, SAC and Ramsar, together with their component Sites of Special Scientific Interest (SSSI), which lie adjacent to the Strathy South forest boundary.

In response to the concerns raised by SNH, the Applicant undertook an assessment of various route options in an Access Route Review[1] (which is included as a separate document with the application package for Strathy South Wind Farm). The overall aim of this routing study was to identify the optimal access route for Strathy South wind farm, taking account of environmental, engineering, local and planning constraints and to satisfy the Appropriate Assessment requirements under Conservation (Natural Habitats, &c.) Regulations 1994 and amendments. The results of the Access Route Review identified a preferred route which is presented on Figure A4.1 and results in the least impact in terms of land take within the Caithness and Sutherland Peatlands SPA, SAC and Ramsar. A full assessment of the potential habitat impacts was undertaken for the access track and the grid route within the SAC and the results of this assessment were used to inform the design process in relation to route alignment.

All areas of intact habitat (primarily blanket bog and wet heath) within the forest boundary have been mapped and used as a constraint in the Modified 2013 Scheme. This constraints mapping exercise identified areas of wetland (including groundwater dependant terrestrial ecosystems) and peatlands which have been used as constraints in the design process, where possible.

Furthermore, all infrastructure has been designed, and would be micro-sited, at least 70 m from all watercourses with the exception of watercourse crossings. In addition, wherever possible, the design of the Modified 2013 Scheme, locates infrastructure within areas of afforested ground thus reducing the footprint and impacts on valued habitats.

As noted for ornithology, the reduction in number of turbines, from 77 to 47, has led to a reduction in the wind farm's physical footprint (helping to reduce the extent of habitat effects, and increasing the area available for habitat restoration).

The design of the Modified 2013 Scheme has aimed to further decrease the potential impacts upon watercourses and the fauna and flora reliant on them. The decrease in turbine numbers also results in a significant decrease in the number of watercourse crossings required from 26 to 18 as the amount of on-site track has been rationalised.

An updated peat slide risk assessment has been undertaken as part of the ES Addendum. The results of this assessment fed into the constraints exercise in order to reduce potential impacts from peat slide on terrestrial habitats, aquatic habitats fish and other protected fauna species.

Other Issues

Substantial further peat depth probing has been undertaken in order to assist with the design process. As discussed above, the results of the peat probing have been used to update the peat slide risk assessment, the results of which were used to inform the site layout.

Encapsulated bog is known to be present on-site. A 50 m buffer around 'encapsulated bog' was applied during the design process along with a detailed assessment of peat depths in order to avoid deep peat areas.

A review of archaeological constraints as part of the design review process led to the removal of Turbine 34 which was sited in proximity to the Lochstrathy settlement, a site of regional importance. The removal of this turbine has also reduced the potential effects on Lochstrathy Bothy.

Landscape and Visual Design Principles

In addition to the above considerations, the design strategy was informed, in part, by advice from landscape architects in order to help maintain a good relationship between the landscape and visual characteristics of the area and the Modified 2013 Scheme. Cumulative impacts were a key consideration, particularly in relation to the consented Strathy North wind farm and the Strathy Wood wind farm (which is at the scoping stage).
The relationship with landscape and visual considerations is influenced by factors such as:

- turbine layout and number or density;
- the overall size and relative proportions of turbines;
- positioning of turbines relative to the landform and the land use or settlement pattern; and
- proximity to prominent focal points and features.

As the design developed, driven by various environmental constraints and by emerging technologies and practices, the potential consequences for this relationship have been considered and recommendations made for each of the options available. These have related primarily to the wind turbine geometry and scheme layout.

(a) Wind Turbines

A range of turbines are commercially available and the final choice will be dependent on economics and available technology at the time of construction. For the purposes of the assessments presented in the ES Addendum and this Design Statement, assumptions relating to the specific geometry and overall maximum height of the turbines have been made.

The 47 wind turbines would be up to 135 m in height and would be three-bladed, horizontal axis turbines, automatically controlled to ensure that they all face directly into the wind at all times. The turbine towers would be of a tapering tubular steel construction and the blades of a fibre-reinforced epoxy. The finish of the turbines is proposed to be a semi-matt pale grey colour.

Since the design review process began, a number of alternative turbine manufacturers and models have been considered. One of the key considerations in this has been to achieve a rotor diameter to tower height ratio which matches closely with those of consented development at Strathy North. The intention of this is to try and tie the two developments together so that, whilst turbines at Strathy South would be larger than those to the north, the visual proportions of their elements would be similar. The modelled turbine is not an exact match for this ratio but it does represent the best balance available when other environmental and technical constraints are considered.

An area of hard standing around the base of each turbine would be required for construction and maintenance purposes. The specific details of these would depend on a number of factors and would not be determined until the construction stage. A transformer would also be required for each turbine, and depending on the turbine specification selected, these may be contained within the turbine towers, or located adjacent to each turbine.

If located adjacent to the turbine, they would be sited within the hardstanding and would typically have an area of 4 m x 3 m and 2 m in height. The external finish would reflect the tones and colours of the landscape context.

[1] ENVIRON (2013) Strathy South Wind Farm Access Route Review (Ref: UK12-17180)

(b) Scheme Layout

The optimum layout of the Modified 2013 Scheme has been refined through an iterative design process in order to achieve a balance of technical efficiency and performance whilst keeping impacts to a minimum.

Due to their size and scale, the wind turbines are likely to be the most visible and visually prominent element of the Modified 2013 Scheme. It has therefore been important to consider advice on visual composition from key viewpoints, at each stage of the design process. As part of this, reference was made to current best practice guidance and this helped to inform the layout design. The following broad design objectives and principles were employed in the development of the turbine layout design:

- to create a site specific layout that relates to the scale of the landscape within which it is located and responds to the landform at a local and broader scale; and
- to minimise impacts on natural and cultural heritage resources as far as practical, in balance with technical performance.

Design Solution

The design solution includes:

- 47 wind turbines, with an overall tip height of up to 135 m;
- Four on-site borrow pits;
- A switching station in the eastern section of the site would be connected to turbines by underground cabling;
- Access from the main road to by-pass village to reduce environmental impacts;
- Main access track would use the consented track through Strathy North wind farm, continue south across the River Strathy (the preferred of two possible crossing locations) in Strathy Wood and connect with the existing forestry track, south towards the site;
- Creation of a habitat corridor on-site to reduce ornithological impacts;
- Landscape measures in terms of peatland habitat reinstatement.

The design solution meets the technical requirements but these are balanced against environmental constraints. This has involved a significant reduction in the number of turbines over the design process and micro-siting to avoid environmental constraints and reduce visual impacts from key viewpoints, (such as Strathy village), particularly by balancing the avoidance of “bunching” of turbines whilst at the same time ensuring that they are seen as a group rather than individuals.

Key landscape proposals involve the extensive restoration of peatland habitat, with associated ecological and landscape benefits.

The ecological, soil and water constraints have been met by:

- applying 70 m watercourse buffers to avoid burns, lochans (except at watercourse crossings);
- rationalisation of site infrastructure has been undertaken following turbine removal to minimise the number of watercourse crossing and land take from on-site tracks;
- the avoidance of areas of deep peat and encapsulated bog;
- the creation of habitat management areas for peat restoration;
- creation of a habitat corridor; and
- widening and upgrading of the proposed access track aims to avoid, or otherwise minimise, the impact of the Modified 2013 Scheme on the SAC including, where possible, siting any new track construction (including passing places), and grid connection cables, within currently disturbed ground (i.e. non-qualifying habitats).

Strathy South Wind Farm

Peat Management Plan

Prepared for:
SSE Renewables Developments (UK) Ltd
Glasgow, UK

Prepared by:
ENVIRON
Edinburgh, UK

Date:
July 2013

Project or Issue Number:
UK12-17181

ENVIRON

Contract No:	UK12-17181
Issue:	2
Author (signature):	Alex Turner
Project Manager/Director (signature):	Kate Lyon/Nathan Swankie
Date:	July 2013

This report has been prepared by ENVIRON with all reasonable skill, care and diligence, and taking account of the Services and the Terms agreed between ENVIRON and the Client. This report is confidential to the client, and ENVIRON accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by ENVIRON beforehand. Any such party relies upon the report at their own risk.

ENVIRON disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the Services.

Version Control Record

Issue	Description of Status	Date	Reviewer Initials	Author Initials
A	First Draft	13th June 2013	NS	AT
B	Second Draft	19th June 2013	NS	AT
C	Draft Issue for Client Review	19th June 2013	NS	AT
D	Incorporation of Client Comments	21st June 2013	KL	AT
1	Issue for Legal Review	21st June 2013		AT
2	Final Issue	16th July 2013	KL	AT

Peat Management Plan
Strathy South Wind Farm
SSE Renewables

Contents

1 Introduction 1

2 Site Context 3

2.1 Background 3
2.2 Habitats 3
2.3 Peat Conditions 3

3 General Excavation Principles 5

4 Estimation of Excavation and Re-instatement Peat Volumes 7

4.1 Track and Drainage Excavation 7
4.2 Foundations and Hardstanding Excavation 8
4.3 Other Infrastructure Excavation 9
4.4 Reinstatement Volumes 9

5 Classification of Excavated Material 11

6 Handling of Excavated Material 13

7 Temporary Storage 15

7.1 Temporary Borrow Pit Storage 15

Annex A: Calculation of Peat Excavation and Reuse

List of Tables

Table 2.1: Peat thicknesses at Probe Locations 4

Table 4.1: Peat excavation for cut and floated tracks 8

Table 4.2: Peat excavation for foundation and hardstanding areas 8

Table 4.3: Peat excavation for Switching Station 9

Table 4.4: Peat required for restoration and reinstatement activities 9

1 Introduction

In 2007, SSE Generation Limited ('the Applicant') submitted an application for Section 36 Consent for a wind farm known as Strathy South, referred to as the 'Original 2007 Scheme'. The 2007 application remains undetermined pending receipt of further environmental information as requested by stakeholders in relation to a number of specific matters arising through the application consultation process. To address these matters and to further reduce environmental impact, the Applicant has made modifications to the Original 2007 Scheme and, (in September 2012) confirmed their intention to produce an ES Addendum for the modified scheme (hereafter referred to as 'the Modified 2013 Scheme').

ENVIRON has been commissioned to complete a peat management plan to accompany the application for consent under Section 36 of the Electricity Act 1989.

This report provides supporting information to Chapter A4: Development Description of the Environmental Statement Addendum (ES) for the Modified 2013 Scheme. It provides details of the predicted volumes of peat that will be excavated on the site, the characteristics of the peat that will be excavated, and how and where this excavated peat will be stored, reused and managed. This report also details of what quantities and thicknesses of catotelmic and acrotelmic peat will be excavated and reused. A description of the proposed Modified 2013 Scheme is provided in Chapter A4: Development Description and the layout is shown on Figure A4.1 Modified 2013 Scheme.

This report has been compiled in accordance with the following best practice guidance:

- Guidance on Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste (SEPA & Scottish Renewables (2012));
- Developments on Peatland: Site Surveys & Best Practice (Scottish Natural Heritage, SEPA, Scottish Government, The James Hutton Institute (2011));
- Floating Roads on Peat Guidance (Scottish Natural Heritage & Forestry Commission (2010));
- Good Practice During Wind Farm Construction (Scottish Renewables, Scottish Natural Heritage, SEPA, Forestry Commission Scotland, (2010)); and
- SEPA Regulatory Position Statement – Developments on Peat (SEPA, (2010)).

The following sections of this report provide:

- a description of the peat conditions on site, with reference to the Peat Landslide and Hazard Risk Assessment (SLR, 2013; Technical Appendix TA A14.1);
- detail of the construction activities that will generate peat and of the estimated volumes that will be generated as well as the estimated re-use volumes;
- detail of the physical nature of the peat and confirmation of its suitability for the reuses proposed;
- methods and procedures for handling excavated soils and turves; and
- details of temporary storage.

2 Site Context

2.1 Background

The site is located within the Strathy South Forest block, approximately 15 km south of Strathy village, and 30-35 km west of Thurso. Strathy South Forest extends 12 – 17 km inland from the north coast and the proposed wind farm occupies most of the forest between Loch nam Breac Mór and the River Strathy, an area of approximately 1,600 hectares (ha).

The site varies in altitude between approximately 130 m and 200 m. The topography undulates throughout most of the forest with the lower ground towards the central boggy inner boundary of the U-shaped forest area, which follows the River Strathy valley. The area is open and gently undulating in character, with extensive blanket bog, lochs and pools. Strathy South Forest is a commercial conifer plantation and occupies most of the forest between Loch nam Breac Mor and the River Strathy. The proposed turbines would be located within the U-shaped area of Strathy South Forest.

Peaty soil and peat deposits cover most of the site and variously overly glacially derived soils such as glacial till comprising, sand and gravels and in places bedrock. There are exposures of bedrock and where exposed these are seen to be metasedimentary rocks over the entire site.

2.2 Habitats

The site is dominated by plantation coniferous woodland on areas of varying peat depths; dominant species within the forest canopy include lodgepole pine (Pinus contorta) and Sitka spruce (Picea sitchensis). Rides and glades throughout the plantation areas are a mixture of blanket mire, wet and dry heath, with scattered areas of acid grassland on areas of shallow mineral soil. Areas of marshy grassland and acidic flush habitat surround watercourses and waterbodies across the site. The site is adjacent to the Caithness and Sutherland Peatlands SAC and the Strathy Bogs SSSI, which comprise wet heath and blanket mire habitats for which the areas are designated.

Whilst extensive areas within Strathy South Forest are mapped as having potential for groundwater dependence, in general, given the flat or gentle sloping nature of these areas, the majority of these habitats will be largely ombrotrophic (rainfed). In addition, the majority of these habitats relate to NVC M15 wet heaths, however, there is a strong likelihood that these habitats are the result of changes in vegetation composition over a period of time due to the influence of forestry and drainage. Prior to afforestation, these habitats are likely to have been M17 or similar non-groundwater dependant habitat types, particularly in areas of peat >0.5 m.

2.3 Peat Conditions

A peat probing, walkover survey and peat slide risk assessment was undertaken by SLR, which is included as Technical Appendix A14.1 of the ES. A total of 2,462 locations were probed across the site to determine the thickness of peat, including 700 probe locations undertaken in 2007. The extent of peat coverage and depth of peat on the site is shown on Figure 5 in Technical Appendix A14.1.

In general, the peat is mapped as being developed over the whole of the site where the peat is extensively draped over existing glacial till and bedrock. The peat has been subject to limited erosion from fluvial activity and localised erosion, causing minor hagging and ponding

on the peat. The peat within the site is generally a blanket type peat overlying the underlying strata, dissected by distinct watercourses, with thicker peat (deeper isolated peat) at the stream head of the River Strathy to the south of the site.

Peat was found to vary across the site in terms of thickness, surface slopes and apparent characteristics. Peat thickness varies from zero to 5.0 m within the site, as shown in Table 2.1 below. Accumulations of peat less than 0.50 m thick are considered to be too thin to be classified as true peat deposits and are often classified as organic soils or peaty soils.

Table 2.1: Peat thicknesses at Probe Locations

Number of Probes	Peat Thickness
163	>3.0 m
720	1.5 – 3.0 m
1068	0.5 – 1.5 m
511	<0.5 m

Details of the specific ground conditions at each of the turbine locations are included in Table 6.5 in Technical Appendix A14.1 of the ES Addendum.

3 General Excavation Principles

The Modified 2013 Scheme has been designed within the confines of a number of environmental constraints. From the outset, the design of the Modified 2013 Scheme has sought to avoid areas of deep peat on site (see Chapter A4: Development Description (Environmental Statement Addendum 2013)). To this extent, it is considered that the current layout provides an optimal solution to the competing environmental constraints.

During the construction of the Modified 2013 Scheme, all reasonable measures would be taken to avoid or minimise excavations and minimise disturbance to peat and peatland habitats. Further mitigation may include maximising batter angles in cuttings and the use of floating track.

Ground disturbance areas around excavations would be kept to a minimum and would be clearly defined on site. Access to working areas during construction would be restricted to specified routes, comprising constructed tracks.

Cable routes would in general follow access tracks. Any disturbance relating to the cable route to Dalangwell, not via access tracks, would only be temporary for a short duration of time, in accordance with approved method statements. Any peat excavated would be replaced; therefore this has not been included within the excavation volumes.

Peat and topsoil originally excavated at the temporary laydown areas, concrete batching plant , temporary construction compounds and borrow pits will be stored and also reinstated, therefore peat generated from these areas have not been included within the excavation volumes.

Appropriate plant such as low pressure models would be used to avoid unnecessary disturbance to the ground surface. Any mobile plant would be positioned on constructed tracks or hardstanding areas and the use of long reach excavators for excavations and reinstatements would be used where possible to enable sufficient room to allow initial side casting or peat turfs and subsequent reinstatement.

Bog mats may also be used if required for cable ploughing proposals through the designated areas.

4 Estimation of Excavation and Re-instatement Peat Volumes

The construction period for the Modified 2013 Scheme would be approximately 22 months on-site. The programme and nature of construction activities projected are described in Chapter 4: Development Description of the 2007 ES. Those activities which will generate volumes of peat areas are as follows:

- establishment of the temporary construction compounds, which will include stripping of topsoil, peat and remaining sub-soil and stockpiling of the material for later reinstatement in accordance with the CEMP requirements;
- establishment of four borrow pit areas, which will require that superficial soils ("overburden") are stripped off and stockpiled in designated areas, in accordance with the requirements of the CEMP;
- formation of cut track and upgrades to existing track, which would involve: the removal and temporary storage of turves, as appropriate, followed by excavation down to formation level;
- construction of the turbine foundations and crane hardstandings, which would require the excavation of peat and subsoil to expose underlying bedrock. The depth of the excavation would be dependent on the depth to bedrock, but is likely to be up to approximately 4 m;
- excavation of trenches for underground cabling between the turbines and the substation, which would be approximately 0.5 m wide by 0.8 m (minimum) deep;
- development of the laydown areas and concrete batching plant;
- construction of the switching station and welfare buildings, and construction compound; and ploughing of the cable alongside the access track (when leaving the Strathy South boundary to the north) where existing bunds adjacent to existing track may need to be removed to provide an even surface for ploughing.

Details of the estimated peat volumes associated with each of these activities are provided below. The detailed calculations of peat excavation and re-use are presented in Annex A.

4.1 Track and Drainage Excavation

For the construction of access tracks, it is proposed to float tracks where peat is greater than 1 m in depth and to cut/excavate tracks where peat is less than 1 m in depth.

Table 4.1 provides the indicative dimensions of the proposed tracks and peat excavated as a result.

Table 4.1: Peat excavation for cut and floated tracks

Description	Dimension
New Track width (m)[1]	7.0
Length of cut track (m) [2]	25716.43
Depth of excavation (m) [3]	0.65
Volume of peat excavated (m^3)	117,010
Volume of peat excavated from drainage ditches on cut tracks (assuming 0.7 m width and 0.5 m depth) (m^3)[4]	4500
Allowance for 1:1 batters (m^3)	16,716
Volume of peat excavated from cut off ditches on floating tracks (assuming 0.7 m width and 0.5 m depth) (m^3)[5]	944
Total Peat Generated from tracks and ditches (m^3)	**139,170**

4.2 Foundations and Hardstanding Excavation

Turbine foundation and crane pad construction will be undertaken in line with best practice. At this stage it is assumed that gravity foundations will be used for all turbines.

Table 4.2 provides the indicative dimensions for foundations and hardstanding and the peat excavated as a result.

Table 4.2: Peat excavation for foundation and hardstanding areas

Description	Dimension
Turbine Foundations	
Total Turbine foundation volume (m^3)	6415
Diameter of excavation at top (m)	50.00
Depth of excavated peat (average) (m)	1.38
Cut slope angle	3.5
Diameter of excavation at base of peat (m)	40.34

[1] Average of widths taken for upgrade to existing track and new track.

[2] Length of track for Preferred Option; includes new access track, (including preferred bridge crossing of the River Strathy, and upgrades to existing track)

[3] Average peat excavation depth along length of access track

[4] Assumes V-shaped drainage ditch

[5] Assumes V-shaped drainage ditch

Table 4.2: Peat excavation for foundation and hardstanding areas	
Description	**Dimension**
Turbine Foundations	
Volume of peat excavated per base (m^3)	2236
Total Peat Generated from Turbine Bases (m^3)	**105,071**
Hardstandings	
Area of hardstanding (m2)	832.5
Depth of excavation (m)	1.38
Volume of peat per base (m3)	1149
Total Peat Generated from Hardstandings (m3)[6]	**35,097**

4.3 Other Infrastructure Excavation

Construction of temporary infrastructure on-site, including laydown areas, and concrete batching plant, will be undertaken in line with best practice. Any peat removed will be stored temporarily before reinstatement. Table 4.3 provides the indicative dimensions of the Switching Station and Control Room, and the peat excavated as a result.

Table 4.3: Peat excavation for Switching Station	
Description	**Dimension**
Control Room/Switching Station : volume of peat excavated (m^3)	5,000.00
Total Peat Generated from Excavations (m^3)	**5,000.00**

4.4 Reinstatement Volumes

Table 4.4 sets out the volumes of peat required for specific restoration activities and areas on the site including the reinstatement and landscaping of site infrastructure and borrow pits.

Table 4.4: Peat required for restoration and reinstatement activities	
Description	**Dimension**
Total peat re-used on cut and floating tracks (m^3) based on 1:5 profile	35,800
Total peat re-used for borrow pit restoration (m^3) (to depth of 1.45 m)	160,515
Reinstatement volume for area around turbines (m^3)	88,023
Total Volume of Peat Re-used (m^3)	**284,338**

[6] 35% of Hard standing Area already counted in Turbine Foundation excavation

5 Classification of Excavated Material

There are two distinct layers within a peat bog, the upper acrotelm and the lower catotelm. The acrotelm is the fibrous surface to the peat bog, typically less than 0.5 m thick; which exists between the growing bog surface and the lowest position of the water table in dry summers. The majority of the peat found on the site is classified as upper acrotelm, very slightly to slightly decomposed with some fibrous content and moderate water content up to 1.5 m in depth. This material would be suitable for reuse without the need for any engineering measures.

The deeper peat generally in excess of 1.5 m is classified as the acrotelm, moderately decomposed with a high fibrous content and moderate water content. There are various stages of decomposition of the vegetation as it slowly becomes assimilated into the body of the peat. Generally, the acrotelm is not considered to be reusable. The design process has ensured that the layout would avoid the requirement for excavation of the acrotelm[7].

The peat is generally flat lying with very little erosion or hagging associated with it. Where the peat was found to be deeper (>1.5 m) the level of decomposition was far more evident with increased humification and higher moisture content.

Further detail is provided in section 5 of the peat slide risk assessment, which is included as Technical Appendix A14.1.

[7] Peat Landslide and Hazard Risk Assessment (SLR, 2013; Technical Appendix TA A14.1):Drawing No. 2: Geomorphology and 5: Interpreted Peat Depths

6 Handling of Excavated Material

As detailed within the Construction Environmental Management Plan (CEMP), which is included as Technical Appendix A4.1 of the ES, the excavation of soils would be undertaken in such a manner as to avoid cross contamination between distinct horizons, where possible. The different soil horizons would be kept and stored separately for use at a later date.

During and after excavation, storage, haulage and reuse of excavated material would be planned to minimise material movement around the site. Where possible, immediate reuse is preferred to temporary storage.

Turves will be stripped and handled with care and kept vegetation side up such that damage to the living vegetation mat is prevented or minimised as far as possible.

7 Temporary Storage

As detailed within Technical Appendix A4.1, temporary storage may be required where material is not required for immediate reinstatement. To minimise handling and haulage distances, where possible excavated material will be stored local to the site of excavation and/or local to the end–use site where it is required for re-profiling, landscaping or structural purposes. Up to five stockpiles of peat would be located on site, if possible located adjacent to the borrow pits and construction compound. The exact storage location(s) would be agreed with the ECoW prior to commencement of main phase of works and provided on a plan to accompany the Peat Management Plan and relevant Method Statements.

Temporary storage locations would be appropriately located and designed to minimise impact to sensitive habitats and species, prevent risks from material instability (particularly in peatland areas) and run-off into watercourses.

Stripped materials would be carefully separated to keep peat and other soils apart, and stored in appropriately designed and clearly defined separate piles. Excavated peat would be excavated as turves which should be as large as possible and kept wet in order to minimise desiccation during storage.

Stockpiles would be isolated from any surface drains and a minimum of 50 m away from watercourses, unless otherwise agreed with the ECoW. Stockpiles will include appropriate bunding to minimise any pollution risks where required. Excavated topsoils would be stored on geotextile matting to a maximum of 1 m thickness.

Peat would not be stockpiled or deposited permanently higher than 1 m, and turf will be stockpiled separately. Peat would not be stockpiled for more than 6 months.

Turves must be stored turf side up and must not be allowed to dry out. The condition of stored turves would be monitored by the Contractor and the ECoW.

7.1 Temporary Borrow Pit Storage

Where the excavated material is identified to be required elsewhere in restoration works, although re-use is not imminent, specified areas within the working borrow pit may provide suitable temporary storage locations. However, the handling of the stored material must be kept to a minimum and appropriate drainage, pollution prevention and material stability measures must be designed prior to the temporary deposition of the material to ensure material is maintained in a suitable condition for future use.

SSE Renewables
Peat Management Plan
Strathy South Wind Farm

Annex A: Calculation of Peat Excavation and Reuse

UK12-17181 Issue: 2
ENVIRON

Calculation of Peat Excavation and Re-Use

Generated		
Access Tracks		
Length of Access Track Cut	25716.43	m
Width of Access Track	7.00	m
Depth of Excavation	0.65	m
Volume Peat Excavated	117009.76	m^3
Further Allowance for 1:1 batters	16715.68	m^3
Total Peat Generated from Cut Tracks	**133725.44**	m^3
Drainage Ditches on cut tracks		
Length	25716.43	m
Width	0.70	m
Depth	0.50	m
Volume	**4500.38**	m^3
Cut off ditches for Floating Tracks		
Length	10785.64	m
Percentage cut off ditches	50.00%	
Applied Length	5392.82	
Width	0.7	m
Depth	0.5	m
Volume	**943.7435**	m^3
Foundation Excavation		
Diameter of Excavation at top of Peat	50.00	m
Depth of Excavated Peat (Average)	1.38	m
Cut Slope Angle	3.50	
Diameter of Excavation at Base of Peat	40.34	
Volume of Peat per base	2235.56	m^3
Total Volume of Peat from Bases	**105071.34**	m^3
Hardstandings		
Area	832.50	m^2
Depth of Excavation	1.38	m
Volume of Peat per base	1148.85	m^3
Percentage of Area counted in Foundation	35.00	%
Total Volume of Peat from Hardstandings	**35097.37**	m^3
Switching Station Compound		
Length	100	m
Width	100	m
Depth	0.5	m
Total Volume of Peat from Bases	**5000**	m^3
Total Volume Excavated	**284338.27**	m^3

Re-Used		
Access Tracks		
Length of Access Track Floated	10785.64	m
Height of floated track	0.80	m
Gradient of peat profile 1:	5.00	
Length of profile	4.00	m
Length of Track Cut	25716.43	m
Height of cut track	0.10	m
Gradient of peat profile 1:	5.00	
Length of profile	0.50	m
Total Peat Re-used on Floating Tracks	**35799.87**	m^3
Borrow Pits		
Borrow Pit A		
Width	242.88	m
Length	242.88	m
Area	58990.69	m^2
Borrow Pit B		
Width	124.54	m
Length	124.54	m
Area	15510.21	m^2
Borrow Pit C		
Width	157.64	m
Length	157.64	m
Area	24850.37	m^2
Borrow Pit D		
Width	90.83	m
Length	90.83	m
Area	8250.09	m^2
Depth of peat to reinstate	1.492	m
Total Volume of Peat used to Reinstate Borrow	**160515.27**	m^3
(peat/topsoil originally excavated at borrow pits will be stored and also reinstated)		
Reinstatement to Foundations		
Diameter for foundation Excavation	50.00	m
Area	1962.50	m^2
Diameter for Tower and Access Track around Tow	20.00	m
Area	314.00	m^2
Area for Reinstatement	1648.50	m^2
Hardstanding area affected*	291.38	m^2
Area for Reinstatement	1357.13	m^2
Depth of Peat	1.380	m^3
Total Volume for all 47 turbines	**88023.13**	m^3
Total Volume of Material to Re-Used	**284338.27**	m^3
Difference	**0.00**	m^3

Turbine Number	Peat Depth (m)
1	0.25
2	0.73
3	0.59
4	0.38
5	0.48
6	2.96
7	1.54
8	0.75
9	0.6
10	0.73
11	1.4
12	2.47
13	2.77
14	0.94
15	1.13
16	0.41
17	0.48
18	0.72
19	2.24
20	0.79
21	3.29
22	1.09
23	1.52
24	1.37
25	0.95
26	2.08
27	1.66
28	1.38
29	1.61
30	2.24
31	0.9
32	1.06
33	1.83
34	3.41
35	2.45
36	2.95
37	1.5
38	0.31
39	0.51
40	0.32
41	0.74
42	2.09
43	0.6
44	2.81
45	0.85
46	2.41
47	0.76
47	**1.38**

Scottish Government Windfarm Carbon Assessment Tool - Version 2.7.0

27/10/2012

This spreadsheet calculates payback time for windfarm sited on peatlands using methods given in Nayak et al, 2008 (http://www.scotland.gov.uk/Publications/2008/06/25114657/0) and revised equations for GHG emissions (Nayak, D.R., Miller, D., Nolan, A., Smith, P. and Smith, J.U., 2010, Calculating carbon budgets of wind farms on Scottish peatland. Mires and Peat 4: Art. 9. Online: (http://www.mires-and-peat.net/map04/map_04_09.htm)

Version 2.0.0 - Adapted to include detail of forestry management, Smith et al., 2011.

http://www.scotland.gov.uk/WindFarmsAndCarbon

Version 2.7.0 - Includes multiple regions for forestry and construction (access to calculation worksheets protected for planning purposes)

Version 2.7.1 - Equivalent to version 2.7.0 but with worksheets unprotected for your own use. Do not use this version in planning applications.

INSTRUCTIONS

A There are 6 worksheets giving instructions, data entry and outputs, ...

- Instructions
- Do I need to use this tool? ....Click here to find out Click here
- Core input data .... Data needed in all calculations
- Forestry input data .... Extra details sometimes needed for forestry calculations
- Construction input data .... Extra details sometimes needed for construction calculations
- Payback time and CO2 emissions

...and 8 numbered worksheets showing calculations:

1. Windfarm CO_2 emission saving
2. CO_2 loss due to turbine life
3. CO_2 loss due to backup
4. Loss of CO_2 Fixing Pot.
5. Loss of soil CO_2
   - 5a. Volume of peat removed
   - 5b. CO_2 loss from removed peat
   - 5c. Volume of peat drained
   - 5d. CO_2 loss from drained peat
   - 5e. Emission rates
6. CO_2 loss by DOC & POC loss

7i. Forestry CO_2 loss - simple

7ii. Forestry CO_2 loss - detailed

- 7a. C sequest. in trees (3PG)
- 7b. C seq. in soil under trees
- 7c. Average stand data
- 7d. Windspeed ratios

8. CO_2 gain - site improvement

In addition, there are spreadsheets containing references and requesting feedback.

- References
- Frequently asked questions

B Enter information into the pink-shaded cells in the worksheet "Core input data" Click here

C View payback time shown in the yellow-shaded cells in the worksheet "Payback time and CO2 emissions" Click here

D Intermediate stages in the calculations are shown in numbered worksheets 1 to 8

E Notes on calculations are given in pale green text boxes.... Click here to see example of Notes Box

Assumptions are given in pale blue text boxes.... Click here to see example of Assumptions Box

Protocols for measurements are given in pale yellow comment boxes..... Click here to see example of Protocol Box

Contributors:

[1]D.Nayak, [1]J.U. Smith , [1]P. Smith, [1]P.Graves

[1] University of Aberdeen

[2]D. Miller, [2]A. Nolan, [2]J. Morrice

[2] The James Hutton Institute

[3]M. Perks , [3]B. Gardiner

[3] Forestry Commission

[4]G. Xenakis

[4] The University of Edinburgh

[5]S. Waldron, S. Drew

[5] University of Glasgow

Note on official version number

Version X.Y.Z

X refers to the release number
Y refers to released updates on release X
Z refers to unreleased updates on release X.Y

Officially released versions will always have Z=0

If you make changes of your own, please do not refer to your modified spreadsheet using the official version number.

The latest version is published at www.scotland.gov.uk/WindFarmsAndCarbon
Please check you are using the latest official version with Z=0 before submitting a planning application.

Do I need to use this tool?

1. Will the site be drained on construction of the windfarm? Yes

2. Is the soil at the site highly organic? Yes
i.e. is the soil organo-mineral or organic, (i.e. a peaty gley or peat)?

3. Does windfarm construction require a significant amount of deforestation? Yes
i.e. is removal in excess of keyholing the turbines within the forest boundary?

You should use this tool because the soil is highly organic.
Please move to the Core input data sheet and complete the form to obtain an estimate of C payback time

Click here to return to Instructions sheet Click here
Click here to move on to Core input data sheet Click here

Core input data

ENTER INPUT DATA HERE! VALUES SHOULD ONLY BE CHANGED ON THIS SHEET. **DO NOT USE EXAMPLE VALUES AS DEFAULTS!** ENTER YOUR OWN VALUES THAT ARE SPECIFIC TO YOUR PARTICULAR SITE.

Note: The input parameters include some variables that can be specified by default values, but others that must be site specific. Variables that can be taken from defaults are marked with purple tags on left hand side.

Click here to move to Payback Time Click here

Click here to return to Instructions Click here

Input data	Expected values: Enter expected value here	Record source of data	Possible range of values: Enter minimum value here	Record source of data	Enter maximum value here	Record source of data
Windfarm characteristics						
Dimensions						
No. of turbines	47	Fixed	47	DECC, Energy Trends 2012	47	
Lifetime of windfarm (years)	25		25		25	
Performance						
Power rating of turbines (turbine capacity) (MW)	3.4		3.4		3.4	
Capacity factor	Direct input of capacity factor		Direct input of capacity factor		Direct input of capacity factor	
Enter estimated capacity factor (percentage efficiency)	28.1	DECC, Energy Trends 2012	27		34	
Backup						
Extra capacity required for backup (%)	5.5	See data source sheet	5.5	See column D	5.5	
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	Dale et al 2004	10	See column D	10	
Carbon dioxide emissions from turbine life - (eg. manufacture, construction, decommissioning)	Calculate wrt installed capacity		Calculate wrt installed capacity		Calculate wrt installed capacity	
Characteristics of peatland before windfarm development						
Type of peatland	Acid bog	See data source sheet	Acid bog	See Column D	Acid bog	
Average annual air temperature at site (^{0}C)	6.75		6		7.5	
C Content of dry peat (% by weight)	46		45		65	
Average extent of drainage around drainage features at site (m)	10.00		5.00		25.00	
Average water table depth at site (m)	0.40		0.00		1.00	
Dry soil bulk density (g cm^{-3})	0.20		0.10		0.20	
Characteristics of bog plants						
Time required for regeneration of bog plants after restoration (years)	6	See data source sheet	4	See column D	8	
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25		0.12		0.31	
Forestry Plantation Characteristics						
Method used to calculate CO_2 loss from forest felling	Enter simple data	ES Addendum Chapter 4	Enter simple data		Enter simple data	
Area of forestry plantation to be felled (ha)	0		0	See column D	0	
Average rate of carbon sequestration in timber (tC ha-1 yr-1)	0.36	SNH Guidance 2003	0.36	See column D	0.36	

Note: Capacity factor. The capacity factor of any power plant is the proportion of energy produced during a given period with respect to the energy that would have been produced had the wind farm been running continually and at maximum output (DECC (2004); see also www.bwea.com/ref/capacityfactors.html).
Capacity Factor = Electricity generated during the period [kWh]/ (Installed capacity [kW] x number of hours in the period [h])
The average capacity factor between 1998 and 2004 for Scotland was 30% (DTI, 2006, Energy Trends, March 2006). We recommend that a site-specific capacity factor site should be used (as measured during planning stage). The average capacity factor for the United Kingdom, in 2009, was 27%, and 28% for Scotland (Energy Trends, September 2010)

Note: Extra capacity required for backup. If 20% of national electricity is generated by wind energy, the extra capacity required for backup is 5% of the rated capacity of the wind plant (Dale et al 2004, Energy Policy, 32, 1949-56). We suggest this should be 5% of the actual output. If it is assumed that less than 20% of national electricity is generated by wind energy, a lower percentage should be entered (0%).
The House of Lords Economic Affairs Committee report on The Economics of Renewable Energy (2008) (www.parliament.the-stationery-office.co.uk/pa/ld200708/ldselect/ldeconaf/195/19607.htm#n36) notes that to cover peak demand a '20% margin of extra capacity has been sufficient to keep the risk of a power cut due to insufficient generation at a very low level.' The estimate provided by BERR was a range of 10% to 20% of installed capacity of wind energy. E.ON is reported as proposing that the capacity credit of wind power should be 8%, and The Renewable Energy Foundation proposed the use of the square root of the wind capacity (in GW) as conventional capacity (e.g. 36 GW of wind plant to match 6 GW of conventional plant).

Note: Extra emissions due to reduced thermal efficiency of the reserve power generation ≈ 10% (Dale et al 2004).

Note: Emissions from turbine life If total emissions for the windfarm are unknown, emissions will be calculated according to turbine capacity. The normal range of CO_2 emissions is 394 to 8147 t CO_2 MW (White & Kulcinski, 2000; White, 2007).

Note: Type of peatland An 'acid bog' is fed primarily by rainwater and often inhabited by sphagnum moss, thus making it acidic. See Stoneman & Brooks (1997).
A 'fen' is a type of wetland fed by surface and/or groundwater. See McBride et al. (2011).

Note: Time required for regeneration of previous habitat. Loss of fixation should be assumed to be over lifetime of windfarm only. This time could be longer if plants do not regenerate. The requirements for after-use planning include the provision of suitable refugia for peat-forming vegetation, the removal of structures, or an assessment of the impact of leaving them in situ. Methods used to reinstate the site will affect to likely time for regeneration of the previous habitat. This time could also be shorter if plants regenerate during lifetime of windfarm. If so, enter number of years estimated for regeneration.

Note: Carbon fixation by bog plants
Apparent C accumulation rate in peatland is 0.12 to 0.31 tC ha^{-1} yr^{-1} (Turunen et al., 2001; Botch et al., 1995). The SNH guidance uses a value of 0.25 tC ha^{-1} yr^{-1}.
^{1} yr^{-1}.

Note: Area of forestry plantation to be felled. If the forestry was planned to be removed, with no further rotations planted, before the windfarm development, the area to be felled should be

Counterfactual emission factors						
To update counterfactual emission factors from the web Click here (not yet operational)						
Coal-fired plant emission factor (t CO_2 MWh^{-1})	0.912	DUKES (2012) p124	0.912	See column D	0.912	
Grid-mix emission factor (t CO_2 MWh^{-1})	0.443	DUKES (2012) p124	0.443	See column D	0.443	
Fossil fuel-mix emission factor (t CO_2 MWh^{-1})	0.609	DUKES (2012) p124	0.609	See column D	0.609	
Borrow pits						
Number of borrow pits	4	ES Addendum Chapter 4	4	See column D	4	
Average length of pits (m)	153.97	See data source sheet	90.8	See column D	242.88	
Average width of pits (m)	153.97	See data source sheet	90.8	See column D	242.88	
Average depth of peat removed from pit (m)	0.63	See data source sheet	0.50	See column D	1.06	
Foundations and hard-standing area associated with each turbine						
Method used to calculate CO_2 loss from foundations and hard-standing	Rectangular with vertical walls		Rectangular with vertical walls		Rectangular with vertical walls	
Average length of turbine foundations (m)	17.75	See data source sheet	17.75	See column D	17.75	
Average width of turbine foundations (m)	17.75	See data source sheet	17.75	See column D	17.75	
Average depth of peat removed from turbine foundations (m)	1.38		0.25		3.41	
Average length of hard-standing (m)	14.8		12.03		18.5	
Average width of hard-standing (m)	36		29.25		45	
Average depth of peat removed from hard-standing (m)	1.38		1.38		1.38	
Access tracks						
Total length of access track (m)	36502	ES Addendum Chapter 4	36502	See column D	37845	
Existing track length (m)	13179	ES Addendum Chapter 4	13179	See column D	14122	
Length of access track that is floating road (m)	10786	ES Addendum Chapter 4	10786	See column D	11186	
Floating road width (m)	6.65		5		8	
Floating road depth (m)	0.80	See data source sheet	0.80		0.80	
Length of floating road that is drained (m)	5393	See data source sheet	5393		5393	
Average depth of drains associated with floating roads (m)	0.50		0.50		0.50	
Length of access track that is excavated road (m)	25716	ES Addendum Chapter 4	25716		25716	
Excavated road width (m)	5		4.5		8	
Average depth of peat excavated for road (m)	0.65		0.00		1.50	
Length of access track that is rock filled road (m)	0		0		0	
Rock filled road width (m)	0		0		0	
Rock filled road depth (m)	0		0		0	
Length of rock filled road that is drained (m)	0		0		0	
Average depth of drains associated with rock filled roads (m)	0.00		0.00		0.00	
Cable Trenches						
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (eg. sand) (m)	4250	ES Addendum Figure A4.1	4250		4250	
Average depth of peat cut for cable trenches (m)	0.30	PMP plan	0.30		0.30	
Additional peat excavated (not already accounted for above)						

entered as zero.

Note: Plantation carbon sequestration. This is dependent on the yield class of the forestry. The SNH technical guidance assumed yield class of 16 m3 ha^{-1} yr^{-1}, compared to the value of 14 m3 ha^{-1} yr^{-1} provided by the Forestry Commission. Carbon sequestered for yield class 16 m^3 ha^{-1} y^{-1} = 3.6 tC ha^{-1} yr^{-1} (Cannell, 1999).

Note: Coal-Fired Plant and Grid Mix Emission Factors. Coal-fired plant EF = 0.86 t CO_2 MWh^{-1}. Grid-Mix EF = 0.43 t CO_2 MWh^{-1} Source = Defra, 2002.

Note: Fossil Fuel-Mix Emission Factor. The 5 year average emission factor calculated using estimated CO_2 emissions for 2002 and 2003 from the National Atmospheric Emission Inventory (Baggott et al., 2007), and for 2004 to 2006 (Digest of UK Energy Statistics, 2007) is 0.607 tCO_2 MWh^{-1}.

Note: Total length of access track. If areas of access track overlap with hardstanding area, exclude these from the total length of access track to avoid double counting of land area lost.

Note: Floating road depth. Accounts for sinking of floating road. Should be entered as the average depth of the road expected over the lifetime of the windfarm. If no sinking is expected, enter as zero

Note: Length of floating roat that is drained. Refers to any drains running along the length of the road

Note: Rock filled roads. Rock filled roads are assumed to be roads where no peat has been removed and rock has been placed on the surface and allowed to settle.

Note: Depth of peat cut for cable trenches. In shallow peats, the cable trenches may be cut below the peat. To avoid overestimating the depth of peat affected by the cable trenches, only enter the depth of the peat that is cut.

Volume of additional peat excavated (m^3)	27,068.90	See data source sheet	73809	See Column D	27068.9
Area of additional peat excavated (m^2)	49206.0		49206.0		49206
Peat Landslide Hazard					
Weblink: Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	0	See data source sheet	0	See Column D	0
Improvement of C sequestration at site by blocking drains, restoration of habitat etc					
Improvement of degraded bog		See data source sheet			
Area of degraded bog to be improved (ha)	100		50		200
Water table depth in degraded bog before improvement (m)	0.40		0.10		1.00
Water table depth in degraded bog after improvement (m)	0.20		0.00		0.30
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	6		4.00		8.00
Improvement of felled plantation land	0		0		0
Area of felled plantation to be improved (ha)	1133		1133		1465.2
Water table depth in felled area before improvement (m)	0.10		0.40		1.00
Water table depth in felled area after improvement (m)	0.20		0.00		0.30
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	6		4		8
Restoration of peat removed from borrow pits		See data source sheet			
Area of borrow pits to be restored (ha)	10.76		10.76		10.76
Water table depth in borrow pit before restoration (m)	0.10		0.40		1.00
Water table depth in borrow pit after restoration (m)	0.20		0.00		0.30
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	6.0	See data source sheet	4.0		8.0
Removal of drainage from foundations and hardstanding					
Water table depth around foundations and hardstanding before restoration (m)	0.10	See data source sheet	0.40		1.00
Water table depth around foundations and hardstanding after restoration (m)	0.20		0.00		0.30
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	1.5		1		3
Restoration of site after decomissioning					
Will the hydrology of the site be restored on decommissioning?	Yes		Yes		Yes
Will you attempt to block any gullies that have formed due to the windfarm?	Yes		Yes		Yes
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes		Yes		Yes
Will the habitat of the site be restored on decommissioning?	No		No		No
Will you control grazing on degraded areas?	No		No		No
Will you manage areas to favour reintroduction of species	Yes		Yes		Yes

Note: Peat Landslide Hazard. It is assumed that measures have been taken to limit damage (Scottish Executive, 2006, Peat Landslide Hazard and Risk Assessments. Best Practice Guide for Proposed Electricity Generation Developments. Scottish Executive, Edinburgh. pp. 34-35) so that C losses due to peat landslide can be assumed to be negligible. Link: http://www.scotland.gov.uk/Publications/2006/12/21162303/1.

Note: Restoration of site. If the water table at the site is returned to its original level or higher on decommissioning, and habitat at the site is restored, it is assumed that C losses continue only over the lifetime of the windfarm. Otherwise, C losses from drained peat are assumed to be 100%.

Choice of methodology for calculating emission factors	Site specific (required for planning applications)

Note: Choice of methodology for calculating emission factors. The IPCC default methodology is the internationally accepted standard (IPCC, 1997). However, it is stated in IPCC (1997) that these are rough estimates, and "these rates and production periods can be used if countries do not have more appropriate estimates". Therefore, we have developed more site specific estimates for use here based on work from the Scottish Government funded ECOSSE project (Smith et al. 2007: ECOSSE: Estimating Carbon in Organic Soils - Sequestration and Emissions. Final Report. SEERAD Report. ISBN 978 0 7559 1498 2. 166pp.).

Core input data

ENTER INPUT DATA HERE! VALUES SHOULD ONLY BE CHANGED ON THIS SHEET. **DO NOT USE EXAMPLE VALUES AS DEFAULTS!** ENTER YOUR OWN VALUES THAT ARE SPECIFIC TO YOUR PARTICULAR SITE.

Note: The input parameters include some variables that can be specified by default values, but others that must be site specific. Variables that can be taken from defaults are marked with purple tags on left hand side.

Click here to move to Payback Time Click here

Click here to return to Instructions Click here

Forestry input data

ENTER DETAILS OF FORESTRY MANAGEMENT HERE!

Note: Data only needed if select to calculate capacity factor from forestry data (cell C15 in Core input data sheet), or to include detailed forestry management (cell C35 in Core input data

(1) for estimating compensatory planting woodland carbon http://tinyurl.com/woodlandcarboncode

(2) for UK policy http://tinyurl.com/FCPolicy

(3) FC Scotland Control of Woodland Removal (including Compensatory Planting) http://tinyurl.com/FCScotlandCompPlant

No POC losses for bare soil included yet. If extensive areas of base soil is present at site need modified calculation.

Click here to move to Payback Time Click here

Click here to return to Instructions Click here

Input data	Expected values: Enter expected value here	Record source of data	Possible range of values: Enter minimum value here	Record source of data	Enter maximum value here	Record source of data
Windfarm characteristics						
Location						
Distance to nearest biofuel plant (km)						
Dimensions						
Total wind farm area (ha)						
Performance						
Height of turbines (m)						
Average site windspeed (m s^{-1})						
Estimated downtime for maintenance etc (%)						
Emissions due to forestry operations						
Emissions from felling (g CO_2 m^{-3})						
Emissions of CO_2 associated with transportation (g CO_2 km^{-1})						
Forestry Plantation Characteristics						
Note - total number of turbines already specified:						
AREA 1						
Number of turbines in this area						
Power curve - NOT USED! (In CORE INPUT DATA sheet you have selected to input capacity factor directly. No need to select!)	Vestas 2.0 MW Optispeed C2		Vestas 2.0 MW Optispeed C2		Vestas 2.0 MW Optispeed C2	
Major soil sub-group	Peaty gley		Peaty gley		Peaty gley	
Species	Sitka spruce		Sitka spruce		Sitka spruce	
Felled Forest Biomass used as biofuel?	No		No		No	
Felling regime						
Age of forestry when felled for windfarm (yr)						
Area felled around each turbine (ha)						
Width of forest around felled area (m)						
Value of felled forestry as a biomass fuel (MWh t^{-1})						
(Carbon : Biomass) ratio of felled forestry						
Replanting regime						
Years after felling when replanting occurs						
Age of seedlings on planting (yr)						
Area replanted around each turbine (ha)						
AREA 2						
Number of turbines in this area						
Power curve - NOT USED! (In CORE INPUT DATA sheet you have selected to input capacity factor directly. No need to select!)	Vestas 2.0 MW Optispeed C2		Vestas 2.0 MW Optispeed C2		Vestas 2.0 MW Optispeed C2	
Major soil sub-group	Peaty gley		Peaty gley		Peaty gley	
Species	Scots pine		Scots pine		Scots pine	
Felled Forest Biomass used as biofuel?	Yes		Yes		Yes	
Felling regime						
Age of forestry when felled for windfarm (yr)						
Area felled around each turbine (ha)						
Width of forest around felled area (m)						
Value of felled forestry as a biomass fuel (MWh t^{-1})						
(Carbon : Biomass) ratio of felled forestry						
Replanting regime						
Years after felling when replanting occurs						
Age of seedlings on planting (yr)						
Area replanted around each turbine (ha)						

Note: Estimated downtime. Estimated downtime for maintenance etc. Few reports on downtime of wind turbines are publically available. However, one review by Garrad Hassan (2011) suggests that the minimum downtime reported was 2% for the annual moving average for between 8 to 9 years of operation of new turbines, for a sample of 240 turbines. For a summary of findings see Garrad Hassan (2011).

Note: Emissions from felling and timber removal.
Based on emissions factors from UK taken from Morison et al (2011), if clearfelling assumed to be performed by harvester and timber is assumed extracted with forwarder, the emissions are 6657 g CO_2 m^{-3}

Note: Emissions associated with transportation.
Assuming trasportation by trucks running on diesel and 20% of journey taken on forest roads, emissions factor obtained from Morison et al (2011) is 3933000 g CO_2 km^{-1} (range 3850000 – 4015000 g CO_2 km^{-1} - average = 3933000 g CO_2 km^{-1})

Note: Power curve
Based on Vestas 2.0MW Optispeed turbine with roughness class C2, modelled over wind speed of 5-10 m s^{-1}. To define a the power curve for a different turbine type, plot annual power output , *P* (MWh) against annual windspeed, W (m s^{-1}) and fit a linear regression to obtain slope, *a*, and intercept, *b*:

$$P = aW + b$$

Note: Soil sub-group
Used in determination of forestry characteristic.
Peaty gley = Peaty Soils (5-50cm) e.g. peaty gley, peaty podsol
Deep peat = Deep Peat (>50cm) e.g. basin and blanket bogs

Note: Species
So far only Scots pine and Sitka spruce included.

Note: Value of felled forestry Values available in Mason et al., 2009.

Note: Carbon : Biomass ratio of felled forestry Wood biomass can be converted to dry weight using wood density based values from Lavers (1983) with a subsequent assumption that C:dry matter ratio is 50% (Matthews 1993). For simplicity an integrated factor, the 'wood density to biomass factor' taken from Mason et al (2009) can be used.
Value = 0.5

AREA 3			
Number of turbines in this area			
Power curve - NOT USED! (In CORE INPUT DATA sheet you have selected to input capacity factor directly. No need to select!)	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2
Major soil sub-group	Peaty gley	Peaty gley	Peaty gley
Species	Scots pine	Scots pine	Scots pine
Felled Forest Biomass used as biofuel?	Yes	Yes	Yes
Felling regime			
Age of forestry when felled for windfarm (yr)			
Area felled around each turbine (ha)			
Width of forest around felled area (m)			
Value of felled forestry as a biomass fuel (MWh t^{-1})			
(Carbon : Biomass) ratio of felled forestry			
Replanting regime			
Years after felling when replanting occurs			
Age of seedlings on planting (yr)			
Area replanted around each turbine (ha)			
AREA 4			
Number of turbines in this area			
Power curve - NOT USED! (In CORE INPUT DATA sheet you have selected to input capacity factor directly. No need to select!)	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2
Major soil sub-group	Peaty gley	Peaty gley	Peaty gley
Species	Scots pine	Scots pine	Scots pine
Felled Forest Biomass used as biofuel?	Yes	Yes	Yes
Felling regime			
Age of forestry when felled for windfarm (yr)			
Area felled around each turbine (ha)			
Width of forest around felled area (m)			
Value of felled forestry as a biomass fuel (MWh t^{-1})			
(Carbon : Biomass) ratio of felled forestry			
Replanting regime			
Years after felling when replanting occurs			
Age of seedlings on planting (yr)			
Area replanted around each turbine (ha)			
AREA 5			
Number of turbines in this area			
Power curve - NOT USED! (In CORE INPUT DATA sheet you have selected to input capacity factor directly. No need to select!)	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2
Major soil sub-group	Peaty gley	Peaty gley	Peaty gley
Species	Scots pine	Scots pine	Scots pine
Felled Forest Biomass used as biofuel?	Yes	Yes	Yes
Felling regime			
Age of forestry when felled for windfarm (yr)			
Area felled around each turbine (ha)			
Width of forest around felled area (m)			
Value of felled forestry as a biomass fuel (MWh t^{-1})			
(Carbon : Biomass) ratio of felled forestry			
Replanting regime			
Years after felling when replanting occurs			
Age of seedlings on planting (yr)			
Area replanted around each turbine (ha)			

Forestry input data

ENTER DETAILS OF FORESTRY MANAGEMENT HERE!

Note: Data only needed if select to calculate capacity factor from forestry data (cell C15 in Core input data sheet), or to include detailed forestry management (cell C35 in Core input data sheet)

Click here to move to Payback Time Click here

Click here to return to Instructions Click here

Construction input data

ENTER DETAILS OFCONSTRUCTION HERE!

Note: This data only used in the calculation if the selection '**Enter detailed information**' is made in cell C50 of the Core input data sheet.

Click here to move to Payback Time — Click here

Click here to return to Core input data — Click here

Input data	Expected values: Enter expected value here	Record source of data	Possible range of values: Enter minimum value here	Record source of data	Enter maximum value here	Record source of data
Construction design						
Note - total number of turbines already specified:	**47**		**47**		**47**	
AREA 1						
Number of turbines in this area	47		47		47	
Turbine foundations						
Depth of hole dug when constructing foundations (m)						
Approximate geometric shape of whole dug when constructing foundations	Rectangular		Rectangular		Rectangular	
Length at surface (m)						
Width at surface (m)						
Length at bottom (m)						
Width at bottom (m)						
Hardstanding						
Depth of hole dug when constructing hardstanding (m)						
Approximate geometric shape of whole dug when constructing hardstanding	Rectangular		Rectangular		Rectangular	
Length at surface (m)						
Width at surface (m)						
Length at bottom (m)						
Width at bottom (m)						
Piling						
Is piling used?	Yes		Yes		Yes	
Volume of Concrete						
Volume of concrete used (m^3)	18,800		18,800		18,800	
AREA 2						
Number of turbines in this area						
Turbine foundations						
Depth of hole dug when constructing foundations (m)						
Approximate geometric shape of whole dug when constructing foundations	Rectangular		Rectangular		Rectangular	
Length at surface (m)						
Width at surface (m)						
Length at bottom (m)						
Width at bottom (m)						
Hardstanding						
Depth of hole dug when constructing hardstanding (m)						
Approximate geometric shape of whole dug when constructing hardstanding	Rectangular		Rectangular		Rectangular	
Length at surface (m)						
Width at surface (m)						
Length at bottom (m)						
Width at bottom (m)						
Piling						
Is piling used?	Yes		Yes		Yes	
Volume of Concrete						
Volume of concrete used (m^3)						

AREA 3

Number of turbines in this area			
Turbine foundations			
Depth of hole dug when constructing foundations (m)			
Approximate geometric shape of whole dug when constructing foundations	Rectangular	Rectangular	Rectangular
Length at surface (m)			
Width at surface (m)			
Length at bottom (m)			
Width at bottom (m)			
Hardstanding			
Depth of hole dug when constructing hardstanding (m)			
Approximate geometric shape of whole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular
Length at surface (m)			
Width at surface (m)			
Length at bottom (m)			
Width at bottom (m)			
Piling			
Is piling used?	Yes	Yes	Yes
Volume of Concrete			
Volume of concrete used (m^3)			

AREA 4

Number of turbines in this area			
Turbine foundations			
Depth of hole dug when constructing foundations (m)			
Approximate geometric shape of whole dug when constructing foundations	Rectangular	Rectangular	Rectangular
Length at surface (m)			
Width at surface (m)			
Length at bottom (m)			
Width at bottom (m)			
Hardstanding			
Depth of hole dug when constructing hardstanding (m)			
Approximate geometric shape of whole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular
Length at surface (m)			
Width at surface (m)			
Length at bottom (m)			
Width at bottom (m)			
Piling			
Is piling used?	Yes	Yes	Yes
Volume of Concrete			
Volume of concrete used (m^3)			

AREA 5

Number of turbines in this area			
Turbine foundations			
Depth of hole dug when constructing foundations (m)			
Approximate geometric shape of whole dug when constructing foundations	Rectangular	Rectangular	Rectangular
Length at surface (m)			
Width at surface (m)			
Length at bottom (m)			
Width at bottom (m)			
Hardstanding			
Depth of hole dug when constructing hardstanding (m)			
Approximate geometric shape of whole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular
Length at surface (m)			
Width at surface (m)			
Length at bottom (m)			
Width at bottom (m)			
Piling			
Is piling used?	Yes	Yes	Yes
Volume of Concrete			
Volume of concrete used (m^3)			

Results

PAYBACK TIME AND CO_2 EMISSIONS

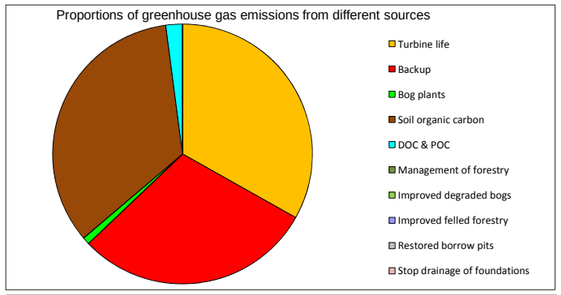
Note: The carbon payback time of the windfarm is calculated by comparing the loss of C from the site due to windfarm development with the carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

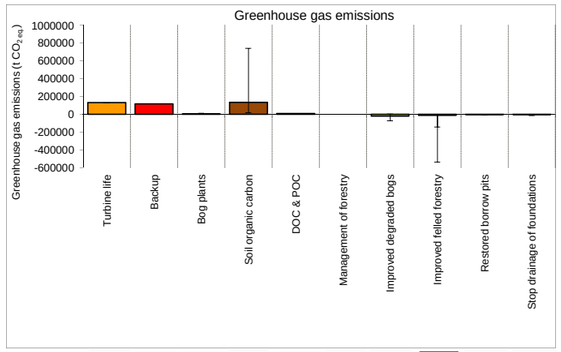
Click here to return to Input data Click here

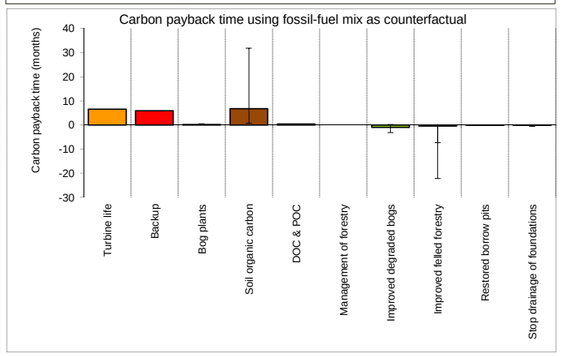
Click here to return to Instructions Click here

	Exp.	*Min.*	*Max.*
1. Windfarm CO_2 emission saving over…			
…coal-fired electricity generation ($tCO_2\ yr^{-1}$)	358742	344699	434065
…grid-mix of electricity generation ($tCO_2\ yr^{-1}$)	174257	167436	210845
…fossil fuel - mix of electricity generation ($tCO_2\ yr^{-1}$)	239555	230177	289853
Total CO_2 losses due to wind farm (t CO_2 eq.)			
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	130587	130587	130587
3. Losses due to backup	117220	117220	117220
4. Losses due to reduced carbon fixing potential	3562	909	10889
5. Losses from soil organic matter	134546	18258	740175
6. Losses due to DOC & POC leaching	8132	1472	298
7. Losses due to felling forestry	0	0	0
Total losses of carbon dioxide	394046	268445	999168
8. Total CO_2 gains due to improvement of site (t CO_2 eq.)			
8a. Gains due to improvement of degraded bogs	-20989	2701	-72962
8b. Gains due to improvement of felled forestry	-9878	-142722	-534522
8c. Gains due to restoration of peat from borrow pits	-94	-1355	-3925
8d. Gains due to removal of drainage from foundations & hardstanding	-108	-665	-14599
Total gains	-31069	-142041	-626009

RESULTS	*Exp.*	*Min.*	*Max.*
Net emissions of carbon dioxide (t $CO_{2\ eq.}$)	**362977**	**-357563**	**857127**
Carbon Payback Time			
…coal-fired electricity generation (years)	1.0	-0.8	2.5
…grid-mix of electricity generation (years)	2.1	-1.7	5.1
…fossil fuel - mix of electricity generation (years)	**1.5**	**-1.2**	**3.7**







Check Check Check Check Check Check Check Check Check Check

Data used in barchart of carbon payback time using fossil-fuel mix as counterfactual

Greenhouse gas emissions

	Exp.	*Min*	*Max*
Turbine life	130587	0	0
Backup	117220	0	0
Bog plants	3562	2653	7327
Soil organic carbon	134546	116288	605629
DOC & POC	8132	6659	0
Management of forestry	0	0	0
Improved degraded bogs	0	0	0
Improved felled forestry	0	132844	0
Restored borrow pits	0	1262	0
Stop drainage of foundations	0	557	0

Data used in barchart of carbon payback time using fossil-fuel mix as counterfactual

Greenhouse gas emissions				Carbon payback time (months)		
	Exp.	*Min.*	*Max.*	*Exp.*	*Min.*	*Max.*
Turbine life	130587	0	0	7	0	0
Backup	117220	0	0	6	0	0
Bog plants	3562	2653	7327	0	0	0
Soil organic carbon	134546	116288	605629	7	6	25
DOC & POC	8132	6659	-7834	0	0	0
Management of forestry	0	0	0	0	0	0
Improved degraded bogs	-20989	-23690	-51973	-1	-1	-2
Improved felled forestry	-9878	132844	-524644	0	7	-22
Restored borrow pits	-94	1262	-3832	0	0	0
Stop drainage of foundations	-108	557	-14491	0	0	-1
	362977			18		

Results

PAYBACK TIME AND CO_2 EMISSIONS

Note: The carbon payback time of the windfarm is calculated by comparing the loss of C from the site due to windfarm development with the carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

Click here to return to Input data Click here

Click here to return to Instructions Click here

Windfarm CO_2 emission saving

Note: The total emission savings are given by estimating the total possible electrical output of the windfarm multiplied by the emission factor for the counterfactual case (coal-fire generation and electricity from grid)

Click here to move to Payback Time Click here

Values taken from input sheet	Total			Forestry Area 1			Forestry Area 2			Forestry Area 3			Forestry Area 4			Forestry Area 5		
	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
Power Generation Characteristics																		
No. of turbines	47	47	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power rating of turbines (turbine capacity) (MW)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Power of windfarm (MW)	159.8	159.8	159.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Estimated downtime for maintenance etc (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Counterfactual emission factors																		
Coal-fired plant emission factor (t CO_2 MWh^{-1})	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912	0.912
Grid-mix emission factor (t CO_2 MWh^{-1})	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443
Fossil fuel-mix emission factor (t CO_2 MWh^{-1})	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609

Calculation of capacity factor	1	Direct input of capacity factor		
		Exp	Min	Max
Entered capacity factor (%)		28.1	27	34

Parameters	*Slope (a)*			*Intercept (b)*		
Partial power curves for different turbines	Exp	Min	Max	Exp	Min	Max
User-defined	0.0	0.0	0.0	0.0	0.0	0.0
Vestas 2.0 MW Optispeed C2	1392.5	1392.5	1392.5	-4291.9	-4291.9	-4291.9

Calculation of capacity factor from forestry management	Total			Forestry Area 1			Forestry Area 2			Forestry Area 3			Forestry Area 4			Forestry Area 5		
	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
Wind speed ratio calculated in 7d				########	########	########	########	########	########	########	########	########	########	########	########	########	########	########
Average site windspeed (m s^{-1})	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual theoretical energy output from turbine (MW $turbine^{-1}$ yr^{-1})	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784	29784
Power curve				Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2	Vestas 2.0 MW Optispeed C2
(Power curve code)				2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Slope (a)				1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5	1392.5
Intercept (b)				-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9	-4291.9
Annual power output from an individual turbine (MW $turbine^{-1}$ yr^{-1})				########	########	########	########	########	########	########	########	########	########	########	########	########	########	########
Calculated capacity factor (%)				########	########	########	########	########	########	########	########	########	########	########	########	########	########	########

Calculation of annual energy output from wind farm	Total			Forestry Area 1			Forestry Area 2			Forestry Area 3			Forestry Area 4			Forestry Area 5		
Direct input of capacity factor																		
Capacity factor(%)	28	27	34	28	27	34	28	27	34	28	27	34	28	27	34	28	27	34
Annual energy output from windfarm (MW yr^{-1})	**393357**	**377959**	**475948**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

RESULTS	Total			Area 1			Area 2			Area 3			Area 4			Area 5		
Windfarm CO_2 emission saving over…																		
…coal-fired electricity generation (tCO_2 yr^{-1})	**358742**	**344699**	**434065**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
…grid-mix of electricity generation (tCO_2 yr^{-1})	**174257**	**167436**	**210845**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
…fossil fuel - mix of electricity generation (tCO_2 yr^{-1})	**239555**	**230177**	**289853**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Click here to move to Payback Time Click here

Windfarm CO_2 emission saving

Note: The total emission savings are given by estimating the total possible electrical output of the windfarm multiplied by the emission factor for the counterfactual case (coal-fire generation and electricity from grid)

Emissions due to turbine life

Note: The carbon payback time of the windfarm due to turbine life (eg. manufacture, construction, decomissioning) is calculated by comparing the emissions due to turbine life with carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

Method used to estimate CO_2 emissions from turbine life (eg. manufacture, construction,	Calculate wrt installed capacity

	Exp	Min	Max
Direct input of emissions due to turbine life (t CO_2 windfarm^{-1})	**0**	**0**	**0**
Calculation of emissions due to turbine life from energy output			
CO_2 emissions due to turbine life (tCO_2 turbine^{-1})	2709	2709	2709
No. of turbines	47	47	47
Total manufacture CO_2 emission of the wind farm due to turbine life (t CO_2 windfarm^{-1})	127334	127334	127334

	Total			Construction Area 1			Construction Area 2			Construction Area 3			Construction Area 4			Construction Area 5		
	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
Calculation of emissions due to cement used in construction																		
Volume of cement used (m^3)	18800	18800	18800	18800	18800	18800	0	0	0	0	0	0	0	0	0	0	0	0
CO_2 emission rate (t CO_2 m^{-3} cement)	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173
Total CO_2 emissions due to cement used in construction	3252	3252	3252	3252	3252	3252	0	0	0	0	0	0	0	0	0	0	0	0

RESULTS			
Losses due to turbine life (eg.	130587	130587	130587
Additional CO_2 payback time of windfarm due to turbine life (eg. manufacture, contruction, decomissioning)			
…coal-fired electricity generation (months)	4	5	4
…grid-mix of electricity generation (months)	9	9	7
…fossil fuel - mix of electricity generation (months)	7	7	5

Click here to move to Payback Time Click here

Emissions due to turbine life

Note: The carbon payback time of the windfarm due to turbine life (eg. manufacture, construction, decomissioning) is calculated by comparing the emissions due to turbine life with carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

Version 1.1– 3 March 2008

Embodied carbon dioxide (ECO_2) and construction materials

CONCRETE	Concrete type	ECO_2 (kgCO_2/m^3)	ECO_2 (kgCO_2/tonne)
Blinding, mass fill, strip footings, mass foundations	GEN1 70 mm (CEM I only)	173	75
Trench foundations [1]	GEN1 120 mm * (CEM I only)	184	80
Reinforced Foundations [1]	RC30 70 mm *** (CEM I only)	318	132
Ground floors [1]	RC35 70 mm ** (CEM I only)	315	133
Structural: in situ floors, superstructure, walls, basements	RC40 70 mm *** (CEM I only)	372	153
High strength concrete [1]	RC50 70mm *** (CEM I only)	436	176
Dense concrete aggregate block [2]	Precast block	147	75
Aerated concrete block [2]	Precast block	121	240
Generic lightweight aggregate block [3]	Precast block	168	120
TIMBER		**ECO_2 (kgCO_2/m^3)**	**ECO_2 (kgCO_2/tonne)**
Timber, UK Sawn Hardwood [4]		369	470
Timber, UK Sawn Softwood [4]		185	440
Plywood [4]		398	750
STEEL		**ECO_2 (kgCO2/m^3)**	**ECO_2 (kgCO_2/tonne)**
UK Produced Structural Steel Sections [5]		15,313	1,932

* includes 25 kg/m^3 steel reinforcement

** includes 30 kg/m^3 steel reinforcement

*** includes 100 kg/m^3 steel reinforcement

References:

1. The ECO2 figures for GEN 1, RC32/40 and RC40/50 were derived using industry agreed representative figures for cementitious materials, aggregates, reinforcement, admixtures and an appropriate figure for water.
2. BRE Environmental Profiles database, Building Research Establishment (BRE), 2006
3. Communication from: the Environment Division, BREEAM Centre, Building Research Establishment (BRE), 2005
4. Hammond, G. & Jones, C., 2006, Inventory of Carbon & Energy (ICE) version 1.5 Beta, Department of Mechanical Engineering, University of Bath, UK.
5. Amato, A and Eaton, K J, A comparative environmental life cycle assessment of modern office buildings, Steel Construction Institute, 1998

Emissions due to backup power generation

Note: CO_2 loss due to back up is calculated from the extra capacity required for backup of the windfarm given in the input data.

	Expected	Minimum	Maximum
Reserve capacity required for backup			
No. of turbines	47	47	47
Power rating of turbines (turbine capacity) (MW)	3.4	3.4	3.4
Power of wind farm (MW h^{-1})	159.8	159.8	159.8
Rated capacity (MW yr^{-1})	1399848	1399848	1399848
Extra capacity required for backup (%)	5.5	5.5	5.5
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10
Reserve capacity (MWh yr^{-1})	7699	7699	7699

Carbon dioxide emissions due to backup power generation			
Coal-fired plant emission factor (t CO_2 MWh^{-1})	0.912	0.912	0.912
Grid-mix emission factor (t CO_2 MWh^{-1})	0.443	0.443	0.443
Fossil fuel- mix emission factor (t CO_2 MWh^{-1})	0.609	0.609	0.609
Lifetime of windfarm (years)	25	25	25
Annual emissions due to backup from…			
…coal-fired electricity generation (tCO_2 yr^{-1})	7022	7022	7022
…grid-mix of electricity generation (tCO_2 yr^{-1})	3411	3411	3411
…fossil fuel - mix of electricity generation (tCO_2 yr^{-1})	4689	4689	4689

RESULTS			
Total emissions due to backup from…			
…coal-fired electricity generation (tCO_2)	175541	175541	175541
…grid-mix of electricity generation (tCO_2)	85268	85268	85268
…fossil fuel - mix of electricity generation (tCO_2)	**117220**	**117220**	**117220**
Additional CO_2 payback time of windfarm due to backup			
…coal-fired electricity generation (months)	6	6	5
…grid-mix of electricity generation (months)	6	6	5
…fossil fuel - mix of electricity generation (months)	6	6	5

Assumption: Backup assumed to be by fossil-fuel-mix of electricity generation. Note that hydroelectricity may also be used for backup, so this assumption may make the value for backup generation too high. These assumptions should be revisited as

Click here to move to Payback Time Click here

Click here to return to Instructions Click here

Note: Wind generated electricity is inherently variable, providing unique challenges to the electricity generating industry for provision of a supply to meet consumer demand (Netz, 2004). Backup power is required to accompany wind generation to stabilise the supply to the consumer. This backup power will usually be obtained from a fossil fuel source. At a high level of wind power penetration in the overall generating mix, and with current grid management techniques, the capacity for fossil fuel backup may become strained because it is being used to balance the fluctuating consumer demand with a variable and highly unpredictable output from wind turbines (White, 2007). The Carbon Trust (Carbon Trust/DTI, 2004) concluded that increasing levels of intermittent generation do not present major technical issues at the percentages of renewables expected by 2010 and 2020, but the UK renewables target at the time of that report was only 20%. When national reliance on wind power is low (less than ~20%), the additional fossil fuel generated power requirement can be considered to be insignificant and may be obtained from within the spare generating capacity of other power sectors (Dale et al, 2004). However, as the national supply from wind power increases above 20%, without improvements in grid management techniques, emissions due to backup power generation may become more significant. The extra capacity needed for backup power generation is currently estimated to be 5% of the rated capacity of the wind plant if wind power contributes more than 20% to the national grid (Dale et al 2004). Moving towards the SG target of 50% electricity generation from renewable sources, more short-term capacity may be required in terms of pumped-storage hydro-generated power, or a better mix of offshore and onshore wind generating capacity. Grid management techniques are anticipated to reduce this extra capacity, with improved demand side management, smart meters, grid reinforcement and other developments. However, given current grid management techniques, it is suggested that 5% extra capacity should be assumed for backup power generation if wind power contributes more than 20% to the national grid. At lower contributions, the extra capacity required for backup should be assumed to be zero. These assumptions should be revisited as technology improves.

Emissions due to backup power generation

Note: CO_2 loss due to back up is calculated from the extra capacity required for backup of the windfarm given in the input data.

Emissions due to loss of bog plants

Note: Annual C fixation by the site is calculated by multiplying area of the windfarm by the annual C accumulation due to bog plant fixation

	Expected	Minimum	Maximum
Area where carbon accumulation by bog plants is lost			
Total area of land lost due to windfarm construction (m^2)	384189	283183	634320
Total area affected by drainage due to windfarm construction (m^{-2})	869201	429006	2268396
Total area where fixation by plants is lost (m^2)	1253390	712188	2902716
Total loss of carbon accumulation			
Carbon accumulation in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31
Lifetime of windfarm (years)	25	25	25
Time required for regeneration of bog plants after restoration (years)	6	4	8
Carbon accumulation up to time of restoration (tCO_2 eq. ha^{-1})	28	13	38
RESULTS			
Total loss of carbon accumulation by bog plants			
Total area where fixation by plants is lost (ha)	125	71	290
Carbon accumulation over lifetime of windfarm (tCO_2 eq. ha^{-1})	28	13	38
Total loss of carbon fixation by plants at the site (t CO_2)	**3562**	**909**	**10889**
Additional CO_2 payback time of windfarm due to loss of CO2 fixing potential			
…coal-fired electricity generation (months)	0	0	0
…grid-mix of electricity generation (months)	0	0	1
…fossil fuel - mix of electricity generation (months)	0	0	0

Assumptions:
1. Bog plants are 100% lost from the area where peat is removed for construction.
2. Bog plants are 100% lost from the area where peat is drained.
3. The recovery of carbon accumulation by plants on restoration of land is as given in inputs.

Click here to move to Payback Time Click here

Emissions due to loss of bog plants

Note: Annual C fixation by the site is calculated by multiplying area of the windfarm by the annual C accumulation due to bog plant fixation

Emissions due to loss of soil organic carbon

Note: Loss of C stored in peatland is estimated from % site lost by peat removal (sheet 5a), CO_2 loss from removed peat (sheet 5b), % site affected by drainage (sheet 5c), and the CO2 loss from drained peat (sheet 5d).

	Expected	Minimum	Maximum
CO_2 loss due to windfarm construction			
Check CO_2 loss from removed peat (t CO_2 equiv)	86392	20671	338681
Check CO_2 loss from drained peat (t CO_2 equiv)	48154	-2413	401494
RESULTS			
Total CO_2 loss from peat (removed + drained) (t CO_2 equiv)	**134546**	**18258**	**740175**
Additional CO_2 payback time of windfarm due to loss of soil CO2			
…coal-fired electricity generation (months)	5	1	20
…grid-mix of electricity generation (months)	9	1	42
…fossil fuel - mix of electricity generation (months)	7	1	31

Click here to move to Payback Time Click here

Emissions due to loss of soil organic carbon

Note: Loss of C stored in peatland is estimated from % site lost by peat removal (sheet 5a), CO_2 loss from removed peat (sheet 5b), % site affected by drainage (sheet 5c), and the CO2 loss from drained peat (sheet 5d).

Volume of Peat Removed

Note: % site lost by peat removal is estimated from peat removed in borrow pits, turbine foundations, hard-standing and access tracks.

If peat is removed for any other reason, this must be added in as additional peat excavated in the core input sheet.

Peat removed from borrow pits	Total		
	Exp	Min	Max
Number of borrow pits	4	4	4
Average length of pits (m)	153.97	90.8	242.88
Average width of pits (m)	153.97	90.8	242.88
Average depth of peat removed from pit (m)	0.625	0.5	1.06
Area of land lost in borrow pits (m^2)	94827	32978.6	235963
Volume of peat removed from borrow pits (m^3)	59266.9	16489.3	250121

Peat removed from turbine foundations	Total			Construction Area 1			Construction Area 2			Construction Area 3			Construction Area 4			Construction Area 5		
	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
Method used to calculate CO_2 loss from foundations	Rectangular with vertical walls																	
Calculation method code		1																
No. of turbines	47	47	47	47	47	47	0	0	0	0	0	0	0	0	0	0	0	0
Length at surface (m)				18	18	18	0	0	0	0	0	0	0	0	0	0	0	0
Width at surface (m)				18	18	18	0	0	0	0	0	0	0	0	0	0	0	0
Length at bottom (m)				18	18	18	0	0	0	0	0	0	0	0	0	0	0	0
Width at bottom (m)				18	18	18	0	0	0	0	0	0	0	0	0	0	0	0
Depth of foundations (m)				1	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Area of land lost in hard-standing (m^2)	14808	14807.94	14807.94	14808	14808	14808	0	0	0	0	0	0	0	0	0	0	0	0
Volume of peat removed from foundation area (m^3)	20434.95	3701.984	50495.07	20434.95	3701.984	50495.07	0	0	0	0	0	0	0	0	0	0	0	0

Peat removed from hard-standing																		
Method used to calculate CO_2 loss from foundations	Rectangular with vertical walls																	
Calculation method code		1																
No. of turbines	47	47	47	47	47	47	0	0	0	0	0	0	0	0	0	0	0	0
Length at surface (m)				15	12.03	18.5	0	0	0	0	0	0	0	0	0	0	0	0
Width at surface (m)				36	29.25	45	0	0	0	0	0	0	0	0	0	0	0	0
Length at bottom (m)				15	12.03	18.5	0	0	0	0	0	0	0	0	0	0	0	0
Width at bottom (m)				36	29.25	45	0	0	0	0	0	0	0	0	0	0	0	0
Depth of hardstanding (m)				1	1.38	1.38	0	0	0	0	0	0	0	0	0	0	0	0
Area of land lost in hard-standing (m^2)	25042	16538	39128	25042	16538.2	39127.5	0	0	0	0	0	0	0	0	0	0	0	0
Volume of peat removed from hardstandingarea (m^3)	34557.4	22822.8	53996	34557.4	22822.8	53996	0	0	0	0	0	0	0	0	0	0	0	0

Peat removed from access tracks	Total		
	Exp	Min	Max
Floating roads			
Length of access track that is floating road (m)	10786	10786	11186
Floating road width (m)	6.65	5	8
Floating road depth (m)	0.8	0.8	0.8
Area of land lost in floating roads (m^2)	71726.9	53930	89488
Volume of peat removed for floating roads	57381.5	43144	71590.4
Excavated roads			
Length of access track that is excavated road (m)	25716	25716	25716
Excavated road width (m)	5	4.5	8
Average depth of peat excavated for road (m)	0.65	0	1.5
Area of land lost in excavated roads (m^2)	128580	115722	205728
Volume of peat removed for excavated roads	83577	0	308592
Rock-filled roads			
Length of access track that is rock filled road (m)	0	0	0
Rock filled road width (m)	0	0	0
Rock filled road depth (m)	0	0	0
Area of land lost in excavated roads (m^2)	0	0	0
Volume of peat removed for rock-filled roads	0	0	0
Total area of land lost in access tracks (m^2)	200307	169652	295216
Total volume of peat removed due to access tracks (m^3)	140959	43144	380182

Additional peat excavated - (not already accounted for above)			
Volume of additional peat excavated (m^3)	27068.9	73809	27068.9
Area of additional peat excavated (m^2)	49206	49206	49206

RESULTS	Total		
	Exp	Min	Max
Total volume of peat removed (m^3) due to windfarm construction	**282287**	**159967**	**761863**
Total area of land lost due to windfarm construction (m^2)	**384189**	**283183**	**634320**

Click here to move to 5b. CO2 loss from removed peat Click here

Click here to move to Payback Time Click here

Volume of Peat Removed

Note: % site lost by peat removal is estimated from peat removed in borrow pits, turbine foundations, hard-standing and access tracks.

If peat is removed for any other reason, this must be added in to the volume of peat removed, area of land lost and % site lost at the bottom of this worksheet.

CO_2 loss from removed peats

Note: If peat is treated in such a way that it is permanently restored, so that less than 100% of the C is lost to the atmosphere, a lower percentage can be entered in cell C10

	Expected	Minimum	Maximum
CO_2 loss from removed peat			
C Content of dry peat (% by weight)	46	45	65
Dry soil bulk density (g cm^{-3})	0.20	0.10	0.20
% C contained in removed peat that is lost as CO_2	100	100	100
Check Total volume of peat removed (m^3) due to windfarm construction	282286.684	159967.039	761862.8611
CO_2 loss from removed peat (t CO_2)	95233	26397	363188

Assumption: If peat is not restored, 100% of the carbon contained in the removed peat is lost as CO_2

CO_2 loss from undrained peat left in situ			
Total area of land lost due to windfarm construction (ha)	38	28	63
CO_2 loss from undrained peat left in situ (t CO_2 ha^{-1})	230	202	386
CO_2 loss from undrained peat left in situ (t CO_2)	8841	5726	24507

CO_2 loss attributable to peat removal only			
CO_2 loss from removed peat (t CO_2)	95233	26397	363188
CO_2 loss from undrained peat left in situ (t CO_2)	8841	5726	24507
RESULTS			
CO_2 loss attributable to peat removal only (t CO_2)	**86392**	**20671**	**338681**

Click here to move to 5. Loss of soil CO_2 Click here

Click here to move to Payback Time Click here

CO_2 loss from removed peats

Note: If peat is treated in such a way that it is permanently restored, so that less than 100% of the C is lost to the atmosphere, a lower percentage can be entered in cell C10

Volume of peat drained

Note: Extent of site affected by drainage is calculated assuming an average extent of drainage around each drainage feature as given in the input data.

Extent of drainage around each metre of drainage ditch	Total		
	Exp	Min	Max
Average extent of drainage around drainage features at site (m)	10	5	25

Peat affected by drainage around borrow pits	Total		
	Exp	Min	Max
Number of borrow pits	4	4	4
Average length of pits (m)	154	91	243
Average width of pits (m)	154	91	243
Average depth of peat removed from pit (m)	0.6	0.5	1.1
Area affected by drainage per borrow pit (m^2)	6559	1916	26788
Total area affected by drainage around borrowpits (m^2)	26235	7664	107152
Total volume affected by drainage around borrowpits (m^3)	8199	1916	56791

Peat affected by drainage around turbine foundation and hardstanding	Total			Construction Area 1			Construction Area 2			Construction Area 3			Construction Area 4			Construction Area 5		
	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
No. of turbines	47	47	47	47	47	47	0	0	0	0	0	0	0	0	0	0	0	0
Average length of turbine foundations at base (m)				18	18	18	0	0	0	0	0	0	0	0	0	0	0	0
Average width of turbine foundations at base(m)				18	18	18	0	0	0	0	0	0	0	0	0	0	0	0
Average depth of peat removed from turbine foundations (m)				1.4	0.3	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average length of hard-standing at base (m)				15	12	19	0	0	0	0	0	0	0	0	0	0	0	0
Average width of hard-standing at base (m)				36	29	45	0	0	0	0	0	0	0	0	0	0	0	0
Average depth of peat removed from hard-standing (m)				1.4	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum depth of drains (m)				1.4	1.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total length of foundation and hardstanding (m)				33	30	36	0	0	0	0	0	0	0	0	0	0	0	0
Total width of foundation and hardstanding (m)				54	47	63	0	0	0	0	0	0	0	0	0	0	0	0
Area affected by drainage of foundation and hardstanding area (m^2)	2126	868	7450	2126	868	7450	0	0	0	0	0	0	0	0	0	0	0	0
Total area affected by drainage of foundation and hardstanding area (m^2)	99922	40787	350150	99922	40787	350150	0	0	0	0	0	0	0	0	0	0	0	0
Total volume affected by drainage of foundation and hardstanding area (m^3)	68946	28143	597006	68946	28143	597006	0	0	0	0	0	0	0	0	0	0	0	0

Peat affected by drainage of access tracks	Total Exp	Total Min	Total Max
Floating roads			
Length of floating road that is drained (m)	5393	5393	5393
Floating road width (m)	6.7	5.0	8.0
Average depth of drains associated with floating roads (m)	0.50	0.50	0.50
Area affected by drainage of floating roads (m^2)	143723	80895	312794
Volume affected by drainage of floating roads (m^3)	35931	20224	78199
Excavated Road			
Length of access track that is excavated road (m)	25716	25716	25716
Excavated road width (m)	5	5	8
Average depth of peat excavated for road (m)	0.7	0.0	1.5
Area affected by drainage of excavated roads (m^2)	514320	257160	1285800
Volume affected by drainage of excavated roads (m^3)	167154	0	964350
Rock-filled roads			
Length of rock filled road that is drained (m)	0	0	0
Rock filled road width (m)	0	0	0
Average depth of drains associated with rock filled roads (m)	0.0	0.0	0.0
Area affected by drainage of rock-filled roads (m^2)	0	0	0
Volume affected by drainage of rock-filled roads (m^2)	0	0	0
Total area affected by drainage of access track (m^2)	658043	338055	1598594
Total volume affected by drainage of access track (m^3)	203085	20224	1042549

Peat affected by drainage of cable trenches	Total Exp	Total Min	Total Max
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (eg. sand) (m)	4250	4250	4250
Average depth of peat cut for cable trenches (m)	0.3	0.3	0.3
Total area affected by drainage of cable trenches (m^2)	85000	42500	212500
Total volume affected by drainage of cable trenches (m^3)	12750.00	6375.00	31875.00

RESULTS	Total Exp	Total Min	Total Max
Total area affected by drainage due to windfarm (m^2)	**869201**	**429006**	**2268396**
Total volume affected by drainage due to windfarm (m^3)	**292980**	**56658**	**1728220**

Click here to move to 5d. CO2 loss from drained peat — Click here

Click here to move to Payback Time — Click here

Volume of peat drained

Note: Extent of site affected by drainage is calculated assuming an average extent of drainage around each drainage feature as given in the input data.

CO_2 loss due to drainage

Note: Note, CO_2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been derived directly from experimental data for acid bogs and fens (see Nayak et al. 2008 - Final report).

Click here to move to 5. Loss of soil CO_2 Click here
Click here to move to Payback Time Click here

	Expected	Minimum	Maximum
Drained Land			
Total area affected by drainage due to wind farm construction (ha)	87	43	227
Will the hydrology of the site be restored on decommissioning?	Yes	Yes	Yes
Will the habitat of the site be restored on decommissioning?	No	No	No

Calculations of C Loss from Drained Land if Site is NOT Restored after Decommissioning

Check Total volume affected by drainage due to wind farm (m^3)	292980	56658	1728220
C Content of dry peat (% by weight)	46	45	65
Dry soil bulk density (g cm^{-3})	0.20	0.10	0.20
Total GHG emissions from Drained Land (t CO_2 equiv.)	98841	9349	823860
Total GHG Emissions from Undrained Land (t CO_2 equiv.)	50687	11762	422365

Assumption: Losses of GHG from drained and undrained land have the same proportion throughout the emission period.

Calculations of C loss from Drained Land if Site IS Restored after Decommissioning

1. Losses if Land is Drained

Flooded period (days $year^{-1}$)	0	0	0
Lifetime of windfarm (years)	25	25	25
Time required for regeneration of bog plants after restoration (years)	6	4	8
Methane Emissions from Drained Land			
Check Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.009	0.082	-0.010
Conversion factor: CH_4-C to CO_2 equivalents	30.67	30.67	30.67
CH_4 emissions from drained land (t CO_2 equiv.)	-765	3148	-2342
Carbon Dioxide Emissions from Drained Land			
Check Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	14.76	3.01	23.15
CO_2 emissions from drained land (t CO_2)	39771	3748	173289
Total GHG emissions from Drained Land (t CO_2 equiv.)	39006	6895	170948

Assumption: The drained soil is not flooded at any time of the year.

Note:Conversion = (23 x 16/12) = 30.67 CO_2 equiv. (CH_4-C)$^{-1}$

2. Losses if Land is Undrained

	Flooded period (days year^{-1})	178	178	178
	Lifetime of windfarm (years)	25	25	25
	Time required for regeneration of bog plants after restoration (years)	6	4	8
	Methane Emissions from Undrained Land			
Check	Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.01	0.48	-0.01
	Conversion factor: CH_4-C to CO_2 equivalents	30.67	30.67	30.67
	CH_4 emissions from undrained land (t CO_2 equiv.)	-373	9015	-1142
	Carbon Dioxide Emissions from Undrained Land			
Check	Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	14.76	-0.53	23.15
	CO_2 emissions from undrained land (t CO_2)	20376	-340	88781
	Total GHG Emissions from Undrained Land (t CO_2 equiv.)	20003	8675	87639

Note:Conversion = (23 x 16/12) = 30.67 CO_2 equiv. (CH_4-C)$^{-1}$

3. CO_2 Losses due to Drainage

Total GHG emissions from drained land (t CO_2 equiv.)	98841	9349	823860
Total GHG emissions from undrained land (t CO_2 equiv.)	50687	11762	422365
RESULTS			
Total GHG emissions due to drainage (t CO_2 equiv.)	**48154**	**-2413**	**401494**

Click here to move to 5. Loss of soil CO_2 Click here

Click here to move to Payback Time Click here

CO_2 loss due to drainage

Note: Note, CO_2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been derived directly from experimental data for acid bogs and fens (see Nayak et al, 2008 - Final report).

Emission rates from soils

Note: Note, CO_2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been thoroughly tested against experimental data (see Nayak et al, 2008 - Final report).

Click here to move to 5d. Click here

Click here to move to Payback Time Click here

Selected Methodology = Site specific (required for planning applications)
Type of peatland = Acid Bog

Calculations following IPCC default methodology	**Expected**	**Minimum**	**Maximum**
Emission characteristics of acid bogs (IPCC, 1997)			
Flooded period (days $year^{-1}$)	178	178	178
Annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	0.04015	0.04015	0.04015
Annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	35.2	35.2	35.2
Emission characteristics of fens (IPCC, 1997)			
Flooded period (days $year^{-1}$)	169	169	169
Annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	0.219	0.219	0.219
Annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	35.2	35.2	35.2
Selected emission characteristics (IPCC, 1997)			
Flooded period (days $year^{-1}$)	178	178	178
Annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	0.04015	0.04015	0.04015
Annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	35.2	35.2	35.2

Assumption: The period of flooding is taken to be 178 days yr^{-1} for acid bogs and 169 days yr^{-1} based on the monthly mean temperature and the lengths of inundation (IPCC, 1997, Revised 1996 IPCC guidelines for national greenhouse gas inventories, Vol 3, table 5-13)

Assumption: The CH_4 emission rate provided for acid bogs is 11 (1-38) mg CH_4-C m^{-2} day^{-1} x 365 days; and for fens is 60 (21-162) mg CH_4-C m^{-2} day^{-1} x 365 days (Aselmann & Crutzen ,1989. J.Atm.Chem. 8, 307-358)

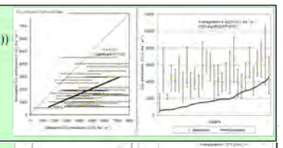
Assumption: CO_2 emissions on drainage of organic soils for upland crops (e.g., grain, vegetables) are 3.667x9.6 (7.9-11.3) t CO_2 ha^{-1} yr^{-1} in temperate climates (Armentano and Menges, 1986. J. Ecol. 74, 755-774).

Calculations following ECOSSE based methodology			
Drained Land			
Total area affected by drainage due to wind farm construction (ha)	87	43	227
Total volume affected by drainage due to wind farm construction (m^3)	292980	56658	1728220
Soil Characteristics that Determine Emission Rates			
Average annual air temperature at the site (°C)	6.75	6	7.5
Average water table depth at site (m)	0.4	0	1
Average water table depth of drained land (m)	0.40	0.13	1.00
Annual Emission Rates following site specific methodology			
Acid bogs			
Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	14.76	3.01	23.15
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	14.76	-0.53	23.15
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.009	0.082	-0.010
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.01	0.48	-0.01
Fens			
Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	45.07	7.68	63.52
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	45.07	3.43	63.52
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.006	0.150	-0.005
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.01	0.56	-0.01
Selected emission characteristics following site specific methodology			
Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	14.76	3.01	23.15
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	14.76	-0.53	23.15
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.009	0.082	-0.010
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.01	0.48	-0.01

Note: Carbon dioxide emissions from acid bogs. Equation derived by regression analysis against 60 measurements (Nayak et al, 2009). The equation derived was

$R_{CO2} = (3.667/1000) \times ((6700 \times \exp(-0.26 \times \exp(-0.0515 \times ((W \times 100)-50)))) + ((72.54 \times T) - 800))$

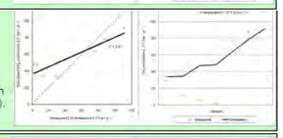
where R_{CO2} is the annual rate of CO_2 emissions (t CO_2 $(ha)^{-1}$ yr^{-1}),
T = average annual peat temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 =0.53 P> 0.05).
Evaluation against 29 independent experiments shows a significant association (r^2 = 0.21; P>0.05) and an average error of 3023 t CO_2 ha^{-1} yr^{-1} which is non-significant (P<0.05) (Smith et al, 1997).



measurements (Nayak et al, 2009). The equation derived was

$R_{CH4} = (1/1000) \times (500 \times \exp(-0.1234 \times (W \times 100))) + ((3.529 \times T) - 36.67))$

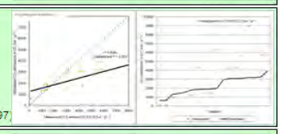
where R_{CH4} is the annual rate of CH_4 emissions (t CH_4-C $(ha)^{-1}$ yr^{-1}),
T = average annual air temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.54, P> 0.05).
Evaluation against 7 independent experiments shows a significant association (r^2 = 0.81; P>0.05) and an average error of 27 t CH_4-C ha^{-1} yr^{-1} (significance not defined due to lack of replicates - Smith et al, 1997).



Note: Carbon dioxide emissions from fens. Equation derived by regression analysis against 44 measurements (Nayak et al, 2009). The equation derived was

$R_{CO2} = (3.667/1000) \times (16244 \times \exp(-0.175 \times \exp(-0.073 \times ((W \times 100)-50))) + (153.23 \times T))$

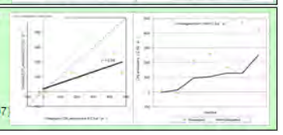
where R_{CO2} is the annual rate of CO_2 emissions (t CO_2 $(ha)^{-1}$ yr^{-1}),
T = average annual peat temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.42, P> 0.05).
Evaluation against 18 independent experiments shows a significant association (r^2 = 0.56; P>0.05) and an average error of 2108 t CO_2 ha^{-1} yr^{-1} (significance not defined due to lack of replicates-Smith et al, 1997)



Note: Methane emissions from fens. Equation derived by regression analysis against experimental data from 36 measurements (Nayak et al, 2009). The equation derived was

$R_{CH4} = (1/1000) \times (-10+563.62 \times \exp(-0.097 \times (W \times 100))) + (0.662 \times T))$

where R_{CH4} is the annual rate of CH_4 emissions (t CH_4-C $(ha)^{-1}$ yr^{-1}),
T = average annual air temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.41, P>0.05).
Evaluation against 7 independent experiments shows a significant association (r^2 = 0.69; P>0.05) and an average error of 164 t CH_4-C ha^{-1} yr^{-1} (significance not defined due to lack of replicate-Smith et al, 1997)



RESULTS

Selected Emission Rates			
Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	14.76	3.01	23.15
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	14.76	-0.53	23.15
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.009	0.082	-0.010
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	-0.01	0.48	-0.01

Click here to move to 5d. CO2 loss from drained peat Click here

Click here to move to Payback Time Click here

Emission rates from soils

Note: Note, CO_2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been thoroughly tested against experimental data (see Nayak et al, 2008 - Final report).

Emissions due to loss of DOC and POC

Note: Note, CO_2 losses from DOC and POC are calculated using a simple approach derived from generic estimates of the percentage of the total CO2 loss that is due to DOC or POC leaching

No POC losses for bare soil included yet. If extensive areas of bare soil is present at site need modified calculation (Birnie et al, 1991)

	Expected	Minimum	Maximum
Total C loss			
Gross CO_2 loss from restored drained land (t CO_2)	0	0	0
Gross CH_4 loss from restored drained land (t CO_2 equiv.)	0	0	0
Gross CO_2 loss from improved land (t CO_2)			
Degraded Bog	0	0	0
Felled Forestry	23341	0	0
Borrow Pits	222	0	0
Foundations & Hardstanding	255	0	0
Gross CH_4 loss from improved land (t CO_2 equiv.)			
Degraded Bog	1102	4506	775
Felled Forestry	0	142992	5676
Borrow Pits	0	1358	42
Foundations & Hardstanding	0	666	155
Conversion factor: CH_4-C to CO_2 equivalents	30.6667	30.6667	30.6667
% total soil C losses, lost as DOC	26	7	40
% DOC loss emitted as CO_2 over the long term	100	100	100
% total soil C losses, lost as POC	8	4	10
% POC loss emitted as CO_2 over the long term	100	100	100
Total gaseous loss of C (t C)	6535	3657	163
Total C loss as DOC (t C)	1699	256	65
Total C loss as POC (t C)	523	146	16

Note: Only restored drained land included because if land is not restored, the C lost has already been counted as carbon dioxide

Assumption: DOC loss ranges between 7 - 40% of the total gaseous loss if calculated from the reported (minimum and maximum) values in Worrall 2009 and is **26%** of the total gaseous loss if calculated from the mean of reported maximum and minimum value in Worrall 2009. These DOC values are flux based on soil water concentration (i.e. 12.5 - 85.9 MgC/KM²/yr) and not on flux at catchment outlet (i.e. 10.3 - 21.8 MgC/KM²/yr)

Worrall, F. et al., 2009. The multi-annual carbon budget of a peat-covered catchment. *Science of The Total Environment*, 407(13), pp.4084-4094.

Assumption: In the long term, 100% of leached DOC is assumed to be lost as CO_2

Assumption: POC loss ranges between 4-10% of the total gaseous loss if calculated from the reported values and is **8%** of the total gaseous loss if calculated from the mean of reported maximum and minimum value in Worrall 2009. POC range is (7 - 22.4 MgC/KM²/yr) (Worrall et al, 2009).

Assumption: In the long term, 100% of leached POC is assumed to be lost as CO_2

RESULTS			
Total CO_2 loss due to DOC leaching (t CO_2)	**6218**	**937**	**238**
Total CO_2 loss due to POC leaching (t CO_2)	**1913**	**535**	**60**
Total CO_2 loss due to DOC & POC leaching (t CO_2)	**8132**	**1472**	**298**
Additional CO_2 payback time of windfarm due to DOC & POC			
…coal-fired electricity generation (months)	0	0	0
…grid-mix of electricity generation (months)	1	0	0
…fossil fuel - mix of electricity generation (months)	0	0	0

Click here to move to Payback Time Click here

Emissions due to loss of DOC and POC

Note: Note, CO_2 losses from DOC and POC are calculated using a simple approach derived from generic estimates of the percentage of the total CO2 loss that is due to DOC or POC leaching

No POC losses for bare soil included yet. If extensive areas of bare soil is present at site need modified calculation (Birnie et al, 1991)

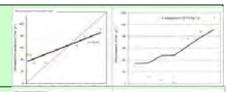
Gains due to site improvement

Note: Note, CO_2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been thoroughly tested against experimental data (see Nayak et al, 2008 - Final report).

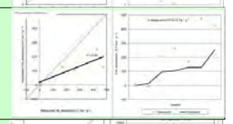
Selected Methodology = Site specific (required for planning applications)
Type of peatland = Acid Bog

Reduction in GHG emissions due to improvement of site	**Expected**				**Minimum**				**Maximum**			
Improvement of…	**Degraded Bog**	**Felled Forestry**	**Borrow Pits**	**Foundations & Hardstanding**	**Degraded Bog**	**Felled Forestry**	**Borrow Pits**	**Foundations & Hardstanding**	**Degraded Bog**	**Felled Forestry**	**Borrow Pits**	**Foundations & Hardstanding**
1. Description of site												
Lifetime of windfarm (years)	25	25	25	25	25	25	25	25	25	25	25	25
Area to be improved (ha)	100	1133	10.76	10	50	1133	10.76	4	200	1465.2	10.76	35
Average air temperature at site (°C)	6.75	6.75	6.75	6.75	6	6	6	6	7.5	7.5	7.5	7.5
Water table depth before improvement (m)	0.40	0.10	0.10	0.10	0.10	0.40	0.40	0.40	1.00	1.00	1.00	1.00
Water table depth after improvement (m)	0.20	0.20	0.20	0.20	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30
2. Losses with improvement												
Flooded period (days $year^{-1}$)	178	178	178	178	178	178	178	178	178	178	178	178
Time required for hydrology and habitat to return to its previous state on restoration (years)	6	6	6	1.5	4	4	4	1	8	8	8	3
Improved period (years)	19	19	19	23.5	21	21	21	24	17	17	17	22
Methane emissions from improved land												
Site specific methane emission from improved soil on acid bogs (t CH_4-C ha^{-1} yr^{-1})	0.030	0.030	0.030	0.030	0.485	0.485	0.485	0.485	0.002	0.002	0.002	0.002
Site specific methane emission from improved soil on fens (t CH_4-C ha^{-1} yr^{-1})	0.075	0.075	0.075	0.075	0.558	0.558	0.558	0.558	0.026	0.026	0.026	0.026
IPCC annual rate of methane emission on acid bogs (t CH_4-C ha^{-1} yr^{-1})	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
IPCC annual rate of methane emission on fens (t CH_4-C ha^{-1} yr^{-1})	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219
Selected annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	0.030	0.030	0.030	0.030	0.485	0.485	0.485	0.485	0.002	0.002	0.002	0.002
CH_4 emissions from improved land (t CO_2 equiv.)	839	9506	90	104	6159	139563	1325	650	134	982	7	27
Carbon dioxide emissions from improved land												
Site specific CO_2 emission from improved soil on acid bogs (t CO_2 ha^{-1} yr^{-1})	6.12	6.12	6.12	6.12	-0.53	-0.53	-0.53	-0.53	10.92	10.92	10.92	10.92
Site specific CO_2 emissions from improved soil on fens (t CO_2 ha^{-1} yr^{-1})	15.89	15.89	15.89	15.89	3.43	3.43	3.43	3.43	31.94	31.94	31.94	31.94
IPCC annual rate of carbon dioxide emission on acid bogs (t CO_2 ha^{-1} yr^{-1})	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IPCC annual rate of carbon dioxide emission on fens (t CO_2 ha^{-1} yr^{-1})	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Selected annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	6.12	6.12	6.12	6.12	-0.53	-0.53	-0.53	-0.53	10.92	10.92	10.92	10.92
CO_2 emissions from improved land (t CO_2)	5953	67449	641	736	-232	-5262	-50	-25	23490	172089	1264	4700
Total GHG emissions from improved land (t CO_2 equiv.)	**6792**	**76955**	**731**	**839**	**5927**	**134301**	**1275**	**626**	**23624**	**173072**	**1271**	**4727**
3. Losses without improvement												
Flooded period (days $year^{-1}$)	0	0	0	0	0	0	0	0	0	0	0	0
Time required for hydrology and habitat to return to its previous state on restoration (years)	6	6	6	1.5	4	4	4	1	8	8	8	3
Improved period (years)	19	19	19	23.5	21	21	21	24	17	17	17	22
Methane emissions from unimproved land												
Site specific methane emission from unimproved soil on acid bogs (t CH_4-C ha^{-1} yr^{-1})	-0.009	0.133	0.133	0.133	0.130	-0.012	-0.012	-0.012	-0.010	-0.010	-0.010	-0.010
Site specific methane emission from unimproved soil on fens (t CH_4-C ha^{-1} yr^{-1})	0.006	0.208	0.208	0.208	0.208	0.006	0.006	0.006	-0.005	-0.005	-0.005	-0.005
IPCC annual rate of methane emission on acid bogs (t CH_4-C ha^{-1} yr^{-1})	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IPCC annual rate of methane emission on fens (t CH_4-C ha^{-1} yr^{-1})	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Selected annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	-0.009	0.133	0.133	0.133	0.130	-0.012	-0.012	-0.012	-0.010	-0.010	-0.010	-0.010
CH_4 emissions from unimproved land (t CO_2 equiv.)	-263	42726	406	466	1653	-3429	-33	-16	-641	-4694	-34	-128
Carbon dioxide emissions from unimproved land												
Site specific CO_2 emission from unimproved soil on acid bogs (t CO_2 ha^{-1} yr^{-1})	14.76	2.05	2.05	2.05	1.85	14.56	14.56	14.56	23.15	23.15	23.15	23.15
Site specific CO_2 emissions from unimproved soil on fens (t CO_2 ha^{-1} yr^{-1})	45.07	5.94	5.94	5.94	5.52	44.65	44.65	44.65	63.52	63.52	63.52	63.52
IPCC annual rate of carbon dioxide emission on acid bogs (t CO_2 ha^{-1} yr^{-1})	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20
IPCC annual rate of carbon dioxide emission on fens (t CO_2 ha^{-1} yr^{-1})	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20
Selected annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	14.76	2.05	2.05	2.05	1.85	14.56	14.56	14.56	23.15	23.15	23.15	23.15
CO_2 emissions from unimproved land (t CO_2)	28044	44107	419	481	1572	280452	2663	1307	97227	712287	5231	19454
Total GHG emissions from unimproved land (t CO_2 equiv.)	**27781**	**86833**	**825**	**947**	**3225**	**277023**	**2631**	**1291**	**96587**	**707594**	**5196**	**19326**
RESULTS												
4. Reduction in GHG emissions due to improvement of site												
Total GHG emissions from improved land (t CO_2 equiv.)	6792	76955	731	839	5927	134301	1275	626	23624	173072	1271	4727
Total GHG emissions from unimproved land (t CO_2 equiv.)	27781	86833	825	947	3225	277023	2631	1291	96587	707594	5196	19326
Reduction in GHG emissions due to improvement (t CO_2 equiv.)	**20989**	**9878**	**94**	**108**	**-2701**	**142722**	**1355**	**665**	**72962**	**534522**	**3925**	**14599**
Additional CO_2 payback time of windfarm due to site improvement												
…coal-fired electricity generation (months)	**-1**	**0**	**0**	**0**	**0**	**-5**	**0**	**0**	**-2**	**-18**	**0**	**0**
…grid-mix of electricity generation (months)	**-1**	**-1**	**0**	**0**	**0**	**-10**	**0**	**0**	**-5**	**-37**	**0**	**-1**
…fossil fuel - mix of electricity generation (months)	**-1**	**0**	**0**	**0**	**0**	**-7**	**0**	**0**	**-4**	**-27**	**0**	**-1**

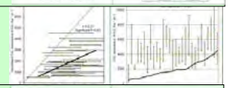
Note: Methane emissions from acid bogs. Equation derived by regression analysis against 57 measurements (Nayak et al, 2009). The equation derived was
$R_{CH4} = (1/1000) \times (500 \times \exp(-0.1234 \times (Wx100)) + ((3.529 \times T) - 36.67))$
where R_{CH4} is the annual rate of CH_4 emissions (t CH_4-C $(ha)^{-1}$ yr^{-1}),
T = average annual air temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.54, P > 0.05).
Evaluation against 7 independent experiments shows a significant association (r^2 = 0.81; P>0.05) and an



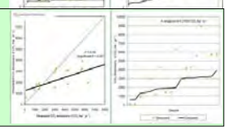
Note: Methane emissions from fens. Equation derived by regression analysis against experimental data from 35 measurements (Nayak et al, 2009). The equation derived was
$R_{CH4} = (1/1000) \times (-10+563.62 \times \exp(-0.097 \times (W \times 100)) + (0.662 \times T))$
where R_{CH4} is the annual rate of CH_4 emissions (t CH_4-C $(ha)^{-1}$ yr^{-1}),
T = average annual air temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.41, P >0.05).
Evaluation against 7 independent experiments shows a significant association (r^2 = 0.69; P>0.05) and an average error of 164 t CH_4-C ha^{-1} yr^{-1} (significance not defined due to lack of replicate-Smith et al, 1997)



$R_{CO2} = (3.667/1000) \times ((6700 \times \exp(-0.26 \times \exp(-0.0515 \times ((Wx100)-50)))) + ((72.54 \times T) - 800))$
where R_{CO2} is the annual rate of CO_2 emissions (t CO_2 $(ha)^{-1}$ yr^{-1}),
T = average annual peat temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 =0.53 P > 0.05).
Evaluation against 29 independent experiments shows a significant association (r^2 = 0.21; P>0.05) and an average error of 3023 t CO_2 ha^{-1} yr^{-1} which is non-significant (P<0.05) (Smith et al, 1997).



Note: Carbon dioxide emissions from fens. Equation derived by regression analysis against 44 measurements (Nayak et al, 2009). The equation derived was
$R_{CO2} = (3.667/1000) \times (16244 \times \exp(-0.175 \times \exp(-0.073 \times ((Wx100)-50))) + (153.23 \times T))$
where R_{CO2} is the annual rate of CO_2 emissions (t CO_2 $(ha)^{-1}$ yr^{-1}),
T = average annual peat temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.42, P > 0.05).
Evaluation against 18 independent experiments shows a significant association (r^2 = 0.56; P>0.05) and an average error of 2108 t CO_2 ha^{-1} yr^{-1} (significance not defined due to lack of replicates-Smith et al, 1997)



Note: Methane emissions from acid bogs. As above

Note: Methane emissions from fens. As above

Note: CO_2 emissions from acid bogs. As above

Note: CO_2 emissions from fens. As above

Click here to move to Payback Time Click here

Gains due to site improvement

Note: Note, CO_2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been thoroughly tested against experimental data (see Nayak et al, 2008 - Final report).

References

Allott T.E.H., Evans M.G., Lindsay J.B., Agnew C.T., Freer J.E., Jones A. and Parnell M. (2009) Water tables in Peak District blanket peatlands. Moors for the Future Report No 17
https://www.escholar.manchester.ac.uk/uk-ac-man-scw:18867.

Anderson D.E. (2002) Carbon accumulation and C/N ratios of peat bogs in North-West Scotland. *Scottish Geographical Journal* 118(4): 323-341.

Anderson R. (1997) Part 4.3. Hydrology and Rainfall. In: Brooks S. and Stoneman R. (Eds.). Conserving Bogs: The Management Handbook. Edinburgh: The Stationary Office: 65-72.

Anderson, R., Artz, R., Mitchell, R., Chapman, S., Smith, J., Smith, P., Cummins, R., Donnelly, D., Cuthbert, A., 2010. Managing and restoring blanket bog to benefit biodiversity and carbon balance – a scoping study. RERAD Report.

Ardente, F., Beccali, M., Cellura, M. and Brano V.L. (2008). Energy performances and life cycle assessment of an Italian wind farm. Renewable and Sustainable Energy Reviews 12, 200-217.

Armstrong A.C. (1983) The measurement of watertable levels in structured clay soils by means of open auger holes. *Earth Surface Processes* 8: 183–187.

Armstrong A, Holden J, Kay P, Foulger M, Gledhill S, McDonald AT, Walker A (2009) Drain-blocking techniques on blanket peat: A framework for best practice. Journal of Environmental Management,90, 3512-3519.

Baggott S.L., Cardenas L., Garnett E., Jackson J., Mobbs D.C., Murrells T., Passant N., Thomson A. and Watterson J.D. (2007) UK Greenhouse Gas Inventory 2000-2005. Annual Report for submission under the Framework Convention on Climate Change. London: HSO.
www.naei.org.uk/reports.php. Report AEAT/ENV/R/2429 13/04/2007

Bengtsson L. and Enell M. (1986) Chemical analysis. In: Berglund B.E. (Ed.) *Handbook of Holocene Palaeoecology and Palaeohydrology* . Chichester: John Wiley: 423-448.

Birnie R., Clayton P., Griffiths P., Hulme P., Roberston R., Soane B. and Ward S. (1991) *Scottish Peat Resources and Their Energy Potential* . Contract Report for ETSU, E/5A/CON/1204/1676, pp.199.

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

Bragg O.M., Hulme P.D., Ingram H.A.P., Johnson J.P., Wilson A.I.A. (1994) A maximum-minimum recorder for shallow water tables, developed for ecohydrological studies on mires. *Journal of Applied Ecology* 31: 589-592.

Buckler et al, 2009.

Cannell M.G.R. (1999) Growing trees to sequester carbon in the UK: answers to some common questions. *Forestry* 72: 238-247.

Carbon Trust/Dti (2004), Renewables Network Impacts Study.
http://www.carbontrust.co.uk/Publications/publicationdetail.htm?productid=CT-2004-03

Dale L., Milborrow D., Stark R. and Strbac G. (2004) Total cost estimates for large-scale wind scenarios in the UK. *Energy Policy* 32: 1949-1956.

DECC (Department of Energy and Climate Change) (2044) UK onshore wind capacity factors 1998-2004
www.decc.gov.uk/assets/decc/statistics/publications/trends/articles_issue/file43950.pdf

Defra (2002) Guidelines for the measurement and reporting of emissions by Direct Participants in UK Emissions Trading Scheme. UKETS(01)05rev2.

Digest of UK Energy Statistics (2007) Department for Business, Enterprise and Regulatory Reform. A National Statistics Publication. London: HSO.
www.berr.gov.uk/energy/statistics/source/electricity/page18527.html

Dryburgh P.M. (1978) *Scotland's Peat Resources: An Introduction to their Potential* . Edinburgh: University of Edinburgh, pp.30

Edwards, P.N., Christie, J.M. (1981) Yield models for forest management. Forestry Commission Booklet 48. Forestry Commission: Edinburgh.

Gardiner, B.A., 2004, Calculation of the Impact of Forestry on Wind Speeds, Forest Research Internal Report, pp.10

Garrad Hassan (2011) Position on Turbine Reliability Risk Assessment: Proven and Qualified Turbine Designs and Turbine Availability in North America
www.gl-garradhassan.com/assets/downloads/GL_Garrad_Hassan_memo_on_availability_and_proven_qualified_turbines.pdf

Grieve, I C , Hipkin, J.A. and Davidson, D.A. (1994) Soil erosion sensitivity in upland Scotland Research, Survey and Monitoring Report No 24, SNH, Perth.

Hargreaves, K.J., Milne, R. & Cannell, M.G.R. (2003). Carbon balance of afforested peatland in Scotland. Forestry 76, 209-317.

Holden J, Evans MG, Burt TP, Horton M (2006) Impact of land drainage on peatland hydrology. Journal of Environmental Quality, 35, 1764-1778.

IPCC, 1997, Revised 1996 IPCC guidelines for national greenhouse gas inventories, Vol 3, table 5-13

Isselin-Nondedeu F., Rochefort L. and Poulin, M. (2007) Long-term vegetation monitoring to assess the restoration success of a vacuum-mined peatland (Québec, Canada). In: Proceedings of International Conference Peat and Peatlands 2007 23: 153-166.
http://www.gret-perg.ulaval.ca/conferences-gret.html?&L=0Firef...cada1c72a857c929118957c47&tx_centrerecherche_pi1[showUid]=902&cHash=ef860450530b5d777846ce5da97d98e0

Lavers, G.M. (1983). The strength properties of timber. 3rd edn. Building Research Establishment Report, HMSO London

Lenzen, M., Munksgaard, J. (2002). Energy and CO2 life-cycle analyses of wind turbines Review and applications. Renew. Energy. 26, 339-362

Magnani, F., Mencuccini, M., Borghetti, M., Berbigier, P., Berninger, F., Delzon, S., Grelle, A., Hari, P., Jarvis, P.G., Kolari, P., Kowalski, A.S., Lankreijer, H., Law, B.E., Lindroth, A., Loustau, D., Manca, G., Moncrieff, J.B., Rayment, M., Tedeschi, V., Valentini, R., Grace, J. (2007) The human footprint in the carbon cycle of temperate and boreal forests. Nature, 447: 848–850.

Mason et al (2009)

Matthews, G.A.R. (1993) The carbon content of trees. Forestry Commission Technical Paper 4. Forestry Commission, Edinburgh

McBride A., Diack I., Droy N., Hamill B., Kones P., Schutten J., Skinner A. and Street M. (2011) *The Fen Management Handbook* . Perth, Scottish Natural Heritage, pp 329.

Met Office (2000) *The Observer's Handbook* . Bracknell, Met Office.

Minnuno, F., Xenakis, G., Perks, M.P. and Mencuccini, M. (2010). Calibration and validation of a simplified process-based model for the prediction of the carbon balance of Scottish Sitka spruce (Picea sitchensis) plantations. Canadian Journal of Forest Research, 40, 2411-2426.

Morison et al (2011). Understanding the Carbon and Greenhouse Gas Balance of UK Forests. Forestry Commission Monogrpah (in press)

Nayak, D.N, Miller, D., Nolan, A., Smith, P., Smith, J., 2008. Calculating carbon savings from wind farms on Scottish peatlands. A New approach. SG Final report.
http://www.scotland.gov.uk/Publications/2008/06/25114657/0

Nayak, D.R., Miller, D., Nolan, A., Smith, P. and Smith, J.U., 2010, Calculating carbon budgets of wind farms on Scottish peatland. Mires and Peat 4: Art. 9.
http://www.mires-and-peat.net/map04/map_04_09.htm

Perks, MP, Lonsdale, J & Gardiner (2009). Forest Management and Wind Turbines: Performance and Carbon Budgets. WindForM Project - FC Internal report). Works out the emissions associated with forest management for establishment of wind farms.

Plado J., Sibul I., Mustasaar M. and Jõeleht A. (2011) Ground-penetrating radar study of the Rahivere peat bog, eastern Estonia. *Estonian Journal of Earth Sciences* 60(1): 31–42.

Scottish Executive (2006) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, pp72.
www.scotland.gov.uk/Resource/Doc/161862/0043972.pdf

Smith et al, 2007. ECOSSE: Estimating Carbon in Organic Soils - Sequestration and Emissions. Final Report. SEERAD Report. ISBN 978 0 7559 1498 2. 166pp

Soil Survey (1974) Soil Survey Laboratory Methods. Soil Survey Technical Monograph No. 6.

Stewart A.J.A. and Lance A. N. (1991) Effects of moor-draining on the hydrology and vegetation of Northern Pennine blanket bog. *Journal of Applied Ecology* 28(3): 1105-1117.

Stoneman R. and Brooks S. (Eds.) (1997) *Conserving Bogs: The Management Handbook*. The Stationery Office, Edinburgh. ISBN 0 11 495836 X.

Sykes J.M. and Lane A.M. (Eds.) (1996) *The UK Environmental Change Network: protocols for standard measurements at terrestrial sites*. London, HM Stationary Office.

Turunen J., Tahvanainen T., Tolonen K. and Pitkänen A. (2001) Carbon accumulation in West Siberian mires, Russia. *Global Biogeochemical Cycles* 15: 285-296.

Vestas (2005). Life cycle assessment of offshore and onshore wind power plants based on Vestas V90-3.0 MW turbines. Vestas Wind Systems A/S Alsvej 21, 8900 Randers, Denmark, www.vestas.com. pp.59.

Waring, R.H. (2000) A process model analysis of environmental limitations on the growth of Sitka spruce plantations in Great Britain. Forestry, 73: 65–79. doi:10.1093/forestry/73.1.65.

Warner B.G., Nobes D.C. and Theimer B.D. (1990) An application of ground penetrating radar to peat stratigraphy of Ellice Swamp, southwestern Ontario. *Canadian Journal of Earth Sciences* 27: 932-938.

White S.W. (2007) Net energy payback and CO_2 emissions from three Midwestern wind farms: an update. *Natural Resources Research* 15: 271-281.

White S.W. and Kulcinski G.L. (2000) Birth to death analysis of the energy payback ratio and CO_2 gas emission rates from coal, fission, wind, and DT-fusion electrical power plants. *Fusion Engineering and Design* 48(248): 473-481.

Worrall, F. et al (2009) The multi-annual carbon budget of a peat-covered catchment. Science of The Total Environment, 407(13), pp.4084-4094.

Xenakis G. (2007) Assessment of carbon sequestration and timber production of Scots pine across Scotland using the process-based model 3-PGN. Ph.D. Thesis. The University of Edinburgh, Edinburgh.

Xenakis, G., Ray, D., Mencuccini, M. (2008) Sensitivity and uncertainty analysis from a coupled 3-PG and soil organic matter decomposition model. Ecological Modelling, 219, 1-16.

Zerva A., Ball T., Smith, K.A. & Mencuccini, M. (2005). Soil carbon dynamics in a Sitka spruce (Picea sitchensis (Bong.) Carr.) chronosequence on a peaty gley. Forest Ecology and Management 205, 227-240.

Frequently Asked Questions

Click here to email question

GENERAL

Syin Yi Phoon (Senior Hydrologist, EnviroCentre Ltd)

Comment: I could see the benefit of protected feature on the all the sheets, but it this means we cannot even copy the equations for testing sensitivity of a parameter without changing the entire sheet. The protection should be removed as it reduces the usefulness of the tool.

Response: Protection of sheets removed

Syin Yi Phoon (Senior Hydrologist, EnviroCentre Ltd)

Comment: We miss the carbon payback table that used to be at the bottom of every carbon gain/loss component. Our clients like to see how quickly they can payback C emitted due to individual components. This is useful in planning and should be replaced.

Response: This feature has been replaced

CORE INPUT DATA

Cameron McIver (Cameron Ecology Ltd)

Question: The note on "extra capacity required for backup (%)" suggests there is a choice of % capacity or % output – I'm not clear how you know which you have chosen.

Response: The note is misleading. The number that should be entered is the percentage of the actual output of the windfarm (MWh yr^{-1}) that is required for backup. Text has been added to the note to clarify this.

Stephen Lockett (AECOM)

Question: Average extent of drainage around drainage features at site (m)
We have reviewed the guidance but are still unsure of what this variable means. We have used a standard input of 100m but the sheet appears to be extremely sensitive to this variable and we have limited confidence on the value chosen. The note in the cell refers to obtaining data on the ground water level but I am unsure how this relates to extent of drainage around drainage features.

Response: Average extent of drainage around each drainage feature can be measured following the method by Stewart and Lance (1991). In order to determine the extent of drainage, the undrained water table depth, and the 95% confidence interval of the measurements are needed.
Possible approach:
1. Install a series of dipwells or boreholes both upslope and downslope from the drainage feature.
2. In the first instance, assume that all dipwells are from undrained areas of the site. This incorrect assumption is used to initialise the iterative process that calculated the water table depth of the undrained soil.
3. For a particular sampling occasion, calculate the mean water table depth and 95% confidence interval from all the available data.
4. Assume all dipwells with water table depths deeper than the calculated mean water table depth plus the 95% confidence interval are within the area that is drained by a ditch and so exclude these from the calculation.
5. Calculate a new mean water table depth and 95% confidence interval using only data from undrained area.
6. Repeat the process until the calculation of the mean water table depth and 95% confidence interval has stabilised, and no further data points need to be excluded. This gives the water table depth of the undrained soil.
7. The distance from the drain to the first dipwell where the water table depth of the undrained soil occurred (to within the 95% confidence interval) can then be assumed to be the total extent of the drainage impact.

Question: Our drainage strategy is to mimic the existing drainage patterns as closely as possible by intercepting surface run-off and discharging at regular intervals downstream of the tracks back onto natural ground. As such, is there an argument this value could be effectively zero?

Response: No – removing water increases the drainage of the site, and this needs to be accounted for. However, if you are following existing drainage patters, it will be easier to determine the extent of drainage because the drains are already established.

Question: For our example site there is a significant difference in pay back when using site specific and IPCC default values (ranging from 3 to 15 years). Would you be able to provide a brief description of what is being ignored when selecting IPCC default?

Response: The IPCC default takes no account of the previous condition of the site. It provides the result for a typical acid bog or fen across Europe.
Therefore, if you are working with an unusually pristine peat or a badly drained peat, you would expect the result to be very different to the average.

5c. Volume of peat drained

Stephen Lockett (AECOM)

Question: Our new drainage will be surface swales above the ground water table so should not have any effect on the ground water table.

Response: If the surface swales will just convey storm water that would not otherwise have percolated into the soil, these swales will have no impact on the water table of the soil profile, but will only impact the water that would have runoff the surface, causing erosion. However, if the swales also reduce the amount of water entering the soil profile, then they could have an impact on the wetness of the soil. This should really be accounted for in the calculation. However, there is nothing to describe this in the carbon calculator, so you would be justified in neglecting this effect but need to indicate this in the notes.

5e. Emission rates from soils

Stephen Lockett (AECOM)

Question: Rate of carbon dioxide emission
We would expect the rate of emission in undrained soil to be worse than the rate in drained soil. This is only the case when the ground water level is very shallow. Does the output define 'drained soil' as soil which is being drained by our engineering activities and 'undrained soil' as excavated soil which was dry to start with?

Response:

I think the confusion comes about due to the definition of terms.
The "drained soil" refers to the soil after it has been drained for the windfarm development. The "undrained soil" refers to the soil before it was drained for the development. This doesn't refer to the status of the site before the development. Agreed, where a "drained site" refers to a site that has already been drained for a number of years, much of the labile carbon would already have been lost, and so losses due to the windfarm construction would be much less than the losses from an "undrained site" where the peat was still in pristine condition.
Worksheet 5e calculates the rate of emissions of CO_2 and CH_4 for the soil
1. when drained (ie dry soil);
2. when undrained (ie wet soil).
In a drained (dry) soil, we expect high rates of CO_2 emissions and low rates of CH_4 emissions.
In an undrained (wet) soil, we expect high rates of CH_4 emissions and low rates of CO_2 emissions.
These rates are then used in sheet 5d to calculate the net GHG emissions (in CO_2 equivalents) attributable to the windfarm development. This is taken as the difference between the losses following drainage for the development and the losses that were occurring before the soil was drained for the development. Because the net emissions are usually higher in the drained (dry) soil than in the undrained (wet) soil, the net emissions due to draining the site usually come out as positive. If we were to compare a "drained site" and an "undrained site" in sheet 5d, the net CO_2 emissions calculated for the drained site would be much less than for the undrained site because a smaller volume of soil is being further drained by the development.

CHANGES IN VERSION 2.1.0

Worksheet	Cells	Change	Thanks to...
Core input data	C31, E31, F31	Redundant input for soil pH removed	Ffion Causer, Natural Power
Forestry input data		Different areas of forestry included	N/A
Construction input data		Different areas of construction included	
1. Windfarm CO_2 emission savings		Different areas of forestry included	
2. CO_2 loss due to turbine life		Different areas of construction included	
5a. Volume of peat removed		Different areas of construction included	
7ii. Forestry CO_2 loss - detail		Different areas of forestry included	
7a. C sequest. in trees (3PG)		Different areas of forestry included	
7d. Wind speed ratios		Different areas of forestry included	

CHANGES IN VERSION 2.2.0

Worksheet	Cells	Change	Thanks to...
Construction input data	C28, C29....	"Volume cement..." changed to "Volume concrete...'	Marianne Brownlee, Arcus Renewable Energy Consulting Ltd
1. Windfarm CO_2 emission saving	F49	=IF(F19=1,365*24*F11*F10*G21/100,SUM(I49,L49,O49,R49,U49)) changed to =IF(D19=1,366*24*F11*F10*G21/100,SUM(I49,L49,O49,R49,U49))	Cameron McIver, Cameron Ecology Ltd

CHANGES IN VERSION 2.3.0

Worksheet	Cells	Change	Thanks to...
5a. Volume of peat removed	F23	=IF('Core input data'!C48=1,'Core input data'!C51,'Construction input data'!D17) changed to =IF('Core input data'!C48=1,'Core input data'!C49,'Construction input data'!D17)	Stuart McGowan, Golder Associates
5a. Volume of peat removed	G23,H23	Similar to above	
5a. Volume of peat removed	F24	=IF('Core input data'!C48=1,'Core input data'!C52,'Construction input data'!D18) changed to =IF('Core input data'!C48=1,'Core input data'!C50,'Construction input data'!D18)	
5a. Volume of peat removed	G24,H24	Similar to above	

CHANGES IN VERSION 2.4.0

Worksheet	Cells	Change	Thanks to...
5c. Volume of peat drained	F33	=($C9+F31+$C9)*($C9+F32+$C9)-(F31*F32) changed to =IF(F23>0,($C9+F31+$C9)*($C9+F32+$C9)-(F31*F32),0)	Stuart McGowan, Golder Associates
5c. Volume of peat drained	G33-T33	Similar to above	

CHANGES IN VERSION 2.5.0

Worksheet	Cells	Change	Thanks to...
7ii. Forestry CO_2 loss - detail	F55	=F50*F53/F54 changed to =IF(F50>0,F50*F53/F54,0)	Jenny Sneddon, AMEC
7ii. Forestry CO_2 loss - detail	G55-T55	Similar to above	
7ii. Forestry CO_2 loss - detail	F46	=IF(F35="Yes", F44*F45, 0) changed to =IF(F35="Yes",IF(F39>0, F44*F45, 0),0	
7ii. Forestry CO_2 loss - detail	G46-T46	Similar to above	
7ii. Forestry CO_2 loss - detail	F63	=(F57*'Core input data'!$E41)-F62 changed to =IF(F55>0,(F57*'Core input data'!$C41)-F62,0)	
7ii. Forestry CO_2 loss - detail	G63-T63	Similar to above	
7ii. Forestry CO_2 loss - detail	G38	='Forestry input data'!$F39 changed to ='Forestry input data'!$H39	
7ii. Forestry CO_2 loss - detail	J38,M38,P38,S38	Similar to above	
7ii. Forestry CO_2 loss - detail	H38	='Forestry input data'!$H39 changed to ='Forestry input data'!$F39	
7ii. Forestry CO_2 loss - detail	K38,N38,Q38,T38	Similar to above	
7ii. Forestry CO_2 loss - detail	D66	=D17+D24+D32-D47-D63 changed to =D17+D24+D32-E47-E63	
7ii. Forestry CO_2 loss - detail	G66, J66, M66, P66, S66	Similar to above	
7ii. Forestry CO_2 loss - detail	E66	=E17+E24+E32-E47-E63 changed to =E17+E24+E32-D47-D63	
7ii. Forestry CO_2 loss - detail	H66, K66, N66, Q66, T66	Similar to above	
5c. Volume of peat drained	C54	='Core input data'!C68 changed to ='Core input data'!C70	SEPA
5c. Volume of peat drained	D54, E54	Similar to above	
5c. Volume of peat drained	D48	='Core input data'!C$65 changed to ='Core input data'!E$65	
5c. Volume of peat drained	E48	Similar to above	
5c. Volume of peat drained	G33	=IF(G23>0,($C9+G31+$C9)*($C9+G32+$C9)-(G31*G32),0) changed to =IF(G23>0,($d9+G31+$d9)*($d9+G32+$d9)-(G31*G32),0)	
5c. Volume of peat drained	J33,M33,P33,S33	Similar to above	
5c. Volume of peat drained	H33	=IF(H23>0,($C9+H31+$C9)*($C9+H32+$C9)-(H31*H32),0) changed to =IF(H23>0,($e9+H31+$e9)*($e9+H32+$e9)-(H31*H32),0)	
5c. Volume of peat drained	J33,M33,P33,S33	Similar to above	

CHANGES IN VERSION 2.6.0

Worksheet	Cells	Change	Thanks to...
Payback Time and CO_2 emissions	D33	=D$31/D9 changed to =D$31/E9	Sarah Lister, Natural Power
Payback Time and CO_2 emissions	D34,D35	Similar to above	
Payback Time and CO_2 emissions	E33	=E$31/E9 changed to =E$31/D9	
Payback Time and CO_2 emissions	E34, E35	Similar to above	
Payback Time and CO_2 emissions	D31	=D19+D25 changed to =D19+E25	
Payback Time and CO_2 emissions	E31	=E19+E25 changed to =E19+D25	
6. CO_2 loss by DOC & POC loss	C11	Contents deleted	Ffion Causer, Natural Power
6. CO_2 loss by DOC & POC loss	D11, E11	Similar to above	
6. CO_2 loss by DOC & POC loss	C26	=(C9+C12+C13+C14+C15+(C10+C17+C18+C19+C20)/C21)/3.66 changed to =((C9+C12+C13+C14+C15)/3.66)+(((C10+C17+C18+C19+C20)/C21)*(12/16))	
6. CO_2 loss by DOC & POC loss	D26,E26	Similar to above	
Do I need to use this tool		Wording changed to clarify that the tool SHOULD be used with highly organic soils, but COULD also be used with sites undergoing drainage or deforestation	SEPA
Core input data	C12	Set to 25 and fixed to comply with planning applications for Section 36 (planning period = 25 years)	
Core input data	Row 25	Average depth of peat at site not used - therefore removed	
1. Windfarm CO_2 emission saving	D48	Set to AVERAGE(G48,J48,M48,P48,S48) to ensure a value is provided	
1. Windfarm CO_2 emission saving	E37	24*365*$D11 changed to 24*365*E11	Sarah Lister, Natural Power
1. Windfarm CO_2 emission saving	F37-U37	Similar to above	
5e. Emission rates from soils	C34	=C28/(C27*10000) changed to =MAX(C28/(C27*10000),C33)	Ffion Causer, Natural Power
5e. Emission rates from soils	D34, E34	Similar to above	

CHANGES IN VERSION 2.7.0

Worksheet	Cells	Change	Thanks to...
8. CO_2 gain - site improvement	C63	=-12*C61/'1. Windfarm CO_2 emission saving'!$D54 changed to =-12*C60/'1. Windfarm CO_2 emission saving'!$D54	Sarah Lister, Natural Power
	D63-N63	Similar to above	
	C64	=-12*C62/'1. Windfarm CO_2 emission saving'!$D54 changed to =-12*C60/'1. Windfarm CO_2 emission saving'!$D54	
	D64-N64	Similar to above	
Core input data	C74	Volume of additional peat excavated added to make the calculation more generalised	Rob McCall, Countryside Council for Wales
	E74, G74	Similar to above	
	C75	Area of additional peat excavated added to make the calculation more generalised	
	E75, G75	Similar to above	
5a. Volume of peat removed	Row 64 - 67	Extra lines added to show the additional peat excavated in this sheet	
	C70	=C14+C27+C39+C62 changed to =C14+C27+C39+C62+C65	
	D70, E70	Similar to above	
	C71	=C13+F26+F38+C61 changed to =C13+F26+F38+C61+C66	
Core input data	B72	"Depth of cable trenches" change to "Average depth of peat cut for cable trenches (m)" to avoid overestimation of peat affected by cable trenches in shallow peats	
Core input data	Row 91	New input: Water table depth in borrow pit before restoration	Sarah Lister, Natural Power
	Row 95	New input: Water table depth around foundations and hardstanding before restoration	
8. CO_2 gain - site improvement	Row 15	Deleted	
	C15 (previously C16)	='Core input data'!C45 changed to ='Core input data'!C91	
	I15, M15	Similar to above	
	D15 (previously D16)	='Core input data'!C50 changed to ='Core input data'!C95	
	J15, N15	Similar to above	
5d. CO_2 loss from drained peat	C43	=C8*(C35+C36)*((C42*C34))/365 changed to =C8*(C35+C36)*((C42*(365-C34)))/365	University of Aberdeen
	D43, E43	Similar to above	
2. CO_2 loss due to turbine life	C9	='Core input data'!C21*C12*'Core input data'!C14*'1. Windfarm CO_2 emission saving'!D48/100 changed to ='Core input data'!C21*C12*'Core input data'!C14	Adrian Barnes, WSP Environment & Energy
	D9,E9	Similar to above	

SCOTTISH EXECUTIVE

Enterprise, Energy and Tourism Directorate
Energy and Telecommunications Division

Ms Joe Baker
Scottish & Southern Energy
Project Development
200 Dunkeld Road
Perth
PH1 3AQ

Meridian Court
5 Cadogan Street
Glasgow G2 6AT

Telephone: 0141-242 5798
Fax: 0141-242 5807
Alice.bayles*@scotland.gsi.gov.uk
http://www.scotland.gov.uk/enterprise/energ

17 August 2007

Dear Ms Baker

ELECTRICITY ACT 1989
THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000
SECTION 36 APPLICATION FOR A WIND FARM AT STRATHY SOUTH, HIGHLAND

I am writing in reference to the application to construct and operate a wind farm at Strathy South. The consultation period has finished for all consultees except The Highland council who have until 10 November 2007 to respond and Scottish Natural Heritage (SNH) who have an extension until 31 August 2007. Please find attached comments made by;

Northern District Salmon Fishery Board
Caithness District Salmon Fishery Board
Civil Aviation Authority - Airspace
Crown Estate
Defence Estates
Health & Safety Executive
NATS
OFCOM
RSPB
SEPA
Forestry Commission
Nuclear Safety Directorate
Highlands and Islands Airports Ltd

There has been no response from BT despite reminders having being sent.

I have included the internal response from Historic Scotland. Also Halcrow felt that the peat stability report was of poor quality.

From a fisheries perspective the following omissions should be corrected;

- There should be an assessment of the combined effects of the proposed Strathy North windfarm.
- Baseline data on the fish within the ES was requested at the scoping stage. Only a habitat survey and anecdotal evidence of salmonid presence has been provided. This is not an acceptable substitute for an electrofishing survey. Identifying spawning areas, fish numbers, species and juvenile nursery areas will allow the developer to tailor the mitigation measures to particular and relevant situations rather than having a general policy. It is difficult to create pollution prevention plans and mitigating engineering solutions when it is unclear what species and the numbers you are dealing with. This would not be a satisfactory situation with birds and neither is it satisfactory when it comes to fish.
- The ES correctly identifies that with tree removal there is a potential for a release of nutrients to water bodies. It does not mention a hydrochemical monitoring programme which could identify at an early stage if mitigation procedures are ineffective, thereby allowing quick response to any problems.
- The ES also correctly identifies that a major source of pollution will come from suspended sediment if it were to reach watercourses. Again there is no mention in the ES of monitoring the suspended solids levels and therefore no way of confirming the effectiveness of the mitigation measures that the developer says will be implemented.
- In respect to these points raised above the following is suggested: The developer should seek to establish at least one years hydrochemical, electrofishing (at possible sites of impaction e.g. track crossings / turbine bases) and macro-invertebrate baseline data, identify suitable control sites away from the potential impacted areas and detail an action plan outlining what they intend to do in the event of a problem. It is further recommended that the electrofishing monitoring programme should be undertaken at the tail end of summer, macro-invertebrate surveys carried out during spring and water quality analysis performed at a monthly basis as a minimum. Continuous stage data and turbidity data should be collected on potentially impacted tributaries and at a suitable control site. Furthermore, it would be expected that a monitoring programme would be implemented during the construction, operational and decommissioning phases of the development.
- Before construction proceeds, the baseline hydrochemical conditions should also be assessed under a range of flow conditions at appropriate spatial and temporal resolutions (fortnightly to monthly). The baseline data should then be used as a fixed tool from which to monitor the wind farms impact and where required, allow rapid action to be taken prior to any major long term impacts.

Also 41 objections (19 of which are confidential) and 1 letter of support have been received regarding the above application. I will email you the relevant spreadsheets.

Yours sincerely

ALICE BAYLES

Bayles A (Alice)

From: Crispian Cook [crispian.cook@bellingram.co.uk]
Sent: 08 August 2007 18:00
To: Energy Consents
Subject: Strathy South Windfarm - Representation

****
This email has been received from an external party and has been swept for the presence of computer viruses.
****

Dear Sirs,

I refer to the application by SSE Generation Limited to the Scottish Ministers for consent to construct and operate a wind farm at Strathy South in Sutherland.

The Northern District Salmon Fishery Board is charged with the statutory responsibility of protecting migratory stocks of Salmon and Sea Trout and the associated fisheries within their area.

The greatest concern that the Board has is to ensure that the migrating fish stocks and the fortunes and values of the fisheries that rely upon them are not affected in any way by the development.

The Environmental Statement prepared by the developers acknowledges that it is likely that Salmon and Trout are present in the River Strathy. The Board would wish to reinforce that the Strathy river system is important habitat for Salmon and trout spawning and that there are well established Salmon fisheries on the river. The Strathy North ES highlighted the fact that there appears never to have been an electro-fishing survey of the system undertaken and today the Board has received an approach from a firm called Waterside Ecology on behalf of SSE Generation Ltd seeking their consent to carry out electro-fishing survey work for both Strathy North and South – well after both Environmental Statements have been produced and submitted. The Boards view is that a full and independent baseline survey of the salmon and trout within the system along with a survey of the condition of the system itself should be undertaken. The survey would contribute to design and construction methodology, allow monitoring of construction if the development is permitted to ensure mitigation of any effects on the salmon/sea trout and the system itself and set the standard for the state that the system and the salmonid population should be left in after completion.

The Board is concerned that, at the moment, the development could be considered for permission without adequate knowledge of the Strathy system and its salmonid population. This means that the Board must object to the application by SSE Generation Ltd as submitted. The Board would however be prepared to discuss with SSE Generation Ltd terms for an agreement that would ensure protection of Salmon and Sea Trout and the fisheries associated with the Strathy River system.

Yours faithfully

Crispian Cook MRICS
Senior Land Agent
Clerk for the Northern District Salmon Fishery Board

Bell Ingram,
Estate Office, Bonar Bridge, Sutherland. IV24 3EA

Tel. 01863 766683
Web Site www.bellingram.co.uk

This email and any files transmitted with it are confidential and intended solely for the use of the individual or entity to whom they are addressed and should not be disclosed to any other party. If you have received this email in error please notify your system manager and the sender of this message. Bell Ingram do not accept any liability for viruses. Please ensure you have adequate virus protection before you open or detach any documents from this transmission.

This email was received from the INTERNET and scanned by the Government Secure Intranet Anti-Virus service supplied by Cable&Wireless in partnership with MessageLabs. (CCTM Certificate Number 2006/04/0007.) In case of problems, please call your organisation□s IT Helpdesk. Communications via the GSi may be automatically logged, monitored and/or recorded for legal purposes.

CAITHNESS DISTRICT SALMON FISHERY BOARD

THURSO EAST
THURSO
CAITHNESS KW14 8HP
TELEPHONE NO: 01847 893134
FAX NO: 01847 896295

Alice Bayles
Scottish Executive
Enterprise, Energy and Tourism Directorate
Energy Consents Unit
Meridian Court
5 Cadogan Street
Glasgow
G2 6AT

RECEIVED
23 JUL 2007

20th July 2007

Dear Mrs Bayles

ELECTRICITY ACT 1989
THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000
SECTION 36 APPLICATION FOR A WIND FARM AT STRATHY SOUTH, HIGHLAND

Thank you for your letter of 2nd July 2007.

As Strathy South is not situated within this Boards area we will not be making any representations on the above application.

Yours sincerely

Peter D Blackwood

Clerk to the Board

Directorate of Airspace Policy

Civil Aviation Authority

Scottish Executive
Enterprise, Energy & Tourism Directorate
Energy and Telecommunications Division
Energy Consents Unit
Meridian Court
5 Cadogan Street
Glasgow G2 6AT

RECEIVED
- 4 JUL 2007

29 June 2007

Reference: 8AP/31/05/01

Dear Sirs,

Proposed Strathy South Wind Turbine Development

Scottish and Southern Energy / SSE Generation Ltd has provided the Civil Aviation Authority (CAA) a copy of the Environmental Statement Non Technical Summary (NTS) relating to the proposed Strathy South wind turbine development. We are advised that the Scottish Executive will request related comment in due course and write in anticipation of such a request.

Scottish and Southern Energy sought this Directorate's comments regarding the subject proposal some years ago and, as previously advised, we commented that the CAA would not wish to make any site-specific observations. That remains the case. However, as advised in my correspondence in September 2004[1], we have no records that the viewpoint of NATS (formally National Air Traffic Services Ltd) had been established. The limited aviation related comment contained with the NTS makes no mention of NATS. It is therefore essential that NATS are provided the opportunity to comment upon the application as a whole. To help complete the aviation related picture the Ministry of Defence (Defence Estates) organisation should be provided a similar opportunity.

More generically, all parties should be aware that:

- There might be a need to install aviation obstruction lighting to some or all of the associated wind turbines should this development be progressed.

  This comment is made specifically if there were concerns expressed by other elements of the aviation industry; ie the operators. For example, if the Ministry of Defence or a local aerodrome had suggested such a need, we the CAA (sponsor of policy for aviation obstruction lighting) would wish, in generic terms, to support such a claim. We would do so if it could reasonably be argued that the structure, by nature of their location and nature, could be considered a significant navigational hazard. That said, if the claim was clearly outside credible limits (ie the proposed turbines were many miles away from an any aerodrome or they were of a height that was unlikely to effect even military low flying) the Authority would play an 'honest-broker' role. In isolation, the CAA would not make any associated case for lighting.

- There is a requirement in the UK for all structures over 300 feet high to be charted on aviation maps. Should this proposed wind turbine development progress and the 300 feet height be breached, to achieve this charting requirement, Scottish and Southern Energy will need to provide details of the development to:

[1] DAP (Smailes) / Scottish Executive (Mansor) correspondence – 8AP/51/06/19/BK dated 7 September 2004.

Civil Aviation Authority
CAA House 45-59 Kingsway London WC2B 6TE www.caa.co.uk
Telephone 020 7453 6545 Fax 020 453 6565 marks.smailes@dap.caa.co.uk

FS 36365 INVESTOR IN PEOPLE

Defence Geographic Centre
AIS Information Centre
Jervis Building
Elmwood Avenue
Feltham
Middlesex
TW13 7AH
Telephone: 0208 818 2708

Whilst none of the above negates any future requirement for consultation in line with Scottish Circular 2/2003, I hope this comment is useful. As and when you require further CAA comment, please do not hesitate to get in touch.

Yours sincerely,

Mark Smailes
ORA5

6 Bell's Brae
Edinburgh, EH4 3BJ

Tel: 0131 260 6070
Fax: 0131 260 6090
Web: www.thecrownestate.co.uk

THE CROWN ESTATE

Scottish Executive
Energy Consents Unit
2nd Floor
Meridian Court
5 Cadogan Street
Glasgow
G2 6AT

Louisa Kemp
Rural Estate Co-ordinator (Scotland & Minerals)
Tel: 0131-260-6073
Fax: 0131-260-6090
E-mail: louisa.kemp@thecrownestate.co.uk

Your Ref.:
Our Ref.:

5 July 2007

Dear Ms Bayles,

Section 36 application for a Wind Farm at Strathy South, Highland

I refer to your letter dated 2 July 2007 regarding the above.

Having checked our records I can confirm The Crown Estate's current interests are not affected by the proposed Strathy South wind farm and we have no comment to make with regard to the environmental statement, non technical summary received from the developer.

I trust the above meets with your approval.

Yours sincerely

Louisa

Louisa Kirk
Rural Estates Co-ordinator (Scotland & Minerals)

\\edin-fes2-v2k-user\lkemp\Docs\Scottish Executive\20070705 Not affected reply ref Strathy South Wind farm.doc

DEFENCE ESTATES
Delivering Estate Solutions to Defence Needs

DE Operations North
Safeguarding Wind Energy
Kingston Road, Sutton Coldfield, B75 7RL

Chris Evans: 0121 311 2025
Claire Duddy: 0121 311 3714
Facsimile: 0121 311 2218
Mobile: 07901 751770
E-mail: chris.evans@de.mod.uk
E-mail: claire.duddy@de.mod.uk
Internet Site: www.defence-estates.mod.uk

Mr Simon Heyes
Scottish & Southern Energy
Inveralmond House
200 Dunkeld Road
Perth
PH1 3AQ

Your Reference:

Our Reference:
DE/C/SUT/43/10/1/1033

Date:
8 February 2008

Dear Mr Heyes

DE Ref Number: 1033

Site Name: STRATHY SOUTH

I am writing to tell you that following your meeting with Squadron Leader Mike Hale, the MOD has withdrawn their concerns with the above proposal.

The application is for 77 turbines at 110 metres to blade tip. This has been assessed using the grid references below as submitted in your pro-forma.

Turbine	100km Square Letter	Easting	Northing
1	NC	80545	52883
2	NC	80940	52720
3	NC	81341	52902
4	NC	80520	52370
5	NC	80850	52335
6	NC	81249	52319
7	NC	80366	52073
8	NC	80756	51900
9	NC	81238	51802
10	NC	80335	51643
11	NC	80671	51390
12	NC	81131	51222
13	NC	80272	51187
14	NC	80630	50982
15	NC	80999	50816
16	NC	80159	50805
17	NC	80504	50589
18	NC	81134	50535
19	NC	80010	50200
20	NC	80353	50080
21	NC	80816	50175
22	NC	79942	49916
23	NC	80304	49702
24	NC	80692	49762
25	NC	79889	49482
26	NC	80264	49236
27	NC	80651	49389

British Quality Foundation
INVESTORS IN PEOPLE
Defence Estates is an Agency of the MOD

28	NC	79863	49078
29	NC	79170	49940
30	NC	79517	49818
31	NC	79086	49632
32	NC	79448	49419
33	NC	78836	48951
34	NC	79140	49030
35	NC	77543	49057
36	NC	78066	49121
37	NC	78381	48940
38	NC	77498	49550
39	NC	77887	49512
40	NC	78513	49316
41	NC	77676	49946
42	NC	78275	49793
43	NC	78679	49700
44	NC	78780	50113
45	NC	78352	50392
46	NC	78810	50479
47	NC	78454	50797
48	NC	78923	50862
49	NC	77973	51067
50	NC	78524	51198
51	NC	78958	51239
52	NC	77895	51622
53	NC	78273	51441
54	NC	78949	51633
55	NC	77840	52128
56	NC	78232	51981
57	NC	78584	51798
58	NC	77617	52569
59	NC	78243	52523
60	NC	78682	52193
61	NC	79047	52069
62	NC	77557	52965
63	NC	77977	52851
64	NC	78753	52583
65	NC	79148	52493
66	NC	78437	52889
67	NC	79183	52843
68	NC	77560	53366
69	NC	78239	53242
70	NC	78883	53035
71	NC	78659	53389
72	NC	79138	53404
73	NC	77367	53912
74	NC	77793	53813
75	NC	78966	53770
76	NC	78898	54196
77	NC	79250	54125

If the application is altered in any way we must be consulted again as even the slightest change could unacceptably affect us.

If you apply for planning permission you must ensure that the relevant planning authority consults this office to ensure that no concerns have arisen since the date of this letter.

British Quality Foundation
PROMOTING BUSINESS EXCELLENCE
INVESTORS IN PEOPLE
Defence Estates is an Agency of the MOD

If planning permission is granted you must tell us;

- the date construction starts and ends;
- the maximum height of construction equipment;
- the latitude and longitude of every turbine.

This information is vital as it will be plotted on flying charts to make sure that military aircraft avoid this area.

Yours sincerely

C. Duddy.

Claire Duddy
Assistant Safeguarding Officer – Wind Energy
Defence Estates

SAFEGUARDING SOLUTIONS TO DEFENCE NEEDS

British Quality Foundation
PROMOTING BUSINESS EXCELLENCE
INVESTORS IN PEOPLE
Defence Estates is an Agency of the MOD

Bayles A (Alice)

From: Durrant, Zoe [Zoe.Durrant@de.defence.gsi.gov.uk]
Sent: 04 July 2007 15:55
To: Bayles A (Alice)
Cc: 'jo.baker@scottish-southern.co.uk'
Subject: Release-Authorised: strathy south wind farm (DE Ref 1033)

Importance: High

****
This email has been received from an external party and has been swept for the presence of computer viruses.
****

Recipient(s): Alice Bayles / Jo Baker

WARNING - CONFIDENTIALITY NOTICE

This e-mail and its contents have been certified at the appropriate classification, and cleared for transmission via the Internet, by the originator. The information contained in this e-mail is private and confidential and for the above named recipient(s) only. For persons other than the intended recipient(s), any use, disclosure, copying or distribution of the e-mail or information contained therein is prohibited and may be unlawful without prior approval from the originator. If you have received it in error, please notify the originator by reply e-mail and delete it from your system.
****

Message:

Thank you for consulting the MOD on the aforementioned 77 turbine wind farm at 110m to blade tip.

We were consulted at pre-planning on the scheme in 2002 when it was for 75 turbines at 118m. The MOD raised low flying concerns on 26/06/02. We have no record of any future consultations to resolve these issues.

The turbines will be within Low Flying Area TTA 14T and will unacceptably affect military activities. These are areas made available for Military Operational Low Flying Training. Within Tactical Training Areas, military fast jets and Hercules aircraft may operate down to a height of 100ft separation distance from the ground and other obstacles. The proliferation of obstacles within this area, therefore, is not only a safety hazard but also severely impacts on the utilisation of the area for this essential Low Flying Training.

Section N of the Non Technical Summary states no objections have been raised with respect to aviation interests. As stated above the MOD has outstanding concerns with respect to low flying, if these matters are not resolved to our satisfaction prior to full planning an objection will be raised. I would be grateful if the developer could provide me with up to date grid references for each turbine (preferably in excel format) to enable the application to be reassessed.

The MOD is willing to work with the developer to explore mitigation measures as these avenues have not as yet been fully explored. We are mindful that Government policy expects to deliver 10% of our electricity from renewable sources by 2010 and are keen to offer further assistance where possible.

Kind Regards

Mrs Zoë Durrant MSc MCIPS
Assistant Head of Safeguarding - Wind Energy
Defence Estates
Safeguarding G8
Kingston Road
Sutton Coldfield
B75 7RL
Tel: 0121 311 2195
Fax: 0121 311 2218
E-mail: zoe.durrant@de.mod.uk

Bayles A (Alice)

From: Durrant, Zoe [Zoe.Durrant@de.defence.gsi.gov.uk]
Sent: 09 July 2007 09:26
To: 'Jo.Baker@Scottish-Southern.co.uk'
Cc: Bayles A (Alice)
Subject: Release-authorised: strathy south wind farm (DE Ref 1033)

****
This email has been received from an external party and
has been swept for the presence of computer viruses.
****

Jo

Our system has been updated with the coordinates provided and sent to the low flying technical advisor. He has confirmed that STRATHY SOUTH is inside the TTA and, is in an area where Fast Jet aircraft start/finish their Low Level runs up and down, therefore the objection will be sustained. I recommend that mitigation suggestions are proposed at the earliest opportunity so discussions with the technical advisor can begin in an attempt to find a mutually agreeable solution.

Kind Regards

Zo

From: Jo.Baker@Scottish-Southern.co.uk [mailto:Jo.Baker@Scottish-Southern.co.uk]
Sent: 05 July 2007 09:55
To: Durrant, Zoe
Cc: Alice.bayles@scotland.gsi.gov.uk
Subject: Re: strathy south wind farm (DE Ref 1033)

Zoe Durrant,

Many thanks for your response. This will be passed on to the relevant members of the team who will be able to discuss mitigation measures.

For your information please find attached an Excel version of the proposed wind turbine locations & anemometry mast locations for the proposed Strathy South Windfarm.

If you should require any further information please do not hesitate to get in contact.

Kind Regards

Jo Baker
Project Developer

Scottish and Southern Energy
Direct Line: 01738 457342

Mobile: 07810 858738
Fax: 01738 456169

"Durrant, Zoe" <Zoe.Durrant@de.mod.uk>

04/07/2007 15:55

To "'Alice.bayles@scotland.gsi.gov.uk'" <Alice.bayles@scotland.gsi.gov.uk>

cc "'jo.baker@scottish-southern.co.uk'" <jo.baker@scottish-southern.co.uk>

Subject strathy south wind farm (DE Ref 1033)

> Recipient(s): Alice Bayles / Jo Baker
>
> WARNING - CONFIDENTIALITY NOTICE
>
> This e-mail and its contents have been certified at the appropriate
> classification, and cleared for transmission via the Internet, by the
> originator. The information contained in this e-mail is private and
> confidential and for the above named recipient(s) only. For persons other
> than the intended recipient(s), any use, disclosure, copying or
> distribution of the e-mail or information contained therein is prohibited
> and may be unlawful without prior approval from the originator. If you
> have received it in error, please notify the originator by reply e-mail
> and delete it from your system.
> **********
> **********
> Message:
>

Thank you for consulting the MOD on the aforementioned 77 turbine wind farm at 110m to blade tip.

We were consulted at pre-planning on the scheme in 2002 when it was for 75 turbines at 118m. The MOD raised low flying concerns on 26/06/02. We have no record of any future consultations to resolve these issues.

The turbines will be within Low Flying Area TTA 14T and will unacceptably affect military activities. These are areas made available for Military Operational Low Flying Training. Within Tactical Training Areas, military fast jets and Hercules aircraft may operate down to a height of 100ft separation distance from the ground and other obstacles. The proliferation of obstacles within this area, therefore, is not only a safety hazard but also severely impacts on the utilisation of the area for this essential Low Flying Training.

Section N of the Non Technical Summary states no objections have been raised with respect to aviation interests. As stated above the MOD has outstanding concerns with respect to low flying, if these matters are not resolved to our satisfaction prior to full planning an objection will be raised. I would be grateful if the developer could provide me with up to date grid references for each turbine (preferably in excel format) to enable the application to be reassessed.

The MOD is willing to work with the developer to explore mitigation measures as these avenues have not as yet been fully explored. We are mindful that Government policy expects to deliver 10% of our electricity from renewable sources by 2010 and are keen to offer further assistance where possible.

HSE

Health and Safety Executive

Hazardous Installations Directorate

Dr G A Cook

Chemical Industries Division
Belford House
59 Belford Road
Edinburgh
EH4 3UE

Tel: 0131 247 2000
Fax: 0131 247 2041
geoffrey.cook@hse.gsi.gov.uk

http://www.hse.gov.uk/

Head of Unit
Anne Wilson

Scottish Executive
Energy Consents Unit
Meridian Court
5 Cadogan Street
Glasgow
G2 6AT

RECEIVED
- 9 JUL 2007

Date 05 July 2007

Reference GC/STRATHY WINDFARM/FR

Dear Sirs

ENVIRONMENTAL ASSESSMENT FOR PROPOSED DEVELOPMENT AT Strathy South, Highland

Thank you for your letter of 2 July 2007 regarding the environmental statement for the proposed development by SSE Generation Ltd at Strathy South.

Environmental Impact Assessments are concerned with projects, which are likely to have significant effects on the environment. HSE's principal concerns are the health and safety of people affected by work activities. HSE has no comments on this environmental statement.

Yours faithfully

Dr G A Cook
HM Principal Inspector of Health and Safety

NATS

NERL Safeguarding – Mailbox 27
NATS – CTC
4000 Parkway
Solent Business Park
Whiteley
Hampshire
PO15 7FL

T: 01489 444687
F: 01489 444013
E: natssafeguarding@nats.co.uk

Alice Bayles
Scottish Executive
Energy Consents Unit
Meridian Court
5 Cadogan Street
Glasgow, G2 6AT

RECEIVED
18 JUL 2007

13th July 2007

Your Ref: Strathy South
Our Ref: N/SFG/W(F)7665

Dear Sir/Madam,

Wind Farm: Strathy South, Highland

The proposed development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal.

However, please be aware that this response applies specifically to the above consultation and only reflects the position of NERL (that is responsible for the management of en route air traffic) based on the information supplied at the time of this application. This letter does not provide any indication of the position of any other party, whether they be an airport, airspace user or otherwise. It remains your responsibility to ensure that all the appropriate consultees are properly consulted.

If any changes are proposed to the information supplied to NERL in regard to this application which become the basis of a revised, amended or further application for approval, then as a statutory consultee NERL requires that it be further consulted on any such changes prior to any planning permission or any consent being granted.

Yours faithfully,

Sarah Allen
Technical Administrator
On behalf of NERL Safeguarding Office

Bayles A (Alice)

From: Steven Alexander [Steven.Alexander@ofcom.org.uk]
Sent: 04 July 2007 16:59
To: Bayles A (Alice)
Cc: jo.baker@scottish-southern.co.uk
Subject: Proposed Windfarm Development at Strathy South. (approx centre NC 795 515) clearance radius 4 km

****
This email has been received from an external party and
has been swept for the presence of computer viruses.
****

WINDFARM CO-ORDINATION REQUESTS FOR
Proposed Windfarm Development at Strathy South. (approx centre NC 795 515) clearance radius 4 km

Planning Application: _Windfarm at Strathy South
For Attention of: Alice Bayles

Dear Alice,

Ofcom has found that no civil fixed links should be affected by the proposal for wind turbines.

This response to your co-ordination request is only in respect of microwave fixed links and does not include broadcast transmissions or scanning telemetry links that may be affected by your proposals.
Contacts for scanning telemetry and TV broadcasting are given below:

CSS Spectrum Management Services Ltd. David Tripp 01458 273 789 david.tripp@css.gb.com (for Scanning Telemetry)
Joint Radio Company (JRC). David Priestley 020 7953 7015 david.priestley@jrc.co.uk (for Scanning Telemetry)

Please note that with regard to assessing the affects to TV reception, the BBC now have an online tool available on their website, at http://windfarms.kw.bbc.co.uk/
Ofcom will no longer be forwarding enquiries received to the BBC or carrying out assessments. Developers are advised to access the online tool.

Please also be advised that this co-ordination request is also only in respect of fixed microwave links managed by the Ofcom, in addition the applicant is obliged to do further checks for the proposals with the CAA, the MOD, NATS. More information is available on the British Wind Energy Association website www.bwea.com .

Regards

Steven Alexander

Steven Alexander BSc (Hons) MIET.
Senior Engineer-Fixed Wireless Services
Spectrum Policy Group
020 7981 3089
steven.alexander@ofcom.org.uk

Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA
020 7981 3000
www.ofcom.org.uk

****
Ofcom is the independent regulator and competition authority for the UK communications industries, with responsibilities across television, radio, telecommunications and wireless communications services.

For further details and to register for automatic updates from Ofcom on key publications and other developments, please visit www.ofcom.org.uk

This email and any files transmitted with it are confidential and intended solely for the use of the individual or entity to whom they are addressed.

If you have received this email in error please notify the originator of the message. This footer also confirms that this email message has been scanned for the presence of computer viruses.

Any views expressed in this message are those of the individual sender, except where the sender specifies and with authority, states them to be the views of Ofcom.
****

This email was received from the INTERNET and scanned by the Government Secure Intranet Anti-Virus service supplied by Cable&Wireless in partnership with MessageLabs. (CCTM Certificate Number 2006/04/0007.) In case of problems, please call your organisation's IT Helpdesk. Communications via the GSi may be automatically logged, monitored and/or recorded for legal purposes.

Scottish Executive
Enterprise, Transport & Lifelong Learning Department
Consents and Emergency Planning Unit
Meridian Court
5 Cadogan Street
Glasgow
G2 6AT

10th August 2007

Dear Ms Bayles,

ELECTRICITY ACT 1989: SECTION 36 APPLICATION FOR A WIND FARM AT STRATHY SOUTH, SUTHERLAND
Your Ref: IEC 3/146

Thank you for inviting RSPB Scotland to comment on the above application to install seventy-seven, 1.8-2.3MW turbines (65m to hub, rotor diameter 90m, giving maximum height to blade tip of 110m, max. output 177MW) and associated infrastructure at Strathy South, Sutherland.

RSPB Scotland objects to this proposal for the following reasons:

- **We consider that the application, both alone and in combination with other proposals including the associated grid connection and the nearby second, major windfarm, Strathy North, for which an application has recently been made, is likely to affect adversely the integrity of the adjacent Special Protection Area (SPA) and Special Area of Conservation (SAC).**
- **As a result the proposal is contrary to the Highland Region Structure Plan, Policy N1; and**
- **Contrary to the Highland Renewable Energy Strategy and Planning Guidelines (May 2006)**

Furthermore, we believe the Environmental Statement (ES) in support of the application is lacking in a number of key areas necessary to facilitate an Appropriate Assessment as required by the Habitats Regulations:

- **The proposals may have an adverse impact upon a pair of hen harriers which nest out-with the SPA but are likely to hunt frequently within it. More information on this species, which is listed on Annex 1 of the EU 'Birds' Directive[1] and is a qualifying interest of the adjacent SPA[2], is needed especially regarding collision risk and to reduce the predicted impact of the development.**
- **Potential impacts of the development on golden eagles breeding on the adjacent SPA, should be investigated further. This species is listed in Annex 1 of the EU 'Birds' Directive and is a cited interest of the adjacent SPA. It is necessary to show that the proposed development will not have an adverse impact upon the SPA golden eagle population.**
- **Potential impacts of the development upon red-throated and black-throated divers breeding on the adjacent SPA, require further examination. This species is listed**

[1] EC Directive on the Conservation of Wild Birds 79/409/EEC
[2] The Caithness and Sutherland Peatlands Special Protection Area

in Annex 1 of the EU 'Birds' Directive and is a cited interest of the adjacent SPA. We detail further work, which we consider to be necessary in the Appendix (Paragraph 5).

- **Potential impacts of the development upon greenshank breeding on the SPA require further examination. Greenshank are a Schedule 1 listed Species[3] and a cited interest of the SPA. We detail further work regarding collision risk and reduction of the potential impact of the development in the Appendix (Paragraph 3).**
- **The access track, grid connection and much of the site infrastructure are proposed on blanket bog and transitional mire, whilst the majority of the site is on deep peat[4]. Blanket bog and transitional mire are habitats listed on Annex 1 of the EU 'Habitats' Directive[5] contributing in part to the Caithness and Sutherland Peatlands SAC. We question the accuracy of the predicted extent of habitat lost or damaged, both directly and indirectly, and believe the implications for the SAC and the wider context, including the UK Biodiversity Plan have been understated.**
- **Cumulative impacts upon the Caithness and Sutherland Peatlands SPA and SAC, arising from this and other developments already in the planning process, and the necessary grid connection should be considered.**

The proposed site is encompassed by Skelpick Peatlands SSSI, Lochan Buidhe Mires SSSI, West Halladale SSSI and Strathy Bogs SSSI, which form part of the Caithness and Sutherland Peatlands SPA and Ramsar site and Special Area of Conservation. The steps outlined in NPPG1, NPPG14 and SOEnD Circular 6/1995 (as updated June 2000) (derived from The Conservation (Natural Habitats, &c.) Regulations 1994 (the Habitats Regulations)) therefore apply. As a result, if the competent authority, in this case the Scottish Executive, "*...concludes that a proposed development unconnected with site management is likely to significantly affect a European site, it must then carry out an appropriate assessment of its implications ..... so as to ascertain whether or not it will adversely affect the integrity of the site*".

In our opinion, a significant effect is likely and "appropriate assessment" under Regulation 48 of the Habitats Regulations is therefore required.

Furthermore, the Circular states that developments (which may be out with the boundaries of the site) likely to affect the integrity of such sites are only permissible if there:

"*are no alternative solutions*" and "*for imperative reasons of overriding public interest, including those of a social or economic nature.*" (June 2000, Annex E, Appendix B). These policy wordings set out the tests required by the Habitats Regulations.

The ES acknowledges the presence, on or adjacent to the site, of red-throated and black-throated diver, hen harrier, golden eagle, merlin, peregrine falcon, golden plover (listed in Annex 1 of the 'Birds Directive') and greenshank (a Schedule 1 listed species under the Wildlife & Countryside Act 1981), all of which are qualifying features of the Caithness & Sutherland Peatlands SPA. It is necessary to show that the proposed development will have no impact upon SPA populations, this has not been done for all of these species hence, with a high level of uncertainty the precautionary principle is invoked and the development, in RSPB's opinion, cannot be consented.

---

[3] The Wildlife & Countryside Act 1981 as amended by the Nature Conservation (Scotland) Act 2004

[4] Peat >0.5m depth is classed as "deep peat" by Forestry Commission Scotland (and is to be avoided for new planting) and by Scottish Natural Heritage in its various peatlands management schemes.

[5] EU Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora 92/43/EEC.

SSE consulted RSPB Scotland over an initial site search in January 2003 and we later submitted formal scoping comment to your offices in September 2004, to which I refer you (RSPB/SE 28/09/04 attached). Throughout the consultation process, we have made the developer aware of our concerns regarding the predicted impacts of this application -both alone, and in conjunction with the associated grid connection- and the previously submitted Strathy North wind farm, upon the adjacent designated sites, their interests and the additional rare birds and habitats present on the site. We are disappointed to note that these are not reflected in the current application, which we suggest is of an unacceptable scale and inappropriate in this location.

The reasoning behind our position is set out in more detail in the Appendix below.

Please contact us if you would like to discuss any aspect of this further.

Yours sincerely,

Kenneth Graham
Conservation Officer
North Highland

Cc: Gordon Mooney (HC), Roger McMichael (SNH), Simon Heyes, (SSE)

APPENDIX
RSPB Scotland's Objection to proposed Strathy North Windfarm 2/3/07

1. Importance of the site

The ES notes that, of the 72 bird species recorded either on, near or flying over the site, 9 are qualifying interests of the adjacent SPA, 16 are listed in Schedule 1 of the Wildlife & Countryside Act whilst 10 are 'Red' and 30 'Amber' listed Birds of Conservation Concern[6]. In a UK context the site and the surrounding area is therefore very rich in rare or threatened species.

2. Hen harrier

2.1 We are concerned that the proposal to construct turbines immediately adjacent to at least one hen harrier nest site may have an adverse effect on breeding success. The location of one of the turbines lies within 200m of the 2003 nest location (Figures CA3 & CA3a Confidential Annex, ES Sect 11.6.5). In order to mitigate potential disturbance effects and minimise the risk of collision associated with breeding behaviour and successful fledging, we recommend that turbines should not be placed within 1km of known hen harrier nest locations and that any habitat enhancement work for this species takes place beyond 500m from any turbine location. Only in certain circumstances, where behaviour is demonstrated to be affected by topographical features, may these distances be reduced. We suggest that the mitigation proposed, *'blocks of existing forestry plantation will be left in the area during the felling operations to provide some screening from the main construction activities '*(ES page 11-34 Sect 11.6.5 (b)) is of unproven efficacy and is likely rapidly to become ineffective due to windthrow. Although the proposal to *'minimise or remove disturbance effects by careful programming of construction works to occur outside the breeding season'* (ES Page 11-34, Sect. 11.6.5 (d)) may prove effective during construction, we suggest that removal or repositioning of turbines within 1km of the nest site would be more appropriate. We suggest that the presence of hen harriers should have been recognised as a constraint in the design process. The developer acknowledges that the felling proposed *'is likely to create a significant area of additional foraging habitat for this species which would lie within the core of the wind farm area and may encourage flight activity'* (ES page 11-34 Sect 11.6.5 (b)). We concur with this and suggest that additional nesting habitat will also become available within the site post felling. We do not believe that an increase in site usage of the site will be restricted to low level foraging behaviour and suggest that a likely increase in breeding behaviour should also be considered in the 'risk analysis'.

2.2 The Developer's collision risk prediction for this species (0.04 birds per year at 95% avoidance (ES Table Fig. 11.24)) indicates a relatively low usage when taken over the entire site. Given the large observation distances involved and the extent of this site, hen harrier activity is likely to be greater than that observed and we suggest that this figure should be regarded as a minimum. Activity will be greater still in future years following tree removal and the recovery of the vegetation post felling.

3. Greenshank

3.1 The ES reports that in 2003 & 2004 seven pairs of greenshank were associated with the site: six pairs in any one year on the SPA, but out-with the core area, and single pairs located within the forest, but greater than 500m from the nearest turbines. The ES indicates (Figure CA6) only minimal flight activity by greenshank within the site and low potential

[6] The Population Status of Birds in the UK, BoCC: 2002-2007

collision risk. Greenshank are medium sized waders whose flight behaviour means they are easily missed during survey. Given the large observation distances involved and the extent of this site, we suggest that these figures should be regarded as minima: activity is likely to be greater than that observed and will be greater still in future years, following tree removal and the recovery of the vegetation post felling, which will make the site more suitable for the species.

3.2 The appropriateness of attracting breeding greenshank into the core windfarm area because of habitat restoration work is questionable and the implications of enhanced collision risk should be considered further. The effectiveness of reduction of disturbance through the retention of plantation forestry (ES 11.6.2 (a)) is also questionable. Our reasoning is expanded upon in our comments below on forest removal (8. Forestry Clearance).

3.3 We endorse the proposal to minimise construction disturbance to birds through appropriate timing of operations. We recommend that, if the application is consented a planning condition be imposed preventing construction work during the period 1 April to 31 July. Construction of the proposed access track to the NW of the site has the potential to affect several pairs of greenshank associated with the SPA. We suggest greater consideration should be given to the likely impacts on the surrounding habitat caused by road construction, which is currently lacking.

4. Golden eagle

Vantage point work presented in the ES has shown that approximately 7% of the golden eagle flights are recorded traversing the site and recognises that these are likely to arise from two pairs associated with the SPA breeding in the vicinity of the proposal (ES Sect.11.6.6,& ES Figs. CA 4a & 4b) whilst some of the past hunting range of the eagles has undoubtedly been lost to afforestation, survey work has shown that the birds do currently utilise the open areas of the plantation. We would expect this to increase as the forest is brought up to current environmental standard in the future. Work at the Beinn an Tuirc wind farm in Kintyre has shown that the resident golden eagles (now down to an unpaired female) only (rarely) traverse the wind farm site to defend their territory and no young have been raised there since the windfarm was constructed[6] (Walker et al, 2005). Similarly, at Beinn Ghlas near Taynuilt, where wind turbines were located very close to the traditional nest sites, no subsequent breeding success has been recorded (Andy Robinson, pers comm.,). In our opinion, installation of a large wind farm in this location may limit eagle usage of the site for as long as the wind farm is present and operational. If the Beinn an Tuirc example is not followed and eagles do use the site then clearly the issue of collision risk will become more acute. We consider that the potential effects of displacement upon loss of hunting area and, consequently, productivity should be quantified through additional modelling.

5. Diver species

Diver- specific vantage point work presented in the ES appears to have been concentrated on two red-throated diver territories and a black-throated diver territory located on the SPA in the vicinity of the proposal. (ES Figs. CA1, CA1a & CA2). This dedicated survey involved looking outwards from the development site and so could not be expected to add to our knowledge of how birds use the proposed windfarm site. Nevertheless, generic Vantage Point survey did cover the site, although examination of the vantage point survey hours and

[6] Walker D., McGrady M., McCluskie A., Madders M. and McLeod D.R.A. Resident Golden Eagle ranging behavior before and after construction of a windfarm in Argyll, *Scottish Birds (2005) 25: 24–40.*

weather summary report (ES Appendix 11.4 pages1-7) reveals that observations did not cover the dawn and dusk periods. Furthermore, dedicated diver surveys covered only one dawn (17th June 2004) and one dusk (15th June 2004) period - the time when divers are expected to be most active as they commute between breeding lochs and feeding areas. Survey work has not covered the pair of red-throated divers located to the west of the site (ES Fig CA1). We disagree with the statement that *'this constitutes a comprehensive field study on diver activity within the wind farm study area upon which an assessment of impacts can be determined with a reasonable level of confidence'* (ES Sect. 11.4 (i)) and suggest that the survey effort used to determine diver use across the site is inadequate. In our opinion, flights across the development site by red-throated and black-throated divers associated with the SPA are likely to have been under recorded and so the impacts upon these qualifying species may be greater than indicated.

6. Peregrine, Merlin, Short-eared Owl, Golden Plover & Dunlin

These species were recorded at sufficient distances from the proposed windfarm that the risks of disturbance or displacement are low. Their low detectability in flight means that collision risk cannot be reliably predicted from the standard vantage point surveys. The observations presented in the ES, combined with our knowledge of the species and their habitats on similar sites elsewhere, suggest that minimal use is likely to be made of the site at present. It is likely that tree felling and related mitigation will lead to increased use of the area over time for all these species with an attendant increase in collision risk, which should be considered.

7. Cumulative impacts

There are a number of other windfarm applications, which may also have a potential effect on the qualifying populations of species associated with the Caithness and Sutherland Peatlands SPA. We consider that a cumulative assessment of the predicted collision risk for all of the schemes submitted to date, plus this proposal, should be made. Those that have now been refused or dropped out of the planning system should be excluded. This assessment should be undertaken, using the standard modelling approach as recommended by SNH, by assessing the collision risk of the proposed wind farm in addition to those from the other schemes meeting the criterion above, assessing the additional mortality in the context of its effect upon relevant SPA populations. If insufficient information is available for any particular scheme, then best estimates of the missing information should be used, making this clear in the cumulative assessment report. In addition, consideration will have to be given to the cumulative impact arising from necessary grid connection. With no details available on route or whether it is to be over-or under-ground, this will not be straightforward but, again, various likely scenarios can be employed to examine the consequences for SPA and SAC qualifying interests.

8. Forestry clearance

8.1 The ES states that " Approximately 13km^2 of conifer plantation would be cleared during the construction of the wind farm". (ES Sect.10.6.2 (f)). Whilst we agree that "this would provide the opportunity for significant restoration of blanket bog and heathland habitat", it is unclear how much this is required to physically accommodate the development rather than being mitigation for any adverse effects of the proposals on species and habitats. These forestry plantations are inherently unstable and windblow is already prevalent in similar areas of more mature plantation to the north, rendering longer-term retentions for screening or buffering of dubious worth.

8.2 The forestry felling must be carried out in accordance with the UK Forestry Standard, including the Forest & Nature Conservation Guidelines and Forests & Water Guidelines.

Were this to proceed under felling license, then any re-stocking proposals would need to be sympathetic to peatland habitats as outlined in the Peatlands Management Strategy.[7] For example, re-stocking on deep peat sites is unlikely to be looked upon favourably whilst an introduction of native broadleaves to complement and extend riparian habitat networks would be encouraged. In short, what are presented as the main mitigating measures will occur anyway as part of the future management of the forestry as it is brought up to current environmental standard, should this application be refused consent.

8.3 The ES (Sect. 10.6.2(f)) commits the applicant, should consent be given, to "A fully detailed forestry management plan." We commend this, but consider that the present level of detail (ES Sect 14.6.1 (b)) should be expanded upon prior to determination of the application. Furthermore, we recommend that the adoption of and commitment to implementation of this plan, to be approved by SNH and the Highland Council in consultation with other relevant parties including RSPB Scotland, should be the subject of a Section 36(5) condition.

9. Avian monitoring

The ES states that "Additional monitoring is to be undertaken, both during the construction period and for an initial period of three years upon site completion and wind farm commissioning" (ES Sect. 11.7). This will be insufficient to assess bird population changes in a radically modified habitat. A commitment to carry out bird monitoring on the site, plus a suitable control, in years 1,2,3,4,5,10,15 and 20 should be made the subject of a planning condition with survey, reporting and review details included in the Management Plan.

10. Grid connection

The development site is surrounded by the SPA and SAC, which will have to be crossed by the necessary grid connection which will be subject to a separate consent under Section 37 of the Electricity Act 1989 . In our opinion, a significant effect on the SPA and SAC is likely to arise and alternative grid linkages should be considered prior to granting consent for this windfarm application and further consideration given to reducing potential effects on protected species arising from both the windfarm and its grid connection. An "appropriate assessment" under Regulation 48 of the Habitats Regulations will also be required for grid connection.

11. Access

11.1 In our opinion, a significant effect on the SPA and SAC is likely to arise from the proposed access. The ES states, conservatively, that *'A total of 61.24 ha or 0.04% of the SAC may therefore be affected by habitat change' (ES Sect. 10.6.2 (e)).* No information has been presented in the ES regarding impacts of the proposed routes upon breeding birds. The ES states that *'the route proposed between Strathy North and Strathy South forests uses the course of an all terrain vehicle (ATV) track which was regularly used at the time the Strathy South was planted.'* (ES Sect 4.2.3). Having recently viewed the southern part of this route –currently marked by white posts- we could find no evidence of a previously used track of any description. We understand that land management agreements between land owners and SNH specifically exclude new tracking across similar areas of the SAC/SPA and suggest that no new tracks across the SAC/SPA should receive consent, especially as an alternative route already exists.

11.2 A significant amount of land take is proposed on important habitats out-with the SPA/SAC, within the forest complex which we believe should be regarded as of similar importance to the SAC. It is proposed to locate 15 turbines and 29.62 km (42.62km – 13km) of

[7] The Peatlands of Caithness & Sutherland, Management Strategy 2005-2015

track out-with the forested area (ES 10.6.2 (b)) within the Strathy South complex. Our previous experience suggests that the figures quoted in the Impacts Evaluation (ES Section 10, Tables 10.7, 10.8 & 10.9) are based on absolute minima and we would expect the installed running width to be significantly increased when associated ditching, cable trenching, batters etc are included, even on the floating sections. We disagree with the statement that *'the wind farm layout has been designed to avoid the most highly sensitive receptors as far as possible'* (ES10.6.2 (b)). For example, the developer could have restricted turbine positioning to within the current afforested area. We suggest that the important Annex 1 habitats present on the site should have been given a greater weighting as an ecological constraint in the design process.

12. Planning policies - National

12.1: Government advice relating to development within or adjacent to SPAs or SACs is outlined in NPPG1, NPPG14 and SOEnD Circular 6/1995 (as updated June 2000). As the proposed development is likely to have a number of impacts on designated sites (Caithness and Sutherland Peatlands SPA), or protected species (hen harrier, golden eagle, greenshank) the provisions of the Habitats Regulations and the Habitats and Birds Directives apply. The Habitats Regulations require, a structured approach to the impact on European sites. This structured approach is not optional but is required as a matter of both EC and Scots law. This approach requires every competent authority (Scottish Executive Circular 6/1995, as amended 2000), in this instance Scottish Ministers, to undertake the following steps[8]:

12.2: Undertake an assessment as to whether the project is likely to have a 'significant effect' on a European site (Reg. 48(1) and Art. 6(3)) whether in combination with other plans or projects or alone. Reg. 10 defines a European site to include SPAs, SACs and as a matter of government policy, Ramsar sites.
RSPB Scotland considers, for reasons given above, that these proposals are likely to have a significant effect upon the Caithness and Sutherland SPA and SAC.

12.3: If there is likely to be such a significant effect the competent authority must carry out an appropriate assessment (Reg. 48(1) and Art. 6(3)).
RSPB Scotland believes that the Executive, as competent authority, must therefore carry out an appropriate assessment

12.4: The appropriate assessment must consider the implication for the European site 'in view of' that site's conservation objectives (Reg. 48(1) and Art. 6(3).
We have outlined the implications for the site's conservation objectives that we believe are relevant above.

12.5: In light of the conclusions of the assessment the competent authority shall agree to the project only after having ascertained that it will not adversely affect the integrity of the European Site (Reg. 48(5) and Art 6(3)).
We consider that the potential impacts for qualifying interests of the SPA (breeding golden eagle, hen harrier, red-throated diver and black-throated diver) and SAC (blanket bog and transitional mire) are sufficiently serious that there could be an adverse effect on site integrity, were these proposals to be consented in their current format and so urge refusal. The developer has not been able to produce sufficient evidence to contradict this evaluation.

[8] As the proposals are neither directly connected with nor necessary to the conservation management of the site, an earlier step is omitted here.

12.6: If it cannot be ascertained that the project will not adversely affect the integrity of the European site, the authority must then consider whether there are any alternative solutions (Reg. 49(1) and Art. 6(4)).
Alternative solutions, such as the development of windfarm sites elsewhere to generate an equivalent amount of energy, obviously exist.

Consideration of further steps, including granting consent for the project "for imperative reasons of overriding public interest" need not then be considered.

13. Planning policies - Development Plan

Policy N1 Nature conservation of the Highland Region Structure Plan (2001) reflects the above advice with respect to developments within or adjacent to SPAs:

" Developments which would have an adverse effect on the conservation interests for which a site has been designated will only be permitted where there is no alternative solution and there are imperative reasons of over-riding public interest, including those of a social or economic nature."

Regarding sites of national importance (*eg* SSSIs) it states:

"Developments will only be permitted where the objectives of designation and the overall integrity of the area will not be compromised or any significant adverse effects on the qualities for which the area has been designated are clearly outweighed by social and economic benefits of national importance."

Potential sites for wind energy generation need to be assessed in relation to the criteria outlined above, which will include all Annex 1 listed bird species and habitats previously mentioned. To proceed with the development in its current format we suggest is inappropriate and is contrary to the development plans.

14. Planning Guidelines

RSPB Scotland is supportive of the Highland Renewable Energy Strategy and Planning Guidelines (May 2006). We note that the proposal falls out-with a 'preferred development area' for 'prospective development zones for national and major onshore windfarms designed for meeting national/regional energy requirements', which this application represents. We are aware that these are guidelines, which do not preclude the development of proposals subject to the requisite environmental tests being met. Given the difficulties in meeting these requirements, we believe that consenting the current proposal would seriously undermine the value of the strategy. In our opinion, the development in its current format is inappropriate in this location.

RECEIVED

SEPA
Scottish Environment Protection Agency

Our Ref: CM/FJV/EA/2007/1045
Your Ref: Unknown

FAO Alice Bayles

Energy Consents Units
Meridian Court
5 Cadogan Street
Glasgow
G2 6AT

If telephoning ask for:
Cerian MacInnes

6 August 2007

Dear Madam

ELECTRICITY ACT 1989
THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000
SECTION 36 APPLICATION FOR A WINDFARM AT STRATHY SOUTH, SUTHERLAND

Thank you for consulting SEPA on the above application and accompanying Environmental Statement (ES). SEPA comments as follows. Please note that these comments are without prejudice to SEPA's consideration of any elements controlled through environmental regulation administered by SEPA.

Summary
SEPA notes that the proposed layout lies close to a number of watercourses and areas of deep peat. SEPA requires further information on a number of elements as detailed below to fully assess the impact upon watercourses, private water supplies and peatlands. SEPA therefore **objects** to this application until either the site layout is revised to relocate elements away from these sensitive receptors or until the below further information is submitted.

Notwithstanding this SEPA is satisfied with the remainder of the ES and considers that once the above matters have been dealt with, the mitigation measures identified within the ES can form the basis of a more detailed construction method statement and be secured through various conditions as detailed below.

1. The Water Environment (Controlled Activities) (Scotland) Regulations 2005

1.1 On the basis of the information available and without prejudice to the determination of any corresponding application(s) for CAR authorisation, SEPA expects the proposal to fall into Category 1 - "proposal accords with WFD objectives – 'capable' of being authorised".

2. Cumulative Affects

2.1 SEPA notes that this proposal lies close to the Strathy North windfarm proposal. Given the cumulative scale of Strathy South and Strathy North windfarm proposals there may well be significant environmental impacts upon peatland habitats, designated sites and landscape. These are not areas within SEPA's expertise and therefore SEPA advises the determining authority to seek the views of SNH on these cumulative impacts.

Cont'd/...

3. Access Track Layout

3.1 SEPA notes that the access track layout on Figure 4.2 appears to differ from the other site layout drawings contained within the ES and therefore SEPA in unclear as to what exactly is proposed and therefore cannot fully assess the environmental acceptability of the proposals. In addition it was difficult to ascertain whether there were other differences between the other site layout drawings too.

3.2 In particular there are differences regarding access routes between turbines 29 and 31, 43 and 29, 30 and 22, 40 and 37, 32 and 34, 38 and 39, 45 and 46 and finally 41 and 45. Some these routes involve watercourse crossings and therefore given the number of differences this could mean a significant change in the impact upon the water environment. SEPA therefore **objects** until a new site layout plan is submitted illustrating exactly what is proposed.

3.3 In addition SEPA notes that there may be opportunities to minimise the length of access tracks and number of watercourse crossings. SEPA is unable to comment on specific layout issues until the above issue is clarified however SEPA advises the applicant to assess the layout prior to submitting this new layout plan ensuring that only necessary access tracks are proposed and that watercourse crossings are kept to a minimum.

3.4 SEPA notes the proposal to create a floating road for the main site access utilising an 'existing' ATV track as opposed to an existing forestry track as shown on the Ordnance Survey map. The ATV track is not shown on any existing maps and no further information is submitted on the existing condition of this track therefore it is unclear what impact developing this route would have although it appears that proposed track traverses an area of deep peat. SEPA therefore **objects** to this element of the proposal until further information including photographs of this 'existing' track and the potential impacts of this track are submitted. SEPA also notes the track traverses designated sites and therefore the views of SNH should be sought on this matter.

3.5 SEPA notes that access to the site is proposed via a bypass to Strathy village. Through consultation on Strathy North windfarm proposal it is SEPA's understanding that this bypass is required to enable the delivery of the large turbine components. Given that this new road is proposed through a previously undeveloped area of peat SEPA's preference is that the existing road is utilised to prevent further habitat loss of peatland areas. If the applicant proposes to pursue this new road option then SEPA **requests** that further information is provided to demonstrate that the impact of this new road is not significant.

Cont'd/...

4. Layout in Relation to Peatland

4.1 SEPA notes from Figure 14.4 that some turbines and associated track lengths are located in areas of deep peat. SEPA prefers for areas of deep peat to be avoided both due to the risk of peat instability but also the impacts upon peatland habitats. In particular it would seem that the location of turbines 3,6, 9, 30, 40, 52, 55, 56, 58, 74, 77 are poorly placed. SEPA notes that the proposed mitigation is to micro-site to areas of shallow peat. SEPA assumes that micro-siting in this instance refers to distances of up to 50m and requests that a **condition** is applied requiring micro-siting to be limited to 50m. Based on Figure 14.4 it would not appear to be possible for turbines 9, 40, 52, 55, 58 and 77 to be relocated to an area of shallow peat within 50m. SEPA therefore **objects** unless these turbines and associated access tracks are relocated to areas of shallower peat **prior** to determination when the potential knock-on impact of doing so can be fully assessed as part of the ES. The applicant should note the comments in section 3 in relation to site layout plan differences and it may be that the new site layout plan alters these comments.

4.2 SEPA notes that a peat stability risk assessment is included in Appendix 14.1. SEPA notes that for a number of turbines and access tracks that this assessment identifies the need to do further site assessment of the peat slide risk and to possibly relocate some turbines and tracks up to 90m away from the current proposed position. This is a large distance to relocate elements and could significantly alter the impact of the proposal. SEPA therefore **objects** unless this work is carried out **prior** to determination so that it can be demonstrated that a lower risk area can be identified and so that any knock-on effects of the changes can be assessed as part of the ES. Please note that SEPA's objection relates to the potential inability to implement the proposed mitigation and is not a technical comment on the peat stability assessment itself.

4.3 Mitigation measures in relation to stability have also been identified for other aspects of the scheme. SEPA requests that these be covered as follows:

i) Details of good practice measures, including proposals for working in relation to heavy rainfall be provided in a construction method statement (CMS) (see section 13 for further details on the CMS);
ii) Details on monitoring proposals specifically related to stability also provided in the CMS;
iii) A **condition** be applied requiring additional peat probing prior to commencement of development to determine the final location of those parts of the scheme identified as having a "tolerable" risk before mitigation. Agreement of determining authority in consultation with SEPA and other bodies such as SNH if the location is greater than micro-siting or if there are any knock- on effects; and
iv) The appointment of an onsite geotechnical engineer during construction be ensured by **condition.**

Cont'd/...

5. Layout in Relation to Ecology and Nature Conservation

5.1 It is noted that the proposed floating access track and upgrading of an existing access track will encroach on the Caithness and Sutherland SAC, SPA and Ramsar and component SSSI and will result in a loss of habitat. While the ES indicates that the loss of habitat will be very small and therefore suggests it will not be significant, the advice of Scottish Natural Heritage (SNH) should be sought on whether or not cumulative losses of small areas are likely to impact on the integrity of the designation. Mitigation is proposed in the form of restoration of other areas to blanket bog, however, the techniques proposed are relatively unproven (further comments below) and it is not clear whether similarly high quality habitat will be formed. It is imperative that SNH's views on this are taken on board.

5.2 In addition areas of "encapsulated bog" as they are defined on Figure 4.2 appear to have been avoided however due to the above differences in site layout plans, and the number of proposals to relocate elements subject to further peat investigation, this may not be the case. On this basis SEPA requests that a **condition** be applied that development cannot be micro-sited onto areas of encapsulated bog as identified in Figure 4.2 of the ES.

5.3 SEPA requests that the employment of a construction ecologist, as suggested in the best practice guidelines as mitigation, be ensured by planning **condition.**

5.4 The applicant should note the comments in section 3 in relation to site layout plan differences and it may be that the new site layout plan alters these comments.

6. Location of Concrete Batching Plant

6.1 The ES states that the concrete batching plant will be located at one of the three site compounds however no details as to which construction compound this is will be have been submitted. On this basis SEPA in unable to fully assess the environmental acceptability of this proposal and therefore SEPA **objects** until the location of the concrete batching plant is shown on a plan.

7. Water Abstraction

7.1 SEPA notes from the information submitted that water abstraction is proposed on the site for concrete batching, dust suppression and welfare facilities however no further details on the location or quantity of this abstraction are provided. SEPA is therefore unable to fully assess these proposals and therefore **objects** until the above further information is submitted.

8. Private Water Supplies

8.1 SEPA notes the presence of four private water supplies as shown on Drawing 8672/006. It is stated that private water supplies located in the vicinity of the wind farm area (ES 14.5.8) depend from superficial sources. This includes Dallangwell where water is pumped through porous pipes embedded at shallow depth in the Strathy River alluvium. It appears that there are no details of its precise position however Dallangwell water supply is believed to be 130 m downstream from the River Strathy crossing and is likely to be affected qualitatively during the track construction. The applicant proposes various mitigation measures to prevent siltation and pollution. These measures include water quality monitoring, pollution prevention measures and an emergency water supply should a pollution incident occur.

Cont'd/...

8.2 SEPA requests that these mitigation measures and monitoring are included within the below requested construction method statement. In addition SEPA requests a **condition** is applied requiring the proposed emergency water supply for Dallangwell to be readily available on site during the entire construction period.

8.3 SEPA also welcomes the applicant's proposal for a 100m exclusion zone around the intakes of any private water supplies. It is SEPAs understanding that this exclusion zone means that no construction activities can take place within this 100m zone. On this basis SEPA requests that a **condition** is applied requiring no construction activities to take place within 100m of any water supply intake.

9. Watercourse Crossings

9.1 SEPA welcomes the applicant's watercourse crossing assessment however SEPA requires some further information to enable it to fully assess the environmental acceptability of the watercourse crossings, particularly with regard to private water supplies. On this basis SEPA **objects** until further information is submitted. In particular SEPA requests a colour map showing all the watercourse crossings, proximity to private water supplies where relevant, photographs of the location of the proposed watercourse crossings and details as to whether each watercourse crossing is new or upgraded from existing crossings.

9.2 The applicant should note that that SEPA has a policy against unnecessary culverting of watercourses. This can be found on SEPA's website at (http://www.sepa.org.uk/pdf/wfd/guidance/engineering/positionstateculvertingwatercourses.pdf). Schemes should be designed to avoid by preference crossing watercourses, and to bridge watercourses which cannot be avoided. Culverting is the least desirable option.

9.3 SEPA therefore welcomes the applicant proposal to utilise bridging solutions where possible however SEPA discourages the use of pipe culverts or box culverts. Where bridging solutions are not feasible SEPA's preference is for arched or bottomless culverts to be utilised. Once SEPA has assessed the further submitted information SEPA may request that a condition is applied requiring that either a bridging solutions or bottomless culverts to be utilised.

9.4 SEPA welcomes the applicant's consideration of natural habitat and environmental concerns. Where migratory fish may be present (such as trout, salmon or eels) any culverts should be designed in accordance with the Scottish Executive guidance on River Crossings and Migratory Fish. This guidance can be found on the Scottish Executive website at: www.scotland.gov.uk/consultations/transport/rcmf-06.asp

9.5 SEPA welcomes the applicant's proposal to include mammal passages due to the presence of otters and other small mammals.

10. Buffers to Watercourses

10.1 The ES states varying buffers to watercourses and lochans. The largest buffers stated are in the non technical summary which states that buffers of 60m from watercourses and 70m from fish bearing lochans will be utilised.

Cont'd/...

10.2 Applying the precautionary approach SEPA requests that a **condition** applied ensuring a minimum buffer between all turbines and other construction activities, except those specifically identified below, to all watercourses (with the exception of road works leading to watercourse crossings) be set at 70 m.

10.3 However, SEPA has experience from other sites that this may be insufficient to settle suspended matter from gley soils where the water is diverted for settlement across vegetation. Therefore SEPA also requests a **condition** requiring the approval of the determining authority in consultation with SEPA (and others as necessary) of a scheme of site specific buffer distances. This scheme should include full site specific implementation details such as specific buffer distances to be added dependant upon the sensitivity of the soil, terrain, vegetation and other site specific characteristics.

10.4 SEPA also requests that the employment of a construction hydrologist, as suggested as a best practice guideline in Appendix 4.2 be ensured by **condition.**

11. Borrow Pits

11.1 SEPA notes that several sites for borrow pits have been identified. Although the excavated volumes for each site is reported in Appendix 14.2. These are said to be broad estimates and there is a substantial difference between the required volume and the potential volume from the sites, evaluated in 212,535 m^3 (Appendix 14.2 Paragraph 5). This difference will increase further if 10% wastage of unsuitable overburden is added bringing the total volume to 283,000 m^3.

11.2 It also is understood that Strathy South wind farm access is provided by the track running from the A836 through the proposed Strathy North wind farm. The access track construction is included for its entire length in the Strathy South application (ES 4.2.3). However, if the Strathy North wind farm will go ahead the material required for the construction of the common section of the access track (approx. 13 km or 22% of Strathy South total tracks) will be likely excavated from borrow pits located in the Strathy North area, with consequent reduction of aggregates volume extracted from the Strathy South borrow pits.

11.3 It is important that that borrow pits are only opened where required therefore further assessment should be undertaken to ensure only necessary borrow pits are pursued. SEPA welcomes the applicant's proposal to submit a method statement for the formation, management and restoration of the borrow pits to be agreed before the opening of the borrow pits (ES 4.3.2 and 14.6.1). SEPA requests that a **condition** is applied requiring the submission to and approval by the determining authority, in consultation with SEPA [and other bodies such as SNH, should this be desired], of a full site specific borrow pit method statement, submission to be a minimum of one month prior to commencement of development, which should include a proposed phased working programme so that borrow pits are only opened sequentially as required.

Cont'd/...

11.4 Of the 8 proposed borrow pits 6 will be excavated in the bedrock formation (Borrow Pits 1,2,4,6,7 and 9) and 2 in sand and gravel superficial deposits (Borrow Pits 3 and 5). In particular borrow pit 3 is located close (about 50 m) to the Allt Badain burn and borrow pit 5 close (about 100 m) to the River Strathy. Considering that the proposed levels of excavation for borrow pits 3 and 5 will be respectively 3 m and 4 m below ground level, there is the potential for the excavation to intercept the groundwater table. Considering the high permeability of the sand and gravel formation there is a possibility for surface water from the Allt Badain burn and the River Strathy to flood the excavations.

11.5 It is SEPA's understanding that the applicant proposes trial pits and test drilling to inform the design of the borrow pits. SEPA requests that these investigations should also provide data on the depth of the groundwater table for borrow pits 3 and 5 and the excavation method should consider the depth of the borrow pit floor in respect to the maximum groundwater level. Borrow pits 3 and 5 should be risk assessed over the likelihood of floods form groundwater seepage or surface water from the Allt Badain burn and River Strathy and a plan submitted as part of the above method statement on the consequent drainage/dewatering actions during the borrow pits operational life.

11.6 SEPA requests that the proposed method statement for borrow pit working be a **condition** of permissions. The statement should cover, in relation to water, at least the information set out within Planning Advice Note 50: Controlling the Environmental Effects of Surface Mineral Workings in relation to surface water (pages 24-25) and, where relevant, in relation to groundwater (pages 22 –23). Information on the proposals for turf and overburden removal and storage for reinstatement is specifically requested and should be included in the statement.

12. Waste Management

12.1 A number of comments are made throughout the ES regarding the handling, use, storage and disposal of surplus material, however, no coherent consideration of waste minimisation and management seems to have taken place. Given the scale of the project there are likely to be significant volumes of surplus peat and soils which if it is not disposed of appropriately could cause significant environmental harm.

12.2 Therefore SEPA **objects** until clarification on waste management principles is provided. Individual waste streams should be identified and then details of proposals to minimise the production of waste, storage, use and disposals should be provided.

12.3 SEPA also requests that it be a **condition** of permissions that a detailed waste management plan, detailing the issues outlined above, be agreed with the determining authority in consultation with SEPA.

12.4 The developer should note that SEPA has produced guidance to assist in the consideration as to whether any particular material is waste, which is available on SEPA's website at http://www.sepa.org.uk/pdf/guidance/waste/is_it_waste_v2.pdf

Cont'd/...

13. Pollution Prevention

13.1 SEPA is satisfied with the general mitigation principles detailed in the ES. SEPA requests that a **condition** is applied requiring the submission to and approval by the determining authority, in consultation with SEPA [and other bodies such as SNH, should this be desired], of a full site specific construction method statement, submission to be a minimum of one month prior to commencement of development. It should incorporate detailed pollution avoidance and mitigation measures for **all** construction elements (including the borrow pits and the River Strathy crossing) potentially capable of giving rise to pollution. The following however are especially highlighted.

i) Detailed measures to prevent erosion, sedimentation or discolouration will be required.

ii) Monitoring proposals and contingency and emergency plans. SEPA would expect this to include the establishment of an environmental checklist to monitor and plan construction activities, specifically:
- Proposals for daily visual inspections and the recording of required environmental actions (for example, in relation to silt management or peat stability);
- Proposals for planning activities in light of the weather (up to 3 day forecast), particularly in relation to heavy rain. Various commercial companies and the Met Office can provide (at a cost) three to five day forecasts tailor made for an individual site;
- Details of temporary peat and vegetation storage areas and management to prevent environmental impact; and
- Aspects relating to peat stability mitigation.

iii) Specific measures to address silt-laden run-off from temporary and permanent access tracks and other engineering operations.

iv) Proposals and mitigation measures for the dewatering of turbine basis. Of specific relevance is demonstration that there is sufficient area to allow settlement of silty water and if not other appropriate means for treating the dirty water.

v) Specific measures to prevent entry of cement materials to watercourses and, if it is determined to batch on site, mitigation related to this. The potential polluting effects of cement in watercourses is well known.

vi) The location and design of bulk storage of fuel or oils and its subsequent use. SEPA notes and welcomes the proposals outlined for stores to have impervious bases and be placed within a secure bund. The use of drip trays and the like are also noted. All vehicles and plant should be regularly inspected, with particular emphasis on hydraulic hoses, for fuel and oil leaks. Oil spill kits will need to be maintained on site.

vii) Permanent drainage arrangements for access tracks, turbines and switch station based on sustainable drainage principles.

viii) Details of cable laying, especially in relation to watercourse crossings.

Cont'd/...

13.2 When drawing up the mitigation measures the developer should note the good practice guidance referred to in the appendix to this letter. In relation to tendering, the following guidance in section 10.2 of CIRIA C648 should specifically be noted: "*One of the main drivers for environmental improvements is pressure applied by clients through standards laid down in contract documentation. Contracts should specify exact requirements for water pollution prevention in order to encourage high standards and to allow for like for like tender evaluation*".

13.3 SEPA requests that a site specific de-forestation method statement to be agreed with the determining authority in consultation with SEPA and any other necessary bodies is also a **condition** of permission. This should be based on recognised best practice, such as the Forest and Water Guideline. SEPA is specifically interested in how the following will be managed and minimised:

- Impacts on the watercourses; and
- Risk of peat slide.

13.4 SEPA also requests that approval be made subject to a **condition** requiring satisfactory foul drainage arrangements associated with the control house and temporary construction compounds. The applicant should investigate land soakaway (either total soakaway or raised mound soakaway) options compatible with the Non-Domestic Technical Handbook.

14. Timing of construction

14.1 SEPA notes that the construction period will be approximately 22 months. SEPA welcomes the commitment that works will be programmed to "avoid periods of high sensitivity" and therefore requests that it be ensured by **condition** that the timing of these construction activities avoids the wettest winter months when pollution is more likely and more difficult to manage.

15. Oil Storage

15.1 SEPA welcomes the proposal for the substation to be enclosed within a building. SEPA advises the planning authority to ensure that all transformer areas are bunded and for bunding to be in accordance with SEPA's guidelines for Above Ground Oil Storage Tanks - PPG2. PPG2 can be found on SEPA's website www.sepa.org.uk.

15.2 It is SEPA's understanding that fuel storage is proposed only at the site compounds. SEPA does not object to this fuel storage provided the design and installation of the oil storage tank is in accordance with the Water Environment (Oil Storage) (Scotland) Regulations 2006.

16. Peatland Restoration Proposal

16.1 SEPA welcomes the developer's proposal to reinstate a considerable portion of blanket bog habitat. However, it is SEPA's understanding that the proposals for restoration are generally experimental, based upon the RSPB's experiences on their Forsinard reserve, and their longterm achievability is still unproven. Very little information is provided in the ES on the techniques and methods proposed and it would have been useful if more had been presented.

Cont'd/...

16.2 SEPA requests that full details of restoration in the form of a Habitat Management Plan are agreed as a **condition** of any permission. The aims and objectives of the restoration should be clearly stated and it should cover proposals for, amongst other issues, infill of trenches, re-vegetation of disturbed areas, protection of existing interests, water table management, control of tree regeneration, long term monitoring and feed back mechanisms. Further guidance on this should be sought from SNH.

17. Carbon Balance

17.1 SEPA notes that brief consideration of the carbon balance of the development has been given, quoting SNH guidance. No site specific information has been used. The determining authority will need to consider whether such an approach is acceptable. The determining authority will also need to consider the extent to which the carbon balance of the project on a peatland area is poorer than for an equivalent windfarm not located on a peatland area and how that affects the sustainability of the development.

18. Grid Connection and On Site Cabling

18.1 SEPA welcomes the proposal to locate on site cabling adjacent to access tracks and to utilise excavated materials as backfill. It is SEPA's understanding that these proposals apply to the cabling to the national grid connection as well. If this is not the case please consult SEPA again highlighting this issue.

If you have any queries relating to this matter please contact Cerian MacInnes on 01349 860415 or email at Cerian.MacInnes@sepa.org.uk.

Yours faithfully

Cerian MacInnes
Planning Unit (North)

REGULATORY ADVICE FOR THE APPLICANT

Local SEPA Office
Caithness and North Sutherland - Thurso Business Park, Thurso, Caithness KW14 7XW
Tel: 01847 894422

The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR)
From 1 April 2006 the above regulations replace the Control of Pollution Act and Groundwater Regulations. These new regulations not only control discharges to watercourses and land but also cover abstractions, impoundments and engineering works within and in the vicinity of inland surface waters. This means that activities such as culverting, ditch clearing, dredging, bridging and damming all now require to be authorised under CAR.

In order to ensure proportionate controls over activities, the Regulations provide for three levels of control: General Binding Rules (GBRs), Registrations and Water Use Licences. If SEPA considers that GBRs or a Registration will not provide sufficient environmental protection, SEPA can require a higher level of control. For example, SEPA could require an activity which was covered by GBRs to be Registered or even Licensed. Any person undertaking an activity which falls within the scope of the GBRs do not have to contact SEPA but must abide by any rule laid out in the Regulations which relates to their activity. However, an application must be made to SEPA for a Registration or Licence. SEPA has 30 days for determining an application for Registration and 4 months for a Licence; this should be taken into consideration when planning works. CAR allows a variety of different authorisable activities at the one site to be covered by a single licence.

The publication 'The Water Environment (Controlled Activities) (Scotland) Regulations 2005: A Practical Guide' provides very useful advice on CAR and it is recommended that all applicants consult this document which is available both from the website (www.sepa.org.uk/wfd/index.htm) and from local SEPA offices to determine whether an application for authorisation is required for the development.

The Water Environment (Oil Storage) (Scotland) Regulations 2006
The Regulations apply to any kind of container which is being used and which is stored on premises above ground, whether inside or outside a building. These include fixed tanks, intermediate bulk containers, drums (oil drums or similar containers used for storing oil) or mobile bowsers. The range of premises covered by the Regulations is wide including land and mobile plant but does not include storage of oil in vehicles or vessels.

It is not necessary for storage facilities to be registered with SEPA however applicants should ensure compliance with the Regulations. Full details of the requirements can be found from SEPA's website at: www.sepa.org.uk/regulation/oilstorage2006/index.htm.

The Pollution Prevention and Control (Scotland) Regulations 2000 (PPC)
The above regulations are concerned with prevention or minimisation of emissions to air, water and soil, as well as waste, from industrial and agricultural installations.

The applicant should note that the crushing of rock or grading or screening of rock or any road stone coating process, except where they are unlikely to result in the release into the air of particulate matter, are Part B prescribed processes under Section 3.5 of The Pollution Prevention and Control (Scotland) Regulations 2000 (PPC).

Further details on PPC can be found at www.sepa.org.uk/ppc/index.htm

In addition it may be that waste management licences or permits under the Pollution Prevention and Control [PPC] (Scotland) Regulations 2000 will be required for temporary or permanent storage or disposal areas and for these areas to be considered landfills within the context of the Landfill (Scotland) Regulations 2003. SEPA raises this as the interrelationship of the Electricity Act and the Landfill (Scotland) Regulations 2003 may be an issue, particularly in relation to the locational requirements under the Landfill (Scotland) Regulations 2003. Regulation 5 of these Regulations places a duty on planning authorities as it specifies that "A planning permission under the Town and Country Planning (Scotland) Act 1997 may be granted for a landfill only if the requirements of paragraph 1(1) of Schedule 3 to these Regulations have been taken into consideration." However whether this planning requirement also relates to applications under the Electricity Act is still an issue which the Executive will need to consider. SEPA advises the applicant to discuss this with the Scottish Executive prior to determination.

Waste Management Licensing (Scotland) Regulations 1994 (As Amended)
SEPA encourages waste minimisation whenever possible. Further details can be found on SEPA's website (found at www.sepa.org.uk/wastemin/index.htm).

SEPA similarly encourages the recovery and reuse of controlled waste, such as soils from other sites provided that it is in accordance with the Waste Management Licensing Regulations 1994. Any proposals for reuse or recycling of materials, such as soils from other sites, may require to be registered with SEPA under a Waste Management Exemption. There are specific criteria which if met will constitute an exemption from licensing under these Regulations (namely Paragraph 35 of Schedule 3 to the Regulations). These exemptions are required to be registered by SEPA and the details must be forwarded to the relevant SEPA office. Applicants should first consult SEPA's website at www.sepa.org.uk/regulation/waste/exemptions.htm and then contact the local SEPA office for further advice.

POLLUTION PREVENTION ADVICE

In addition to the requirements of legislation the following good practice guidance should be considered when developing and an appropriate strategy for prevention pollution from the development:

- Pollution Prevention Guidance note PPG2: Above ground storage tanks (SEPA);
- Pollution Prevention Guidance note PPG4: Disposal of sewage where no mains drainage is available (SEPA);
- Pollution Prevention Guidance note PPG5: Works in, near or liable to affect Watercourses (SEPA);
- Pollution Prevention Guidance note PPG6 - Working at Construction and Demolition Sites (SEPA);
- Control of Water Pollution from Construction Sites – Guidance for consultants and contractors (CIRIA C532);
- Control of Water Pollution from Linear Construction Sites – Site Guide (CIRIA 649);
- Control of Water Pollution from Linear Construction Projects – Technical Guidance – (CIRIA C648);
- SEPA Code of Practice - 'Mineral extraction code of practice for the owners and operators of quarries and other mineral extraction sites';
- CIRIA C697 SuDS manual
- The Small Environmental Guidance for Construction Works (SEPA/CIRIA); and
- Forests and Water Guidelines: Fourth Edition (Forestry Commission)

SEPA would expect to see the principles contained within this guidance to be incorporated within any construction method statement requested.

ECopy: David Robinson, SEPA, Thurso
ECopy: Marco Baglioni, SEPA, Dingwall

Proposed Wind Farm at Strathy South

Electricity Act 1989
The Electricity Works (Environmental Impact Assessment)(Scotland) Regulations 2000
Section 36 Application for a Wind Farm at Strathy South, Highland

Forestry Commission Scotland Comments on the Environmental Statement

7 August 2007

Introduction

This document represents Forestry Commission Scotland (FCS) views on the proposed wind farm at Strathy South, as described in the Environmental Statement(ES) for the project sent on 2 July 2007.

In this response FCS focuses on identified shortcomings of the ES in relation to assessment of the impact of the proposal in regard to woodlands.

Background

FCS supports the Scottish Executive's commitment on renewables. FCS is the Scottish Executive's(SE) competent authority on forests and woodlands. As such, FCS has a role and can contribute to the evaluation of developing proposals when they may have an effect on a woodland environment.

Forestry in Scotland is guided by the Scottish Forestry Strategy (2006).

In July 2007 we were consulted on this proposal although other bodies including Scottish Natural Heritage and The Highland Council were involved at the Feasibility (3.2.3) and Scoping (5.3.2 and appendix 5.1) stages and have had the opportunity for assessment and input during the process. The Highland Council did raise the point that FCS should be involved (Appendix 5.1 Summary of Consultation Responses).

FCS Assessment of the ES

Non-Technical summary

C. The Development omits to inform the reader that the windfarm development involves the removal of all or the majority of the Strathy South Plantation. At something approaching 1300 hectares (13km2) this is one of the largest single woodland clearances proposed in the UK. When combined

with the proposal at Strathy North this is a proposed removal approaching 2000 hectares.

F. Landscape and visual Assessment where the removal of forestry is near the bottom of the list when it should be placed nearer the top with road construction as initial work. There is minimal consideration of the removal of (extensive) woodland and replacement with open moorland.

G. Ecology where there is finally reference to removal of 13km2 of plantation.

P. Social and Economic gives no consideration for possible uses of an undetermined amount of timber. At a conservative estimate of 100 tonnes per hectare this is a possible potential resource of 130000 tonnes of material. It is accepted some may be available and some unavailable.

Figure 2 contains no indication of scale or rate of removal.

Figure 5 this montage has the potential to mislead as it appears the plantation is still visible with the pylons superimposed.

Environmental Statement Vol. 2

Chapter 2.4.2 has limited reference to the developing wood fuel industry such as Wick Heat and Power. The statements made are an underestimate of its presence. There is a vast (13K tonnes potential) that has been dismissed. Information can be found at www.usewoodfuel.co.uk and recently the SE has provided a grant fund of £7.5million towards various costs for processing and use. The web site has information and links to the Scottish Bio-mass Support Scheme.

Chapter 3.2.3 has omitted reference to FCS in the feasibility where the issues identified in this report would most likely have been raised. Refer to the Background above.

Chapter 4 is the Development Description and does not include a chapter on the woodland removal. This is probably the single biggest woodland removal proposed in Scotland or the UK. As such readers (local, forest industry and the media) deserve a full explanation. Trees and woodland do provide a positive contribution to climate change. Scottish Executive has provided funding (£3 million) to FCS to increase the establishment programme of the National Forest and this aspect has not been explored fully within the ES.

Chapter 4.9 Mitigation refers to reinstatement but no indication that this site or scale is appropriate. There is no rationale offered for retained plantation around Loch nan Clach or alongside the watercourses. There appears to be little design explanation for the proposed additional planting.

Chapter 5 Scoping shows that FCS were not involved at this stage.

Chapter 8 Landscape Character opens with the Scope of Assessment. As stated above this is a very significant removal of established plantation. Although the felling of trees was identified FCS were not included in the scoping.

8.6.4 Landscape Character Zone B has omitted reference to the retained woodland or the addition of woodland. This is needed to inform the reader of the processes used.
The difficulty is that the information presented in the ES on this issue is confined to the presentation of proposals. There is no analytical information to explain or support how the mitigation proposals were arrived at. Nor are there perspective illustrations of the potential visual and landscape effects of the proposed forestry prescriptions and mitigation proposals to facilitate their assessment.

Chapter 9 Visual Impact Again FCS were not involved in scoping. There is no consideration of:

- the effects of plantation removal
- the effects of the proposed retained plantation shapes
- the effects of proposed additional planting

Chapter 10.9 f – forestry clearance is helpful but limited. There is no information on the age of the trees, the volume of material being removed nor alternative potential alternative uses. There is no design process described for the landscape impacts of the felling, retentions or new planting.

Chapter 14 covering soil and water does not appear to consider the effects of large scale tree removal on the water table. No comment is possible as there is no assessment. FC does have a hydrologist who could provide comment on any available data.

Chapter 16 includes other issues. Discussion on the role of forests in carbon storage versus the proposal is not clearly explained to the reader. The use of the woodlands for walking recreation is not considered fully.

Chapter 16.3.5 Forestry Commission Access Land is an unknown context as FC land (publicly owned) has always been subject to open access. All woodlands and other land are now subject to the provisions of The Land Reform (Scotland) Act 2003 whether promoted or not. Table 16.3.3 is a summary of anticipated impacts and refers to hills but not to woodlands.

Appendix 4 The Design Principles *(Appendix 4.3, p2)* omits woodland effects completely. *Appendix 5.2,p3* states the removal of forest as unknown. This is because no assessment is presented to guide and inform the reader. There are Forestry Commission Landscape Design Guidelines that would help inform the design process. These are available at www.forestry.gov.uk.

Photomontages such as 9.6.1b, 9.6.7b and 9.6.8b may mislead the reader as while showing the towers they do not show the removed forest, the new forest edges, any proposed tree planting nor the added track network.

FCS Recommendations

FCS recommends that there is a need to carry out an assessment of the impact of the felling on the current landscape and also the impact of the felling on the woodland left behind along with any planting proposed both now and as it develops to address the following principles:

- The impact of removal of woodland from the area.

- The impact of the areas of woodland to remain and to be added too, and in particular how the proposed boundaries will fit with the landscape both now and in the longer term.

1. Concept designs considering shape and scale of open space for the woodland felling, retained areas of existing woodland, associated replanting and the access tracks should be prepared for the forest and woodland areas.
2. All concept designs should be developed through the established process of survey, analysis and design, and illustrated by perspectives generated from agreed vantage points, showing the implications of such changes.
3. All concept designs should be prepared by a landscape architect with relevant forest and woodland landscape design experience, in conjunction with a harvesting forester.
4. The identification of all forest and woodland areas that may require design of appropriate shape and scale of open space should be agreed with all relevant stakeholders. FCS would be happy to advise on this process given an appropriate period of time.
5. Informed by 1. above, Chapter 8, Appendix 4.3, Appendix 5.2 and associated photomontages should be revised.
6. All plans illustrating landscape associated works should include contours.
7. Chapter 2.4.2 should be revised to reflect a more accurate situation to the reader.
8. Chapter 4 should be revised to discuss the scale of woodland removal, how this sits with various SE renewable policies and any options for alternatives or mitigation.
9. Revise chapter 14 to include assessment of the impact of large scale tree removal on water table levels and associated effects.
10. Revise chapter 16 to fully explain to readers the issues and arguments, the assessment and possible mitigation in this case for the role of forests for carbon in the climate change debate. Revise the discussion on access.

Forestry Commission Scotland

Highland Conservancy

Bayles A (Alice)

From: Julie.Maher@hse.gsi.gov.uk
Sent: 14 August 2007 14:41
To: Bayles A (Alice)
Subject: RE: TRIM Document : 2007/119219 : Dounreay No Objection Letter - Strathy North Wind Farm - 5 June 2007

****
This email has been received from an external party and
has been swept for the presence of computer viruses.
****

Hi Alice,

We do not need to be consulted on this. We only need to be sent applications if they are within 5 km EPZ zone for Dounreay NPS.

This application appears 15 km approx. from Dounreay.

I will sent no objection letter on this today.

Many thanks

Julie

Julie Maher
ND Siting/Land Use Planning Section
4 S.2 Redgrave Court
Merton Road
Bootle
Liverpool
L20 7HS

Tel:0151 951 3996
Fax:0151 951 3942

email: juliemaher@hse.gsi.gov.uk

From: Alice.Bayles@scotland.gsi.gov.uk [mailto:Alice.Bayles@scotland.gsi.gov.uk]
Sent: 14 August 2007 12:38
To: Julie Maher
Subject: RE: TRIM Document : 2007/119219 : Dounreay No Objection Letter - Strathy North Wind Farm - 5 June 2007

Hi Julie

Looking at page 18 Table 9.3 *Wind farms within 60km of Strathy South in planning, consented and operational and Strathy South; Current at December 2006* (attached for your reference) it appears that the distance from Strathy South (centre-centre, km) to Strathy North is 3.1km.

Let me know if you need any further information.

Alice Bayles
Energy Consents

-----Original Message-----

From: Julie.Maher@hse.gsi.gov.uk [mailto:Julie.Maher@hse.gsi.gov.uk]
Sent: 14 August 2007 11:46
To: Bayles A (Alice)
Subject: RE: TRIM Document : 2007/119219 : Dounreay No Objection Letter - Strathy North Wind Farm - 5 June 2007
Importance: High

****

This email has been received from an external party and

has been swept for the presence of computer viruses.

****

Hi Alice,

Please can you advise how many miles away the Strathy south Wind Farm is from the ND Site - Dounreay ?

Many Thanks

Julie

From: Alice.Bayles@scotland.gsi.gov.uk [mailto:Alice.Bayles@scotland.gsi.gov.uk]
Sent: 14 August 2007 11:20
To: Julie Maher
Subject: RE: TRIM Document : 2007/119219 : Dounreay No Objection Letter - Strathy North Wind Farm - 5 June 2007

Sorry Julie, just read the attachment. We did receive the Strathy North response from you before on 5th June. It is actually the **Strathy South** response that is outstanding. I think I might have mistitled the email to you earlier, but the attached letters referred to the Strathy South application.

Alice Bayles
Energy Consents

-----Original Message-----
From: Julie.Maher@hse.gsi.gov.uk [mailto:Julie.Maher@hse.gsi.gov.uk]
Sent: 14 August 2007 09:58
To: Bayles A (Alice)
Subject: TRIM Document : 2007/119219 : Dounreay No Objection Letter - Strathy North Wind Farm - 5 June 2007

****
This email has been received from an external party and
has been swept for the presence of computer viruses.
****

Dear Alice,

I've attached our letter from 5th June.

Please let me know if you did not received the original.

Thanks

Julie

Julie Maher
ND Siting/Land Use Planning Section
4 S.2 Redgrave Court
Merton Road
Bootle
Liverpool
L20 7HS

Tel:0151 951 3996
Fax:0151 951 3942

email: juliemaher@hse.gsi.gov.uk

------< TRIM Record Information >------

Record Number : 2007/119219
Title : Dounreay No Objection Letter - Strathy North Wind Farm - 5 June 2007

****
Please Note: Incoming and Outgoing E-mail messages are routinely monitored for compliance with our policy on the use of electronic communications.

Interested in Occupational Health & Safety information?
Please visit the HSE website at the following address to keep yourself up to date

www.hse.gov.uk

Or contact HSE Infoline on 0845 345 0055 or email hse.infoline@natbrit.com.

****

****

This e-mail (and any files or other attachments transmitted with it) is intended solely for the attention of the addressee(s). Unauthorised use, disclosure, storage, copying or distribution of any part of this e-mail is not permitted. If you are not the intended recipient please destroy the email, remove any copies from your system and inform the sender immediately by return.

Communications with the Scottish Executive may be monitored or recorded in order to secure the effective operation of the system and for other lawful purposes. The views or opinions contained within this e-mail may not necessarily reflect those of the Scottish Executive.

****

****
This e-mail (and any files or other attachments transmitted with it) is intended solely for the attention of the addressee(s). Unauthorised use, disclosure, storage, copying or distribution of any part of this e-mail is not permitted. If you are not the intended recipient please destroy the email, remove any copies from your system and inform the sender immediately by return.
Communications with the Scottish Executive may be monitored or recorded in order to secure the effective operation of the system and for other lawful purposes. The views or opinions contained within this e-mail may not necessarily reflect those of the Scottish Executive.
****

Bayles A (Alice)

From: Anne Phillips [APhillips@hial.co.uk]
Sent: 08 August 2007 14:50
To: Bayles A (Alice)
Cc: ken.mccorquodale@highland.gov.uk; Muir John; jo.baker@scottish-southern.co.uk
Subject: Wind Farm at Strathy South

****
This email has been received from an external party and
has been swept for the presence of computer viruses.
****

Our Ref: 188WIC280607

Dear Ms Bayles,

ELECTRICITY ACY 1989 THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000 SECTION 36 APPLICATION FOR A WIND FARM AT STRATHY SOUTH, HIGHLAND

With reference to the above proposed development. This development is approximately 55km West of Wick Airport and is therefore outside the 30 km safeguarded area around the airport. Highlands and Islands Airports have little grounds on which to object to this proposal.

However, the proliferation of developments and the cumulative effect is of far more concern.

Strathy North with 35 turbines was received as a separate application. This application, for Strathy South, is in an adjacent site, and is for an additional 77 turbines.

It is possible that the development may have potential impact on local aviation activity. The Directorate of Airspace Policy, Civil Aviation Authority are probably best placed to answer this. In addition, the CAA will provide advice and recommendations regarding any lighting requirements for aviation obstruction purposes; that is if the structures present a significant hazard to air navigation owing to the nature or location of the structures.

Yours sincerely

ANNE PHILLIPS
Operations Manager
Highlands and Islands Airports
Head Office
Inverness
IV2 7JB

Tel 01667 464244

As requested, a hard copy is in the post.

This email was received from the INTERNET and scanned by the Government Secure Intranet Anti-Virus service supplied by Cable&Wireless in partnership with MessageLabs. (CCTM Certificate Number 2006/04/0007.) In case of problems, please call your organisation□s IT Helpdesk. Communications via the GSi may be automatically logged, monitored and/or recorded for legal purposes.

HISTORIC SCOTLAND

We safeguard the nation's built heritage and promote its understanding and enjoyment

Alice Bayles
Energy Executive
Energy Consents Unit
Meridian Court
5 Cadogan Street
GLASGOW
G2 6AT

Development Assessment Team
Room E3
Longmore House
Salisbury Place
Edinburgh
EH9 1SH

Direct Line: 0131 668 8898
Direct Fax: 0131 668 8765
Switchboard: 0131 668 8600
HS.DAT@scotland.gsi.gov.uk

Our ref: AMN/16/H
Your ref: Letter dated 2 July 2007

08 August 2007

Dear Ms Bayles

Electricity Act 1989
The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000
Section 36 application for a wind farm at Strathy South, Highland

I refer to your letter of 2 July 2007, notifying us of the submission of an application for the above proposed development, and the accompanying Environmental Statement (ES). We have now considered the content of the ES for our statutory historic environment interests, and our comments here will cover the following issues.

- The adequacy of the ES, for its assessment of the issues impacting on those sites within our statutory remit

- The principle of the proposed development

There are a number of scheduled monuments, listed buildings and one garden and designed landscape identified in the Inventory in the vicinity which have been addressed in the ES. On the basis of the information provided, we are content to accept that the proposed development will not have a direct impact on any such sites. We note that there are a number of unscheduled sites within the proposed development boundary, and that the proposed development will have an impact on them. We advise that you contact the Highland Council Archaeologist for advice on the treatment of these sites in the ES.

INVESTOR IN PEOPLE

POSITIVE ABOUT DISABLED PEOPLE

From the information provided, we are content that where there are Category A-listed buildings within the study area, the site of the proposed wind farm will not be visible and there will be no impact upon these sites. We advise that you contact Highland Council for advice on the treatment of the proposed development on the settings of those Category B and C(S) listed buildings in its vicinity, in the ES. We have no further comments to make for our listed building interests.

The impact of the proposed development on **Tongue House** Inventory Garden and designed landscape is addressed in the landscape and visual chapter of the ES. We are content that the proposed wind farm will not have an impact on this site, and have no further comments to make for our designed landscape interests.

In light of the above information, the issue likely to be significant for our interests is the impact of the wind farm on the settings of those nationally important scheduled monuments in its vicinity. Our comments in this letter relate to this issue.

The Environmental Statement

Having considered the assessment of the likely impacts of the proposed development as set out in the ES, we can confirm that we are broadly content with the assessment methodology and its application in the cultural heritage chapter. On this basis, we agree with the conclusion presented in section 13.6.4 (d) of the ES that the proposed development will have an impact of moderate significance on the scheduled ancient monument known as **Ben Griam Beg, fort, Forsinard** (index no 1836). We note that Table 13.7 shows that impacts of moderate significance are considered 'significant' in the context of this ES, and we welcome this information.

We consider that the impact of the development is heightened because of the monument's elevated position and because the surrounding landscape has very little modern development apart from forestry. However, overall, the distance of the turbines from the monument and their placement below the skyline means that we do not feel that the impact of the wind farm on the setting of this monument is so unacceptably significant as to warrant an objection to this application.

An assessment of the cumulative impacts of a number of wind farms in the vicinity of the proposed Strathy South development is provided in the Visual Impacts chapter. The impacts of these developments on the setting of SAM 1836 are shown in Figure 9.7.1. Table 9.26 states that this impact will be substantial. Whilst we agree that the cumulative impact of other proposed wind farms in the area, such as Strathy North, Ackron, Forss 1 and Forss 2 will be substantial, this does not alter our position.

The Development

Overall, we can confirm that the ES provides an adequate level of information which has been sufficient for us to reach a conclusion on the significance of this proposal for our historic environment interests. In essence, we consider that although the development will have an adverse impact on the setting of a nationally important scheduled ancient

monument in its vicinity we are content that this is not of such an order to warrant our objection to this application.

Finally, we note that this proposed wind farm lies within an area zoned as 'presumption against development' for national and major onshore wind farms in the Highland Renewable Energy Strategy.

Yours sincerely

William Kidd

Copy to: Highland Council

INVESTOR IN PEOPLE

POSITIVE ABOUT DISABLED PEOPLE

Our ref: PCS/122275
Your ref: NS/SC/LUK121781

If telephoning ask for:
Cerian Baldwin

17 September 2012

Robert Logan
Energy Consents and Deployment Unit
4th Floor
5 Atlantic Quay
150 Broomielaw
Glasgow
G2 8LU

Dear Mr Logan

The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011
Strathy South Wind Farm - Addendum Scoping

Thank you for consulting SEPA on the scoping opinion for the Environmental Statement Addendum. We are generally satisfied with the proposed scope of the proposed Addendum however as five years have passed since our last consultation on this proposal we wish to highlight our current best practice on the proposed Addendum topics as detailed below.

In summary we request that the Addendum includes:

- Peat management plan and peat balance
- Details of how forest residues will be managed
- Information on wetlands if relevant
- Details of private water supply mitigation
- Details of watercourse crossings and consideration of any flood risk
- Details of proposed watercourse buffers
- Details of proposed water abstractions
- Details on borrow pits
- Updated construction environmental management principles

We would welcome meeting with the applicant at an early stage to discuss any of the issues raised in this letter.

1. Disturbance and re-use of excavated peat

1.1 We welcome the proposal to carry out peat probing and to submit a Peat Management Plan. It is now normal practice for developers to produce a Peat Management Plan. The Peat Management Plan should include:

a) A detailed map of peat depths (this must be to full depth) with all the built elements overlain so it can clearly be seen how the development avoided deep peat. The peat depth survey should include details of the basic peatland characteristics.

b) A table showing where surplus peat will be generated and what the quantities will be (Table 1 and the background text begin to do this already just not enough detail);

c) A table showing what quantity of this surplus peat will catotelmic and what quantity will be acrotelmic;

d) Where this surplus peat will be stored and for how long it will be stored shown on a map;

e) Details of how the stored peat will be kept fit for any restoration purpose;

f) A table showing where the catotelmic peat will be re-used and how much will be re-used including details of thickness;

g) A table showing where the acrotelmic peat will be re-used and how much will be re-used including details of thickness/width;

1.2 We would expect all these details to be in accordance with Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste and our Regulatory Position Statement – Developments on Peat. An example of a peat balance table is enclosed in Appendix 1 of this letter however this is just an example and the applicant may have a better way of illustrating the required peat balance data. The use of a table often illustrates where further peat minimisation is necessary and where best to re-use any surplus peat.

1.3 In our experience there a number of common issues which we often query within Peat Management Plans and therefore we wish to take the opportunity to highlight these below so that they can be addressed in the Peat Management Plan.

a) Any proposals for road shoulders should follow the best practice guidance detailed in Pages 14 and 15 of the Scottish Renewables Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste, Page 27 of the Scottish Natural Heritage (SNH) and Forestry Commission (FCS) Floating Roads on Peat guidance and Pages 38 and 39 of SEPA, SNH and Scottish Renewables and FCS guidance Good practice during windfarm construction. Please note that only acrotelmic peat turves are likely to be suitable for battering road verges due to the liquid properties of catotelmic peat. Any landscaping or road batters should be limited to the areas of ground already disturbed.

b) The location of any temporary storage need to be submitted detailing where they will be located and how they avoid any watercourses, groundwater dependant terrestrial ecosystems or other sensitive areas. In addition details of how the storage areas will be constructed, what types of peat will be stored and the peat maintained fit for re-use should be submitted. This information may also be of interest to geotechnical engineers assessing the peat stability proposals. Please note that any soils or peat stored for greater than 3 years will require a permit under The Landfill (Scotland) Regulations 2003.

c) Details of where alternate construction techniques have been used such as piling or floating roads should be submitted and then this should be detailed within the Peat Management Plan as it shows how the disturbance of peat has been minimised where possible. For example this could be simply shown on map showing the location of floating or upgraded roads and piled turbine bases alongside a peat balance table.

d) Where peat is re-used details of how the hydrology and drainage will be managed to maintain the peat integrity should be detailed. For example how will peat turves be used, how will hydrology be maintained to prevent drying out and subsequent oxidisation.

e) Please note that current good practice is that any crane hardstanding areas should be left in place with no peat cover to allow access for maintenance. In addition the aggregate layer of the hardstanding may act as a drain and peat can dry out.

1.4 By adopting an approach of minimising disruption to peatland, the volume of excavated peat can be minimised and the commonly experienced difficulties in dealing with surplus peat reduced. The generation of surplus peat is a difficult area which needs to be addressed from the outset given the limited scope for re-use.

1.5 There are important waste management implications of measures to deal with surplus peat as set out within our Regulatory Position Statement - Developments on Peat. Landscaping with surplus peat (or soil) may not be of ecological benefit and consequently a waste management exemption may not apply. In addition we consider disposal of significant depth of peat as being landfilled waste, and this again may not be consentable under our regulatory regimes. Experience has shown that peat used as cover can suffer from significant drying and oxidation, and that peat redeposited at depth can lose structure and create a hazard when the stability of the material deteriorates. This creates a risk to people who may enter such areas or through the possibility of peat slide and we are aware that barbed-wire fencing has been erected around some sites in response to such risks.

1.6 It is therefore essential that the scope for minimising the extraction of peat is explored and alternative options identified that minimise risk in terms of carbon release, human health and environmental impact. Early discussion of proposals with us is essential, and an overall approach of minimisation of peatland disruption should be adopted. If it is proposed to use some excavated peat within borrow pits or bunding then details of the proposals, including depth of peat and how the hydrology of the peat will be maintained, should be outlined in the ES or planning submission.

1.7 Our Planning and Energy webpage provides links to current best practice guidance on peat survey, excavation and management.

2. Forest removal and forest waste

2.1 We note that the windfarm is located within a forest area however it is unclear how the timber will be removed. We would support the approach of key-holing wherever possible as large scale felling can result in a peak release of nutrients which can affect local water quality. We may, however, be supportive of clear felling in cases where planting took place on deep peat and it is proposed through a Habitat Management Plan to reinstate peat-forming habitats. This should be specifically referenced in the ES.

2.2 We would be especially interested in and are likely to have significant concerns relating to any proposals to fell to waste where the waste generated by the process will be managed by techniques such as chipping, mulching or spreading. This is because where material is classed as waste then appropriate waste management options require consideration and, where appropriate, adoption. In such cases we would wish the ES to include information which explains how the waste hierarchy has been applied in a way which delivers the best overall environmental outcome and if this is not demonstrated we are likely to be object to the application.

2.3 It has previously been argued that using waste on the site could yield an ecological improvement and so has been considered as an exemption under waste management licensing. However, this approach is now being questioned as the results of early research show there is a lack of clarity and evidence to support the claim that this practice delivers overall ecological improvement for the main target vegetation types (blanket bog or wet heath).Currently, this restoration practice is being tested and researched at a number of sites across Scotland. This research will provide greater clarity on the benefits and risks associated with the practice. If ecological benefit from use of waste is to be claimed, then reliable site-specific evidence must be provided. For avoidance of doubt, where it is sought to claim ecological benefit from deposition of forestry waste a) the ecological benefit must relate to the land to which the waste is applied rather than off-site benefits and b) there must not be an ecological harm also associated with the deposition of the waste. Note that if there are likely to be significant amounts of surplus forestry material without a clear use, and if scope for an exemption under waste management is unclear, then unfortunately we may need to object to an application due to our inability to advise on consentability under our regulatory regime and hence it is essential that these issues are addressed at an early stage.

2.4 Nationally we are working with our SEARS partners to agree common principles for considering the use of forest material / waste wood on peatland sites for restoration projects. This work is currently being agreed and will soon be published on our website as *Principles for Use of Forest Residue for Peatland Restoration*. The draft principles within it which should be applied are as follows:

- Full justification for using the material on-site must be provided. Evidence must be provided to show that all options for use of the material off-site have been considered;
- The proposed use of the material must be beneficial in reaching the objectives of the Habitat Management Plan (HMP) as agreed by the local authority in consultation with statutory agencies (SNH and SEPA). Detailed monitoring proposals should be included in the HMP;
- Material used on site should not have any negative impact on the water environment or other sensitive receptors (e.g. protected species);
- Details of the size, volume, and depth of material to be used on site must be provided. A detailed map showing areas where the material will be used and extent of cover should also be provided;
- A clear specification for contractors is required to ensure the correct machinery is used, and that any material left on site is used in line with the HMP. The quality of the material is an important factor; maximum chip size (or other criteria) should be defined and agreed with the contractor. A maximum depth of material should also be agreed with the contractor.

2.5 We ask that where the ecological benefit proposed by the fell to waste activity does not relate to improvement of peatland habitats that the expected environmental benefit is outlined and fully justified in the ES.

3. Disruption to wetlands including peatlands

3.1 We welcome the proposal to carry out an updated National Vegetation Community survey. The following further information should be included if relevant.

3.2 If there are wetlands or peatland systems present, the ES should demonstrate how the layout and design of the proposal, including any associated borrow pits, hard standing and roads, avoid impact on such areas.

3.3 A Phase 1 habitat survey should be carried out for the whole site and the guidance A Functional Wetland Typology for Scotland should be used to help identify all wetland areas. National Vegetation Classification should be completed for any wetlands identified. Results of these findings should be submitted, including a map with all the proposed infrastructure overlain on the vegetation maps to clearly show which areas will be impacted and avoided.

3.4 Groundwater dependent terrestrial ecosystems, which are types of wetland, are specifically protected under the Water Framework Directive. The results of the National Vegetation Classification survey and Appendix 2 (which is also applicable to other types of developments) of our Planning guidance on windfarm developments should be used to identify if wetlands are groundwater dependent terrestrial ecosystems.

3.5 The route of roads, tracks or trenches within 100 m of groundwater dependent terrestrial ecosystems (identified in Appendix 2) should be reconsidered. Similarly, the locations of borrow pits or foundations within 250 m of such ecosystems should be reconsidered. If infrastructure cannot be relocated outwith the buffer zones of these ecosystems then the likely impact on them will require further assessment. This assessment should be carried out if these ecosystems occur within or outwith the site boundary so that the full impacts on the proposals are assessed. The results of this assessment and necessary mitigation measures should be included in the ES.

3.6 For areas where avoidance is impossible, details of how impacts upon wetlands including peatlands are minimised and mitigated should be provided within the ES or planning submission. In particular impacts that should be considered include those from drainage, pollution and waste management. This should include preventative/mitigation measures to avoid significant drying or oxidation of peat through, for example, the construction of access tracks, dewatering, excavations, drainage channels, cable trenches, or the storage and re-use of excavated peat. Detailed information on waste management is required as detailed below. Any mitigation proposals should also be detailed within the Construction Environmental Management Document, as detailed below.

4. Existing groundwater abstractions

4.1 We welcome the previous information on private water supplies. It is now best practice for the following issues to be assessed and therefore we ask that this is included within the Addendum to ensure that all current information requirements are met.

4.2 Roads, foundations and other construction works associated with large scale developments can disrupt groundwater flow and impact on groundwater abstractions. To address this risk a list of groundwater abstractions both within and outwith the site boundary, within a radius of i)100 m from roads, tracks and trenches and ii) 250 m from borrow pits and foundations) should be provided.

4.3 If groundwater abstractions are identified within the 100 m radius of roads, tracks and trenches or 250 m radius from borrow pits and foundations, then either the applicant should ensure that the route or location of engineering operations avoid this buffer area or further information and investigations will be required to show that impacts on abstractions are acceptable. Further details can be found in Appendix 2 (which is also applicable to other types of developments) of our Planning guidance on windfarm developments.

5. Engineering activities in the water environment

5.1 We welcome the proposal to submit details of all the proposed watercourse crossings. Our current information requirements are detailed below. In addition please note our comments on flood risk as detailed in Section 6 below. It would also be useful if details of the proposed watercourse buffers were confirmed as it is unclear whether the buffers in the ES are still proposed.

5.2 In order to meet the objectives of the Water Framework Directive of preventing any deterioration and improving the water environment, developments should be designed to avoid engineering activities in the water environment wherever possible. The water environment includes burns, rivers, lochs, wetlands, groundwater and reservoirs. We require it to be demonstrated that every effort has been made to leave the water environment in its natural state. Engineering activities such as culverts, bridges, watercourse diversions, bank modifications or dams should be avoided unless there is no practicable alternative. Paragraph 211 of SPP deters unnecessary culverting. Where a watercourse crossing cannot be avoided, bridging solutions or bottomless or arched culverts which do not affect the bed and banks of the watercourse should be used. Further guidance on the design and implementation of crossings can be found in our Construction of River Crossings Good Practice Guide. Other best practice guidance is also available within the water engineering section of our website.

5.3 If the engineering works proposed are likely to result in increased flood risk to people or property then a flood risk assessment should be submitted in support of the planning application and we should be consulted as detailed below.

5.4 A site survey of existing water features and a map of the location of all proposed engineering activities in the water environment should be included in the ES or planning submission. A systematic table detailing the justification for the activity and how any adverse impact will be mitigated should also be included. The table should be accompanied by a photograph of each affected water body along with its dimensions. Justification for the location of any proposed activity is a key issue for us to assess at the planning stage.

5.5 Where developments cover a large area, there will usually be opportunities to incorporate improvements in the water environment required by the Water Framework Directive within and/or immediately adjacent to the site either as part of mitigation measures for proposed works or as compensation for environmental impact. We encourage applicants to seek such opportunities to avoid or offset environmental impacts. Improvements which might be considered could include the removal of redundant weirs, the creation of buffer strips and provision of fencing along watercourses. Fencing off watercourses and creating buffer strips both helps reduce the risk of diffuse water pollution and affords protection to the riparian habitat.

6. Flood risk

6.1 Previously we did not seek flood risk information on watercourse crossings for windfarms sites however since 2007 we have had issues with the impacts of watercourse crossings and their associated approach roads impacting on the capacity of flood plains. We note the proposed crossing of the River Strathy along with a number of other watercourse crossings. We welcome the applicant's proposal to submit details of the watercourse crossings. As part of this information details of the sizing of the proposed crossings and any approach roads across flood plains should be included.

6.2 If a flood risk is identified then a Flood Risk Assessment should be carried out following the guidance set out in the Annex to the SEPA-Planning Authority flood risk protocol. Our Technical flood risk guidance for stakeholders outlines the information we require to be submitted as part of a Flood Risk Assessment, and methodologies that may be appropriate for hydrological and hydraulic modelling.

7. Water abstraction

7.1 We welcome the proposal to submit further information on the proposed water abstraction. Where water abstraction is proposed we request that the ES, or planning submission, details if a public or private source will be used. If a private source is to be used the information below should be included. Whilst we regulate water abstractions under The Water Environment (Controlled Activities) (Scotland) Regulations 2011, the following information is required at the planning stage to advise on the acceptability of the abstraction at this location:

- Source e.g. ground water or surface water;
- Location e.g. grid reference and description of site;
- Volume e.g. quantity of water to be extracted;
- Timing of abstraction e.g. will there be a continuous abstraction;
- Nature of abstraction e.g. sump or impoundment;
- Proposed operating regime e.g. details of abstraction limits and hands off flow;
- Survey of existing water environment including any existing water features;
- Impacts of the proposed abstraction upon the surrounding water environment.

7.2 If other development projects are present or proposed within the same water catchment then we advise that the applicant considers whether the cumulative impact upon the water environment needs to be assessed. The ES or planning submission should also contain a justification for the approach taken.

8. Pollution prevention and environmental management

8.1 Since 2007 it is now best practice for all the pollution prevention and environmental management proposals to be included within one document which we will seek by way of a condition. It is likely that the further information on peat management, forestry removal, watercourse crossings, forestry works, private water supplies and borrow pits would influence this and therefore it would be good to update this section of ES in line with these further bits of information.

8.2 We advise that the applicant should, through the EIA process or planning submission, systematically identify all aspects of site work that might impact upon the environment, potential pollution risks associated with the proposals and identify the principles of preventative measures and mitigation. This will establish a robust environmental management process for the development. A draft Schedule of Mitigation should be produced as part of this process. This should cover all the environmental sensitivities, pollution prevention and mitigation measures identified to avoid or minimise environmental effects. Details of the specific issues that we expect to be addressed are available on the Pollution Prevention and Environmental Management section of our website.

8.3 A Construction Environmental Management Document is a key management tool to implement the Schedule of Mitigation. We recommend that the principles of this document are set out in the ES outlining how the draft Schedule of Mitigation will be implemented. This document should form the basis of more detailed site specific Construction Environmental Management Plans which, along with detailed method statements, may be required by planning condition or, in certain cases, through environmental regulation. This approach provides a useful link between the principles of development which need to be outlined at the early stages of the project and the method statements which are usually produced following award of contract (just before development commences).

8.4 We would refer you to best practice advice prepared by SNH, SEPA and the windfarm industry Good Practice During Windfarm Construction. Additionally, the Highland Council (in conjunction with industry and other key agencies) has developed a guidance note Construction Environmental Management Process for Large Scale Projects.

9. Borrow pits

9.1 We previously sought further information on the borrow pits and note that the number of borrow pits has reduced and that one has been made larger. It would be useful if these changes could be summarised within the Addendum.

9.2 Where borrow pits are proposed, information should be provided regarding their location, size and nature. In particular, details of the proposed depth of the excavation compared to the actual topography and water table should be submitted. In addition details of the proposed restoration profile, proposed drainage and settlement traps, turf and overburden removal and storage for reinstatement should be submitted.

9.3 The impact of such facilities (including dust, blasting and impact on water) should be appraised as part of the overall impact of the scheme. Information should cover, in relation to water; at least the information set out in Planning Advice Note PAN 50 Controlling the Environmental Effects of Surface Mineral Workings (Paragraph 53). In relation to groundwater, information (Paragraph 52 of PAN 50) only needs to be provided where there is an abstraction or groundwater dependent terrestrial ecosystem within 250 m of the borrow pit. Additional information on groundwater is provided above.

10. Regulatory advice for the applicant

10.1 Details of regulatory requirements and good practice advice for the applicant can be found on our website at www.sepa.org.uk/planning.aspx. If you are unable to find the advice you need for a specific regulatory matter, please contact a member of the operations team in your local SEPA office at Strathbeg House, Clarence Street, Thurso KW14 7JS. Telephone 01847 894 422.

If you have any queries relating to this letter, please contact me by telephone on 01349 860415 or e-mail at planning.dingwall@sepa.org.uk.

Yours sincerely

Cerian Baldwin
Senior Planning Officer
Planning Service

Copy to: nswankie@environcorp.com;

Disclaimer
This advice is given without prejudice to any decision made on elements of the proposal regulated by us, as such a decision may take into account factors not considered at the planning stage. We prefer all the technical information required for any SEPA consents to be submitted at the same time as the planning application. However, we consider it to be at the applicant's commercial risk if any significant changes required during the regulatory stage necessitate a further planning application and/or neighbour notification or advertising. We have relied on the accuracy and completeness of the information supplied to us in providing the above advice and can take no responsibility for incorrect data or interpretation, or omissions, in such information. If we have not referred to a particular issue in our response, it should not be assumed that there is no impact associated with that issue. If you did not specifically request advice on flood risk, then advice will not have been provided on this issue. Further information on our consultation arrangements generally can be found in How and when to consult SEPA, and on flood risk specifically in the SEPA-Planning Authority Protocol.

Appendix 1: Example Peat Balance Table Example

		Upgraded access tracks	New 'cut' access tracks	Turbine bases	Hardstandings	Borrow pit A	Borrow Pit B	Substation	Construction compound A	Construction compound B	Cabling	Total
Excavation	Plan area											
	Depth of acro excav											
	Depth of cato excv											
	Acrotem excavated											
	Catotelm excavated											
	Total excavation											
Re-Use Requirement	Length or depth											
	X-area or plan area											
	Vol											
Construction Re-use/Reinstatement	Acrotelm re-used inc width and depth											
	Catotelm re-used inc width and depth											
	Total initial re-use											
Temporary storage	Acrotelm stored											
	Catotelm stored											
	Total stored											
Final re-use	Acrotelm re-used inc width and depth											
	Catotelm re-used inc width and depth											
	Total initial re-use											
Balance	Acrotelm balance											
	Catotelm balance											
	Overall balance											

Chairman
David Sigsworth
Chief Executive
James Curran

Dingwall Office
Graesser House, Fodderty Way,
Dingwall Business Park, Dingwall, IV15 9XB
tel 01349 862021 fax 01349 863987
www.sepa.org.uk

Kate Lyon

Subject: FW: Strathy South Wind Farm, Strathy, Sutherland - consultation letter

From: Alexander Macdonald [mailto:Alexander.Macdonald@snh.gov.uk]
Sent: 19 September 2012 09:53
To: robert.logan@scotland.gsi.gov.uk
Cc: Nathan Swankie
Subject: Strathy South Wind Farm, Strathy, Sutherland - consultation letter

Dear Mr Logan

We have been copied into the consultation letter (dated 4 September 2012) from ENVIRON to the Scottish Government Energy Consents and Deployment Unit in relation to the proposed Strathy South Wind Farm, Strathy, Sutherland.

We have no comments to make on the letter which sets out modifications to the wind farm proposal.

Yours sincerely

Alexander Macdonald
Operations Officer
Scottish Natural Heritage
The Links
Golspie Business Park
Golspie KW10 6UB
01408 634063

****
This email and any files transmitted with it are confidential and intended solely for the use of the individual or entity to whom they are addressed. If you have received this email in error please notify the system manager or the sender.

Please note that for business purposes, outgoing and incoming emails from and to SNH may be monitored.

Tha am post-dealain seo agus fiosrachadh sam bith na chois dìcmhair agus airson an neach no buidheann ainmichte a-mhàin. Mas e gun d' fhuair sibh am post-dealain seo le mearachd, cuiribh fios dhan manaidsear-siostaim no neach-sgrìobhaidh.

Thciribh an aire airson adhbharan gnothaich, 's dòcha gun tèid sùil a chumail air puist-dealain a' tighinn a-steach agus a' dol a-mach bho SNH

****

Proposed Wind Farm at Strathy South

Revised Comments from Forestry Commission Scotland

7 March 2013

Forestry Commission Scotland (FCS) does not object to the application.

Strathy South Forest sits in and is completely surrounded by the Caithness and Sutherland SAC and SPA. Consequently the removal of this woodland and the restoration of the site is seen as having wider environmental benefit. In consideration with the Scottish Government Woodland Removal Policy this would mean that this woodland removal would not require compensatory planting.

However FCS is aware that the removal of the woodland without compensatory planting may be appropriate but the proposal to use the site for a wind farm raises a number of other environmental concerns in particular with SNH and SEPA. Therefore these comments should not be taken in isolation. In addition, there are still a number of points of detail that FCS would wish to be taken into account.

Timber recovery
If the proposal went ahead the recovery of timber for off site use and or processing must be maximised.
Any harvesting operations should be staged to avoid flooding timber markets.
It would be helpful to consider the scale and rate of removal. It would be helpful to state the work processes and how impacts on the site will be minimised.
There may be opportunities to assist local renewable projects.

Other
It is not clear if it is still proposed to leave any woodland?
Are there proposals for any replanting on site?
Design proposals will be required if these are considerations.

FCS Recommendations

- The woodland removal has to be considered in the context of the proposed wind farm and the overall impact on the environment.

- Prepare a forest plan
  - Include harvesting plans and timber utilisation proposals
  - Show retained woodland and restocking options

Richard Wallace
Forestry Commission Scotland
Highland and Islands Conservancy

Kate Lyon

From: Robert.Logan@scotland.gsi.gov.uk
Sent: 11 September 2012 09:48
To: William.Kidd@scotland.gsi.gov.uk
Subject: RE: Section 36 Strathy South Windfarm

William,

The documents you have received are not the formal Addendum information. The details sent, which have been circulated to other consultees, are a pre-Addendum clarification letter/report from the developers outlining what work has been undertaken since the initial application consultation responses to deal with the issues raised etc. A response is not required from you in relation to these details, however if you have any comments then please feel free to pass these onto myself or the developers directly as there will be a formal Addendum consultation sometime in November and any comments may prove of use for incorporating into that documentation.

Please contact me if you need further clarification.

regards

Robert

Robert Logan
Scottish Government | Energy Consents & Deployment Unit
5 Atlantic Quay | 150 Broomielaw | Glasgow G2 8LU
Dir Dial: (+44) 0300 2441240 | robert.logan@scotland.gsi.gov.uk

---

From: Kidd W (William)
Sent: 11 September 2012 09:00
To: Logan R (Robert)
Cc: Melrose J (Joyce)
Subject: Section 36 Strathy South Windfarm

Robert,

Just to let you know Historic Scotland has just received the addendum for the above windfarm.

Regards

Billy Kidd
Heritage Management Business Support Officer (EIA/SEA)
Historic Scotland
Room E10
Longmore House
Salisbury Place
Edinburgh
EH9 1SH
Telephone: 0131 668 8898

JMP

Our Ref SCT6572B

4 October 2012

JMP Consultants Limited
Mercantile Chambers
53 Bothwell Street
Glasgow
G2 6TS

T 0141 221 4030
F 0800 066 4367
E glasgow@jmp.co.uk

www.jmp.co.uk

The Scottish Government
Energy Consents Unit
4th Floor
5 Atlantic Quay
150 Broomielaw
Glasgow G2 8LU

Dear Sirs

THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000
SECTION 36 APPLICATION FOR PROPOSED STRATHY SOUTH WIND FARM, STRATHY, SUTHERLAND (ENVIRONMETAL STATEMENT ADDENDUM)

With reference to correspondence received by Transport Scotland from Environ UK limited dated 4 September 2012 on the above development, we write to inform you of our involvement as Term Consultants to Transport Scotland – Trunk Road Network and Bus Operations (TS-TRBO) in relation to the provision of advice on issues affecting the trunk road network.

We have been passed a copy of the Environmental Statement (ES) Addendum Scoping Report prepared by Environ Limited in support of the above development. Having reviewed the information submitted we would make the following comments on behalf of Transport Scotland.

We note that in 2007, Scottish and Southern Energy Limited submitted an application (ref 07/00263/S36SU) for Section 36 consent for the proposed Strathy Wind Farm located on land near Strathy in Sutherland. This application was supported by an ES and we acknowledge that JMP reviewed the ES submitted and issued a formal response which concluded that the development would not have any significant environmental impact on the trunk road network.

We understand that following consultation on the Section 36 Application and consideration of the views expressed in the consultation responses, it is proposed to amend the development and therefore submit an ES Addendum to show how the issues raised by cosultees have been addressed.

We note among other proposed amendments that it is proposed to reduce the number of wind turbines from 77 turbines to 68 turbines. We also note that access to the proposed development site will still be from the A836. We would comment that the A836 is part of the local road network and in these circumstances; we have no specific comments to make on the actual access point itself.

The report indicates that the proposed route for turbine components will still be from the port of entry at Scrabster Harbour. Traffic would exit Scrabster Harbour onto the A9(T) southbound and turn right onto the A836 and head westbound towards the site access.

We note the origin of general construction traffic has yet to be confirmed however given that the delivery of turbine components would be via the A9(T) before accessing the site, Transport Scotland will need to be satisfied that the existing A9(T)/A836 is of an appropriate standard in order to accommodate conventional HGV traffic and the movement of abnormal loads accessing the site. The details required would include a report which considers the movement of abnormal loads including swept path analysis, measures required including the temporary removal of street furniture, any proposed junction widening, traffic management etc to ensure that transportation will not have any detrimental effect on structures within the route path. We note from the Scoping report that the developer intends to provide such a report with the Addendum submission.

As the development is reducing in size there is no proposal to re-visit the traffic impacts from the development. We can confirm that this is acceptable on this occasion.

Notwithstanding that, we can confirm our previous view that there will be no significant trunk road impacts with regard to Noise and Air Quality associated with additional traffic on the trunk road network and can also confirm that we do not require any further information in this regard.

I trust that the above is satisfactory and should you wish to discuss any issues raised in greater detail, please do not hesitate to contact me at our Glasgow Office.

Yours faithfully

Alan DeVenny
Associate Director

Tel 0141 226 6923
Email alan.devenny@jmp.co.uk

Kate Lyon

From: dale.aitkenhead@bt.com on behalf of radionetworkprotection@bt.com
Sent: 25 October 2012 14:38
To: Kate Lyon
Subject: RE: UK12-17181 - Strathy South Wind Farm

Follow Up Flag: Follow up
Flag Status: Flagged

Categories: Red Category

Hi Kate

I looked at the changes and at this time BT will not be providing any comment at this stage thank you.

Regards
Dale Aitkenhead
BTO Service Delivery -Operations Control TM, Radio Frequency Allocation & Network Protection
Tel 0191 2696372
mobile : 07540 897558
dale.aitkenhead@bt.com
Web: http://operate.intra.bt.com/operate

Let us know how we're doing here in SD Oerations Control... Please take our 30sec Mini-Survey below

BT Internal Customers... http://formwize.intra.bt.com/run/survey3.cfm?ID=79809

From: Kate Lyon [mailto:KLyon@environcorp.com]
Sent: 25 October 2012 14:17
To: radionetworkprotection G
Subject: UK12-17181 - Strathy South Wind Farm

Dear Mr Aitkenhead

A re-consultation letter was sent to you on 4th September 2012 regarding the proposed changes to the Strathy South Wind Farm development in Sutherland. I have just left you a voicemail message, but I would be grateful if you could confirm if you will be providing any comment at this stage or whether you will be waiting until the ES Addendum is submitted later this year.

Kind regards

Kate

ENVIRON

Kate Lyon | Consultant
ENVIRON UK Ltd | 11-12 Swallow Court | Devonshire Gate| Tiverton | Devon EX16 7EJ
T: +44 (0)1884 842 010
klyon@environcorp.com

Kate Lyon

Subject: FW: Strathy South Wind Farm Environmental Statement Addendum

---

From: Windfarms [mailto:Windfarms@caa.co.uk]
Sent: 12 September 2012 11:01
To: Econsents Admin
Subject: RE: Strathy South Wind Farm Environmental Statement Addendum

Dear Sir/Madam,

Having reviewed the proposed changes to the above development and the supporting information provided, I would highlight the need to establish the positions of the relevant aviation consultees (MOD, NATS/NERL and HIAL-Wick Airport) regarding the increased height of the proposed turbines and any potential impacts of this proposed change. I would also add the need, if the proposed development is approved, to inform the Defence Geographic Centre ICGDGC-ProdAISAFDb@mod.uk of the locations, heights and lighting status of the turbines and meteorological masts, the estimated and actual dates of construction and the maximum height of any construction equipment to be used, prior to the start of construction, to allow for the appropriate inclusion on Aviation Charts, for safety purposes.

Owing to the height of the proposed turbines there is no CAA requirement for the turbines to be lit, although if an aviation stakeholder (including the MOD) made a request for lighting it is highly likely that the CAA would support such a request.

Should you have any further questions please feel free to contact me, details below.

Yours Sincerely

Neal Henley
N R HENLEY
Squadron Leader (RAF)
Surveillance and Spectrum Management
Directorate of Airspace Policy
Civil Aviation Authority
45-59 Kingsway London WC2B 6TE
Tel: 020 7453 6534 Fax: 020 7453 6565
windfarms@caa.co.uk

****

Before Printing consider the environment.

This e-mail and any attachment(s) are for authorised use by the intended recipient(s) only. It may contain proprietary material, confidential information and/or be subject to legal privilege. If you are not an intended recipient then please promptly delete this e-mail, as well as any associated attachment(s) and inform the sender. It should not be copied, disclosed to, retained or used by, any other party.
Thank you.

Please note that all e-mail messages sent to the Civil Aviation Authority are subject to monitoring / interception for lawful business

****

This email was received from the INTERNET and scanned by the Government Secure Intranet anti-virus

Kate Lyon

Subject: FW: UK12-17181 - Strathy South Wind Farm

From: Kemp, Louisa [mailto:Louisa.Kemp@thecrownestate.co.uk]
Sent: 30 October 2012 15:17
To: Kate Lyon
Subject: RE: UK12-17181 - Strathy South Wind Farm

Dear Kate

As none of the Crown Estates currently interests are affected by this proposal we will not be providing any comments.

Kind regards
Louisa

This message contains information that may be confidential, privileged or otherwise protected by law from disclosure. It is intended for the exclusive use of the Addressee(s). Unless you are the addressee or authorized agent of the addressee, you may not review, copy, distribute or disclose to anyone the message or any information contained within. If you have received this message in error, please contact the sender by electronic reply to email@environcorp.com and immediately delete all copies of the message.

MINISTRY OF DEFENCE

Energy Consents & Development Unit*
Scottish Government
4th Floor, 5 Atlantic Quay
150 Broomielaw
Glasgow
G2 8LU

Defence Infrastructure Organisation

David Naylor-Gray
Safeguarding Officer
Safeguarding - Wind Energy
Defence Infrastructure Organisation
Kingston Road
Sutton Coldfield
West Midlands
B75 7RL

Telephone: 0121 311 3810
Facsimile: 0121 311 2218
E-mail: DIOOpsNorth-LMS7a2@mod.uk

04 October 2012

Your Reference: SECTION 36 SCOPING
Our Reference: DIO/SUT/43/10/1/1033

Dear Sir/Madam

DIO Reference Number: 1033

Site Name: STRATHY SOUTH

Site Address: Strathy, Sutherland

Planning Application Number: NA

We have been advised by Environ UK Ltd that an application for Section 36 consent for the above wind energy development has been presented to the Scottish Government.

I am writing to inform you that the MOD objects to the proposal. Our assessment has been carried out on the basis that there will be 68 turbines, 135 metres in height from ground level to blade tip and located at the grid references below as stated in the planning application or provided by the developer:

Turbine	100km Square letter	Easting	Northing
1	NC	80545	52883
2	NC	80940	52720
3	NC	81341	52902
4	NC	80539	52474
5	NC	80850	52335
6	NC	81249	52319
7	NC	80366	52073
8	NC	80756	51900
9	NC	81238	51802
10	NC	80335	51643
11	NC	80671	51390
12	NC	81131	51222
13	NC	80272	51187
14	NC	80630	50982
15	NC	80999	50816
16	NC	80159	50805
17	NC	80549	50536
18	NC	81134	50535
19	NC	80005	50338
20	NC	80353	50080
21	NC	80816	50175
22	NC	79942	49916
23	NC	80304	49702
24	NC	80692	49762
25	NC	79889	49482
26	NC	80264	49236
27	NC	80651	49389
28	NC	79863	49078
29	NC	79193	50084
30	NC	79517	49818
31	NC	79086	49632
32	NC	79448	49419
33	NC	78873	48913
35	NC	77543	49057
36	NC	78066	49121
37	NC	78381	48940
38	NC	77498	49550
39	NC	77887	49512
40	NC	78513	49316
41	NC	77676	49946
42	NC	78275	49793
43	NC	78679	49700
44	NC	78780	50113
45	NC	78352	50392
46	NC	78810	50479
47	NC	78454	50797
48	NC	78923	50862
49	NC	77973	51067
50	NC	78524	51198
51	NC	78958	51239
52	NC	77895	51622
53	NC	78273	51441
54	NC	78949	51633
55	NC	77840	52128
56	NC	78232	51981
57	NC	78584	51798
61	NC	79047	52069
62	NC	77557	52965
63	NC	77977	52851
68	NC	77560	53366
69	NC	78239	53242
71	NC	78659	53389
72	NC	79138	53404
73	NC	77367	53912
74	NC	77793	53813
75	NC	78966	53770
76	NC	78898	54196
77	NC	79250	54125

Low Flying

The turbines will be within The Highlands Restricted Area, and will unacceptably affect military activities. Tactical Training Areas are made available for military operational low flying training. Within them military fast jets and Hercules aircraft may operate to as little as 100ft separation from the ground and other obstacles. The proliferation of obstacles within this area is not only a safety hazard but also severely impacts on its utilisation for essential low flying training.

If the developer is able to overcome the issues stated above, the MOD will request that all turbines be fitted with 25 candela omni-directional red lighting or infrared lighting with an optimised flash pattern of 60 flashes per minute of 200ms to 500ms duration at the highest practicable point.

It should be noted that, when we were previously consulted about this development, we initially objected and then, following discussions with the developer, withdrew our objection. This consultation was for a wind farm comprising of turbines with a height to blade tip of 110m. The wind farm now proposed comprised of significantly taller turbines.

MOD Safeguarding wishes to be consulted and notified about the progress of planning applications and submissions relating to this proposal to verify that it will not adversely affect defence interests.

I hope this adequately explains our position on the matter. Further information about the effects of wind turbines on MOD interests can be obtained from the following website:

MOD: http://www.mod.uk/DefenceInternet/MicroSite/DIO/WhatWeDo/Operations/ModSafeguarding.htm

Yours sincerely

David Naylor-Gray
Safeguarding Officer – Wind Energy
Defence Infrastructure Organisation

SAFEGUARDING SOLUTIONS TO DEFENCE NEEDS

Kate Lyon

Subject: FW: Strathy South Wind Farm, Strathy, Sutherland - Revised Layout

-----Original Message-----
From: Windfarms Team [mailto:windfarms@jrc.co.uk]
Sent: 11 September 2012 11:28
To: energyconsents@scotland.gsi.gov.uk
Cc: Nathan Swankie; Ruaridh.maclean@scottish-southern.co.uk
Subject: Strathy South Wind Farm, Strathy, Sutherland - Revised Layout

Dear Sir/Madam,

Planning Ref: n/a

Name/Location: Strathy South Wind Farm

Total 68 turbines:

TURBINE:
Strathy South T1 hub 85m blades 50m
Grid ref OSGB 280537 952889

No links affected

TURBINE:
Strathy South T2 hub 85m blades 50m
Grid ref OSGB 280926 952722

No links affected

TURBINE:
Strathy South T3 hub 85m blades 50m
Grid ref OSGB 281333 952907

No links affected

TURBINE:
Strathy South T4 hub 85m blades 50m
Grid ref OSGB 280539 952474

No links affected

TURBINE:
Strathy South T5 hub 85m blades 50m
Grid ref OSGB 280833 952333

No links affected

TURBINE:
Strathy South T6 hub 85m blades 50m
Grid ref OSGB 281241 952315

No links affected

TURBINE:
Strathy South T7 hub 85m blades 50m
Grid ref OSGB 280352 952241

No links affected

TURBINE:
Strathy South T8 hub 85m blades 50m
Grid ref OSGB 280741 951889

No links affected

TURBINE:
Strathy South T9 hub 85m blades 50m
Grid ref OSGB 281222 951796

No links affected

TURBINE:
Strathy South T10 hub 85m blades 50m
Grid ref OSGB 280333 951630

No links affected

TURBINE:
Strathy South T11 hub 85m blades 50m
Grid ref OSGB 280667 951370

No links affected

TURBINE:
Strathy South T12 hub 85m blades 50m
Grid ref OSGB 281130 951185

No links affected

TURBINE:
Strathy South T13 hub 85m blades 50m
Grid ref OSGB 280278 951185

No links affected

TURBINE:
Strathy South T14 hub 85m blades 50m
Grid ref OSGB 280630 950981

No links affected

TURBINE:
Strathy South T15 hub 85m blades 50m
Grid ref OSGB 280981 950815

No links affected

TURBINE:
Strathy South T16 hub 85m blades 50m
Grid ref OSGB 280148 950796

No links affected

TURBINE:
Strathy South T17 hub 85m blades 50m
Grid ref OSGB 280549 950536

No links affected

TURBINE:
Strathy South T18 hub 85m blades 50m
Grid ref OSGB 281130 950537

No links affected

TURBINE:
Strathy South T19 hub 85m blades 50m
Grid ref OSGB 280065 950338

No links affected

TURBINE:
Strathy South T20 hub 85m blades 50m
Grid ref OSGB 280352 950093

No links affected

TURBINE:
Strathy South T21 hub 85m blades 50m
Grid ref OSGB 280815 950167

No links affected

TURBINE:
Strathy South T22 hub 85m blades 50m
Grid ref OSGB 279944 949907

No links affected

TURBINE:
Strathy South T23 hub 85m blades 50m
Grid ref OSGB 280296 949704

No links affected

TURBINE:
Strathy South T24 hub 85m blades 50m
Grid ref OSGB 280685 949741

No links affected

TURBINE:
Strathy South T25 hub 85m blades 50m
Grid ref OSGB 279870 949481

No links affected

TURBINE:
Strathy South T26 hub 85m blades 50m
Grid ref OSGB 280259 949241

No links affected

TURBINE:
Strathy South T27 hub 85m blades 50m
Grid ref OSGB 280648 949389

No links affected

TURBINE:
Strathy South T28 hub 85m blades 50m
Grid ref OSGB 279870 949074

No links affected

TURBINE:
Strathy South T29 hub 85m blades 50m
Grid ref OSGB 279193 950084

No links affected

TURBINE:
Strathy South T30 hub 85m blades 50m
Grid ref OSGB 279519 949815

No links affected

TURBINE:
Strathy South T31 hub 85m blades 50m
Grid ref OSGB 279074 949630

No links affected

TURBINE:
Strathy South T32 hub 85m blades 50m
Grid ref OSGB 279444 949407

No links affected

TURBINE:
Strathy South T33 hub 65m blades 45m
Grid ref OSGB 278873 948913

No links affected

TURBINE:
Strathy South T34 - DELETED

No links affected

TURBINE:
Strathy South T35 hub 85m blades 50m
Grid ref OSGB 277537 949056

No links affected

TURBINE:
Strathy South T36 hub 85m blades 50m
Grid ref OSGB 278056 949111

No links affected

TURBINE:
Strathy South T37 hub 65m blades 45m
Grid ref OSGB 278370 948056

No links affected

TURBINE:
Strathy South T38 hub 85m blades 50m
Grid ref OSGB 277667 949556

No links affected

TURBINE:
Strathy South T39 hub 85m blades 50m
Grid ref OSGB 277889 949519

No links affected

TURBINE:
Strathy South T40 hub 85m blades 50m
Grid ref OSGB 278500 949296

No links affected

TURBINE:
Strathy South T41 hub 85m blades 50m
Grid ref OSGB 277667 949944

No links affected

TURBINE:
Strathy South T42 hub 85m blades 50m
Grid ref OSGB 278259 949796

No links affected

TURBINE:
Strathy South T43 hub 85m blades 50m
Grid ref OSGB 278667 949704

No links affected

TURBINE:
Strathy South T44 hub 85m blades 50m
Grid ref OSGB 278778 950093

No links affected

TURBINE:
Strathy South T45 hub 85m blades 50m
Grid ref OSGB 278333 950019

No links affected

TURBINE:
Strathy South T46 hub 85m blades 50m
Grid ref OSGB 280148 950463

No links affected

TURBINE:
Strathy South T47 hub 85m blades 50m

Grid ref OSGB 278444 950796

No links affected

TURBINE:
Strathy South T48 hub 85m blades 50m
Grid ref OSGB 278907 950852

No links affected

TURBINE:
Strathy South T49 hub 85m blades 50m
Grid ref OSGB 277963 951074

No links affected

TURBINE:
Strathy South T50 hub 85m blades 50m
Grid ref OSGB 278519 951185

No links affected

TURBINE:
Strathy South T51 hub 85m blades 50m
Grid ref OSGB 278963 951241

No links affected

TURBINE:
Strathy South T52 hub 85m blades 50m
Grid ref OSGB 277889 951630

No links affected

TURBINE:
Strathy South T53 hub 85m blades 50m
Grid ref OSGB 278259 951444

No links affected

TURBINE:
Strathy South T54 hub 85m blades 50m

Grid ref OSGB 278944 951630

No links affected

TURBINE:
Strathy South T55 hub 85m blades 50m
Grid ref OSGB 277833 952111

No links affected

TURBINE:
Strathy South T56 hub 85m blades 50m
Grid ref OSGB 278222 952000

No links affected

TURBINE:
Strathy South T57 hub 85m blades 50m
Grid ref OSGB 278574 951796

No links affected

TURBINE:
Strathy South T58 - DELETED

No links affected

TURBINE:
Strathy South T59 - DELETED

No links affected

TURBINE:
Strathy South T60 - DELETED

No links affected

TURBINE:
Strathy South T61 hub 85m blades 50m
Grid ref OSGB 279037 952074

No links affected

TURBINE:
Strathy South T62 hub 85m blades 50m
Grid ref OSGB 277556 952963

No links affected

TURBINE:
Strathy South T63 hub 85m blades 50m
Grid ref OSGB 277963 952852

No links affected

TURBINE:
Strathy South T64 - DELETED

No links affected

TURBINE:
Strathy South T65 - DELETED

No links affected

TURBINE:
Strathy South T66 - DELETED

No links affected

TURBINE:
Strathy South T67 - DELETED

No links affected

TURBINE:
Strathy South T68 hub 85m blades 50m
Grid ref OSGB 277574 953352

No links affected

TURBINE:

Strathy South T69 hub 85m blades 50m
Grid ref OSGB 278222 953241

No links affected

TURBINE:
Strathy South T70 - DELETED

No links affected

TURBINE:
Strathy South T71 hub 85m blades 50m
Grid ref OSGB 278648 953370

No links affected

TURBINE:
Strathy South T72 hub 85m blades 50m
Grid ref OSGB 279130 953389

No links affected

TURBINE:
Strathy South T73 hub 85m blades 50m
Grid ref OSGB 277352 953907

No links affected

TURBINE:
Strathy South T74 hub 85m blades 50m
Grid ref OSGB 277796 953815

No links affected

TURBINE:
Strathy South T75 hub 85m blades 50m
Grid ref OSGB 278963 953741

No links affected

TURBINE:
Strathy South T76 hub 85m blades 50m

Grid ref OSGB 278889 954185

No links affected

TURBINE:
Strathy South T77 hub 85m blades 50m
Grid ref OSGB 279241 954111

No links affected

Cleared with respect to radio link infrastructure operated by:-

Scottish Hydro (Scottish & Southern Energy) and Scotia Gas Networks

JRC analyses proposals for wind farms on behalf of the UK Fuel & Power Industry and the Water Industry in north-west England. This is to assess their potential to interfere with radio systems operated by utility companies in support of their regulatory operational requirements.

In the case of this proposed wind energy development, JRC does not foresee any potential problems based on known interference scenarios and the data you have provided. However, if any details of the wind farm change, particularly the disposition or scale of any turbine(s), it will be necessary to re-evaluate the proposal.

In making this judgement, JRC has used its best endeavours with the available data, although we recognise that there may be effects which are as yet unknown or inadequately predicted.JRC cannot therefore be held liable if subsequently problems arise that we have not predicted.

It should be noted that this clearance pertains only to the date of its issue. As the use of the spectrum is dynamic, the use of the band is changing on an ongoing basis and consequently, developers are advised to seek re-coordination prior to considering any design changes.

Regards

Keith Brogden

Wind Farm Team

The Joint Radio Company Limited
Dean Bradley House,
52 Horseferry Road,
LONDON SW1P 2AF
United Kingdom

DDI: +44 20 7706 5197
TEL: +44 20 7706 5199
Skype: keithb_jrc

<keith.brogden@jrc.co.uk>

NOTICE:
This e-mail is strictly confidential and is intended for the use of the addressee only. The contents shall not be disclosed to any third party without permission of the JRC.

JRC Ltd. is a Joint Venture between the Energy Networks Association (on behalf of the UK Energy Industries) and National Grid.
Registered in England & Wales: 2990041
<http://www.jrc.co.uk/about>

Kate Lyon

Subject: FW: Proposed Windfarm: Strathy South - 2012 Addendum (Our Ref: W(F)7665)

From: ALLEN, Sarah J [mailto:Sarah.ALLEN@nats.co.uk] **On Behalf Of** NATS Safeguarding
Sent: 06 September 2012 15:31
To: 'econsentsadmin@scotland.gsi.gov.uk'
Cc: Nathan Swankie
Subject: Proposed Windfarm: Strathy South - 2012 Addendum (Our Ref: W(F)7665)

The proposed development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal.

However, please be aware that this response applies specifically to the above consultation and only reflects the position of NERL (that is responsible for the management of en route air traffic) based on the information supplied at the time of this application. This letter does not provide any indication of the position of any other party, whether they be an airport, airspace user or otherwise. It remains your responsibility to ensure that all the appropriate consultees are properly consulted.

If any changes are proposed to the information supplied to NERL in regard to this application which become the basis of a revised, amended or further application for approval, then as a statutory consultee NERL requires that it be further consulted on any such changes prior to any planning permission or any consent being granted.

Yours faithfully,

Sarah Allen
Technical Administrator
On behalf of NERL Safeguarding Office

If you are not the intended recipient, please notify our Help Desk at Email Information.Solutions@nats.co.uk immediately. You should not copy or use this email or attachment(s) for any purpose nor disclose their contents to any other person.

NATS computer systems may be monitored and communications carried on them recorded, to secure the effective operation of the system.

Please note that neither NATS nor the sender accepts any responsibility for viruses or any losses caused as a result of viruses and it is your responsibility to scan or otherwise check this email and any attachments.

NATS means NATS (En Route) plc (company number: 4129273), NATS (Services) Ltd (company number 4129270), NATSNAV Ltd (company number: 4164590) or NATS Ltd (company number 3155567) or NATS Holdings Ltd (company number 4138218). All companies are registered in England and their registered office is at 4000 Parkway, Whiteley, Fareham, Hampshire, PO15 7FL.

From: Spectrum Licensing [mailto:Spectrum.Licensing@ofcom.org.uk]
Sent: 03 October 2012 11:31
To: Nathan Swankie
Cc: Windfarms (windfarms@atkinsglobal.com); windfarms@jrc.co.uk
Subject: RE: Strathy South Wind Farm

FIXED LINK REPORT FOR WINDFARM CO-ORDINATION AREA:

Dear Sir/Madame

For a response on all future requests please only provide the following to Spectrum.Licensing@ofcom.org.uk:

- **UK NGR,**
- **Site/town**
- **Email address for response**
- **Search radius (optional)**

Please do not post to Ofcom:

- **planning/scoping requests**
- **large packets/parcels in the post**

Search Radius 3000m at Centre NGR NC7950051500 NO Links Identified. Search includes an additional 500m of requested radius.

Links	Company	Contact	Telephone	Email
#N/A		#N/A		#N/A

These details are provided to Ofcom by Fixed Link operators at the time of their licence application and cannot verified by Ofcom for accuracy or currency and Ofcom makes no guarantees for the currency or accuracy of information or that they are error free. As such, Ofcom cannot accept liability for any inaccuracies or omissions in the data provided, or its currency however so arising. The information is provided without any representation or endorsement made and without warranty of any kind, whether express or implied, including but not limited to the implied warranties of satisfactory quality, fitness for a particular purpose, non-infringement, compatibility, security and accuracy.

Our response to your co-ordination request is only in respect of microwave fixed links managed and assigned by Ofcom within the bands and frequency ranges specified in the table below. The analysis identifies all fixed links with either one link leg in the coordination range or those which intercept with the coordination range. The coordination range is a circle centred on your provided national grid reference. We add an additional 500 metres to the coordination range that you request. Therefore if you have specified 500 metres the coordination range will be 1km.

If you should need further information regarding link deployments and their operation then you will need to contact the fixed link operator(s) identified in the table above directly.

Additional coordination is also necessary with the band managers for the water, electricity and utilities industries which operate in the frequency ranges 457-458 MHz paired with 463-464 MHz band. You should contact both the following:

- Atkins Ltd at windfarms@atkinsglobal.com.
- Joint Radio Company (JRC) at windfarms@jrc.co.uk. Additionally, you can call the JRC Wind Farm Team on 020 7706 5197.

For self coordinated links operating in the 64-66GHz, 71-76GHz and 81-86GHz bands a list of current links can be found at: http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/

Regarding assessment with respect to TV reception, the BBC has an online tool available on their website: http://www.bbc.co.uk/reception/info/windfarm_tool.shtml . Ofcom do not forward enquiries to the BBC.

Please note other organisations may require coordination with regard to your request. More information regarding windfarm planning is available on the British Wind Energy Association website www.bwea.com .

Table of assessed fixed links bands and frequency ranges

Band (GHz)	Frequency Range (MHz)
1.4/1.5	1350 -1375 1450 -1452 1492 -1530
1.6	1672 – 1690
1.7	1764 – 1900
2	1900 – 2690
4	3600 – 4200
6	5925 – 7110
7.5	7425 – 7900
11	10700 – 11700
13	12750 – 13250
14	14250 – 14620
15	14650 – 15350
18	17300 – 19700
22	22000 – 23600
25	24500 – 26500
28	27500 – 29500
38	37000 – 39500
50	49200 – 50200
55	55780 – 57000

Regards

From: Nathan Swankie [mailto:nswankie@environcorp.com]
Sent: 03 October 2012 09:33
To: Spectrum Licensing
Cc: Windfarms (windfarms@atkinsglobal.com); windfarms@jrc.co.uk; Kate Lyon
Subject: RE: Strathy South Wind Farm

Simon, I have taken further advice on the search radius and I am now advised that it can be reduced to 3 km. Therefore I would be grateful if you could please re-run my request as follows:

- Site Centre: NC 79500 51500
- Strathy South Wind Farm, Strathy Forest, Strathy, Sutherland
- nswankie@environcorp.com
- 3000m

Apologies for any inconvenience.

Best Regards

From: Nathan Swankie [mailto:nswankie@environcorp.com]
Sent: 01 October 2012 12:38
To: Spectrum Licensing
Subject: RE: Strathy South Wind Farm

Simon – thanks for your e-mail and clarification – that's very helpful.

The approximate site centre is NC 79500 51500. I'm happy to take your guidance if you consider that the consultation distance should be reduced.

Best Regards

Nathan

ENVIRON

Nathan Swankie | Senior Manager
ENVIRON UK Ltd | 7 Walker Street | Edinburgh | EH3 7JY
T: +44 (0)131 225 9899 | M: +44 (0)7920 114 029
nswankie@environcorp.com

Registered in England Company No: 2331163 | Registered Office: 5 Stratford Place | London W1C 1AX

From: Spectrum Licensing [mailto:Spectrum.Licensing@ofcom.org.uk]
Sent: 26 September 2012 14:44
To: Nathan Swankie
Subject: RE: Strathy South Wind Farm

Nathan, Ofcom is very much hands off in this process. We have 1 function only and that is to carry out searches for fixed links at a given NGR over a given radius. All we require from the enquire is an NGR in the form SP 12345 12345, in your case an NGR for the site centre will be fine, an address (which you have already given) and a radius, typically 500m but fair enough as you have a huge wind farm proposal, 34km it is. If you can provide the site centre, we will carry out the search for you.

I don't mean to be rude but there is no need to attach anything, all we want is the NGR.

Regards,

Simon Mitchell
Ofcom Licensing Centre
Riverside House
LONDON SE1 9HA
020 7981 3096

From: Nathan Swankie [mailto:nswankie@environcorp.com]
Sent: 25 September 2012 13:45
To: Spectrum Licensing
Cc: Kate Lyon
Subject: Strathy South Wind Farm

Dear Sirs,

I am writing in connection with the above wind farm. I recently issued a copy of a consultation letter (dated 4 September and enclosed) and was subsequently requested by OGCOM to provide:

- Turbine co-ordinates – see enclosed spreadsheet and Figure 2 'Modified Scheme'
- Consultation distance (calculated as 34km radius based on 68 turbines x 500m)
- Address – Strathy South Wind Farm, Strathy Forest, Strathy, Sutherland – see Figure 1 enclosed for site location

Please let me know if you require any further information – I look forward to receiving your response.

Best Regards

ENVIRON

Nathan Swankie | Senior Manager
ENVIRON UK Ltd | 7 Walker Street | Edinburgh | EH3 7JY
T: +44 (0)131 225 9899 | M: +44 (0)7920 114 029
nswankie@environcorp.com

Registered in England Company No: 2331163 | Registered Office: 5 Stratford Place | London W1C 1AX

This message contains information that may be confidential, privileged or otherwise protected by law from disclosure. It is intended for the exclusive use of the Addressee(s). Unless you are the addressee or authorized agent of the addressee, you may not review, copy, distribute or disclose to anyone the message or any information contained within. If you have received this message in error, please contact the sender by electronic reply to email@environcorp.com and immediately delete all copies of the message.

****
For more information visit www.ofcom.org.uk

This email (and any attachments) is confidential and intended for the use of the addressee only.

If you have received this email in error please notify the originator of the message and delete it from your system.

This email has been scanned for viruses. However, you open any attachments at your own risk.

Any views expressed in this message are those of the individual sender and do not represent the views or opinions of Ofcom unless expressly stated otherwise.
****

This message contains information that may be confidential, privileged or otherwise protected by law from disclosure. It is intended for the exclusive use of the Addressee(s). Unless you are the addressee or authorized agent of the addressee, you may not review, copy, distribute or disclose to anyone the message or any information contained within. If you have received this message in error, please contact the sender by electronic reply to email@environcorp.com and immediately delete all copies of the message.

****
For more information visit www.ofcom.org.uk

This email (and any attachments) is confidential and intended for the use of the addressee only.

If you have received this email in error please notify the originator of the message and delete it from your system.

This email has been scanned for viruses. However, you open any attachments at your own risk.

Any views expressed in this message are those of the individual sender and do not represent the views or opinions of Ofcom unless expressly stated otherwise.
****

This message contains information that may be confidential, privileged or otherwise protected by law from disclosure. It is intended for the exclusive use of the Addressee(s). Unless you are the addressee or authorized agent of the addressee, you may not review, copy, distribute or disclose to anyone the message or any information contained within. If you have received this message in error, please contact the sender by electronic reply to email@environcorp.com and immediately delete all copies of the message.

****
For more information visit www.ofcom.org.uk

This email (and any attachments) is confidential and intended for the use of the addressee only.

If you have received this email in error please notify the originator of the message and delete it from your system.

This email has been scanned for viruses. However, you open any attachments at your own risk.

Any views expressed in this message are those of the individual sender and do not represent the views or opinions of Ofcom unless expressly stated otherwise.
****

Kate Lyon

Subject: FW: Strathy South Wind Farm Strathy Sutherland

From: Anne Phillips [mailto:APhillips@hial.co.uk]
Sent: 22 October 2012 17:40
To: EconsentsAcmin@scotland.gsi.gov.uk
Cc: robert.logan@scotland.gsi.gov.uk; Nathan Swankie
Subject: Strathy South Wind Farm Strathy Sutherland

Plan App Ref: 07/00263/S36SU
HIAL Ref: 2012/0380/WIC (prev.188/WIC/280607)

Dear Sir/Madam,

PROPOSAL: **Environmental Statement Addendum – Strathy South Wind Farm (max height to blade tip 135m)**
LOCATION: **Strathy Sutherland**

With reference to the above, our calculations show that, at the given position and height, this development would not infringe the safeguarding surfaces for **Wick Airport.**

However, due to its height and position, red obstacle lights may be required to be fitted at the hub height of some of the turbines.

As a minimum the Civil Aviation Authority (CAA) recommends that all proposed developments over 90m in height should be notified to the CAA through:

Off Route Airspace 5
Directorate of Airspace Policy
Civil Aviation Authority
CAA House
45-59 Kingsway
London WC2B 6TE
Email marks.smailes@caa.co.uk

Provided that these conditions are met Highlands and Islands Airports Limited would not object to this proposal.

Anne Phillips
Operations Manager
Highlands and Islands Airports Limited
Head Office, Inverness Airport, Inverness IV2 7JB
☏ 01667 464244 (DIRECT DIAL)
✉ safeguarding@hial.co.uk 🌐 www.hial.co.uk

Kate Lyon

Subject: FW: Strathy South Wind Farm

From: Eleisha Fahy [mailto:eleisha_fahy@scotways.com]
Sent: 01 October 2012 11:07
To: Nathan Swankie
Subject: RE: Strathy South Wind Farm

Dear Nathan,

Thank you for your email. We are being asked to consider such a large number of planning applications at present, so as you have indicated there will be a further opportunity to comment, we have decided to wait until the ES Addendum is submitted.

Kind regards,
Eleisha

Eleisha Fahy
Access Enquiries
Scottish Rights of Way and Access Society (ScotWays)
24 Annandale Street, Edinburgh EH7 4AN
tel/fax: 0131 558 1222
web: www.scotways.com
follow us on Twitter: @ScotWays
find us on Facebook: www.facebook.com/scotways

Safeguarding Public Access in Scotland since 1845

A company limited by guarantee, registered in Scotland
Company number 24243
Registered office as above
Scottish Charity number SC015460

From: Nathan Swankie [mailto:nswankie@environcorp.com]
Sent: 12 September 2012 10:03
To: Eleisha Fahy
Subject: RE: Strathy South Wind Farm

Dear Eleisha,

If you have any comments that you wish to make prior to the ES Addendum being submitted, these should be provided by the end of September. Please note that there will be a further opportunity to consult on the proposals, once the ES Addendum is submitted, currently anticipated to be in November 2012.

Best Regards

Nathan

ENVIRON

Nathan Swankie | Senior Manager
ENVIRON UK Ltd | 7 Walker Street | Edinburgh | EH3 7JY
T: +44 (0)131 225 9899 | M: +44 (0)7920 114 029
nswankie@environcorp.com

Registered in England Company No: 2331163 | Registered Office: 5 Stratford Place | London W1C 1AX

From: Eleisha Fahy [mailto:eleisha_fahy@scotways.com]
Sent: 07 September 2012 16:44
To: Nathan Swankie
Subject: Strathy South Wind Farm

Dear Mr Swankie,

Thank you for forwarding a copy of the consultation letter provided to the ECDU for Strathy South Wind Farm dated 4th September 2012. We are very busy with consultation requests at present, so an indication of the time by which our response is required would be very helpful.

As we are a small charity, it is usual for us to request a voluntary contribution towards our expenses. The suggested amount is £75; an invoice will be enclosed with your copy of any comments made.

Looking forward to hearing from you,
Kind regards,
Eleisha

Eleisha Fahy
Access Enquiries
Scottish Rights of Way and Access Society (ScotWays)
24 Annandale Street, Edinburgh EH7 4AN
tel/fax: 0131 558 1222
web: www.scotways.com
follow us on Twitter: @ScotWays
find us on Facebook: www.facebook.com/scotways

Safeguarding Public Access in Scotland since 1845

A company limited by guarantee, registered in Scotland
Company number 24243
Registered office as above
Scottish Charity number SC015460

This message contains information that may be confidential, privileged or otherwise protected by law from disclosure. It is intended for the exclusive use of the Addressee(s). Unless you are the addressee or authorized agent of the addressee, you may not review, copy, distribute or disclose to anyone the message or any information contained within. If you have received this message in error, please contact the sender by electronic reply to email@environcorp.com and immediately delete all copies of the message.

From: Windfarms (windfarms@atkinsglobal.com) [mailto:windfarms@atkinsglobal.com]
Sent: 04 October 2012 09:27
To: Nathan Swankie
Subject: WF 19659 - Strathy South Wind Farm, Strathy Forest, Strathy, Sutherland - NC 79500 51500

Dear Nathan,

I am responding to an email of 03-Oct-12, regarding the above named proposed development.

The above application has now been examined in relation to UHF Radio Scanning Telemetry communications used by our Client in that region and we are happy to inform you that we have **NO OBJECTION** to your proposal.

Please note that this is not in relation to any Microwave Links operated by Scottish Water

Atkins Limited is responsible for providing Wind Farm/Turbine support services to TAUWI.

Atkins Limited is responsible for providing Wind Farm/Turbine support services to the Telecommunications Association of the UK Water Industry. Web: www.tauwi.co.uk

Windfarm Support
ATKINS
The official engineering design services provider
for the London 2012 Olympic and Paralympic Games
Web: www.atkinsglobal.com/communications

This email and any attached files are confidential and copyright protected. If you are not the addressee, any dissemination of this communication is strictly prohibited. Unless otherwise expressly agreed in writing, nothing stated in this communication shall be legally binding.

The ultimate parent company of the Atkins Group is WS Atkins plc. Registered in England No. 1885586. Registered Office Woodcote Grove, Ashley Road, Epsom, Surrey KT18 5BW. A list of wholly owned Atkins Group companies registered in the United Kingdom and locations around the world can be found at http://www.atkinsglobal.com/site-services/group-company-registration-details

Consider the environment. Please don't print this e-mail unless you really need to.

Kate Lyon

Subject: FW: Strathy South Wind farm

-----Original Message-----
From: Andrew Puls [mailto:Andrew.Puls@highland.gov.uk]
Sent: 01 March 2013 13:41
To: 'catherine dagg'
Cc: Kate Lyon; 'Nicki Small'; Nathan Swankie
Subject: RE: Strathy South Wind farm

Cathy,
An omission certainly. We find that for assessing impacts to setting there is no substitute to actually visiting the site, and certainly we would have more confidence in your judgement knowing that you had been there and experienced the monument for yourself. A quick note on wireframes. We have consistently found that in the majority of cases wireframes give the appearance of a much more significant impact when compared to photomontages. Large scale development, when shown how it fits against a realistic depiction of the actual landscape and crucially alongside other features such as trees, walls, powerlines etc, normally shows the impact to be significantly less severe than suggested by wireframes alone. Something that may be worthy of consideration in this case.
Regards
Andrew

-----Original Message-----
From: catherine dagg [mailto:cathydagg@gmail.com]
Sent: 01 March 2013 12:04
To: Andrew Puls
Cc: Kate Lyon; Nicki Small; Nathan Swankie
Subject: Re: Strathy South Wind farm

Hi Andy

I can confirm that new ZTVs will be produced once the design is fixed, and that any new key receptors will be incorporated into the ES addendum. Wireframes specific to Ben Griam Beg (and any new receptors) will be used to evaluate cumulative impacts.

I gather that you would consider the lack of a site visit to Ben Griam Beg a serious omission

Cathy

On 3/1/13, Andrew Puls <Andrew.Puls@highland.gov.uk> wrote:
Hello Cathy,

Non-Statutory Register: Archaeological sites included no longer need to be assessed by virtue of their inclusion in the non-statutory register; Highland Council stopped using this as method for assessing significance some years ago. However, where non-statutory or statutory archaeological and historic sites, features or cultural landscapes are to be directly or indirectly impacted by the development, they will still need to be assessed, irrespective of any past inclusion in the non-statutory register.

Key receptors and Ben Griam Beg: Given the proposed increased height, can I assume new ZTV's will be produced? In the event these demonstrate potential impacts on significant cultural heritage assets other than Ben Griam Beg, then these will need to form part of the assessment. HET would expect a site visit to be made to any site where an impact is predicated in order to better assess magnitude. HET would also expect appropriate visualisations from the such receptors.

Cumulative effects: Generally happy with the approach suggested. However, I do note that Ben Griam Beg is located on the high ground to the south, and will need to be assessed for cumulative impacts.

If you need any further information at this stage, please let me know.

If you need any further information at this stage, please let me know.

Regards

Andrew

-----Original Message-----
From: catherine dagg [mailto:cathydagg@gmail.com]
Sent: 21 February 2013 11:01
To: Andrew Puls
Cc: Kate Lyon; Nicki Small; Nathan Swankie
Subject: Strathy South Wind farm

Andy

please find attached a zip file containing three documents relating to the proposed Strathy South windfarm. The addendum to the ES is nearing completion, and I want to be sure we have covered all points:

Letter to HCAU confirming several points raised during discussions last August and bringing you up to date on actions

Figure showing site layout and access track

Copy of letter sent to ECDU 4th September 2012

best wishes

Cathy

Unless related to the business of the Highland Council, the views or opinions expressed within this e-mail are those of the sender and do not necessarily reflect those of The Highland Council, or associated bodies, nor does this e-mail form part of any contract unless so stated.

Mura h-eil na beachdan a tha air an cur an cèill sa phost-d seo a' buntainn ri gnothachas Chomhairle na Gàidhealtachd, 's ann leis an neach fhèin a chuir air falbh e a tha iad, is chan eil iad an-còmhnaidh a' riochdachadh beachdan na Comhairle, no buidhnean buntainneach, agus chan eil am post-d seo na phàirt de chunnradh sam bith mura h-eil sin air innse.

Wild Land Assessment

A8.1 Introduction

As referred to in Chapter A8: Landscape Character, it is appropriate to carry out an assessment of potential impacts upon areas of wild land which may arise from development of the Modified 2013 Scheme. This assessment follows similar desk- and field-based methodologies to those applied the landscape character impact assessment (a more detailed description is given at Section A8.4 below) applied to guidance[1] and mapping[2] produced by SNH.

A8.2 Scope of Assessment

A8.2.1 Project Interactions

A detailed description of the Modified 2013 Scheme is provided in Chapter A4: Development Description. However, the elements relevant to this assessment are the construction and operation of 47 turbines with a tip height of up to 135 m with a modelled tower height of 83 m and a modelled rotor diameter of 104 m within this tip height.

Owing to the intervening distances involved, other elements of the scheme, such as the internal track layout, borrow pits, laydown areas and access would have limited effect on the impacts being assessed.

A8.2.2 Study Area

The study area used for this assessment is the same as that used for the assessment in Chapter A8: Landscape Character and shown on Figure A8.1: Key Landscape Constraints.

A8.2.3 Impacts to be Assessed

This assessment identifies areas of wild land (guided by SNH mapping and confirmed using site appraisal) and considers potential indirect short-term (construction) and long-term (operational) impacts upon these areas.

A8.2.4 Impacts Scoped out of Assessment

Impacts arising from the process of decommissioning are considered to be of a similar nature and duration to those arising from the construction process and therefore have not been considered separately in this chapter. Where this assessment refers to potential construction impacts, these are also representative of predicted decommissioning impacts.

A8.3 Policy and Legislative Context

A full description of updated policy and legislation relating to this development is provided in Chapter A7: Planning Context. Listed below is a summary of those relevant to this element of the assessment.

[1] SNH (2007) Assessing the Impacts on Wild Land

[2] SNH (2002) Search Areas for Wild Land and SNH (2012) Relative Wildness throughout Scotland

A8.3.1 International Legislation and Policy

There is no international legislation or policy relevant to this assessment.

A8.3.2 National Legislation and Policy

Several national policy, guidance and consultation documents relating to wild land, and assessment of impacts on it, have been published, including:

- SNH Policy Statement - Wildness in Scotland's Countryside (2002);
- SNH Map - Search Areas for Wild Land (2002);
- SNH Interim Guidance Note - Assessing the Impacts on Wild Land (2007);
- SNH Map - Relative Wildness throughout Scotland (2012); and
- SNH Map - Core Areas of Wild Land in Scotland (2013).

These documents set out the position of SNH in relation to wild land and its importance within National Planning Framework for Scotland. It should be noted that the latest mapping produced in 2012 and 2013 is at consultative stage and, as stated on the SNH website, "until the results of the consultation have been considered and Government confirms its approach in the finalised National Planning Framework in 2014, (SNH) will continue to apply the established set of Search Areas for Wild Land". However, given the length of time passed since the 2002 mapping was adopted, comparison of the map sets has been useful in understanding the potential for wild land to exist within the study area.

A8.4 Methodology

The wild land assessment has been carried out in accordance with criteria from SNH Interim Guidance Note: Assessing the Impacts on Wild Land (February 2007), with reference to SNH Policy Statement No. 02/03: Wildness in Scotland's Countryside. The assessment has been carried out in parallel with the landscape character assessment and also takes account of the Guidelines for Landscape and Visual Impact Assessment (GLVIA), published by the Landscape Institute and the Institute of Environmental Assessment, 2nd Edition (2002). This assessment should be read in conjunction with the Landscape Character Assessment.

Areas identified as having the potential to exhibit qualities of wild land (as defined in SNH Policy Statement No. 02/03) were assessed for quality of wild land, magnitude of change and significance of effect using a tabular format, adapted from the SNH interim guidance[3].

The guidance identifies two classifications of criteria for identifying the quality of wild land; physical attributes and perceptual attributes. The criteria used for identifying the strength of each of these attributes are detailed in the Table A8.1.01 and A8.1.02.

[3] SNH (2007) Assessing the Impacts on Wild Land

Table A8.1.1: Physical Attributes – Strength of Attribute

Physical Attribute	High	Medium	Low	Negligible
Perceived Naturalness	Area perceived as generally natural	Majority of area perceived as generally natural	Some of area perceived as generally natural	Area not perceived as generally natural
Lack of construction or other artefacts	No, or minimal, perceptible evidence of artefacts	Some artefacts visible but are not prominent	Some artefacts visible and are prominent	Several artefacts clearly visible and are prominent
Evidence of contemporary land uses	Contemporary land use not apparent	Some contemporary land use apparent though not significantly detracting	Some contemporary land use apparent and locally detracting	Contemporary land use apparent and detracting
Rugged or challenging terrain	Rough, tough terrain. Steep ground requiring an appreciable level of fitness to traverse and sturdy footwear. Navigation across this terrain requires high degree of skill.	Appreciable skill in navigation required, including in poor visibility, requiring a degree of accuracy. Rough terrain with some steep ground and requiring a degree of fitness and sturdy footwear.	Some rough areas, but generally terrain easy to cross. Only slightly strenuous. Navigation reasonably straightforward with landform or tracks providing relatively easy to cross terrain.	Easily traversed terrain requiring no navigation skill.
Remoteness and inaccessibility	No roads, tracks or paths. No key routes available for crossing area.	Some route availability through landform, but no roads, tracks or paths in area.	Few tracks or paths available to traverse area but wider area still relatively inaccessible.	Close to public roads with easily accessed network of paths or tracks.

Table A8.1.2: Perceptual Attributes – Strength of Attribute

Perceptual Attribute	High	Medium	Low	Not Present
Sense of sanctuary or solitude	Landscape experience provides intense perceptions of sanctuary or solitude and experience of being a long way from developed areas.	Perceptions of sanctuary or solitude likely to be obtained from most areas but some localised influence of human activity from neighbouring areas.	Perceptions of sanctuary or solitude may be obtained in some localised pockets but generally not present.	Landscape experience provides very little, if any, sense of sanctuary or solitude.
Risk, a sense of awe or anxiety	Landscape perceived as having a high degree of potential risk with a level of skill required to maintain safety. Steep cliffs, drops and very rugged terrain are likely to be dominant and risk may be intensified by extreme weather, ice or snow.	Landscape perceived as having a degree of potential risk in some areas. There may be some cliffs or steep drops in some areas but this is unlikely to be the dominant terrain.	Generally likely to be only a small degree of perceived risk limited to steep slopes and rugged terrain in some areas which can easily be avoided.	No or very little degree of perceived risk.
Arresting or inspiring qualities	Landscape experience arouses intense arresting or inspiring impressions. Landscape perceived as being highly dramatic and very extensive with a high degree of 'naturalness'.	Landscape experience arouses inspiring or arresting impressions in some areas. Landscape likely to exhibit dramatic or extensive views from some areas with large areas of perceived 'naturalness'.	Landscape generally perceived as having limited arresting or inspiring qualities but some impressive or attractive views may be obtained from some parts.	Landscape perceived as having very little or no arresting or inspiring qualities.

Table A8.1.2: Perceptual Attributes – Strength of Attribute

Perceptual Attribute	High	Medium	Low	Not Present
Physically challenging terrain	Terrain appears complex, rugged and difficult to navigate without high degree of skill. There are cliffs, very steep slopes ridges and peaks and high elevation subject to the influence of extreme weather.	Terrain appears fairly rugged with some steep areas, rock outcrops and summits requiring a level of skill to navigate although other, easier routes will be present.	Terrain appears generally unchallenging with roads, tracks and paths present and only a few steep slopes or areas of rough topography.	Terrain does not appear challenging.

A8.4.1 Wild Land Quality

Based on the strength identified for the above criteria an overall quality of wild land rating has been applied to each of the areas assessed ranging from Low to High as follows:

- High – The area has an overriding sense of wildness. It is large scale and remote with little evidence of human influence on the landscape and strong impressions of isolation. It is likely to be difficult to access with a rugged and challenging terrain, inspiring qualities and a considerable sense of awe or risk;
- Medium – The area has a generally dominating sense of wildness. It is likely to be large scale and fairly remote although locally influenced by some human interventions or neighbouring land uses. There is likely to be some rugged or challenging terrain and impressive or dramatic views from some areas and a general sense of isolation; and
- Low – The area has some qualities of wild land but is influenced by human interventions such as tracks, paths and forestry, which will be locally dominating. There will be some difficult terrain with a limited degree of risk, but tracks and paths will provide easier routes through the landscape. A sense of solitude or isolation is likely to be experienced in some areas and there may be some expansive or impressive views.

A8.4.2 Magnitude of Change

Values for magnitude of change during the construction and operational phases of the Modified 2013 Scheme were applied taking into consideration each of the physical and perceptual attributes. Values for magnitude of change were based on the following criteria:

- High – Total loss or alteration to attribute;
- Medium – Partial loss or alteration to attribute;

- Low – Minor loss or alteration to attribute resulting in a change to the baseline; and
- Negligible – Very minor or no loss to the baseline attribute. The introduction of the Development would not change the baseline assessment.

A8.4.3 Assessment of Impact

A final rating of potential impact during the construction and operation of the Development was applied to each LCA based on the identified values for magnitude of change for each attribute and taking into account the wild land quality rating. Explanation of the impact ratings is described below:

- Substantial Adverse – The activities or development would result in total or substantial loss of wild land characteristics of the area or would result in sufficient erosion of wild land quality to result in a high quality area being reduced to low quality;
- Moderate Adverse – The activities or development would result in partial loss of wild land characteristics or would result in sufficient erosion of wild land quality to result in a high quality area being reduced to medium quality or a medium quality area being reduced to low quality;
- Slight Adverse – The activities or development would result in localised impacts to wild land characteristics but would not be sufficient to result in a reduction of overall wild land quality; and
- Neutral – The activities or development would result in no discernible impact to the wild land quality or characteristics.

The above criteria represent points along a sliding scale and due to the nature of landscape and wildness, interim ratings have been utilised where considered more appropriate.

For the purpose of this assessment, impacts of a Moderate Adverse rating or greater are considered to be significant.

A8.5 Baseline Conditions

A review of the study area against the 2012 SNH mapping shows that areas of darkest green shown, i.e. areas of highest relative wildness, correlate well with the Flow Country and the Ben Armine Forest SAWLs of the 2002 SNH mapping while the area of the Ben Hope Massif SAWL shows differing shades, indicating a greater degree of variation in its relative wildness. In addition to this, there are several smaller areas of potentially high relative wildness indicated around the lochs between the site and Ben Griam Beg, on the open moor above Strath Halladale and the River Strathy valley and around Beinn Ratha.

Following site visits, there is broad agreement with the indicated potential wild land areas at Ben Armine Forest, around Ben Hope and the Flow Country. However, there is notable visual impact from elements such as coniferous plantation, peat cutting, wind turbines, communication infrastructure overhead electricity transmission lines at the other areas indicated on the 2012 mapping. These observations show that these areas do not accord with the physical and perceptual attributes for wild land described in SNH guidance and they are therefore not considered further in this Wild Land Assessment.

For the reasons outlined above, the Wild Land Assessment has focussed on potential impacts within three areas of the 2012 SNH mapping, roughly correlating to (and henceforth referred to as) the Ben Hope Massif, Ben Armine Forest and Flow Country SAWLs of the 2002 SNH mapping.

A8.5.1 Ben Armine Forest

The extent of this SAWL is shown on Figure A8.1: Key Landscape Constraints. When analysing the attribute Extent of Area, it was noted that, within the study area, this SAWL extends south-west from Loch Naver, encompassing high ground south of Loch Rimsdale and Loch Badanloch. It is remote from intensive human activity: vehicle access is possible to the periphery and it is reasonably difficult to access by foot. The extent of the area is sufficient to engender a sense of remoteness (High).

There are two localised study zones (LSZ) within this search area: Ben Armine (sample location is at NC 694 273, approximately 23 km from the site periphery) and The Whip / Ben Klibreck (sample location is at NC 625 322, approximately 23 km from the site periphery).

(i) Ben Armine LSZ

The following physical attributes of the Ben Armine LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (heathland, rock outcrops), catchment system unmodified; High.
- Lack of construction or other artefacts – to north, forestry and tracks visible (Medium); to south, generally more 'natural' hillsides but with turbines at Lairg and Achany/ Rosehall visible in the distance in some weather conditions (Medium).
- Little Evidence of Contemporary Land Uses – open heath / bog; High.
- Rugged or otherwise challenging terrain – Medium challenge associated with higher rugged heathland terrain and steep slopes / rugged cliffs and High challenge associated with boggy peatlands to south and east.
- Remoteness and inaccessibility – one private track to lodges, running between Loch Choire and Loch Badanloch along foot of high ground provides limited vehicular access to some of the area. Also, network of walker's paths, mostly along valleys and lower ground; nevertheless a sense of remoteness prevails, especially to the south; Medium-High.

The following perceptual attributes of the Ben Armine LSZ have been recorded:

- Sense of sanctuary or solitude; High.
- Sense of risk, awe or anxiety; Medium-High.
- Arresting or inspiring qualities; Medium.
- Fulfilment of physical challenge to penetrate this area; Medium.

The overall Wild Land Quality of the Ben Armine LSZ is considered to be Medium-High.

(ii) The Whip / Ben Klibreck LSZ

The following physical attributes of The Whip / Ben Klibreck LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (heathland, rock outcrops), catchment system unmodified; High.
- Lack of construction or other artefacts – to north-east, extensive forestry / firebreaks and tracks visible (Medium-Low); to south, more 'natural' hillsides (High).
- Little Evidence of Contemporary Land Uses – open heath / bog; High.
- Rugged or otherwise challenging terrain – Medium challenge associated with higher rugged heathland terrain and steep slopes / rugged cliffs / scree.
- Remoteness and inaccessibility – relatively close and accessible by walkers from the A836 south of Altnaharra. Also estate track / footpath along Loch Coire immediately to south; Medium-Low.

The following perceptual attributes of The Whip / Ben Klibreck LSZ have been recorded:

- Sense of sanctuary or solitude; High.
- Sense of risk, awe or anxiety; Medium.
- Arresting or inspiring qualities; Medium.
- Fulfilment of physical challenge to penetrate this area; Medium-High.

The overall Wild Land Quality of The Whip / Ben Klibreck LSZ is considered to be Medium-High.

A8.5.2 Ben Hope Massif

The extent of this SAWL is shown on Figure A8.1: Key Landscape Constraints. When analysing the attribute Extent of Area, it was noted that, within the study area, this SAWL extends north and west from Loch Loyal, and A836, and south of A838, encompassing massifs associated with Ben Hope and Ben Loyal. It is remote from intensive human activity: vehicle access is possible to the periphery and glens and it is reasonably difficult to access by foot. The extent of the area is sufficient to engender a sense of remoteness (High).

There are three localised study zones (LSZ) within this search area: Ben Hiel (sample location is at NC 595 499, approximately 18 km from the site periphery), Meallan Liath (sample location NC 514 503, approximately 25 km from site periphery) and Cnoc an Daimh Mhor (sample location is at NC 533 428, approximately 25 km from the site periphery).

(i) Bein Hiel LSZ

The following physical attributes of the Ben Hiel LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (heathland, rock outcrops), catchment system unmodified; High.
- Lack of construction or other artefacts – to north, Tongue Causeway, mast, isolated houses; to east, turbines at Bettyhill and Borgie Forest (Medium-Low); to west, more 'natural' hillsides (High).
- Little Evidence of Contemporary Land Uses – open heath / bog; High.
- Rugged or otherwise challenging terrain – Medium-High challenge associated with higher rugged heathland terrain and steep slopes / rugged cliffs.
- Remoteness and inaccessibility – relatively close and accessible by walkers from the A836 south of Tongue (Ben Loyal). Also estate track from Tongue to Loch an Dherue immediately to west of Ben Loyal; Medium-Low.

The following perceptual attributes of the Ben Hiel LSZ have been recorded:

- Sense of sanctuary or solitude; High.
- Sense of risk, awe or anxiety; High.
- Arresting or inspiring qualities; High.
- Fulfilment of physical challenge to penetrate this area; High.

The overall Wild Land Quality for the Ben Hiel LSZ is considered to be High.

(ii) Meallan Liath LSZ

The following physical attributes of the Meallan Liath LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (heathland, rock outcrops), catchment system unmodified; High.
- Lack of construction or other artefacts – to north, settled coastal strip, estate houses, mast (Medium); to south, more 'natural' hillsides (High).
- Little Evidence of Contemporary Land Uses – open heath / bog; High.
- Rugged or otherwise challenging terrain – Medium-High challenge associated with higher rugged heathland terrain and steep slopes / rugged cliffs.
- Remoteness and inaccessibility – relatively close and accessible by walkers from the minor road Hope-Altnaharra; Medium-Low.

The following perceptual attributes of the Meallan Liath LSZ have been recorded:

- Sense of sanctuary or solitude; High.
- Sense of risk, awe or anxiety; High.
- Arresting or inspiring qualities; High.
- Fulfilment of physical challenge to penetrate this area; High.

The overall Wild Land Quality for the Meallan Liath LSZ is considered to be High.

(iii) Cnoc an Daimh Mhor LSZ

The following physical attributes of the Cnoc an Daimh Mhor LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (heathland, rock outcrops), catchment system unmodified; High.
- Lack of construction or other artefacts – to north, forestry, tracks, mast (Medium); to south, more 'natural' hillsides (High).
- Little Evidence of Contemporary Land Uses – open heath / bog; High.
- Rugged or otherwise challenging terrain – Medium-High challenge associated with higher rugged heathland terrain.
- Remoteness and inaccessibility – relatively close and accessible by walkers from A836 5 km to east; track from Kinloch Lodge 2 km to north; unclassified road by Loch Meadie 3 km to south-west; Low.

The following perceptual attributes of the Cnoc an Daimh Mhor LSZ have been recorded:

- Sense of sanctuary or solitude; Medium-High.
- Sense of risk, awe or anxiety; Medium-High.
- Arresting or inspiring qualities; Medium-High.
- Fulfilment of physical challenge to penetrate this area; Medium.

The sensitivity of the Cnoc an Daimh Mhor LSZ to change resulting from the 2013 Modified Scheme is considered to be Medium-High.

A8.5.3 Flow Country

The extent of this SAWL is shown on Figure A8.1: Key Landscape Constraints. When analysing the attribute Extent of Area, it was noted that, within the study area, this SAWL extends east of the A897 near Forsinard, below the Far North railway line, and south to Ben Aliskey. It is remote from intensive human activity: vehicle access is possible up some glens and it is difficult to access by foot. The extent of the area is sufficient to engender a sense of remoteness (Medium).

There are three localised study zones (LSZ) within this search area: Knockfin Heights (sample location is at NC 916 302, approximately 22 km from the site periphery), Cnoc Garbhleathaid (sample location NC 968 362, approximately 21 km from site periphery) and Ben Aliskey (sample location is at ND 045 386, approximately 27 km from the site periphery).

(i) Knockfin Heights LSZ

The following physical attributes of the Knockfin Heights LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (heathland, peat bog), catchment system unmodified; High.
- Lack of construction or other artefacts – to west, mast, tracks, road, forestry visible (Medium-Low); to east, more 'natural' flow country landscape (High); to the

south, distant views of turbines at Gordonbush in some weather conditions (Medium).

- Little Evidence of Contemporary Land Uses – open heath / peat bog; High.
- Rugged or otherwise challenging terrain – High challenge associated with boggy peatlands.
- Remoteness and inaccessibility – relatively close to A837 but difficult to access on foot due to boggy terrain and closest vehicle tracks well east; High.

The following perceptual attributes of the Knockfin Heights LSZ have been recorded:

- Sense of sanctuary or solitude; Medium.
- Arresting or inspiring qualities; Medium.
- Fulfilment of physical challenge to penetrate this area; Medium-High.

The overall Wild Land Quality for the Knockfin Heights LSZ is considered to be Medium.

(ii) Cnoc Garbhleathaid LSZ

The following physical attributes of the Cnoc Garbhleathaid LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (peat bog / dubh lochans), catchment system unmodified; High.
- Lack of construction or other artefacts – to north, 'natural' flow country but distant views of Causeymire & Buolfrach wind farms and mast visible (Medium); to east, 'natural' flow country but with views of forestry (Medium).
- Little Evidence of Contemporary Land Uses – open heath / bog; High.
- Rugged or otherwise challenging terrain – High challenge associated with extensive boggy peatlands.
- Remoteness and inaccessibility – estate track as far as The Glutt and footpath up Glutt Water Glen but difficult to access on foot; High.

The following perceptual attributes of the Cnoc Garbhleathaid LSZ have been recorded:

- Sense of sanctuary or solitude; Medium.
- Arresting or inspiring qualities; Medium-Low.
- Fulfilment of physical challenge to penetrate this area; High.

The overall Wild Land Quality for the Cnoc Garbhleathaid LSZ is considered to be Medium.

(iii) Ben Aliskey LSZ

The following physical attributes of the Ben Aliskey LSZ have been recorded:

- Perceived naturalness – functioning natural habitats (heathland, bog, rock outcrops), catchment system unmodified; High.
- Lack of construction or other artefacts – to north-east, distant views of Causeymire, Camster & Buolfruich wind farms, oil rigs, scattered houses and a mast visible; diminished sense of wildness (Low).
- Little Evidence of Contemporary Land Uses – open heath / bog; High.
- Rugged or otherwise challenging terrain – High-Medium challenge associated with boggy peatlands but less so than for Cnoc Garbhleathaid.
- Remoteness and inaccessibility – estate track as far as Dalnawillan Lodge and footpath thereafter; Low.

The following perceptual attributes of the Ben Aliskey LSZ have been recorded:

- Sense of sanctuary or solitude; Low.
- Arresting or inspiring qualities; Low.
- Fulfilment of physical challenge to penetrate this area; Low.

The overall Wild Land Quality for the Ben Aliskey LSZ is considered to be Low.

A8.6 Effects Evaluation

A8.6.1 Basis of Assessment

The description of the Modified 2013 Scheme contained in ES Addendum Chapter A4: Development Description includes a turbine with a maximum tip height of up to 135 m, a modelled hub height of 83 m and a modelled rotor diameter of 104 m. While the constructed turbines may differ within these parameters, up to the 135m tip height, these maximum dimensions have been used to generate computer modelling on which to base assessment.

Potential impacts have been assessed using Zone of Theoretical Visibility (ZTV) diagrams and wireline visualisation (as described in Section 9.5.2 of Chapter A9: Visual Impact).

A8.6.2 Ben Armine Forest Search Area for Wild Land

Table A8.1.3: Ben Armine Forest SAWL – Ben Armine LSZ

Physical Attribute	Strength of Attribute	Magnitude of Change (Construction)	Magnitude of Change (Operation)
Perceived naturalness	High	Low	Low
Lack of construction or other artefacts	Medium	Low	Low
Evidence of contemporary land uses	High	Low	Low
Rugged or challenging terrain	Medium or High	Low	Low

Table A8.1.3: Ben Armine Forest SAWL – Ben Armine LSZ			
Remoteness and inaccessibility	Medium-High	Low	Low
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	High	Low	Low
Sense of risk, awe or anxiety	Medium-High	Low	Low
Arresting or inspiring qualities	Medium	Low	Low
Physically challenging terrain	Medium	Low	Low
Impacts	**Wild Land Quality**	**Impact During Construction**	**Impact During Operation**
	Medium-High	Slight Adverse	Slight Adverse

Table A8.1.4: Ben Armine Forest SAWL – The Whip / Ben Klibreck LSZ			
Physical Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Perceived naturalness	High	Low	Low
Lack of construction or other artefacts	Medium-Low or High	Low	Low
Evidence of contemporary land uses	High	Low	Low
Rugged or challenging terrain	Medium	Low	Low
Remoteness and inaccessibility	Medium-Low	Low	Low
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	High	Low	Low
Risk, a sense of awe or anxiety	Medium	Low	Low
Arresting or inspiring qualities	Medium	Low	Low
Physically challenging terrain	Medium-High	Low	Low

Impacts	Wild Land Quality	Impact During Construction	Impact During Operation
	Medium-High	Slight Adverse	Slight Adverse

A8.6.3 Ben Hope Massif Search Area for Wild Land

(i) Bein Hiel LSZ

Table A8.1.5: Ben Hope Massif SAWL – Ben Hiel LSZ			
Physical Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Perceived naturalness	High	Medium	Medium
Lack of construction or other artefacts	Medium-Low or High	Medium	Medium
Evidence of contemporary land uses	High	Medium	Medium
Rugged or challenging terrain	Medium-High	Medium	Medium
Remoteness and inaccessibility	Medium-Low	Medium	Medium
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	High	Medium	Medium
Risk, a sense of awe or anxiety	High	Medium	Medium
Arresting or inspiring qualities	High	Medium	Medium
Physically challenging terrain	High	Medium	Medium
Impacts	**Wild Land Quality**	**Impact During Construction**	**Impact During Operation**
	High	Moderate Adverse	Moderate Adverse

(ii) Meallan Liath LSZ

Table A8.1.6: Ben Hope Massif SAWL – Meallan Liath LSZ			
Physical Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Perceived naturalness	High	Negligible	Negligible
Lack of construction or other artefacts	Medium or High	Negligible	Negligible

Table A8.1.6: Ben Hope Massif SAWL – Meallan Liath LSZ			
Evidence of contemporary land uses	High	Negligible	Negligible
Rugged or challenging terrain	Medium-High	Negligible	Negligible
Remoteness and inaccessibility	Medium-Low	Negligible	Negligible
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	High	Negligible	Negligible
Risk, a sense of awe or anxiety	High	Negligible	Negligible
Arresting or inspiring qualities	High	Negligible	Negligible
Physically challenging terrain	High	Negligible	Negligible
Impacts	**Wild Land Quality**	**Impact During Construction**	**Impact During Operation**
	High	Slight Adverse	Slight Adverse

(iii) Cnoc an Daimh Mhor LSZ

Table A8.1.7: Ben Hope Massif SAWL – Cnoc an Daimh Mhor LSZ			
Physical Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Perceived naturalness	High	Negligible	Negligible
Lack of construction or other artefacts	High	Negligible	Negligible
Evidence of contemporary land uses	High	Negligible	Negligible
Rugged or challenging terrain	Medium-High	Negligible	Negligible
Remoteness and inaccessibility	Low	Negligible	Negligible
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	Medium-High	Negligible	Negligible
Risk, a sense of awe or anxiety	Medium-High	Negligible	Negligible

Arresting or inspiring qualities	Medium-High	Negligible	Negligible
Physically challenging terrain	Medium	Negligible	Negligible
Impacts	**Wild Land Quality**	**Impact During Construction**	**Impact During Operation**
	Medium-High	Negligible	Negligible

A8.6.4 Flow Country Search Area for Wild Land

(i) Knockfin Heights LSZ

Table A8.1.8: Flow Country SAWL – Knockfin Heights LSZ			
Physical Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Perceived naturalness	High	Low	Low
Lack of construction or other artefacts	High or Medium-Low or Medium	Low	Low
Evidence of contemporary land uses	High	Low	Low
Rugged or challenging terrain	High	Low	Low
Remoteness and inaccessibility	High	Low	Low
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	Medium	Low	Low
Arresting or inspiring qualities	Medium	Low	Low
Physically challenging terrain	Medium-High	Low	Low
Impacts	**Wild Land Quality**	**Impact During Construction**	**Impact During Operation**
	Medium	Slight Adverse	Slight Adverse

(ii) Cnoc Garbhleathaid LSZ

Table A8.1.9: Flow Country SAWL – Cnoc Garbhleathaid LSZ			
Physical Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Perceived naturalness	High	Negligible	Negligible

Table A8.1.9: Flow Country SAWL – Cnoc Garbhleathaid LSZ			
Lack of construction or other artefacts	Medium	Negligible	Negligible
Evidence of contemporary land uses	High	Negligible	Negligible
Rugged or challenging terrain	High	Negligible	Negligible
Remoteness and inaccessibility	High	Negligible	Negligible
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	Medium	Negligible	Negligible
Arresting or inspiring qualities	Medium-Low	Negligible	Negligible
Physically challenging terrain	High	Negligible	Negligible
Impacts	**Wild Land Quality**	**Impact During Construction**	**Impact During Operation**
	Medium	Negligible	Negligible

(iii) Ben Aliskey LSZ

Table A8.1.10: Flow Country SAWL – Ben Aliskey LSZ			
Physical Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Perceived naturalness	High	Negligible	Negligible
Lack of construction or other artefacts	Low	Negligible	Negligible
Evidence of contemporary land uses	High	Negligible	Negligible
Rugged or challenging terrain	Medium-High	Negligible	Negligible
Remoteness and inaccessibility	Low	Negligible	Negligible
Perceptual Attribute	**Strength of Attribute**	**Magnitude of Change (Construction)**	**Magnitude of Change (Operation)**
Sense of sanctuary or solitude	Low	Negligible	Negligible
Arresting or inspiring qualities	Low	Negligible	Negligible

Physically challenging terrain	Low	Negligible	Negligible
Impacts	**Wild Land Quality**	**Impact During Construction**	**Impact During Operation**
	Low	Negligible	Negligible

A8.7 Summary & Conclusion (inc. residual impacts)

SNH mapping[4] indicates several locations within the study area with differing potential to show wild land characteristics. Initial site observation ruled out the majority of these areas owing to influence from man-made elements. Three areas, at Ben Armine Forest, around Ben Hope and the Flow Country, were considered to have potential to show wild land characteristics and so were studied further. These areas roughly correlate to the Ben Hope Massif, Ben Armine Forest and Flow Country SAWLs of an earlier version of SNH mapping[5].

Although the Modified 2013 Scheme is not located within any of these areas, it is intervisible with parts of them (see Figure A8.2). These areas of intervisibility were used to identify LSZs.

A site survey was carried out in each of these LSZs and an assessment carried out to assess whether these areas displayed wild land characteristics, the magnitude of change likely to result from the Modified 2013 Scheme and the potential impacts arising.

It is concluded that each of these areas identified have wild land characteristics in varying degrees and that their overall quality varies between High (in the case of the Ben Hope Massif) and Medium-Low (in the case of the Flow Country).

The magnitude of change has been assessed as generally Negligible or Low, with the exception of the Ben Hiel LSZ (part of the Ben Hope Massif SAWL) where it would be Medium and would result in a Moderate Adverse impact. However, apart from this localised area, impacts on the wild land resource have been assessed as either Slight Adverse or Negligible and, therefore, are not considered to be significant.

It should be noted that the Wild Land Assessment summarised above does not consider cumulative impacts other than for those wind farms which are in operation, i.e. part of the baseline. However, Strathy North Wind Farm has received planning consent and, in 2007, it was anticipated that it would have a Slight Adverse impact on the Ben Hope Massif SAWL[6]. In line with best practice at the time, potential impacts were assessed across the SAWL rather than areas of identified wild land or individual LSZs within a search area. It is therefore likely that this predicted Slight Adverse impact across the SAWL is a mean assessment with higher or lower impacts occurring at specific locations, such as Ben Heil.

[4] SNH (2012) Relative Wildness throughout Scotland
[5] SNH (2002) Search Areas for Wild Land
[6] SSE (2007) Strathy North Wind Farm Environmental Statement

Once constructed, it is anticipated that Strathy North Wind Farm would reduce the perceptual qualities which contribute to the Ben Heil LSZ Wild Land Quality and would also reduce the magnitude of change which would result from the Modified 2013 Scheme. It is considered that the combination of these factors would result in an impact at the Ben Hiel LSZ of less than Moderate Adverse (as was assessed above) and this would therefore not be significant.

A8.8 Bibliography

Strathy South Wind Farm Environmental Statement (2007), Scottish and Southern Energy plc.

Renewable Energy and the Natural Heritage (2010), Scottish Natural Heritage

Strategic Locational Guidance for Onshore Wind Farms (updated 2009), Scottish Natural Heritage

Onshore Wind Energy: Interim Supplementary Guidance (2012), The Highland Council

Guidelines for Landscape and Visual Impact Assessment, Second Edition (2002), Spon Press

Assessing the Cumulative Impacts of Onshore Wind Energy Developments (2012), Scottish Natural Heritage

Strathy North Wind Farm Environmental Statement (2007), Scottish and Southern Energy plc.

Table A8.1.11: Glossary and Abbreviations

Glossary	
Term	**Definition**
Modified 2013 Scheme	The development as described in Chapter A4: Development Description of this 2012 Addendum.
Original 2007 Scheme	The development as described in Chapter 4: Development Description of the 2007 ES.
National Scenic Area	A national level landscape designation applied to the highest quality scenic areas.
Abbreviations	
ES	Environmental Statement
ZTV	Zone of Theoretical Visibility
SNH	Scottish Natural Heritage
SAWL	Search Area for Wild Land
LSZ	Local Search Zone

Cumulative Landscape Character

A8.1 Introduction

Cumulative impacts are those which occur as a result of the construction of more than one development of a particular type. In terms of landscape character, cumulative impacts may result where a number of wind farms combine, increasing the prevalence of wind turbines within a landscape to an extent where they may become a defining characteristic. The likely significance of these impacts relates to the number of wind farms affecting the landscape, their scale, the inter-relationship between their respective visual envelopes and the sensitivity and capacity of the particular landscape to accommodate this type of development.

Since the 2007 ES was prepared, a number of developments included in the cumulative assessment have been removed from the cumulative baseline, others have been added and some have changed their status within the planning system. In March 2012, SNH published 'Assessing the Cumulative Impact of Onshore Wind Energy Developments' which updates the recommended methodology for carrying out cumulative landscape character assessment. To properly reflect this updated guidance and the latest baseline information, it is necessary to complete a new cumulative landscape character assessment rather than updating that of the 2007 ES.

A8.2 Scope of Assessment

A8.2.1 Project Interactions

A detailed description of the Modified 2013 Scheme is provided in Chapter A4: Development Description. However, the changes relevant to this assessment are the construction and operation of 47 turbines and a tip height of up to 135 m with a modelled tower height of 83 m and a modelled rotor diameter of 104 m within this tip height.

Other elements of the scheme, such as the internal track layout, borrow pits, laydown areas and access would have limited effect on the cumulative impacts being assessed and have therefore been scoped out of the assessment.

A8.2.2 Study Area

A study area based on a standard buffer of between 35 km and 60 km from the development periphery was considered (in line with SNH guidance). Having examined available information and consulted with SNH, it was decided that an irregular (or variable-distance) study area was appropriate in order to focus on the most significant impacts and potentially sensitive areas, including those at distant designated landscapes such as North-West Sutherland and Assynt-Coigach National Scenic Areas (NSAs). This variable-distance boundary is shown on Figure A8.3: Landscape Designations and Cumulative ZTV.

The potential cumulative impacts of all sites within 60 km of the site will be considered within this variable-distance study area.

A8.2.3 Impacts to be Assessed

This chapter considers potential long-term (operational) impacts upon designated and non-designated landscape within the study area. These impacts may be direct or indirect.

A8.2.4 Impacts Scoped out of Assessment

Due to the uncertainty of the timing of construction activity for the Modified 2013 Scheme and other such activity, and the assumptions relating to the cumulative baseline scenario, as described below, temporary structures, tracks and activity relating to construction have not been considered within the cumulative assessment. It therefore focuses on the potential cumulative impacts relating to the main permanent structures and other associated features.

A8.3 Policy and Legislative Context

A full description of updated policy and legislation relating to this development is provided in Chapter A7: Planning Context. Listed below is a summary of updates relevant to landscape impacts.

A8.3.1 International Legislation and Policy

No international legislation or policy relevant to this assessment has been updated since the 2007 ES was prepared.

A8.3.2 National Legislation and Policy

Since the 2007 ES was written, the following national policy guidance relating to landscape and wind energy development has been published:

- SNH - Siting and Designing Windfarms in the Landscape (2009);
- SNH - Strategic Locational Guidance for Onshore Wind Farms in respect of the Natural Heritage (updated 2009);
- SNH - Renewable Energy and the Natural Heritage (2010); and
- SNH - Assessing the Cumulative Impact of Onshore Wind Energy Developments (2012).

These documents set out the position of SNH in relation to developments of the type proposed; being supportive of their potential contribution to addressing climate change, acknowledging that they may result in impacts upon the landscape and promoting appropriate location and design of developments in order to minimise those impacts. These policy documents have been considered as part of this assessment.

A8.3.3 Regional Policy

There is no regional policy or guidance specifically related to the assessment of cumulative landscape impacts.

A8.3.4 Local Policy

There is no local policy or guidance specifically related to the assessment of cumulative landscape impacts.

A8.4 Methodology

The methodology for the cumulative landscape assessment is based on that described in SNH guidance: 'Assessing the Cumulative Impact of Onshore Wind Energy Development' (March 2012). The assessment considers the potential for combined impacts to static views within the landscape which may be either simultaneous (where wind farms would be observable at the same time) or successive (where an observer would be required to turn to experience multiple wind farms). The assessment also considers the potential for sequential impacts which may be experienced whilst moving through the landscape.

The cumulative assessment is based on the Landscape Character Types (LCTs) and designated areas identified on Figure A8.3 and A8.4. Areas are evaluated using a tabular format in accordance with the process outlined below.

The cumulative assessment has involved five key stages:

- Evaluation of the capacity of the identified landscape to accommodate wind farm development;
- Analysis of the baseline wind development scenario;
- Evaluation of the cumulative sensitivity to change;
- Evaluation of the potential magnitude of change to the baseline scenario resulting from the Modified 2013 Scheme; and
- Assessment of the potential cumulative impacts arising from the introduction of the Modified 2013 Scheme into the baseline scenario.

A8.4.1 Evaluation of the Capacity of the Landscape

An evaluation of sensitivity to change has been attributed to each LCT or designated area based on analysis of the baseline scenario in relation to the identified capacity value of the landscape to accommodate wind farm development. This is based on a three point scale from High to Low as follows:

- High Sensitivity – The baseline wind farm scenario is very close to or achieves the identified capacity of the area resulting in little opportunity for additional development without significant impact;
- Medium Sensitivity – The baseline wind farm scenario leaves some opportunity for additional development within the landscape without significant impact resulting; and
- Low Sensitivity – The baseline scenario has little influence on the capacity value resulting in a landscape potentially tolerant of a large degree of additional development.

A8.4.2 Identification of the Cumulative Magnitude of Change

Magnitude of change concerns the measurement of change which would occur as a result of the introduction of the Modified 2013 Scheme into the baseline scenario.

This is identified based on the consideration of the potential nature, size, scale and location of the proposed change within the context of the existing baseline scenario. The evaluation of the magnitude of change is based on the criteria outlined in the main landscape assessment methodology (as described in Chapter 8 of the 2007 ES).

A8.4.3 Assessment of Potential Cumulative Impacts

Assessment of potential cumulative impacts is based on analysis of the relationship between the cumulative sensitivity to change and the magnitude of change and is made using a degree of professional judgement. It should be noted that the cumulative impact assessed is the result of the addition of the Modified 2013 Scheme to the existing baseline scenario. The cumulative impact assessment is based on a four point scale as follows:

- Substantial Adverse - The addition of the Modified 2013 Scheme, into the cumulative baseline scenario, would result in the capacity of the landscape to accommodate wind farm development being exceeded and the combined appearance of wind turbines in the landscape becoming a dominant and character defining feature;
- Moderate Adverse – The addition of the Modified 2013 Scheme, into the cumulative baseline scenario, would increase the appearance of wind turbines in the landscape to the extent that they may become locally dominant, but the development would not exceed the overall capacity of the landscape to accommodate wind farm development;
- Slight Adverse – The addition of the Modified 2013 Scheme, into the cumulative baseline scenario, would add to the appearance of wind turbines in the landscape but would not result in a noticeable change to key landscape characteristics; and.
- Neutral – The addition of the Modified 2013 Scheme, into the cumulative baseline scenario, would not result in any discernible increase in the appearance or dominance of wind turbines in the landscape.

A8.5 Baseline Conditions

A8.5.1 Context

The landscape character assessment (Chapter A8) is based on Local Character Zones (LCZs) which are refined, local scale areas derived from regional Landscape Character Types (LCTs) contained in SNH Review No. 103; this approach suited the more local scale of that assessment. Given the extent of the cumulative landscape character assessment, it is not appropriate to assess to this local level of detail and so this assessment is based on the regional LCTs.

A review of data from, and consultation with, SNH and THC identified 33 other existing, consented and proposed wind farms and one scoping site within 60 km of the Modified 2013 Scheme. Generally, scoping stage sites are not included in the cumulative assessment. However, in this case, Strathy Wood Wind Farm has been included as it is in such close proximity to the site.

Although all identified wind farms within 60 km of the site will be considered, only their impacts on LCAs and designated landscapes within the irregular-distance study area will be assessed.

These identified wind farms form the cumulative baseline scenario and are shown on Figure A9.25 Cumulative Search Area Plan and detailed in Table A8.2.1, below. This information is correct at 16 May 2013.

Table A8.2.1: Development Information included in the Cumulative Impact Assessment

Status	Reference & Name	Location	No. of Turbines	Turbine Geometry
Operational	1. Forss I	Near Thurso	2	H=62 D=94
	2. Forss II	Near Thurso	4	H=62 D=94
	3. Buolfruich	Dunbeath	15	H=44 D=52
	4. Causeymire	Westerdale	21	H=60 D=80
	5. Kilbraur	Strath Brora	19	H=70 D=90
	6. Kilbraur Extension	Strath Brora	8	H=80 D=90
	7. Flex Hill	Bilbster	3	H=60 D=80
	8. Achairn	Wick	3	H=60 D=80
	9. Achany	Lairg	19	H=67 D=70
	10. Gordonbush	Brora	35	H=67 D=80
	11. Lairg	Lairg	3	H=59.5 D=80
	12. Bettyhill	Bettyhill	2	H=80 D=90
Under Construction	13. Rosehall	Lairg	19	H=55 D=70
	14. Baillie Hill	Westfield	21	H=70 D=80
	15. Camster	Bilbster	25	H=80 D=80
	16. Wathegar	Bilbster	5	H=60 D=80
Approved	17. Causeymire Extension	Westerdale	3	H=60 D=80
	18. Stroupster	Nybster	12	H=60 D=104

Table A8.2.1: Development Information included in the Cumulative Impact Assessment

Status	Reference & Name	Location	No. of Turbines	Turbine Geometry
	19. Burn of Whilk	East Clyth	9	H=70 D=92
	20. Melness	Tongue	3	H=49 D=52
	21. Strathy North	Strathy	33	H=70 D=80
	22. Wathegar 2	Bilbster	9	H=60 D=80
Submitted	23. Halsary	Mybster	18	H=60 D=80
	24. Dunbeath	Dunbeath	17	H=80 D=90
	25. Sallachy	Lairg	22	H=74.5 D=101
	26. Dalnessie	Lairg	27	H=73.5 D=95
	27. Braemore	Lairg	24	H=80 D=93
	28. Limekiln	Dounreay	24	H=98.4 D=52
	29. Glencassley	Lairg	26	H=80 D=91.2
	30. Bad A Cheo	Westermire	13	H=65 D=80
	31. Rumster	Lybster	3	H=50 D=50
Appeal	32. Forss III	Near Thurso	5	H=55 D=52
Scoping	33. Strathy Wood	Strathy	28	H=100 D=93

A cumulative zone of theoretical visibility (ZTV) showing the visual envelope of the Modified 2013 Scheme and that of the cumulative baseline scenario has been produced in order to identify areas of combined and sequential visibility, see Figures A9.27 and A9.28. This demonstrates that the cumulative baseline scenario is one of relatively widespread visibility of wind farms within the study area.

A8.6 Effects Evaluation

A8.6.1 Basis of Assessment

The description of the Modified 2013 Scheme in ES Addendum Chapter A4: Development Description contains a turbine with a maximum tip height of up to 135 m, a modelled hub height of 83 m and a modelled rotor diameter of 104 m. While the constructed turbines may differ within these parameters, these maximum dimensions have been used to generate computer modelling on which to base assessment.

Wireline visualisations and ZTV diagrams have been produced using the methods outlined in Section 9.5.2 of Chapter A9: Visual Impact. These have been used to assess potential impacts on landscape character types and landscape designations within the study area. These assessments are detailed in tables contained in Appendix A8.3: Cumulative Landscape Assessment Tables.

A8.6.2 General Findings

The cumulative ZTVs (Figures A9.27 to A9.61) indicate that there may potentially be combined or sequential visibility of the Modified 2013 Scheme and at least one other wind farm from the majority of LCTs identified in the study area. Much of the area is subject to existing impacts as a result of the cumulative baseline scenario, as described above.

Technical Appendix A8.3 provides a cumulative assessment of each designated landscape and LCT within the study area identified as potentially receiving cumulative impacts. The following paragraphs provide a summary of those predicted to receive significant cumulative impacts.

A8.6.3 Designated Areas

The cumulative landscape character assessment found that the majority of designated landscapes within the study area would receive impacts of either Neutral or Slight Adverse. These levels of impact are not considered to be significant. In the case of the Bens Griam and Loch nan Clar Special Landscape Area (SLA), it was found that there would be localised significant impacts.

(i) Bens Griam and Loch nan Clar Special Landscape Area

This local designation is located to the south of the site. It features prominent hills surrounded by sweeping moorland and upland lochs and its accessible solitude and views of the Flow Country are highlighted as special qualities.

Impacts arising from introduction of the Modified 2013 Scheme would be indirect. Although extensively influenced by wind energy development within the baseline scenario, at a variety of directions and distances, the introduction of the Modified 2013 Scheme would result in turbines appearing in views at a closer proximity to hills and slopes than would otherwise be the case. The resulting impact, across the designation as a whole, would be Slight Adverse (and therefore not significant) but with localised impacts of up to Moderate Adverse (significant) on the hill summits and north-facing slopes.

A8.6.4 Landscape Character Types

The cumulative landscape character assessment found that the majority of LCTs within the study area would receive impacts ranging from Neutral or Slight-Moderate Adverse. These levels of impact are not considered to be significant. In the case of 4 – Lone Mountains however, it was found that there would be significant impacts.

(i) 4 – Lone Mountains LCT

The Lone Mountains LCT occurs in eight areas across the study area. These are areas of prominent, steep sided, rugged mountains rising above surrounding moorland and lochs.

Impacts arising from introduction of the Modified 2013 Scheme would be indirect. This LCT is affected, to varying degrees across each of its eight areas, by wind energy development within the baseline scenario. The Modified 2013 Scheme would be visible at distances ranging between 7 km and 56 km and, in many cases, would be imperceptible. Impacts arising close to the site would result in an overall impact of Moderate Adverse on the LCT which is considered significant.

A8.7 Summary & Conclusion

The cumulative assessment has found that the majority of the landscape designations and LCTs identified within the study area would receive impacts ranging from Neutral to Slight-Moderate Adverse, and therefore not significant, cumulative impacts as a result of the addition of the Modified 2013 Scheme into the cumulative baseline scenario. However, it is anticipated that the Lone Mountains LCT would receive Moderate Adverse, and therefore significant, cumulative impacts. This is the combined result of its High sensitivity to further change (other developments have an extensive and varied effect across this LCT) and the Medium magnitude of change which would result from the Modified 2013 Scheme.

Contributing factors similar to those noted above for the Lone Mountains LCT would result in some areas within the Bens Griam and Loch nan Clar SLA receiving locally Moderate cumulative impacts. However, the overall cumulative impact on the Bens Griam and Loch nan Clar SLA would be Slight Adverse, and therefore not significant.

A8.8 bibliography

Strathy South Wind Farm Environmental Statement (2007), Scottish and Southern Energy plc

Renewable Energy and the Natural Heritage (2010), Scottish Natural Heritage

Strategic Locational Guidance for Onshore Wind Farms (updated 2009), Scottish Natural Heritage

Highland Wide Local Development Plan (2012), The Highland Council

Onshore Wind Energy: Interim Supplementary Guidance (2012), The Highland Council

Assessment of Highland Special Landscape Areas (2012), The Highland Council

Sutherland Local Plan (2010), The Highland Council

Guidelines for Landscape and Visual Impact Assessment, Second Edition (2002), Spon Press

Assessing the Cumulative Impacts of Onshore Wind Energy Developments (2012), Scottish Natural Heritage

Table A8.2.2: Glossary and Abbreviations	
Glossary	
Term	**Definition**
Modified 2013 Scheme	The development as described in Chapter A4: Development Description of this 2012 Addendum.
Original 2007 Scheme	The development as described in Chapter 4: Development Description of the 2007 ES.
National Scenic Area	A national level landscape designation applied to the highest quality scenic areas.
Special Landscape Area	A regional or local level landscape designation applied by The Highland Council since June 2012.
Abbreviations	
ES	Environmental Statement
ZTV	Zone of Theoretical Visibility
SNH	Scottish Natural Heritage
THC	The Highland Council
LCZ	Local Character Zone
NSA	National Scenic Area
SLA	Special Landscape Area

Cumulative Landscape Character Assessment Tables

Landscape Designations

Designation	Capacity for Wind Development	Baseline Scenario	Sensitivity to Additional Change	Nature of Change	Magnitude of Change	Cumulative Impact
Kyle of Tongue NSA	Low	Direct and indirect impacts. Melness wind farm is within the designated area and indirect impacts result from several other cumulative wind farms identified in the baseline scenario. There is widespread influence, particularly on the northern section of the NSA and on higher ground and summits including Ben Hope, Meallan Liath, Ben Loyal and Cnoc nan Cúilean. Melness and Bettyhill wind farms have the greatest influence. The special qualities of the NSA are given as: • An ever-present backdrop of mountains; • The Kyle – a link from an inhabited coast to a wild moorland; • Scale, from domestic to monumental; • The constantly changing character of the Kyle; • Rich variety of coastal scenery; and • Distinct pattern of settlement. The THC Spatial Framework for Onshore Wind Energy gives the NSA Significant Protection.	High	Indirect: Areas of combined visibility largely limited to hill tops and slopes. The Modified 2013 Scheme would increase the extent of the NSA affected by wind energy development in a few small areas of the NSA; near Loch a'Bhualaidh, eastern slopes of Meall a' Choire Leacaich and the south eastern slopes of Cnoc nan Cúilean towards Loch Loyal. The Modified 2013 Scheme would appear adjacent to other wind farms, specifically Strathy North. Introduction of the Modified 2013 Scheme would not affect the mountain backdrop to the Kyle or the Kyle itself.	Low	Slight Adverse
North-West Sutherland NSA	Low	Indirect impacts. Several developments identified in the baseline scenario are visible from within the NSA. The influence of wind turbines is largely limited to the ridge tops and summits of around Foinaven, Arkle and Creagan Meall Horn hills. The special qualities of the NSA are given as: • A landscape of rock; • The backdrop of extensive mountains; • A complex cnocan landscape of rock, water and sky; • Intimate mix of sea and land; • Contrast between extensive uninhabited land and localised human settlement; • Extensive tracts of wild land; and • Handa's towering sea cliffs. The THC Spatial Framework for Onshore Wind Energy gives the NSA Significant Protection.	High	Indirect: Distant change (approximately 45 km), limited to the higher slopes and summits. The Modified 2013 Scheme would appear adjacent to other wind farms and would marginally increase the extent of the NSA affected by wind farm visibility at the summit of Sàbhal Mor in the south-east of the NSA. Introduction would affect views from the NSA rather than any of its special qualities.	Negligible	Neutral
Assynt-Coigach NSA	Low	Indirect impacts. Several developments identified in the baseline scenario are visible from within the NSA. There is widespread influence to the eastern extent of the NSA. Sallachy and Glencassley wind farms are in close proximity to the NSA. The special qualities of the NSA are given as: • Spectacular scenery of lone mountains; • Rocky topography of great variety; • Settlements nested within a wider landscape of mountain peaks,	High	Indirect: The Modified 2013 Scheme would result in a distant change (approximately 53 km) with areas of combined visibility largely limited to hill tops and slopes of Ben More Assynt, Conival and Càrn nan Conbhairean. This introduction would marginally increase the extent of the NSA affected by wind turbines near Beinn Àird da Loch and Sail na Slataich. These changes would not affect the key qualities of the NSA.	Negligible	Neutral

Designation	Capacity for Wind Development	Baseline Scenario	Sensitivity to Additional Change	Nature of Change	Magnitude of Change	Cumulative Impact
		wild moorlands and rocky seascapes; • Extensive cnocan landscapes; • A coastline of endless drama; • An intricate multitude of lochs and lochans; • A landscape of vast open space and exposure; • Significant tracts of wild land; • Unexpected and extensive tracts of native woodland; and • A still, quiet landscape under a constantly changing sky. The THC Spatial Framework for Onshore Wind Energy gives the NSA Significant Protection.				
Eriboll East and Whiten Head SLA	Low	Indirect impacts. A number of wind farms identified in the baseline scenario, in particular Bettyhill, Strathy North and Strathy Wood. These result in a limited area by the coast in the north of the designation being influenced by wind farms. The special qualities of the SLA are given as: • Striking geological and landscape contrasts; • Striking views; and • Sparse settlement and naturalness.	High	Indirect Areas of combined visibility would be limited to the northern section of the SLA and the Modified 2013 Scheme would not increase the area of the designation currently influenced by wind farms.	Negligible	Neutral
Farr Bay, Strathy and Portskerrra SLA	Low	Indirect impacts. A number of wind farms identified in the baseline scenario result in a generally widespread influence across the SLA. The special qualities of the SLA are given as: • Dramatically intricate coastline and forceful sea; • Moorland and crofting mosaic; • Big skies and extensive views; and • Historical dimension.	Medium	Indirect The Modified 2013 Scheme would not increase the extent of the designation currently affected by wind farms. Other existing, consented or proposed wind farms including Strathy North, Strathy Wood and Bettyhill would be in the foreground and more dominant in the view.	Negligible	Neutral
The Flow Country and Berriedale Coast SLA	Low	Indirect impacts. All wind farms identified in the baseline scenario have some influence upon this designation. There is general widespread influence across the SLA although little impact resulting from wind farms on low lying areas to the south, particularly along Berriedale Water and Langwell Water. Dunbeath, Bad a Cheo, Causeymire and its Extension have the greatest influence due to their proximity and extent. The special qualities of the SLA are given as: • Distinctive mountain and moorland skyline; • Exposed peaks, vast openness and intimate glens; and • The historic landscape.	Medium	Indirect Impact would be limited to hill tops of Scaraben, Morven and Small Mount in the south and areas of sweeping moorland in the northern section of the SLA. There are closer and more prominent wind farms in the foreground.	Negligible	Neutral
Bens Griam and Loch nan Cloch SLA	Low	Indirect impacts. A number of wind farms identified in the baseline scenario influence higher ground and slopes of Ben Griam Mór, Ben Griam Beg, Meall á Bhúirich and Beinn a'Mhadaidh. Gordonbush wind farm has the greatest influence. The special qualities of the SLA are given as: • Accessible solitude; and	Medium-High	Indirect Areas of combined visibility would generally be limited to hill tops and slopes. The Modified 2013 Scheme would marginally increase the area of the designation currently affected by wind turbines at the north-western slopes of Ben Griam Mór, Beinn a'Mhadaidh and Cnoc Bad a' Ghille Dhuibh, along with a small area at the eastern extent of the designation (near Achentoul Forest). Turbines would appear	Low (locally Medium)	Slight Adverse (locally Moderate)

Designation	Capacity for Wind Development	Baseline Scenario	Sensitivity to Additional Change	Nature of Change	Magnitude of Change	Cumulative Impact
		• Flow country views.		in closer proximity than other identified cumulative wind farms.		
Ben Klibreck and Loch Choire SLA	Low	Indirect impacts. The majority of wind farms identified in the baseline scenario affect this designation with widespread influence across the SLA. The low-lying valleys of Loch Choire, Loch a' Bhealaich and other watercourses are unaffected. Dalnessie wind farm has the greatest influence due to its close proximity to the south of the designation. The special qualities of the SLA are given as: • Distinctive mountains; • Secluded glen with network of tracks; • Extensive views from peaks and summits; and • Historic landscape.	Medium-High	Indirect Areas of combined visibility would generally be limited to hill tops and slopes. The Modified 2013 Scheme would extend views of wind farms from lower slopes adjacent to Loch Choire and Loch a' Bhealaich. In addition there would be an increase to the extent of the area affected by wind turbines at the north-eastern slopes of Ben Klibrek.	Negligible	Neutral
Loch Fleet, Loch Brora and Glen Loth SLA		Indirect impacts. A number of wind farms identified in the baseline scenario influence hill tops and slopes in part of the SLA found within the study area. Gordonbush has the greatest influence due to its close proximity to the west of the designation. The special qualities of the SLA are given as: • Historic features; • An integrated combination of landforms; and • Accessible yet secluded glens and lochs	Medium	Indirect Areas of combined visibility would generally be limited to hill tops and northern and western facing slopes. The Modified 2013 Scheme would marginally increase the extent of the designation affected by wind turbines on the lower northern slopes of Beinn Mhealaich and Choire Mhór (although this would be at a distance of approximately 34 km).	Negligible	Neutral
Tongue House GDL	ZTV analysis shows there to be no cumulative impact in the study area.					
Kildonan Lodge GDL	ZTV analysis shows there to be no cumulative impact in the study area.					
Langwell Lodge GDL	ZTV analysis shows there to be no cumulative impact in the study area.					
Dunbeath Castle GDL	ZTV analysis shows there to be no cumulative impact in the study area.					

Designation	Capacity for Wind Development	Baseline Scenario	Sensitivity to Additional Change	Nature of Change	Magnitude of Change	Cumulative Impact
1. Sweeping Moorland	Medium to High	Direct and indirect impacts. Several areas of this LCT occur within the study area. They are extensively affected by numerous wind farms at all stages of the planning process. SNH Review No. 103 suggests that wind farm development has potential to "…relate to the exposed, wind dominated character of this landscape…" The THC Spatial Framework for Onshore Wind Energy shows several areas of this LCT are shown to be within Areas of Search.	Low	Indirect: The site is directly adjacent to an area of this LCT. Impacts arising from the Modified 2013 Scheme would generally be limited to areas of the LCT within 30 km of the site. These impacts would be coincident with other developments close to the north coast, particularly Strathy North and Strathy Woods.	Low	Slight Adverse
1a. Flat Peatland	Medium to High	Direct and indirect impacts. Several areas of this LCT occur within the study area. They are extensively affected by numerous wind farms at all stages of the planning process. As a subtype of the Sweeping Moorland LCT, wind farm development has similar potential to relate to this landscape. The THC Spatial Framework for Onshore Wind Energy shows several areas of this LCT are shown to be within Areas of Search.	Low	Direct: Several wind turbines from the Modified 2013 Scheme would be located within an area of this LCT. Indirect: Impacts arising from the Modified 2013 Scheme would generally be limited to areas of the LCT within 34 km of the site. These impacts would be coincident with other developments close to the north coast, particularly Strathy North and Strathy Woods.	Low	Slight Adverse
2. Moorland Slopes & Hills	Medium	Direct and indirect impacts. Several areas of this LCT occur within the study area. They are extensively affected by numerous wind farms at all stages of the planning process. SNH Review No. 103 states that, in this LCT, "…it tends to be most appropriate to arrange a wind farm in a concentrated and/ or ordered group…" The THC Spatial Framework for Onshore Wind Energy shows some areas of this LCT are shown to be within Areas of Search.	Low to Medium	Indirect: The site is close to several areas of this LCT. Impacts arising from the Modified 2013 Scheme would generally occur in areas close to, or distant south or west of, the site. These nearby impacts would be coincident with other developments close to the north coast, particularly Strathy North and Strathy Woods while more distant impacts would be less noticeable than those of intervening development within the baseline scenario.	Low	Slight Adverse
3. Cnocan	ZTV analysis shows there to be no cumulative impact in the study area.					
4. Lone Mountains	Low	Indirect impacts. Eight areas of this LCT occur within the study area. They are all affected, in most cases extensively, by numerous wind farms at different stages of the planning process. SNH Review No. 103 explains that, in this LCT, "…elements will tend to have a greater impact, the closer they are to the mountains and also if they cross the character type boundary." The THC Spatial Framework for Onshore Wind Energy shows only one the eight areas (Beinn Stumanadh) to be in an Area of Search.	High	Indirect: Summits and facing slopes in the majority of these LCT areas would be affected by the Modified 2013 Scheme. This would be at differing distances (varying between 7 km and 56 km) and in the context of neighbouring developments. From summits, development would be seen in a variety of directions.	Medium	Moderate Adverse
5. Irregular Massif	Low	Indirect impacts. This LCT occurs in three areas at the western extent of the study area. Impacts result from wind farms of a variety of scales and at several directions and distances. SNH Review No. 103 states that "…changes which occur in … adjacent areas can have a substantial impact on account of the extensive views from the highest peaks within this landscape." The THC Spatial Framework shows a small proportion of this LCT to be in an Area of Search.	High	Indirect: The Modified 2013 Scheme would be visible, at distance (between 40 km and 56 km), surrounded by the Sweeping Moorland LCT. Wind energy development has become one of the characteristics of that LCT and is relatively common in such views. These turbines would therefore not be in conflict with the landscape pattern experienced from these mountains.	Low	Slight Adverse
6. High Cliffs &	Low	Indirect impacts.	High	Indirect.	Negligible	Neutral

Designation	Capacity for Wind Development	Baseline Scenario	Sensitivity to Additional Change	Nature of Change	Magnitude of Change	Cumulative Impact
Sheltered Bays		Seven areas of this LCT occur within in the study area (all of them along the north coast). ZTV analysis suggests a degree of impact to these areas from the baseline scenario but, as the focus of these areas is out to sea and along sections of nearby coast, the actual impact of these is far less. SNH Review No. 103 suggests that "…structures may seem less disruptive where they have lightness of form". The THC Spatial Framework for Onshore Wind Energy does not include any of these areas in an Area of Search.		The Modified 2013 Scheme would impact on some areas of this LCT but, similar to those arising in the baseline scenario, these impacts would be largely imperceptible given the more dominant focal points and character of the landscape.		
7. Long Beaches, Dunes & Links	Low	Indirect impacts. Three areas of this LCT exist within the study area. While ZTV analysis suggests a degree of impact to these areas from the baseline scenario, the focus of these areas is out to sea and along sections of nearby coast, the actual impact of these is far less. Whilst recognising the potential for new elements to be noticeable, SNH Review No. 103 advises that "…numerous or large structures can be accommodated without seeming to dominate because of the openness and vast scale". The THC Spatial Framework for Onshore Wind Energy does not include any of these areas in an Area of Search.	High	Indirect. One area of this LCT (west of Bettyhill) would potentially be affected by the Modified 2013 Scheme. Turbine blades would be seen on the skyline, behind existing turbines at Bettyhill but this would be over a distance of 11 km and at a location where the primary focus is out to sea and the adjacent coastline.	Low	Slight Adverse
8. Kyles, Firths & Sea Lochs	ZTV analysis shows there to be no cumulative impact in the study area.					
9. Strath	Low	Indirect impacts. The degree of influence varies across different areas of this LCT. SNH Review No. 103 recommends that "…key considerations of change within this landscape character type concern its distinct linear space, enclosure, land use pattern and historic character." The THC Spatial Framework for Onshore Wind Energy shows some of these areas to be in an Area of Search.	High	Indirect. The Modified 2013 Scheme would result in impacts at Strathnaver (5 km west), Strath Vagastie (28 km south-west, a tributary of Loch Naver) and Strath Halladale (8 km east). Predominantly, turbine tips would be seen alongside those of Strathy North. Focus within these straths is on the valley floor whereas these turbine tips would be seen above the enclosing skyline of the strath.	Low	Slight-Moderate Adverse
10. Coastal Shelf	ZTV analysis shows there to be no cumulative impact in the study area.					
12. Town	ZTV analysis shows there to be no cumulative impact in the study area.					
13. Open Intensive Farmland	Medium	Direct and Indirect impacts. This LCT is limited to Caithness (in the north-east of the study area) and occurs in five separate areas. Impacts result from wind farms of a variety of scales and at several directions and distances. SNH Review No. 103 outlines different scenarios for wind energy development relevant to this LCT and explains that: "From a distance, (a) wind farm (maybe) seen as (a) sculptural element within (a) large scale and (the) simplicity of landscape and sea beyond." The THC Spatial Framework shows some of these areas to be in an Area of Search.	Low	Indirect. A section of one of the areas would potentially be affected by the Modified 2013 Scheme. This would be at a distance of approximately 30 km and in the context of several closer wind farms and wind farm clusters in different directions.	Negligible	Neutral
14. Mixed Agricultural & Settlement	Medium	Direct and Indirect impacts. This LCT is found in one area of Caithness (in the north-east of the study area). Impacts result from wind farms of a variety of scales and at several directions and distances. SNH Review No. 103 suggests that although "…new vertical elements will be particularly noticeable…tall thin structures often appear to blend	Medium	Indirect. The Modified 2013 Scheme has potential to affect two parts of this LCT already affected by wind energy development. Turbine blades would be visible against the skyline at a distances of approximately 30 & 35 km and would therefore be imperceptible.	Negligible	Neutral

Designation	Capacity for Wind Development	Baseline Scenario	Sensitivity to Additional Change	Nature of Change	Magnitude of Change	Cumulative Impact
		into the wide skies of this landscape". The THC Spatial Framework shows some of areas of this LCT to be in an Area of Search.				
15. Small Farms & Crofts	Low	Indirect impacts. Small areas of this LCT are found across the study area, usually in the more accessible or sheltered areas. The characters of each of these are affected to differing degrees by wind energy development within the baseline scenario. SNH Review No. 103 describes this LCT as "a 'melting pot' of different characteristics" and advises that "…new elements are … concentrated to create and identifiable pattern of their own." The THC Spatial Framework shows a small number of these areas to in Areas of Search.	Medium	Indirect. Areas of this LCT located either along the north coast or in Caithness (between Lathercnwheel and Thurso) would potentially be affected by the Modified 2013 Scheme. Those in Caithness would be affected by distant (approximately 35 km) views of turbines on the skyline and in the context of existing nearby developments. For those areas along the north coast which are potentially affected, the character is generally influenced by expansive views out to sea or the visual focus is introverted within the development. The Modified 2013 Scheme would be seen in the context of the consented Strathy North development over distances ranging from approximately 10 to 20 km.	Low	Slight Adverse

A9.1 VISUAL ASSESSMENT – VIEWPOINT TABLES

VP1 – View from Ben Griam Beg

2007 ES Summary	**Expectation of View**	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
	High	High	High	Whole cluster visible in middle ground	Medium	Elevated; obvious in north-facing views; below skyline	Long Term
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	High	High	Medium	Substantial	Forestry removal/ blanket bog reinstatement	Substantial	Moderate
2013 Changes	**Horizontal Spread** The Modified 2013 Scheme would slightly reduce the horizontal spread of the scheme at this viewpoint.		**Turbine Spacing** The Modified 2013 Scheme would improve the relationship between turbines (e.g. turbines 1 & 4), due to removing and relocating elements to avoid overlapping. In some areas, there is a greater degree of turbine blade 'clashing' or 'stacking' but, in others, this has been improved by the removal of turbines. This improvement is particularly true around the centre of the scheme in this view (i.e. turbines 52, 55, 64 & 69).		**Screening / Obstruction** The Modified 2013 Scheme would not affect the scheme's potential to screen or obscure any key landscape elements, including the skyline.		**Impacts** No Change

*MoC = Magnitude of Change

VP3 – View from A836 near Borgie

2007 ES Summary	**Expectation of View**	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
	Medium	Medium	Medium	Turbine tops just visible to south east of east-facing view	Low	Elevated; oblique view, part-screened by topography	Long term
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	N/C	Low	Low	Negligible	N/A from Location	Slight	Slight
2013 Changes	**Horizontal Spread** The Modified 2013 Scheme would result in turbine tips which were not previously visible breaking the skyline and increasing the horizontal spread of the scheme. However, at this distance, it is unlikely that the small sections of blade tip shown would be perceptible.		**Turbine Spacing** The Modified 2013 Scheme would increase the scale of the turbines but there would be no perceptible increase in the number of turbines and blades 'clashing' or overlapping in this view.		**Screening / Obstruction** The Modified 2013 Scheme would increase the proportion of turbines visible above the skyline in this view.		**Impacts** Increase: Slight-Moderate

*MoC = Magnitude of Change

VP4 – View from Strathy

2007 ES Summary							
	Expectation of View	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
	Low	Low	Low	1-19 blade tips visible; bypass limited view	Low	Slightly elevated, view up valley	Long Term
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	Low	Low	Low	Negligible	Change in alignment at design stage to reduce visual impact	Negligible	Negligible

2013 Changes				
	Horizontal Spread The Modified 2013 Scheme would result in several turbines which were not previously visible breaking the skyline and increasing the horizontal spread of the scheme. However, at this distance, it is unlikely that the small sections of blade tip shown would be perceptible.	**Turbine Spacing** The Original 2007 Scheme would result in a number of isolated groups of turbine tips breaking the skyline. The Modified 2013 Scheme would potentially fill in some of these gaps. However, at this distance, it is unlikely that many of the small sections of blade tip shown would be perceptible.	**Screening / Obstruction** The Modified 2013 Scheme would increase the proportion of turbines visible above the skyline in this view, particularly to the left. There would be a greater number of hubs and towers visible as a result of the Modified 2013 Scheme. At this distance however, it is unlikely that this small change would be perceptible.	**Impacts** No Change

*MoC = Magnitude of Change

VP5 – View from Achargary

2007 ES Summary							
	Expectation of View	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
				No View	-	-	-
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	-	-	-	-	-	-	-

2013 Changes				
	Horizontal Spread The Modified 2013 Scheme would slightly increase the horizontal spread of turbines visible.	**Turbine Spacing** The Modified 2013 Scheme would omit a number of turbines previously visible (albeit only small sections of blade tip), potentially increasing the gaps between turbines. The extent to which overlapping of blades from some turbines would be visible would also slightly increase.	**Screening / Obstruction** The length of turbine blades visible above the skyline would increase, becoming perceptible, as a result of the Modified 2013 Scheme.	**Impacts** Increase: Slight-Moderate

*MoC = Magnitude of Change

VP8 – View from bothy at Strathy Loch

2007 ES Summary	**Expectation of View**	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
	High	High	High	Tree removal, turbines adjacent, borrow pits and tracks	High	Turbines adjacent	Long Term
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	High	High	Medium High	Substantial	Forestry removal/ blanket bog reinstatement	Substantial	Moderate/ Substantial

2013 Changes	**Horizontal Spread** The Modified 2013 Scheme would not affect the horizontal spread of the scheme from this viewpoint.	**Turbine Spacing** While there is some variance in turbine spacing due to removing and relocating turbines in the Modified 2013 Scheme, this would result in a negligible difference when viewed from this location.	**Screening / Obstruction** Changes proposed under the Modified 2013 Scheme would not change the degree of screening or obstruction from this viewpoint.	**Impacts** No Change

*MoC = Magnitude of Change

VP9 – View from Bettyhill viewpoint

2007 ES Summary	**Expectation of View**	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
	Medium	High	Medium-High	39-57 blade tips, c. 9km distant at focal point of view	Medium	Horizontal, front-on	Long Term
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	Low-Medium	Medium	Medium	Moderate	N/A at this location	Moderate-Substantial	Moderate-Substantial

2013 Changes	**Horizontal Spread** The Modified 2013 Scheme would result in a slightly greater visible spread when seen from this viewpoint.	**Turbine Spacing** As a result of the Modified 2013 Scheme, there would be an increased concentration of turbine visibility and overlapping in the central section of the view. At this distance however, it is unlikely that this effect would be perceptible.	**Screening / Obstruction** The length of turbine blades visible above the skyline would increase slightly and there would be a greater number of hubs visible as a result of the Modified 2013 Scheme.	**Impacts** No Change

*MoC = Magnitude of Change

VP13 – View from east of Melvich

2007 ES Summary	**Expectation of View**	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
	High	Low	Medium	39-57, blade tips just visible	Medium	Oblique, distant, part-screened by topography	Long Term
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	NC	Low	Low	Low	N/A at this location	Slight	Slight
2013 Changes	**Horizontal Spread** The Modified 2013 Scheme would not affect the horizontal spread of the scheme at this viewpoint.	**Turbine Spacing** When viewing the Original 2007 Scheme from this viewpoint, there would be a gap between the furthest right turbine and the main group. The Modified 2013 Scheme would remove this gap, improving coherence of the scheme. As a result of the Modified 2013 Scheme, there would be an improvement in the degree of overlap, particularly in the central section of the view due to repositioning of turbines.		**Screening / Obstruction** The length of turbine blades visible above the skyline would increase slightly and there would be a greater number of hubs visible as a result of the Modified 2013 Scheme. At this distance however, it is unlikely that this effect would be perceptible.		**Impacts** No Change	

*MoC = Magnitude of Change

VP15 – View from Lednagullin

2007 ES Summary	**Expectation of View**	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
				No View	-	-	-
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	-	-	-	-	-	-	-
2013 Changes	**Horizontal Spread** There is no visibility of either the Original 2007 Scheme or the Modified 2013 Scheme from this viewpoint.	**Turbine Spacing** There is no visibility of either the Original 2007 Scheme or the Modified 2013 Scheme from this viewpoint.		**Screening / Obstruction** There is no visibility of either the Original 2007 Scheme or the Modified 2013 Scheme from this viewpoint.		**Impacts** No Change	

*MoC = Magnitude of Change

VP16 – View from Syre Lodge

2007 ES Summary							
	Expectation of View	**Importance of Changed View**	**Sensitivity to Change**	**Change / Effect**	**Extent**	**Angle & Nature of View**	**Duration**
				No View	-	-	-
	MoC* (during construction)	**MoC* (winter year 1)**	**MoC* (summer year 15)**	**Impact during construction**	**Mitigation**	**Impact (winter year 1)**	**Impact (summer year 15)**
	-	-	-	-	-	-	-

2013 Changes				
	Horizontal Spread The Modified 2013 Scheme would result in one set of blade tips being visible above the skyline. At a distance of 9.5 km however, it is unlikely that this would be perceptible in most conditions.	**Turbine Spacing** The Modified 2013 Scheme would result in one set of blade tips being visible above the skyline. At a distance of 9.5 km however, it is unlikely that this would be perceptible in most conditions.	**Screening / Obstruction** The Modified 2013 Scheme would result in one set of blade tips being visible above the skyline. At a distance of 9.5 km however, it is unlikely that this would be perceptible in most conditions.	**Impacts** Increase: Negligible

*MoC = Magnitude of Change

Cumulative Visual Impact Assessment

A9.1 INTRODUCTION

Cumulative impacts are those that occur as a result of the construction of more than one development of a particular type. In terms of visual amenity, cumulative impacts may result where a number of wind farms combine to increase the appearance and prominence within a particular view. The likely significance of these impacts relates to the number of wind farms visible and their scale, location and inter-relationship to each other within the view.

Since the 2007 ES was prepared, a number of developments included in the cumulative assessment have been removed from the cumulative baseline, others have been added and some have changed their status within the planning system. In March 2012, Scottish Natural Heritage (SNH) published 'Assessing the Cumulative Impact of Onshore Wind Energy Developments' which updates the recommended methodology for carrying out cumulative visual impact assessment. To properly reflect this updated guidance and the latest baseline information, it has been necessary to complete a new cumulative visual impact assessment rather than updating that of the 2007 ES.

A9.2 SCOPE OF ASSESSMENT

A9.2.1 Project Interactions

A detailed description of the Modified 2013 Scheme is provided in Chapter A4: Development Description. However, the elements relevant to this assessment are the construction and operation of 47 turbines with a modelled tower height of 83 m and a modelled rotor diameter of 104 m within a maximum tip height of up to 135 m.

Other elements of the scheme, such as the internal track layout, borrow pits, laydown areas and access would have limited effect on the cumulative impacts being assessed.

A9.2.2 Study Area

A study area based on a standard buffer of between 35 km and 60 km from the development periphery was considered (in line with SNH guidance). Having examined available information and consulted with SNH, it was decided that an irregular (or variable-distance) study area was appropriate in order to focus on the most significant impacts, including those at locations as far from the scheme as Ben More Assynt (approximately 55 km south-west of the site) and Foinavon (approximately 46 km west of the site). This variable-distance boundary is shown on Figure A8.3: Landscape Designations and Cumulative ZTV.

The potential cumulative impacts of all sites within 60 km of the site will be considered within this variable-distance study area.

A9.2.3 Impacts to be Assessed

This Technical Appendix considers potential long-term (operational) impacts upon views from cumulative viewpoints agreed during consultation.

A9.2.4 Impacts Scoped out of Assessment

Impacts arising from the process of decommissioning are considered to be of a similar nature and duration to those arising from the construction process and therefore have not been considered separately in this chapter. Where this assessment refers to potential construction impacts, these are also representative of predicted decommissioning impacts.

A9.3 POLICY AND LEGISLATIVE CONTEXT

A full description of updated policy and legislation relating to this development is provided in Chapter A7: Planning Context. Listed below is a summary of updates relevant to landscape impacts.

A9.3.1 International Legislation and Policy

No international legislation or policy relevant to this assessment has been updated since the 2007 ES was prepared.

A9.3.2 National Legislation and Policy

Since the 2007 ES was written, the following national policy guidance relating to landscape and wind energy development has been published:

- SNH - Siting and Designing Windfarms in the Landscape (2009);
- SNH - Strategic Locational Guidance for Onshore Wind Farms in respect of the Natural Heritage (updated 2009);
- SNH - Renewable Energy and the Natural Heritage (2010); and
- SNH - Assessing the Cumulative Impact of Onshore Wind Energy Developments (2012).

These documents set out the position of SNH in relation to developments of the type proposed; being supportive of their potential contribution to addressing climate change, acknowledging that they may result in impacts upon the landscape and promoting appropriate location and design of developments in order to minimise those impacts. These policy documents have been considered as part of this assessment.

A9.3.3 Regional Policy

There is no regional policy or guidance specifically related to the assessment of cumulative landscape impacts.

A9.3.4 Local Policy

There is no local policy or guidance specifically related to the assessment of cumulative landscape impacts.

A9.4 METHODOLOGY

The methodology is based on that described in SNH guidance: 'Assessing the Cumulative Impact of Onshore Wind Energy Development', SNH, March 2012. The assessment considers the potential for combined views of wind farms from both static viewpoint receptors; combined views of wind farms / wind turbines may be either simultaneous (where developments would be observable at the same time) or successive (where an observer would be required to turn to experience multiple wind farms). The assessment also considers the potential for sequential impacts experienced from route receptors where different developments become visible whilst moving through the landscape; sequential impacts may be occasional, frequent or constant.

The cumulative visual assessment has involved four key stages:

- Identification and analysis of the baseline wind development scenario for each viewpoint / route;
- Evaluation of the cumulative sensitivity to change;
- Evaluation of the potential magnitude of change to the baseline scenario resulting from the Modified 2013 Scheme; and
- Assessment of the potential cumulative impacts arising from the introduction of the Modified 2013 Scheme into the baseline scenario.

A9.4.1 Evaluation of the Baseline Scenario

Analysis of the baseline involves an appreciation of the existing view within the context of the baseline wind development scenario, which assumes that all consented and proposed wind farms have been constructed. Baseline information on existing and proposed wind farms within the study area has been collected using information provided by SNH and The Highland Council (THC). Proposed sites are generally taken to be those for which applications have been submitted although, in this case, Strathy Wood (currently at EIA scoping stage) is included in this category because of its proximity to the site.

Identification of the baseline situation involves consideration of the scale, location and nature of the baseline wind farms within the view, the proportion of the view which is occupied by wind turbines and the potential importance of this part of the view to the viewer.

A9.4.2 Evaluation of the Cumulative Sensitivity to Change

The evaluation of sensitivity to change concerns the nature of the existing view in the context of the baseline wind development scenario, and the potential for further wind turbines to be accommodated within that view without significantly altering, obstructing or dominating the view. An evaluation of sensitivity to change has been attributed to each receptor based on a three point scale (where a view would fall into two different categories a degree of professional judgement is employed):

- High Sensitivity – Where existing wind farms / turbines are well accommodated within a valued or well composed view and / or the proposed changed landscape forms an important part of the view;
- Medium Sensitivity – Where existing wind farms / turbines are present but not prominent in the existing view, and / or the proposed changed landscape forms a less important part of the view; and
- Low Sensitivity – Where existing wind farms / turbines are prominent in an existing view and / or the changed landscape forms an unimportant part of the view.

A9.4.3 Evaluation of the Cumulative Magnitude of Change

Magnitude of change concerns the measurement of change which would occur as a result of the introduction of the proposed wind farm into the baseline wind development scenario. This is identified based on the consideration of the potential nature, size, scale and location of the proposed change within the existing view, and in relation to the existing wind farms / turbines within the view. The evaluation of the magnitude of change is based on the criteria outlined in the main visual assessment methodology.

A9.4.4 Assessment of Potential Cumulative Impacts

Assessment of potential cumulative impacts is based on analysis of the relationship between the cumulative sensitivity to change and the magnitude of change and is made using a degree of professional judgement. It should be noted that the cumulative impact assessed is the result of the addition of the Modified 2013 Scheme to the existing baseline scenario. The cumulative impact assessment is based on a four point scale as follows:

- Substantial Adverse – The addition of the Development to the baseline view would result in a very noticeable increase in wind turbines to the extent whereby they would become a dominating or obstructive feature within the view;
- Moderate Adverse – The addition of the Development to the baseline view would result in a noticeable increase in wind turbines to the extent whereby they would become prominent but would not dominate or obstruct the view;
- Slight Adverse – The addition of the Development to the baseline view would result in a perceptible increase in wind turbines but would not increase the prominence of wind farms / turbines as a feature in the view; and
- Neutral – The addition of the Development, in combination with other wind farms, would not result in any discernible increase in the appearance of wind turbines in the view.

A9.4.5 Limitations of Cumulative Assessment

Due to the uncertainty of the timing of construction activity for the Modified 2013 Scheme and other such activity, and the assumptions relating to the cumulative baseline scenario, as described below, temporary structures, tracks and activity relating to construction have not been considered within the cumulative assessment. It therefore focuses on the potential cumulative impacts relating to the main permanent structures and other associated features.

A9.5 BASELINE CONDITIONS

A9.5.1 Context

A review of data from, and consultation with, SNH and THC identified 33 other existing, consented and proposed wind farms and one scoping site within 60 km of the

Development. Generally, scoping stage sites are not included in the cumulative assessment. However, in this case, Strathy Wood Wind Farm has been included as it is in such close proximity to the site.

Although all identified wind farms within 60 km of the site will be considered, only their impacts on viewpoint and route receptors within the irregular-distance study area will be assessed.

These identified wind farms form the cumulative baseline scenario and are shown on Figure A9.25 and detailed in Table A9.1, below. This information is correct at 16 May 2013.

Table A9.1: Development Information included in the Cumulative Impact Assessment

Status	Reference & Name	Location	No. of Turbines	Turbine Geometry
Operational	1. Forss I	Near Thurso	2	H=62 D=94
	2. Forss II	Near Thurso	4	H=62 D=94
	3. Buolfruich	Dunbeath	15	H=44 D=52
	4. Causeymire	Westerdale	21	H=60 D=80
	5. Kilbraur	Strath Brora	19	H=70 D=90
	6. Kilbraur Extension	Strath Brora	8	H=80 D=90
	7. Flex Hill	Bilbster	3	H=60 D=80
	8. Achairn	Wick	3	H=60 D=80
	9. Achany	Lairg	19	H=67 D=70
	10. Gordonbush	Brora	35	H=67 D=80
	11. Lairg	Lairg	3	H=59.5 D=80
	12. Bettyhill	Bettyhill	2	H=80 D=90
Under Construction	13. Rosehall	Lairg	19	H=55 D=70
	14. Baillie Hill	Westfield	21	H=70 D=80

Table A9.1: Development Information included in the Cumulative Impact Assessment

Status	Reference & Name	Location	No. of Turbines	Turbine Geometry
	15. Camster	Bilbster	25	H=80 D=80
	16. Wathegar	Bilbster	5	H=60 D=80
Approved	17. Causeymire Extension	Westerdale	3	H=60 D=80
	18. Stroupster	Nybster	12	H=60 D=104
	19. Burn of Whilk	East Clyth	9	H=70 D=92
	20. Melness	Tongue	3	H=49 D=52
	21. Strathy North	Strathy	33	H=70 D=80
	22. Wathegar 2	Bilbster	9	H=60 D=80
Submitted	23. Halsary	Mybster	18	H=60 D=80
	24. Dunbeath	Dunbeath	17	H=80 D=90
	25. Sallachy	Lairg	22	H=74.5 D=101
	26. Dalnessie	Lairg	27	H=73.5 D=95
	27. Braemore	Lairg	24	H=80 D=93
	28. Limekiln	Dounreay	24	H=98.4 D=52
	29. Glencassley	Lairg	26	H=80 D=91.2
	30. Bad A Cheo	Westermire	13	H=65 D=80
	31. Rumster	Lybster	3	H=50 D=50
Appeal	32. Forss III	Near Thurso	5	H=55 D=52
Scoping	33. Strathy Wood	Strathy	28	H=100 D=93

Analysis of the cumulative ZTVs and wireline projections led to the identification of eight cumulative viewpoints, as detailed in Table 9.4, below. These viewpoints have been selected to give a representational overview of potential cumulative impacts from different directions and locations within the overall study area. Only viewpoints with potential combined visibility have been selected as only these have the potential to experience cumulative impacts. In addition to the viewpoints, five route receptors with potential visibility of the Modified 2013 Scheme and at least one other wind farm have been identified and assessed for sequential cumulative impacts. The locations of the cumulative viewpoints and route receptors are shown on Figure 9.26: Cumulative LVIA Study Area and the baseline description and sensitivity of each are described Technical Appendix 9.3: Cumulative Visual Impact Assessment Tables.

Table A9.2: Cumulative Viewpoint Receptors

Reference	Location	Easting	Northing
CVP1	Ben Griam Beg	283038	941234
CVP2	A836 near Borgie	269436	957261
CVP3	Sgor Chaonasaid (Ben Loyal)	257976	949855
CVP4	East of Melvich	291734	964449
CVP5	Ben More Assynt	231824	920176
CVP6	Foinavon	231315	951499
CVP7	Forsinard	288410	940515
CVP8	Strathy	284127	965047

Table A9.3: Cumulative Route Receptors

Reference	Route
CR1	A836
CR2	A897
CR3	A9
CR4	Thurso to Inverness Railway

A9.5.2 Desk Studies

Wireline diagrams and photomontages have been generated using a model of the Modified 2013 Scheme from viewpoints identified and agreed during consultation described in Table A8.1. This has allowed comparison with the Original 2007 Scheme. These are contained on Figures A9.4 to A9.24.

Wireline diagrams were also generated for some individual receptors to allow comparison between the Original 2007 Scheme and the Modified 2013 Scheme. This was done to give the assessor an overall impression of the implications of design changes rather than to reassess specific impacts which are not being reconsidered as part of this assessment update.

A9.6 EFFECTS EVALUATION

A9.6.1 Basis of Assessment

The description of the Modified 2013 Scheme contained in ES Addendum Chapter A4: Development Description includes a turbine with a maximum tip height of up to 135 m, a modelled hub height of 83 m and a modelled rotor diameter of 104 m. While the constructed turbines may differ within these parameters up to the 135m tip height, these maximum dimensions have been used to generate computer modelling on which to base assessment.

Wireline visualisations and ZTV diagrams have been produced using the methods outlined in Section 9.5.2 of Chapter A9: Visual Impact of the ES Addendum. These have been used to assess potential impacts on landscape character types and landscape designations within the study area. These assessments are detailed in tables contained in Technical Appendix A9.3: Cumulative Visual Impact Assessment Tables.

A9.6.2 Viewpoint Receptors

As outlined in Table A9.2, eight cumulative viewpoints were identified within the overall study area. These include a cross section of distant and close proximity views from most directions and are representative of the range of cumulative impacts expected from the introduction of the Modified 2013 Scheme into the cumulative baseline scenario.

Tables contained in Technical Appendix A9.3 describe the assessment at each viewpoint receptor. Of the eight, two are anticipated to receive significant cumulative impacts and these are described in more detail below.

CVP1 – Ben Griam Beg is a prominent hill located within an area of sweeping moorland located approximately 8.5 km south of the site. There are 360°, elevated, panoramic views from the summit, which include views across the Flow Country, to the north coast and to distant mountains and sea lochs or kyles. The majority of identified cumulative wind farms would be visible from this viewpoint, with Strathy North and Strathy Wood appearing in the middle-distance. The Modified 2013 Scheme would be seen in relatively close proximity and would therefore appear as a prominent element in part of the view, adjacent to Strathy North and Strathy Wood. This clustering pattern of development would be similar to that of Forss I, Forss II, Limekiln and Baillie Hill to the right of the view and at a greater distance.

Due to the relatively close proximity, the Modified 2013 Scheme would increase the impression of wind farms within views from this location to the extent of them becoming a prominent feature. It is therefore considered that its addition to the baseline scenario would result in Moderate Adverse, and therefore significant, cumulative impact on views from the summit of Ben Griam Beg.

CVP2 – A836 near Borgie is a point on the main road passing along the north coast in the study area. From this location, views are channelled by the surrounding landform, with the focus across nearby Strathnaver to an area of sweeping moorland beyond. Four of the wind farms identified in the cumulative baseline would be visible from this viewpoint: Bettyhill, Strathy North, Strathy Wood and Melness. The Modified 2013 Scheme would be seen on the skyline, adjacent to Strathy North and Strathy Wood.

The Modified 2013 Scheme would increase the prominence of wind farms in the landscape by increasing the extent of the horizon which would feature turbines and turbine blades (i.e. horizontal spread). This, combined with the increased scale of turbines visible, would result in a Moderate Adverse, and therefore significant, cumulative impact on views from the A836 near Borgie.

A9.6.3 Route Receptors

As outlined in Table A9.3, four route receptors were identified within the overall study area. These are representative of the range of cumulative impacts expected from the introduction of the Modified 2013 Scheme into the cumulative baseline scenario.

Tables contained in Technical Appendix A9.3 describe the assessment at each route receptor. Of the four, none are anticipated to receive significant cumulative impacts.

A9.7 SUMMARY & CONCLUSION

The assessment has found that impacts resulting from addition of the Modified 2013 Scheme into the cumulative baseline scenario, from the majority of the receptors identified within the study area, would range from Neutral to Slight-Moderate Adverse and are therefore not considered significant.

However, it is anticipated that the View from Ben Griam Beg (CVP1) and View from A836 near Borgie (CVP2) would receive Moderate Adverse, and therefore significant, cumulative impacts. While changes in the baseline scenario and methodology make it difficult to draw direct comparison, it should be noted that the 2007 ES cumulative visual impact assessment found there to be a potential Substantial Adverse impact at CVP1.

Cumulative Viewpoints

Ref	Description of Receptor (s)	Baseline Description	Sensitivity to Additional Change	Existing and Proposed Wind Farms Visible in Combination with Strathy South				Nature of Changes	Cumulative Magnitude of Change	Cumulative Impact
				Simultaneous		Successive				
CVP1	**View from Ben Griam Beg**	Elevated, panoramic 360° views over the surrounding moorland with blocks of coniferous forestry, kyles, lochs and distant mountains. The majority of wind farms identified in the cumulative baseline are present within views resulting in multiple wind farms being visible in most directions (although principally to the south and east).	High	Forss Forss II Bettyhill Baillie Hill	Strathy North Limekiln Strathy Wood	Achairn Bad A Cheo Baillie Hill Bettyhill Buolfruich Burn of Whilk Camster Causeymire I Causeymire II Dunbeath Flex Hill Forss Forss II	Forss III Gordonbush Halsary Kilbraur Kilbraur II Lairg Limekiln Rumster Strathy Wood Stroupster Wathegar I Wathegar II	The Modified 2013 Scheme would be seen in relatively close proximity (8.4 km) in views to the north-west. This would increase the scale of a cluster of wind energy development when seen from this hill top, appearing closer and more prominent than others in the same group. Clustering of turbines in this way is preferable to an extensive pattern of development and would not affect the relationship between moorland and lochs to the west or the more distant relationship between moorland, kyles and prominent mountains.	Medium	Moderate Adverse
CVP2	**View from A836 near Borgie**	View from the A836 road across rolling moorland. Four wind farms identified in the cumulative baseline are present within views.	Medium	Bettyhill Strathy North	Strathy Wood	Melness	-	The Modified 2013 Scheme would be seen to the south-east, 8.4 km distant, along the skyline and partially screened by topography. Turbines would appear as an extension to Strathy North and Strathy Wood which are within the same view (although those at Strathy South would be more prominent in the view).	Medium	Moderate Adverse
CVP3	**Sgor Chaonasaid (Ben Loyal)**	Elevated, panoramic 360° views over the surrounding landscape, including the Kyle of Tongue NSA to the north and west. The majority of wind farms identified in the cumulative baseline are present within views, resulting in multiple wind farms being visible in many directions.	Low to Medium	Achairn Bad A Cheo Baillie Hill Bettyhill Burn of Whilk Camster Causeymire I Causeymire II Dalnessie Dunbeath Flex Hill Forss Forss II	Forss III Gordonbush Halsary Kilbraur Limekiln Melness Rumster Strathy North Strathy Wood Stroupster Wathegar I Wathegar II	Burn of Whilk	-	The Modified 2013 Scheme would be seen at a distance of 19.4 km in views to the east, away from the NSA. Turbines would appear as an extension to Strathy North and Strathy Wood. This distant change would not impact upon the relationship between the nearby mountains and kyles or sea lochs and the sweeping moorland beyond.	Medium	Slight Adverse
CVP4	**East of Melvich**	View from the A836 road east of Melvich across moorland with some electrical distribution infrastructure in the	Low to Medium	Strathy North	Strathy Wood	Baillie Hill Bettyhill Forss	Forss II Forss III	The Modified 2013 Scheme would be seen in distant views (15.7 km) to the south-west. Turbines would appear	Negligible	Neutral

Ref	Description of Receptor (s)	Baseline Description	Sensitivity to Additional Change	Existing and Proposed Wind Farms Visible in Combination with Strathy South				Nature of Changes	Cumulative Magnitude of Change	Cumulative Impact
				Simultaneous		Successive				
		view. Seven wind farms identified in the cumulative baseline are present in views.						as an extension to Strathy Wood and Strathy North (although they would be partially screened by topography).		
CVP5	**Ben More Assynt**	Elevated, panoramic 360° views over the surrounding landscape, including the Assynt-Coigach NSA to the north and west. Several wind farms identified in the cumulative baseline are present in views. Sallachy wind farm is in close proximity to this viewpoint and is a prominent feature in views.	Medium	Achany Baillie Hill Bettyhill Braemore Dalnessie Forss Forss II Forss III Glencassley	Kilbraur Kilbraur II Lairg Limekiln Rosehall Sallachy Strathy North Strathy Wood Stroupster	Glencassley Gordonbush	Stroupster	The Modified 2013 Scheme would be seen in distant views (54 km) to the north-east, well away from the NSA. Turbines would be alongside other developments in a distant group. Nearby developments south of Loch Shin are prominent in the middle-distance.	Negligible	Neutral
CVP6	**Foinavon**	Elevated, panoramic 360° views over the surrounding landscape, including the North-West Sutherland NSA to the south and west. The majority of	High	Achairn Bad A Cheo Baillie Hill Bettyhill Causeymire I Causeymire II Flex Hill Forss	Halsary Kilbraur Limekiln Melness Strathy North Strathy Wood Stroupster Wathegar I	Achany Dalnessie Forss III Glencassley	Kilbraur II Rosehall Sallachy	The Modified 2013 Scheme would be seen in distant views (46 km) to the east, in a similar direction and distance to the majority of other developments in this view.	Negligible	Neutral

Ref	Description of Receptor (s)	Baseline Description	Sensitivity to Additional Change	Existing and Proposed Wind Farms Visible in Combination with Strathy South				Nature of Changes	Cumulative Magnitude of Change	Cumulative Impact
				Simultaneous		Successive				
		wind farms identified in the cumulative baseline are present in views.		Forss II	Wathegar II					
CVP7	**Forsinard**	View from the A897 road over flat moorland with occasional isolated hills. Three wind farms identified in the cumulative baseline are present in views to the north-west.	Medium	Limekiln Strathy North	Strathy Wood	-	-	The Modified 2013 Scheme would be seen in views to the north-west and would appear to extend the influence of wind farms, although a large part of the development would be screened by topography.	Low	Slight Adverse
CVP8	**East of Strathy**	View from settlement across the A836 road and agricultural pastures toward moorland. Two wind farms identified in the cumulative baseline are visible. Strathy North wind farm is the most prominent on the skyline.	Low	Strathy North	Strathy Wood	-	-	The Modified 2013 Scheme would be seen in views to the south-west; however, Strathy North wind farm is more prominent in the view and would filter views of turbines.	Negligible	Neutral

Route Receptors

Ref	Description of Receptor(s)	Baseline Description	Sensitivity to Additional Change	Existing and Proposed Wind Farms Visible in Combination with Strathy South			Nature of Changes	Cumulative Magnitude of Change	Cumulative Impact
				Continuous	Frequent	Occasional			
R1	**A836**	The route follows the north coast, winding between areas of rolling moorland and dropping down into the series of kyles and valleys which feature. In the west and central section, views of wind farms in the cumulative baseline are generally intermittent and along the coast or south to the moorland interior. The more level and open character in the east means development visible there tends to be seen for longer sections of the route.	Medium-Low		Bettyhill Strathy North Strathy Wood	Baillie Hill Dalnessie Dunbeath Forss I Forss II Forss III Limekiln Melness	The Modified 2013 Scheme would be intervisible with other wind farms intermittently when travelling along western and central sections of the route. This pattern would be in keeping with that of the baseline and would occur at a direction and distance in keeping with other sites (e.g. Strathy North). Turbines at Strathy South would also be visible for a short stretch of the eastern section of the route. This would be at a point where nearby development (e.g. Baillie Hill and Limekiln) are visible. Given the proximity of these developments and their existing impact on the character of the area, it is unlikely that Strathy South would be considered prominent here.	Low	Slight Adverse

Ref	Description of Receptor(s)	Baseline Description	Sensitivity to Additional Change	Existing and Proposed Wind Farms Visible in Combination with Strathy South			Nature of Changes	Cumulative Magnitude of Change	Cumulative Impact
				Continuous	Frequent	Occasional			
R2	**A897**	The route passes through Strath Halladale and Strath of Kildonan, also passing across an area of open moorland at the watershed between the two valleys. The stretch through Strath of Kildonan, in the south, is largely screened from development by surrounding landform. Turbine tips are visible along some sections of the route passing through Strath Halladale. More open sections, south of Forsinard and at Kinbrace, are affected by several wind farms.	Medium-High			Dalnessie Gordonbush Limekiln Strathy North Strathy Wood	The Modified 2013 Scheme would be intervisible with other development along a section of the route south of Forsinard. At this point, wind turbines would be visible in all directions, albeit at distance, with the cluster at Strathy representing the nearest and largest grouping. Visibility of all developments at this point would be limited to short sections of the horizon and the expansive surrounding landscape is considered to be of a scale which can accommodate this without it being an overbearing effect.	Low	Slight-Moderate Adverse
R3	**A9**	The section of the A9 which is within the study area runs from Helmsdale to Thurso. A short section of the road, near Dunbeath, is affected by wind turbines which are nearby and adjacent to the east coast (e.g.	Low			Achairn Bad A' Cheo Baillie Hill Buolfruich Burn of Whilk Camster Causeymire Causeymire Ext. Dunbeath	Introduction of the Modified 2013 Scheme would result in a small number of turbine tips being visible on the skyline at distance (over 36 km) at a point in the route where the roadside cluster of Halsary, Bad A' Cheo,	Negligible	Neutral

Ref	Description of Receptor(s)	Baseline Description	Sensitivity to Additional Change	Existing and Proposed Wind Farms Visible in Combination with Strathy South			Nature of Changes	Cumulative Magnitude of Change	Cumulative Impact
				Continuous	Frequent	Occasional			
		Burn of Whilk, Buolfruich and Dunbeath). The section of the route between Thurso and Latheron is relatively open and affected by wind farms at a variety of distances and directions, most notably by a roadside cluster south of Mybster and Spittal.				Flex Hill Forss I Forss II Forss III Halsary Limekiln Rumster Strathy North Strathy Wood Stroupster Wathegar Wathegar Ext.	Causeymire and Causeymire Ext. would be prominent in views. The remainder of the route would be unaffected by wind turbines at Strathy South.		
R4	**Thurso to Inverness Railway**	Intervisibility along the Thurso to Inverness Railway was considered and, for the lengths of route potentially affected by the Modified 2013 Scheme, found to be broadly similar as that for the A897.							

Consultation Responses Specific to Ecological Receptors

1. **Email SNH to RPS following discussion on impacts from track construction in peatland habitats and mitigation / compensation for impacts on qualifying habitats within a Natura site.**

From: Alexander Macdonald [mailto:Alexander.Macdonald@snh.gov.uk]
Sent: 25 September 2012 12:09
To: Simon Zisman
Subject: RE: Strathy South Monday call?

Simon

Follcwing our telephone conversation yesterday I thought I'd just send a short email confirming the points we discussed.

We discussed the access track and considered a zone in the order of 10 to 25 metres from the outer edge of the access track drainage ditches. Up to approximately 10 metres we considered that there's likely a direct impact, and from 10 to 25 metres this is likely to be more of an indirect impact.

On your second question relating to tree removal we would rather have the stunted trees removed first.

Using mulch as a management technique is an issue which is currently being discussed within SNH and SEPA at the moment. There is a meeting between SNH and SEPA in early October and I hope we will be given a direction on the use of mulching following this.

We discussed mitigation and I think the term is used in different ways. With respect to 'Natura', the term mitigation would mean enhancement/restoration of habitats within the designated site rather than out with the site. Enhancement of habitats out with the designated site would be termed compensation.

Happy to discuss further if you wish.

Regards
Alec

Alexander Macdonald
Operations Officer
Scottish Natural Heritage
The Links
Golspie Business Park
Golspie KW10 6UB
01408 634063

2. **Email SNH to RPS following submission of assessment of impacts on qualifying habitats due to track widening and grid connection through the Caithness and Sutherland Peatlands SAC (Report 5).**

From: Alexander Macdonald [mailto:Alexander.Macdonald@snh.gov.uk]
Sent: 28 November 2012 09:41
To: Matthew Pannell
Cc: Simon Zisman
Subject: RE: Strathy South Wind Farm Access Track Impact Report

Dear Matt cc Simon

Thanks for sending the report for the Strathy South wind farm access tracks.

Access Track Construction
The report is sufficiently detailed to allow us to form an opinion.

The report identifies that there will be direct and indirect impacts on SAC qualifying habitat, affecting 3.74 ha and 9.24 ha respectively. Direct impacts can be considered in most cases synonymous with 'losses'. Indirect impacts may result in loss or significant change.

It is possible that mitigation measures may reduce some of these impacts, just as it is equally possible that in some areas the impacts may extend over a greater area, for example where wider trackside batters are required to accommodate areas of deeper peat.

The figures provided are accepted as a reasonable indication of the likely loss and change to SAC qualifying habitats.

Within the context of the Conservation Objectives for the site, i.e.

To ensure for the qualifying habitats that the following are maintained in the long term:
- Extent of the habitat on site
- Distribution of the habitat within the site
- Structure and function of the habitat
- Processes supporting the habitat
- Distribution of typical species of the habitat
- No significant disturbance of typical species of the habitat

These 'losses' are incompatible with the first objective regarding extent. We would suggest that the other objectives are not significantly compromised, other than within the context of the areas of habitat lost.

It could be suggested that the areas of qualifying habitat that would be lost are insignificant within the context of the SAC. That might be the case if the habitats were uniform across the SAC but it is well demonstrated and widely accepted that this is not the case.

The losses may be relatively small on an areal basis, but as the peatlands in this area have already been subject to considerable loss and damage through forestry and past agricultural practice, <u>any</u> further loss is significant.

Given the above, we would have no alternative but to <u>maintain our objection</u> on Natura habitat grounds.

Deer Grazing
The monitoring work regarding current deer densities within the woodlands and on the SAC are sufficient and provide a reasonable estimate of deer usage and thereby, potential

populations. No attempt appears to have been made as yet to undertake Habitat Impact Assessment on the surrounding SAC habitats although this is mentioned as part of the mitigation measures set out in section 4.4 on page 20.

Key within the Deer Management Plan (DMP) will be an initial assessment of surrounding SAC habitats thereby establishing a baseline against which to measure impact levels in the future. Trampling is likely to be the more critical of impacts on bog sites. It is likely that any potential negative impacts and deer welfare issues can be mitigated through a competent DMP with a focus on these issues.

I would be happy to discuss any of the above further.

Regards
Alec

Alexander Macdonald
Operations Officer
Scottish Natural Heritage
The Links
Golspie Business Park
Golspie KW10 6UB
01408 634063

3. Email SNH to RPS following submission of updated assessment of impacts on qualifying habitats due to track widening and grid connection through the Caithness and Sutherland Peatlands SAC (Report 5b).

From: Alexander Macdonald [Alexander.Macdonald@snh.gov.uk]
Sent: 20 March 2013 11:22
To: Matthew Pannell
Subject: RE: Strathy South Access Track

Hi Matt
Following our meeting last week regarding the access track I've noted a few points from Andrew regarding the report:

Summary
We generally welcome and are supportive of the measures described to reduce the impacts of this proposed development. Some additional detailed Method Statements are required to ensure that the stated aims and objectives can be applied during construction.

Detailed comments
Page 5, Section 2.1.1 Segment 2 - Main Site Access Route
3rd Paragraph. Passing places. It is assumed that these will be constructed on the west side of the track and that the cables will be laid to the west of them. Encroachment into qualifying habitat should be avoided. Further details required in the Strathy South ES Addendum.

Page 6, Section 2.1.1 Segment 2 - Main Site Access Route
3rd paragraph. "Construction proposals include the removal of the peat spoil heaps where this area is required for widening and cable installation. Following construction, reinstatement of these former spoil heaps would take place...".
We support this objective. There are, however, a number of elements to the proposal which require further consideration:

- The fate of the removed spoil. It is stated in the last paragraph of this section that this will be addressed through a Peat Management Plan. It should, however, be acknowledged that this material is likely to comprise a mixture of peat and mineral soil.
- There may be implications for the operation of the cable plough of removing the spoil heaps. The cable plough will be running on a bare peat surface very close to the edge of the batter down to the track. This may have implications for stability. This should be addressed through a detailed Method Statement to complement that provided for the Mybster-Camster cable.
- Revegetation of the exposed peat. This should be undertaken at the earliest opportunity after the cables are laid. Ideally, blanket bog turf removed from other parts of the development would be used. However this may be in short supply. Options to ensure early and appropriate vegetation cover should be prepared and presented.

Page 6, Section 2.1.2 Grid Connection Route (Adjacent to Segment 2)
1st Paragraph. Excavations for cable joints. A detailed Method Statement is required which demonstrates measures to avoid direct impacts on qualifying habitat and, minimise indirect impacts. This might include using an excavator located on the track, or the use of bog mats. Consideration also has to be given to the temporary placement of excavated material to avoid damage to qualifying habitat and minimise the risk of destabilizing the roadside bank.

Page 7, Section 2.1.2 Grid Connection Route (Adjacent to Segment 2)
Final Paragraph. Identifies some of the issues mentioned above, and although these are addressed in part in Section 5, further detail will be required in the Construction Method Statement.

Page 7, Section 2.1.3 Segment 3 - Yellow Bog
We welcome the commitment to avoid further land take and to run the cables within the track.

Page 12, Section 3.2 Methods for Estimating Potential Impacts (Direct and Indirect) on Qualifying Habitats
3rd Paragraph. "The overriding premise to track widening would be that any construction works aim to minimize loss or modification to SAC qualifying habitats". Suggest the aim should be to avoid loss or modification, albeit accepting that there may be circumstances which determine that the aim is not achieved.

Pages 16 & 17, Section 4 Assessment of Potential Impacts on Qualifying Habitats resulting from Installation of Grid Connection Cables/
Re Impact 4. We advise that the cable jointing areas are selected not only to avoid areas of qualifying habitat, but always where the topography is relatively uniform, i.e. where there is little altitudinal difference between the track and the adjacent track-side bank.

Page 17, Section 5 Construction mitigation measures
We welcome the commitment to the mitigation measures described.
We advise that there should be an additional measure to the effect that there will be no refuelling of the cable plough when it is operating off the constructed track. This is to reduce the risk of fuel spills affecting SAC qualifying habitat.

Pages 17 - 20, Long-term mitigation measures
We welcome the proposal for these additional measures and the implicit recognition of the value of the habitat and the importance for it of an intact hydrological regime.

Hope the above comments are of assistance.

Regards
Alec

Alexander Macdonald
Operations Officer
Scottish Natural Heritage
The Links
Golspie Business Park
Golspie KW10 6UB
01408 634063

4. **File Note SEPA to SSER/ENVIRON following scoping meeting on 8th March 2013 covering a range of topics within SEPA's remit.**

SEPA	MEETING DISCUSSION - RECORD SHEET	BF005.6
Date: 8 March 2013	Location: SEPA Office Dingwall	File Ref: PCS/125013
Reason for meeting: Strathy South Windfarm Addendum Scoping		
Attendees: Cerian Baldwin (SEPA), John MacDonald (SEPA), Emma Summers (SEPA), Nicki Small (SSER), Nathan Swankie (ENVIRON on behalf of SSER), Neil McKay (SSER)		

Brief discussion of 2007 and scheme evolution
- Nathan provided an overview of where the scheme was at and what the proposed addendum would cover. SEPA highlighted that their remit in terms of commenting of planning/Section 36 consultations had widened since 2007 but that hopefully their response PCS/122275 dated 17 September 2012 covered all our current information requirements.

Peat
- SSER confirmed the updated peat survey work and draft peat management plan should take into account of SEPA's current information requirements. SEPA are keen for the draft Peat Management Plan to be integral to any draft CEMP within the Addendum.

Water Environment
- SSER confirmed that the survey work has been updated to take account of SEPA's current information requirements regarding watercourse crossings, flood risk, private water supplies and abstractions. SEPA noted the proposals for borrow pit areas of search and micro siting. SEPA flagged up the importance of Strathy North, Strathy South and Strathy Wood developments coming to some agreement to minimise the number of new crossings across the River Strathy. SSER confirmed that discussions were ongoing with the developer for Strathy Wood, E.ON, in an effort to achieve sharing of infrastructure. In addition, in terms of buffers to waterbodies SEPA has no set threshold and considers buffers to be site specific. The best way forward is for the developer to determine a minimum buffer, utilise GIS to show this buffer around all the built infrastructure and then to provide more detailed risk assessments and mitigation where the buffer is breached. This is most usefully shown through the use of a map showing the buffers and areas where it could be breached along with target notes/assessments for those breaches.

Ecology and Nature Conservation
- SSER confirmed that GWDTE assessment work has been undertaken but that scope to avoid some them is difficult due to the advanced stage of the scheme. SEPA highlighted the need for clear mapping which highlights the proximity of GWDTEs clearly in relation all the built infrastructure again showing SEPA's buffers (as detailed in PCS/122275) which flags up any areas which require further assessment or mitigation proposals.

Forest Removal and Forestry Waste
- SSER set out the difficulties with extracting timber from the site (including potential damage to underlying peat and the lack of harvestable quality timber from juvenile trees) and the need to look for peatland restoration whilst balancing the need to deter raptors from the site. SSER

noted that there were some differences for the Strathy South site which made it even more challenging than for Strathy North, including being surrounded on four sides by the SPA and generally having lower yield classes. SSER also confirmed that FCS is content to see the forestry removed without re-planting, as the forestry is currently impacting upon the underlying peat. SEPA set out the need for all options to be looked at before mulching is considered and the need to meet the requirements of our Management of Forestry Waste Guidance. SEPA are keen for a detailed aerial survey of the forest resource as suggested by Neil McKay to firstly ascertain what the timber resource and condition is. SEPA would then expect detailed site specific proposals to be worked up using tools such as mapping, decision trees and matrices to determine the different methods of removing the trees. These would need to have regard to the waste hierarchy and waste minimisation and other issues such as restoring the peatland and protecting carbon stores, protecting the water environment and pollution prevention. Details of the proposed methods, locations, volumes and depths would need to be provided. SSER advised that they are committed to working with UHI and are currently exploring peatland research proposals – SSER suggested that this could be offered via the HMP if SEPA considered this would be of benefit. SEPA were keen to see a holistic approach which involves SNH and any research work involving the UHI/RSPB. Once the proposals are more worked up it would be good to have a joint meeting to establish a joint solution. SEPA are keen for this to be in advance of the submission for the formal Addendum to enable scope for proposals to be revised if necessary.

AOB

- SEPA is keen to see any draft assessments or chapters of the ES Addendum. These should be sent to planning.dingwall@sepa.org.uk

Name: Cerian Baldwin

Scottish and Southern Energy Renewables

Technical Appendix A10.2

Strathy South Wind Farm Habitats, Vegetation and Protected Species

09 July 2013

Project Number: SEC7232

RPS
Ocean Point One
4th Floor
94 Ocean Drive
Edinburgh
EH6 6JH

Tel: 0131 555 5011
Fax: 0131 555 4911
Email: matthew.pannell@rpsgroup.com

QUALITY MANAGEMENT

Prepared by:	Name:	**Stephen Lockwood**	Title:	**Ecologist**
	Signature:			
Authorised by:	Name:	**Matt Pannell**	Title:	**Senior Ecologist**
	Signature:			
Current Status:	**Final**			
Issue Date:	**09 July 2013**	Revision Number:	**-**	
		Revision Notes:	**-**	
Project File Path:	**S:\Strathy Projects - All Ghost Folders\7232 SEC - SSE S South Reporting WS9 Ghost Folder\Technical\Reports in Progress\Ecology Addendum Chapt 10\Final Versions\UK12-17181_2_TA A10.2 - Habitats and Protected Spp.doc**			

This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001: 2008

COPYRIGHT © RPS

The material presented in this report is confidential. This report has been prepared for the exclusive use of Scottish and Southern Energy Renewable (SSER) and shall not be distributed or made available to any other company or person without the knowledge and written consent of SSER or RPS.

CONTENTS

EXECUTIVE SUMMARY **1**

1 INTRODUCTION **3**

1.1 Background **3**

2 METHODOLOGY **4**

2.1 Survey Methods **4**
2.1.1 Desk Study 4
2.1.2 Field Based Vegetation Surveys 4
2.1.3 Field Based Protected Fauna Species Surveys 5
2.2 Limitations **8**

3 SURVEY RESULTS **9**

3.1 Desk Study Results **9**
3.1.1 Vegetation 9
3.1.2 Protected Fauna Species 9
3.2 Field Survey Results **10**
3.2.1 Vegetation Survey Results 10
3.2.2 Detailed NVC Community Descriptions 13
3.2.3 Evaluation of Botanical Interests 20
3.2.4 Protected Species Survey Results 22

4 SUMMARY **24**

5 REFERENCES **26**

FIGURES

Figure A10.2.1 – Designated Sites

Figure A10.2.2. – Phase 1 Survey Results Overview, Access and Cable Route

Figure A10.2.3 – Phase 1 Survey Results, Access and Cable Route

Figure A10.2.4 – Phase 1 Survey Results Overview, Wind Farm Site

Figure A10.2.5 – Phase 1 Survey Results, Wind Farm Site

Figure A10.2.6 – NVC Survey Results Overview, Access and Cable Route

Figure A10.2.7 – NVC Survey Results, Access and Cable Route

Figure A10.2.8 – NVC Survey Results Overview, Wind Farm Site

Figure A10.2.9 – NVC Survey Results, Wind Farm Site

Figure A10.2.10 – Protected Species Survey Results Overview, Access and Cable Route

Figure A10.2.11 – Protected Species Survey Results, Access and Cable Route

Figure A10.2.12 – Protected Species Survey Results Overview, Wind Farm Site

Figure A10.2.13 – Protected Species Survey Results, Wind Farm Site

Figure A10.2.14 – Groundwater Dependant Terrestrial Ecosystems, Access and Cable Route

Figure A10.2.15 – Groundwater Dependant Terrestrial Ecosystems, Wind Farm Site

APPENDIX 1 – NVC POLYGON COMMUNITY COMPOSITIONS

APPENDIX 2 – NVC SURVEY TARGET NOTE RECORD

APPENDIX 3 – DETAILED PROTECTED SPECIES SURVEY RESULTS

File Path & Name: P:\CONTRACT\UK171xx\UK12_17181 SSE Strathy South ES Addendum\Report\ES Addendum\Volume 4_Technical Appendix\TA Chapter 10_Ecology\TA A10.2\UK12-17181_3_TA A10 2 - Habitats and Protected Spp.doc

rpsgroup.com

EXECUTIVE SUMMARY

RPS was commissioned by SSE Renewables (UK) Ltd (SSER) acting on behalf of the applicant SSE Generation Ltd, to undertake National Vegetation Classification (NVC) and protected species surveys within Strathy South Forest; the site of a proposed wind farm development, and all routes associated with proposed access tracks and grid connection requirements. The forest is situated approximately 12 km south of the village of Strathy, Sutherland.

The main purpose of the surveys was to provide baseline information to facilitate a thorough assessment of the potential impacts from the proposed wind farm development on habitats and protected fauna species. Vegetation surveys aimed to classify all habitats within the survey area to NVC community level, and wherever possible to sub-community level. Similarly, protected species surveys sought to identify the presence and distribution of protected fauna species (non-avian) within the survey area.

The wind farm survey area is dominated by coniferous plantation forestry comprised of a mixed crop dominated by Sitka spruce and lodgepole pine. The forestry is interspersed with rides of predominantly mire or heath habitats, and larger glades containing heath, mire, and bog pool communities. Outwith afforested areas, the survey area abuts open moorland that is dominated by a mosaic of mire and heath communities which contain a number of high water table areas and thus, bog pool and open water communities are present.

Within the wind farm survey area a total of 21 different NVC communities and 34 sub-communities were found. A number of these are of national and international importance being listed as Annex 1 Biotopes under the EC Habitats Directive and the Habitats Regulations 1994 (as amended), listed on the Scottish Biodiversity List as important for conservation within Scotland, and within the Sutherland LBAP.

The preferred access route exits the wind farm site via its northern boundary, following the route of the existing forestry track as it crosses the Caithness and Sutherland Special Area of Conservation (SAC). The track then passes through Strathy Wood and into Strathy North Wind Farm to link with the existing infrastructure for this development. The proposed grid connection will follow the route of the access route before running directly north within the Strathy North Wind Farm to connect to an existing sub-station (as presented on Figure A4.1 of the ES Addendum).

The Caithness and Sutherland SAC is designated for:

- *Upland bogs including blanket bog and depressions on peat substrates;*
- *Upland dwarf shrub heath including wet heathland with cross-leaved heath;*
- *Upland fen, marsh, and swamp including very wet mires often identified by an unstable 'quaking surface;*
- *Standing open water and canals including acid peat-stained lakes and ponds;*
- *The otter population present within the site boundary; and,*
- *Marsh saxifrage found within the site boundary.*

Vegetation surveys conducted along the length of the preferred access route passing through the SAC, found the surrounding area to be dominated by the mire and wet heath habitats for which the site is designated. However, large areas of piled spoil remain from previous construction activities along track verges. Spoil areas are currently recolonising with a mixture of upland species; however, this is not of an assemblage which is able to be categorised within recognised nomenclature. Vegetation within non-afforested areas of Strathy Wood and Strathy North contain remnant mire and wet heath habitats; however, these have been modified through forestry influences such as drainage, and consequently show a limited diversity of defining species.

Protected species surveys throughout all areas found evidence of both otter and water vole in habitats associated with watercourses and flushes. Indicative signs of pine marten presence were also widespread across the wind farm site, with two potential denning sites identified, and an individual sighted at the eastern end of the track crossing Yellow Bog. No signs of wildcat were found within the survey area; however, their niche requirements are similar to those of pine marten and thus the area may contain suitable habitat for the species.

No signs of badger or red squirrel presence were seen across the survey area; however, a known badger sett is present inside the grid connection survey area within Strathy North Wind Farm. Outside of this location there is limited potentially suitable habitat for badger, with drier areas generally of a rocky substrate unsuitable for the creation of setts. The poor quality of the forestry crop and lack of broadleaved trees indicates a limited food resource for red squirrels. This, coupled with the isolated nature of the plantations from other potential foraging areas would suggest the survey areas offer limited potential for the species. No signs of their presence were seen throughout the course of the surveys.

The survey area offers numerous areas of suitable habitat for both reptiles and amphibians. Rocky outcrops and areas of dry heath would provide suitable basking habitat and refugia for reptiles, whilst acidic flush areas would similarly be suitable for amphibians. No reptiles or amphibians were seen during the course of the surveys.

In consultation with SNH (Email 26th July 2012), no additional surveys were conducted for bat species; however, the stone building located at Lochstrathy in the south of the wind farm survey area is thought to offer suitable roosting potential for the species.

1 INTRODUCTION

1.1 Background

RPS was commissioned by SSE Renewables (UK) Ltd (SSER) acting on behalf of the applicant SSE Generation Ltd, to undertake National Vegetation Classification (NVC) and protected fauna species surveys in relation to a proposed wind farm development within Strathy South Forest, including the route of the proposed access track and grid connection. The site is located approximately 12 km south of the village of Strathy, Sutherland (Central Ordnance Survey (OS) Grid Reference: NC 790 520), and approximately 2 km south of the consented Strathy North Wind Farm at there closest boundaries.

The turbine envelope would be contained entirely within Strathy South Forest (Figure A4.1). The proposed access route would leave the north-east of Strathy South Forest following the route of the existing forestry track through Strathy Wood, before crossing the River Strathy into Strathy North Forest to link up with the consented Strathy North wind farm track infrastructure. Where the track would cross the River Strathy, two potential bridge location options have been identified. The western most option is referred to as the preferred option and the eastern most as the alternative option. The route of the proposed grid connection would follow the access track into Strathy North Forest before taking a direct route north to the proposed sub-station situated near Dallangwell (Figure A4.14). The section of track and grid connection running through Strathy Wood is within the Caithness and Sutherland Special Area of Conservation (SAC).

Surveys for important habitats and fauna species were undertaken previously in order to inform the development of an Environmental Statement (ES) submitted as part of the initial planning application in 2007 (the Original 2007 Scheme). Surveys conducted in 2011/2012, and detailed within this Technical Appendix, provide an updated set of baseline conditions to those previously reported in the 2007 submission. The 2011/2012 updated surveys were undertaken in order to inform a comprehensive assessment of the potential impacts due to the Modified 2013 Scheme for the proposed Strathy South Wind Farm.

Fish and aquatic invertebrate surveys are outwith the scope of this report. Surveys for these species were conducted separately, the results of which are the subject of separate reports and are provided as Technical Appendix A10.4 and A10.5 respectively of the ES Addendum.

2 METHODOLOGY

2.1 Survey Methods

Baseline data to assess the habitats and protected fauna species present for the proposed wind farm, associated access track options, and the required grid connection were collated through a variety of desk and field based studies. The methodologies used are detailed below in Sections 2.1.1 - 3.

The following list of figures provides an overview of the survey areas described in this section:

- Figure A10.2.2 Phase 1 Survey Results Overview – Access and Cable Route
- Figure A10.2.4 Phase 1 Survey Results Overview – Wind Farm Site
- Figure A10.2.6 NVC Survey Results Overview – Access and Cable Route
- Figure A10.2.8 NVC Survey Results Overview – Wind Farm Site
- Figure A10.2.10 Protected Species Survey Results Overview – Access and Cable Route
- Figure A10.2.12 Protected Species Survey Results Overview – Wind Farm Site

2.1.1 Desk Study

Baseline information regarding the site and surrounding area was collated from a variety of sources including SNH SiteLink website[1], the National Biodiversity Network Gateway (NBNG) database[2], Magicmap[3], and through consultation with local recording bodies.

Additional data collated for the Strathy North Wind Farm and surveys undertaken by the developer E.ON within Strathy Wood have also been included within this assessment. Results from these two surveys allow the wider area surrounding the proposed grid connection and access tracks to be assessed for their capability to support protected fauna species, along with containing any habitats of conservation importance. The proposed grid connection route and both the preferred and alternative access route options have also been buffered by 200 m, highlighting any potential constraints from protected species or habitats found during these surveys may pose to these.

Strathy North Wind Farm Data

A suite of baseline surveys was conducted for the consented Strathy North Wind Farm in support of the 2007 ES for the site. Habitat data has been used in the current report including specifically Phase 1 habitat survey data (2004) and NVC survey data (2005). In addition, pre-construction surveys for the wind farm were undertaken in 2012 and 2013 for recent forestry felling operations; results are similarly included within this assessment.

Strathy Wood (E.ON) Data

Habitat and protected species surveys were undertaken within the area of Strathy Wood by the developer E.ON in July – October 2011 in conjunction with a proposed wind farm for the area. Results of these surveys have been used to assess the potential effects of the alternative access route and grid connection within this area. This data was collected following methods similar to the standard methodology as outlined in Sections 2.1.2 and 2.1.3 for surveys covering the wider survey area.

2.1.2 Field Based Vegetation Surveys

[1] http://gateway.snh.gov.uk/sitelink/

[2] http://data.nbn.org.uk/

[3] http://magic.defra.gov.uk/website/magic/

The main site of the proposed development was surveyed between July and August 2011 with the area covered including the Strathy South Plantation and a 100 m buffer surrounding the site boundary. Additional vegetation surveys were conducted in July 2012 for the proposed access route and grid connection from the boundary of Strathy South Forest north through Strathy Wood. The route follows the course of the existing forestry access track, with the survey assessing the route and a surrounding buffer of 200 m.

All vegetation surveys classified and mapped areas using National Vegetation Classification (NVC) nomenclature (Rodwell 1991, 2000, 2006) to community level, and wherever possible sub-community level. Each definable area was individually mapped onto 1:10 000 Ordnance Survey (OS) mapping; these areas are referred to throughout the report as 'polygons'. Due to the complex nature of vegetation communities, there were numerous polygons in which several different communities were present forming a mosaic, each too small to be mapped individually. In these areas, the compositions of the communities within the mosaic were noted, including percentage cover values, and the dominant community identified. Some locations within the survey area did not fit into the standard NVC nomenclature or the proposed revisions to the existing communities. Where this occurred the vegetation was given a prefix for the community and the assemblage of species noted; these are described and listed within this report.

A desk study using OS maps and internet-based aerial photography, guided an initial assessment of the survey area, and the likely major community present. The surveyors walked the area to visit all apparently different habitat communities, and each 'stand' (apparent community) was sampled by recording the vascular plants, bryophytes and lichens present and their relative dominance noted. Consequently, qualitative rather than quantitative data was recorded on community composition; domin scale quadrat data was not recorded. Aggregate species were treated as such, e.g. *Euphrasia* agg., *Taraxacum officinale* agg.

Areas such as forestry, which are not included within the NVC communities, were noted using the JNCC Phase 1 nomenclature (2010) with the dominant species within the stand noted.

Target notes were made where any species of interest were found, with the location of the target note recorded using a hand held GPS.

Botanical nomenclature in this report follows that of Stace (2010) for vascular plants, Atherton *et al* (2010) for bryophytes and Purvis *et al* (1992) for lichens.

2.1.3 Field Based Protected Fauna Species Surveys

The protected species survey area, including the route of the preferred access track and grid connection and a 200 m buffer, and Strathy South Forest and a 250 m buffer, was surveyed for both UK and European protected species between June and August 2012. All areas of suitable habitat, as previously identified by vegetation surveys, were searched for indicative signs of protected species presence. Desk studies and other surveys undertaken for protected species in relation to the consented Strathy North Wind Farm and the proposed Strath Halladale to Dallangwell 132kV Grid Connection, had identified the presence of the following species within the wider area:

- Otter (*Lutra lutra*)
- Water vole (*Arvicola amphibius*)
- Badger (*Meles meles*)
- Wildcat (*Felix silvestris*)
- Pipistrelle bats (*Pipistellus spp.*)
- Pine marten (*Martes martes*)
- Common reptiles
- Amphibians.

Standard survey methods, detailed below, were used to search for indicative field signs. As agreed with SNH (Email 26th July 2012), bat surveys were not undertaken due to the limited potential for suitable roosting sites within the survey area and surrounding habitats. Survey methods for each species were undertaken in accordance with the following literature:

- Otter - Bang and Dahlstrøm (2001);
- Water vole - Strachan and Moorhouse (2010);
- Badger - Neal and Cheeseman;
- Wildcat – Kitchener (1995) and Forestry Commission Scotland (2009);
- Pine marten – Harris and Yalden (2008); and
- Common reptiles and amphibians – Gent and Gibson (2003)

The detailed survey methodology for each species is provided below.

Otter

All waterbodies, watercourses and minor ditches within the survey area were assessed for their potential to support otters. Otter field signs are described in Bang and Dahlstrøm (2001) and include resting sites (e.g. holts and couches), spraints, prints and feeding remains. Descriptions of these and other field evidence terms are provided below.

- **Holts** - these are underground features where otters live. They can be tunnels within bank-sides, underneath root-plates or boulder piles, and even man-made structures such as disused drains. Holts are used by otters to rest up during the day due to the crepuscular nature of their foraging activities and may be used as natal or breeding sites. Otters may use holts permanently or temporarily;
- **Couches** - these are above ground resting sites. They may be partially sheltered, or fully exposed. Couches may be regularly used, especially in reedbeds and on in-stream islands. They have been known to be used as natal and breeding sites. Couches can be very difficult to identify, sometimes consisting of no more than an area of flattened grass or earth, and are best identified by the presence of other field signs (e.g. spraints). Where rocks or rock armour are used as couches, these can be almost impossible to identify without observing the otter in-situ;
- **Prints** - otters have characteristic footprints that can be found in soft ground and muddy areas;
- **Spraints** - otter faeces can be used to mark territories, often on in-stream boulders. They can be present within or outside the entrances of holts and couches. Spraints have a characteristic smell and often contain fish remains;
- **Feeding signs** - the remains of prey items may be found at preferred feeding stations. Remains of fish, crabs or skinned amphibians can indicate the presence of otter;
- **Paths** - these are terrestrial routes that otters take when moving between resting-up sites and watercourses, or at high flow conditions when they will travel along bank sides in preference to swimming; and
- **Slides and play areas** - slides are typically worn areas on steep slopes where otters slide on their bellies, often found between holts/couches and watercourses. Play areas are used by juvenile otters in play, and are often evident by trampled vegetation and the presence of slides. These are often positioned in sheltered areas adjacent to the natal holt.

Any of the above field signs can be used as anecdotal evidence to indicate the potential presence of otters within an area; however spraints and prints are the most reliably identifiable evidence of the species' presence.

Suitable otter habitats are varied; however they require an abundance of forage and prey including fish, amphibian, small mammal and invertebrate species. Refugia such as reedbeds and areas of high grass are similarly important throughout an area. The interconnectivity between watercourses and waterbodies is an important factor in assessing the suitability of a site for otter potential. The species is a wide ranging forager and will often patrol a large territory in search of food. Territory size is dependent on food resources within an area, the population density within any particular area, and the sex of an individual. However, it is not uncommon for males to travel upwards of 16 km in the course of a night whilst foraging.

Wildcat and Pine Marten

Wildcats and pine martens are notoriously difficult to survey for, as their scats (the most obvious field signs), are similar to those of fox and stoat when seen in the field. As such the survey focussed on assessing the habitat suitability for this species. This typically includes mature woodland, including coniferous plantations, although they will forage in open habitats as well. In particular, the survey searched for areas which might hold suitable potential for denning sites including hollow trees, root plates, boulder piles or rocky outcrops. Wildcat survey guidance is provided in FCS (2009) and field signs are described in Kitchener (1995) and Bang and Dahlstrøm (2001). Pine marten are described in Harris and Yalden (2008).

Badger

Areas of suitable badger habitat such as broadleaved woodland, copses and scrub, particularly those surrounding cultivated areas were identified within the survey area as these tend to be favoured by the species. During the survey such habitats were searched for signs of badger and any indicative evidence noted. Badger field signs are described in Neal and Cheeseman (1996), Bang and Dahlstrøm (2001), and in SNH (2001) and include:

- Setts (including main, subsidiary and outlier setts);
- Latrines (dung pits used as territorial markers);
- Prints;
- Foraging signs (snuffle holes); and
- Guard hairs snagged on wire fencing.

Any of the above signs (with the exception of foraging signs) can be taken as diagnostic evidence of the presence of badger.

Water Vole

All watercourses, minor ditches and small waterbodies within the survey area were assessed for their potential to support water voles. Habitat suitability criteria were based on information given in Strachan and Moorhouse (2006) and included the species' known preference for:

- Slow flowing water;
- Low water level fluctuation;
- Banks suitable for burrowing;
- Lush bank-side vegetation to provide food and shelter; and
- An absence of American mink (*Neovison vison*), a predator of water vole.

Within areas identified as suitable sites for water vole presence, diagnostic field signs were searched for. These include evidence of:

- Feeding signs including grass and reed clippings;
- Lawns and runways throughout the area showing a regular passage of the species along certain routes;
- Burrows in banks along watercourses, and where no banking is available, signs of nests in the surrounding grasses or reeds; and
- Latrines and piles of droppings.

Red Squirrel

Preferential habitat for red squirrel includes:

- Areas of mature coniferous or broadleaved woodland that are capable of producing an annual seed crop; and
- An absence of grey squirrels (*Sciurus carolinensis*) in the surrounding area.

Squirrel field signs were also searched for. These include:

- Dreys (tree-top resting sites); and
- Feeding remains (chewed pine cones, particularly at traditional feeding stations such as on top of tree stumps).

It should be noted however, that it is not possible to distinguish red squirrel dreys and feeding remains from those of grey squirrels. The most reliable method of confirming the species presence is the sighting of an actual animal. Therefore, given the relatively low likelihood of seeing a red squirrel during the survey, the main aim of the survey was to identify whether squirrels (regardless of species) were likely to be present within the site.

Reptiles and Amphibians

The habitat requirements of common lizard (*Zootoca vivipara*), slow worm (*Anguis fragilis*), adder (*Vipera berus*), common frog (*Rana temporaria*), and common toad (*Bufo bufo*) (the species most likely to occur in this part of Scotland) are relatively broad but in general they require areas of dense vegetation such as grassland, heath, scrub and woodland edge for foraging and shelter as well as more open, preferably south facing areas in which to bask (Gent and Gibson, 2012). They also require suitable refugia habitat such as wood and rock piles in which to shelter and more importantly to hibernate during the winter. Examples of such habitat and their potential to support reptiles were noted where present.

2.2 Limitations

No limitations as to the effectiveness of the surveys were identified with all fieldwork conducted at an appropriate time of year within suitable weather conditions. As such, the findings of this report provide a representative assessment of the baseline conditions of the site at the time of survey.

3 SURVEY RESULTS

For ease of understanding all internet based results such as those found within the NBNG database, SNH Sitelink, and Magicmap are included within Section 3.1. Results from all field surveys including those undertaken for the Strathy North Wind Farm, Strathy Wood, the Common Access Route crossing the Caithness and Sutherland SAC, and Strathy South Forest are included within Section 3.2 and 3.3

3.1 Desk Study Results

3.1.1 Vegetation

All ordnance survey 10 km grid squares in which the proposed development area is situated in or surrounded by were searched for records of species as listed on the International Union for Conservation of Nature (IUCN) Red List of a status of vulnerable or greater. The grid squares included within the desk study area are NC74, NC75, NC84, and NC85. Table A1 below shows the results of the study.

TABLE A1 SPECIES CLASSED AS VULNERABLE OR GREATER (IUCN) PRESENT IN 10 KM GIRD SQUARES WITHIN THE VICINITY OF THE PROPOSED DEVELOPMENT

Species	Grid Squares	IUCN Status
Alpine Mouse-ear (*Cerastium alpinum*)	NC84	Vulnerable
Corn Spurrey (*Spergula arvensis*)	NC74, NC75, NC84, NC85	Vulnerable
Northern Rock-cress (*Arabis petraea*)	NC84	Vulnerable

Note: Records are from the NBNG database.

It is important to note that the desk study utilises the NBNG database, as most recording bodies now upload all field records to this site. However, the system needs to be used with caution as, in this case, marsh saxifrage (*Saxifraga hirculus*), a designating species of the Caithness and Sutherland SAC and underlying Site of Special Scientific Interest (SSSI) which surrounds the proposed development area, is not recorded. The species is listed as vulnerable with the IUCN Red List.

3.1.2 Protected Fauna Species

Desk study results for protected species in the vicinity of the proposed development area can be seen in Table A2 below.

TABLE A2 RESULTS OF THE DESK STUDY FOR PROTECTED SPECIES RECORDS WITHIN THE VICINITY OF THE PROPOSED DEVELOPMENT

Protected Species	Closest Historical Records To Site
Otter	Otter records are present showing activity within the site boundary from 1979, 2 km to the west of site from 2000, and 5 km to the west of site from 2005.
Water vole	Water vole records are present 9 km north west of site at Betty Hill from 1984.
Wildcat	Wildcat have been recorded 10 km to the north east of site in 1995 along the Halladale River.

TABLE A2 RESULTS OF THE DESK STUDY FOR PROTECTED SPECIES RECORDS WITHIN THE VICINITY OF THE PROPOSED DEVELOPMENT

Protected Species	Closest Historical Records To Site
Pine marten	Records of pine marten 5 km to the west of site are present from 2008. Pine marten have also been sighted within the Strathy North Wind Farm development during construction in 2013.
Badger	Badger has been recorded 8 km to the north west of site from 1984 along the River Naver. Active badger setts are also know to be present within the eastern section of the Strathy North Wind Farm development close to the River Strathy, approximately 6 km north of the proposed site's boundary.
Bats	Records of common pipistrelle along the River Strathy 8 km to the north of site are present from 2006.
Red squirrel	A single record of red squirrel presence is recorded at Borgie Forest from 1998, approximately 10 km to the west of the Development area.
Adder	Adder have been recorded 4 km to the east of site in 2010.
Common lizard	Common lizard have been recorded 7 km to the west of site in 2010.
Common frog	Records of common frog are present 7 km to the north west of site from 1984.
Common toad	Records of common toad 6 km to the north west of site are present from 1984
Slow worm	Slow worm records 7 km to the north west of site are present from 1984.

Notes: Records are from the NBNG database.

3.2 Field Survey Results

3.2.1 Vegetation Survey Results

Grid Connection Route

The route of the proposed grid connection follows the proposed access route from Strathy South Forest, through Strathy Wood and Strathy North Wind Farm, as shown in Figure A4.14. Vegetation results along these sections are detailed in Section 3.2.2 for the access tracks below. Where the grid connection leaves the access track within Strathy North Forest, the grid connection would run along a series of rides. The results of vegetation surveys for this section of the grid connection are detailed separately here. The route of the grid connection within Strathy North Wind Farm can also be seen in Figures A10.2.2 and A10.2.4.

The rides along which the grid connection route would run within Strathy North Forest predominately contain a mixture of mire and wet heath habitats and communities. These habitats and communities have been modified to an extent through forestry influences and are dependent on the depth of peat present and the drainage undertaken for forestry purposes. Table A3 below details the dominant communities present along this section of grid connection route, along with the quantity of each community and habitats found within the 200 m survey buffer.

Section 3.2.2 provides detailed descriptions of the species present within each of the NVC communities present along with their relevant conservation status within both UK and EU legislation.

TABLE A3 AGGREGATE COVER OF THE DOMINANT COMMUNITY TYPES ALONG THE GRID CONNECTION WITHIN STRATHY NORTH FOREST	
NVC Community	**Area covered (ha)**
Coniferous Woodland Plantation	161.44
M15 *Trichophorum germanicum – Erica tetralix* mire	7.74
H10 Calluna vulgaris - Erica cinerea heath	1.91
M25 *Molinea caerulea – Potentilla erecia* mire	1.74
U20 *Pteridium aquilinum – Galium saxatile* community	1.65
M17 *Trichophorum germanicum – Eriophorum vaginatum* mire	1.29
M6 *Carex echinata – Sphagnum fallax/denticulatum* mire	0.53
M4 *Carex rostrata – Sphagnum fallax* mire	0.43

Access Track Routes

The proposed section of access track between Strathy South Forest and Strathy Wood will pass through the Caithness and Sutherland Peatland SAC following the route of the existing forestry track. The site is designated for the following attributes:

- Upland bogs including blanket bog and depressions on peat substrates;
- Upland dwarf shrub heath including wet heathland with cross-leaved heath;
- Upland fen, marsh, and swamp including very wet mires often identified by an unstable 'quaking' surface;
- Standing open water and canals including acid peat-stained lakes and ponds;
- The otter population present within the site boundary; and,
- Marsh saxifrage found within the site boundary.

Vegetation surveys found the area directly adjacent to the existing forestry track contained large areas of spoil remaining from construction activities. In various places, these areas have recolonised with a variety of species common to peatland habitats. However, due to their modified nature, they are not able to be categorised within the NVC or Phase 1 survey nomenclature. Areas outwith those modified by previous construction activities contain upland habitats including wet heath, dry heath, blanket mire, and acid grassland.

Habitats and communities found within Strathy Wood and Strathy North Forest adjacent to the proposed access track contain a mixture of modified mire habitats within forest rides, areas of felled coniferous plantation woodland, and small sections of wet and dry heath where peat depths are shallow allowing more minerotrophic species to exist. Habitats and communities present within these afforested areas are atypical of those documented within literature having undergone modifying influences such as drainage and the addition of fertilisers for forestry purposes.

In total, 12 NVC communities (nine dominant communities) were identified, with a further three sub-communities identified within these. Locations of habitats and their associated NVC communities throughout the survey area can be seen in Figures A10.2.2 – A10.2.5, with the detailed community compositions described in Section 3.2.2 below. All mapped communities presented in these figures can be assumed to be 100% of the listed community rather than mosaics. Table A4 below lists the dominant communities found along the proposed access track (both preferred and alternative options) and grid connection, along with the quantity of each of these habitats found within the 200 m survey buffer.

TABLE A4 AGGREGATE COVER OF THE DOMINANT NVC COMMUNITIES PRESENT ALONG THE ACCESS TRACK ROUTE OPTIONS		
NVC Community	**Area covered within Preferred Route Option (ha)**	**Area covered within Alternative Route Option (ha)**
Coniferous Woodland Plantation	63.97	71.09
M15 *Trichophorum germanicum – Erica tetralix* mire	42.26	45.29
M17 *Trichophorum germanicum – Eriophorum vaginatum* mire	29.95	31.53
M25 *Molinea caerulea – Potentilla erecta* mire	14.48	11.61
Standing Water	0.91	0.91
MG9 Holcus lanatus – Deschampsia cespitosa grassland	0.24	-
M19 *Calluna vulgaris – Eriophorum vaginatum* mire	0.24	0.23
S9 Carex rostrata swamp	0.21	0.21
U20 *Pteridium aquilinum – Galium saxatile* community	0.06	0.31
M4 *Carex rostrata – Sphagnum fallax* mire	0.04	0.04
M6 *Carex echinata-Sphagnum fallax/denticulatum* mire	-	0.47
Mixed woodland	-	0.21

Strathy South Forest

In total, 21 NVC communities were found within the wind farm survey area which were able to be further categorised into 34 sub-communities. An additional eight habitats were recorded at Phase 1 habitat level as they did not fit sufficiently within any NVC community. Many communities and habitats found within this area were mapped as mosaics, however, only the dominant communities are shown on the accompanying figures (Figures A10.2.8 - 9). All polygons within the detailed results figure (A10.2.9) have been numbered with the corresponding polygon. The NVC compositions of each polygon are presented in Table AA1 in Appendix 1 of this report.

The survey area is currently dominated by a mature forestry crop of Sitka spruce (*Picea sitchensis*) planted on a peat substrate of varying depth. Although the conifer crop is semi-mature, the substrate on which it has been planted is nutrient poor, and thus the trees are of poor growth and form. Despite their lack of size, the density at which they have been planted allows little light to penetrate to ground level and as such the ground flora has become all but

shaded out and replaced by a layer of needle litter. Due to the limited biological diversity within the forestry crop the focus of the survey was on the rides and glades running throughout the forestry which might contain rare or protected communities.

The majority of the communities found outwith the afforested areas can be categorised as either mire or heath communities, with occasional grassland communities present, and aquatic communities found within the waterbodies across the site. The locations at which certain communities are found within the survey boundary are predominately determined by the underlying substrate (either peat or mineral based), the height of the water table in the area, the associated drainage (either artificial or natural), and the local topography. Heath communities tend to be found in areas of shallow peat and low water tables, often on the steep banks of water courses or close to rocky outcrops. Conversely, mire communities are found within rides and outwith the plantation's boundary in areas of high water table and often deeper peat.

Overview Figure A10.2.8 shows that the survey area is dominated by the four communities listed below:

- M15 *Trichophorum germanicum – Erica tetralix* wet heath
- M17 *Trichophorum germanicum – Eriophorum vaginatum* blanket mire
- M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire
- M25 *Molinea caerulea – Potentilla erecta* mire

Table A5 below shows the aggregate cover of the dominant communities across the site.

TABLE A5 AGGREGATE COVER OF THE DOMINANT COMMUNITY TYPES ACROSS THE SITE

NVC Community	Area of site covered (ha)
Coniferous Woodland Plantation	1,141
M17 *Trichophorum germanicum – Eriophorum vaginatum* mire	490
M15 *Trichophorum germanicum – Erica tetralix* mire	139
M25 *Molinea caerulea – Potentilla erecta* mire	86
M19 *Calluna vulgaris – Eriophorum vaginatum* mire	42
M20 *Eriophorum vaginatum* mire	14
M23 *Juncus effusus/acutiflorus – Galium saxatile* mire	4
M18 *Erica tetralix – Sphagnum papillosum* mire	2

The following section of the report provides descriptions of each community present within the survey area and the context of the location in which it has been found. The relationship with other associated communities is discussed, and where appropriate, the protection which it is afforded through inclusion in relevant legislation is highlighted.

3.2.2 Detailed NVC Community Descriptions

H10 Calluna vulgaris - Erica cinerea heath community
This community is dominated by ling heather (*Calluna vulgaris*), with abundant bell heather (*Erica cinerea*) present throughout. Occasional stands of blaeberry (*Vaccinium mrytillus*) are present, interspersed with patches of wavy hair-grass (*Deschampsia flexuosa*), crowberry (*Empetrum nigrum*), deer grass (*Trichophorum germanicum*), green-ribbed sedge (*Carex binervis*), and tormentil (*Potentilla erecta*).

Within the total survey area three sub-communities of H10 are found, H10a being the typical community, generally species-poor, as described above with no other distinguishing feature and is the sub-community most commonly found within the site. H10b contains woolly hair moss (*Racomitrium lanuginosum*) in silvery mats beneath the dwarf shrubs with scattered *Cladonia* lichens frequently present. The dwarf shrub sward is noticeably sparser in this sub-community than in the typical H10a sub-community.

H10c contains a higher percentage cover of grasses within its species assemblage, with a notable increase in species such as sweet vernal-grass (*Anthoxanthum odoratum*) red fescue (*Festuca rubra*), sheep's fescue (*Festuca ovina*), and common bent grass (*Agrostis capillaris*).

All three communities are found on relatively free-draining areas of low water table and shallow peat, particularly on the steep banks surrounding tracks and watercourses running through the site. The communities are generally present in mosaics closely associated with M17 *Trichophorum germanicum – Eriophorum vaginatum* blanket mire communities which occur on the tops of these banks where the peat substrate is much deeper.

H12 Calluna vulgaris – Vaccinium mrytillus heath community
This community is dominated by mature stands of ling heather interlaced with blaeberry, with the understorey dominated by bryophytes such as red-stemmed feather-moss (*Pleurozium scherberi*), heath plait-moss (*Hypnum jutlandicum*) and glittering wood-moss (*Hylacomium splendens*). Heath bedstraw (*Galium saxatile*) and tormentil are frequently found throughout the community.

One sub-community is identified as being present on site; H12b *Vaccinium vitis-idaea – Cladonia impexa* sub-community. This is generally regarded as the wetter form of the community and contains raised levels of crowberry (*Empetrum nigrum*) and *Cladonia* lichens. The community is found within the wind farm survey area in three mosaics (polygons 17, 39, and 51) within the survey area, and on site is associated with M17 *Trichophorum germanicum – Eriophorum vaginatum* blanket mire and M25 *Molinea caerulea – Potentilla erecta* mire communities.

M1 Sphagnum denticulatum bog pool community
This community is dominated by *Sphagnum denticulatum* and *Sphagnum cuspidatum*, with species such a bog asphodel (*Narthecium ossifragum*), common sundew (*Drosera rotundifolia*), and common cotton grass (*Eriophorum angustifolium*) frequently present. The community is usually present in shallow pools or soakways within the blanket bogs, and is found within a number of mosaics throughout the site.

The community is most closely associated with M17 *Trichophorum germanicum – Eriophorum vaginatum* blanket mire or M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire communities and is generally present within glades throughout the survey area where the water table is closest to the surface. Deep bog pools containing bog bean (*Menyanthes trifoliata*) are often present within the same mosaics as the M1 bog pools.

M2 Sphagnum cuspidatum/fallax bog pool community
This community is dominated by *Sphagnum fallax* and *Sphagnum cuspidatum,* and although two sub-communities are present within the NVC classification, the distinction is not made between them within this survey. The community is widespread throughout the wind farm site and found within mosaics containing other mire communities such as M17 *Trichophorum germanicum – Eriophorum vaginatum* blanket mire, M18 *Erica tetralix – Sphagnum papillosum* blanket mire, M20 *Eriophorum vaginatum* blanket mire, and M15 *Trichophorum germanicum – Erica tetralix* wet heath. These mosaics are most often found in glades within the forestry or along the site boundary abutting the blanket bog out-with the survey area. The presence of this community and the M1 communities are often seen as an indication of 'high quality' blanket mire due to the required presence of a permanently high water table.

M6 Carex echinata-Sphagnum fallax/denticulatum mire community
Star sedge (*Carex echinata*) is a characteristic constant presence in M6, over a bed of sphagnum mosses dominated by *Sphagnum fallax* and *Sphagnum denticulatum*. Within the survey area two sub-communities are found; M6b and M6c.

M6b, *Carex nigra – Nardus stricta* sub-community, is found in one polygon on site, polygon 39, with this sub-community being dominated by common sedge (*Carex nigra*), carnation sedge (*Carex panicea*), common cotton grass, with frequent mat grass (*Nardus stricta*) and heath rush (*Juncus squarrosus*) present throughout.

M6c, *Juncus effusus* sub-community, is widespread throughout the site in areas surrounding burns and water bodies. The community is dominated by soft rush, with a mixture of sedges; common sedge and star sedge, grasses; wavy hair-grass and velvet bent grass (*Agrostis canina*), and mosses; *Polytrichum commune* and *Sphagnum fallax,* common throughout the soft rush (*Juncus effusus*) sward.

Both sub-communities are found in mosaics in association with M17 *Trichophorum germanicum – Eriophorum vaginatum* blanket mire, M23 *Juncus effusus/acutiflorus – Galium palustre* rush pasture, and are most commonly found surrounding small water bodies and burns draining afforested sections of the survey area.

M15 Trichophorum germanicum – Erica tetralix wet heath community
This wet heath community is present throughout much of the site, and is found in areas along the wind farm site boundary, along rides and tracks throughout afforested areas, and surrounding the access track crossing the SAC. Three sub-communities were found during the surveys; M15a, M15b, M15c.

M15a, *Carex panicea* sub-community, resembles a mire community more than a wet heath and is characterised by the abundance of carnation sedge, star sedge, and heath rush being present within a sparse sward of deer grass and cross-leaved heath. A patchy carpet of sphagnum mosses and woolly hair moss can be present including *Sphagnum denticulatum* and *Sphagnum fallax.* Within the survey area the sub-community is found in five polygons within the wind farm site (46, 48, 49, 51, and 72) predominately in the north-east of the site. Within these mosaics the sub-community was most closely associated with M17 *Trichophorum germanicum – Eriophorum vaginatum* blanket mire.

M15b is the typical community and is dominated by deer grass, cross-leaved heath, and ling heather, with hare's tail cotton-grass (*Eriophorum vaginatum*) being scarce throughout, thus differentiating it from the M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire community. Sphagnum mosses are rare within this community with only *Sphagnum capillofolium* being present in any measureable abundance, and only in patchy tussocks. The sub-community is common throughout the survey areas and is found in mosaics associated with a number of other wet heath and mire communities.

M15c is the *Cladonia* rich sub-community, containing a short open sward of cross-leaved heath, bell heather, and deer grass. *Cladonia* lichens are frequently present throughout the sub-community as is woolly hair moss. The sub-community is found in six polygons throughout the wind farm site, often being the dominant community within the mosaic, and in association with other mire and wet heath communities.

M17 Trichophorum germanicum – Eriophorum vaginatum blanket mire community
The M17 communities are characterised by the constant presence of hare's-tail cotton-grass, deer grass, and purple moor-grass, with clumps of ling heather and cross-leaved heath present throughout. The community is abundant across the site with three different sub-communities present.

M17a, *Drosera rotundifolia – Sphagnum* species sub-community, is the wettest of the M17 sub-communities and is dominated by hare's tail cotton-grass and deer grass, with abundant ling heather and a carpet of sphagnum mosses containing *Sphagnum capillofolium* and *Sphagnum papillosum.* Bog asphodel and common sundew are frequently found throughout the sub-community. The sub-community is often found in areas where the water table is close to the surface and thus it is most closely associated with the bog pool communities of M1 and M2, and open water pools containing bog bean and broad-leaved pondweed (*Potamogeton natans*).

M17b, *Cladonia* species sub-community, is dominated by deer grass; however, hare's-tail cotton-grass becomes patchy, as does the carpet of sphagnum mosses that are found within the understorey of M17a. Common sundew is uncommon within this community, and *Cladonia* lichens replace these species in the understorey. Areas of bare peat are frequent throughout. M17b is the dominant NVC community in the areas outwith the forestry crop, especially on the boundary of the survey area.

M17c, *Juncus squarrosus – Rhytidiadelphus loreus* sub-community, is characterised by the presence of heath rush, mat grass, and pleurocarpous mosses within the dominant deer grass and hare's-tail cotton-grass sward. The sub-community is found in one polygon within the wind farm site (polygon 61), within a mosaic of M25 *Molinea caerulea – Potentilla erecta* mire, and M23 *Juncus effusus/acutiflorus – Galium palustre* rush pasture.

M18 Erica tetralix – Sphagnum papillosum blanket mire community
This community is widespread throughout the wind farm site, found in over 20 locations predominately within mosaics associated with other mire communities such as M15, M17 and M19, and particularly with the bog pool communities of M1, M2, and the open water bog bean pools.

The only sub-community present within the survey area is M18a, *Sphagnum magellanicum – Andromeda polifolia* sub-community, which is typified by a low sward of cross-leaved heath and ling heather, with an understorey dominated by *Sphagna* including *Sphagnum papillosum, S. capillofolium, S. cuspidatum, S. tenellum,* and *S. magellanicum.* Creeping strands of cranberry (*Vaccinium oxycoccus*) are present throughout the sub-community, and occasional areas of pleurocarpous mosses are also present.

M19 Calluna vulgaris – Eriophorum vaginatum blanket mire community
The M19 community is found throughout the site, either along forest rides or in mosaics with other wet heath and blanket mire communities such as M17 and M15. Two sub-communities are present across the wind farm site; M19a *Erica tetralix* sub-community, and M19b *Empetrum nigrum* sub-community, however the community was not found surrounding the access track or grid connection.

The majority of the M19a sub-community is found in the southwest of the site at polygons 78 and 83. Polygon 78 has undergone extensive mechanical disturbance in preparation for a forestry crop which has subsequently not been planted. As such the area has a large number of drainage channels containing bare peat with the community sitting atop of these mechanically created furrows. The sub-community is usually dominated by heather and hare's-tail cotton-grass however, within polygon 78, due to the intensive localised drainage, hare's-tail cotton-grass abundance is significantly diminished. Deer grass and wavy hair-grass are occasionally found but are not a constant feature, and the understorey has frequent *Sphagnum capillofolium, S.papillosum, S.tenellum,* and *S.fallax.* Mosses such as *Pleurozium scherberi and Hypnum jutlandicum* are also abundant.

The M19b sub-community is found in polygons 30 and 31 in the north of the site. The sub-community is similar in species assemblage to that of M19a, however there is an increased abundance of crowberry within the dwarf shrub sward.

Both sub-communities are most closely associated with M17, M1, and M2 within the mosaics in which they are found on site.

M20 Eriophorum vaginatum blanket mire community
Hare's-tail cotton-grass is the dominant characteristic within this community with ericoid shrubs having a negligible impact on the foliar cover within the areas. Heather and blaeberry are occasionally present, but they do not occur consistently throughout the community. Wavy hair-grass, purple moor-grass, and common cotton-grass are frequently found, and the community often forms mosaics with M23 *Juncus effusus / acutiflorus – Galium palustre* rush pasture communities. Sphagnum mosses and bryophytes are not frequently found within the understorey which is often dominated by algae over a peat substrate, or by small carpet mosses such as *Campylopus introflexus.* This community is often a sign of high grazing pressures where the more palatable dwarf shrub heath species have been grazed out from the sward leaving only the tougher, nutrient poor grass species. Areas of M20 *Eriophorum vaginatum* blanket mire are found scattered throughout the wind farm site, with the species poor sub-community M20a being highlighted in some areas. This community was not found surrounding either the access track or grid connection.

M23 Juncus effusus / acutiflorus rush pasture community
This community is dominated by rush species with Yorkshire fog (*Holcus lanatus*), and marsh bedstraw (*Galium palustre*) abundantly present. Sweet vernal-grass, meadowsweet (*Filipendula ulmaria*), and lesser spearwort (*Ranunculus flammula*) are also frequently found within the community. The understorey often contains frequent mosses, such as *Calliergonella cuspidata* and *Rhytidiadelphus squarrosus*.

Both sub-communities are present within the survey area; M23a *Juncus acutiflorus* sub-community and M23b *Juncus effusus* sub-community, with the major distinction between them being the dominated rush type within the sward (although the other rush species maybe present in abundance).

Within the survey area the community is found surrounding burns and drainage ditches throughout the wind farm site, and is often present within mosaics dominated by M6c *Carex echinata-Sphagnum fallax/denticulatum* mire, *Juncus effusus* sub-community, and M25 *Molinea caerulea – Potentilla erecta* mire.

M25 Molinea caerulea – Potentilla erecta mire community
The M25 community is characterised by the constant present of a dominant purple moor-grass sward growing in dense tussocks interlaced with tormentil throughout. Within the survey area both sub-communities are found and where appropriate the differentiation between them made. In many areas it is not possible to accurately subscribe a sub-community type, and where this occurs, these areas are noted by the community only.

M25a, *Erica tetralix* sub-community, is differentiated from the other sub-communities by the occasional presence of ericoid species scattered throughout the purple moor-grass sward. M25b, *Anthoxanthum odoratum* sub-community, contains a higher assemblage of grass species such as sweet vernal-grass, brown-bent grass, mat grass, sheep's fescue, or Yorkshire fog within the sward. Both of these sub-communities are wide spread throughout the survey area, particularly through the ride systems of both Strathy South and Strathy North forests, surrounding burns crossing the access route within the SAC, and surrounding Loch nan Clach in the north-west of the site.

M29 Hypericum elodes – Potamogeton polygonifolius soakway community
The constant presence of marsh St John's wort (*Hypericum elodes*) and bog-pondweed (*Potamogetan polygonifolius*) characterise this community, usually found within the slow flowing water of soakways within blanket mires. The community is most closely associated within mosaics containing M1 and M2 bog pools, with the margins of the two communities often blurring into one as sphagnum mosses increase the shallower the soakway becomes.

Within the survey area the community is found in polygon 52 of the wind farm site at the start of the mapped burn as the forestry drains into the depression within the forest ride.

MG9 Holcus lanatus – Deschampsia cespitosa grassland community
This grassland is characterised by the dominant tall tussocks of tufted hair-grass (*Deschampsia cespitosa*), with abundant Yorkshire fog and sweet vernal-grass present throughout the sward. Grasses such as cock's foot (*Dactylis glomerata*) are occasionally seen and soft rush is frequently present, but insufficiently for the areas to be classified as an MG10 *Holcus lanatus – Juncus effusus* rush pasture. Scattered herbs such as creeping buttercup (*Ranunculus repens*) and marsh thistle (*Cirsium palustre*) are also frequently seen.

The community is rare within the survey area, present in only two locations within the wind farm site; polygons 34 and 38, and within these polygons only accounting for 1 and 10 percent of the coverage respectively.

MG10 Holcus lanatus – Juncus effusus rush-pasture community
This community is characterised by the presence of soft rush tussocks within a sward of Yorkshire fog, with frequent creeping bent-grass (*Agrostis stolonifera*), rough meadow-grass (*Poa trivialis*), meadow buttercup (*Ranunculus acris*), and creeping buttercup (*Ranunculus repens*) present throughout.

The typical sub-community, MG10a, is the only type found within polygon 1 in the wind farm site in a mosaic dominated by M15b *Trichophorum germanicum – Erica tetralix* wet heath, typical sub-community.

U2 Deschampsia flexuosa grassland community
Wavy hair-grass dominates this community with frequent to occasional heather present within the grass sward. Sweet vernal-grass, common bent-grass, and sheep's fescue are also frequent present.

This community was only present within polygon 5 of the wind farm site, and represented only one percent of the total cover of the area. As such, although two sub-communities are present within the NVC nomenclature, there was insufficient cover to classify the area in such detail. Other communities present within this mosaic include M17b, M15b, and M6c.

U4 Festuca ovina – Agrostis capillaris – Galium saxatile grassland community
The U4 community is dominated by sweet vernal-grass, sheep's fescue and common bent-grass, with frequent heath bedstraw and tormentil throughout. Within the survey area two sub-communities are present; U4b and U4d both found solely within the wind farm site survey area.

U4b, *Holcus lanatus – Trifolium repens* sub-community, is found in polygons 72, 73, and 95 in mosaics associated with mire communities such as M17, M25, and M6c. Additionally to the common species found within the U4 community, other grass species such as Yorkshire fog, cock's foot, and occasional crested dog's-tail (*Cynosurus cristatus*) are present within the sward.

U4d, *Luzula multiflora – Rhytidiadelphus loreus* sub-community, is found within polygon 68 in association with the M17 mire community along the edge of the River Strathy as it passes the north-western edge of the survey area. In addition to the constant species assemblage for the community, the sub-community contains frequent woodrush (*Luzula multiflora*), tufted hair-grass, brown bent-grass, and carnation sedge.

U6 Juncus squarrosus – Festuca ovina grassland community
The constant presence of heath rush, sheep's fescue, and common hair-moss within the species assemblage characterises this community, and it is found in polygon 108 of the wind farm survey area in association with the mire communities M17 and M15.

The area takes the form of the U6d *Agrostis capillaris- Luzula multiflora* sub-community, and in addition to the constants found within the community, grasses such as brown bent-grass, wavy hair-grass, mat grass, and sweet vernal-grass are frequently present throughout the sward.

U20 Pteridium aquilinum – Galium saxatile community
Stands of bracken (*Pteridium aquilinum*) of varying densities make up U20, with heath bedstraw and tormentil, the fern fronds typically 'swarming' through U4 acid grassland, often on deeper soils. The community is found sporadically along the banks of the River Strathy as it flows through the wind farm site from south to north, and in rides within Strathy North forest through which the grid connection will pass. Two sub-communities are present throughout the survey areas; U20a and U20c.

The U20a *Anthoxanthum odoratum* sub-community is the most species rich of the sub-communities containing Yorkshire fog, sweet vernal-grass, common sorrel (*Rumex acetosa*), and a carpet of mosses including *Hypnum jutlandicum* and *Rhytidiadelphus squarrosus*.

The U20c species poor sub-community contains stands of bracken which are significantly denser than the U20a sub-community, and as such few other species are present. The stands grow upwards from a matt of their own leaf litter and only the constants of the community are able to survive in these areas.

S4 Phragmites australis swamp community
This community lines a number of sections of the River Strathy in polygon 73 within the wind farm survey area and is dominated by common reed (*Phragmites australis*) which forms a swamp along the river's banks.

S9 Carex rostrata swamp community
This swamp community is characterised by the large bottle sedge (*Carex rostrata*) which dominates the sward along water body edges. There are two sub-communities which are both found within the survey area: S9a in which bottle sedge forms single-species stands; and the more herb rich S9b sub-community containing species such as bog bean, common sedge, lesser spearwort, marsh marigold (*Caltha palustris*), and bog pondweed.

The communities are found in three locations across the wind farm survey area at polygons 50, 52, and 85, in association with other mire communities and areas of standing water.

Menyanthes trifoliate swamp (MS) community
The *Menyanthes trifoliate* swamp community is not defined within the NVC nomenclature but is distinct from others and is therefore justified in being mentioned by itself. The community is dominated by bog bean standing in isolated pools of water, with occasional areas of *Sphagnum cuspidatum* floating within the pools. The pools are often found in mosaics with other mire and bog pool communities such as M1, M2, M17, and M18. The pools appear to be oligotrophic and of a low pH, with little other vegetation present within them.

Juncus effusus grassland (Je) community
This community is not present within the NVC nomenclature but is characterised by a soft rush sward covering a species poor acid grassland containing common bent-grass, sheep's fescue, sweet vernal-grass, wavy hair-grass, and heath rush. The community is present throughout the survey area within rides, and along burn and track sides.

Open Water (OW)
There are a number of areas of open water within the site in which no vegetation exists. The largest of these is in the west of the wind farm site at polygon 18; however, there are a number of smaller less obvious areas such as those on the edge of polygon 7, polygon 10, 24, 30, 79, 92, and 110, and to the east of the access track within the SAC

Many of the glades within the survey area contain areas where the water table is very close to the surface, and therefore during heavy rainfall ephemeral pools of water are also like to occur.

Running Water (RW)
Throughout the survey areas there are a number of natural burns and tributaries flowing through afforested areas and mire habitats, draining the areas of high water table such as the bog pools and lochans into the larger water courses such as the River Strathy.

Due to the narrow width of most of these watercourses they are generally not mapped on their own, but included within the polygon which they are passing through and noted as running water. The mosaics in which they occur thus including the assemblage of communities which surrounds them.

Bare Rock (BR)
Within the wind farm survey area there are a number of areas contained within the mapped mosaics that are bare rock. These areas are not mapped singularly as they are often intermingled with areas of dry heath such as H10 or H12; however, they are listed with a number of polygons communities' assemblages within Table AA1 within Appendix A1.

Bare Peat (BP)
Throughout the wind farm survey area there are numerous polygons which have bare peat listed as one of their attributes of percentage cover. Some bare peat is exposed by human disturbance during the afforestation of the site, e.g. polygon 78 which was ploughed but never afforested, the furrows subsequently failing to recolonise with vegetation.

Areas of bare peat and spoil also surround the existing access track crossing the SAC where previous construction activities have piled waste materials. These areas are recolonising with an assemblage of upland species, however, section of this spoil still remain unvegetated.

Broadleaved Plantation Woodland (PBW)
Within the afforested areas of the site there are a number of small areas in which the coniferous forestry crop has been felled and replaced with planted broadleaved trees including birch species (*Betula spp.*), rowan (*Sorbus aucuparia*), and beech (*Fagus sylvatica*). These trees are currently at the sapling stage and within Appendix 1 Table AA1 are noted by the Phase 1 survey nomenclature as PBW as these areas do not fit sufficiently within the NVC.

Coniferous Woodland Plantation (PCW)
Mature Sitka spruce and lodgepole pine conifer plantation dominates the survey area, with little botanical interest within the understorey of these areas. There has been some felling activity with restocking of the areas being undertaken recently (polygon 9).

3.2.3 Evaluation of Botanical Interests

As can be seen from Table A6, there are numerous communities present within the survey area which have been designated as either an Annex 1 Biotope under the EC Habitats Directive and the Habitats Regulations 1994 (as amended), listed on the Scottish Biodiversity List as important for conservation across Scotland, or listed as a Sutherland LBAP Priority Habitat. Although many of the species within these habitats are not nationally rare, the communities in which they are found are of international or national significance.

Eleven of the NVC communities found within the survey boundary are included on the Scottish Biodiversity List as requiring priority action for conservation. Similarly, a number of habitats present but not able to be categorised using the NVC nomenclature are listed with the Sutherland LBAP.

A number of NVC communities found within all survey boundaries are also listed as groundwater dependent terrestrial ecosystems (GWDTEs) according to SEPA (2012) guidance. Their potential dependence on groundwater influences are categorised in Table A6 below.

TABLE A6 NVC COMMUNITIES, THEIR RELEVANT CONSERVATION DESIGNATIONS AND AREAS OCCUPIED WITHIN THE SURVEY BOUNDARY

NVC Code	NVC Community	Annex 1 Biotope Code	Annex 1 Biotope Name	Scottish Biodiversity List Code	GWDTEs Potential (High/Medium/ None)
H10	*Calluna vulgaris - Erica cinerea* heath.	H4030	European dry heaths	H1, H3	None
H12	*Calluna vulgaris – Vaccinium mrytillus* heath.	H4030	European dry heaths	H1, H3	None
M1	*Sphagnum denticulatum* bog pool community	H7150	Depressions on peat substrates of the Rhynchosporion	H1, H3	None
M2	*Sphagnum cuspidatum/fallax* bog pool community, *Sphagnum fallax* sub-community	H7150	Depressions on peat substrates of the Rhynchosporion	H1, H3	None
M6	*Carex echinata-Sphagnum*	-	-	H1, H3	High

TABLE A6 NVC COMMUNITIES, THEIR RELEVANT CONSERVATION DESIGNATIONS AND AREAS OCCUPIED WITHIN THE SURVEY BOUNDARY					
NVC Code	**NVC Community**	**Annex 1 Biotope Code**	**Annex 1 Biotope Name**	**Scottish Biodiversity List Code**	**GWDTEs Potential (High/Medium/ None)**
	fallax/denticulatum mire				
M15	*Trichophorum germanicum – Erica tetralix* wet heath	H4010 / H7130	Northern Atlantic wet heaths with *Erica tetralix* / Blanket bogs	H1, H3	Medium
M17	*Trichophorum germanicum – Eriophorum vaginatum* blanket mire	H7130	Blanket bogs	H1, H3	None
M18	*Erica tetralix – Sphagnum papillosum* blanket mire	H7130	Blanket bogs	H1, H3	None
M19	*Calluna vulgaris – Eriophorum vaginatum* blanket mire	H7130	Blanket bogs	H1, H3	None
M20	*Eriophorum vaginatum* blanket mire	H7130	Blanket bogs	H1, H3	None
M25	M25 *Molinea caerulea – Potentilla erecta* mire	H7120 / H7130	Degraded raised bog, Blanket bog	H1, H3	Medium
M23	*Juncus effusus/acutiflorus – Galium palustre rush pasture*	-	-	H1, H3	High
U6	*Juncus squarrosus – Festuca ovina* grassland	-	-	H3	None
S4	*Phragmites australis* community	-	-	H1, H3	None

Notes:
1. A number of habitats listed on the Sutherland LBAP are not included within the Scottish Biodiversity list and are present on site. These are Coniferous Plantation Woodland, Rivers and Burns, and Lochs.
2. Area figures relate to the dominant habitat within a polygon.

Figures A10.2.14 and A10.2.15 show that a number of communities, particularly within the wind farm survey area, contain medium potential to be classified as a GWDTE. However, prior to afforestation it is likely that the entire site was a mosaic of blanket mire communities and the

negative effects associated with afforestation has altered the species assemblages remnant within rides and glades to reflect those of wet heath and wet modified bog (M15 *Trichophorum cespitosum – Erica tetralix).*

A number of species of particular interest are present within the survey area. These can be seen within the Target Note Record for the NVC survey in Appendix 2 and marked on Figures A10.2.10 and A10.2.11. These include records of dwarf birch (*Betula nana*) in a number of locations which is listed as Nationally Scarce by the IUCN.

3.2.4 Protected Species Survey Results

Grid Connection

Protected species surveys undertaken for the Strathy North Wind Farm 2007 ES, along with ongoing pre-construction surveys (2012/2013) within the wind farm's boundary have identified the presence of otter, pine marten, badger, wildcat, and water vole.

Within the 200 m survey buffer surrounding the section of proposed grid connection route through Strathy North Forest, the only protected species recorded was that of a badger sett previously identified within the Strathy North 2007 ES. Details of this badger sett are provided in Confidential Annex 1.

Access Routes

Surveys conducted in 2012 found indicative signs of otter, water vole and pine marten within the 200 m survey buffer surrounding the proposed access route. These signs were concentrated along the River Strathy within Strathy Wood. In addition, these surveys found indicative signs of water vole colonies along Allt Dhonuill Ghuinne burn to the west of the access track and north of the preferred crossing of the River Strathy. No further signs of protected species presence were identified within the 200 m survey buffer along the access route between Strathy South and Strathy North.

A summary of all protected species survey results for each proposed route option can be seen in Figures A10.2.10/11. Detailed results for all surveys are listed within Table AA3 within Appendix 3 of this Technical Appendix.

Strathy South Forest

Results from protected species surveys conducted for the Original 2007 Scheme along with the updated 2012 results can be seen in Figures A10.2.12 and A10.2.13. A summary of the findings for all surveys is provided in Table A7 below, with further details recorded in Table AA3 within Appendix 3 of this report.

The main findings from 2007 and 2012 were the continued widespread presence of otter and watervole with signs of these two species being similar across the two survey visits. No potential otter holts were found during the 2012 surveys. Pine marten sign within the forest boundary increased markedly between the two survey visits indicating a potential increase in use of the site by this species. Two potential pine marten den sites were also found in 2012.

No evidence of the presence of red squirrel was found during the course of the protected species surveys despite some areas of suitable habitat being present within the survey boundary. Areas of potentially suitable habitat were noted throughout the survey area for reptiles and amphibians including patches of rock and rush pasture respectively. No evidence of wildcat presence was seen during the surveys; however, their niche requirements are similar to pine marten, thus afforested sections of the survey area offer potential suitable habitat for this species.

No additional bat activity surveys were conducted in 2012 given the lack of suitable roosting sites. However, it was noted that the stone building in the south of the survey area (Lochstrathy) contained the potential to be used as a bat roost. No significant bat signs such as staining or droppings were noted, but the slate roof contained suitable access points for the species.

TABLE A7 SUMMARY OF 2007 AND 2012/13 PROTECTED SPECIES SURVEY RESULTS			
Species	**Indicative Sign**	**Count of sign found across the survey area per year**	
		2007	**2012/13**
Otter	Feeding signs	0	2
	Sprainting	41	50
	Prints		1
	Slides		2
	Holts	2	0
	Sightings	1	0
Pine marten	Den	0	2
	Scats	3	42
	Sightings	0	1
Water vole	Droppings	25	7
	Burrows		15
	Sightings	1	0

Notes: 2007 otter surveys did not differentiate between spraints and print signs. Likewise, water vole presence of droppings and burrows were not differentiated In 2007.

4 SUMMARY

The NVC survey results (Figures A10.2.6 – A10.2.9) indicate the Strathy South wind farm site consists of areas dominated by coniferous plantation forestry, interspersed with rides containing a mixture of mire and heath communities. Open glades within afforested areas tend to be dominated by mire and wet heath communities in particular M15, M17, and M25. Glade areas often contain deep peat and high water tables, thus scattered bog pools and areas of open water are also frequently present. The non-forested areas within the survey buffer surrounding Strathy South Forest, the track crossing Yellow Bog, and the access track running from Strathy South to Strathy Wood, are dominated by areas of M17 mire. This indicates that prior to the afforestation of Strathy North and South the entire area is likely to have been a mixture of mire and wet heath communities dependent on the local topography. Within Strathy North and Strathy Wood Forests there exists a similarly assemblage of communities within the ride and glade systems as found in Strathy South Forest, with these habitats and communities having also been affected by the afforestation of the areas.

Many of the communities present throughout the site are listed as either Annex 1 Biotopes under the EU Habitats Directive or on the Scottish Biodiversity List as a priority habitat for conservation within Scotland. These include the heath communities H10 and H12, and the mire communities M1, M2, M6, M15, M17, M18, M19, and M20. Although these habitats are listed under both EU and UK legislation, the quality of the habitats present within the survey area must be taken into account when assessing any potential effect the development might have upon these. No quantitative data was collected in relation to habitat quality during the surveys; however, surveyors noted that many habitats within the survey area were atypical from those listed within the literature, having been adversely affected primarily through drainage associated with afforestation.

Protected species surveys conducted within the site boundary and associated survey buffers, found evidence of water vole within acidic flush areas of rides and surrounding watercourses. Water vole evidence includes both droppings and burrows. The protected species surveys similarly found evidence of wide spread utilisation of the area by otters. Evidence of otter was recorded in the form of spraints along watercourses, along with associated feeding signs, prints and slide marks. Holts previously identified during surveys undertaken for the 2007 ES were checked in 2012. No sign of these holts was found in 2012 and no additional holts or couches were identified during these surveys.

Evidence of pine marten utilisation is present across the wind farm site. Scats from the species were found along rides and tracks, along with two potential dens being identified in the north-west of survey area. An individual was also seen at the eastern end of the track crossing Yellow Bog, further confirming the wide-scale use of the area by the species. No evidence of pine marten presence was found along the proposed access route or grid connection. However, sightings of pine marten and their signs within Strathy North Forest indicate their widespread presence within Strathy North Forest.

No evidence of wildcat was found within the survey area, however, the species are notoriously cryptic and do have similar niche requirements to pine marten; consequently their presence within the site can not be ruled out despite the current lack of survey evidence.

No evidence of the presence red squirrel was found during the surveys. The poor quality of the coniferous crop, and the lack of broadleaved trees, means that the habitat would be unsuitable for supporting a population of red squirrel, especially given the isolated nature of the site from other potential food sources.

During pre-construction surveys of the Strathy North wind farm development area in 2013, a badger sett, also identified during the Strathy North 2007 ES surveys, was found within Strathy North Forest. This sett has the potential to still be active and falls within the 200 m protected species survey buffer for the grid connection. Other drier areas within the survey area offer little potential for badger setts given the rocky nature of the substrate.

Bat surveys conducted for the Strathy South 2007 ES concluded there was limited potential for bat roosts within and adjacent to Strathy South Forest. The only structure with potential for bat roosts was a stone building present at Lochstrathy in the south of the survey area. However, ground level inspection of this building in 2012 found no indicative signs of use by bats. No additional surveys were undertaken for bats given the lack of potential roosts, as agreed with SNH.

5 REFERENCES

Bang, P & Dahlstrøm, P (2001). Animal Tracks and Signs. Oxford University Press, Oxford.

Forestry Commission Scotland (2009) Forestry Operations and Wildcats in Scotland. FCS Guidance Note 35d. Forestry Commission Edinburgh.

Gent, T. and Gibson, S. (Eds.), (2003). Herpetofauna Worker's Manual. Joint Nature Conservation Committee.

Harris, S., Yalden D.W. (2008) Mammals of the British Isles Handbook. 4th edition, The Mammal Society.

Joint Nature Conservancy Council (2010) Handbook for Phase 1 habitat survey - a technique for environmental audit. JNCC.

Kitchener, A. (1995) The Wildcat. Mammal Society Publications. London.

Neal, E. & Cheeseman, C. (1996). Badgers. Poyser Natural History, London.

Purvis, O.W., Coppins, B.J., Hawksworth, D.L., James, P.W. & Moore, D.M. (1992). The Lichen Flora of Great Britain and Ireland. The British Museum (Natural History).

Rodwell, J.S. (Ed.) (1991 et seq.). British Plant Communities. 5 volumes: Vol. 1 (1991) - Woodlands and Scrub; Vol. 2 (1991) - Mires and Heaths; Vol. 3 (1992) - Grasslands and montane communities; Vol. 4 (1995) - Aquatic communities, swamps and tall-herb fens; Vol. 5 (2000) - Maritime Cliffs, Sand Dunes, Saltmarshes and Other Vegetation. Cambridge University Press, Cambridge.

Rodwell, J.S (2006). National Vegetation Classification: Users' Handbook. Joint Nature Conservation Committee, Peterborough.

Rodwell, J.S., Dring, J.C., Averis, A.B.G., Proctor, M.C.F., Malloch, A.J.C., Schaminée, J.N.J., & Dargie T.C.D. (2000). Review of coverage of the National Vegetation Classification. JNCC Report No. 302. Peterborough: Joint Nature Conservation Committee.

RPS (2013) Strath Halladale to Dallangwell 132kV Connection (Section 37 Application submitted May 2013).

Scottish Natural Heritage (2001). Scotland's Wildlife: Badgers and Development.

Stace, C.A. (2010). New Flora of the British Isles. 3rd Edition. Cambridge University Press.

Strachan, R and Moorhouse, T. (2010). Water Vole Conservation Handbook, Third Edition. The Wildlife Conservation Research Unit.

File Path & Name: P:\CONTRACT\UK171xx\UK12_17181 SSE Strathy South ES Addendum\Report\ES Addendum\Volume 4_Technical Appendix\TA Chapter 10_Ecology\TA A10.2\UK12-17181_3_TA A10 2 - Habitats and Protected Spp.doc
rpsgroup.com

FIGURES

Figure A10.2.1 – Designated Sites
Figure A10.2.2. – Phase 1 Survey Results Overview, Access and Cable Route
Figure A10.2.3 – Phase 1 Survey Results, Access and Cable Route
Figure A10.2.4 – Phase 1 Survey Results Overview, Wind Farm Site
Figure A10.2.5 – Phase 1 Survey Results, Wind Farm Site
Figure A10.2.6 – NVC Survey Results Overview, Access and Cable Route
Figure A10.2.7 – NVC Survey Results, Access and Cable Route
Figure A10.2.8 – NVC Survey Results Overview, Wind Farm Site
Figure A10.2.9 – NVC Survey Results, Wind Farm Site
Figure A10.2.10 – Protected Species Survey Results Overview, Access and Cable Route
Figure A10.2.11 – Protected Species Survey Results, Access and Cable Route
Figure A10.2.12 – Protected Species Survey Results Overview, Wind Farm Site
Figure A10.2.13 – Protected Species Survey Results, Wind Farm Site
Figure A10.2.14 – Groundwater Dependant Terrestrial Ecosystems, Access and Cable Route
Figure A10.2.15 – Groundwater Dependant Terrestrial Ecosystems, Wind Farm Site

APPENDIX 1 – NVC POLYGON COMMUNITY COMPOSITIONS

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
1	M15b	80	AG1	10	H10 a	10	MG10a	1	track																	
2	M17b	80	M6c	20																						
3	M17b	95	M17a	5																						
4	M17b	90	M17a	1	M15 b	5	H10b	1	M2	1																
5	M17b	50	M15b	30	M6c	10	U2	5	H10b	1	M25	1	U2 0													
6	M17b	90	H10b	5	track	5																				
7	M17b	85	M17a	1	M19 a	1	M18 a	1	OW	5	M25	5	H1 0	1												
8	M17b	90	H10a	10	PBW	1																				
9	PCW	90	M17b	10																						
10	M17b	80	M1	1	M18 a	10	M2	1	OW	5	MS	1														
11	M17b	30	AG1	5	M25	10	H10	1	M15b	20	M19	30	tra	5												

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
											a		ck													
12	M17b	100																								
13	M18a	60	M15b	10	OW	30	M2	1	M6c	1	M20 a	5														
14	M15b	85	M25	10	track	5	H10	5																		
15	M17b	100																								
16	M17a	50	M17b	40	M17 a	5	OW	5	M1	1	M2	1	M2 5	1												
17	M25	90	M17a	5	M19 a	1	H12b	5	M17b	5																
18	OW	99	Je	1																						
19	M17a	90	OW	2	M18 a	5	MS	1	M2	1	M25	1														
20	OW	100																								
21	M17a	45	M15b	35	M18 a	15	H10b	1	M17b	5																
22	M17b	100																								
23	M17b	90	M18a	5	M2	1	OW	5	M1	1	MS	1														

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
24	M17b	30	M6c	20	M19 a	20	M25 b	30	U20c	1																
25	M17a	60	M25b	1	M6c	1	M19 a	10	M15b	10	AG 1	10	M2 5a	10												
26	trees	70	M25a	30																						
27	M15b	70	M25b	20	track	1	M2	1	M25a	10																
28	track	10	M15b	60	M25 b	30																				
29	M17b	60	M17a	30	M15 b	10	M2	1	M1	1	M18 a	1	MS	1												
30	M17b	50	M18a	10	M17 a	35	M2	1	M1	1	OW	1	MS	1	M19 b	1										
31	M17b	80	M25a	3	RW	1	M23 b	1	M19b	5	M15 b	10														
32	M25a	40	M23b	30	RW	1	M15 b	10	M17b	20																
33	M17b	95	M2	1	M17 a	5	M25 a	5																		
34	M25a	50	M17b	20	MG9	10	M23 b	10	RW	1	M6c	10														

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
35	M17b	60	M18a	20	M2	10	M1	5	OW	1	MS	1														
36	M15b	80	M19a	10	M17a	10																				
37	M17a	50	M15b	50	M6c	1																				
38	M17b	60	M25a	10	M6c	10	M23b	10	AG1	5	RW	1	M2	1	M18a	1	S9	1	MS	1	M1	1	MG9	1		
39	M17b	70	AG1	1	M6c	5	M23b	10	M2	1	M6b	1	RW	1	MS	1	H12b	10	M25a	5						
40	M17b	90	M2	1	M25a	5	M6c	2	RW	1	M23b	2	AG1	1												
41	M17b	70	M17a	25	M15b	5	M2	1	M25a	2																
42	M17b	80	M17a	20	M2	1																				
43	M15b	90	M17b	10	M2	1																				
44	M19a	50	M20a	10	M17a	20	M17b	20																		
45	M17a	90	M18a	2	M1	1	M2	1	M17b	10	MS	1														

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
46	M17b	55	M20a	25	M18a	10	M2	1	M1	5	MS	1	OW	5	M15a	1										
47	OW	50	M18a	5	M2	20	M17b	20	M6c	1																
48	M17b	50	M15a	40	M25a	10	M2	1																		
49	M15a	70	M17b	20	H10b	10																				
50	M17b	50	OW	10	MS	10	M18a	10	M2	10	M1	5	M17a	5	S9b	1										
51	M17b	70	M17a	30	M2	1	M15a	1	H12	1																
52	M20a	40	M25a	20	M6c	30	M19a	1	S9a	1	M29	1	M2	1	M17b	10										
53	M17b	70	M25a	10	H10c	5	M6c	5	M23b	10																
54	M15b	45	M25b	40	track	10	AG1	5																		
55	M17b	70	M20a	1	M2	1	M6c	1	M17a	10	M18a	20														
56	M17b	60	M23b	10	M15b	20	RW	1	M25a	10																

File Path & Name: P:\CONTRACT\UK171xx\UK12_17181 SSE Strathy South ES Addendum\Report\ES Addendum\Volume 4_Technical Appendix\TA Chapter 10_Ecology\TA A10.2\UK12-17181_3_TA A10 2 - Habitats and Protected Spp.doc

3

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
57	M17b	80	M23b	10	M25a	10																				
58	M15c	94	M2	1	M17b	5	M18a	1																		
59	M15c	80	H10b	20	rock exposure	1	M25a	1																		
60	M17a	47	M17b	50	M18a	1	M2	1	M25a	1																
61	M25a	95	M23b	1	M17c	5																				
62	M17b	80	M25b	5	M23b	5	AG1	1	RW	1	M2	1	M6c	1	M18a	1	M20a	1	M25a	1						
63	M17b	80	M25b	5	M23b	5	M19a	1	RW	1	M2	1	M6c	1	M15b	1	M15c	5								
64	M25a	40	M25b	20	M15b	30	M6c	10	RW	1	M17a	5														
65	M15b	75	M25a	20	H10b	5	rock exposure	1																		

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
66	M15b	80	M6c	5	M17a	10	M2	1																		
67	M25b	30	M15c	40	M17b	30																				
68	M17b	33	U4d	20	M25b	20	M23b	20	RW	5	M2	1	U20a	1	M15c	2										
69	M25b	40	M15b	10	M15c	50																				
70	M15	60	M6c	10	M25a	10	M25b	10	M19a	10																
71	M25b	50	M6c	5	M25a	20	M15	20																		
72	M15a	30	M17b	30	M19a	5	U20	1	M25b	10	M23b	10	RW	1	H10b	1	U4b	10	M25a	1	M6c	1				
73	M17b	50	M25b	20	M25a	1	M6c	1	U4b	5	AG1	1	M23b	10	M19	2	M18a	1	M2	1	M15b	5	M20a	1	U20	5
74	M17a	60	M15b	30	M15c	5	M2	5	MS	1																
75	M17a	65	M15b	35																						

File Path & Name: P:\CONTRACT\UK171xx\UK12_17181 SSE Strathy South ES Addendum\Report\ES Addendum\Volume 4_Technical Appendix\TA Chapter 10_Ecology\TA A10.2\UK12-17181_3_TA A10 2 - Habitats and Protected Spp.doc

3

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
76	M17a	80	M6c	15	M25 a	5																				
77	M17b	95	M17a	5	M2	1																				
	M17b	60	M25a	30	M15 b	10	M2	1																		
78	M19a	90	M17b	10	M25 a	1																				
79	M17b	80	M17a	10	MS	5	M1	1	M2	1	Bar e Pea t	1	M1 8a	1												
80	M17b	50	M25b	30	M17 a	10	M25 a	10																		
81	M17a	70	M17b	20	M19 a	5	M25 a	5	M1	1	MS	1														
83	M17b	90	M17a	5	M18 a	1	M1	1	M2	1																
84	M19a	50	M20a	30	M17 a	15	M25 a	5																		
85	S9b	80	M6c	20																						

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
86	M15b	100																								
87	M17a	95	MS	5	M1	1																				
88	M17b	35	M19a	20	M17 a	15	M25 a	15	H10a	10	M20 a	5	M6 c	5												
89	M17b	85	M19a	10	MS	5	M1	1																		
90	M15b	80	M17b	15	M17 a	5																				
91	M17a	70	M17b	20	MS	5	M1	5																		
92	M17b	80	MS	10	M1	5	Bare peat	5	OW	1																
93	M15b	80	M19a	5	M17 b	10	M17 a	5	M6c	1	M23 a	1														
94	M15b	85	M25a	10	M6c	5	M20	1																		
95	Je	70	U4b	30																						
96	M25a	40	M19a	40	H10 b	15	M6c	5																		
97	M17b	100																								
98	M15b	60	M19a	20	M25	10	M6c	10																		

File Path & Name: P:\CONTRACT\UK171xx\UK12_17181 SSE Strathy South ES Addendum\Report\ES Addendum\Volume 4_Technical Appendix\TA Chapter 10_Ecology\TA A10.2\UK12-17181_3_TA A10 2 - Habitats and Protected Spp.doc

3

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
					a																					
99	M17a	100																								
100	M25a	100																								
101	M17a	100																								
102	M25a	95	M19a	5																						
103	M25b	65	H10b	30	M23 b	5																				
104	M17b	90	M17a	10																						
105	M17b	75	M17a	10	M19 a	10	M25 a	5																		
106	M17a	90	MS	10	M1	1	Bare peat	1																		
107	M25a	80	M20a	10	M19 a	5	M17 a	5	M6c	1																
108	M17a	50	M15b	20	M25 a	15	M20	10	U6d	5																
109	H10b	70	bare rock	30																						

TABLE AA1 BREAKDOWN OF NVC COMMUNITY COMPOSTIONS FOR SURVEY POLYGONS ACROSS THE SITE

Polygon ID	Dominant Community	Dominant Community %	Community 2	Community 2 %	Community 3	Community 3 %	Community 4	Community 4 %	Community 5	Community 5 %	Community 6	Community 6 %	Community 7	Community 7 %	Community 8	Community 8 %	Community 9	Community 9 %	Community 10	Community 10 %	Community 11	Community 11 %	Community 12	Community 12 %	Community 13	Community 13 %
110	M17a	80	MS	10	M17 b	5	M1	5	Bare peat	1	M2	1														
111	M17a	85	MS	5	M2	5	M17 b	5																		
112	M23a	60	M17b	20	M25 a	15	H10b	5	AG1	1	M6c	1														
113	M17b	60	M17a	30	Bare peat	10																				
114	M15b	40	MS	30	M17 b	15	M17 a	15	M2	1																

Notes: This data is taken from the raw data provided by the field surveyors. In some instances cover may add to slightly more or less than 100%. This is due to the figures all being approximately rather than exact and thus not a precise measure of the quantity of the communities present across the site. Figures are thought to give a representative assessment of relative abundances of communities within the survey boundary.

File Path & Name: P:\CONTRACT\UK171xx\UK12_17181 SSE Strathy South ES Addendum\Report\ES Addendum\Volume 4_Technical Appendix\TA Chapter 10_Ecology\TA A10.2\UK12-17181_3_TA A10 2 - Habitats and Protected Spp.doc

3

APPENDIX 2 – NVC SURVEY TARGET NOTE RECORD

TABLE AA2 AREAS OF NOTABLE INTEREST WITHIN THE SURVEY BOUNDARY AND THEIR ASSOCIATED TARGET NOTE NUMBER

Target Note Number*	Grid Reference	Note
1	NC 773523	A bog pool containing *Carex diocia* and *Eleocharis multicaulis* which is rare within bog pool habitats present at this location.
2	NC 793535	*Betula nana* found at this location within an M18a community.
4	NC 802519	A pine marten seen crossing the road at this location.
7	NC 794521	A pine marten seen at this location.
8	NC 799511	S9 /S4 ferruginous spring present.
9	-	*Betula nana* common in wetter parts of bog between Yellowbog Burn and River Strathy and present into the periphery of the buffer zone
9	-	*Betula nana* common in wetter parts of bog between Yellowbog Burn and River Strathy and present into the periphery of the buffer zone
9	-	*Betula nana* common in wetter parts of bog between Yellowbog Burn and River Strathy and present into the periphery of the buffer zone

Notes

* target notes unrelated to habitats and protected species are not presented.

APPENDIX 3 – DETAILED PROTECTED SPECIES SURVEY RESULTS

TABLE AA3 DETAILED PROTECTED SPECIES SURVEY RESULTS FOR 2007 AND 2012

Survey Year	Species	Field Sign	Easting	Northing
2007	Otter	Holt	279340	952281
2007	Otter	Holt	280322	953149
2007	Otter	Live animal	281893	953992
2007	Otter	Spraints and footprints	276800	952498
2007	Otter	Spraints and footprints	276747	952888
2007	Otter	Spraints and footprints	276704	952915
2007	Otter	Spraints and footprints	276651	953080
2007	Otter	Spraints and footprints	276677	953097
2007	Otter	Spraints and footprints	276760	953196
2007	Otter	Spraints and footprints	276889	953341
2007	Otter	Spraints and footprints	277001	953206
2007	Otter	Spraints and footprints	277160	953097
2007	Otter	Spraints and footprints	277163	953027
2007	Otter	Spraints and footprints	277173	952948
2007	Otter	Spraints and footprints	277170	952845
2007	Otter	Spraints and footprints	277223	952667
2007	Otter	Spraints and footprints	277107	952485
2007	Otter	Spraints and footprints	277421	953189
2007	Otter	Spraints and footprints	279612	956300
2007	Otter	Spraints and footprints	277636	950783
2007	Otter	Spraints and footprints	277167	949712
2007	Otter	Spraints and footprints	279288	948779
2007	Otter	Spraints and footprints	279301	948795
2007	Otter	Spraints and footprints	279374	948848
2007	Otter	Spraints and footprints	279414	948848
2007	Otter	Spraints and footprints	279629	949695
2007	Otter	Spraints and footprints	279350	952487
2007	Otter	Spraints and footprints	279358	952440
2007	Otter	Spraints and footprints	279342	952225
2007	Otter	Spraints and footprints	279187	951999
2007	Otter	Spraints and footprints	280206	952232
2007	Otter	Spraints and footprints	280169	952203
2007	Otter	Spraints and footprints	280252	951998
2007	Otter	Spraints and footprints	280206	952071
2007	Otter	Spraints and footprints	280145	951827
2007	Otter	Spraints and footprints	280162	951875
2007	Otter	Spraints and footprints	280143	951929
2007	Otter	Spraints and footprints	280155	952003
2007	Otter	Spraints and footprints	280174	952039
2007	Otter	Spraints and footprints	280525	951675
2007	Otter	Spraints and footprints	280629	951678
2007	Otter	Spraints and footprints	280688	951512
2007	Otter	Spraints and footprints	280762	951434
2007	Otter	Spraints and footprints	280403	952927
2007	Pine marten	Scats	279679	949137
2007	Pine marten	Scats	280188	952000
2007	Pine marten	Scats	277350	952747
2007	Water Vole	Live animal	281026	951413

TABLE AA3 DETAILED PROTECTED SPECIES SURVEY RESULTS FOR 2007 AND 2012

Survey Year	Species	Field Sign	Easting	Northing
2007	Water Vole	Signs	277186	953102
2007	Water Vole	Signs	277394	953198
2007	Water Vole	Signs	277490	953142
2007	Water Vole	Signs	277504	953119
2007	Water Vole	Signs	277212	952828
2007	Water Vole	Signs	277193	952474
2007	Water Vole	Signs	277206	952504
2007	Water Vole	Signs	277503	955779
2007	Water Vole	Signs	279545	955620
2007	Water Vole	Signs	279538	955563
2007	Water Vole	Signs	279538	955511
2007	Water Vole	Signs	279724	953258
2007	Water Vole	Signs	279694	953060
2007	Water Vole	Signs	280329	953381
2007	Water Vole	Signs	280329	953242
2007	Water Vole	Signs	280379	953186
2007	Water Vole	Signs	280432	953043
2007	Water Vole	Signs	280409	952987
2007	Water Vole	Signs	280199	952141
2007	Water Vole	Signs	280194	952133
2007	Water Vole	Signs	279312	952177
2007	Water Vole	Signs	279232	952054
2007	Water Vole	Signs	280971	951281
2007	Water Vole	Signs	280994	951222
2007	Water Vole	Signs	279714	949096
2012	Otter	feeding signs	276954	953436
2012	Otter	feeding signs	277182	953002
2012	Otter	print	279148	950992
2012	Otter	slide	277192	952878
2012	Otter	slide	278041	950098
2012	Otter	spraint	277000	954033
2012	Otter	spraint	277150	953567
2012	Otter	spraint	276827	953348
2012	Otter	spraint	276788	953257
2012	Otter	spraint	277019	953296
2012	Otter	spraint	277032	953182
2012	Otter	spraint	277186	953041
2012	Otter	spraint	277202	953025
2012	Otter	spraint	277179	952973
2012	Otter	spraint	277313	952770
2012	Otter	spraint	277395	953015
2012	Otter	spraint	277790	953407
2012	Otter	spraint	276595	952209
2012	Otter	spraint	278113	953857
2012	Otter	spraint	278612	952428
2012	Otter	spraint	279464	954422
2012	Otter	spraint	279379	954366
2012	Otter	spraint	279461	953958
2012	Otter	spraint	279422	953870
2012	Otter	spraint	279451	952793
2012	Otter	spraint	279438	952669
2012	Otter	spraint	280410	952891

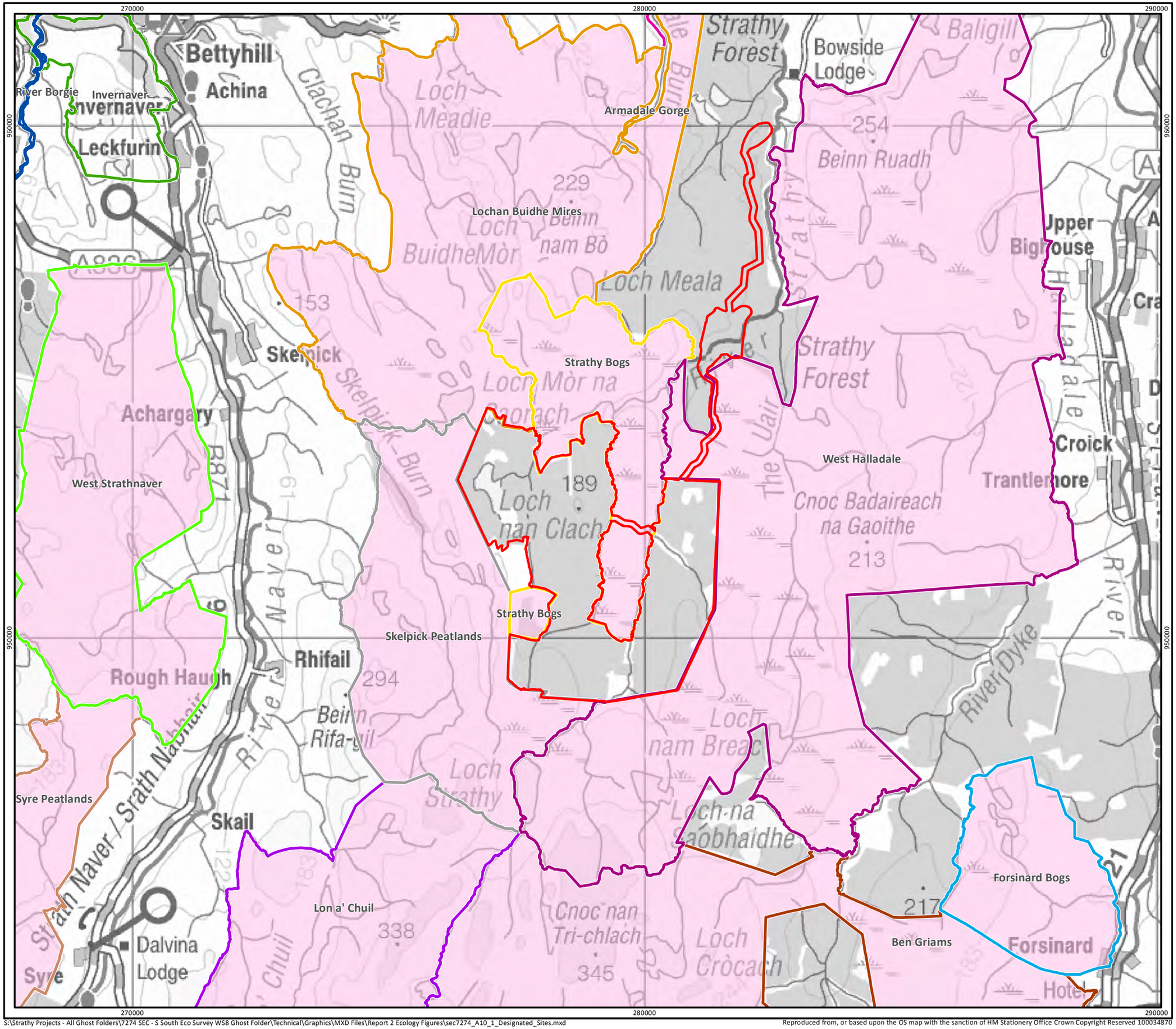
TABLE AA3 DETAILED PROTECTED SPECIES SURVEY RESULTS FOR 2007 AND 2012

Survey Year	Species	Field Sign	Easting	Northing
2012	Otter	spraint	280430	952969
2012	Otter	spraint	280437	953031
2012	Otter	spraint	280437	953077
2012	Otter	spraint	280404	953119
2012	Otter	spraint	280835	952777
2012	Otter	spraint	280913	952924
2012	Otter	spraint	281089	952894
2012	Otter	spraint	280172	952000
2012	Otter	spraint	280153	951961
2012	Otter	spraint	280538	951677
2012	Otter	spraint	280890	951347
2012	Otter	spraint	281027	951445
2012	Otter	spraint	279277	952144
2012	Otter	spraint	277736	952008
2012	Otter	spraint	279094	951507
2012	Otter	spraint	279321	950894
2012	Otter	spraint	277905	950701
2012	Otter	spraint	277875	950650
2012	Otter	spraint	277926	950599
2012	Otter	spraint	277099	949766
2012	Otter	spraint	277099	949455
2012	Otter	spraint	279107	948744
2012	Otter	spraint	279173	948736
2012	Otter	spraint	279670	949203
2012	Otter	spraint	279040	949477
2012	Otter	spraint	279133	949592
2012	Otter	spraint	279173	949655
2012	Otter	spraint	279740	949907
2012	Pine marten	den	277950	953122
2012	Pine marten	den	277754	953709
2012	Pine marten	scat	276872	954239
2012	Pine marten	scat	277205	953495
2012	Pine marten	scat	277440	953015
2012	Pine marten	scat	277251	952715
2012	Pine marten	scat	277323	952718
2012	Pine marten	scat	277506	952607
2012	Pine marten	scat	277104	952173
2012	Pine marten	scat	278814	953524
2012	Pine marten	scat	278841	952904
2012	Pine marten	scat	280832	952816
2012	Pine marten	scat	281220	952829
2012	Pine marten	scat	281341	952826
2012	Pine marten	scat	280234	952153
2012	Pine marten	scat	280234	952065
2012	Pine marten	scat	280339	951889
2012	Pine marten	scat	280907	951390
2012	Pine marten	scat	281171	950900
2012	Pine marten	scat	281220	950551
2012	Pine marten	scat	281207	950495
2012	Pine marten	scat	281324	950286
2012	Pine marten	scat	277685	951656
2012	Pine marten	scat	277215	949980

File Path & Name: P:\CONTRACT\UK171xx\UK12_17181 SSE Strathy South ES Addendum\Report\ES Addendum\Volume 4_Technical Appendix\TA Chapter 10_Ecology\TA A10.2\UK12-17181_3_TA A10 2 - Habitats and Protected Spp.doc
rpsgroup.com

TABLE AA3 DETAILED PROTECTED SPECIES SURVEY RESULTS FOR 2007 AND 2012

Survey Year	Species	Field Sign	Easting	Northing
2012	Pine marten	scat	277225	949939
2012	Pine marten	scat	279121	950945
2012	Pine marten	scat	278952	950102
2012	Pine marten	scat	277303	949040
2012	Pine marten	scat	277710	949222
2012	Pine marten	scat	278014	950081
2012	Pine marten	scat	278914	949274
2012	Pine marten	scat	278348	953114
2012	Pine marten	scat	278613	952950
2012	Pine marten	scat	277459	953177
2012	Pine marten	scat	277449	953316
2012	Pine marten	scat	277430	753385
2012	Pine marten	scat	277363	953591
2012	Pine marten	scat	277363	953591
2012	Pine marten	scat	277363	953591
2012	Pine marten	scat	277345	953633
2012	Pine marten	scat	277660	953609
2012	Pine marten	scat	277682	953598
2012	Pine marten	scat	277310	953731
2012	Pine marten	scat	277425	952853
2012	Pine marten	sighting	280168	950037
2012	Water vole	burrow	277186	953087
2012	Water vole	burrow	277728	953025
2012	Water vole	burrow	277525	952313
2012	Water vole	burrow	279262	953609
2012	Water vole	burrow	279304	953348
2012	Water vole	burrow	279386	953048
2012	Water vole	burrow	277709	952052
2012	Water vole	burrow	277723	951981
2012	Water vole	burrow	277719	951927
2012	Water vole	burrow	279196	951954
2012	Water vole	burrow	279074	951646
2012	Water vole	burrow	279087	951554
2012	Water vole	burrow	279158	950955
2012	Water vole	burrow	277955	950000
2012	Water vole	burrow	277688	949074
2012	Water vole	droppings	277026	953266
2012	Water vole	droppings	277747	952999
2012	Water vole	droppings	279271	953573
2012	Water vole	droppings	279324	953322
2012	Water vole	droppings	279395	953018
2012	Water vole	droppings	279118	951544
2012	Water vole	droppings	279070	951700



SSE Renewables

RPS

Key

- Site Boundary
- Caithness and Sutherland Peatlands SPA and SAC

Site of Special Scientific Interest

- Armadale Gorge
- Ben Griams
- Forsinard Bogs
- Invernaver
- Lochan Buidhe Mires SSSI
- Lon a' Chuil
- River Borgie
- Skelpick Peatlands
- Strathy Bogs
- Syre Peatlands
- West Halladale SSSI
- West Strathnaver

Scale 1:70,000 @ A3

0 0.5 1 2 km

N

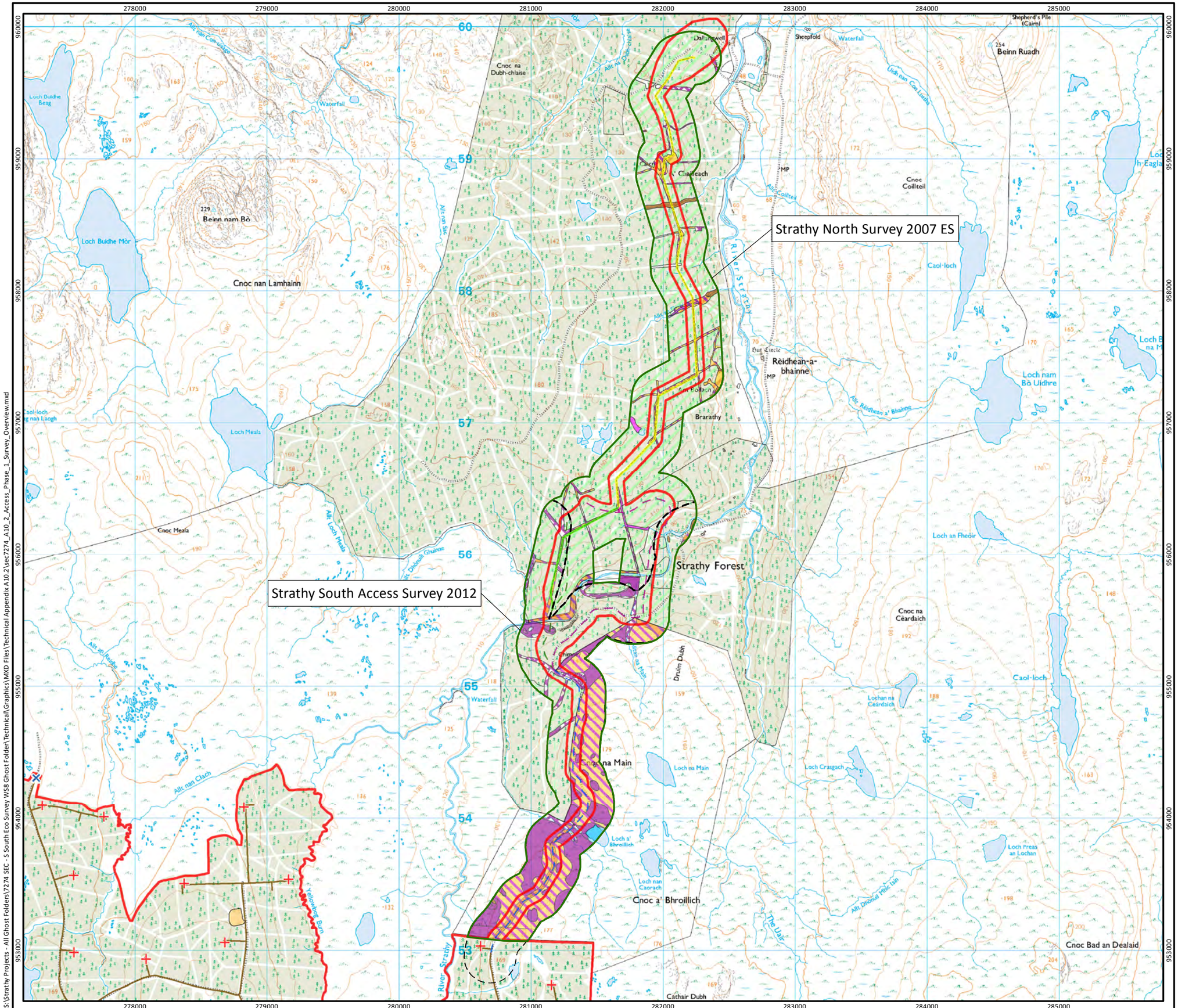
Figure A10.2.1

Designated Sites

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Report 2 Ecology Figures\sec7274_A10_1_Designated_Sites.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_2_Access_Phase_1_Survey_Overview.mxd

SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Borrow Pit
- Survey Area (200m from Access and Cable Routes)

Phase 1 habitats

- Coniferous woodland plantation
- Broadleaved woodland-recently felled
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Dry heath/acid grassland
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water

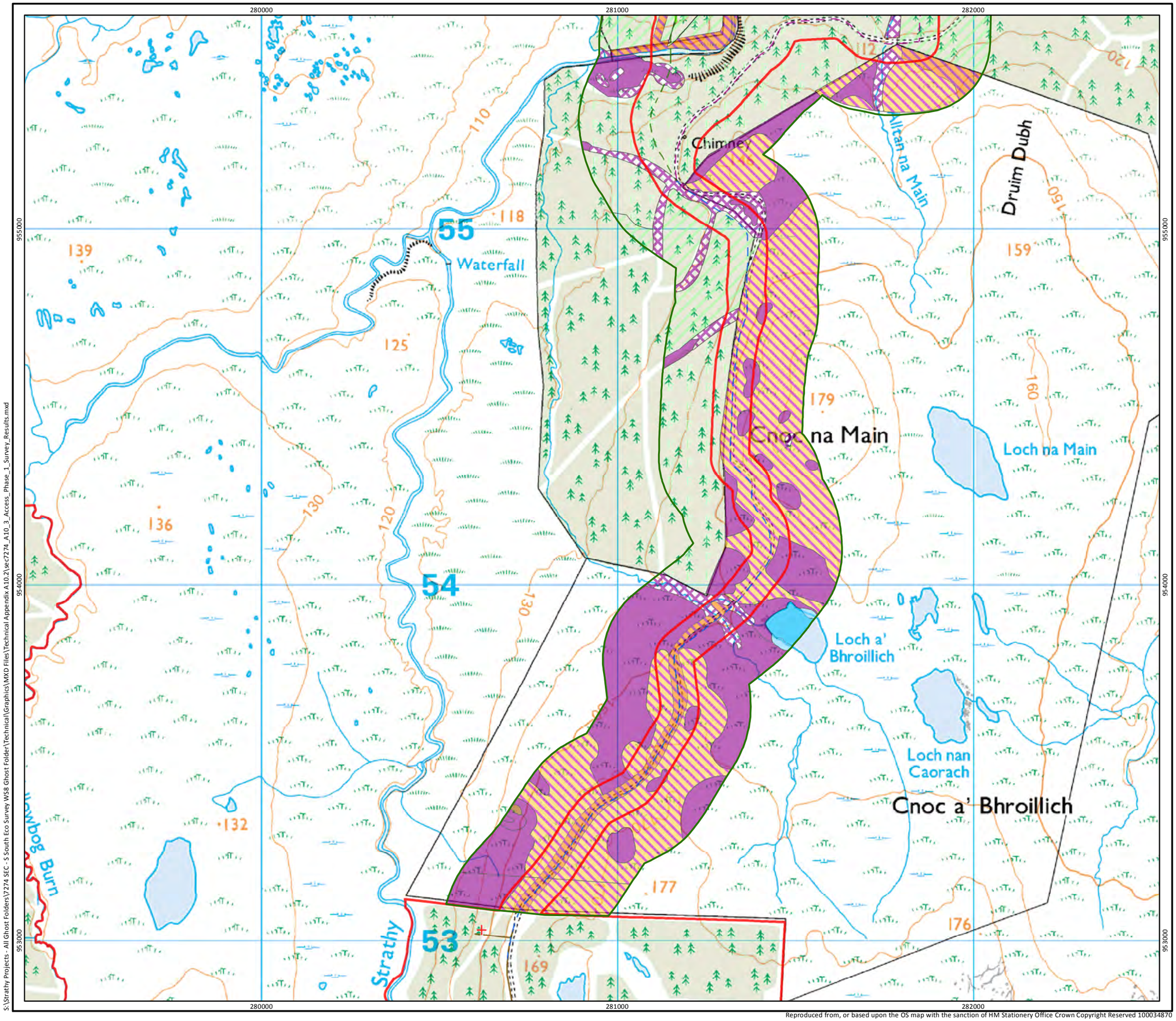
N

Scale 1:27,000 @ A3

0 0.25 0.5 1 km

Figure A10.2.2
Phase 1 Survey Results Overview
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2



SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Phase 1 habitats

- Coniferous woodland plantation
- Broadleaved woodland-recently felled
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Dry heath/acid grassland
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water

N

Scale 1:10,000 @ A3

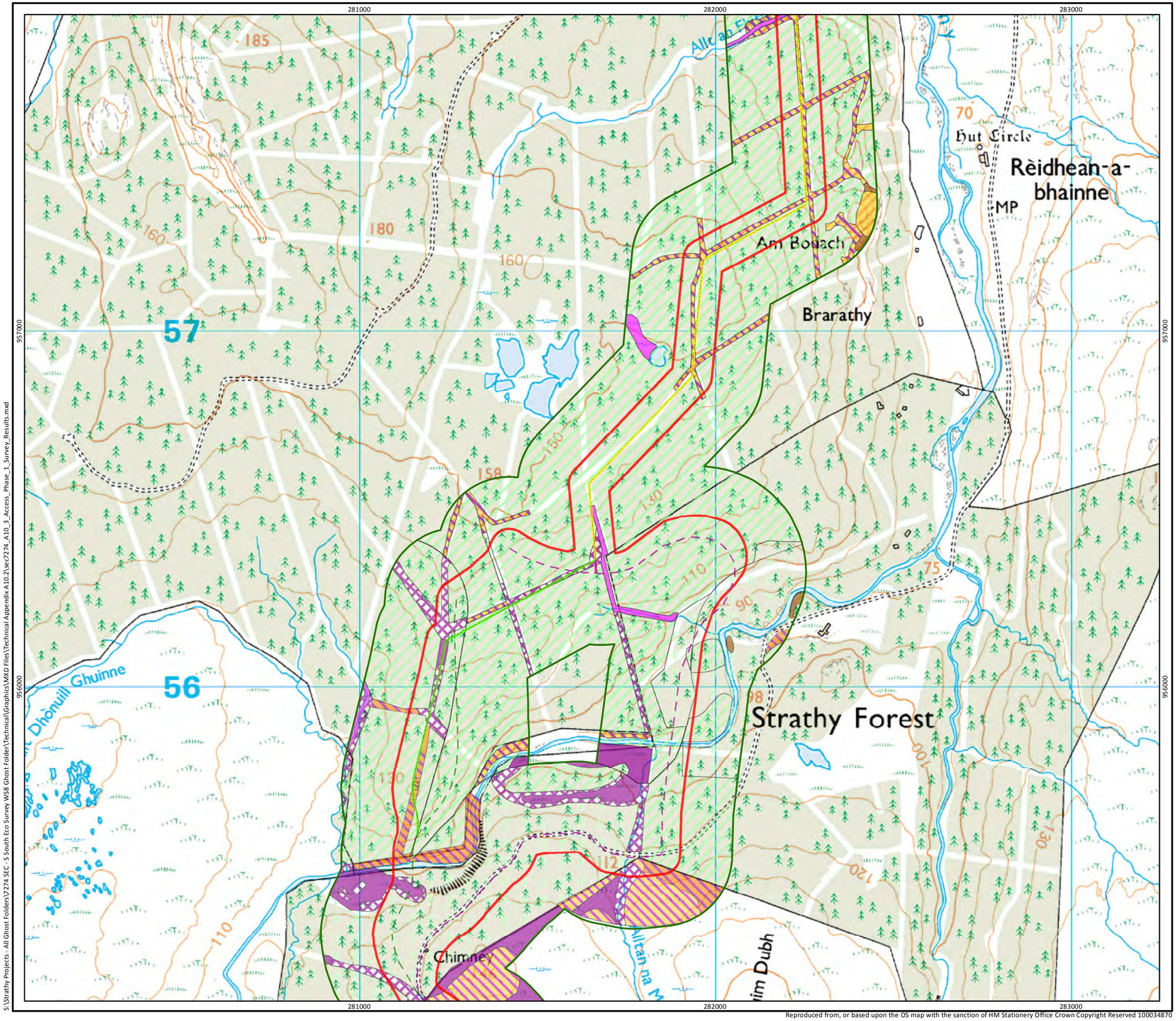
0 125 250 500 m

Figure A10.2.3a
Phase 1 Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\Y2774 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_3_Access_Phase_1_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Phase 1 habitats

- Coniferous woodland plantation
- Broadleaved woodland-recently felled
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Dry heath/acid grassland
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water

N

Scale 1:10,000 @ A3

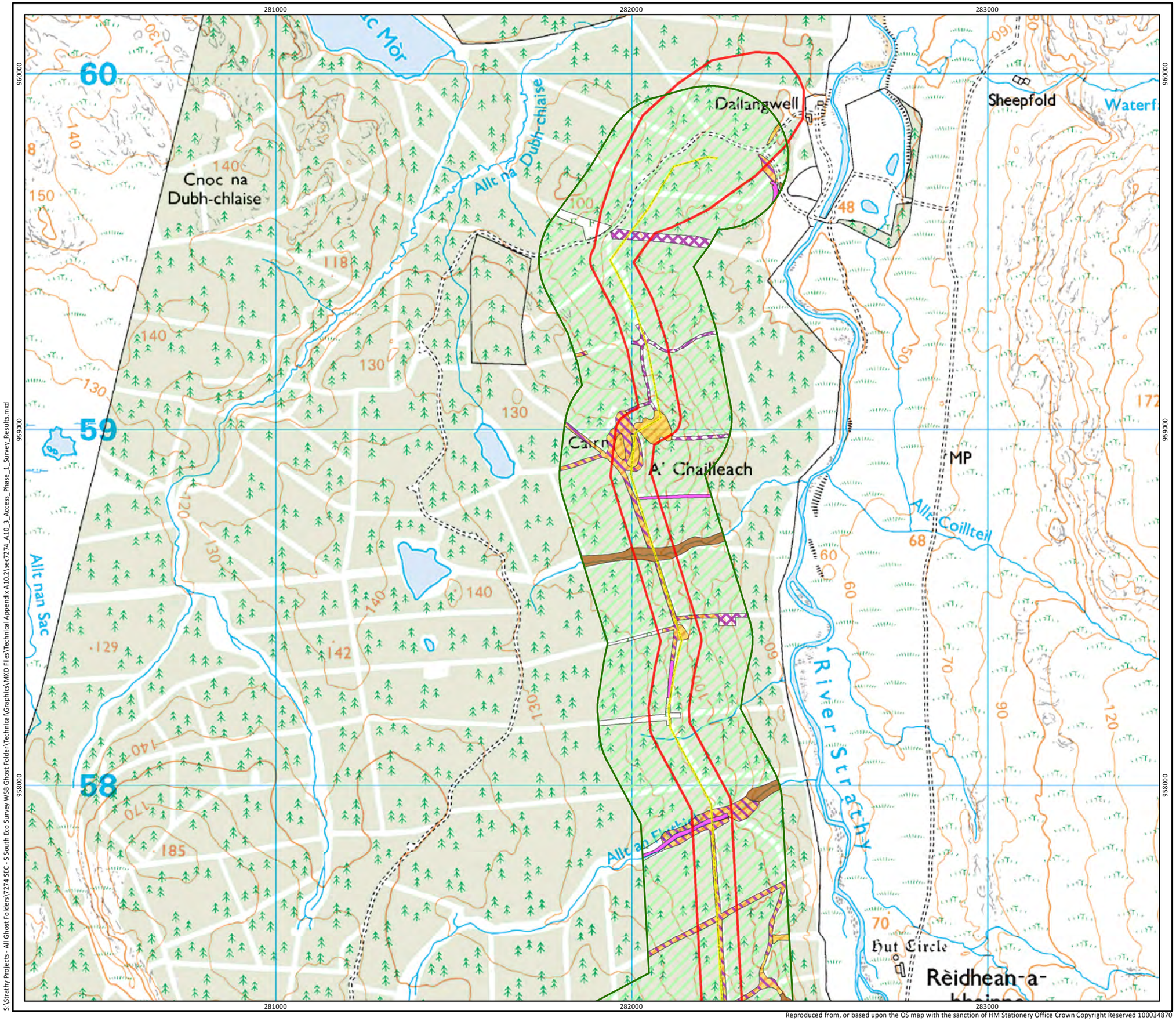
0 125 250 500 m

Figure A10.2.3b
Phase 1 Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey W58 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_3_Access_Phase_1_Survey_Results.mxd



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey W58 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_3_Access_Phase_1_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Phase 1 habitats

- Coniferous woodland plantation
- Broadleaved woodland-recently felled
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Dry heath/acid grassland
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water

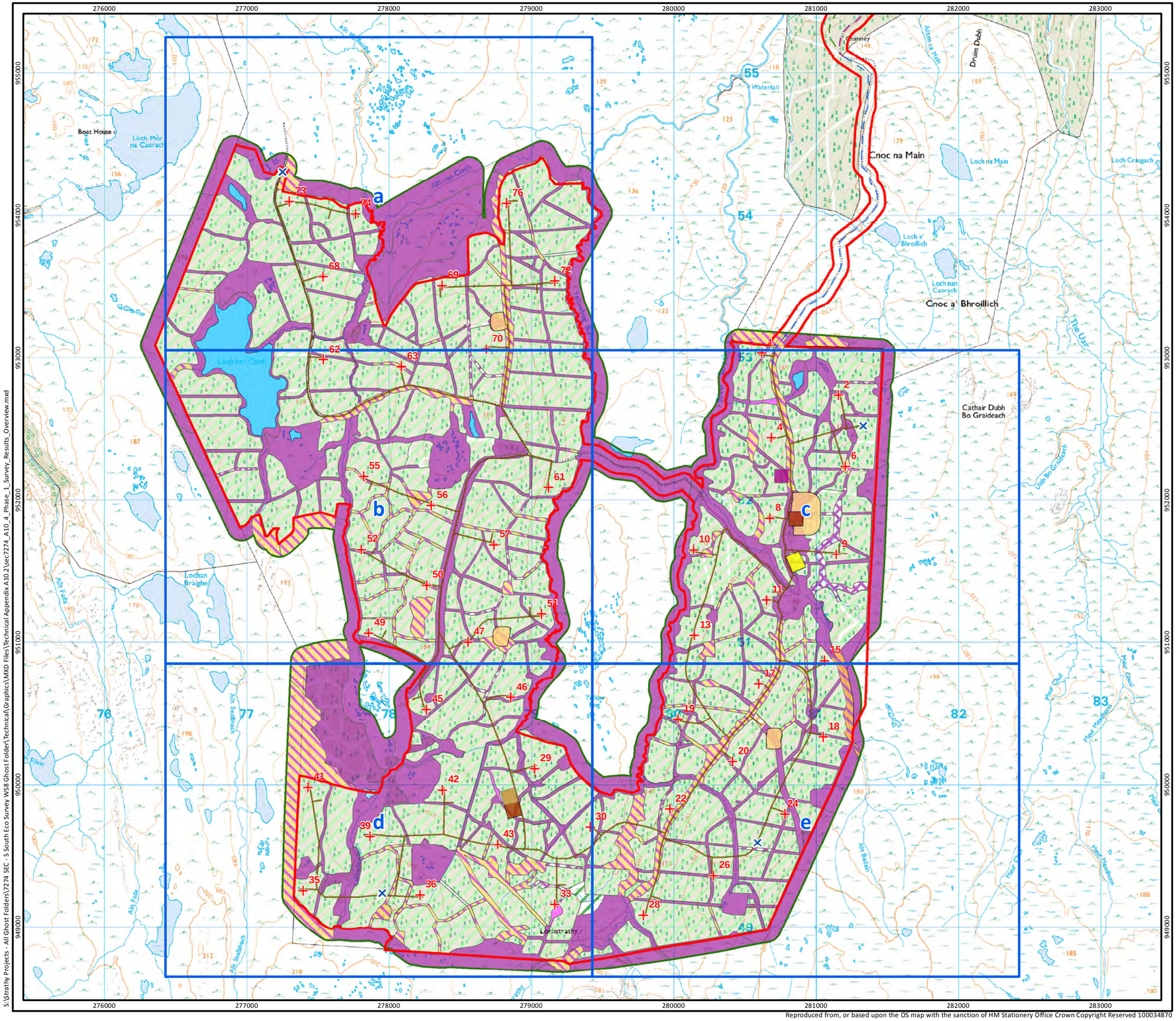
N

Scale 1:10,000 @ A3

0 125 250 500 m

Figure A10.2.3c
Phase 1 Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10.4_Phase_1_Survey_Results_Overview.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Phase 1 habitats

- Broadleaved woodland plantation
- Coniferous woodland plantation
- Unimproved acid grassland
- Marsh/marshy grassland
- Dry dwarf shrub heath
- Wet dwarf shrub heath
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water
- Bare ground/track

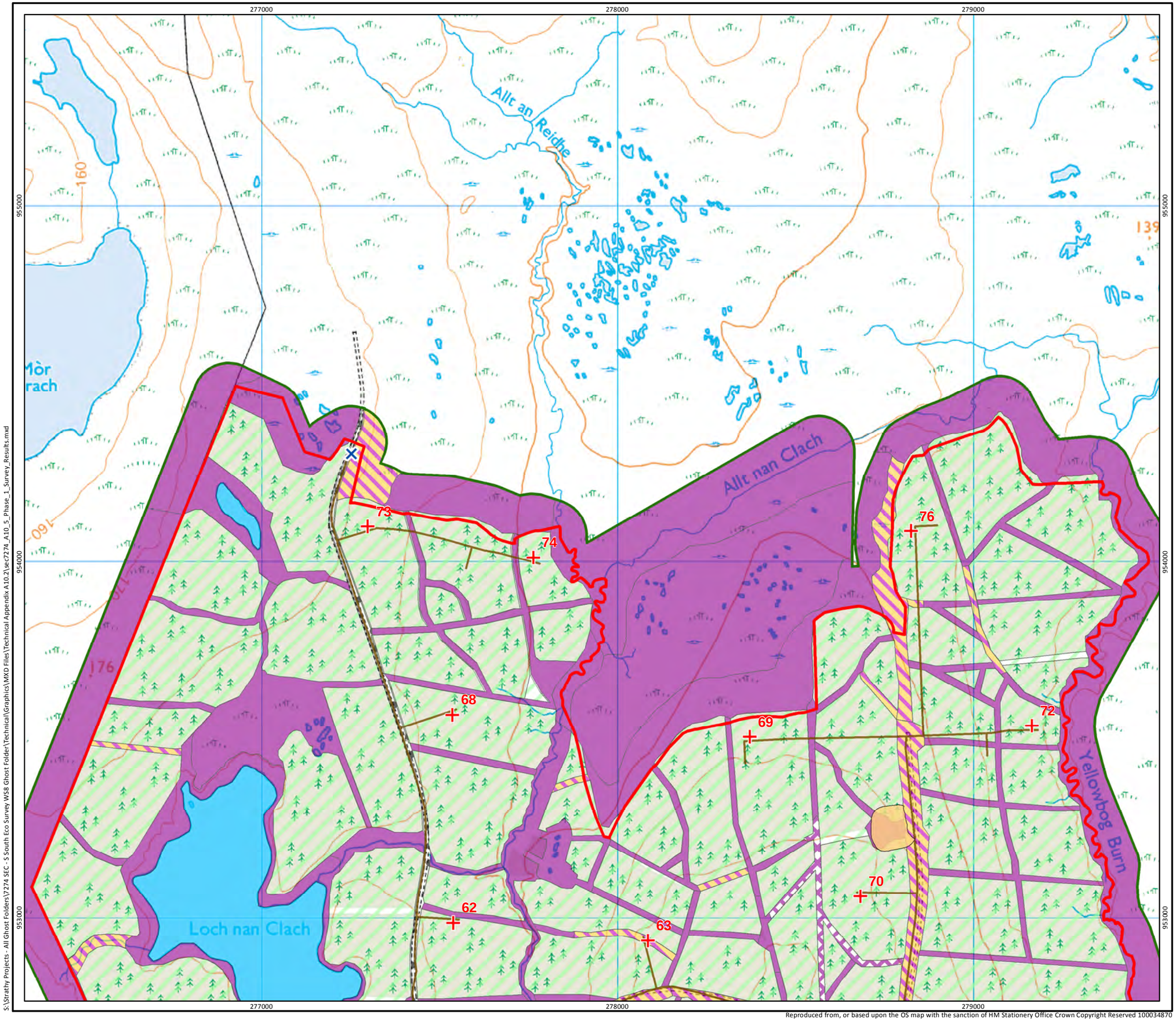
N

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

Figure A10.2.4
Phase 1 Survey Results Overview
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2



SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Phase 1 habitats

- Broadleaved woodland plantation
- Coniferous woodland plantation
- Unimproved acid grassland
- Marsh/marshy grassland
- Dry dwarf shrub heath
- Wet dwarf shrub heath
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water
- Bare ground/track

N

Scale 1:10,000 @ A3

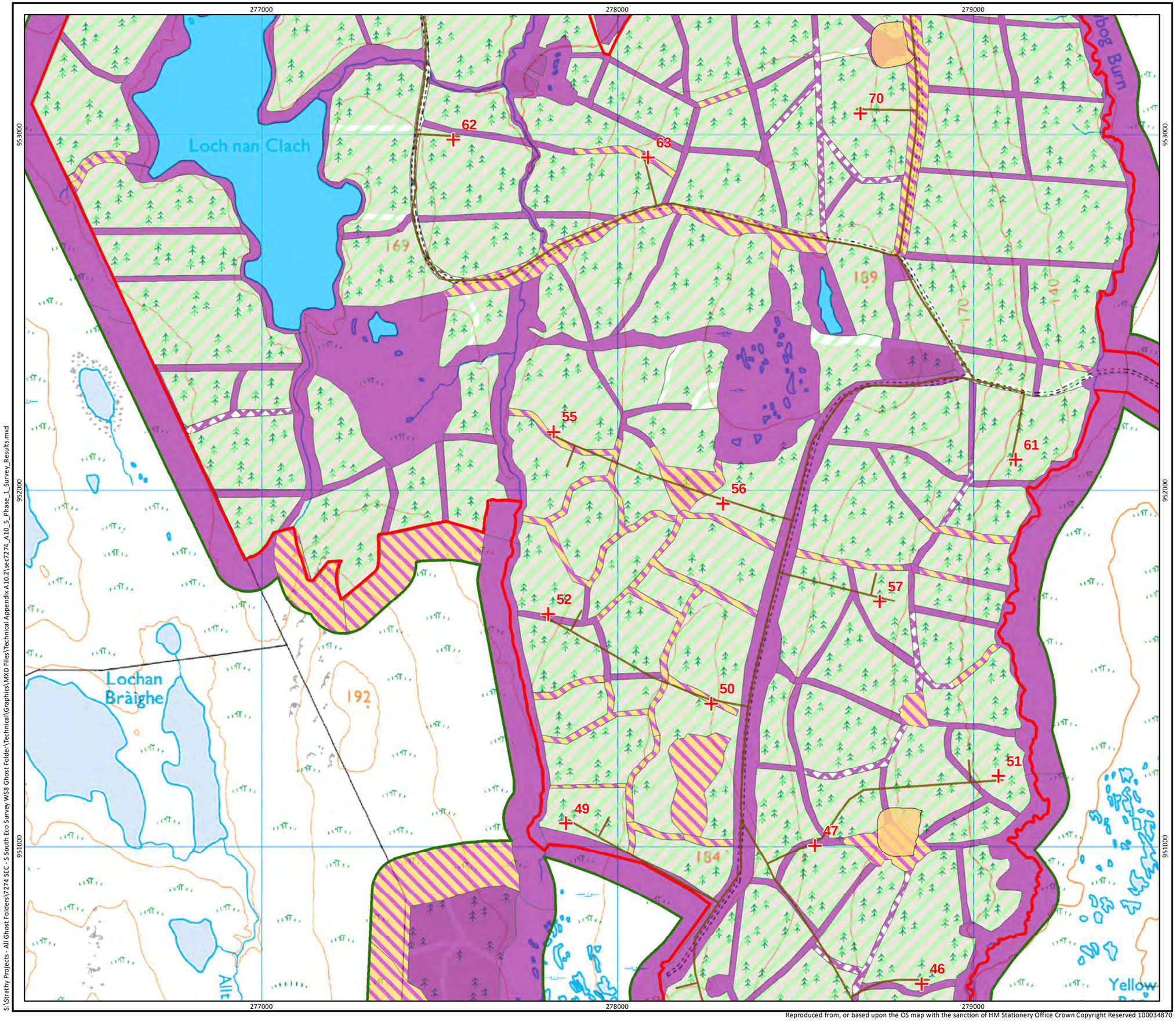
0 125 250 500 m

Figure A10.2.5a
Phase 1 Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_5_Phase_1_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



S:\Strathy Projects - All Ghost Folders\Y274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_5_Phase_1_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Phase 1 habitats

- Broadleaved woodland plantation
- Coniferous woodland plantation
- Unimproved acid grassland
- Marsh/marshy grassland
- Dry dwarf shrub heath
- Wet dwarf shrub heath
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water
- Bare ground/track

N

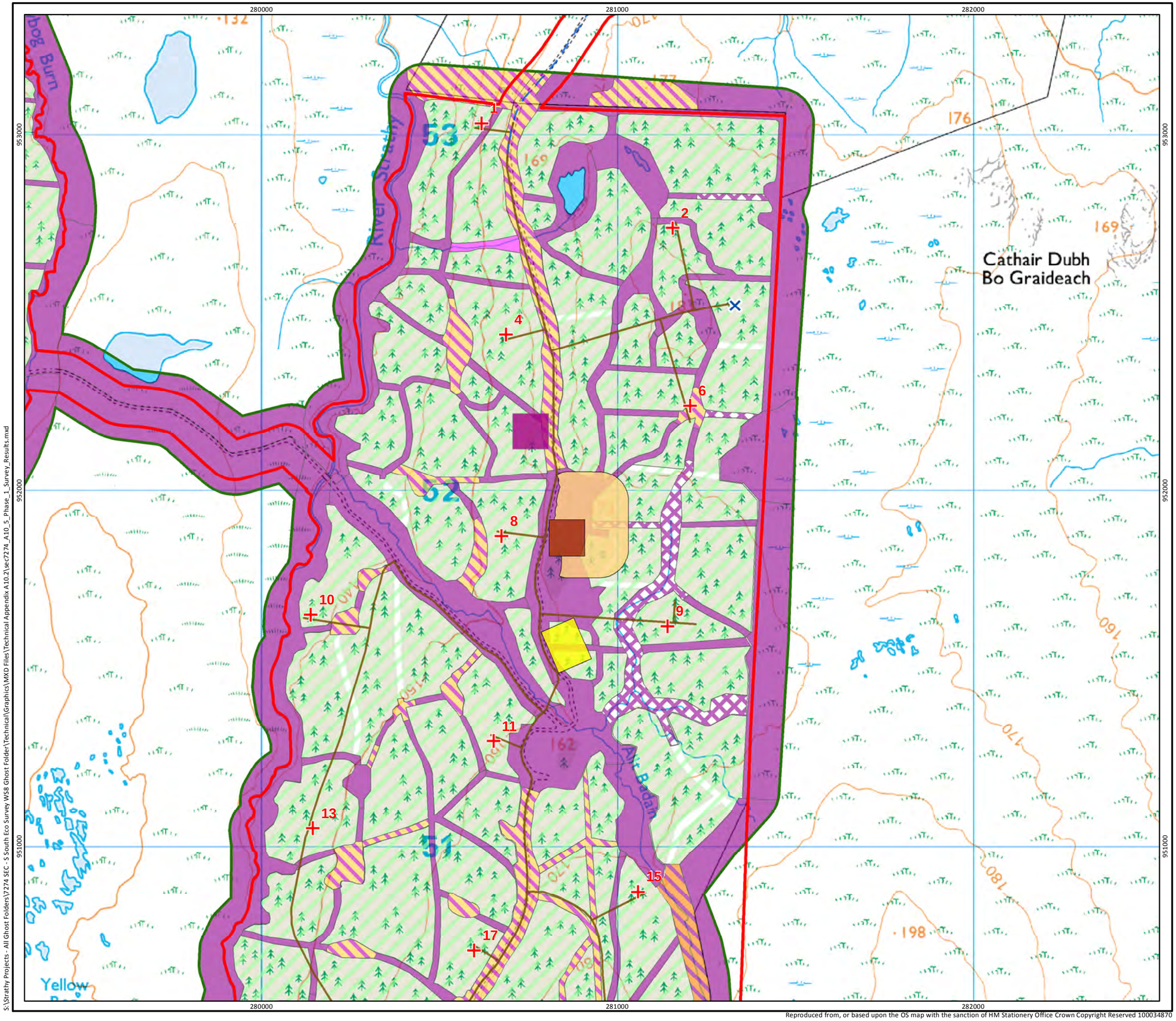
Scale 1:10,000 @ A3

0 125 250 500 m

Figure A10.2.5b
Phase 1 Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_5_Phase_1_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Phase 1 habitats

- Broadleaved woodland plantation
- Coniferous woodland plantation
- Unimproved acid grassland
- Marsh/marshy grassland
- Dry dwarf shrub heath
- Wet dwarf shrub heath
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water
- Bare ground/track

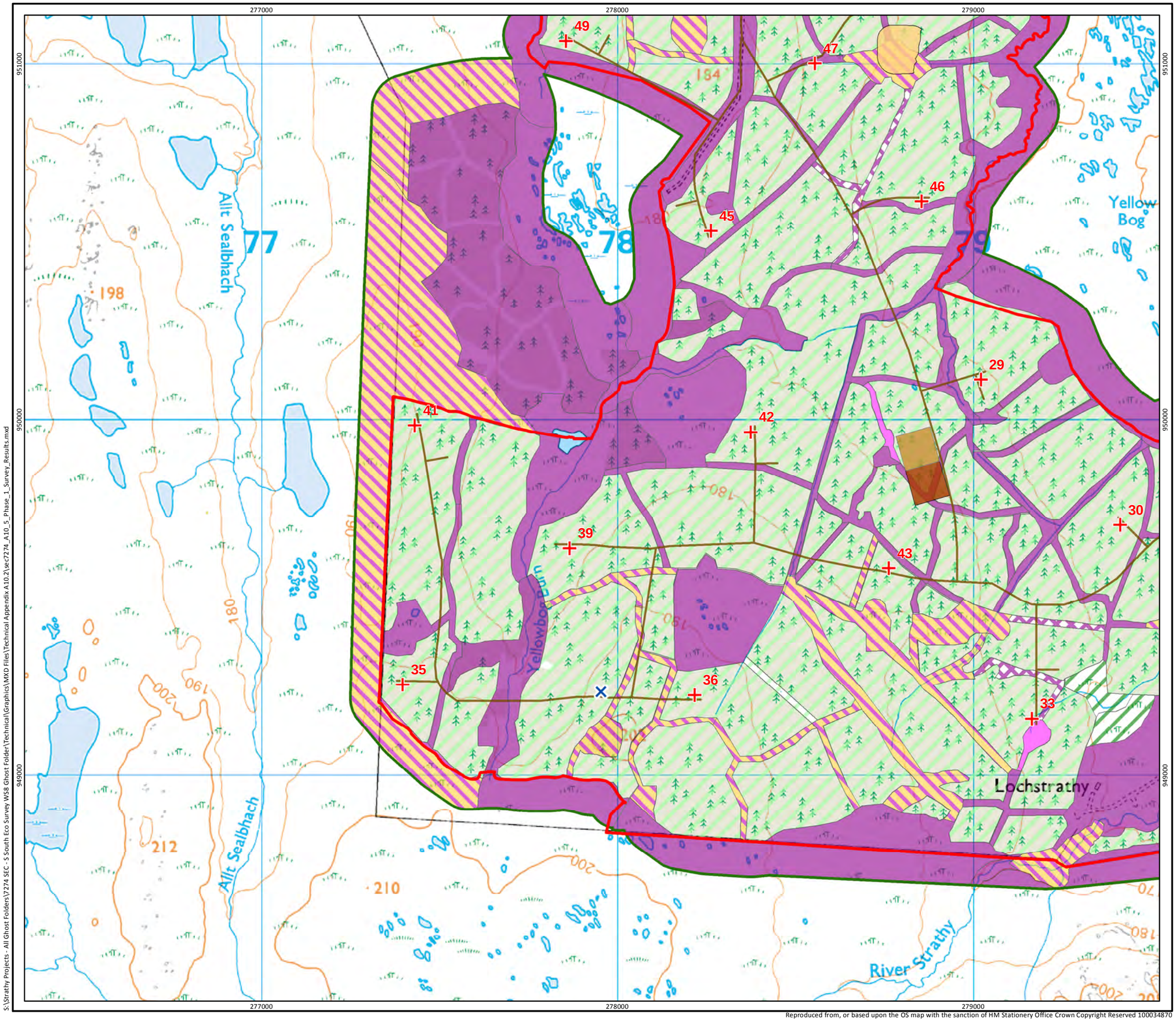
N

Scale 1:10,000 @ A3

0 125 250 500 m

Figure A10.2.5c
Phase 1 Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2



SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Phase 1 habitats

- Broadleaved woodland plantation
- Coniferous woodland plantation
- Unimproved acid grassland
- Marsh/marshy grassland
- Dry dwarf shrub heath
- Wet dwarf shrub heath
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water
- Bare ground/track

N

Scale 1:10,000 @ A3

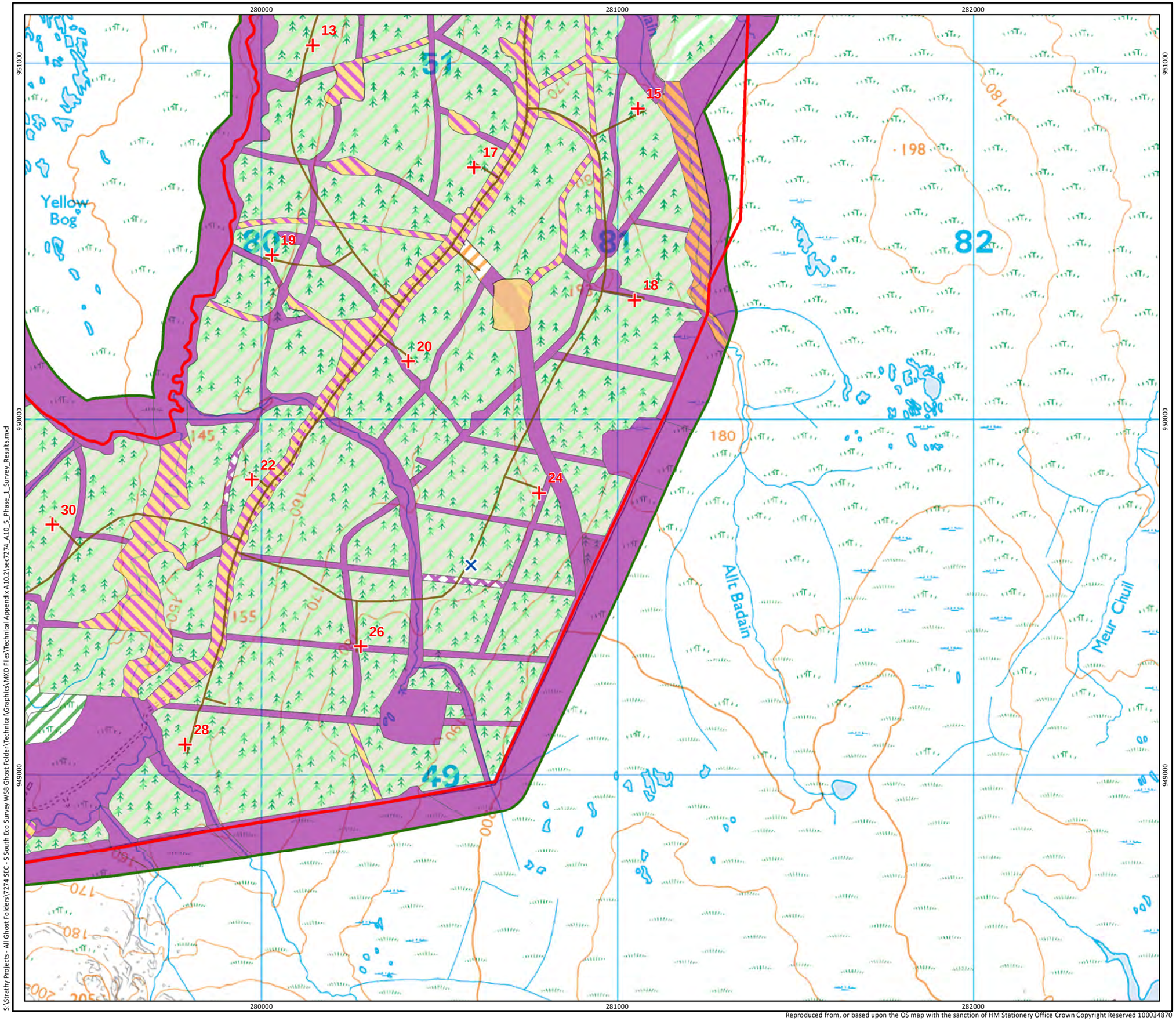
0 125 250 500 m

Figure A10.2.5d
Phase 1 Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_5_Phase_1_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Phase 1 habitats

- Broadleaved woodland plantation
- Coniferous woodland plantation
- Unimproved acid grassland
- Marsh/marshy grassland
- Dry dwarf shrub heath
- Wet dwarf shrub heath
- Blanket bog
- Wet modified bog
- Acid flush
- Swamp
- Standing water
- Bare ground/track

N

Scale 1:10,000 @ A3

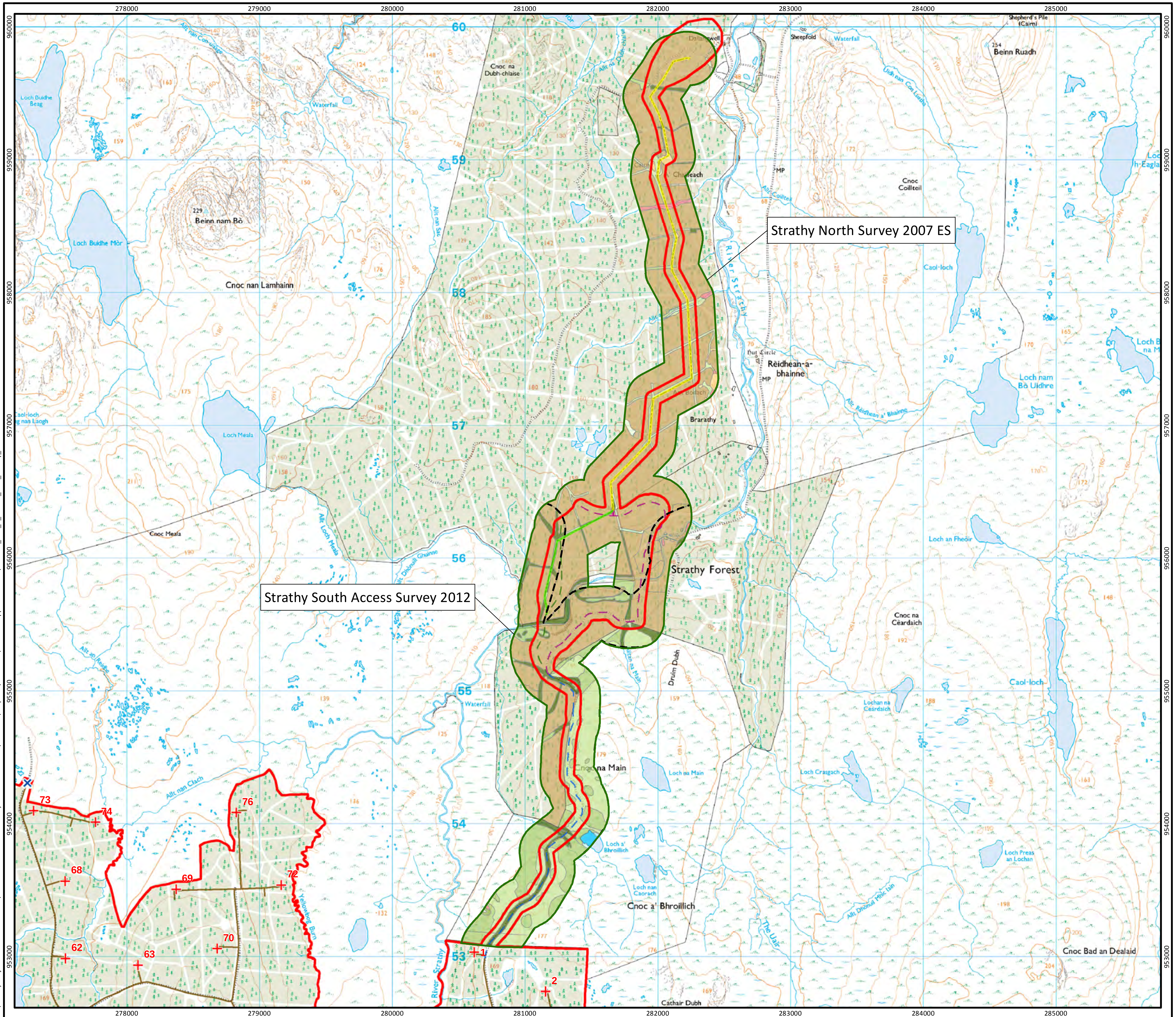
0 125 250 500 m

Figure A10.2.5e
Phase 1 Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\Y274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10.5_Phase_1_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_6_Access_NVC_Survey_Overview.mxd

SSE Renewables

RPS

Key

- Turbines
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey area (200m from access and cable routes)

Dominant NVC Communities

- H10
- M4
- M6
- M15
- M17
- M18
- M19
- M25
- MG9
- U20
- Forestry
- Standing water

Scale 1:27,000 @ A3

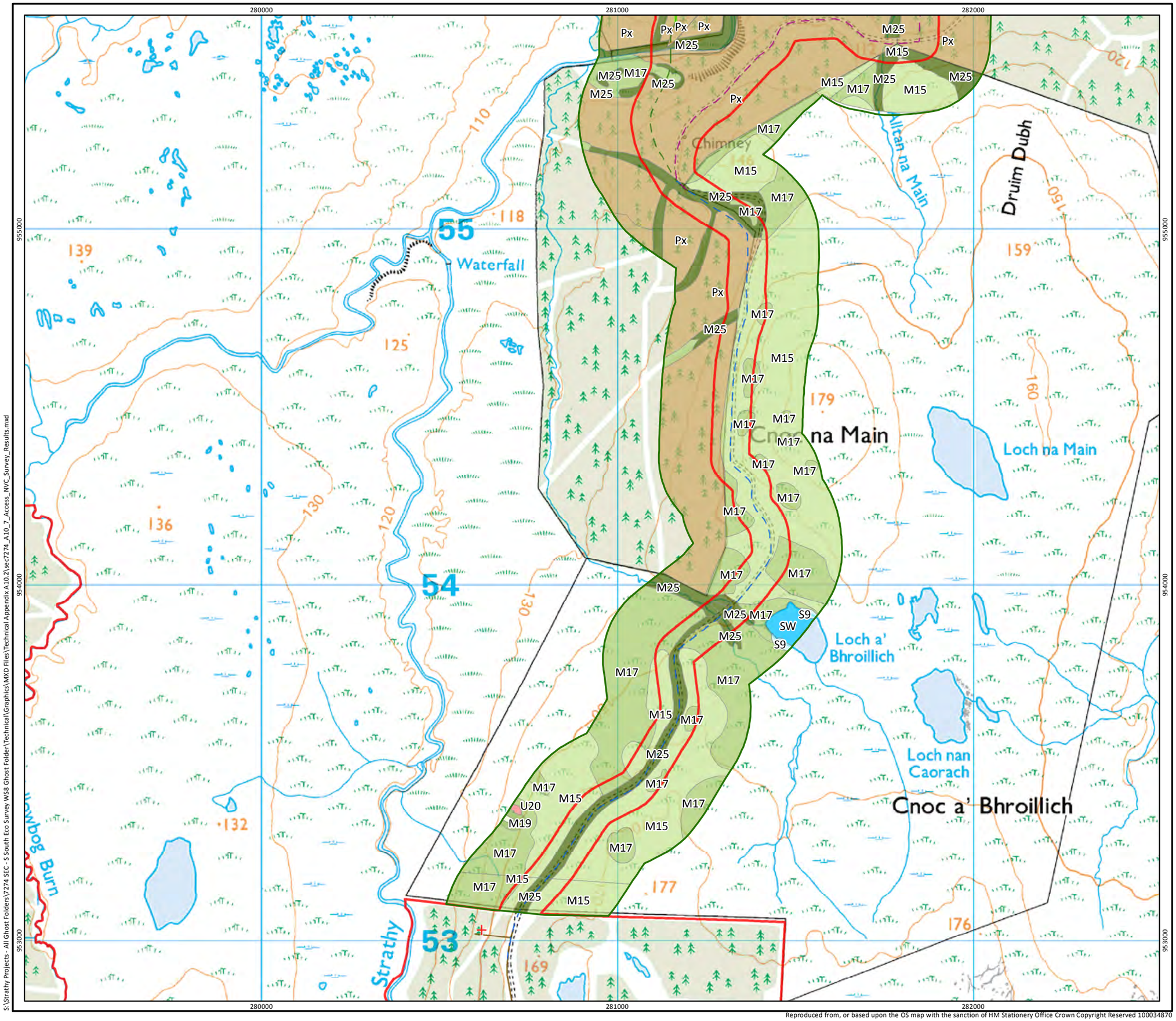
0 0.25 0.5 1 km

N

Figure A10.2.6
NVC Survey Results Overview
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Dominant NVC Communities

- H10
- M4
- M6
- M15
- M17
- M18
- M19
- M25
- MG9
- U20
- Forestry
- Standing water

N

Scale 1:10,000 @ A3

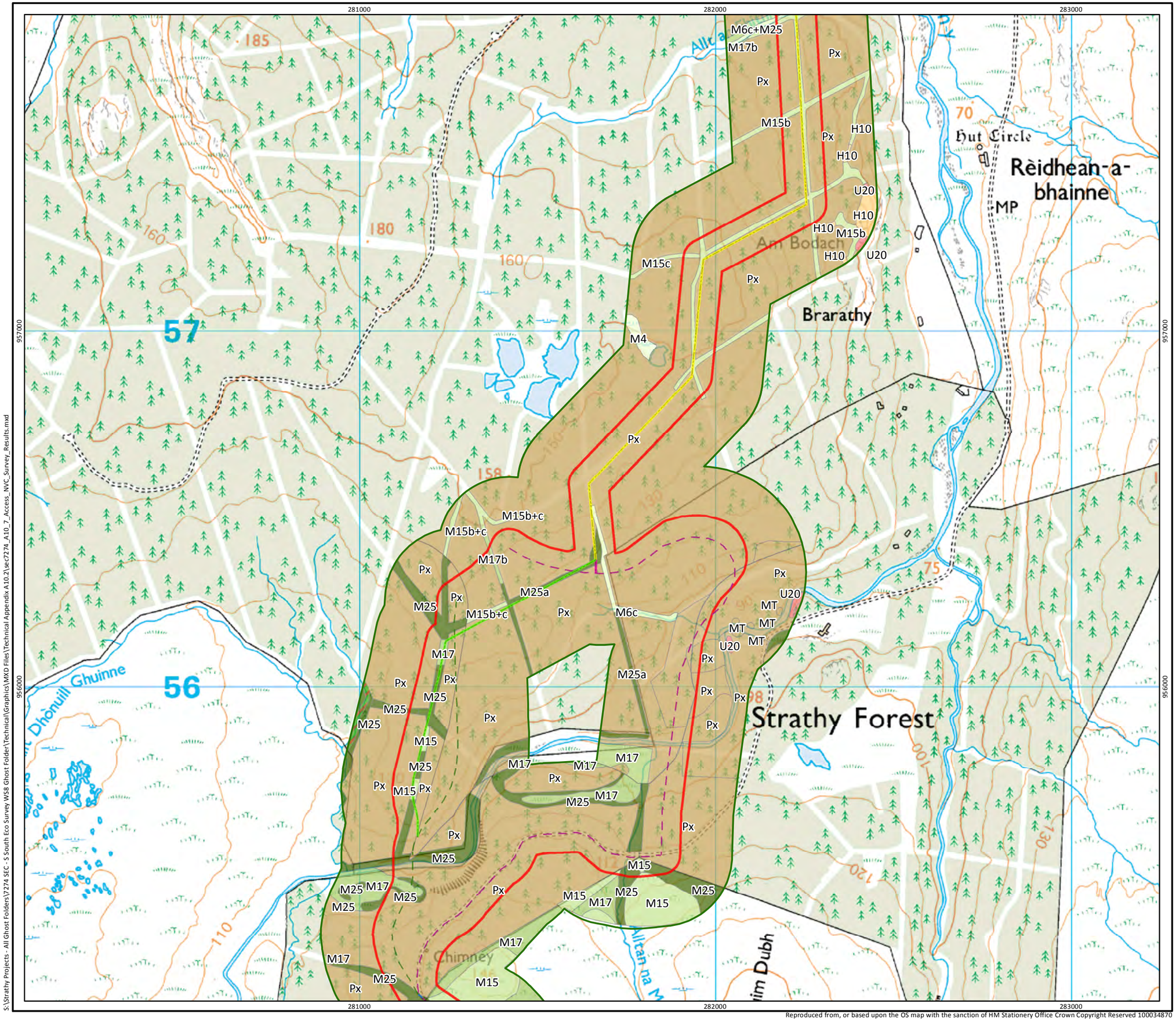
0 125 250 500 m

Figure A10.2.7a
NVC Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_7_Access_NVC_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Dominant NVC Communities

- H10
- M4
- M6
- M15
- M17
- M18
- M19
- M25
- MG9
- U20
- Forestry
- Standing water

N

Scale 1:10,000 @ A3

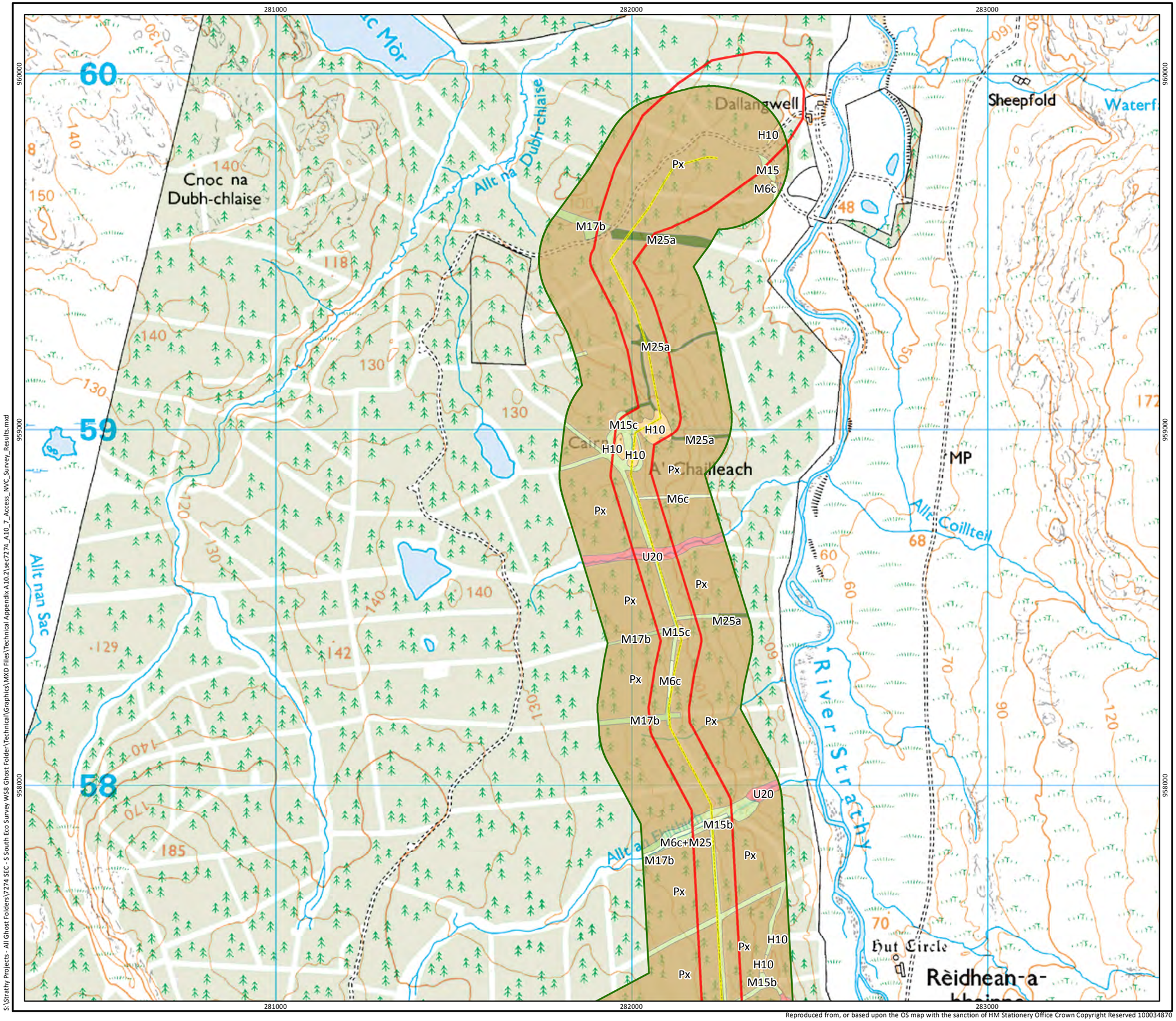
0 125 250 500 m

Figure A10.2.7b
NVC Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_7_Access_NVC_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_7_Access_NVC_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Dominant NVC Communities

- H10
- M4
- M6
- M15
- M17
- M18
- M19
- M25
- MG9
- U20
- Forestry
- Standing water

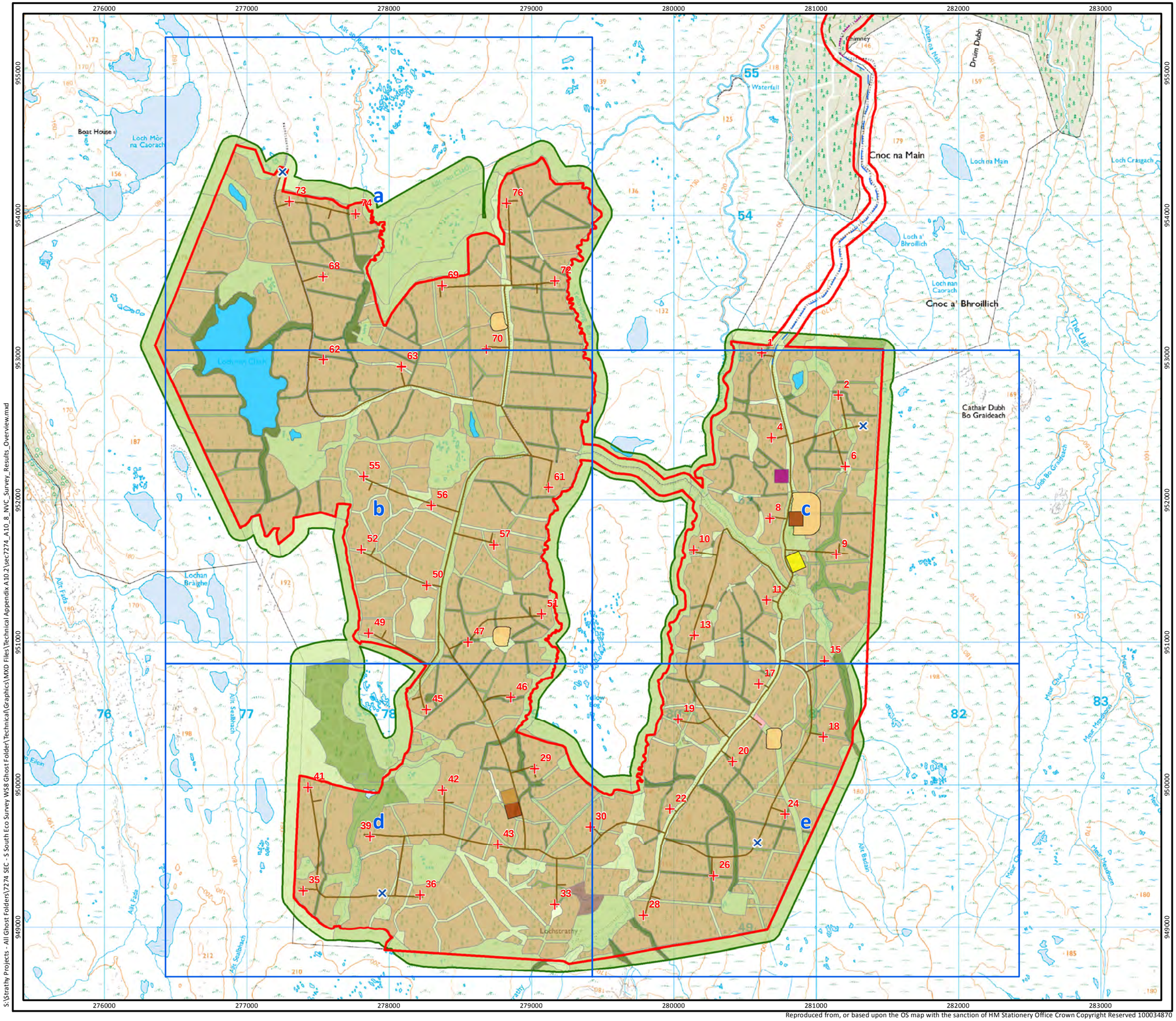
N

Scale 1:10,000 @ A3

0 125 250 500 m

Figure A10.2.7c
NVC Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10.8_NVC_Survey_Results_Overview.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Dominant NVC Communities

- H10
- M6
- M15
- M17
- M18
- M19
- M20
- M23
- M25
- S9
- U6
- Broadleaved woodland
- Forestry
- Standing water
- Track

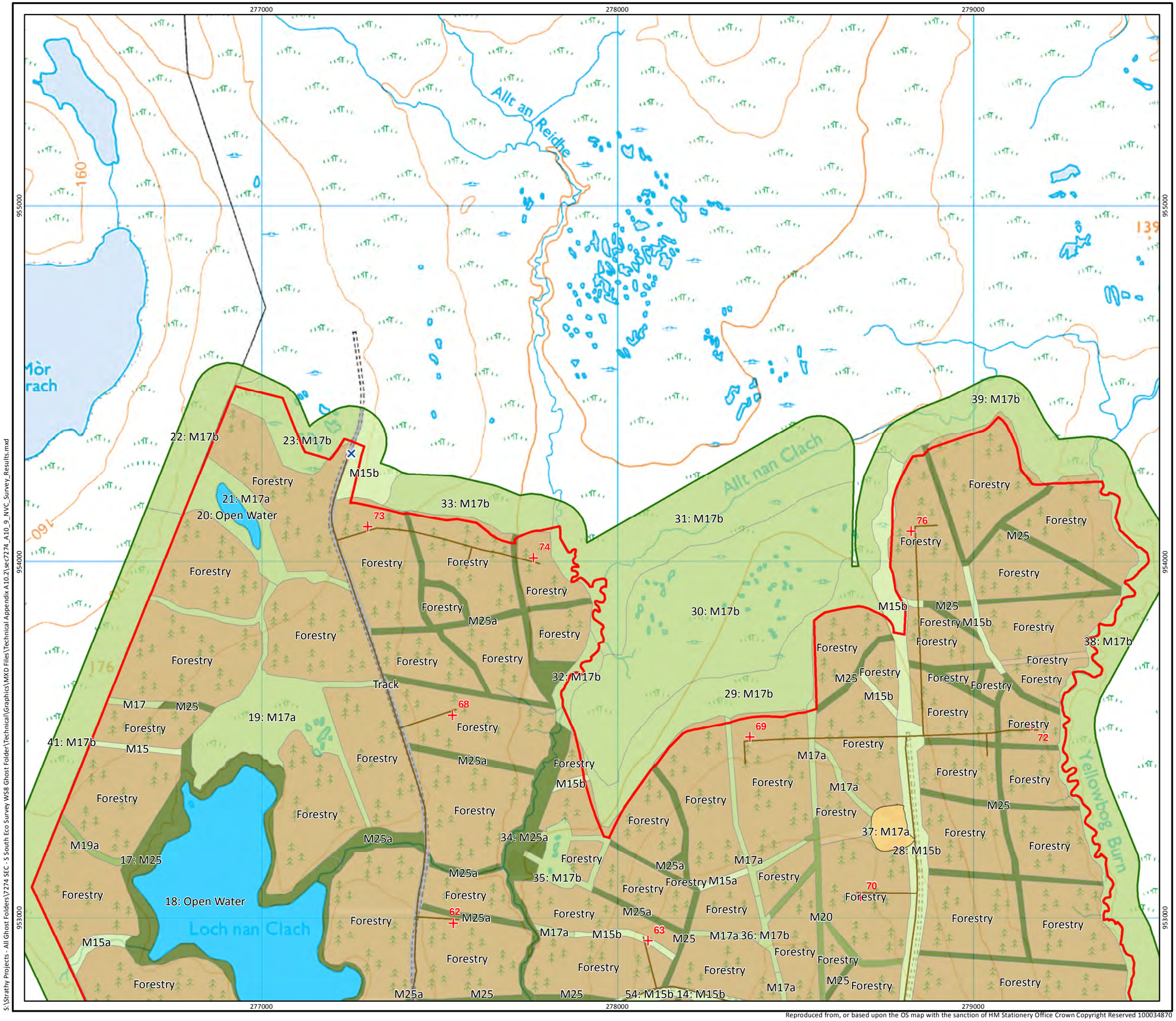
N

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

Figure A10.2.8
NVC Survey Results Overview
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\Y274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_9_NVC_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Dominant NVC Communities

- H10
- M6
- M15
- M17
- M18
- M19
- M20
- M23
- M25
- S9
- U6
- Broadleaved woodland
- Forestry
- Standing water
- Track

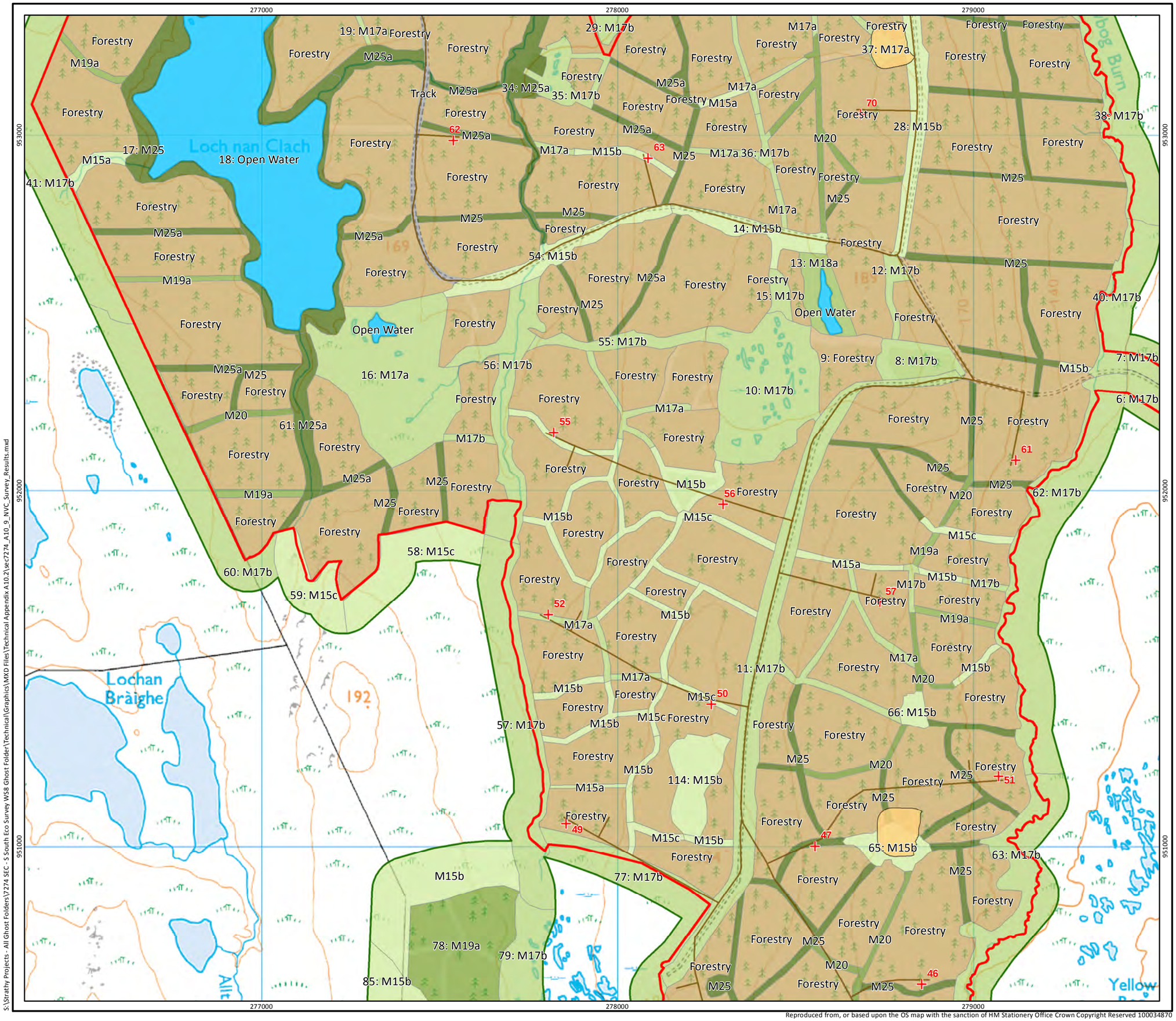
N

Scale 1:10,000 @ A3

0 125 250 500 m

Figure A10.2.9a
NVC Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_9_NVC_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Dominant NVC Communities

- H10
- M6
- M15
- M17
- M18
- M19
- M20
- M23
- M25
- S9
- U6
- Broadleaved woodland
- Forestry
- Standing water
- Track

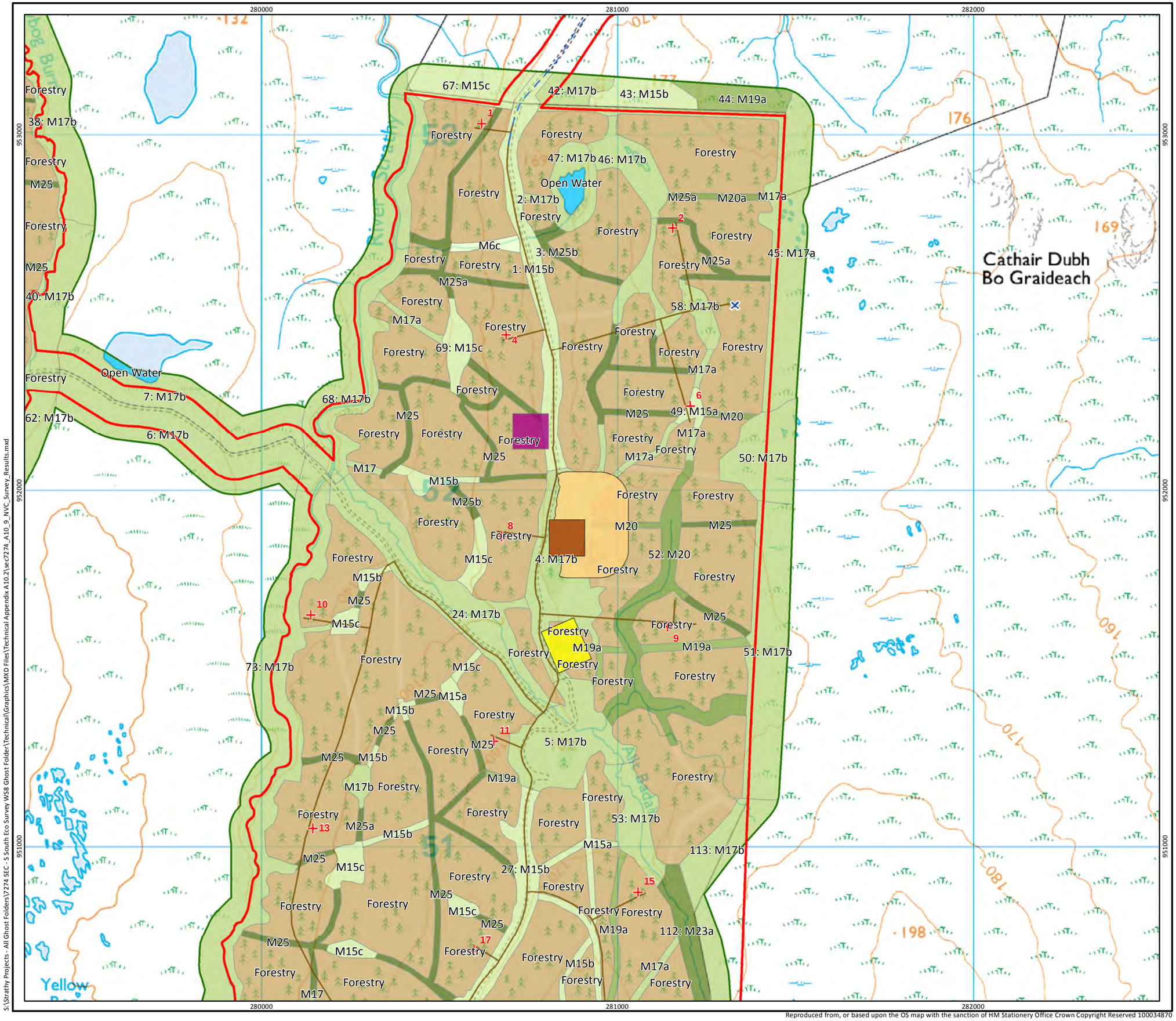
N

Scale 1:10,000 @ A3

0 125 250 500 m

Figure A10.2.9b
NVC Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2



SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Dominant NVC Communities

- H10
- M6
- M15
- M17
- M18
- M19
- M20
- M23
- M25
- S9
- U6
- Broadleaved woodland
- Forestry
- Standing water
- Track

N

Scale 1:10,000 @ A3

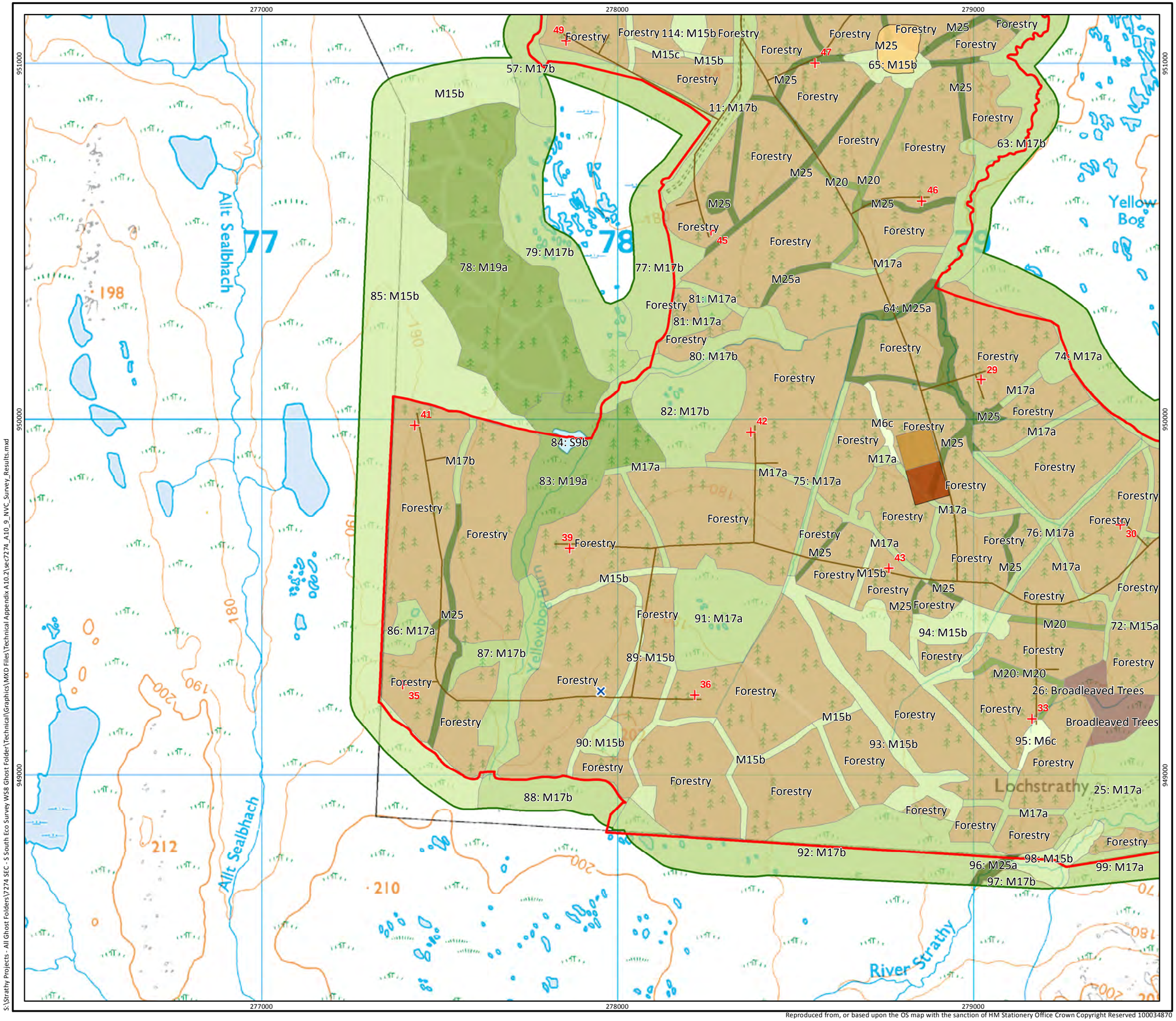
0 125 250 500 m

Figure A10.2.9c
NVC Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\Y274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_9_NVC_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey boundary 2011

Dominant NVC Communities

- H10
- M6
- M15
- M17
- M18
- M19
- M20
- M23
- M25
- S9
- U6
- Broadleaved woodland
- Forestry
- Standing water
- Track

Scale 1:10,000 @ A3

0 125 250 500 m

N

Figure A10.2.9d
NVC Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey W58 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_9_NVC_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

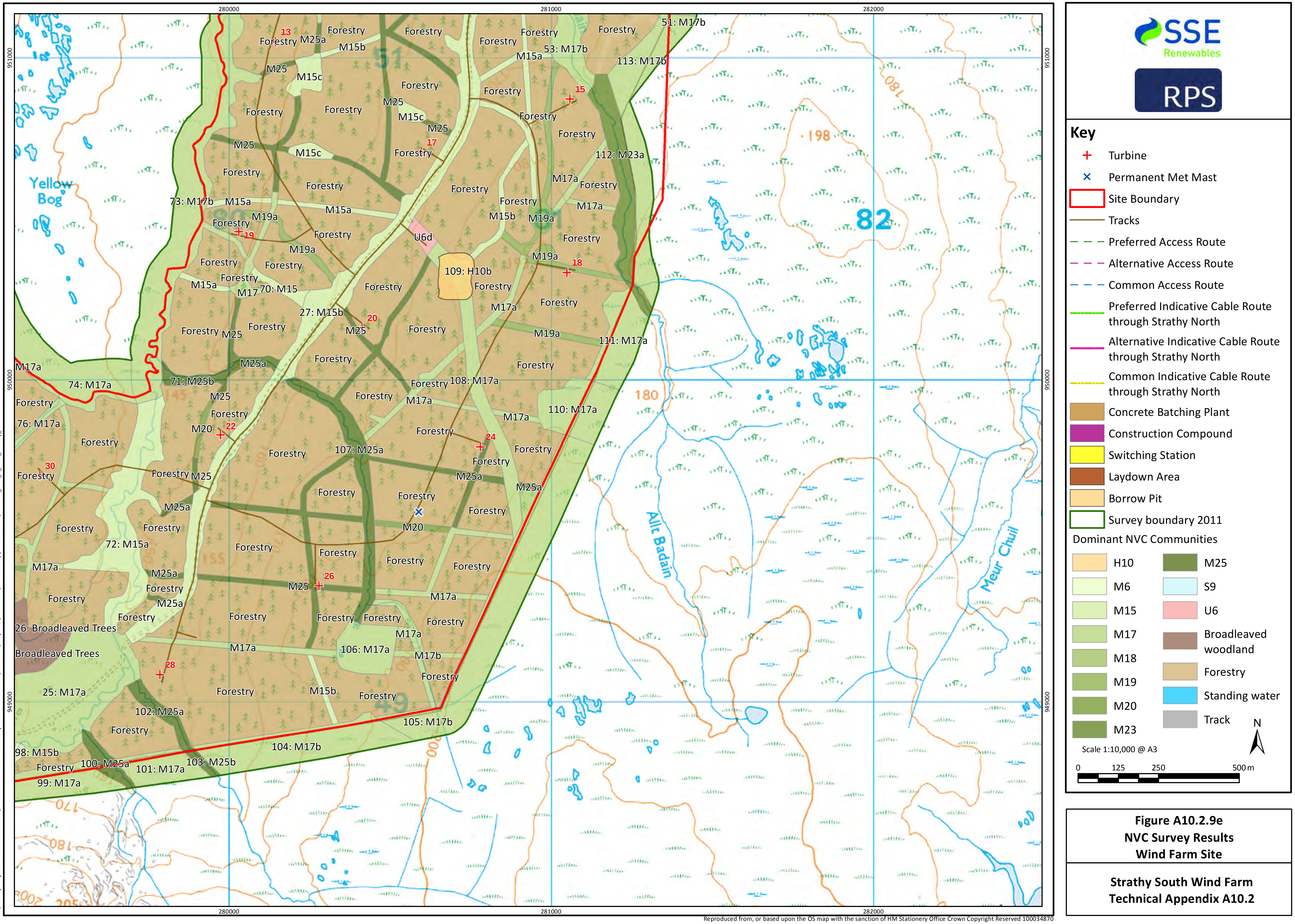


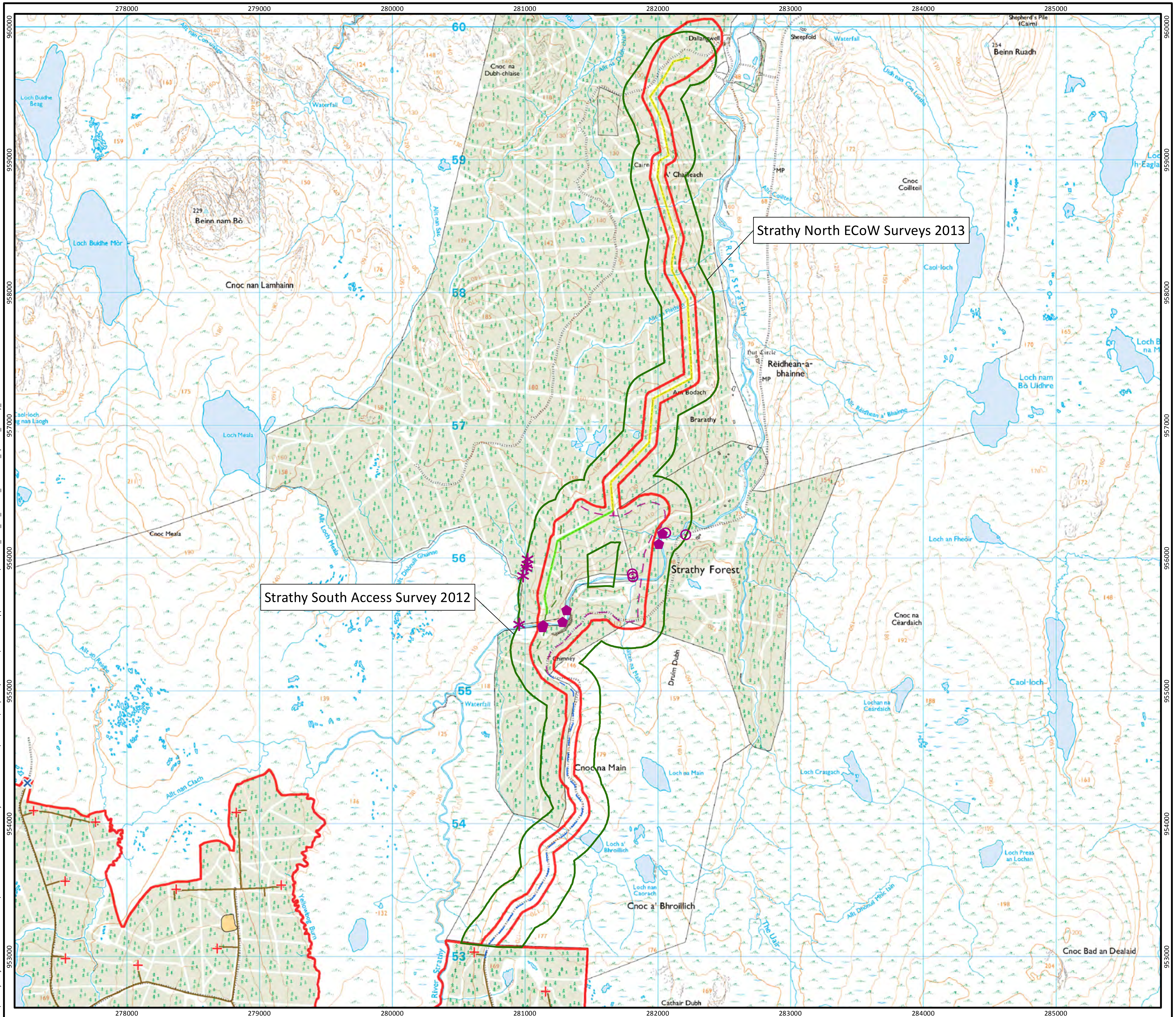
Figure A10.2.9e
NVC Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_9_NVC_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_10_Access_Protected_Species_Survey_Overview.mxd



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

SSE Renewables

RPS

Key

- + Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Borrow Pit
- Survey Area (200m from Access and Cable Routes)

Mammal Evidence Strathy South 2012

- Otter spraint
- Watervole burrow
- Pine marten scat

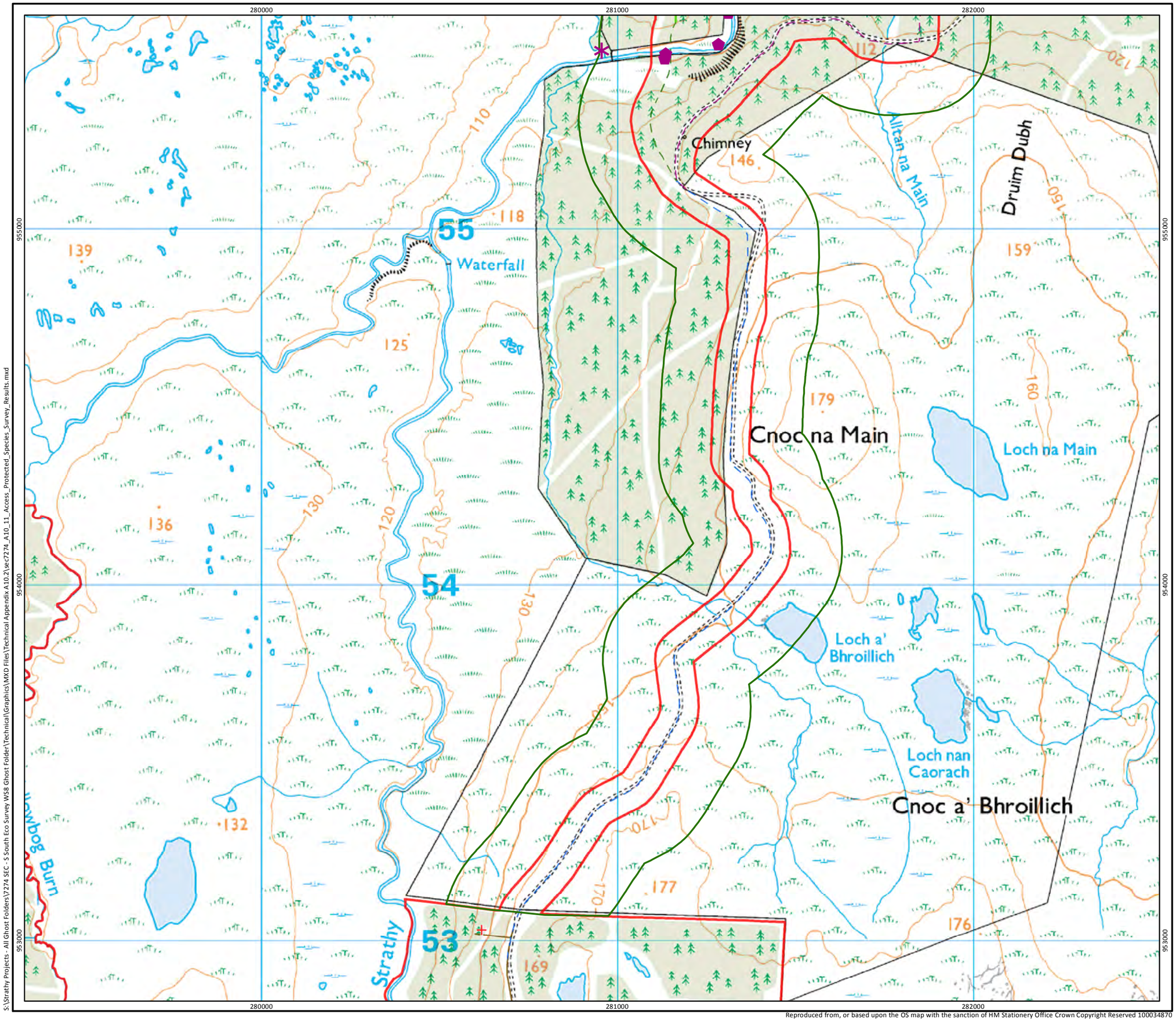
Scale 1:27,000 @ A3

0 0.25 0.5 1 km

N

Figure A10.2.10
Protected Species Survey Overview
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_11_Access_Protected_Species_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Mammal Evidence Strathy South 2012

- Otter spraint
- Watervole burrow
- Pine marten scat

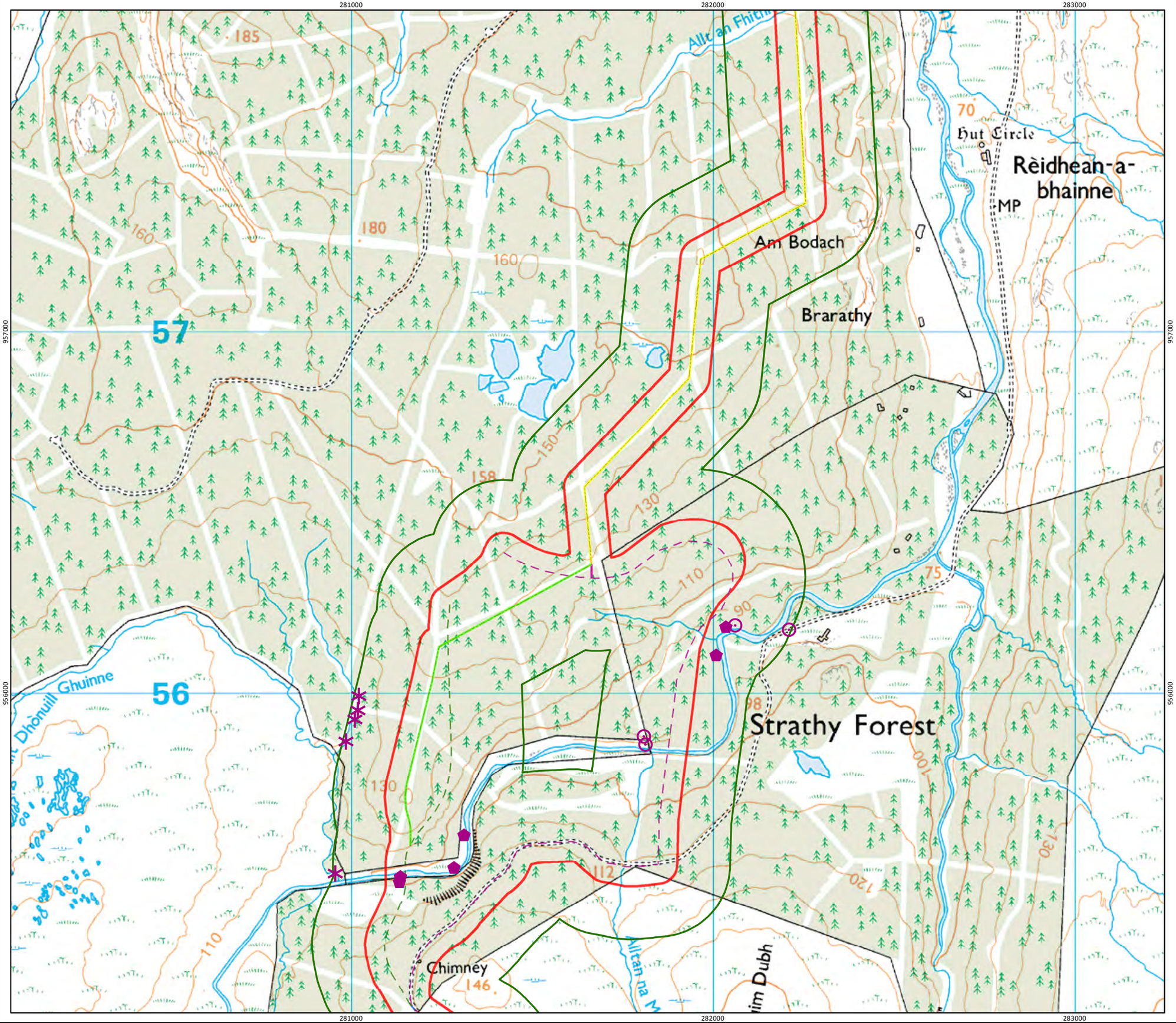
N

Scale 1:10,000 @ A3

0 125 250 500 m

Figure A10.2.11a
Protected Species Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\Y274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sect274_A10_11_Access_Protected_Species_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Mammal Evidence Strathy South 2012

- Otter spraint
- Watervole burrow
- Pine marten scat

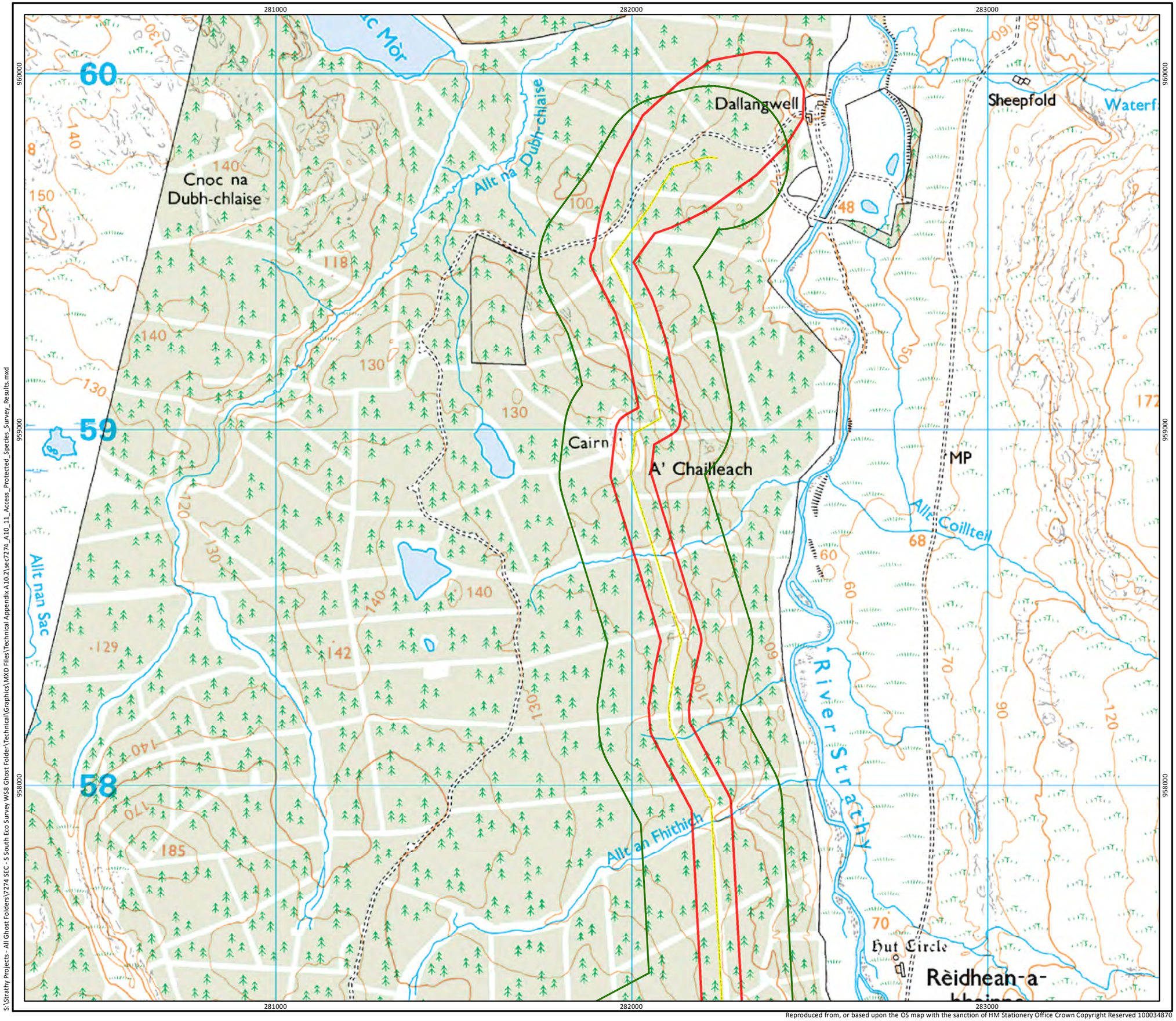
Scale 1:10,000 @ A3

0 125 250 500 m

N

Figure A10.2.11b
Protected Species Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_11_Access_Protected_Species_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Survey Area (200m from Access and Cable Routes)

Mammal Evidence Strathy South 2012

- Otter spraint
- Watervole burrow
- Pine marten scat

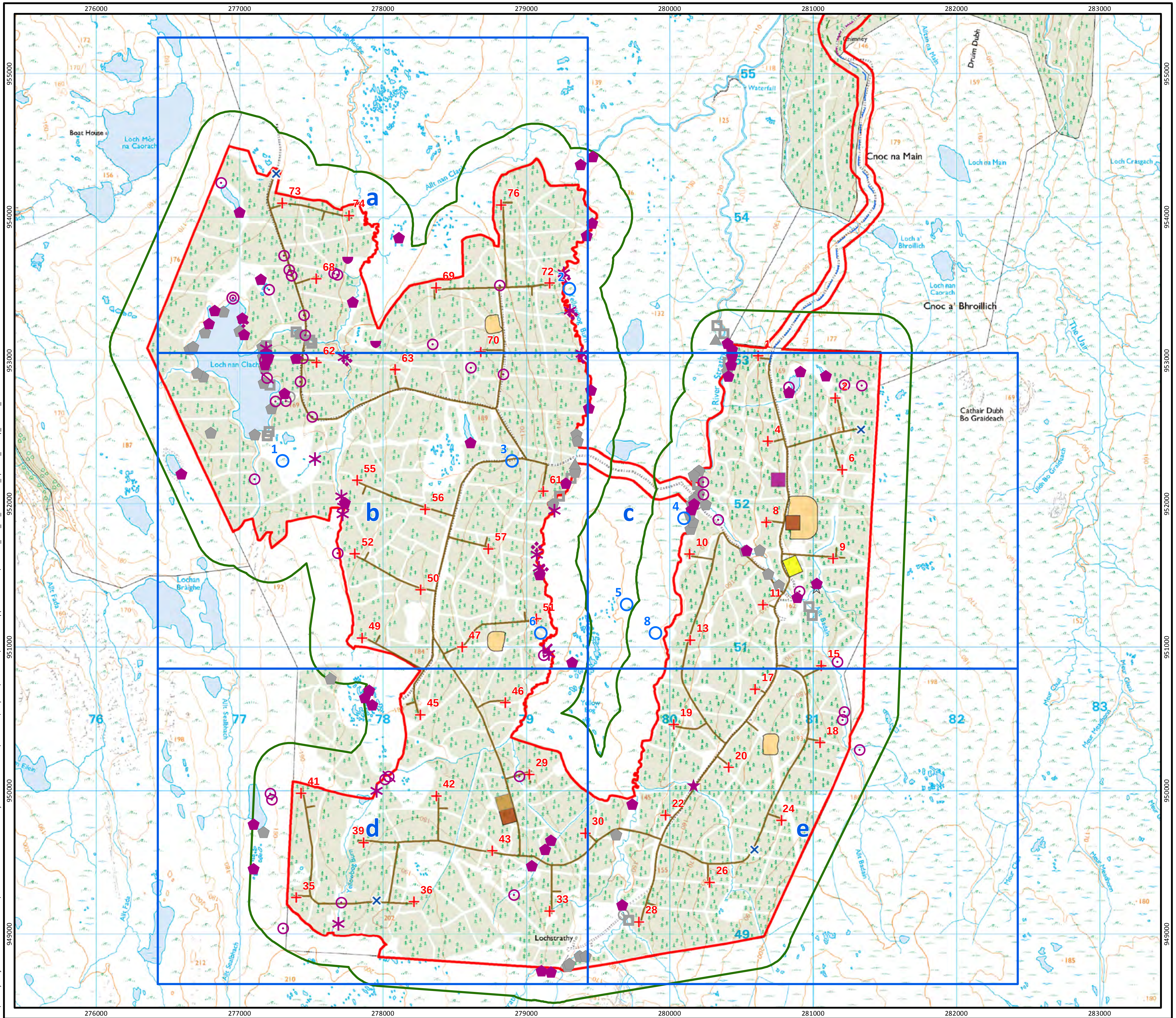
Scale 1:10,000 @ A3

0 125 250 500 m

N

Figure A10.2.11c
Protected Species Survey Results
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2



Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey Boundary 2012
- Target note

Mammal Evidence 2012

- Otter feeding signs
- Otter spraint
- Otter slide
- Otter print
- Watervole droppings
- Watervole burrow
- Pine marten sighting
- Pine marten scat
- Pine marten den

Mammal Evidence 2007 ES

- Otter holt
- Otter spraints and footprints
- Watervole live animal
- Watervole signs
- Pine marten scat

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

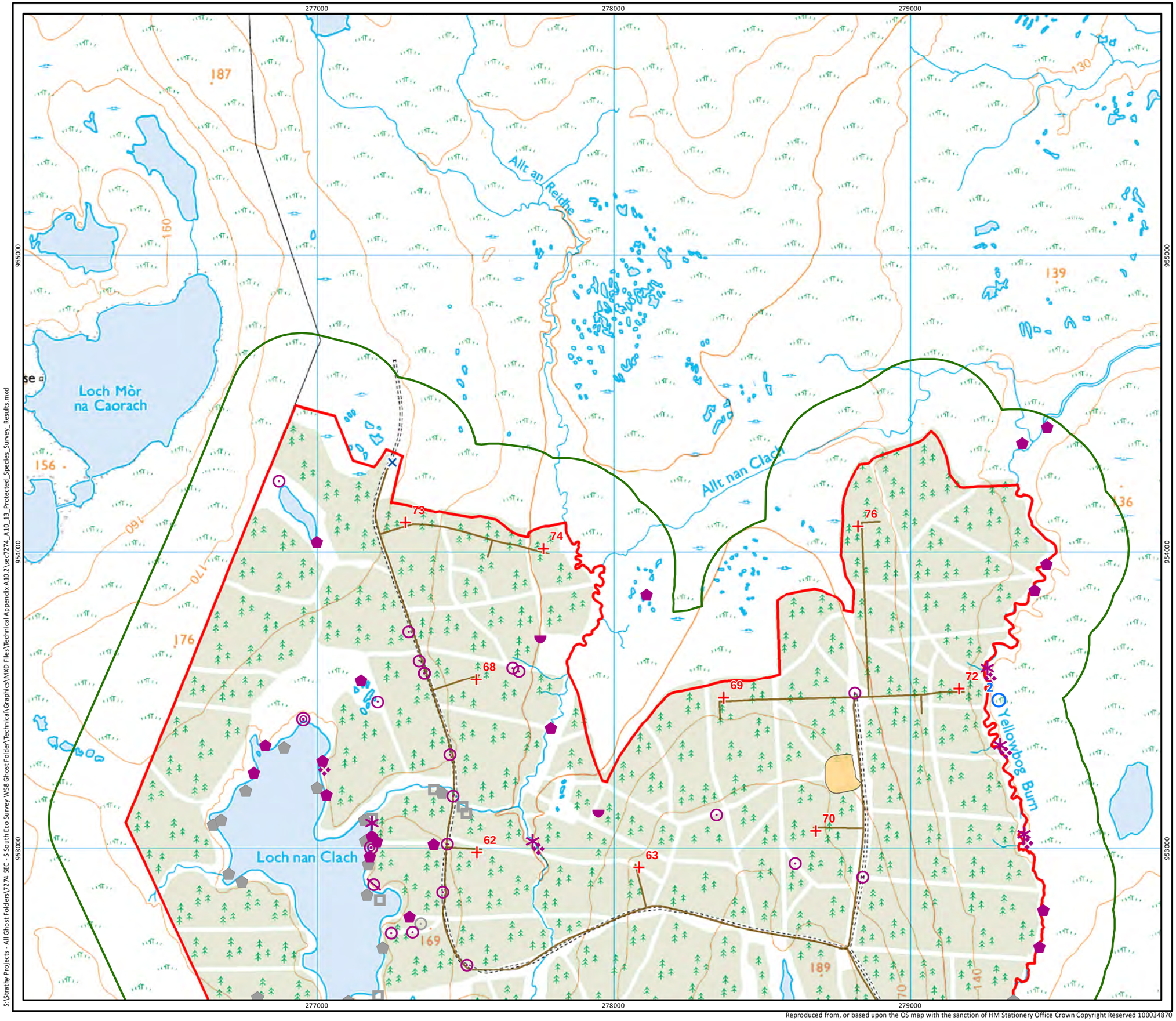
N

Figure A10.2.12
Protected Species Results Overview
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_12_Protected_Species_Survey_Results_Overview.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_13_Protected_Species_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey Boundary 2012
- Target note

Mammal Evidence 2012

- Otter feeding signs
- Otter spraint
- Otter slide
- Otter print
- Watervole droppings
- Watervole burrow
- Pine marten sighting
- Pine marten scat
- Pine marten den

Mammal Evidence 2007 ES

- Otter holt
- Otter spraints and footprints
- Watervole live animal
- Watervole signs
- Pine marten scat

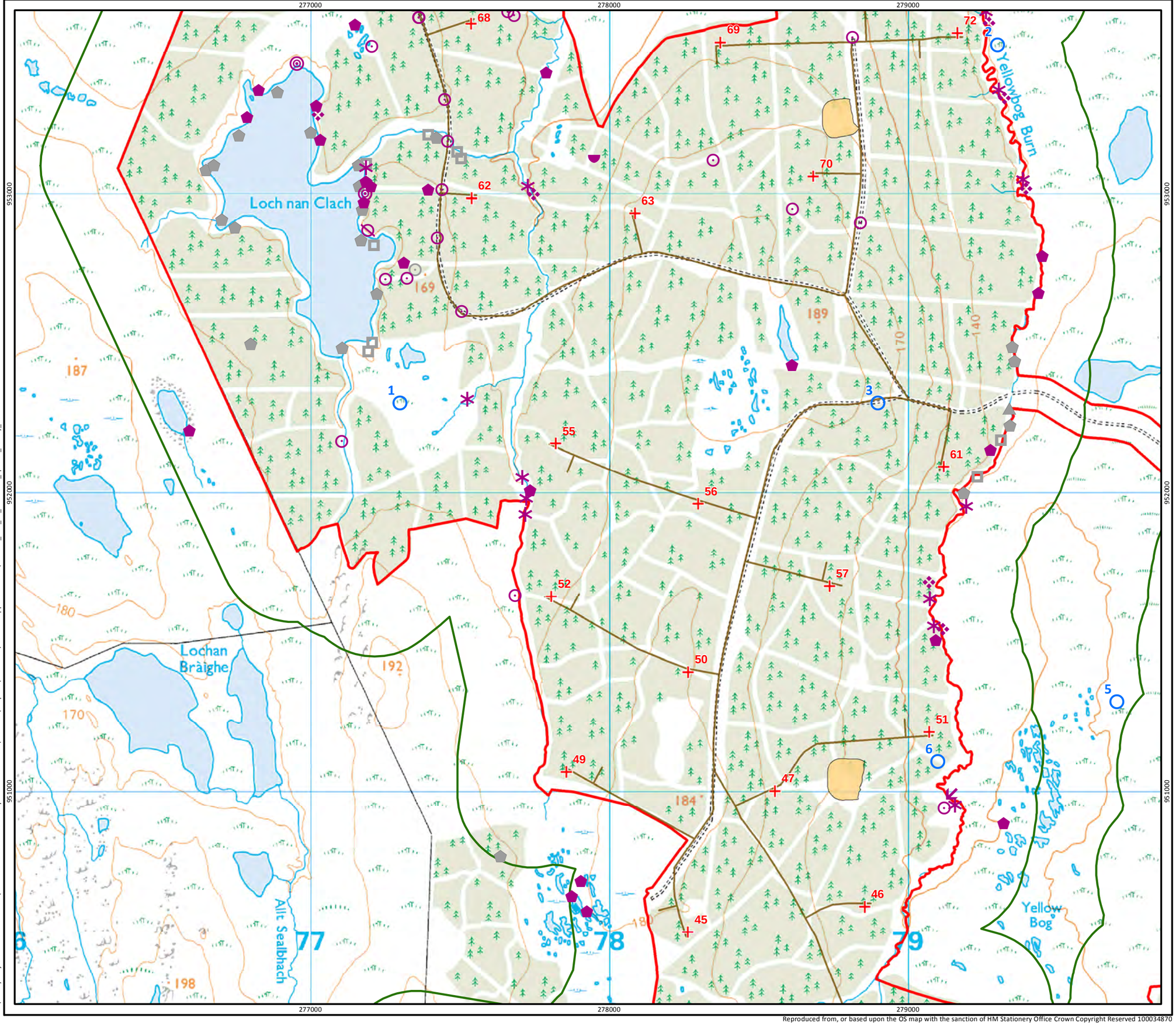
Scale 1:12,000 @ A3

0 125 250 500 m

N

Figure A10.2.13a
Protected Species Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2



SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey Boundary 2012
- Target note

Mammal Evidence 2012

- Otter feeding signs
- Otter spraint
- Otter slide
- Otter print
- Watervole droppings
- Watervole burrow
- Pine marten sighting
- Pine marten scat
- Pine marten den

Mammal Evidence 2007 ES

- Otter holt
- Otter spraints and footprints
- Watervole live animal
- Watervole signs
- Pine marten scat

Scale 1:12,000 @ A3

0 125 250 500 m

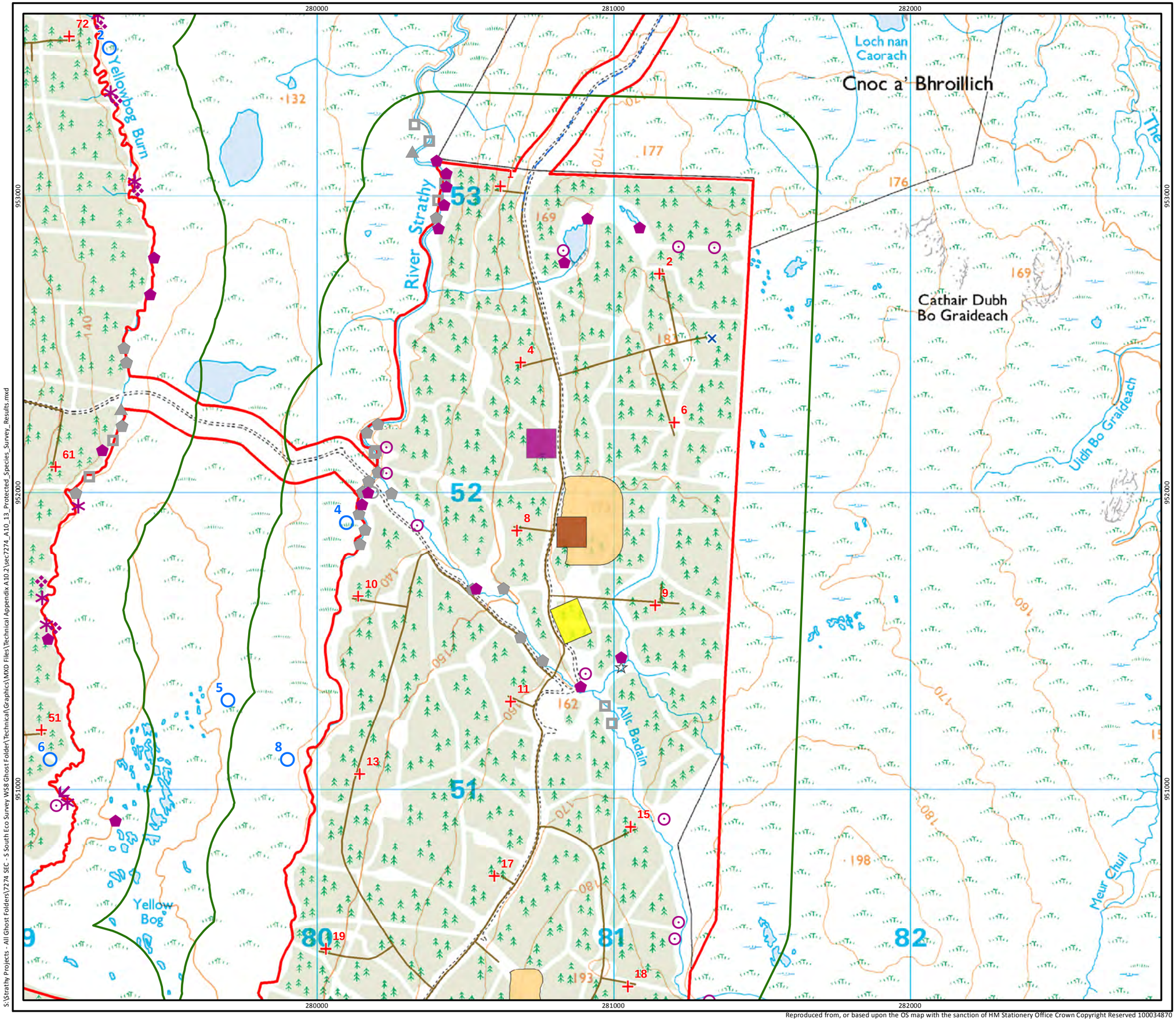
N

Figure A10.2.13b
Protected Species Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_13_Protected_Species_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey Boundary 2012
- Target note

Mammal Evidence 2012

- Otter feeding signs
- Otter spraint
- Otter slide
- Otter print
- Watervole droppings
- Watervole burrow
- Pine marten sighting
- Pine marten scat
- Pine marten den

Mammal Evidence 2007 ES

- Otter holt
- Otter spraints and footprints
- Watervole live animal
- Watervole signs
- Pine marten scat

Scale 1:12,000 @ A3

0 125 250 500 m

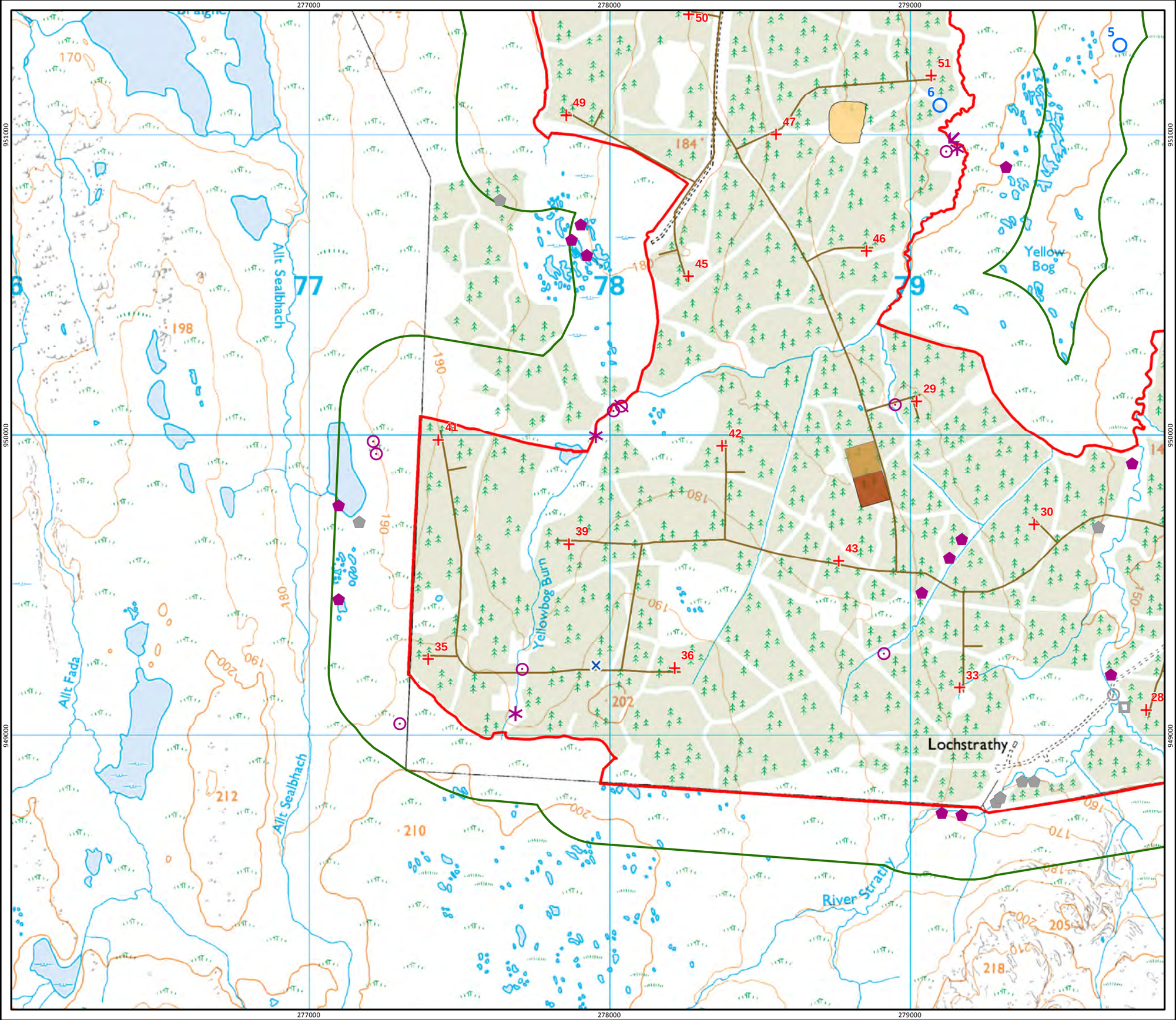
N

Figure A10.2.13c
Protected Species Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_13_Protected_Species_Survey_Results.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey Boundary 2012
- Target note

Mammal Evidence 2012

- Otter feeding signs
- Otter spraint
- Otter slide
- Otter print
- Watervole droppings
- Watervole burrow
- Pine marten sighting
- Pine marten scat
- Pine marten den

Mammal Evidence 2007 ES

- Otter holt
- Otter spraints and footprints
- Watervole live animal
- Watervole signs
- Pine marten scat

Scale 1:12,000 @ A3

0 125 250 500 m

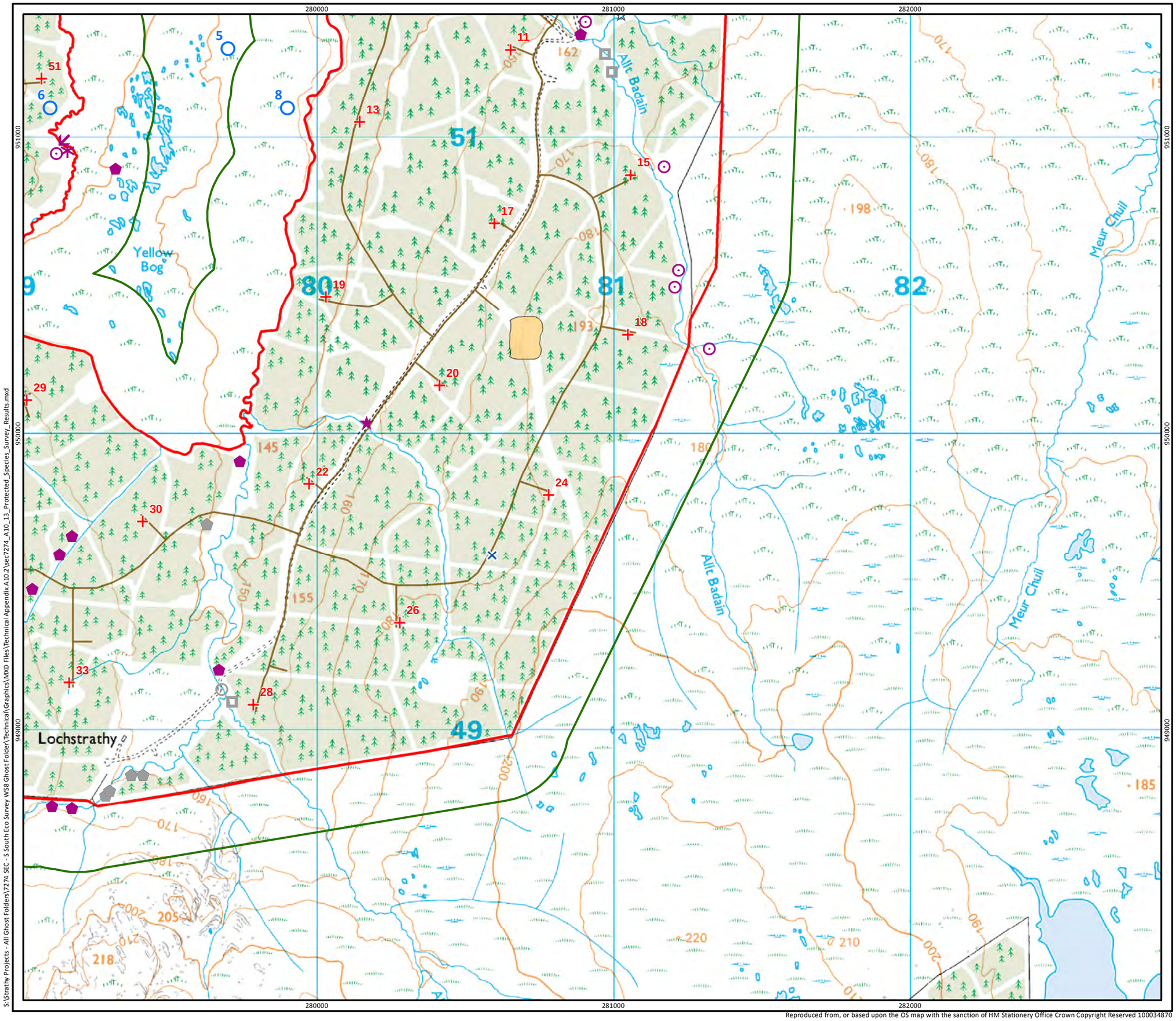
N

Figure A10.2.13d
Protected Species Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey WS8 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_13_Protected_Species_Survey_Results.mxd



S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey W58 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_13_Protected_Species_Survey_Results.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit
- Survey Boundary 2012
- Target note

Mammal Evidence 2012

- Otter feeding signs
- Otter spraint
- Otter slide
- Otter print
- Watervole droppings
- Watervole burrow
- Pine marten sighting
- Pine marten scat
- Pine marten den

Mammal Evidence 2007 ES

- Otter holt
- Otter spraints and footprints
- Watervole live animal
- Watervole signs
- Pine marten scat

Scale 1:12,000 @ A3

0 125 250 500 m

N

Figure A10.2.13e
Protected Species Survey Results
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

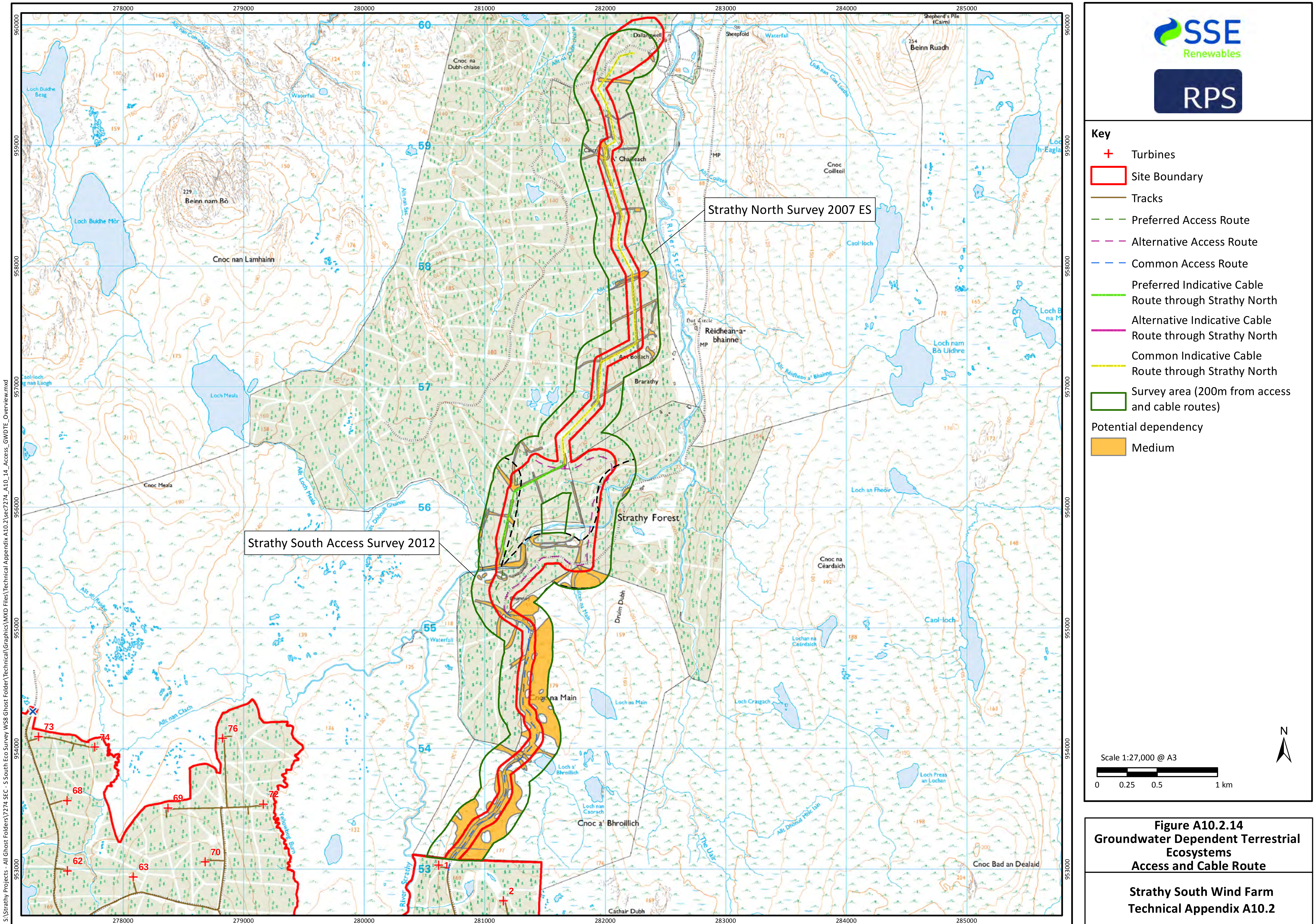
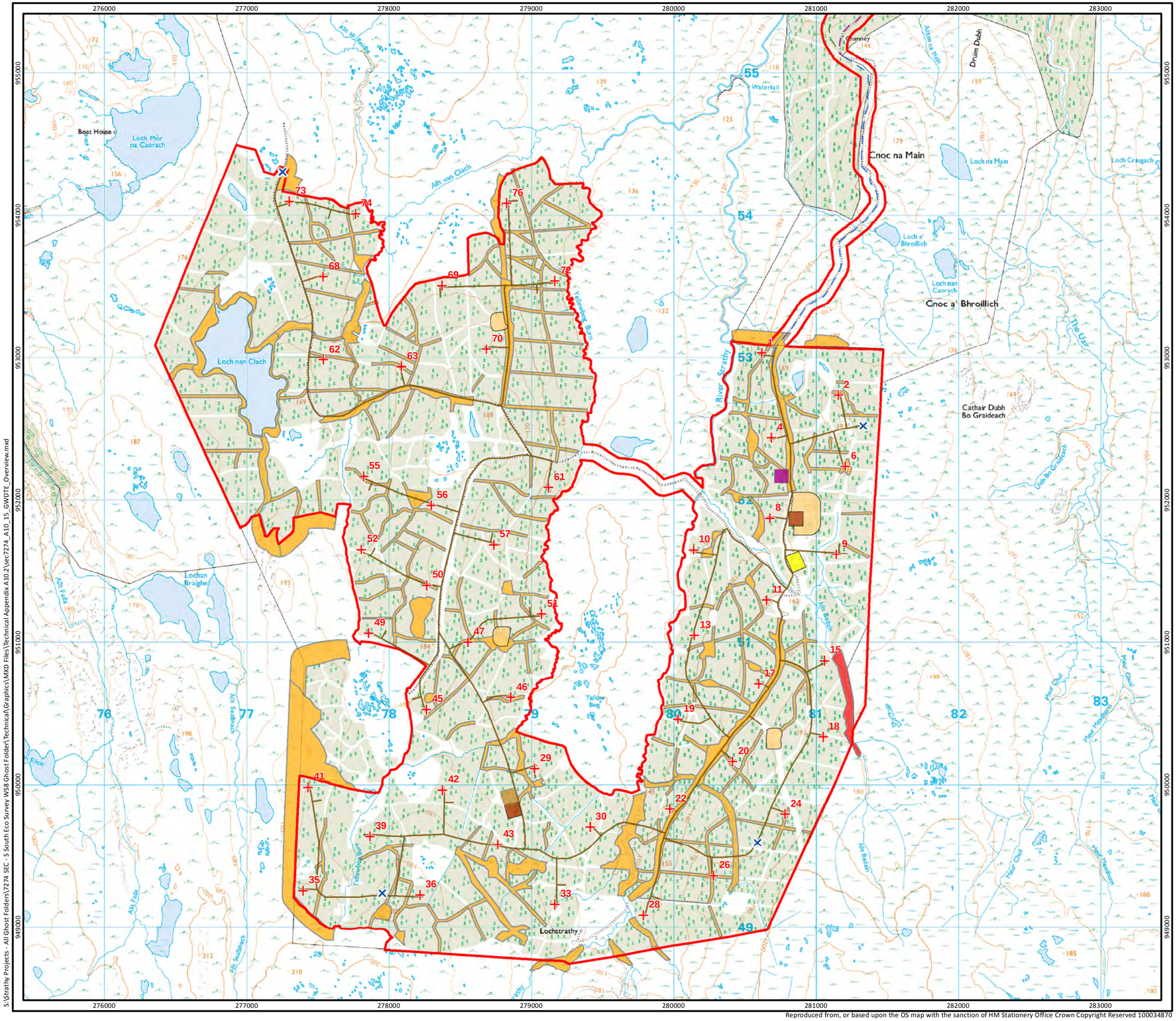


Figure A10.2.14
Groundwater Dependent Terrestrial Ecosystems
Access and Cable Route

Strathy South Wind Farm
Technical Appendix A10.2

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

S:\Strathy Projects - All Ghost Folders\7274 SEC - S South Eco Survey W58 Ghost Folder\Technical\Graphics\MXD Files\Technical Appendix A10.2\sec7274_A10_15_GWDTE_Overview.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Preferred Indicative Cable Route through Strathy North
- Alternative Indicative Cable Route through Strathy North
- Common Indicative Cable Route through Strathy North
- Concrete Batching Plant
- Construction Compound
- Switching Station
- Laydown Area
- Borrow Pit

Potential dependency

- Medium
- High

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

N

Figure A10.2.15
Groundwater Dependent Terrestrial Ecosystems
Wind Farm Site

Strathy South Wind Farm
Technical Appendix A10.2

Technical Appendix A10.4

Strathy South Wind Farm: assessments of fish habitats and populations

Commissioned Report to: SSE Renewables

October 2012

Waterside Ecology
Druimindarroch
Arisaig
Inverness-shire
PH39 4NR
T: 01687 450298
M: 07788717605
jon@watersideecology.co.uk

www.watersideecology.co.uk

Table of Contents **Page**

1 Introduction ... 3
1.1. Background ... 3
1.2. Wind Farm Construction and Operation ... 3
1.3. Project objectives and scope ... 3
1.4. Fish species present ... 4
1.5. Fish habitat requirements ... 4
1.5.1. Salmonids ... 4
1.5.2. Eels ... 5
1.5.3. Lampreys ... 5

2 Objectives ... 5

3 Methods ... 6
3.1. Habitat assessments ... 6
3.2. Fish populations ... 8
3.2.1. Baseline assessment ... 8
3.2.2. Repeat pre-construction surveys ... 8

4 Results ... 11
4.1. Stream habitats ... 11
4.1.1. Overview ... 11
4.1.2. Obstacles to migration ... 12
4.1.3. River Strathy ... 12
4.1.4. Yellowbog Burn ... 13
4.1.5. Allt nan Clach & Allt an Reidhe ... 14
4.1.6. Allt Loch na Saobhaidhe ... 14
4.1.7. Allt Badian ... 14
4.1.8. Allt na Dubh-chlaise ... 14
4.1.9. The Uair ... 15
4.1.10. Allt Dhonuill Ghuinne/Allt Loch Meala ... 15
4.1.11. Other streams ... 15
4.2. Fish populations, baseline assessment 2007 ... 16
4.2.1. Salmon ... 16
4.2.2. Trout ... 18
4.2.3. Other fish species ... 20
4.3. Repeat surveys 2009 and 2012 ... 21
4.3.1. Other fish species ... 22

5 Evaluation ... 22
5.1. Key sites and issues ... 22
5.2. Limitation of data ... 23

6 Conclusions ... 24

7 References ... 24

List of Figures **Page**

Figure 1 Habitat survey sections ... 7
Figure 2 Electric fishing sites 2007 ... 9

Figure 3 Distribution of spawning habitat, River Strathy 13
Figure 4 Salmon size distribution, River Strathy 2007 17
Figure 5 Trout size distribution, River Strathy and tributaries, 2007 19

List of Tables **Page**

Table 1 Salmonid habitat categories used for walkover survey 6
Table 2 Abundance classifications for North Fishery Statistical Region (from Godfrey 2006) 8
Table 3 Electric fishing sites, Strathy catchment 10
Table 4 Habitat availability in the River Strathy and tributary streams 11
Table 5 Habitat availability as percent of total in survey area 11
Table 6 Obstacles to migration 12
Table 7 Salmonid densities at electric fishing sites, Strathy 2007 16
Table 8 Numbers of eels and presence of larval lampreys at electric fishing sites, Strathy 2007 20
Table 9 Salmon fry and parr densities (fish.100 m^{-2}) in each year of monitoring 21
Table 10 Trout fry and parr densities (fish.100 m^{-2}) in each year of monitoring 21
Table 11 Eel numbers (n) in each year of monitoring 22

1 Introduction

1.1. Background

SSE Renewables (UK) Ltd (referred to as SSER) and acting on behalf of the applicant SSE Generation Ltd, propose constructing a wind farm known as Strathy South in Strathy South Forest, , should it be consented. The Strathy South Wind Farm would be constructed about 12 km southwest of Strathy village and would occupy an area currently planted with commercial conifer forest. The proposal is for the construction of 47 wind turbines and associated borrow pits, roads and control building. This would require the clearing of approximately 13 km^2 of forest. Access tracks would be constructed in the forest, extending from the existing forest tracks. A number of new stream crossings are proposed and existing crossings would require upgrading (refer to Technical Appendix A14.3: Strathy South Watercourse Crossing Assessment).

Several streams flow through the site, all of which are part of the River Strathy catchment. The largest of these are the River Strathy, Yellowbog Burn and Allt nan Clach. Smaller streams include Allt an Reidhe, Allt Badian and Allt Loch na Saobhaidhe. The River Strathy itself is a small to medium sized river with a mean daily flow 2.27 $m^3.s^{-1}$ and a total catchment area of 113.5 km^2. The catchment drains the internationally designated peatlands of the 'Flow Country' and the proposed development site has a significant cover of blanket peat.

Surveys of the aquatic environment are required to inform the environmental assessment of the Modified 2013 Scheme. The River Strathy is a valuable salmon *Salmo salar* fishery and concerns have been raised as to the potential effect of the development on salmon and trout *Salmo trutta* populations. Concerns were also raised during the consultation process about the potential for wider impacts on watercourses, mediated via changes in water quality.

1.2. Wind Farm Construction and Operation

During the construction of the wind farm there would be physical disturbance to soils including removal that may alter the hydrological characteristics of the site. In addition, particularly during construction, potential sources of pollution would be present on the site. As a result of exposure of soils during construction, there is also a potential risk of inputs of suspended solids to watercourses, resulting in siltation or sedimentation.

As much of the proposed site is covered in coniferous plantation, extensive felling would be required prior to construction. Conifer removal and breakdown of timber and brash could result in increased nutrient loss from clear-fell sites (Reynolds *et al*. 1995). This in turn may lead to leaching of phosphates, nitrates and potassium into stream water, potentially stimulating algal growth. Nitrate pulses associated with felling have potential to increase stream acidity, but in the longer term this is offset by reduced atmospheric scavenging (Neal *et al*. 1998). Most negative effects can be ameliorated by phasing felling over several years (Neal *et al*. 2004), as is proposed at Strathy South. Felling operations can could also lead to hydrological changes, via altered run-off and transpiration, as well as physical impacts due to sediment run-off.

1.3. Project Objectives and Scope

Hydrological change, pollution, sedimentation or changes to water chemistry have potential to impact aquatic environments and associated species. This report provides baseline data on fish habitats and populations, particularly salmon and trout, which form the basis of local sport fisheries.

Surveys extended outside the wind farm site boundary into the wider River Strathy catchment (see Figures 1 and 2) in order that data and potential impacts were able to be assessed from a catchment perspective. This is particularly important if potential impacts on fish are to be properly assessed at

the population level. The wider surveys also provided baseline data from stream reaches that would receive runoff from the site.

1.4. Fish Species Present

The River Strathy supports recreational fisheries for salmon and trout. These species form the main target of investigations of fish populations although non-salmonid species are considered.

Salmon are widespread in northern and south-western Britain, but absent from large areas of south England due to poor water quality, barriers and habitat degradation (Davies *et al*. 2004). Adult populations have declined throughout the salmon's north Atlantic range over the last ten to twenty years due to a reduction in marine survival (O' Maoileidigh 2002). In addition, the species is threatened throughout its range by pollution, over-exploitation, fish farming, habitat degradation, barriers to migration, predation and mis-management such as inappropriate stocking (Hendry & Cragg-Hine 2003).

Salmon are present in most of the larger rivers in the north of Scotland (Davies *et al*. 2004), including the River Strathy. Salmon are listed under Annex II of the Habitats and Species Directive, requiring EU member states to designate Special Areas of Conservation. Salmon are also listed under the Bern Convention and the UK Biodiversity Action Plan. Salmon are also listed as species of local importance in the Sutherland Local Biodiversity Action Plan (Sutherland Biodiversity Group 2003).

The brown trout is distributed throughout the Atlantic, North, White and Baltic sea basins of Europe, from Spain to Russia. The species occurs both as freshwater resident forms (brown trout) and anadromous forms (sea trout). Although locally common, populations of brown trout and sea trout have declined in many areas due to pollution, disease and habitat degradation. Brown trout genetics are poorly understood but it is clear that numerous genetically distinct sub-populations exist. Unfortunately the phylogeographic structure of trout populations has been almost completely destroyed by stocking (Kottelat & Freyhof 2007) and many unique races may already have been lost (Antunes *et al* 1999). Brown trout are included on the updated UK BAP list. Brown trout and sea trout are widespread in the north of Scotland and both are present in the River Strathy. Both are listed as species of local importance in the Sutherland Local Biodiversity Action Plan.

The only other fish species known to be present in the Strathy catchment, based on data collated from the National Biodiversity Network Gateway and general maps of their distribution produced by Davies *et al*. (2004) is the eel *Anguilla anguilla*. However, the lampreys *Lampetra spp*. and *Petromyzon marinus* are poorly recorded in northern Scotland and a lack of records is not good evidence of their absence (Watt & Ravenscroft 2005). Brook lampreys are present in the River Halladale, immediately to the east of the River Strathy and both brook and sea lampreys are present in the River Naver to the west. All three UK lamprey species are listed on Annex IIa of the Habitats Directive and Appendix III of the Bern Convention.

1.5. Fish Habitat Requirements

1.5.1. Salmonids

The physical habitat requirements of juvenile salmonids have been subject to a considerable amount of detailed study (for reviews see e.g. Crisp 1993; Hendry & Cragg-Hine 2003; Klemetsen *et al.* 2003; Summers *et al*. 1996; Youngson & Hay 1996). Trout and salmon spawn in late autumn and early winter, depositing their eggs in redds which they excavate in gravel and pebble substrates. Spawning depth can range from 5 cm to 90 cm (review by Neary 2006), but it is likely that habitat is selected on the basis of suitable substrate and flow rather than depth *per se*. Eggs are often deposited in areas of accelerating flow, such as the tails of pools and glides, upstream from riffles. However, in upland streams eggs may be deposited in any areas of gravel that can be physically moved. A good supply of oxygen is essential for eggs to develop and this is facilitated by a flow of water through the gravel.

Clogging with fine sediment such as silt and fine sand reduces water flow resulting in egg mortality due to lack of oxygen. Egg survival is also affected by redd 'washouts' during winter spates – the direct, physical, scouring out of eggs from the gravel. Substrate stability, the dynamics of water flow and the weather all determine the extent of siltation and washouts.

After hatching the young fry remain in the gravel as alevins, absorbing nutrient from the remaining yolk sac. On emergence, usually between March and early May, the young fry disperse and set up territories which they defend aggressively. Salmon fry prefer fast flows (>30 cm/s) and favour areas with surface turbulence (riffle habitat). They require a rough bed of pebble, cobble and gravel. Trout fry prefer areas of relatively low velocity water near the streambed and often inhabit slower flows than salmon fry. Cover from stones, plants or debris is required and good cover is essential for maintaining high fry densities. Salmon that have survived their first winter (parr) prefer deeper water than fry (typically 15-40 cm) and a coarser substrate often consisting of pebbles, cobbles and boulders. Trout parr generally favour areas of relatively low current speed where cover is available. Juvenile trout are often to be found in cover alongside the banks, in undercuts, among tree roots or in marginal vegetation. Cover remains important for adult trout and salmon particularly in smaller streams. In larger rivers and lochs this may be less important, as deep water provides refuge.

1.5.2. Eels

Eel habitat requirements have received less attention than those of salmonid fish. Tesch (2003) suggests that so long as temperature and oxygen requirements are met, there are few stretches of water that are not suitable for eels. The main requirement for eels is cover, as they are averse to light and require suitable refuges during daylight hours. Eels of different size show different substrate preferences. Larger eels require large hollows, crevices or weed beds whereas small eels are sometimes abundant in cobble substrates, where they can burrow between the stones. Tree stumps, roots and other large structures provide ideal cover for eels. Eel diet is diverse, but the majority of diet consists of benthic species (Moriarty 1978; Kottelat & Freyhof 2007).

1.5.3. Lampreys

Adult lampreys aggregate to spawn and extrude their eggs into 'nests' excavated in the river bed. The ova require clean, well-oxygenated substrates for their survival. After hatching the young lamprey larvae, known as ammocoetes, drift downstream with the current. They settle in nursery habitat consisting of fine, soft substrates of silt and sand in well oxygenated, slow flowing water. The ammocoetes are blind and feed on fine particulate matter such as diatoms, algae and bacteria. Ammocoetes spend several years in this muddy nursery habitat before metamorphosing (or transforming) from larval to adult form. Upstream migrating lampreys may be prevented from reaching spawning grounds by both natural and man-made barriers. They are weak jumpers, so can be prevented from moving upstream by relatively low vertical barriers.

2 Objectives

The objectives of the survey were to:

(i) Describe stream habitats in the various watercourses draining the site of the proposed wind farm. In particular, to describe their suitability for the various fish species that are potentially present.

(ii) Identify the main obstacles to migration in the above streams, in particular the likely upper limits for the distribution of salmon and sea trout.

(iii) Carry out electric fishing surveys to describe species composition and distribution within target watercourses.

3 Methods

3.1. Habitat Assessments

A full habitat survey was carried out during August and early September 2007. This survey was conducted to inform the 2007 Environmental Statements for both Strathy South and Strathy North wind farms. The survey extended over all the main watercourses within the wind farm boundaries and also the mainstem of the River Strathy downstream to the A836 road bridge (NC 8362 6518), some 500 m upstream from the tidal limit. Survey methods were based on protocols described by Hendry and Cragg-Hine (1997) and Summers *et al*. (1996). These characterise in-stream habitats according to depth, substrate, flow and thus suitability for different age classes of salmonid. The habitat categories used during the survey and in this report are set out in Table 1 (see Appendix 6 for photographic examples of habitat types).

Table 1 Salmonid habitat categories used for walkover survey

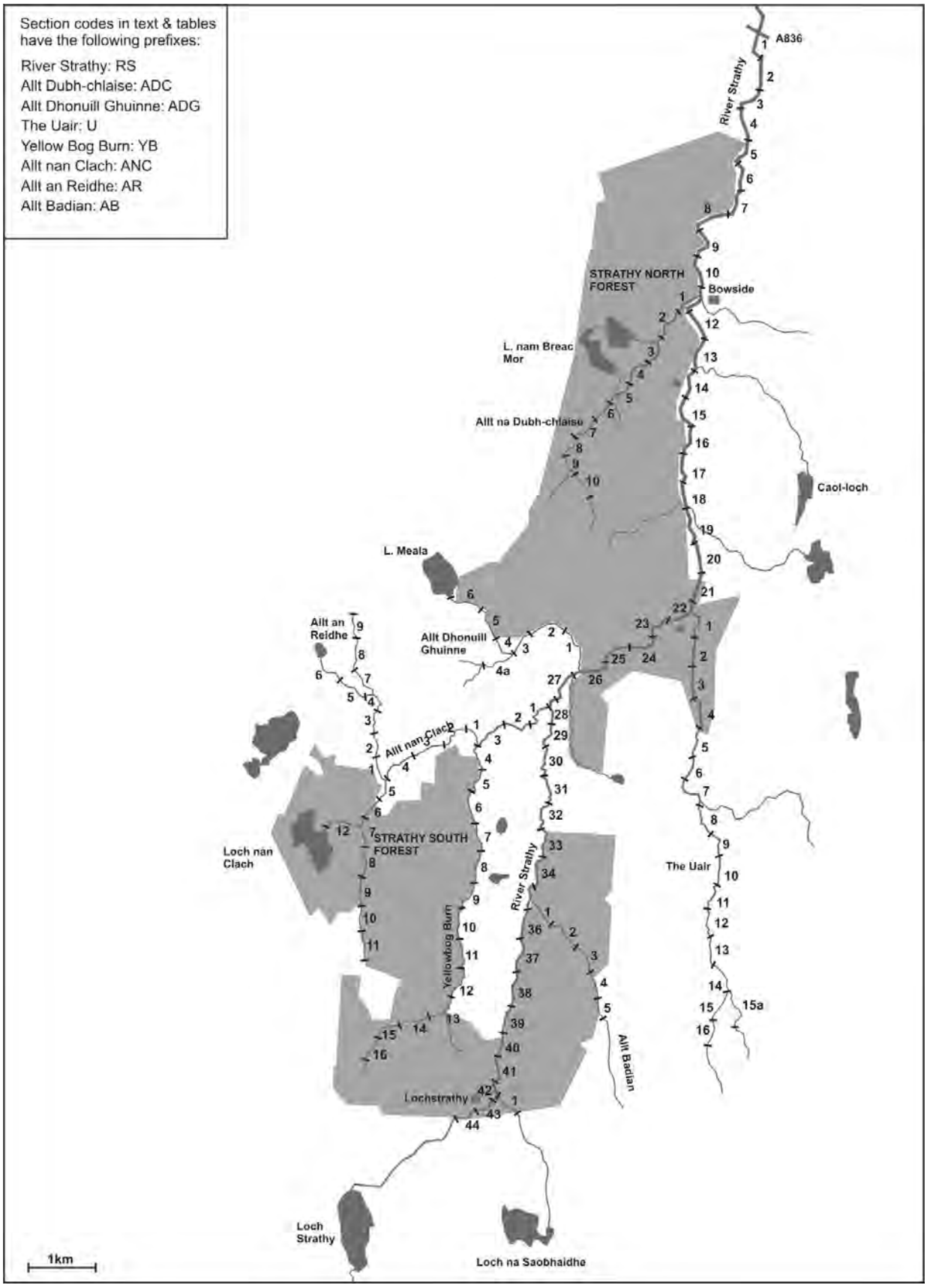
Habitat Type	Classification
Fry habitat	Shallow (< 20 cm) and fast flowing water with surface turbulence and a substrate dominated by pebbles and cobbles
Mixed juvenile habitat	Generally deeper water than fry habitat (20-40 cm) with a pebble, cobble and boulder substrate. Water may be more turbulent than fry habitat. Stream edges often more suited to fry than parr.
Deep juvenile habitat	Water over 40 cm deep with pebble, cobble and boulder substrate and moderate or fast flow (generally in main-stem rivers).
Glides (adult habitat)	Smooth flow with little surface turbulence and generally greater than 30 cm deep. Small substrates dominated by cobbles and fine materials offering little cover for juvenile fish.
Pools (adult habitat)	Little or no perceptible flow and usually greater than 1 metre deep.
Bedrock and gorge	Habitat dominated by sheets of bare rock. Depth usually <50 cm. Little or no cover and unsuited to juvenile fish. May include different flow types including pools (although larger pools recorded separately as Pool).
Spawning	Ideally stable & not compacted. Mean substrate size up to 80 mm. Fines (sand & fine gravel <2 mm) less than 20%. Not silted.
Incised peat channels	Flowing water running through simple channels in peat and lacking hard substrates.

The survey encompassed all potentially suitable habitats in the catchment, the upper limit on each watercourse being where the streams clearly became too small to support salmonids. The exception was the River Strathy itself where the upstream limit was at the deer fence at NC 7925 4876. No access permission could be obtained south of this point, although salmon are known to ascend at least as far upstream as Loch Strathy. A total of 63.1 linear kilometres of river and stream was surveyed.

Surveys were based on contiguous sections of approximately 500 m in length (Figure 1 and Appendix 1). Within each survey section, areas of each habitat type were marked on maps. The broad suitability for juvenile and adult salmonids of each section was noted. The survey also identified barriers to migration that may, in part, determine the distribution of fish species. The likely permeability of obstacles for adult salmonids, eels and lampreys was assessed. Other variables recorded in each survey section were: up and downstream grid reference, wet width (m), substrate stability, compaction and availability of cover for fish alongside banks.

Suitability of habitats for lampreys was assessed based on habitat criteria described by Maitland (2003) and Hardisty (2006).

Figure 1 Habitat survey sections



3.2. Fish Populations

3.2.1. Baseline Assessment

A full baseline assessment of fish populations was carried out during September 2007, covering all watercourses included in the habitat survey. Suitable survey sites, representative of available habitats, were identified during the habitat survey. Fish populations were surveyed by electric fishing, a non-lethal sampling technique. All surveys were carried out to SFCC (2007) protocols and included both fully quantitative and semi-quantitative assessments (Table 3, Figure 2). Fully quantitative surveys provide data on absolute fish abundance within known error margins. The inclusion of semi-quantitative surveys allows a greater number of sites to be assessed than if all sites were surveyed fully quantitatively.

Where practical, fully quantitative sites were isolated using stop nets, to prevent fish from moving in or out of the site during surveys. Each fully quantitative site was fished through three times. The catch from each run through the site was held and processed separately. This multiple pass fishing allows absolute fish densities to be calculated, based on the decline in catch during successive runs. No stop nets were used at semi-quantitative sites and a single electric fishing run was made through each. Some qualitative (presence versus absence) surveys were carried out in the smallest streams (e.g. Allt an Fhithich) to determine presence and/or upstream limits of fish distribution.

Fish were held in covered bins prior to processing and were identified and scored separately for each run. Salmonid fork length was measured to the nearest 1 mm. Scales were collected from trout and salmon to assist with age determination. Fish were allowed to recover fully in clean water before being released back into the survey reach. All fish density data are presented as number of fish per 100 square metres of wetted survey area (fish.100 m^{-2}). The density classifications provided by Godfrey (2006) are used to describe the abundance of salmon and trout within a regional context (Table 2). These densities are based on single-run (semi-quantitative) survey. Zippin (1958) densities are provided for fully quantitative survey sites. Habitat descriptions at electric fishing survey sites were collected according to the SFCC protocol (SFCC 2007).

Table 2 Abundance classifications for North Fishery Statistical Region (from Godfrey 2006)

Class	**Density (fish per 100 m^2)**			
	Salmon 0+	*Salmon 1++*	*Trout 0+*	*Trout 1++*
A (excellent)	>29.4	>16.3	>10.1	>7.6
B (good)	14.8 – 29.3	9.5 – 16.3	5.1 – 10.1	4.4 – 7.6
C (fair)	10.7 – 14.7	6.4 – 9.4	4.2 – 5.0	2.7 – 5.3
D (poor)	5.5 – 10.6	2.2 – 6.3	1.8 – 4.1	1.1 – 2.6
E (very poor)	0.5 – 5.4	1.0 – 2.1	0.5 – 1.7	0.6 – 1.1
F (unclassified)	<0.5	<1.0	<0.5	<0.6

3.2.2. Repeat Pre-construction Surveys

A sub-set of the electric fishing sites at Strathy South were resurveyed during September and early October 2009 and 2012 in order to provide an indication of natural fluctuations in numbers prior to wind farm construction. The following sites were resurveyed: RS8, RS9, RS11, YB2, YB4, ANC1, ANC2, ANC3 (Table 3). Most resurvey work used semi-quantitative fishing.

Figure 2 Electric fishing sites 2007

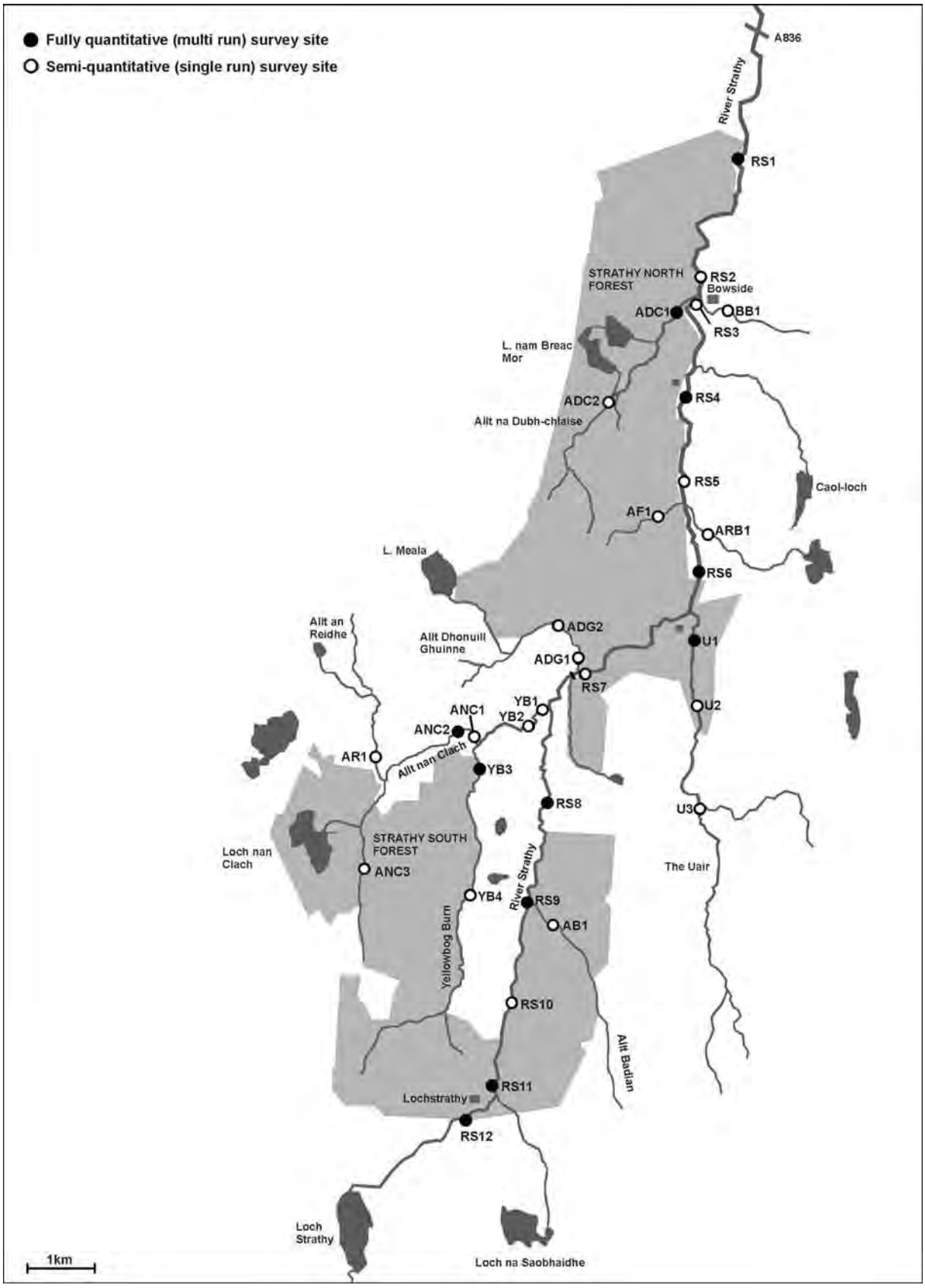


Table 3 Electric fishing sites, Strathy catchment

Code	NGR	Watercourse	Survey type	Area	Year of survey	
					Baseline survey	Strathy South repeat surveys*
RS1	NC 8333 6328	River Strathy	Fully quantitative	408.9	2007	
RS2	NC 8279 6133	River Strathy	Semi-quantitative	132.6	2007	
RS3	NC 8275 6107	River Strathy	Semi-quantitative	318.4	2007	
RS4	NC 8249 5952	River Strathy	Fully quantitative	273	2007	
RS5	NC 8253 5840	River Strathy	Semi-quantitative	238.9	2007	
RS6	NC 8267 5649	River Strathy	Fully quantitative	290.4	2007	
RS7	NC 8098 5547	River Strathy	Semi-quantitative	220.8	2007	
RS8	NC 8045 5349	River Strathy	Fully quantitative	139.6	2007	2009, 2012
RS9	NC 8015 5195	River Strathy	Fully quantitative	133.2	2007	2009, 2012
RS10	NC 7993 5058	River Strathy	Semi-quantitative	132.6	2007	
RS11	NC 7965 4917	River Strathy	Fully quantitative	126	2007	2009, 2012
RS12	NC 7928 4877	River Strathy	Fully quantitative	143.5	2007	
YB1	NC 8040 5496	Yellowbog Burn	Semi-quantitative	22	2007	
YB2	NC 8017 5468	Yellowbog Burn	Semi-quantitative	132	2007	2009, 2012
YB3	NC 7941 5417	Yellowbog Burn	Fully quantitative	80.5	2007	
YB4	NC 7935 5232	Yellowbog Burn	Semi-quantitative	100.1	2007	2009, 2012
ANC1	NC 7937 5444	Allt nan Clach	Semi-quantitative	25.3	2007	2009, 2012
ANC2	NC 7929 5464	Allt nan Clach	Fully quantitative	102.7	2007	2009, 2012
ANC3	NC 7778 5263	Allt nan Clach	Semi-quantitative	50.6	2007	2009, 2012
AR1	NC 7782 5420	Allt an Reidhe	Semi-quantitative	93.6	2007	
ADC1	NC 8239 6085	Allt na Dubh-chlaise	Fully quantitative	110.2	2007	
ADC2	NC 8140 5961	Allt na Dubh-chlaise	Semi-quantitative	58.8	2007	
ADG1	NC 8094 5557	Allt na Dhonuill Ghuinne	Semi-quantitative	70	2007	
ADG2	NC 8076 5605	Allt na Dhonuill Ghuinne	Semi-quantitative	73.8	2007	
AB1	NC 8050 5170	Allt Badian	Semi-quantitative	55.5	2007	
AF1	NC 8181 5763	Allt an Fhithich	Qualitative	N.A.	2007	
ARB1	NC 8280 5760	Allt Reidhean a Bhainne	Qualitative	15	2007	
BB1	NC 8307 6100	Bowside Burn	Qualitative	18	2007	
U1	NC 8268 5598	The Uair	Fully quantitative	117.15	2007	
U2	NC 8273 5476	The Uair	Semi-quantitative	93.1	2007	
U3	NC 8271 5340	The Uair	Semi-quantitative	149.4	2007	

**A number of other sites have been resurveyed during pre-construction monitoring of Strathy North Wind Farm (see Waterside Ecology 2012)*

4 Results

4.1. Stream Habitats

4.1.1. Overview

Tables 4 and 5 summarise habitat availability in the main-stem of the River Strathy and in each of its major tributaries. Over 80% of the wetted survey area is within the mainstem of the River Strathy. Of the tributaries, only The Uair and Yellowbog Burn contribute more than 5% of wetted area. The five smaller tributaries, Allt Loch na Saobhaidhe, Allt na Dubh-chlaise, Allt Badian, Allt nan Clach and Allt Dhonuill Ghuinne, contribute some 6.7% of wetted area in total.

Table 4 Habitat availability in the River Strathy and tributary streams

Watercourse	Wetted area (m^2)	Area (m^2)							
		Fry	*Mixed juvenile*	*Deep juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*
River Strathy	221,723	15,764	126,163	16,490	41,197	20,147	280	0	1,682
Allt L. na Saobhaidhe	510	250	60	0	0	0	0	200	0
Allt Badian	2,220	0	1,187	0	967	66	0	0	0
Yellowbog Burn	14,385	827	5,716	0	6,152	1,097	0	550	43
Allt nan Clach*	10,252	354	2,762	0	2,940	615	0	3,548	32
Allt na Dubh-chlaise	2,585	460	915	0	50	0	0	1,090	70
The Uair	20,820	758	12,401	0	4,507	943	1,240	900	70
Allt Dhonuill Ghuinne	3,515	0	1,725	0	987	91	0	712	0
Total	276,010	18,414	150,930	16,490	56,801	22,960	1,520	7,000	1,897

*includes Allt an Reidhe

Due mainly to its comparatively large size, the mainstem of the River Strathy contains the majority of spawning, juvenile and adult habitats for salmon (Tables 4 and 5). This strongly suggests that the main river is likely to support the bulk of the salmon population and will be the main resource sustaining the salmon fishery. In general, spawning habitat suitable for salmon was scarce in tributary streams and in most of these streams juvenile habitat appeared better suited to trout than salmon, with relatively slow flows and good overhead cover alongside the banks. Appendix 2 provides a description of each section. A series of photographs of survey sections is included as Appendix 7.

Table 5 Habitat availability as percent of total in survey area

Watercourse	% of total in survey area				
	All habitats	*Juvenile habitats*	*Glide & pool*	*Bedrock & peat*	*Spawning*
River Strathy	80.3	85.2	76.9	3.3	88.7
Allt L. na Saobhaidhe	0.2	0.2	0.0	2.3	0.0
Allt Badian	0.8	0.6	1.3	0.0	0.0
Yellowbog Burn	5.2	3.5	9.1	6.5	2.3
Allt nan Clach*	3.7	1.7	4.5	41.6	1.7
Allt na Dubh-chlaise	0.9	0.7	0.1	12.8	3.7
The Uair	7.5	7.1	6.8	25.1	3.7
Allt Dhonuill Ghuinne	1.3	0.9	1.4	8.4	0.0

*includes Allt an Reidhe

4.1.2. Obstacles to Migration

Table 6 summarises obstacles to migration identified during the 2007 walkover survey. No impassable obstacles were identified on the River Strathy, Yellowbog Burn, Allt nan Clach or other streams in Strathy South forest. The waterfall at NC 8052 5491 on the River Strathy and ford at NC 7968 4913 are both clearly passable for both up and downstream migrants. The ford may impede adult salmon at low flows, but as salmon usually move on moderate or high flows this is not a significant issue. Thus the streams within the site boundary are accessible to salmon and sea trout.

The forest surrounding the lower reaches of Allt na Dubh-chlaise has been subject to severe storm damage and numerous trees have fallen across the stream a few hundred metres upstream from the confluence with the River Strathy.

The rapid at the bedrock shelf at NC 8275 5492 on The Uair was judged passable at most flows. It is probable that salmon would choose to run it mainly on moderate or high flows. Due to the energy expenditure required to surmount this type of obstacle, steep rapids may also act as 'thermal barriers', which fish ascend only once the water temperature rises above a threshold level.

No significant obstacles were identified on any of the other major tributaries. A waterfall located a short distance upstream from the River Strathy prevents fish access to Allt na Fhithich.

Table 6 Obstacles to migration

Watercourse	Section	Grid ref	Type	Passable?	Notes
River Strathy	RS28	NC 8052 5491	Water fall	Yes	May impede fish briefly but easily passable all flows (height <1m).
River Strathy	RS42	NC 7968 4913	Ford	Yes	Low flow obstacles fish probably run stream in spate anyway not a problems
Allt na Dubh-chlaise	DC1	NC 8260 6110	Wind-blown trees	Uncertain	Numerous logjams. Stream banks broken down and channel braided. Impossible to fully survey.
The Uair	U4	NC 8275 5492	Rapid/water fall not vertical	Yes, flow dependent	May be flow/temperature dependent.
Allt an Fhithich	AF1	NC 8230 5793	Waterfall	No	No suitable habitat above fall (tiny, peat-based stream).

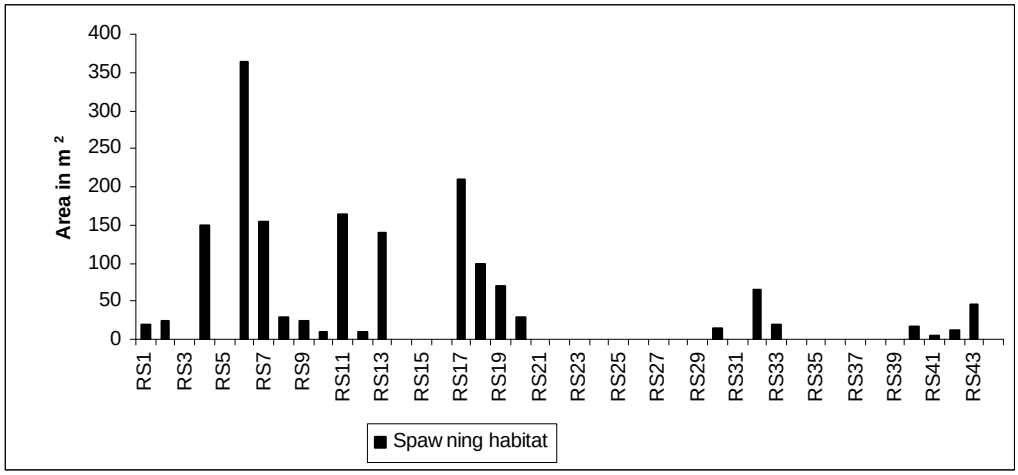
4.1.3. River Strathy

The walkover survey covered approximately 22 km of the River Strathy, from the main road bridge at NC 8362 6518 upstream to the deer fence at the southern edge of Strathy Forest (NC 7925 4876). At the upstream limit of the survey wet width is about 3 m, at the lower limit 16 m.

Where the river enters the site from the south, it is fast flowing and boulder strewn. The gradient soon eases and much of the upper river is meandering with steep, stable bank faces and many pools and glides. Long sections of the upper river flow through blanket peat. Upstream from the Yellowbog Burn confluence the average gradient of the River Strathy is around 0.5% and small substrates, particularly coarse sand are abundant. Below the Yellowbog Burn confluence (sections RS1 to RS28) the nature of the river changes, becoming stony with a bed dominated by cobble, pebble and boulder. The current in the lower river is moderate or fast with a gradient of approximately 0.8%. These broad changes in character are reflected in the distribution of juvenile salmon habitat. Upstream from the Yellowbog Burn confluence in section RS 27 the proportions of glide and pool habitat are greater than below. The converse is true of juvenile salmon habitat. Of 158,417 m^2 of habitat classified as fry, mixed or deep juvenile habitat in the River Strathy, an estimated 143,270 m^2 (90%) is downstream from the confluence with Yellowbog Burn and less than 10% is within the site boundary.

Spawning habitats in each survey section are quantified in Appendix 3 and their distribution in the River Strathy is shown graphically in Figure 3. Salmon spawning habitat is scarce in the vicinity of the site, with only 97 m^2 identified upstream from section RS33 (the downstream edge of the forest). The bulk of spawning habitat is in the lower river, well downstream from the site, with an estimated 1505 m^2 in sections RS1 to RS20. Between sections RS21 and RS31, a distance of 5.5 km, there is very little spawning habitat for salmon or trout.

Figure 3 Distribution of spawning habitat, River Strathy



Very little bank erosion was evident in the upper and middle reaches of the River Strathy and there appear to be few sources of pebble, cobble and gravel to the channel. Similarly, few materials seem to be carried into the river from the various tributaries, which are also mainly very stable. It is not until section RS22, a short distance upstream from The Uair confluence, that rapid bank erosion can be seen, contributing significant quantities of cobble, pebble and gravel to the watercourse. This probably accounts for the downstream bias in the distribution of spawning habitat.

Habitat quality for juvenile salmon in the upper reaches of the River Strathy was mainly judged to be moderate. Large amounts of coarse sand are present in the slower flowing areas, filling spaces around the larger substrates and reducing cover for fish. Nevertheless some good quality habitat is present in the faster sections and limited instream cover from boulders and cobbles is compensated for by the presence of good bank-side cover in the form of undercuts and draped vegetation.

4.1.4. Yellowbog Burn

Yellowbog Burn is a large sub-catchment to the west of the River Strathy. In its lower reaches, the burn is about 4 m in width, reducing to 0.5 m at the upper limit of the survey area. The stream drains blanket bog and the conifer woodland of Strathy South Forest, in the heart of the site. The forest has been planted well back from the stream and even within the plantation there are large areas of open bog and wet heath.

Gradient and substrate composition in Yellowbog Burn are variable and strongly affect habitat suitability for juvenile salmon and trout. The lower reaches (YB1 to YB4) have moderate current speed and gradient of ~0.7%, with substrates of cobble and pebble. These sections contain habitat suitable for salmon parr and fry as well as trout. Further upstream, in the vicinity of the site, the gradient eases and long sections of the stream meander between steep peat banks. These sections appear better suited to trout than to salmon. Trout were observed as far up as section YB14 and may be present even further upstream.

Spawning habitat is not abundant in the Yellowbog Burn (Table 4). Small areas totalling 21 m^2 are present in sections YB1 and YB2, downstream from the site, and these were judged potentially

suitable for spawning salmon (Appendix 3). Further upstream there are small patches of spawning substrate in sections YB8 and YB13, suited mainly to trout. Other small, un-quantifiable patches may be present, but would be unlikely to be suitable for salmon. Overall the availability of spawning habitat in the upper reaches is reduced by compaction of substrates. Cobbles and pebbles, where present, are mainly embedded in a peaty matrix with little interstitial space.

In summary, the better salmon habitat is in the lower part of the survey reach downstream from the site. Habitats further upstream, within the site boundary, appear suited to trout. Spawning habitat is not abundant and in the upper reaches is also suited mainly to trout.

4.1.5. Allt nan Clach & Allt an Reidhe

Allt nan Clach flows into Yellowbog Burn at the top of section YB3. Sections ANC6 to ANC11 flow through Strathy South Forest. The forest is planted well back from the stream throughout in accordance with forestry guidelines. At section ANC5 the stream runs out onto open moorland/blanket bog and is joined from the northwest by Allt an Reidhe. The width of Allt nan Clach varies from 3 m in section ANC 1 to 0.4 m in section ANC11.

The lower 1 km of Allt nan Clach is dominated by moderate flows and pebble/cobble substrates. These reaches provide good quality habitat for juvenile salmon and trout as well as spawning habitats totalling 32 m^2 that are suitable for both species. Further upstream the gradient eases and the stream is slow flowing, meandering between steep peat banks. These upper reaches are suited mainly to trout. Section ANC12 is the outflow stream from Loch nan Clach. It begins as a peat channel flowing through tussocks then gathers pace below the track where pebbles around stable boulder and abundant bank cover provide good trout fry habitat.

Allt an Reidhe drains open moorland and blanket bog. It is a small stream with moderate or low gradient. The meandering channel provides a variety of little pools and glides with good cover for juvenile trout, especially in the lower 1 km. However, spawning habitat is lacking and no suitable areas for salmon spawning were identified.

4.1.6. Allt Loch na Saobhaidhe

This stream drains Loch na Saobhaidhe and joins the River Strathy a short distance downstream from Lochstrathy bothy. Surveyors had access for survey only on the lower 600 m, the section within the site boundary. Here the stream is small, averaging around 1 m wet width. Banks are steep, the stream cutting through peat, and bankside cover from undercuts and draped vegetation cover is good. The stream is suited mainly to juvenile trout; particularly fry as the stream is mainly rather shallow. Spawning substrate for salmon is absent. A few small patches of gravel suitable for trout spawning are present.

4.1.7. Allt Badian

Allt Badian drains an area of blanket bog between The Uair and the River Strathy. It flows into the River Strathy by the track in section RS35. Surveyors had access for survey only on the lower 2.2 km, within the forest fence. This is the section within the site boundary.

Habitat suitable for rearing juvenile salmon is confined mainly to the lower 1 km, with the best habitat immediately upstream from the River Strathy. Most of section AB1 and AB2 is rather steep (gradient ~3%) with habitats consisting of short runs and torrents interspersed with little pools. Cover alongside the banks is good. Spawning habitat was limited to small patches that could not be quantified and are unlikely to be suitable for salmon.

4.1.8. Allt na Dubh-chlaise

Allt na Dubh-chlaise lies almost entirely within Strathy North Forest. The stream varies in width from about 0.3 m in the upper part of the survey area to 1.5 m near its confluence with the River Strathy at NC 8274 6121. The lower three survey reaches are in mature conifer forest that has been planted

right to the edge of the stream. It is likely that this area of forest pre-dates the publication of the Forest and Water Guidelines (Forestry Commission 2003). Habitats in the lower reach are degraded as a result, with increased bank erosion, compaction and over-shading. South of the fence line in sections ADC4 to ADC10, the conifer plantation has been planted well back from the watercourse, in accordance with current guidelines.

Total wetted area at the time of survey was approximately 2,600 m^2 of which over 50% was classified as fry or mixed juvenile habitat (Table 4). The middle reaches in section ADC4 to ADC6 appear well suited to trout production with moderate flows and good bank-side cover. Much of the upper stream i.e. section ADC7 to ADC10 is peat channel, lacking in hard substrate and largely unsuitable for salmonid production. Spawning habitat suited to salmon is confined to the lower reaches of the stream in section ADC1 and ADC2 where an estimated 70 m^2 was available.

The small offshoot that feeds Loch nam Breac Mor is mainly peat-based with few areas of hard substrate suitable for spawning or rearing juvenile trout or salmon.

4.1.9. The Uair

The lower 1.2 km of the Uair (sections U1 to U3) flows through mixed woodland and heath, the conifer plantation having been felled some years ago. The upper parts of section U3 and section U4 flow through the remaining plantation, which does not conform to the current Forest and Water Guidelines and grows to the stream edge. Further upstream, The Uair flows across open peat moorland and blanket bog.

Over 20,000 m^2 of wetted area are present in the survey sections of The Uair, of which 63% was classified as fry or mixed juvenile habitat (Table 4 and 5). The bulk of this habitat is in sections U1 to U9, upstream of which most of the stream is glide and peat channel. The lower reaches, downstream from the forestry fence at NC 827 547, are moderately stable with substrates dominated by cobble and pebble in fast flows. Further upstream the substrate has a high proportion of cobble, but this is set in a matrix of smaller substrate including peat, reducing both cover for fish and interstitial space for macroinvertebrates.

Spawning habitat suitable for salmon is limited in The Uair, with only 70 m^2 identified in 8.6 linear kilometres of survey. Undoubtedly further small patches exist that could not be quantified, but it is clear that spawning opportunity may limit salmon distribution and abundance in The Uair. Most of the spawning habitat is in sections U8 to U12.

4.1.10. Allt Dhonuill Ghuinne/Allt Loch Meala

This small stream drains Loch Meala (NC 788 568) and flows alongside the southwest edge of Strathy North Forest. Habitat suitable for juvenile salmon is mainly limited to the lower 1 km but even here the stream is suited more to trout, with moderate or slow flows and good cover along the banks. Spawning habitat for salmon is absent. Flow is partially regulated by a dam and sluice at the outflow of Loch Meala, although the dam was leaking at the time of survey.

4.1.11. Other streams

Allt an Fhithich drains into the River Strathy from Strathy North Forest. It is probable that a few juvenile salmon and trout move into the lower reaches from the River Strathy but the upper parts appear unsuited to salmonid fish and the waterfall at NC 8230 5793 prevents access to most of the burn.

No formal habitat surveys of other streams were undertaken. The small, unnamed stream draining Loch a Bhroillich (NC 815 538) was examined from the track to the River Strathy. The stream is unsuitable for salmon and habitats are degraded having been planted over with conifer. Several other streams drain into the River Strathy from the east, including Allt na Ceardaich (NC 836 651), Allt an Reidhe Ruaidh (NC 836 642), Bowside Burn (NC 827 611), Uidh nan Con Luatha (NC 827 601), Allt

Coillteil (NC 827 600) and Allt Reidhean a Bhainne (NC 826 578). All of these appear capable of supporting trout populations in their lower reaches and together may make a significant contribution to trout production in the catchment.

4.2. Fish Populations, Baseline Assessment 2007

4.2.1. Salmon

Salmon densities at electric fishing sites are given in Table 7. Salmon were present at all survey sites in the River Strathy (n=12). They were also present in the lower reaches of Allt na Dubh-chlaise, The Uair, Allt Badian, Yellowbog Burn, Allt nan Clach and Allt Dhonuill Ghuinne. Salmon were absent from the middle and upper reaches of the larger tributaries (Allt nan Clach, Yellowbog Burn and The Uair) and from all of the smaller tributaries.

Table 7 Salmonid densities at electric fishing sites, Strathy 2007

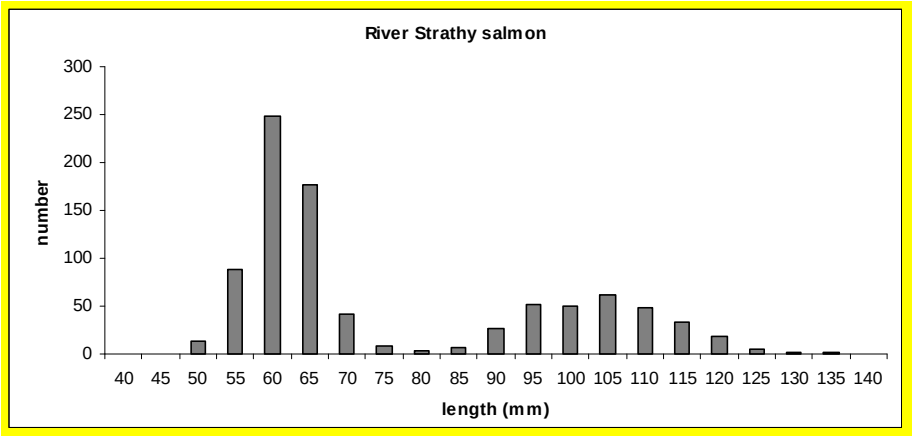
Watercourse	**Site**	**Density (fish.100 m^{-2})**			
		Salmon fry	*Salmon parr*	*Trout fry*	*Trout parr*
River Strathy	RS1	37 (1.0)	16.4 (0.9)	0	0.9 (0.0)
River Strathy	RS2	*18.1*	*11.3*	*5.2*	*1.5*
River Strathy	RS3	*16.3*	*4.7*	*0.6*	*0.6*
River Strathy	RS4	20.5 (1.9)	17.2 (0.0)	0.3	0.3 (0.0)
River Strathy	RS5	*27.2*	*5*	*0*	*0*
River Strathy	RS6	10.7 (1.5)	13.8 (3.4)	*1.3*	*3.8*
River Strathy	RS7	*0*	*0.5*	*1.3*	*0.5*
River Strathy	RS8	53.0 (2.5)	29.4 (2.9)	*0*	*0.7*
River Strathy	RS9	34.5 (4.2)	16.5 (0.0)	9 (0.)	3.8 (0.0)
River Strathy	RS10	*11.3*	*11.3*	*7.5*	*3*
River Strathy	RS11	65.1 (7.0)	16.7 (2.0)	22.2 (7.5)	2.4
River Strathy	RS12	*0.7*	20.2 (3.2)	6.3 (0.0)	18.8 (15.7)
Allt Badian	AB1	*1.8*	*3.6*	*20*	*7.3*
Yellowbog Burn	YB1	*0*	*9.1*	*0*	*13.6*
Yellowbog Burn	YB2	*0*	*3.8*	*6.8*	*7.6*
Yellowbog Burn	YB3	*0*	*0*	19.9 (3.9)	23.6 (3.7)
Yellowbog Burn	YB4	*0*	*0*	*35*	*11*
Allt nan Clach	ANC1	*27.7*	*11.9*	*23.7*	*11.9*
Allt nan Clach	ANC2	1.0 (0.0)	2.0 (0.0)	52.6 (2.3)	12.7 (0.0)
Allt nan Clach	ANC3	*0*	*0*	*29.6*	*13.8*
Allt an Reidhe	AR1	*0*	*0*	*8.5*	*17.1*
Allt na Dubh-chlaise	ADC1	*0*	*2.7*	10 (0.0)	25.4 (0.0)
Allt na Dubh-chlaise	ADC2	*0*	*0*	*47.6*	*18.7*
Allt Dhonuill Ghuinne	ADG1	*0*	*0*	*7.1*	*10*
Allt Dhonuill Ghuinne	ADG2	*0*	*1.3*	*4.1*	*12.2*
Allt an Fhithich	AF1	*0*	*0*	*0*	*0*
Allt Reidhean a Bhainne	ARB1	*0*	*0*	*33.3*	*6.7*
Bowside Burn	BB1	*0*	*0*	*22.2*	*5.6*
The Uair	U1	2.6 (0.0)	3.4 (0.0)	0.9	15.4 (0.0)
The Uair	U2	*0*	*1.1*	*3.2*	*4.3*
The Uair	U3	*0*	*0*	*12.7*	*14.7*

Data are Zippin densities (±95% confidence limit). Data in italics are all-run minimum density.

Size distribution of salmon in the River Strathy is shown on Figure 4. The fry (0+) age class is clear, with a cut-off between fry and parr at about 75 mm. Most parr appear to be 1+ years of age and this

was confirmed by scale readings. Only a few of the largest parr were aged 2+. This age distribution indicates that most salmon smolts migrate at age 2+.

Figure 4 Salmon size distribution, River Strathy 2007



The electric fishing data (Table 7) suggest that the River Strathy itself is the main area for salmon production in the catchment, with only limited contribution from tributary streams. This is consistent with the results of the habitat survey. Single-run minimum density data (Appendix 5) give mean densities of 17.8 fry (±12.5 s.d.) and 9.8 (±5.0 s.d.) parr.100 m^{-2} in the main stem of the River Strathy. By regional standards both densities would be classified as good.

Salmon parr numbers were good at all four sites on the River Strathy that lie within the site boundary (RS9, 10, 11 and 12). Fry abundance was more variable. The lack of fry at sites RS10 and RS12 is likely to be a reflection of habitat. Site RS10 was dominated by deep glide. RS12 is dominated by very large boulders and in places is torrential.

The almost complete lack of salmon at site RS7 was striking, as the site appeared to offer good quality habitat for juvenile salmon. This site is located in habitat survey section RS26. The lack of spawning habitat between survey section RS21 and 31 was noted above and the very low density of salmon may reflect this.

As the occurrence of juvenile salmon in tributaries streams was so patchy it would not be realistic to calculate an average density. However, it is clear from the data that salmon, where present, occurred at relatively low density at most tributary sites. The only survey site outwith the River Strathy itself that held good numbers of young salmon was ANC1 on Allt nan Clach, where good densities of fry and fair densities of parr were present. Fry and parr were also present at site ANC2, albeit at lower density. Parr of age 1+ and 2+ years were caught, the presence of three age classes suggesting regular salmon spawning in this stream in the years preceding the 2007 survey.

No salmon fry were found at electric fishing sites in the Yellowbog Burn, although small numbers of salmon parr (age 1+) were present at the two most downstream sites (YB1 and YB2). This may suggest that successful spawning in this stream is not an annual event, or that the parr had migrated upstream from the River Strathy. The parr that were present had grown rapidly (mean length 125 mm at age 1+), perhaps as a result of lack of competition. Small numbers of salmon fry and parr were present in Allt Badian and again it is not known whether these hatched in the stream or swam up from the River Strathy. This also holds for the single salmon parr captured in Allt Dhonuill Ghuinne.

Salmon were found at the lower two sites on The Uair, but densities were very low, especially at site U2 where a single parr of 125 mm was caught. This site is upstream from the steep, bedrock rapid at NC 8275 5492, indicating that this obstacle is passable to upstream migrating salmonids. Densities

were also low at site U1 where only three fry and four parr were captured from 117 m^2 of stream. Overall, the survey suggests that salmon do not penetrate far up The Uair and that successful spawning above the rapids may not occur annually.

Three salmon parr aged 1+ were caught at site ADC1 on the Allt na Dubh-chlaise. Fry were absent.

In summary, salmon distribution in the catchment during 2007 was largely restricted to the main-stem of the River Strathy and to the lower reaches of tributaries. In most tributary streams, parr were more abundant than fry and overall densities were very low, perhaps suggesting that juvenile salmon migrated in to these streams from the River Strathy. The exception was the lower Allt nan Clach where there was evidence suggesting regular spawning by salmon.

4.2.2. Trout

Trout were present at most survey sites, the exceptions being site RS5 on the River Strathy and AF1 on Allt an Fhithich, which was fishless (Table 7). RS5 is dominated by fast, shallow riffle habitat, better suited to salmon. AF1 is a small peat-based channel and the lack of fish was expected on the basis of the poor habitat. The broad trend in the trout distribution and abundance was opposite to that for salmon i.e. trout abundance was highest in tributary streams and lowest in the lower River Strathy.

During 2007, average single-run trout density in the River Strathy was 3.2 (±3.5 s.d.) and 1.7 (±1.6 s.d.) fish.100 m^{-2} for fry and parr respectively. These densities would be classified as poor by regional standards. However density varied greatly between sites and was higher in the upper reaches of the river within Strathy South Forest. This reflects the nature of habitats; the slower flows and greater bank-side cover of the narrow upper reaches better suiting trout production than the open, more swiftly flowing lower reaches.

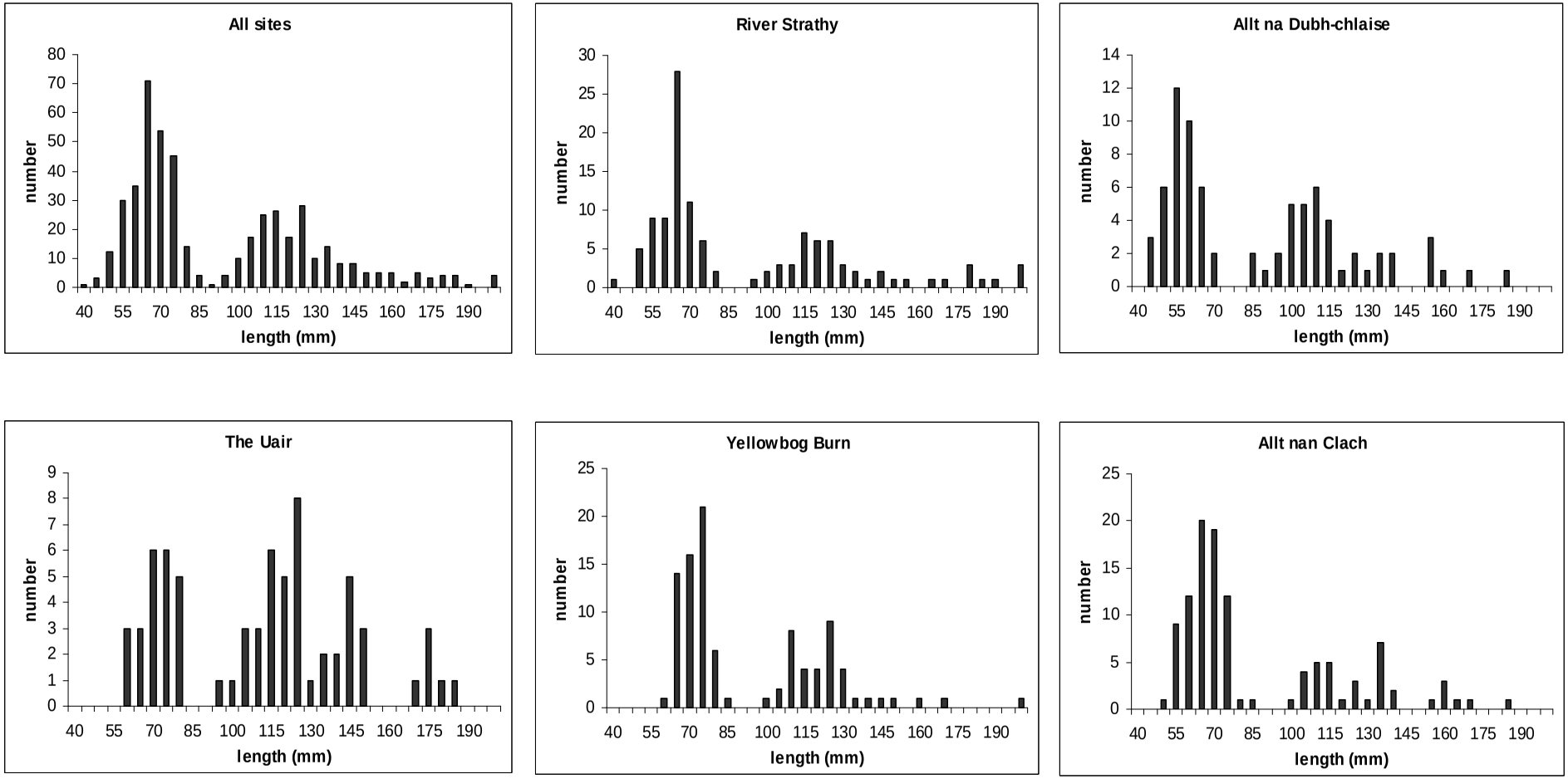
Average trout density in tributary streams was 17.5 (±14.2) fry.100 m^{-2} and 11.5 (±4.7) parr.100 m^{-2}. Regional standards would classify these densities as excellent. Trout were plentiful in the Yellowbog Burn and Allt nan Clach, both of which flow through the Strathy South Wind Farm site. Given the relatively large size of these streams, it is probable that they are important producers of trout within the catchment. Trout were also present at good densities in the Allt Badian and Allt an Reidhe.

Further north, trout density in The Uair was highest at the upper site, U3. The two downstream sites, U1 and U2, were dominated by run and riffle habitat while site U3 had large areas of pool, well suited to older (>0+) trout, along with sheltered edges providing cover for trout fry. Large areas of habitat suitable for trout are present throughout the middle and upper reaches of The Uair and this stream is likely to sustain a considerable proportion of the catchment's trout population. Trout parr densities in Allt na Dubh-chlaise were excellent at both survey sites. Fry abundance was excellent at the upper site, ADC2, and good at ADC1. The other minor tributary streams examined contained trout fry and parr and densities in most were fair or good.

Figure 5 shows the size distribution of juvenile trout in different parts of the catchment. The fry year class is clear at 40 – 80 mm fork length. A strong 1+ year class is also present in all parts of the catchment, peaking at a length of 110 to 120 mm in most areas. Few older trout were present at most sites. It is not possible to distinguish between sea and brown trout prior to migration. However, as the River Strathy is known to have a run of sea trout and most or all sites have clear access to the sea, it is probable that many of the trout are the progeny of sea trout. The relative weakness of the 2+ and 3+ age groups in samples may suggest that most sea trout smolts migrate to sea at age 2+.

In summary, trout were well distributed throughout the catchment. Highest juvenile densities were present in the tributary streams and upper reaches of the River Strathy. Juvenile trout were relatively scarce in the lower parts of the River Strathy. Due to their relatively large size, the Yellowbog Burn, Allt nan Clach and The Uair along with the upper River Strathy are likely to be the most important areas for trout production.

Figure 5 Trout size distribution, River Strathy and tributaries, 2007



4.2.3. Other Fish Species

Presence of non-salmonid fish species at electric fishing sites is shown in Table 8. Lamprey larvae were found at only one site, RS2 on the River Strathy downstream from the Allt na Dubh-chlaise confluence. The larvae were *Lampetra sp*. i.e. either brook or river lamprey. The surveyors also carried out a spot check in the bottom 50 m of Allt na Dubh-chlaise at NC 8274 6116 and *Lampetra* larvae were found to be present.

The only other fish species present was the eel. Eels were present at most sites. They were more abundant at sites in the lower River Strathy than elsewhere. Most of the eels in the lower river were small, mainly less than 20 cm in length. Further upstream fewer eels were present but individuals tended to be larger. This is a fairly common pattern since young eels do not show such rapid upstream migrations as salmon and may remain in the lower reaches of rivers for many years (Tesch 2003; Moriarty 1978).

Table 8 Numbers of eels and presence of larval lampreys at electric fishing sites, Strathy 2007

Site	Presence of larval lamprey habitat	Larvae present?	Eels (n)	Other fish species
RS1	No suitable habitat noted at site	-	40	none
RS2	Small patches of suitable habitat present	Yes	0	none
RS3	No suitable habitat noted at site	-	10	none
RS4	No suitable habitat noted at site	-	25	none
RS5	No suitable habitat noted at site	-	10	none
RS6	No suitable habitat noted at site	-	30	none
RS7	No suitable habitat noted at site	-	25	none
RS8	Suitable habitat in stable sand and around weeds	no	15	none
RS9	No suitable habitat noted at site	-	5	none
RS10	No suitable habitat noted at site	-	4	none
RS11	Very small patches of stable fine sand	no	4	none
RS12	No suitable habitat noted at site	-	0	none
AB1	No suitable habitat noted at site	-	0	none
YB1	No suitable habitat noted at site	-	0	none
YB2	No suitable habitat noted at site	-	8	none
YB3	Soft sediment in this area consists of peat	no	4	none
YB4	No suitable habitat noted at site	-	8	none
ANC1	Some coarse sand present	no	0	none
ANC2	No suitable habitat noted at site	-	5	none
ANC3	No suitable habitat noted at site	-	1	none
AR1	No suitable habitat noted at site	-	2	none
ADC1	Sub-optimal habitat present – rather coarse sand	no	2	none
ADC2	No suitable habitat noted at site	-	0	none
ADG1	No suitable habitat noted at site	-	12	none
ADG2	No suitable habitat noted at site	-	6	none
AF1	No suitable habitat noted – peat only	No	0	none
ARB1	No suitable habitat noted at site	-	1	none
BB1	No suitable habitat noted at site	-	0	none
U1	No suitable habitat noted at site	-	6	none
U2	No suitable habitat noted at site	-	0	none
U3	Small patches of stable sand present – sub-optimal	No	2	none

4.3. Repeat Surveys 2009 and 2012

Salmon densities at Strathy South sites, resurveyed during 2009 and 2012, are shown in Table 9. Salmon numbers at mainstem sites in the River Strathy appear to have declined somewhat over the years of monitoring, particularly during 2012 when parr numbers were very low at sites RS8 and RS9. With the exception of site ANC1, salmon were always scarce at tributary sites and this has remained the case. Salmon fry and parr were relatively abundant at site ANC1 during 2007, but have been scarce since. The data suggest that considerable annual fluctuations in salmon abundance can be expected to occur at the Strathy South Wind Farm site and in waters receiving runoff from the site.

Table 9 Salmon fry and parr densities (fish.100 m^{-2}) in each year of monitoring

Site	Salmon fry			Salmon parr		
	2007	2009	2012	2007	2009	2012
RS8	36.5	26.5	19.3	18.6	17.2	2.9
RS9	21.0	8.3	6.8	13.5	9.0	3.8
RS11	37.3	40.5	6.3	10.3	15.9	14.3
YB2	0.0	0.0	3.8	3.8	3.8	0.0
YB4	0.0	0.0	0.0	0.0	0.0	0.0
ANC1	27.7	0.0	1.0	11.9	0.0	1.0
ANC2	1.0	0.0	1.0	1.9	2.9	1.0
ANC3	0.0	0.0	0.0	0.0	0.0	0.0
Mean	15.4	9.4	4.8	7.5	6.1	2.9

Note: All data are single run minimum densities based on 2007 wetted area

Few consistent patterns of increase or decrease were found in trout density across the three surveys (Table 10). Salmon fry numbers dropped at most sites between 2007 and 2009. Most showed an increase between 2009 and 2012 but few reached the densities found in 2012. Trout parr numbers were generally rather low during 2012. Habitat composition at electric fishing sites changed very little between surveys (Appendix 6). The main changes recorded related to flow types and depth, both of which were considered to reflect between-year variation in water level rather and physical change at the survey sites.

Table 10 Trout fry and parr densities (fish.100 m^{-2}) in each year of monitoring

Site	Trout fry			Trout parr		
	2007	2009	2012	2007	2009	2012
RS8	0.0	0.0	0.7	0.7	0.7	1.4
RS9	8.2	0.8	4.5	2.3	5.3	0.8
RS11	8.7	5.6	7.9	2.4	2.4	3.2
YB2	6.8	8.3	10.6	7.6	6.8	5.3
YB4	35.0	17.0	25.0	11.0	1.0	0.0
ANC1	23.7	40.0	15.3	11.9	12.0	3.8
ANC2	37.0	12.7	16.6	8.8	5.8	4.9
ANC3	29.6	13.8	19.8	13.8	21.7	5.9
Mean	18.6	12.3	12.5	7.3	7.0	3.2

Note: All data are single run minimum densities based on 2007 wetted area

4.3.1. Other Fish Species

In common with the 2007 baseline, lampreys were identified at few sites during 2009. A single brook lamprey transformer, 143 mm in length, was captured at site ANC1. This demonstrates that the species may be quite widespread in the River Strathy catchment including the upper tributaries.

The only other fish recorded were eels. Eel numbers were low at all sites during the 2012 survey (Table 11).

Table 11 Eel numbers (n) in each year of monitoring

Site	2007	2009	2012
RS8	15.0	4.0	1.0
RS9	5.0	4.0	1.0
RS11	4.0	4.0	0.0
YB2	8.0	18.0	2.0
YB4	8.0	2.0	2.0
ANC1	0.0	4.0	1.0
ANC2	5.0	16.0	6.0
ANC3	1.0	1.0	0.0
Mean	5.8	6.6	1.6

5 Evaluation

5.1. Key Sites and Issues

The largest streams draining the site are the upper River Strathy, Yellowbog Burn and Allt nan Clach. The bulk of the juvenile salmon habitat identified by the walkover surveys is in the lower River Strathy, downstream from the Yellowbog burn confluence. Approximately 10% of juvenile salmon habitat identified during the survey lies within the site boundary. Juvenile salmon numbers in these habitats were good during 2007 and, while some decline was evident in subsequent years, the upper River Strathy clearly makes a substantial contribution to overall salmon production from the catchment.

The Yellowbog Burn and Allt nan Clach are populated mainly by trout, which were present at good densities during most surveys. In contrast to salmon, trout were relatively scarce in the lower reaches of the River Strathy, but were present in moderate numbers in the upper reaches. It can be concluded that the streams around and within Strathy South Forest are of major importance to sustaining the trout population in the catchment. As these streams are accessible to migratory salmonids, it is likely that a proportion of the juvenile trout will migrate as sea trout.

Spawning habitat was shown to be scarce in the streams of the upper catchment. Estimates made during the habitat survey suggest that the total area of salmon spawning habitat in the upper River Strathy (section RS28 to RS44), Yellowbog burn, Allt nan Clach and Allt an Reidhe and minor streams draining Strathy South Forest is 252 m^2. Some 70% of this i.e. 177 m^2 is in the River Strathy. While it can be difficult to identify all possible spawning habitats - fish can and do use small pockets of habitat not readily identifiable during extensive surveys - spawning habitat availability could be limiting the salmon and trout abundance in the upper river. The following estimates suggest this may be the case. Fecundity and inter-stage survival figures are based on data provided by Hendry & Cragg-Hine (1997) and Mills (1991).

Spawning habitat of 177 m^2 is sufficient for ~19 female salmon (if fully utilised).

Egg deposition from 19 females is ~82460

Based on 10% survival of ova to summer fry this would result in 8246 fry

Available fry and mixed juvenile habitat = 18227 m^2

Maximum potential fry density therefore = 8246/18227 = 0.45 (45.2 fry.100 m^{-2})

This potential density is not high, suggesting that there may be little or no excess fry production from spawning habitat in the upper river. Indeed since both trout and salmon are likely to use some of the same spawning areas, maximum fry production for either species may be less than suggested above. The lack of juvenile salmon at site RS7 is consistent with the suggestion of limited production in the upper river since, were the upper reaches over-stocked, some downstream migration into vacant habitat around RS7 might be expected. Spawning habitat in the Yellowbog Burn and Allt nan Clach appeared to be even more limited than in the River Strathy and may well limit both salmon and trout production in these streams.

If as seems likely spawning habitat is a limiting resource in the upper catchment, any damage to or loss of this resource would be expected to have a direct and detrimental effect on fish populations. The overall impact on salmon may be less than for trout, as most salmon production is from the lower river. Nevertheless, if salmon and trout populations are to be protected throughout their range in the catchment, protection of spawning areas in the upper catchment will have to be a key focus of mitigation and site management.

Salmon spawning activity in northern Scotland generally peaks in November. Trout spawn a little earlier, activity normally peaking in October. Ova of both species remain in the gravel over the winter, hatching out in spring. Fry swim up from the gravel in March or April, to coincide with increasing water temperature and food supply. Developing ova and alevins (hatched but not yet free-swimming) can be damaged or killed by excessive fine silt clogging sediments at spawning sites, so it will be particularly important to avoid episodic siltation when these sensitive stages are in the gravel. Any changes to hydrology or water chemistry that might lead to excessive algal growth could also be detrimental to fish, clogging interstitial spaces and reducing oxygen availability.

Careful management of run-off, avoidance of pollution and phased felling of conifers may all help minimise risk to stream habitats. In addition, new stream crossings should be micro-sited to avoid removing or damaging spawning areas. New crossings and alterations to existing crossings on all streams should ensure fish passage is maintained.

Lampreys were identified in the lower River Strathy and the Allt na Dubh-chlaise during 2007. In 2009 a brook lamprey transformer was caught in the lower reaches of the Allt nan Clach. Survey effort on lampreys was limited and it should be assumed that they might occur anywhere suitable habitat is present. Larval lamprey habitat was not abundant and the lamprey population may not be large. Lamprey spawning sites, developing ova and prolarvae (hatched but not yet burrowing) can be damaged or killed by excessive fine silt clogging sediments at spawning sites. Few data exist on other water quality requirements of lampreys (Maitland 2003). However, it is known that they are sensitive to prolonged periods of low oxygen tension and Maitland suggests that water quality should attain UK Water Quality Class A2.

5.2. Limitation of Data

By the standards of many fisheries investigations, survey effort was high. Experienced surveyors walked all accessible parts of the catchment in order that key habitats were properly identified and quantified. The survey is likely to have provided accurate estimates of habitat quantity and distribution. The majority of stream habitats were classified as stable (Appendix 2) and this stability was confirmed by assessments of habitat at electric fishing sites, which changed little over a 5-year period (see Appendix 6). Given this stability, the distribution and quality of salmonid habitats are unlikely to change greatly over the next few years and the conclusions of the 2007 habitat survey will

hold. The greatest difficulty experienced was in assessing spawning habitat availability for trout. Trout can use small areas of substrate that may be difficult to quantify or identify, especially in peat-stained water. It is therefore possible that spawning availability in headwater streams is slightly under-estimated. Nevertheless, the trends in spawning habitat distribution are very clear-cut and conclusions on relative distribution in the catchment are considered reliable. The larger patches of spawning habitat likely to be used by salmon will not have been missed and their recorded distribution shows good agreement with juvenile salmon distribution.

Thirty-one electric fishing sites were surveyed during 2007, 11 fully quantitatively. Due to the high degree of spatial variation in salmonid density, the number of sites required to measure even quite large changes over time is high (Bohlin *et al*. 1990; Cowx & Fraser 2003). The repeat surveys during 2009 and 2012 suggest that the salmon population can be expected to show considerable year-to-year fluctuations even in the absence of new development or activity within the catchment. High inter-annual variation can make the detection of even quite large impacts (positive or negative) on fish populations difficult (Temple & Pearsons 2007) and knowledge of naturally occurring fluctuations is valuable if the impact of developments is not to be overestimated (Fisheries Committee 2007).

6 Conclusions

(i) The River Strathy catchment sustains populations of salmon, trout, eels and brook lamprey. Salmon and trout densities were generally fair to excellent by regional standards, although highly variable through the survey area.

(ii) Trout were abundant in the upper parts of the River Strathy and in the various tributary streams draining the site. They were less abundant in the lower parts of the catchment indicating that the headwaters are of particular importance in maintaining trout populations. As there is clear access to the sea, it is probable that a proportion of juvenile trout migrate as sea trout.

(iii) Within the site boundary, salmon were mainly restricted to the upper River Strathy and the lower parts of Allt nan Clach. Occasional salmon fry or parr were found elsewhere, but successful spawning in the smaller streams is likely to be sporadic.

(iv) The bulk of salmon production is likely to be downstream of the site, particularly between the Uair confluence and the sea where large areas of suitable habitat capable of holding good densities of salmon fry and parr are present.

(v) Production of salmon and, perhaps trout, in the upper catchment may be limited by the availability of suitable spawning habitats. Protection of these habitats should be a primary aim of mitigation and environmental management during wind farm construction.

(vi) Lampreys were found at three sites - the River Strathy below Bowside, the lower reaches of Allt na Dubh-chlaise and Allt nan Clach. Survey effort on lampreys was limited and it should be assumed that they might occur elsewhere in the catchment.

(vii) The data identify key habitats and issues for design of mitigation and provide a baseline against which future change can be assessed. Salmon and trout abundance showed substantial year-to-year fluctuation and reliable baseline assessment has required more than one year of survey from a selection of representative sites.

7 References

Antunes, A., Apostolidid, A., Berrebi, P., Duguid, A., Fergusson, A., Garcia-Martin, J.L., Guyomard, R., Hansen, M.M., Hindar, K., Koljonen, M-L., Laikre, L., Largiadaer, C., Martinez, P., Nielsen, E.E., Palm, S., Ruzzante, D., Ryman, N. & Triantaphylllidis, C. 1999. Conservation Genetic Management of Brown Trout (*Salmo trutta*) in Europe. Report by the Concerted action on identification, management

and exploitation of genetic resources in brown trout (*Salmo trutta*) ("TROUTCONCERT", EU FAIR CT97-3882).

Bohlin, T, Heggberget, T.G. & Strange, C. 1990. Estimation of population parameters using electric fishing: aspects of the sampling design with emphasis on salmonids in streams. In

Cowx, I.G. & Fraser, D. 2003. *Monitoring the Atlantic Salmon*. Conserving Natura 2000 Rivers Monitoring Series No. 7, English Nature, Peterborough.

Crisp, D.T. 1993. The environmental requirements of salmon and trout in fresh water. Freshwater Forum, 3(3): 176-201.

Davies, C., Shelley, J., Harding, P., Maclaren, I., Gardiner, R. & Peirson, G. 2004. Freshwater fishes in Britain, the species and their distribution. Harley Books, Colchester.

Fisheries Committee. 2007. Annual report of the Fisheries Committee (Electricity) for the year to 31 March 2007. Pentland House, Edinburgh.

Forestry Commission. 2003. Forest and Water Guidelines – Fourth Edition. Forestry Commission. Edinburgh. 66pp.

Godfrey, J. D. 2006. Site condition monitoring of Atlantic salmon cSACs. Commissioned report to Scottish Natural Heritage, December 2006. Scottish Fisheries Co-ordination Centre, Pitlochry.

Hardisty, M.W. 2006. Lampreys: Life Without Jaws. Forest Text, Ceridigion, 272pp.

Hendry, K. & Cragg-Hine, D. 1997. Restoration of Riverine salmon habitats. Fisheries Technical Manual 4, Environment Agency, Bristol.

Hendry, K & Cragg-Hine, D. 2003. Ecology of the Atlantic Salmon. Conserving Natura 2000 Rivers Ecology Series No. 7, English Nature, Peterborough.

Klemetsen, A., Amundsen, P-A, Dempson, J.B., Jonsson, B., Jonsson, N., O'Connell, M.F. and Mortensen, E. 2003. Atlantic salmon *Salmo salar* L., brown trout *Salmo trutta* L. and Arctic charr *Salvelinus alpinus* (L.): a review of aspects of their life histories. Ecology of Freshwater Fish, 12, 1-19.

Kottelat, M. & Freyhof, J. 2007. Handbook of European Freshwater Fishes. Kotellat, Cornol, Switzerland and Freyhof, Berlin, Germany.

Maitland, P.S. 2003. Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

Mills, D. 1991. Ecology and Management of Atlantic Salmon. Chapman and Hall, London.

Moriarty, C.M. 1978. Eels, A Natural and unnatural History. David & Charles Ltd., Newton Abbot, Devon.

Neal, C., Reynolds, B., Wilkinson, J., Hill, T., Neal, M., Hill, S. & Harrow, M. 1998. The impacts of conifer harvesting on runoff water qquality: a regional survey for Wales. Hydrology and Earth System Sciences, 2: 323-344.

Neal, C., Reynolds, B., Neal, M., Wickham, H., Hill, L. & Williams, B. 2004. The impact of conifer harvesting on stream water quality: the Afon Hafren, mid-Wales. Hydrology and Earth System Sciences, 83: 503-520.

Neary, J.P. 2006. Use of Physical Habitat Structure to Assess Stream Suitability for Brown Trout: A Case Study of Three Upland Scottish Streams. Ph.D. Thesis, University of Stirling, October 2006.

O' Maoileidigh, N. 2002. Overview of the report of the Working Group on North Atlantic Salmon. Pp 3-5 in: Joint Meeting on Causes of Marine Mortality of Salmon in the North Pacific and North Atlantic

Oceans and in the Baltic Sea. North Pacific Anadromous Fish Commission Technical Report 4. Vancouver, Canada.

Reynolds, B., Stevens, P.A., Hughs, S., Parkinson, J.A. & Weatherly, N.S. 1995. Stream chemistry impacts of conifer harvesting in Welsh catchments. Water, Air & Soil Pollution, 79: 147-170.

SFCC. 2007. Scottish Fisheries Co-ordination Centre Electrofishing Team Leader Training manual. Inverness College. June 2007.

Summers, D., Giles, N. & Willis, D.J. 1996. Restoration of Riverine Trout Habitats: A Guidance Manual. Fisheries Technical Manual 1, R&D Technical Report W118, Environment Agency, Bristol.

Sutherland Biodiversity Group. 2003. The Sutherland Biodiversity Action Plan. Planning & Development Services, The Highland Council, October 2003.

Temple, G.M. & Pearsons, T.N. 2007. Electrofishing: backpack and drift boat. Pages 95-132 in Johnson, D.H., Shrier, B.M., O'Neal, J.S., Knutzen, J.A., Augerot, X., O'Neil, T.A. & Pearsons, T.N. 2007. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

Tesch, F. W. 2003. The Eel. 3rd Edition. Blackwell Science, Oxford.

Waterside Ecology. 2012. Strathy North wind farm: fish monitoring program 2011. Commissioned report to Scottish & Southern Energy. February 2012

Watt, J. & Ravenscroft, N.O.M. 2005. The distribution of lampreys in Scotland: National lamprey survey 2003-2004. Final Report to Scottish Natural Heritage. Era Report No. 39. Era, Aberchirder, Aberdeenshire.

Youngson, A & Hay, D. 1996 The Lives of Atlantic Salmon. An illustrated account of the life-history of Atlantic salmon. Swan Hill Press, Shrewsbury.

Zippin, C. 1958. The removal method of population estimation. Journal of Wildlife Management, 22: 82-90.

Appendix 1 Salmonid habitat survey sections

Section	Watercourse	Altitude (m)	NGR downstream	NGR upstream	Section length (m)	Water level	Stream bed visible (%)
RS1	River Strathy	5	NC8362 6518	NC8361 6484	500	medium	70
RS2	River Strathy		NC8361 6484	NC8363 6431	500	medium	70
RS3	River Strathy	10	NC8363 6431	NC8335 6402	500	medium	70
RS4	River Strathy		NC8335 6402	NC8343 6367	500	medium	80
RS5	River Strathy		NC8343 6367	NC8328 6317	500	medium	90
RS6	River Strathy		NC8328 6317	NC8333 6285	500	medium	80
RS7	River Strathy	20	NC8232 6273	NC8308 6240	500	medium	80
RS8	River Strathy		NC8308 6240	NC8271 6219	500	medium	100
RS9	River Strathy	30	NC8271 6219	NC8274 6179	500	medium	95
RS10	River Strathy		NC8274 6179	NC8278 6134	500	medium	90
RS11	River Strathy		NC8278 6134	NC8256 6093	500	medium	80
RS12	River Strathy		NC8256 6093	NC8273 6036	500	medium	80
RS13	River Strathy	40	NC8282 6048	NC8265 6015	500	medium	95
RS14	River Strathy		NC8265 6015	NC8253 5958	500	medium	95
RS15	River Strathy		NC8253 5958	NC8263 5922	500	medium	85
RS16	River Strathy	50	NC8263 5922	NC8249 5881	500	medium	85
RS17	River Strathy		NC8249 5881	NC8248 5239	500	medium	85
RS18	River Strathy	60	NC8248 5239	NC8254 5793	500	medium	75
RS19	River Strathy		NC8254 5793	NC8256 5770	500	medium	75
RS20	River Strathy		NC8256 5770	NC8275 5700	500	medium	85
RS21	River Strathy	70	NC8275 5700	NC8267 5657	500	medium	90
RS22	River Strathy		NC8267 5657	NC8227 5625	540	low	80
RS23	River Strathy	80	NC8227 5625	NC8204 5597	500	low	80
RS24	River Strathy		NC8204 5597	NC8166 5585	515	low	80
RS25	River Strathy	90	NC8166 5585	NC8131 5554	500	medium	90
RS26	River Strathy	100	NC8131 5554	NC8085 5545	500	medium	90
RS27	River Strathy		NC8085 5545	NC8047 5497	500	medium	95
RS28	River Strathy	110	NC8047 5496	NC8051 5464	500	low	70
RS29	River Strathy	114	NC8051 5464	NC8044 5429	500	low	60
RS30	River Strathy	115	NC8044 5429	NC8038 5387	500	low	25
RS31	River Strathy		NC8038 5387	NC8046 5347	570	low	50
RS32	River Strathy	122	NC8045 5349	NC8037 5312	500	low-mod	95
RS33	River Strathy	124	NC8037 5312	NC8037 5272	520	low-mod	100
RS34	River Strathy	126	NC8037 5272	NC8022 5222	530	low-mod	100
RS35	River Strathy	130	NC8022 5222	NC8014 5182	500	low-mod	100
RS36	River Strathy	133	NC8014 5182	NC8003 5139	500	low-mod	100
RS37	River Strathy	137	NC8003 5139	NC7998 5095	470	low-mod	100
RS38	River Strathy	140	NC7998 5095	NC7992 5050	500	low-mod	100
RS39	River Strathy	143	NC7992 5050	NC7978 5011	500	low-mod	100
RS40	River Strathy	145	NC7978 5011	NC7975 4977	450	low-mod	100
RS41	River Strathy	149	NC7975 4977	NC7970 4941	500	low-mod	98
RS42	River Strathy	150	NC7970 4941	NC7965 4903	455	low-mod	95
RS43	River Strathy	155	NC7965 4903	NC7938 4886	500	low-mod	95
RS44	River Strathy	158	NC7938 4886	NC7925 4876	200	low-mod	90
ADC1	Allt na Dubh-chlaise	35	NC8274 6121	NC8241 6091	500	medium	50
ADC2	Allt na Dubh-chlaise	50	NC8241 6091	NC8195 6015	500	medium	30
ADC3	Allt na Dubh-chlaise		NC8195 6015	NC8170 5988	500	medium	0
ADC4	Allt na Dubh-chlaise	65	NC8170 5988	NC8169 5986	500	medium	70
ADC5	Allt na Dubh-chlaise		NC8169 5986	NC8139 5958	500	medium	80
ADC6-7	Allt na Dubh-chlaise	100	NC8139 5958	NC8086 5903	1000	medium	50
ADC8-9	Allt na Dubh-chlaise		NC8086 5903	NC8106 5835	1000	medium	50
ADC10	Allt na Dubh-chlaise	130	NC8106 5835	NC8114 5785	500	medium	50

Section	Watercourse	Altitude (m)	NGR downstream	NGR upstream	Section length (m)	Water level	Stream bed visible (%)
U1	The Uair	80	NC8262 5637	NC8268 5604	500	low	60
U2	The Uair	90	NC8268 5604	NC8263 5552	500	low	60
U3	The Uair	100	NC8263 5552	NC8261 5506	500	low	60
U4	The Uair	113	NC8261 5506	NC8277 5462	500	low	60
U5	The Uair	120	NC8277 5462	NC8261 5422	500	low	50
U6	The Uair	129	NC8261 5422	NC8247 5374	500	low	40
U7	The Uair	135	NC8247 5374	NC8271 5343	500	low	40
U8	The Uair	140	NC8271 5343	NC8284 5311	500	low	50
U9	The Uair	145	NC8284 5311	NC8303 5274	500	low	40
U10	The Uair	146	NC8303 5274	NC8100 5226	500	low	10
U11	The Uair	146	NC8100 5226	NC8284 5192	500	low	20
U12	The Uair	148	NC8284 5192	NC8289 5153	500	low	40
U13	The Uair	150	NC8289 5153	NC8293 5107	500	low	30
U14	The Uair	152	NC8293 5107	NC8315 5067	500	low	
U15	The Uair		NC8315 5067	NC5093 5026	500	low	
U16	The Uair	160	NC5093 5026	NC8285 4980	500	low	
U15a	Uair, Meur Ghual		NC8316 5068	NC8327 5020	650	low	
AB1	Allt Badian	140	NC8020 5205	NC8051 5169	500	low	60
AB2	Allt Badian	150	NC8051 5169	NC8086 5135	500	low	70
AB3	Allt Badian	165	NC8086 5135	NC8108 5094	500	low	50
AB4	Allt Badian	171	NC8108 5094	NC8124 5054	500	low	50
AB5	Allt Badian	175	NC8124 5054	NC8125 5029	240	low	50
ALS1	A. L. na Saobhaidhe	155	NC7970 4909	NC7987 4886	510	low-mod	100
YB1	Yellowbog Burn	110	NC8046 5497	NC8026 5470	550	medium	95
YB2	Yellowbog Burn	120	NC8026 5470	NC7985 5468	515	medium	80
YB3	Yellowbog Burn		NC7985 5468	NC7941 5437	500	medium	75
YB4	Yellowbog Burn		NC7940 5435	NC7948 5397	500	medium	20
YB5	Yellowbog Burn	126	NC7948 5397	NC7927 5365	500	medium	5
YB6	Yellowbog Burn	127	NC7927 5365	NC7933 5320	550	medium	20
YB7	Yellowbog Burn	130	NC7933 5320	NC7945 5280	525	medium	40
YB8	Yellowbog Burn	133	NC7945 5280	NC7935 5233	500	medium	50
YB9	Yellowbog Burn	137	NC7935 5233	NC7919 5193	500	medium	50
YB10	Yellowbog Burn	142	NC7919 5193	NC7911 5152	500	medium	30
YB11	Yellowbog Burn	144	NC7911 5152	NC7909 5099	560	medium	30
YB12	Yellowbog Burn	149	NC7909 5099	NC7900 5063	550	medium	30
YB13	Yellowbog Burn	155	NC7900 5063	NC7865 5025	560	medium	90
YB14	Yellowbog Burn	170	NC7865 5025	NC7824 5017	500	medium	40
YB15	Yellowbog Burn	172	NC7824 5017	NC7795 5000	500	medium	25
YB16	Yellowbog Burn	174	NC7795 5000	NC8125 5029	500	medium	30
ANC1	Allt nan Clach	125	NC7941 5437	NC7917 5460	455	medium	80
ANC2	Allt nan Clach	130	NC7917 5460	NC7890 5440	500	medium	70
ANC3	Allt nan Clach	140	NC7890 5440	NC7845 5423	500	medium	80
ANC4	Allt nan Clach		NC7845 5423	NC7805 5399	500	medium	70
ANC5	Allt nan Clach	145	NC7805 5399	NC7795 5374	500	medium	50
ANC6	Allt nan Clach	146	NC7795 5374	NC7776 5328	500	medium	20
ANC7	Allt nan Clach		NC7776 5328	NC7774 5286	500	medium	30
ANC8	Allt nan Clach	155	NC7718 5315	NC7772 5238	500	medium	75
ANC9	Allt nan Clach	160	NC7772 5238	NC7770 5193	500	medium	90
ANC10-11	Allt nan Clach		NC7770 5193	NC7778 5099	500	medium	
ANC12	Allt nan Clach	150	NC7767 5313	NC7718 5315	500	medium	75
AR1	Allt an Reidhe	145	NC7794 5394	NC7784 5419	400	medium	50
AR2	Allt an Reidhe		NC7784 5419	NC7777 5458	500	medium	60
AR3	Allt an Reidhe		NC7777 5458	NC7782 5490	500	medium	60

Section	Watercourse	Altitude (m)	NGR downstream	NGR upstream	Section length (m)	Water level	Stream bed visible (%)
AR4	Allt an Reidhe	150	NC7782 5490	NC7770 5520	500	medium	60
AR5	Allt an Reidhe	160	NC7770 5520	NC7727 5540	500	medium	40
AR6	Allt an Reidhe		NC7727 5540	NC7700 5573	500	medium	10
AR7	Allt an Reidhe	160	NC7776 5518	NC7750 5551	300	medium	20
AR8-9	Allt an Reidhe		NC7750 5551	NC7750 5620	1100	medium	20
ADG1	A. Dhonuill Ghuinne	100	NC8097 5548	NC8069 5609	830	medium	85
ADG2	A. Dhonuill Ghuinne	120	NC8069 5609	NC8029 5607	500	medium	80
ADG3	A. Dhonuill Ghuinne		NC8029 5607	NC7999 5578	500	medium	80
ADG4	A. Dhonuill Ghuinne		NC7999 5579	NC7963 5599	500	medium	60
ADG5	A. Dhonuill Ghuinne	130	NC7963 5599	NC7943 5639	500	medium	70
ADG6	A. Dhonuill Ghuinne	150	NC7943 5639	NC7906 5652	520	medium	100
ADG4a	A. Dhonuill Ghuinne	130	NC7992 5573	NC7943 5555	500	medium	60
AF1	Allt an Fhithich	65	NC8251 5800	NC8202 5778	500	medium	75
AF2	Allt an Fhithich	80	NC8202 5778	NC8151 5759	500	medium	50
LB1	A. L. a Bhroillich	105	NC8092 5545	NC8077 5510	500	low	20
LB2	A. L. a Bhroillich	120	NC8077 5510	NC8082 5467	500	low	30
LB3	A. L. a Bhroillich	135	NC8082 5467	NC8085 5413	500	low	40
LB4	A. L. a Bhroillich	150	NC8085 5413	NC8129 5390	500	low	60

Appendix 2 Survey Sections: habitat descriptions

Section	Stable substrate?	Compacted?	Bank cover		Other
			Left	Right	
RS1	yes	no	mod.	mod.	Quite deep with moderate flow, best juvenile habitat by edges.
RS2	yes	no	mod.	mod.	Usable juvenile habitat but in glide.
RS3	yes	no	mod.	mod.	Good mixed juvenile in riffle at lower end. Rest of juvenile habitat moderate quality at edges of glide.
RS4	yes	no	mod.	mod.	Some good areas of cobble/pebble/boulder well suited to juvenile salmon.
RS5	yes	no	mod.	good	Excellent riffle sections with good cover for fry and parr. Tree roots provide good cover along right bank.
RS6	yes	no	good	good	Riffles and glides. Substrate mainly cobble and pebble. Roots and undercuts along banks.
RS7	mod.	no	poor	poor	Some good fry habitat at top of section and at riffles. Substrates large cobble with scattered boulder.
RS8	mod.	no	good	poor	Long reaches of wide shallow mixed juvenile habitat. Bracken right bank and alders backed by conifer left.
RS9	mod.	no			Pockets of adult holding water among areas of deep juvenile habitat. Only a few pockets of potential spawning habitat. Close conifers not creating problems at present.
RS10	mod.	no	mod.	poor	Riffle, run, glide sequences. Mainly cobble. Most of section is juvenile habitat. Close conifers not creating problems at present.
RS11	mod.	no	poor	poor	Lots of good quality mixed juvenile habitat throughout. Holding water for adults, spawning and good juvenile habitat. A good section.
RS12	mod.	no	poor	poor	Good edges for fry but mainly mixed juvenile habitat. Eroding banks. Sequences of riffles, runs and glides over cobble. Point and side bars.
RS13	yes	no	mod.	mod.	Good mixed juvenile habitat and pools for adults.
RS14	yes	no	poor	mod.	River has moved around in this area but rate of change is not rapid and juvenile habitat is good quality.
RS15	yes	no			Some deeper pockets in glides would hold adults. Good juvenile habitat.
RS16	yes	no	mod.	mod.	Good fry habitat at edges including along glide sections.
RS17	yes	no	poor	mod.	Stable boulder with cobble and gravel.
RS18	yes	no	poor	poor	Meandering with plenty good mixed juvenile habitat. Some deep scours suitable for adults.
RS19	yes	no	mod.	mod.	Riffle/glide sequences with good mixed juvenile habitat.
RS20	yes	no	poor	mod.	Mainly riffle and shallow glide. Some deeper pockets will hold adults.
RS21	yes	partly	mod.	mod.	Riffle and shallow glide. Lots of good quality habitat. Eroding right bank at top provides useful inputs of gravel and pebble.
RS22	yes	no	mod.	mod.	Boulders and cobble - good juvenile habitat. Lack of spawning habitat. Conifers felled.
RS23	yes	no	poor	poor	Natural flow interrupted by pool creation - boulder weirs backing up water. Rest is stable mixed juvenile habitat.
RS24	yes	no	poor	poor	Large, stable mossy boulder surrounded by cobble, gravel and coarse sand. Conifer mainly felled.
RS25	yes	no	mod.	mod.	Excellent juvenile habitat with lots of stable riffle and good boulder cover.
RS26	yes	no	mod.	mod.	Mix of glide and juvenile habitat. Conifer mainly ok but some is planted too close.
RS27	yes	no	mod.	mod.	Excellent habitat with lots of stable riffle. Some deeper pockets around big boulders and under banks may hold adults.
RS28	yes	partly	mod.	mod.	Stable boulder surrounded by coarse sand and gravel . patches of weed throughout. 20-40 cm fast flow. Good juvenile habitat.
RS29	yes	no	mod.	mod.	Stable boulder surrounded by coarse sand and gravel . patches of weed throughout. 20-40 cm fast flow. Good juvenile

					habitat.
RS30	yes	no	mod.	mod.	30-100 cm deep. Slow flowing over coarse sand and gravel. Much weed cover. Good trout habitat. Some salmon parr and fry habitat in shallower weed areas.
RS31	yes	no	mod.	mod.	Some glide habitat would be expected to support juveniles. Spawning absent or very poor due to high sand content of substrate.
RS32	yes	partly	mod.	mod.	Mainly low gradient glide & pool. A little spawning habitat in top of section. Little typical juvenile salmon habitat.
RS33	yes	partly	poor	poor	Similar habitat as previous section but more wide shallow fry habitat and glide.
RS34	yes	partly	poor	poor	Similar habitat as previous 1 km upstream but wider & shallower - adequate juvenile habitat but no spawning. Too stable with no bank erosion and no input or movement of pebble or gravel.
RS35	yes	partly	mod.	mod.	Moderate to fast flow 10-25 cm in juvenile habitat. Coarse sand & gravel round stable mossy boulder & big cobble. Less weed cover than sections 40-39.
RS36	yes	partly	mod.	mod.	Moderate to fast flow 10-25 cm in juvenile habitat. Coarse sand & gravel a round stable mossy boulder & big cobble.
RS37	yes	partly	mod.	mod.	Moderate quality juvenile habitat as cover reduced by sand round larger substrates.
RS38	yes	partly	good	good	Cover in stream still quite poor as sand round larger substrate but increasing amount of juvenile habitat compared with upstream.
RS39	yes	partly	mod.	mod.	Gradient increasing a bit - some more reaches of fry & juvenile habitat.
RS40	yes	partly	mod.	mod.	Mainly suited trout. Little salmon spawning habitat in this area and poor juvenile salmon habitat. Meandering glide dominated by coarse sand. Much macrophyte growth. Partial compaction – possibly natural. Forest well back 30 m and no significant tributaries from woodland.
RS41	yes	no	mod.	mod.	Habitat is mainly glide with coarse stable sand and gravel around cobble. Lots instream weed providing some cover. Mainly suitable for trout.
RS42	yes	no	good	good	Good mixed juvenile salmon habitat upper 2/3. Sandy glide lower 1/3 with macrophyte and undercut providing good trout habitat.
RS43	yes	no	good	good	Meandering section of pool, riffle sequences with small spawning areas at pool tails. Good mixed juvenile habitat with lots of undercut for trout.
RS44	yes	no	good	good	Good stable habitat with mixed depths and flows. good boulder cover for trout and much instream habitat suitable for salmon parr.
ADC1	yes	partly	poor	poor	Over-shaded and partly compacted. Planted over. Large parts inaccessible due to wind-blown trees. Banks breaking down due to fallen trees diverting flow.
ADC2	yes	partly	poor	poor	Over-planted with conifers. Much could not be surveyed due to dense conifer and wind-blow.
ADC3	yes	unknown			Unable to access due to dense conifer and wind-blown trees.
ADC4	yes	partly	good	good	Quality 3 for trout fry and parr. Stable large cobble. Good habitat but very little spawning opportunity.
ADC5	yes	partly	good	good	Quality 2 for trout fry and parr. Peat channel in lower parts then cobble further up.
ADC6-7	yes	partly	good	good	Quality 2 for trout fry and parr. Stream becoming steeper. Drier, bracken-covered banks. Runs and pools between steep banks. Little spawning.
ADC8-9	yes	n.a.	n.a.	n.a.	Peat channel unlikely to support fish.
ADC10	yes	n.a.	n.a.	n.a.	Peat channel unlikely to support fish.
U1	yes	no	mod.	mod.	Fast-moderate flow. 15-40 cm deep with boulder and large cobble. Good cover. Good quality parr habitat.
U2	yes	no	poor	poor	Fast-moderate flow. 15-40 cm deep with boulder and large cobble. Good cover. Good quality parr habitat.

U3	yes	no	poor	poor	Good parr habitat. Fast flows round stable boulder 15-40 cm deep. Boulder & cobble dominant.
U4	yes	no	poor	poor	Lower part of section is torrential with rapids and eddying pools among large blocks of stone. Further up is parr habitat somewhat hemmed in by conifer forest.
U5	yes	partly	mod.	mod.	Stable boulders in 15-40 cm of water. Boulder set in partly compacted materials. Less cobble than lower down. Spawning absent or confined to very small pockets unsuitable for salmon.
U6	yes	yes	good	good	Stable boulders in 20-40 cm of water. Boulder set in partly compacted materials. Less cobble than lower down. Spawning absent or confined to very small pockets unsuitable for salmon.
U7	yes	yes	good	good	Stable boulder in 20-40 cm moderate flow. Trout habitat. Little by way of loose cobble or pebble.
U8	yes	partly	good	good	Some short reaches of shallow, weedy cobble & pebble suitable for fry. Rest is stable boulder in 20-40 cm moderate flow. Trout habitat. Little by way of loose cobble or pebble. Some spawning present.
U9	yes	yes	good	good	Fast runs through big stable boulder lower reaches. Gradient reduced near top of section.
U10	yes	n.a.	good	good	Deep pool and glide.
U11	yes	n.a.	good	good	Deep peat glide interspersed with shallower sandy glide. Very poor salmon habitat
U12	yes	no	good	good	Wide glide & pool in lower reaches, narrower and moderate flow near middle with some spawning.
U13	yes	partly	good	good	Mainly trout habitat.
U14	yes	n.a.			Much reduced volume above confluence. Some stony fry habitat. Glide interspersed with lots 5-15 cm deep moderate flow habitat with scattered weed - suitable mainly for trout fry. *Potamogeton* in glides.
U15	yes	n.a.			Stream above confluence is very small entirely unsuitable for salmon.
U16	yes	n.a.			20 cm wide channel through *Juncus*.
u15a	yes	n.a.	good	good	Slow glide with occasional pool. Weedy.
ALS1	yes	no	good	good	Mainly suited trout fry; better salmon habitat at bottom. Narrow little stream with moderate flow & steep overhanging banks. Substrate coarse sand, cobble boulder in 10-20 cm depth.
AB1	yes	yes	good	good	Becomes narrower and more glide-like through steep peat banks.
AB2	yes	yes	good	good	Run/pool habitat - quite steep and fast compared with upstream. Little or no spawning habitat.
AB3	yes	yes	good	good	Poor salmon habitat, May support a few small trout. Moderate flow and 10-25 cm deep. Compaction in AB5-AB3 seems natural. All streams examined have this phase of 'development'. Towards bottom of section becomes faster and more stony. Most of section similar to AB4 but a bit larger.
AB4	yes	yes	good	good	Some faster boulder dominated water near bottom [mossy boulder compacted]. Otherwise similar to AB5. Meandering with some deeper pools on corners. Steep banks in peat. Flat stream bed of cobble & mossy boulder set in peat or hard compacted substrate. Poor salmon habitat. May support a few small trout. Moderate flow and 10-25 cm deep.
AB5	yes	yes	good	good	Cobble & mossy boulder set in peat or hard compacted substrate. Poor salmon habitat, may support a few small trout. Moderate flow and 10-25 cm deep.
YB1	yes	partly	mod.	mod.	Good juvenile habitat. Stable boulder but cover reduced by sand.
YB2	yes	partly	good	good	Good habitat in lower reaches. Cover reduced and compaction further upstream. Eroding banks mainly peat and provide little hard material.
YB3	yes	partly	mod.	mod.	Compacted in part. Faster steeper bits quite good. Little spawning other than little patches suit trout.
YB4	yes	partly	mod.	mod.	Moderate quality salmon parr habitat, especially lower reaches
YB5	yes	no	mod.	mod.	Trout parr habitat. 50-100 cm deep pool/glide covered in *Potamogeton*. Little flow. Trout present.
YB6	yes	no	mod.	mod.	Sand over peat substrate, 20 – 50 cm very slow flow. *Potamogeton* and a feathery macrophyte. Trout parr habitat.

YB7	yes	partly	mod.	mod.	Lower parts are glide with sand & peat between steep peat banks. Juvenile habitat at top is poor quality - mossy stones set in sand and peat.
YB8	yes	partly	mod.	mod.	Silted below track - this also seen above. Best for trout.
YB9	yes	no	good	good	Some Good quality juvenile habitat especially near bottom of section.
YB10	yes	no	good	good	Mostly extremely poor for salmon. Probably a few trout in pools. Starts moderate gradient but reverts to low gradient glide/pool in lower reaches.
YB11	yes	no	good	good	Very low gradient channel becoming wider [to 3m], with more pool habitat. Some juvenile habitat toward bottom as gradient increases.
YB12	yes	n.a.	good	good	Gradient reduces compared with upstream. Stream becomes steep sided channel through peat.
YB13	yes	no	good	good	5-20 cm mixed flow & hard substrate. Small patches of spawning and good trout fry habitat.
YB14	yes	no	good	good	Trout seen. Improving compared with. upstream. Gravel and pebble among boulder in parts near bottom of reach. By bottom of section there is some good trout fry habitat.
YB15	yes	n.a.	mod.	mod.	Occasional boulder and run at bottom end but very poor fish habitat.
YB16	yes	n/a			Small peat channel - may hold small trout but improbable
ANC1	yes	partly	mod.	mod.	Lots of nice juvenile habitat and spawning. Very good trout habitat - stable with Good bank-side cover.
ANC2	yes	partly	good	good	Lower part of section is better habitat. Compacted higher up.
ANC3	yes	yes	mod.	mod.	Mainly canal with short riffle sections. Stony bits are compacted.
ANC4	yes	partly	mod.	mod.	Mostly peaty canal. Some short riffles but they have little cover.
ANC5	yes	n.a.	poor	poor	Peat channel 1 to 2.5 m in width. Peat and coarse sand substrate in 40-80 cm of water. Slow to moderate flow. Much *Potamogeton*. Steep banks. Wet heath.
ANC6	yes	yes	mod.	mod.	Cobble and boulder set in peat and with sand around. Habitat best suited to trout. Faster flow than section 5, narrower more energetic with more large substrates.
ANC7	yes	partly	mod.	mod.	Poor quality juvenile habitat below & above loch confluence. Mainly peat channel.
ANC8	yes	no	poor	poor	Fry habitat below track is silted. Boulder & big cobble set in peat - poor.
ANC9	yes	n.a.	mod.	mod.	Mainly peat occasionally boulder or cobble
ANC10-11					Small peat channel.
ANC12	yes	partly	good	good	Small peat channel flowing out of loch. Pebble, gravel & boulder below track - good trout fry habitat.
AR1	yes	partly	mod.	good	Rather canal like in parts with occasional stony riffles. Bedrock and peat in parts.
AR2	yes	yes	good	good	Mainly canal-like. Riffles are compacted and weedy.
AR3	yes	yes	good	good	Probably supports a few trout with good bank-side cover.
AR4	yes	yes	good	good	Probably supports a few trout with good bank-side cover.
AR5	yes	n.a.	good	good	Incised peat channel. River in a 'peat tube' often underground.
AR6	yes	n.a.	good	good	Incised peat channel. River in a 'peat tube' often underground.
AR7	yes	n.a.	good	good	Peat canal. River in a 'peat tube' often underground. Some cobble sections.
AR8-9	yes	n.a.	good	good	Incised peat channel. River in a 'peat tube' often underground.
ADG1	yes	partly	good	good	Quite compacted but good bankside cover. Best habitat in lower half.
ADG2	yes	yes	good	good	Peaty with compacted cobbles on the bottom. No spawning.

ADG3	yes	n.a.	mod.	mod.	Peaty channel. Very poor.
ADG4	yes	n.a.	good	good	Peat channel lacking in hard substrate.
ADG5	yes	yes	good	good	Some riffle and cobble substrate but mainly peat channel.
ADG6	yes	partly	good	good	Pebble & cobble in riffles. Undercut banks. Fish unable to access loch due to sluice.
ADG4a	yes	n.a.	good	good	Peaty & small.
AF1	yes	partly	mod.	mod.	Gorge at bottom near R. Strathy. Impassable waterfall at NC 823 579.
AF2	yes	n.a.	n.a.	n.a.	Peat channel appears totally unsuitable for fish.
LB1	yes	yes	poor	poor	Poor quality and compacted.
LB2	yes	yes	poor	poor	Boulder and cobble but these are set in peat and provide little cover. Totally engulfed in conifer thicket.
LB3	yes	yes	poor	poor	A poor 'drain' through dense conifer. Steep peat banks and compacted cobble on peat bed.
LB4	yes	yes	mod.	mod.	Better for trout - especially fry. Stony channel with steep peat sides. Over-planted with conifer.

Appendix 3 Spawning habitat locations, Strathy catchment, 2007.

Survey section	Site code	NGR	Area m^2	Suitability		Washout?	Notes
				Salmon	Trout		
River Strathy							
RS1	S1.1	NC8357 6500	20	moderate	moderate	no	Tail of pool.
RS2	S2.1	NC8358 6471	25	moderate	moderate	maybe	A bit unstable. The river clearly shifts around at this location.
RS4	S4.1	NC8335 6390	150	moderate	good	no	Pebble riffle.
RS6	S6.1	NC8333 6285	100	moderate	moderate	no	Tail of glide.
RS6	S6.2	NC8333 6312	25	good	moderate	no	Tail of glide.
RS6	S6.3	NC8328 6317	240	good	moderate	no	30m reach of pebble, gravel and cobble in riffle.
RS7	S7.1	NC8322 6240	60	good	moderate	no	Right side of channel at tail of glide.
RS7	S7.2	NC8328 6261	60	good	poor	no	Too large grain for trout.
RS7	S7.3	NC8332 6273	35	moderate	poor	no	Run in to pool.
RS8	S8.1	NC8308 6240	30	moderate	moderate	no	Mainly to right bank in glide merging to fry habitat.
RS9	S9.1	NC8283 6192	25	moderate	poor	no	
RS10	S10.1	NC8269 6168	10	moderate	poor	unknown	Pockets below pool.
RS11	S11.1	NC8261 6100	15	moderate	poor	no	Small pockets in riffle.
RS11	S11.2	NC8275 6106	80	moderate	poor	no	Left side at tail of pool.
RS11	S11.3	NC8274 6122	70	good	poor	no	Tail of pool - good habitat.
RS12	S12.1	NC8269 6071	10	moderate	poor	no	Pockets for 2 or 3 redds – rest of area is mainly coarse, unsuitable cobble.
RS13	S13.1	NC8269 6030	80	good	poor	unknown	Right side below pool.
RS13	S13.2	NC8266 6019	60	moderate	poor	unknown	Rather sandy.
RS17	S17.1	NC8253 5339	90	good	good	no	Tail of glide, mixed grain size.
RS17	S17.2	NC8249 5848	100	moderate	good	no	Some coarse sand.
RS17	S17.3	NC8247 5862	20	good	moderate	no	At tail of pool in shallow riffle.
RS18	S18.1	NC8253 5801	75	good	poor	no	
RS18	S18.2	NC8253 5803	25	poor	good	no	
RS19	S19.1	NC8264 5754	40	good	moderate	no	
RS19	S19.2	NC8256 5770	30	good	good	no	Too coarse substrate for trout.
RS20	S20.1	NC8264 5738	30	poor	good	no	Top of pool.
RS30	S30.1	NC8040 5995	15	moderate	moderate	no	Several patches in glide - a bit sandy but useable.
RS32	S32.1	NC8036 5315	40	good	moderate	no	
RS32	S32.2	NC8035 5324	25	good	poor	no	Good holding pool immediately downstream.
RS33	S33.1	NC8037 5308	20	moderate	moderate	no	Tail of pool on eroded corner - note lack of spawning in ~4 km upstream.
RS40	S40.1	NC7978 4993	6	poor	poor	no	Quite sandy.

RS40	S40.2	NC7976 5001	10	moderate	moderate	no	
RS41	S41.1	NC7969 4964	5	poor	moderate	no	
RS42	S42.1	NC4967 4908	5	moderate	good	no	Left channel at island.
RS42	S42.2	NC7963 4926	6	moderate	poor	no	On bend.
RS43	S43.1	NC7952 4885	30	good	good	no	Good quality pebble gravel at tail of pool.
RS43	S43.2	NC7955 4891	10	moderate	good	no	Good quality pebble gravel at tail of pool.
RS43	S43.3	NC7959 4897	5	moderate	good	no	Good quality pebble gravel at tail of pool.
Yellowbog Burn							
YB1	YB1.1	NC8026 5470	16	moderate	moderate	no	Other possible scattered small patches in reach, but these poor for salmon.
YB2	YB2.1	NC8000 5461	5	good	good	unknown	Compaction of substrates reduces habitat availability.
YB8.1	YB8.1	NC7936 5237	9	poor	poor	no	Silted. 3 patches.
YB13	YB13.1	NC7889 5035	8	poor	good	no	Above and below minor tributary. Good habitat - other smaller patches present all way to bottom of section [total ~10 m^2] that would suit trout.
YB13	YB13.2	NC7884 5031	5	poor	good	no	Uppermost site - Good habitat.
Allt nan Clach							
ANC1	ANC1.1	NC7939 5440	10	moderate	poor	no	Pebble bank on bend.
ANC1	ANC1.2	NC7937 5444	12	poor	moderate	no	
ANC1	ANC1.3	NC7930 5463	10	moderate	moderate	unknown	Tail of glide.
The Uair							
U1	U1.1	NC8272 5618	5	moderate	poor	no	Top of left channel at braided area.
U4	U4.1	NC8276 5468	5	moderate	poor	no	In area of conifers on bend.
U8	U8.1	NC8273 5340	5	moderate	moderate	no	Other small patches of uncompacted cobble / gravel in glide [total 5 m^2] but not classic spawning habitat.
U8	U8.2	NC8277 5319	10	moderate	poor	no	Not compacted, Good spawning habitat.
U11	U11.1	NC8284 5199	10	poor	moderate	no	Sandy.
U12	U12.1	NC8286 5178	15	moderate	moderate	no	Three patches of Good habitat.
U12	U12.2	NC8284 5168	20	moderate	moderate	no	Deposited peat may reduce egg survival but not compacted. Four patches.
Allt na Dubh-chlaise							
ADC1	ADC1.1	NC8270 6120	60	good	good	no	Just inside deer fence.
ADC2	ADC2.1	NC8238 6095	10	moderate	moderate	unknown	

Appendix 4 Habitat availability by survey section and sub-catchment

River Strathy

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	*TOTAL*
RS1	16	640	2960	960	640	2800	0	0	20	**8020**
RS2	14	840	2800	2240	1120	0	0	0	25	**7025**
RS3	12	0	2160	0	3120	720	0	0	0	**6000**
RS4	16	1760	3360	2080	800	0	0	0	150	**8150**
RS5	16	1120	5280	320	1280	0	0	0	0	**8000**
RS6	11	1100	1980	495	935	990	0	0	365	**5865**
RS7	15	1800	2400	0	2250	1050	0	0	155	**7655**
RS8	18	0	4860	2700	1440	0	0	0	30	**9030**
RS9	12	360	2700	1560	960	420	0	0	25	**6025**
RS10	13	0	5005	585	0	910	0	0	10	**6510**
RS11	10	600	1750	800	0	1850	0	0	165	**5165**
RS12	13	0	2470	2340	0	1690	0	0	10	**6510**
RS13	14	0	3570	560	2100	770	0	0	140	**7140**
RS14	14	0	5460	0	840	700	0	0	0	**7000**
RS15	13	0	5200	0	1300	0	0	0	0	**6500**
RS16	15	1650	3300	0	2550	0	0	0	0	**7500**
RS17	14	980	3500	420	980	1120	0	0	210	**7210**
RS18	10	0	2700	0	2300	0	0	0	100	**5100**
RS19	14	0	4200	0	1610	1190	0	0	70	**7070**
RS20	14	0	7000	0	0	0	0	0	30	**7030**
RS21	16	0	5760	0	2240	0	0	0	0	**8000**
RS22	14	0	7000	0	0	560	0	0	0	**7560**
RS23	13	0	2730	1430	1170	1170	0	0	0	**6500**
RS24	13	0	6695	0	0	0	0	0	0	**6695**
RS25	14	0	6510	0	0	490	0	0	0	**7000**
RS26	12	0	6000	0	0	0	0	0	0	**6000**
RS27	11	0	5500	0	0	0	0	0	0	**5500**
RS28	7	0	3080	0	0	140	280	0	0	**3500**
RS29	7	0	2100	0	1190	210	0	0	0	**3500**
RS30	8	0	0	0	2800	1200	0	0	15	**4015**
RS31	6	420	420	0	2100	480	0	0	0	**3420**
RS32	4	360	240	0	1040	360	0	0	65	**2065**
RS33	4.5	810	900	0	540	90	0	0	20	**2360**
RS34	4.2	756	1176	0	294	0	0	0	0	**2226**
RS35	3.5	420	420	0	910	0	0	0	0	**1750**
RS36	3.2	0	1024	0	480	96	0	0	0	**1600**
RS37	3	0	900	0	330	180	0	0	0	**1410**
RS38	3.3	198	858	0	363	231	0	0	0	**1650**
RS39	3	300	195	0	1005	0	0	0	0	**1500**
RS40	3.5	350	0	0	1050	175	0	0	16	**1591**
RS41	3.5	560	0	0	980	210	0	0	5	**1755**
RS42	3	210	600	0	480	75	0	0	11	**1376**
RS43	3	390	840	0	0	270	0	0	45	**1545**
RS44	3.5	140	560	0	0	0	0	0	0	**700**
Total		**15764**	**126163**	**16490**	**41197**	**20147**	**280**	**0**	**1682**	**221723**

Yellowbog Burn

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
YB1	4	440	1480	0	280	0	0	0	16	**2216**
YB2	3	60	1020	0	465	0	0	0	5	**1550**
YB3	4	0	520	0	1480	0	0	0	0	**2000**
YB4	1.8	0	522	0	324	54	0	0	0	**900**
YB5	2.2	0	88	0	484	528	0	0	0	**1100**
YB6	1.6	0	0	0	832	48	0	0	0	**880**
YB7	1.6	40	400	0	400	0	0	0	0	**840**
YB8	1.6	0	368	0	400	32	0	0	9	**809**
YB9	1.6	0	624	0	80	96	0	0	0	**800**
YB10	1.4	154	21	0	441	84	0	0	0	**700**
YB11	1.5	0	210	0	375	255	0	0	0	**840**
YB12	0.9	0	72	0	423	0	0	0	0	**495**
YB13	0.7	133	259	0	0	0	0	0	13	**405**
YB14	0.6	0	132	0	168	0	0	0	0	**300**
YB15	0.6	0	0	0	0	0	0	300	0	**300**
YB16	0.5	0	0	0	0	0	0	250	0	**250**
Total		**827**	**5716**	**0**	**6152**	**1097**	**0**	**550**	**43**	**14385**

Allt nan Clach and Allt an Reidhe

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
ANC1	3	15	600	0	660	90	0	0	32	**1397**
ANC2	2.5	0	775	0	250	225	0	0	0	**1250**
ANC3	1.5	0	188	0	563	0	0	0	0	**750**
ANC4	2	0	260	0	620	120	0	0	0	**1000**
ANC5	1.8	0	90	0	0	72	0	738	0	**900**
ANC6	1.4	42	294	0	0	0	0	364	0	**700**
ANC7	1.1	0	176	0	0	44	0	330	0	**550**
ANC8	0.8	120	136	0	0	0	0	144	0	**400**
ANC9	0.6	33	0	0	0	0	0	267	0	**300**
ANC10	0.4	0	0	0	0	0	0	200	0	**200**
ANC11	0.4	0	0	0	0	0	0	200	0	**200**
ANC12	0.4	120	0	0	0	0	0	120	0	**240**
AR1	0.8	24	32	0	232	32	0	0	0	**320**
AR2	0.8	0	152	0	216	32	0	0	0	**400**
AR3	0.8	0	0	0	400	0	0	0	0	**400**
AR4	1	0	0	0	0	0	0	500	0	**500**
AR5	0.4	0	0	0	0	0	0	200	0	**200**
AR6	0.25	0	0	0	0	0	0	125	0	**125**
AR7	0.3	0	0	0	0	0	0	90	0	**90**
AR8-9	0.3	0	60	0	0	0	0	270	0	**330**
Total		**354**	**2763**	**0**	**2941**	**615**	**0**	**3548**	**32**	**10252**

Allt Loch na Saobhaidhe

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
ALS1	1.0	250	60	0	0	0	0	200	0	**510**

Allt Badian

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
AB1	1.1	0	352	0	198	0	0	0	0	**550**
AB2	1.3	0	650	0	0	0	0	0	0	**650**
AB3	1.1	0	143	0	341	66	0	0	0	**550**
AB4	0.7	0	42	0	308	0	0	0	0	**350**
AB5	0.5	0	0	0	120	0	0	0	0	**120**
Total		**0**	**1187**	**0**	**967**	**66**	**0**	**0**	**0**	**2220**

Allt na Dubh-chlaise

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
ADC1	1.5	0	420	0	0	0	0	0	60	**480**
ADC2	1.3	0	195	0	0	0	0	0	10	**10205**
ADC3		0	0	0	0	0	0	0		**0**
ADC4	1	0	300	0	50	0	0	0		**350**
ADC5	1	310	0	0	0	0	0	190		**500**
ADC6-7	0.6	150	0	0	0	0	0	450		**600**
ADC8-9	0.3	0	0	0	0	0	0	300		**300**
ADC10	0.3	0	0	0	0	0	0	150		**150**
Total		**460**	**915**	**0**	**50**	**0**	**0**	**1090**	**70**	**2585**

The Uair

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
U1	5	0	2250	0	0	0	250	0	5	**2505**
U2	4	120	1880	0	0	0	0	0	0	**2000**
U3	4.5	0	2250	0	0	0	0	0	0	**2250**
U4	4.5	158	1103	0	0	0	990	0	5	**2255**
U5	3.5	0	1750	0	0	0	0	0	0	**1750**
U6	2.8	0	1400	0	0	0	0	0	0	**1400**
U7	2.8	0	756	0	364	280	0	0	0	**1400**
U8	2.1	189	74	0	714	74	0	0	15	**1065**
U9	1.8	0	621	0	207	72	0	0	0	**900**
U10	2.3	0	0	0	759	391	0	0	0	**1150**
U11	2	0	0	0	1000	0	0	0	10	**1010**
U12	1.8	108	198	0	531	63	0	0	25	**925**
U13	1.6	104	80	0	552	64	0	0	0	**800**
U14	1	80	40	0	380	0	0	0	0	**500**
U15	0.3	0	0	0	0	0	0	150	0	**150**
U16	0.2	0	0	0	0	0	0	100	0	**100**
U15a	1	0	0	0	0	0	0	650	0	**650**
Total		**759**	**12401**	**0**	**4507**	**943**	**1240**	**900**	**60**	**20810**

Allt Dhonuill Ghuinne

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
ADG1	1.5	0	795	0	375	75	0	0	0	**1245**
ADG2	0.8	0	192	0	192	16	0	0	0	**400**
ADG3	1	0	80	0	420	0	0	0	0	**500**
ADG4	0.6	0	0	0	0	0	0	300	0	**300**
ADG5	0.6	0	138	0	0	0	0	162	0	**300**
ADG6	1	0	520	0	0	0	0	0	0	**520**
ADG4a	0.5	0	0	0	0	0	0	250	0	**250**
Total		**0**	**1725**	**0**	**987**	**91**	**0**	**712**	**0**	**3515**

Allt an Fhithich

Section	Wet width (m)	Area (m^2)								
		Fry	*Mixed Juvenile*	*Deep Juvenile*	*Glide*	*Pool*	*Bedrock*	*Peat*	*Spawning*	***TOTAL***
AF1	0.8	0	0	0	0	0	80	320	0	**400**
AF2	0.5	0	0	0	0	0	0	250	0	**250**
Total		**0**	**0**	**0**	**0**	**0**	**80**	**570**	**0**	**650**

Appendix 5. Single run minimum densities from 2007 baseline survey and regional density classification (Godfrey 2006)

Site Code	Area	Number caught first run				Minimum density (fish.100 m^{-2})				Density classification			
		Salmon fry	Salmon parr	Trout fry	Trout parr	Salmon fry	Salmon parr	Trout fry	Trout parr	Salmon fry	Salmon parr	Trout fry	Trout parr
RS1	408.9	106	45	0	4	25.9	11.0	0.0	1.0	B	C	F	F
RS2	132.6	24	15	7	2	18.1	11.3	5.3	1.5	B	C	B	D
RS3	318.4	52	15	2	2	16.3	4.7	0.6	0.6	B	D	E	E
RS4	273	35	38	1	0	12.8	13.9	0.4	0.0	C	B	F	F
RS5	238.9	65	12	0	0	27.2	5.0	0.0	0.0	B	D	F	F
RS6	290.4	19	17	3	11	6.5	5.9	1.0	3.8	D	D	E	C
RS7	220.8	0	1	3	1	0.0	0.5	1.4	0.5	F	F	E	F
RS8	139.6	51	26	0	0	36.5	18.6	0.0	0.0	A	A	F	F
RS9	133.2	28	18	11	3	21.0	13.5	8.3	2.3	B	B	B	D
RS10	132.6	15	15	10	4	11.3	11.3	7.5	3.0	C	B	B	C
RS11	126	47	13	11	3	37.3	10.3	8.7	2.4	A	B	B	D
RS12	143.5	0	17	7	7	0.0	11.8	4.9	4.9	F	B	C	C
YB1	22	0	2	0	3	0.0	9.1	0.0	13.6	F	C	F	A
YB2	132	0	5	9	10	0.0	3.8	6.8	7.6	F	E	B	B
YB3	80.5	0	0	10	11	0.0	0.0	12.4	13.7	F	F	A	A
YB4	100.1	0	0	35	11	0.0	0.0	35.0	11.0	F	F	A	A
ANC1	25.3	7	3	6	3	27.7	11.9	23.7	11.9	B	C	A	A
ANC2	102.7	1	2	38	9	1.0	1.9	37.0	8.8	E	E	A	A
ANC3	50.6	0	0	15	7	0.0	0.0	29.6	13.8	F	F	A	A
AR1	93.6	0	0	8	16	0.0	0.0	8.5	17.1	F	F	B	A
ADC1	110.2	0	3	9	23	0.0	2.7	8.2	20.9	F	E	B	A
ADC2	58.8	0	0	28	11	0.0	0.0	47.6	18.7	F	F	A	A
ADG1	70	0	0	7	5	0.0	0.0	10.0	7.1	F	F	B	B
ADG2	73.8	0	0	3	9	0.0	0.0	4.1	12.2	F	F	D	A
AB1	55.5	1	2	11	4	1.8	3.6	19.8	7.2	E	D	A	B
AF1	N.A.	0	0	0	0	0.0	0.0	0.0	0.0	F	F	F	F
ARB1	15	0	0	5	1	0.0	0.0	33.3	6.7	F	F	A	B
BB1	18	0	0	4	1	0.0	0.0	22.2	5.6	F	F	A	B
U1	117.1	1	3	1	15	0.9	2.6	0.9	12.8	E	D	E	A
U2	93.1	0	1	3	4	0.0	1.1	3.2	4.3	F	E	D	C
U3	149.4	0	0	19	22	0.0	0.0	12.7	14.7	F	F	A	A

Appendix 6. Habitat at repeat electric fishing sites, 2007 to 2012

YEAR	SITE	DEPTH (cm)						SUBSTRATE									FLOW TYPES							
		<10	*11-20*	*21-30*	*31-40*	*41-50*	*>50*	*HO*	*SI*	*SA*	*GR*	*PE*	*CO*	*BO*	*BE*	*OB*	*SM*	*DP*	*SP*	*DG*	*SG*	*RU*	*RI*	*TO*
2007	RS8	*5*	*30*	*30*	*30*	*5*	*0*	*10*	*0*	*10*	*10*	*5*	*40*	*25*	*0*	*0*	*0*	*0*	*10*	*10*	*10*	*50*	*20*	*0*
2009	RS8	*5*	*45*	*35*	*10*	*5*	*0*	*5*	*0*	*10*	*10*	*2*	*55*	*23*	*0*	*0*	*0*	*0*	*10*	*10*	*30*	*25*	*25*	*0*
2012	RS8	*0*	*15*	*30*	*45*	*10*	*0*	*5*	*0*	*10*	*10*	*2*	*55*	*23*	*0*	*0*	*5*	*0*	*5*	*0*	*5*	*60*	*25*	*0*
2007	RS9	5	15	20	40	20	0	0	0	10	5	5	40	40	0	0	0	10	0	10	0	60	20	0
2009	RS9	5	15	20	40	20	0	0	0	10	5	5	40	40	0	0	0	10	0	10	0	65	15	0
2012	RS9																							
2007	RS11	0	25	45	25	5	0	0	0	5	10	10	55	20	0	0	0	5	5	20	5	60	5	0
2009	RS11	10	35	50	5	0	0	0	0	5	5	5	65	20	0	0	0	5	0	0	15	60	20	0
2012	RS11																							
2007	YB2	0	30	40	25	5	0	0	0	5	10	5	45	35	0	0	0	5	10	15	15	50	10	0
2009	YB2	5	50	40	5	0	0	0	0	5	10	5	45	35	0	0	0	5	10	0	50	25	10	0
2012	YB2	0	3	30	60	5	2	0	0	5	10	5	45	35	0	0	0	5	10	0	0	70	15	0
2007	YB4	5	65	25	5	0	0	2	0	3	10	15	70	10	0	0	5	0	10	5	25	45	10	0
2009	YB4	35	55	1	0	0	0	2	3	3	10	22	65	5	0	0	10	0	10	0	40	30	10	0
2012	YB4	5	60	30	5	0	0	5	0	5	5	20	55	5	0	0	5	10	10	0	40	30	10	0
2007	ANC2	5	50	30	10	5	0	0	0	2	5	10	58	25	0	0	0	5	10	10	30	35	10	0
2009	ANC2	10	50	30	10	0	0	0	0	3	10	12	50	25	0	0	5	5	20	5	10	45	10	0
2012	ANC2	5	25	30	35	5	0	1	0	2	10	12	55	20	0	0	0	20	0	0	0	70	10	0
2007	ANC3	10	35	30	20	5	0	10	0	5	10	5	50	20	0	0	0	15	30	10	20	20	5	0
2009	ANC3	20	35	25	15	5	0	10	0	5	10	10	45	20	0	0	0	15	30	0	20	30	5	0
2012	ANC3	0	25	25	30	15	5	10	0	5	10	10	45	20	0	0	0	25	0	10	0	60	5	0

Substrates: HO = high organic (peat); SI = silt; SA = sand; GR = gravel; PE = pebble; CO = cobble; BO = boulder; BE = bedrock; OB = obscured.
Flow types: SM = shallow marginal; DP = deep pool; SP = shallow pool; DG = deep glide; SG = shallow glide; RU = run; RI = riffle; TO = torrent.

Appendix 7 Examples of habitat categories used in habitat assessments and site descriptions

Fry

Mixed juvenile

Glide

Pool

Spawning

Peat channel

Appendix 8 Selected photographs, habitat survey

RS5, good salmon habitat in lower River Strathy

RS14. Bank erosion providing substrate to channel

RS27. Middle and upper river is very stable

RS34 showing stable substrate and macrophytes

RS41 in Strathy South Forest

RS44 near the upstream limit of the survey

YB1 in the lower reaches of Yellowbog Burn

YB7 with stable substrate and undercut banks

YB9 and habitat best suited to trout fry

ANC1, looking south

ANC4, glide with *Potamogeton*

ANC6

AB1 on Allt Badian

AR3 on Allt an Reidhe

ALS 1 on Allt Loch na Saobhaidhe

STRATHY SOUTH WIND FARM:
FRESHWATER INVERTEBRATE SURVEY

October 2012

Aquaterra Ecology

Aquaterra Ecology, Crombie Cottage, Aberchirder, Huntly, Aberdeenshire AB54 7QU

Table of Contents **Page**

1 Introduction ... 2
1.1. Background ... 2
1.2. Biomonitoring ... 2

2 Objectives ... 2

3 Methods ... 3
3.1. Field sampling ... 3
3.1.1. Kick samples ... 3
3.1.2. Surber samples ... 3
3.1.3. Sites ... 3
3.2. Invertebrate identification ... 4
3.3. Water quality indices ... 4
3.3.1. BMWP and ASPT ... 4
3.3.2. Water Chemistry Status ... 4
3.3.3. Index of Acidity ... 5

4 Results and Discussion ... 6
4.1. Sites: environmental variables ... 6
4.1.1. Substrate ... 6
4.1.2. Macrophytes and Canopy Cover ... 6
4.2. Invertebrate Communities ... 7
4.2.1. Relative Proportions of Invertebrate Groups ... 7
4.2.2. Invertebrate Abundance, Diversity and Biomass ... 7
4.3. Biological Indices ... 8
4.3.1. BMWP and ASPT scores ... 8
4.3.2. Water Chemistry Status ... 8
4.3.3. Index of Acidity ... 9
4.4. Survey Limitations ... 9

5 Conclusions ... 9

6 References ... 10

Summary

Background

Macroinvertebrate communities were sampled using standard kick sampling methods (SEPA 2001) from sixteen sample sites, five on the River Strathy, two on the Allt Badian, four on the Yellowbog Burn, two on the Allt nan Clach and three on The Uair. Sampling took place in the period 4th to 7th September 2007 in conditions of low flow. Samples were identified to family level and indices of water quality (BMWP, ASPT scores) were produced.

At each site three Surber samples were taken to provide quantitative measures of invertebrate abundance and biomass. Major groups (Malacostraca, Ephemeroptera, Trichoptera, Plecoptera, Mollusca, Odonata and adult Coleoptera) were identified to species level to identify presence of any rare species and to provide data for production of two biological indices, namely Water Chemistry Status and Index of Acidity.

Environmental variables including bed width, depth, flow and substrate profile were recorded at each site and GPS generated grid references and photographs taken to enable future site identification.

Main Findings

(i) Invertebrate communities largely consisted of species commonly found in Scottish watercourses and no rarities were identified.

(ii) The relative proportions of invertebrate groups indicated clean well-oxygenated conditions with no significant organic enrichment.

(iii) Abundance, diversity and biomass of invertebrates appeared moderate in all watercourses.

(iv) ASPT scores indicate that the River Strathy had good-excellent water quality (A1-A2) and all the other Strathy South watercourses had good water quality (A2).

(v) Water Chemistry Status and Index of Acidity Scores indicated that the watercourses are slightly acidic, pH 5.6 or above. The watercourses are acidic enough to affect the invertebrate community and some of the more sensitive acid intolerant species were entirely absent from the survey area. The Allt Badian and the upper reaches of the Yellowbog Burn may be significantly acidified but further work is required to establish this conclusively.

(vi) Overall the water quality, invertebrate communities and productivity should support sustainable salmonid populations if other environmental factors are suitable.

1 Introduction

1.1. Background

SSE Renewables (UK) Ltd (referred to as SSER) and acting on behalf of the applicant SSE Generation Ltd, propose constructing a wind farm known as Strathy South in Strathy South Forest. Should it be consented, the Strathy South Wind Farm would be constructed about 12 km south-west of Strathy Village. The site would occupy an area currently planted with commercial conifer forest.

The River Strathy and several tributary streams flow through the site. The River Strathy itself is a small to medium sized river with a total catchment area of 113.5 km^2. The catchment drains the internationally designated peatlands of the 'Flow Country' and the site has a significant cover of blanket peat. The river sustains fisheries for salmon and sea trout.

Surveys of the aquatic environment are required to inform the environmental assessment of the Modified 2012 Scheme. Concerns were raised during the consultation process about the potential for impacts on water quality, resulting from tree felling, exposure of soils and siltation.

1.2. Biomonitoring

Many aquatic invertebrates have specific habitat requirements, including a limited range of water chemistry, and these species can be used as biological indicators to both broadly assess the general quality of freshwater burns and rivers, and to assess more specific chemical status, for example acidity. The production of biotic indices to assess water quality is an established method using the BMWP (Biological Monitoring Working Party) and ASPT (Average Score Per Taxon) scoring system. These scores were primarily developed for identifying organic pollution, but they are widely used as indicators of general stream health.

Biotic indices can be used to overcome the difficulties associated with direct monitoring of pH, which tends to fluctuate markedly in acidic streams. Macroinvertebrates integrate recent (weeks to months) pH conditions at a site (Davy-Bowker *et al.* 2005) and are therefore well suited for bio-monitoring where the sampling frequency is constrained. In general, the relationship between the tolerance of most acid-sensitive invertebrates and that of salmonid fish is fairly close, although trout can survive slightly more acid conditions than some of the invertebrate indicators (Patterson and Morrison 1993).

Assessment of macroinvertebrates can therefore both augment the interpretation of chemical analysis of water quality and monitor the biological consequences of changes in water chemistry.

Quantitative assessments of macroinvertebrates also provide accurate characterisations of the community, and a measure of biodiversity and productivity of a watercourse. Total invertebrate biomass can be used as an indication of the productivity of invertebrate fauna, potentially important in sustaining salmonid populations.

2 Objectives

The freshwater invertebrate survey of the watercourses of the River Strathy catchment provides:

(i) A description of the macroinvertebrate community including species level identification in most major groups (Malacostraca, Ephemeroptera, Trichoptera, Plecoptera, Mollusca [excepting Sphaeriidae], Odonata and adult Coleoptera)

(ii) BMWP and ASPT scores as an assessment of water quality (SEPA 2001)

(iii) Indices of acidity: Water Chemistry Status (Patterson & Morrison 1993) and Index of Acidity (Clyde River Purification Board 1995)

(iv) Quantitative sampling to assess invertebrate abundance and to provide a measure of biodiversity and productivity

(v) A description of the environmental variables at each monitoring site including depth, width, flow, substrate profile, estimates of in-stream vegetation and canopy cover.

3 Methods

3.1. Field Sampling

3.1.1. Kick samples

Sampling was based on standard kick sampling methodologies employed by Scottish Environment Protection Agency (SEPA). A 25 cm diameter kick sample net with a 1 mm mesh was used at all sites. Kick sampling at all sites was conducted in riffle-type habitat.

The sampling procedure involved a total of 3 minutes of kick sampling at each site. Sampling covered the whole width of the stream. The net was held vertically, downstream from the sampler's feet and resting on the riverbed. The sampler disturbed the riverbed vigorously with the heels, by kicking or rotating, to dislodge the substrate to a depth of about 10 cm. Dislodged invertebrates were washed into the sampling net.

A further 1-minute period of hand sampling was carried out at all sites, searching on and under stones and rocks for attached invertebrates such as molluscs and cased caddis.

Samples from kicking and hand collecting were preserved together in 70% Industrial Methylated Spirits (IMS) in sealed plastic containers.

3.1.2. Surber samples

Surber samples were taken to quantitatively assess invertebrate abundance. A standard Surber sampler with an area of approximately 0.1 m^2 and a 500 µm mesh net was placed in a suitable riffle-type habitat, on hard substrates with a depth of 5-20 cm. The leading edge of the net of the sampler was made level with the substrate, to prevent loss of invertebrates, after which the entire sampler frame was established in the substrate. If stones restricted placement of the sampler they were moved and included in the sample if >50% of the stone was in the sample area.

Sampling involved the removal of any invertebrates from surface stones followed by agitation of the substrate, the disturbed invertebrates being swept by the current into the net. Plants present were either picked over and washed or included in the sample for laboratory invertebrate searching. The sampling procedure ceased when all substrates within the sampler frame had been thoroughly washed into the net. Surber sampling was conducted at riffle areas.

3.1.3. Sites

Sample sites were selected with riffle habitat wherever possible. Riffles are one of the most productive habitats in rivers and streams and are the standard habitat for water quality bio-monitoring (SEPA 2001).

Two sites were selected on the River Strathy between the Yellowbog Burn confluence and the Strathy Forest to assess cumulative impacts from the Modified 2013 Scheme. Two sample sites were chosen in the Yellowbog Burn below the Allt nan Clach confluence to assess possible cumulative impacts at the west side of the site. Two sites were chosen on the River Strathy between the Yellowbog Burn and the Strathy South forest edge to assess cumulative impacts on the east side of the site and a further River Strathy site just above the Allt Badian tributary burn was selected to monitor impacts from turbines in the east. Two sample sites each on Allt nan Clach, Yellowbog Burn and the Allt Badian were used to provide baseline data on potentially impacted individual streams.

In addition, three sampling points were sited in The Uair, a burn unaffected by the Modified 2013 Scheme. These sites were chosen as potential control sites. Control sites may be required for monitoring purposes, as invertebrate populations are subject to significant year-to-year variations.

Sample sites were accurately recorded using photographs and ten figure GPS grid references (Garmin etrex, accuracy of <15 metres RMS). Physical environmental factors including stream width, depth, flow and substrate profiles (using Wentworth scale) were recorded for both the kick habitat and the sample area within the Surber samplers (Tables 2 & 3). Water temperature and pH were recorded with a portable meter Hannah HI 98129, resolution 0.1ºC and 0.01 pH, accuracy ± 0.5 ºC and ± 0.1 pH unit. Data was recorded on standard field sheets (Appendix 7).

3.2. Invertebrate Identification

Invertebrates were examined using a Wild binocular microscope at 6-50X magnification and a Brunel compound microscope at 100X. Identification used standard keys (Brooks & Lewington 1999, Edington & Hildrew 1995, Elliot, Humpesch & Macan 1988, Elliot, & Mann 1979, Friday 1988, Hynes 1977, Macan 1959, Macan 1977, Nilsson 1996, 1997, Reynoldson & Young 2000, Timm & Veldhuijzen van Zanten 2002 and Wallace, Wallace & Philipson 1990).

Specimens from kick samples were identified to the appropriate taxonomic level to provide a biological assessment of water quality using BMWP (Biological Monitoring Working Party) and ASPT (Average Score Per Taxon) scores. Specimens from Surber samples were identified to species level in major groups.

Surber samples were washed through a 500 µm Endecott sieve and invertebrates counted to give a quantitative measure of abundance (small chironomids <2.5 mm long were excluded). The invertebrates were then dried at a constant temperature of 60ºC for 48 hours. The dried sample was then weighed on an analytical balance (readability 0.1 mg) to produce a biomass gm/m² (dry weight).

3.3. Water Quality Indices

3.3.1. BMWP and ASPT

These scores were primarily developed for identifying organic pollution, but they are widely used as indicators of general stream health.

Biological Monitoring Working Party (BMWP) scores were calculated for each invertebrate sample from each site. The scoring system is based on the pollution sensitivity of each invertebrate family. The scale is 1-10 and a score of 1 is allocated to the most pollution tolerant families and 10 to the most pollution sensitive (Appendix 1). The BMWP score is the sum of the group scores for the sample. The ASPT (Average Score Per Taxon) score is the average score for each group present in the sample.

Low BMWP or ASPT scores indicate possible pollution, high scores indicate good water quality. A simplified version of the Scottish River Classification Scheme (1997) used by SEPA is set out below.

Table i. Simplified Scottish River Classification Scheme as used by SEPA.

Class	Description	BMWP	ASPT	Comments
A1	Excellent	≥85	≥6.0	Sustainable salmonid population*
A2	Good	70-84	5.0-5.9	Sustainable salmonid population*
B	Fair	50-69	4.2-4.9	Salmonids may be present
C	Poor	15-49	3.0-4.1	Fish may be present
D	Seriously Polluted	<15	<3.0	Fish absent or seriously restricted

*If other environmental variables are suitable

The physical nature of the watercourse and the sampling effort of different individual samplers can influence the BMWP score. ASPT is viewed as a more stable and reliable index of pollution.

The number of scoring taxa is also an indicator of water status. A fall in the number of taxa is a general index of ecological damage, including overall pollution encompassing organic, toxic and physical pollution such as siltation, and damage to the habitats or the river channel, (General Quality Assessment of Rivers, Environment Agency website).

3.3.2. Water Chemistry Status

Patterson and Morrison (1993) developed a Definition of Classes for water chemistry status based on the presence of invertebrate indicator groups. Two indicator groups are used: Group 1 taxa with a

normal minimum pH of 6.0 and Group 2 with a normal minimum pH of 5.5 (Appendix 3). Three classes were defined (Table ii).

Table ii. Water Chemistry Classes

Class	Description	Comment
Class 1	Circumneutral	Group 1 taxa present. The water chemistry is suitable for the great majority of plants and animals. Alkalinity should be sufficient to buffer against most acid spate waters and the mean pH is ≥6.0 and unlikely to drop below 5.6. Salmonid fish are not stressed by the water chemistry.
Class 2	Not significantly acidified	Group 1 absent, group 2 present. The water chemistry is suitable for all except the most sensitive taxa. The mean pH is likely to be 5.6 or above. Where heavy metal and aluminium levels are low and/or organic content is high mean pH could be as low as 5.3. The water chemistry is likely to be suitable for salmonid fish but such streams may be vulnerable to future acidification.
Class 3	May be acidified	Groups 1 and 2 absent. Water chemistry may be acid to the point where wildlife is significantly affected including reduction of invertebrate diversity and reduction of salmonid fish populations, especially salmon. Further survey and chemical analysis is recommended to improve the diagnosis.

3.3.3. Index of Acidity

The Index of Acidity classification was developed by the Clyde River Purification Board to describe the probability and likely magnitude of acidification of freshwaters (Clyde River Purification Board 1995). Although developed for streams in Ayrshire and Argyll, the system has been applied by SEPA for more northern rivers and has shown good correspondence with juvenile salmon densities (Ian Milne, SEPA Dingwall, pers. comm.). As with the index of Water Chemistry Status, this index is based on the presence or absence of taxa with varying degrees of acid sensitivity from two lists: A and B (Appendix 3.). The classifications for samples collected between May and October are set out in Table iii:

Table iii. Index of Acidity Classes

Class	Description	Comment
Class I	Non-acid or slightly acid	At least three taxa from both Lists A and B present. Salmonid populations probably undamaged.
Class II	Intermediate	One or two List A taxa present or if List A taxa absent more than two List B taxa are present. Salmonid populations may show some signs of acid damage, for example reduced densities and missing or weak age classes.
Class III	Acid	List A absent and two or fewer List B taxa present. Trout populations reduced or absent and probably unable to sustain juvenile salmon.

4 Results and Discussion

4.1. Sample Sites: environmental variables

Sample site details and sampling dates are found in Table 1. Environmental variables recorded at kick sample sites, and within the Surber samplers are recorded in Tables 2 and 3.

4.1.1. Substrate

In its upper reaches the River Strathy is a small river, some 5.1 to 12.7 m wide and 14 – 33 cm deep in the middle of the sampled riffles. The substrate at all sample sites was stable but not compacted. The substrate composition was dominated by cobbles (60-75%, mean 67%). Boulders were the second largest component at four of the five sample sites and no silt or sand was recorded.

The Allt Badian is a small burn only 1.8 m and 2.8 m wide at the sampling points with depths of 17 cm and 6 cm. Both the Yellowbog Burn and the Allt nan Clach are medium sized burns 1.9 – 4.3 m wide and 3.6 – 3.8 m wide respectively. The Yellowbog Burn was 14 – 16 cm deep and the Allt nan Clach was 8 cm and 12 cm deep at the time of sampling. Sampling took place in low flows. The substrate at all these watercourses was similar to the River Strathy, the principal component being cobbles with mainly boulders and pebbles. Much of the substrate of these burns was embedded in peat and was very stable.

The Uair is a moderate sized burn, 4.3 - 6.1 m wide and 7 – 13 cm deep at the sites. The main component of the substrate was again cobbles (55-65%) with boulders (15-25%) second. The substrate appeared to be stable.

4.1.2. Macrophytes and Canopy Cover

A characteristic feature of the upper reaches of the River Strathy and the tributary burns was the level of in-stream macrophyte cover. In the River Strathy this ranged from 50-70% (mean 58%); in the Allt Badian it was 35% and 30%; in the Yellowbog Burn 40-70% (mean 58%) and in the Allt nan Clach 41% and 80% at the sampling sites. Small amounts of algae were only found at one site ANC1 in the Allt nan Clach indicating that nutrient input is likely to be low in these watercourses. At the site ANC2 the macrophyte cover was half herbaceous vascular plants including *Potamogeton* sp., *Juncus acutiflorus*, *Myriophyllum alterniflorum* and *Agrostis stolonifera*. At all the other sample sites the macrophyte cover was dominated by a mixture of bryophytes although small proportions of vascular plants occurred including the above and *Ranunculus flammula*, *Caltha palustris* and *Glyceria fluitans*.

The bryophytes consisted of various proportions of the mosses *Racomitrium aciculare*, *Fontinalis antipyretica* and *Platyhypnidium riparioides*, along with the liverworts *Chiloscyphus polyanthos* and *Scapania undulata*. Mosses provide a microhabitat within the riffle and have a proportionately different invertebrate community to uncovered areas. The nemourid stoneflies *Amphinemura sulcicollis* and *Protonemura meyeri* comprise a greater part of the community living in moss than bare areas, conversely *Rhithrogena semicolorata* and *Chloroperla torrentium* are absent from moss (Egglishaw 1969). Englund 1991 found that overturning moss covered stones to mimic spate events resulted in thirteen of sixteen invertebrate taxa present decreasing their density. The stable nature of the watercourses in the vicinity of the site and the bryophyte cover is an important factor in determining the invertebrate community present. For example in the Allt Badian Surber samples four had a high macrophyte cover (30-50%, mean 40%) and these had high numbers (29-70, mean 55) of *Protonemura meyeri*. The remaining two Surber samples both had a macrophyte cover of 5% and 19 and 23 (mean 21) specimens of *Protonemura meyeri* present.

Macrophyte cover on the control sites of The Uair (15-30%) consisted of the mosses *Platyhypnidium riparioides* and *Fontinalis antipyretica* and the liverworts *Scapania undulata* and *Chiloscyphus polyanthos,* species typical of acid to neutral conditions.

Canopy cover at all sample sites was zero. The watercourses were open and bankside vegetation consisted mainly of herbaceous vascular plants. The allochthonous (from outside the system, i.e. terrestrial) input of organic matter from bankside vegetation is an important source of food for invertebrates and positive correlations between food abundance and benthic consumer densities are a

common result of comparisons between streams (Richardson 1993). Input is the lowest for herbaceous habitats compared to trees or shrubs (Delong & Brusven 1994) but is still considered an important food resource (Menninger & Palmer 2007). In small watercourses, such as the tributaries in the south of the Strathy catchment, the allochthonous input is proportionately higher than large watercourses (Conners & Naiman 1984). This input of leaf litter provides the detritus that many invertebrates feed on and Egglishaw (1964) showed that plant detritus in a stream was a causal factor in determining the distribution of some invertebrates including *Baetis rhodani* and *Amphinemura sulcicollis*, both found in the watercourses of the Strathy catchment.

4.2. Invertebrate Communities

The groups recorded from each kick sample are shown in Appendix 3. The numbers of invertebrate species present in the Surber samples are shown in Appendix 6.

4.2.1. Relative Proportions of Invertebrate Groups

The proportional abundances of invertebrate groups in Surber samples (mean of three) are shown in Figure 2, expressed as percentages of the total population. The categories in Figure 2 represent the groups Ephemeroptera, Plecoptera and Trichoptera. Diptera contains the chironomids, which are very tolerant of organic pollution or enrichment. The 'Other' Category contains a wide mixture of groups including Coleoptera (beetles), Mollusca, Oligochaeta (worms) and Hirudinea (leeches). They are mainly moderately tolerant of organic pollution.

Macroinvertebrate communities of flowing water typical of large areas of upland Britain are dominated by the aquatic stages of the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddis flies) (Ormerod *et al.* 1993). Stoneflies are generally found in fast flowing, clean, cold well oxygenated streams and an abundance of mayflies is generally a sign of reasonably healthy and productive water (FIN Abundance and Indicator Taxa, Environmental Change Network website). The mayfly families Heptageniidae and Baetidae and species from these families are consistently used as acid sensitive indicators and are known to be vulnerable to both chronic and episodic acidification (Merret *et al.* 1991, Ormerod *et al.* 1993, Patterson & Morrison 1993 and Rutt *et al.* 1990).

Ephemeroptera, Plecoptera and Trichoptera (EPT) were dominant (>50% of total invertebrate numbers) at one site RS9 (59%) on the River Strathy and EPT formed a significant proportion (30-42%) of the invertebrate population at the four upstream sites indicating generally healthy conditions. Baetidae were present at all sites in the River Strathy and therefore it is unlikely the river is severely acidified.

EPT were dominant at both sites (50% & 51%) on the Allt Badian indicating well oxygenated clean conditions. The proportion of Plecoptera however was high (40% & 41%) and since some species of this order can tolerate a pH of 4.0 or less they are usually dominant in the fauna of acid streams (Patterson & Morrison 1993). Although *Baetis vernus* was present in all samples the overall proportion of Ephemeroptera was low (3% & 2%) indicating possible acid conditions.

The proportions of EPT in the Yellowbog Burn were consistent among the sites (47%-57%, mean 51%) again indicating a healthy well oxygenated burn. The proportion of Ephemeroptera (15%-19%) was higher than the Allt Badian but Heptageniidae were largely absent.

EPT proportions in the Allt nan Clach were 61% and 44% and Ephemeroptera were well represented (31% & 14%) indicating a clean healthy watercourse with no severe acidification.

The Uair sample sites were clearly dominated by EPT (63-72%) and organic enrichment was not significant. The proportion of Plecoptera was high, 44-56% of the population, indicating similar conditions of acidity to Allt Badian.

4.2.2. Invertebrate Abundance, Diversity and Biomass

The number of taxa, total numbers and biomass of invertebrates present in Surber samples are shown in Table 3. Invertebrate abundance (as density per m^2) and biomass are also shown graphically in Figures 3 and 4.

The number of taxa at the level of identification used in this study varied from 11-27 (Mean 21) in the River Strathy Surber samples. Direct comparison with other work is not possible as different levels of

taxonomic identification are used in different studies but the invertebrate diversity appears moderate. This is supported by the low BMWP scores, see Section 4.3.1 below.

The number of taxa present in the Surber samples in the other Strathy catchment watercourses watercourses was very similar to the River Strathy: Allt Badian 14-24 (mean 20), Yellowbog Burn 11-23 (mean 20) and Allt nan Clach 17-26 (mean 21). Levels of taxa recorded for the control sites of The Uair were 12-24 (mean 19).

Invertebrate abundance in Surber samples in the River Strathy varied from 27-344 (mean 165). The abundance of invertebrates in the Surber samples was also similar in the tributary burns: Allt Badian 134-231 (mean 196), Yellowbog Burn 42-268 (mean 156) and Allt nan Clach 132-354 (mean 222). Surber samples form The Uair contained 38-246 invertebrates (mean 118).

Biomass is seasonally variable but it can give an indication of productivity of watercourses. The biomass at sites (mean of three Surber samples) was quite low, <0.5 gm dry weight per m², with the only exception RS12 (0.79 gm dry weight per m²).

The diversity, abundance and biomass overall were sufficient to support sustainable salmonid populations.

4.3. Biological Indices

Biological Indices scores (BMWP, ASPT, Water Chemistry Status [Water Class] & Index of Acidity) are shown in Table 1. Scoring taxa present in samples for BMWP, Water Chemistry Status and Index of Acidity are found respectively in Appendices 3 to 5.

4.3.1. BMWP and ASPT scores

Three sites on the River Strathy recorded ASPT scores indicating excellent (A1) water quality and two indicated good (A2) water quality and the range was 5.4-6.5. This was similar to the scores recorded in the River Strathy further downstream (Waterside Ecology 2008). The BMWP scores were variable however (59-91) and tended to be lower than would be expected for the ASPT quality class. If the River Strathy is subject to periodic acidification then the absence of taxa at some sites which are both intolerant of organic pollution and acidity, for example *Sericostoma personatum* and *Ephemerella ignita*, could explain the low BMWP scores.

The Allt Badian and Allt nan Clach had similar ASPT scores (5.5 & 5.5 and 5.2 & 5.6 respectively) and water quality was good (A2) in both burns, but again BMWP scores were low.

Three sample sites on the Yellowbog Burn recorded good ASPT scores and one site, YB1, the farthest downstream sample site, scored ASPT 6.3 indicating excellent water quality. The two upstream sample sites however had very low BMWP scores, 37 and 47, and diversity was low at these locations.

The Uair was similar to the River Strathy with ASPT scores of 5.8-6.1 (two A2, one A1) and low BMWP scores (53-58).

4.3.2. Water Chemistry Status

Note that the scores recorded in Table 1 are generated from the combined invertebrates present in all three Surber samples at each sample site.

All sample sites on the River Strathy had scores of Class 2 for Water Chemistry Status. The total absence of class 1 indicators suggests that the mean pH is 5.6 or above.

Sample sites on the Allt Badian and the Yellowbog Burn also all scored Class 2 indicating similar conditions to the River Strathy.

One sample site on Allt nan Clach recorded a score of Class 1 where a few specimens of *Ancylus fluviatilis* were found. The specimens all appeared to be full-grown. The other sample site scored Class 2 as did the sample sites on The Uair indicating conditions of mean pH 5.6 or above.

4.3.3. Index of Acidity

Note that the scores recorded in Table 1 are generated from the combined invertebrates present in all three Surber samples at each sample site.

The River Strathy had four scores of Class I and one of Class II. This was similar to the River Strathy downstream results (Waterside Ecology 2008) and indicated at the lowest a mean pH of 5.6.

Both sample sites on the Allt Badian scored Class III suggesting that there may be significant acidification in this small burn. This was also the case in the two most upstream sites (YB3 & YB4) on the Yellowbog Burn. This may be the result of the severity or duration of acidification events in these small burn sample sites. However, the results should be treated with caution as riffle habitat was sub-optimal and substrate was particularly embedded at these sample sites. The lack of interstitial spaces in the substrate and possible lower levels of oxygen could result in the absence of some acid indicator taxa, for example the Heptageniidae. Further work would be required to establish conclusively the cause for these scores.

The two sample sites at Allt nan Clach, the two most downstream sample sites (YB1 & YB2) on the Yellowbog Burn and the two control sites on The Uair scored Class II indicating a pH of 5.6 or above.

4.4. Survey Limitations

This survey was conducted in the autumn. Due to the variation in phenology of freshwater benthic invertebrates BMWP scores may therefore be lower than if two sampling periods (spring and autumn) were used. However, single season sampling is adequate for most monitoring purposes and this study has produced good baseline data for the design of a future monitoring programme.

The survey was based on a single habitat and comments on diversity, abundance and biomass reflect the species present in this habitat. However, this habitat is used for the collection of samples for water quality and is a much studied habitat in lotic waters. Invertebrates may also occupy different habitats at times of the year; for example Egglishaw & Mackay (1967) found that *Ecdyonurus spp*. were found in greater concentrations in pools than riffles in April but that the reverse was true in September.

5 Conclusions

- The invertebrate communities present in the watercourses of the River Strathy catchment consisted mainly of common species and no rarities were found. In general communities were typical of those found in clean well oxygenated water. The relative proportions of invertebrate groups indicated no significant organic enrichment. Abundance, diversity and biomass of invertebrates appeared moderate in all watercourses.
- ASPT scores indicated that the water quality of the River Strathy was good-excellent and the water quality in the tributary watercourses was good.
- Water Chemistry Status and Index of Acidity Scores indicated that the watercourses are acidic, pH 5.6 or above. The watercourses are acidic enough to affect the invertebrate community and some of the more sensitive acid intolerant species were entirely absent from the survey area. The Allt Badian and the upper reaches of the Yellowbog Burn may be significantly acidified but further work would be required to establish this conclusively.
- Overall the water quality, invertebrate communities and productivity should support sustainable salmonid populations if other environmental factors are suitable.
- The study has produced good baseline data to inform the design of any future monitoring programme.

6 References

Brooks, S. & Lewington, R. 1999 Field Guide to the Dragonflies and Damselflies of Great Britain and Ireland. British Wildlife Publishing.

Clyde River Purification Board 1995 Provisional Biological Index of Acidity.

Connors, M.E. & Naiman, R.J. 1984 Particulate allochthonous inputs: relationships with stream size in an undisturbed watershed. Canadian Journal of Fisheries and Aquatic Sciences. 41, 1473-1484.

Davy-Bowker, J., Murphy, J.F., Rutt, G.P., Steele, J.E.C. & Furse, M.T. 2005 The development and testing of a macroinvertebrate biotic index for detecting the impact of acidity on streams. Archiv fur Hydrobiologie 163:383-403

Delong, M.D. & Brusven, M.A. 1994 Allochthonous input of organic matter from different riparian habitats of an agriculturally impacted stream. Earth and Environmental Science 18, 1, 59-71.

Edington, J.M. & Hildrew, A.G. 1995 Caseless Caddis Larvae of the British Isles. Pub. No. 53 Freshwater Biological Association.

Egglishaw, H.J. 1964 The distributional relationship between the bottom fauna and plant detritus in streams. Journal of Animal Ecology 33, 463-476.

Egglishaw, H.J. & Mackay, D.W. 1967 A survey of the bottom fauna of streams in the Scottish Highlands part III seasonal changes in the fauna of three streams. Hydrobiologia 30, 3-4, 305-334.

Egglishaw, H.J. 1969 The Distribution of Benthic Invertebrates on Substrata in fast-flowing Streams. Journal of Animal Ecology 38, 1, 19-33.

Elliot, J.M., Humpesch, U.H. & Macan, T.T. 1988 Larvae of the British Ephemeroptera. Pub. No. 49 Freshwater Biological Association.

Elliot, J.M. & Mann, K.H. 1979 A Key to the British Freshwater Leeches. Pub.No. 40 Freshwater Biological Association.

Englund, G. 1991 Effects of Disturbance on Stream Moss and Invertebrate Community Structure. Journal of the North American Benthological Society 10, 2, 143-153.

Friday, L.E. 1988 A Key to the Adults of British Water Beetles. Field Studies Council

Hynes, H.B.N. 1977 Adults and Nymphs of the British Stoneflies (Plecoptera). Pub. No. 17 Freshwater Biological Association.

Macan, T.T. 1959 A Guide to Freshwater invertebrate Animals. Longmans.

Macan, T.T. 1977 British Fresh- and Brackish-Water Gastropods. A key. Pub. No. 13 Freshwater Biological Association.

Menninger, H.L. & Palmer, M.A. 2007 Herbs and grasses as an allochthonous resource in open-canopy headwater streams. Freshwater Biology 52, 9, 1689-1699.

Merret, W.J., Rutt, G.P., Weatherly, N.S., Thomas, S.P. & Ormerod, S.J. 1991 The response of macroinvertebrates to low pH and increased aluminium concentrations in Welsh streams: multiple episodes and chronic exposure. Arch Hydrobiol 121, 1, 115-125.

Nilsson, A. (ed.) 1996 Aquatic Insects of North Europe Vol1. Apollo Books

Nilsson, A. (ed.) 1997 Aquatic Insects of North Europe Vol2. Apollo Books

Ormerod, S.J., Rundle, S.D., Lloyd, E.C. & Douglas, A. A. 1993 The influence of riparian management on the habitat structure and macroinvertebrate communities of upland streams draining plantation forests. Journal of Applied Ecology 30, 13-24.

Patterson, G. & Morrison, B. 1993 Invertebrate Animals as Indicators of Acidity in Upland Streams. HMSO London

Reynoldson, T.B. & Young, J.O. 2000 A key to the Freshwater Triclads of Britain and Ireland. Freshwater Biological Association.

Richardson, J.S. 1993 Limits to Productivity in Streams: Evidence from Studies of Macroinvertebrates. (In Production of juvenile Atlantic salmon, *Salmo salar*, in natural waters) Canadian Journal of Fisheries and Aquatic Sciences: Special Publication 118.

Rutt, G.P., Weatherly, N.S. & Ormerod, S.J. 1990 Relationships between the physicochemistry and macroinvertebrates of British upland streams: the development of modelling and indicator systems for predicting fauna and detecting acidity. Freshwater Biology 24, 463-480

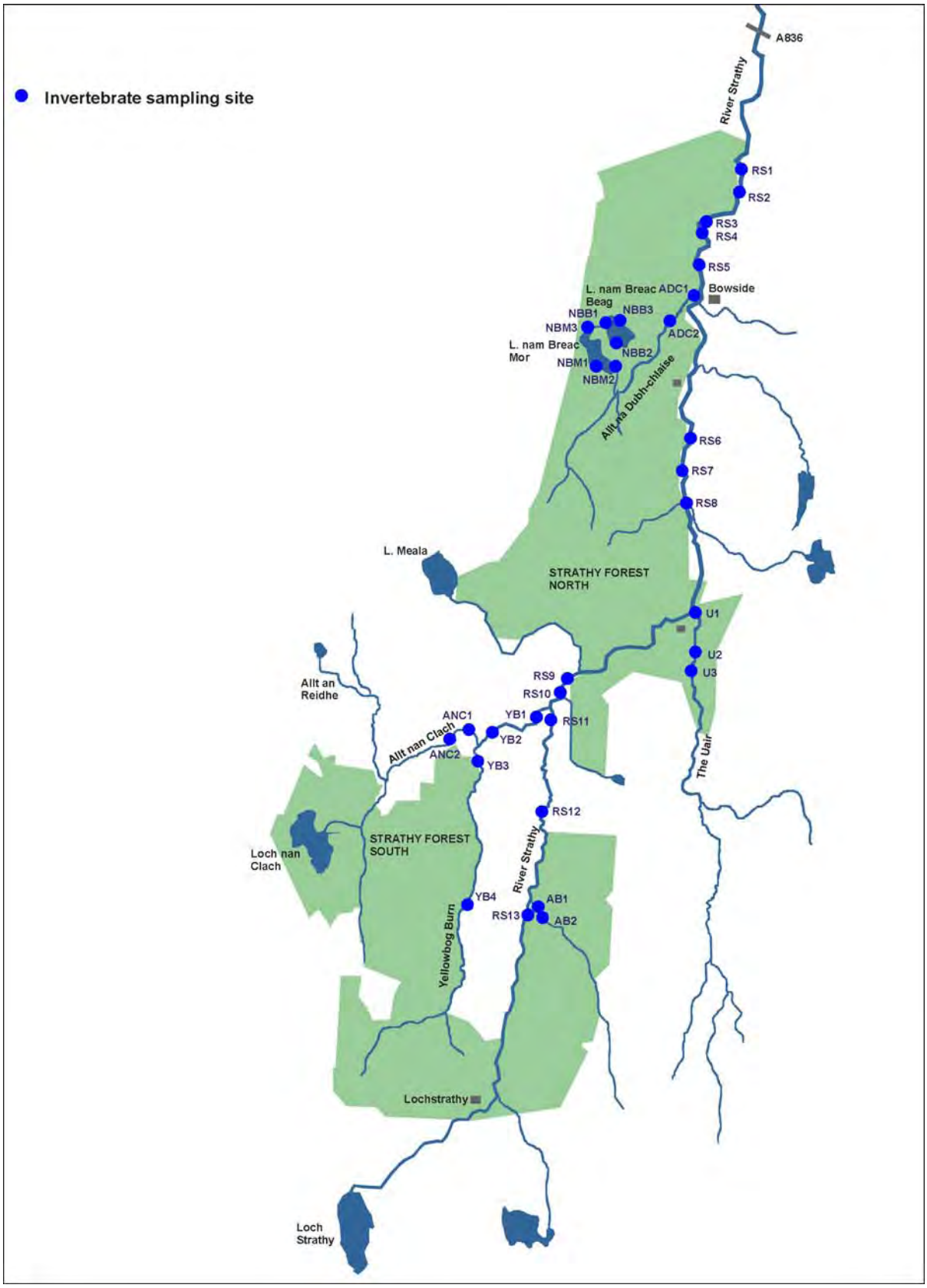
SEPA 2001 Sampling of Freshwater Benthic Invertebrates. Method number NWM/ECOL/002.

Timm, T. & Veldhuijzen van Zanten, H. H. 2002 Freshwater Oligochaeta of North-West Europe. Expert Center for Taxonomic Identification, University of Amsterdam.

Wallace, I.D., Wallace, B. & Philipson, G.N. 1990 A Key to the Case-Bearing Caddis Larvae of Britain and Ireland. Pub. No. 51 Freshwater Biological Association.

Waterside Ecology 2008 Strathy North Wind Farm, Sutherland. Commissioned Report to Scottish and Southern Energy. February 2008.

Figure 1 *Strathy North and South: Invertebrate Sampling Sites*



Note: This report covers sites upstream from Strathy Forest North plus sites on The Uair. Details of invertebrate communities at Strathy North can be found in Waterside Ecology (2008).

Figure 2 *Invertebrate Groups: Percentages of Total Population in Surber Samples (Mean of three samples)*

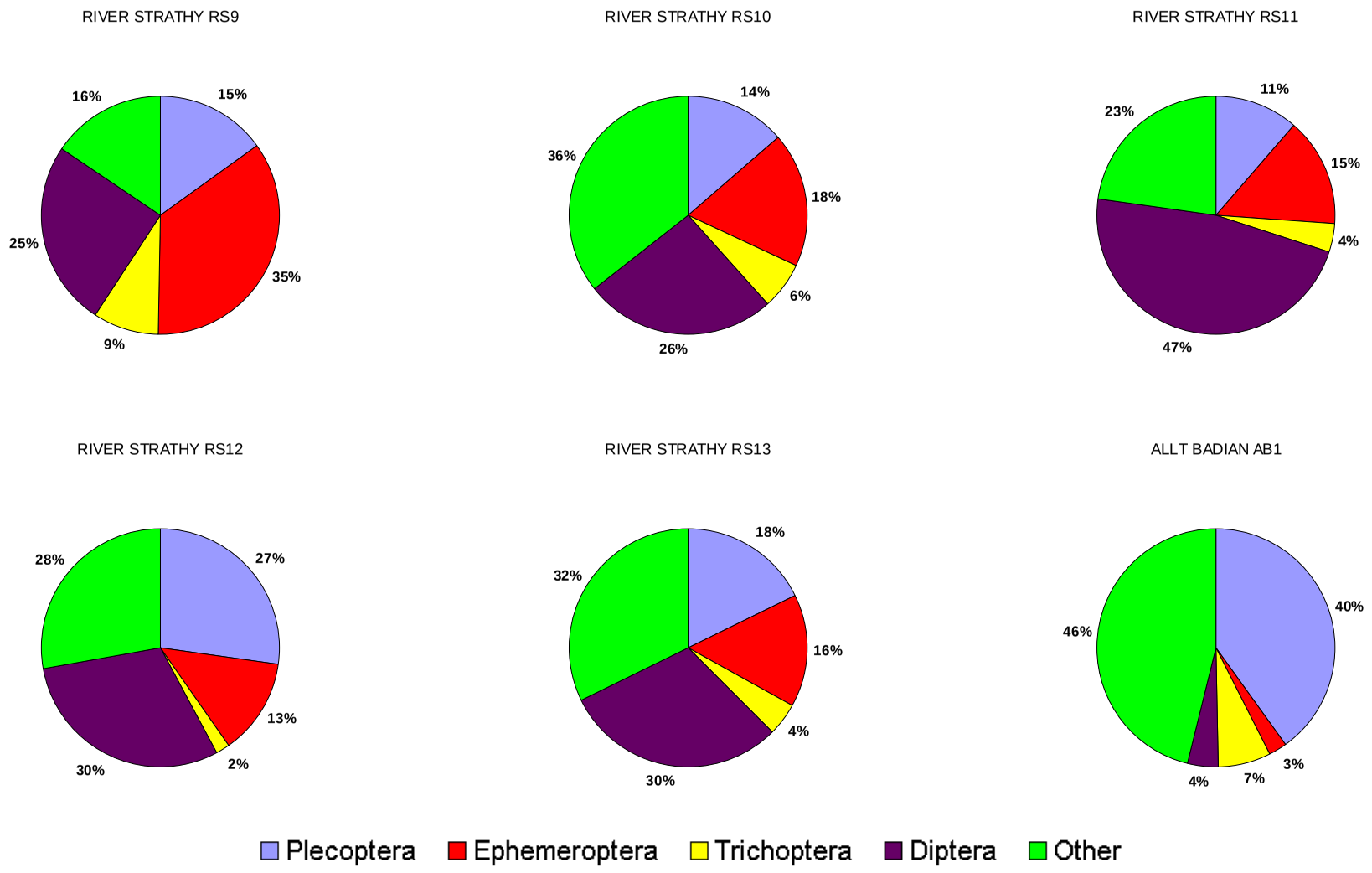


Figure 2 contd. *Invertebrate Groups: Percentages of Total Population in Surber Samples (Mean of three samples)*

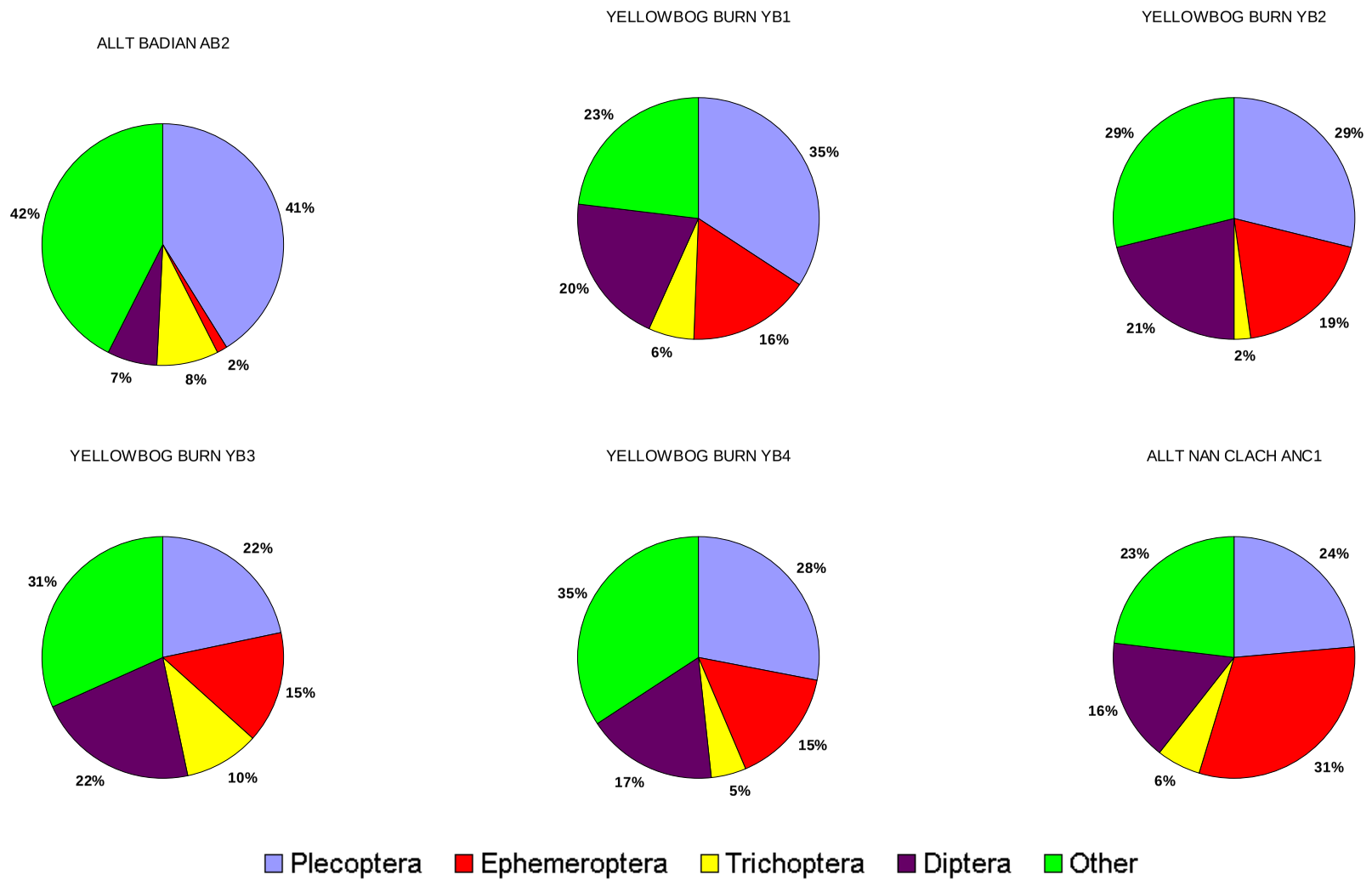


Figure 2 contd. *Invertebrate Groups: Percentages of Total Population in Surber Samples (Mean of three samples)*

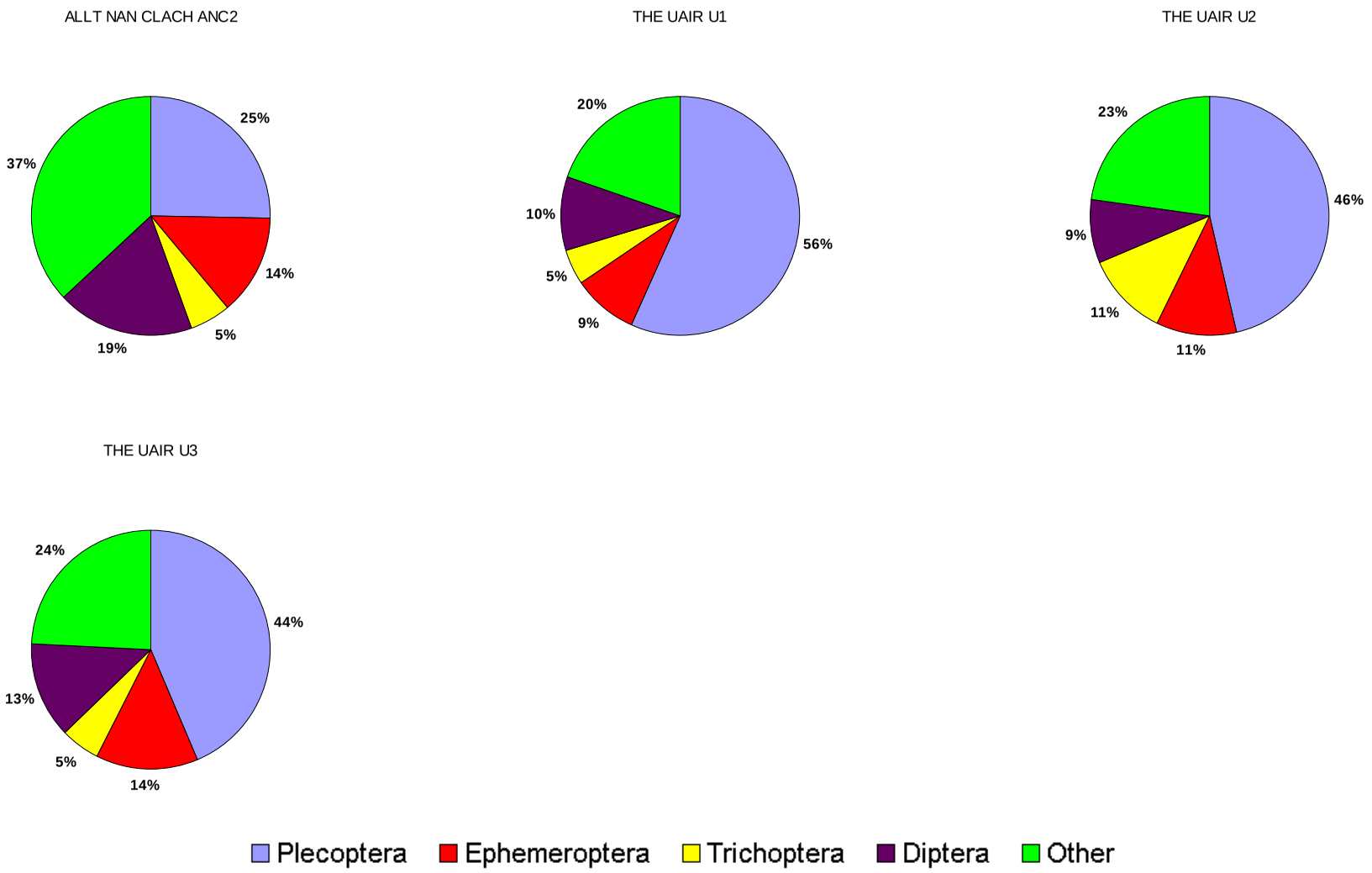


Figure 3 *Mean density (number/m²) of invertebrates in Surber samples (three per site)*

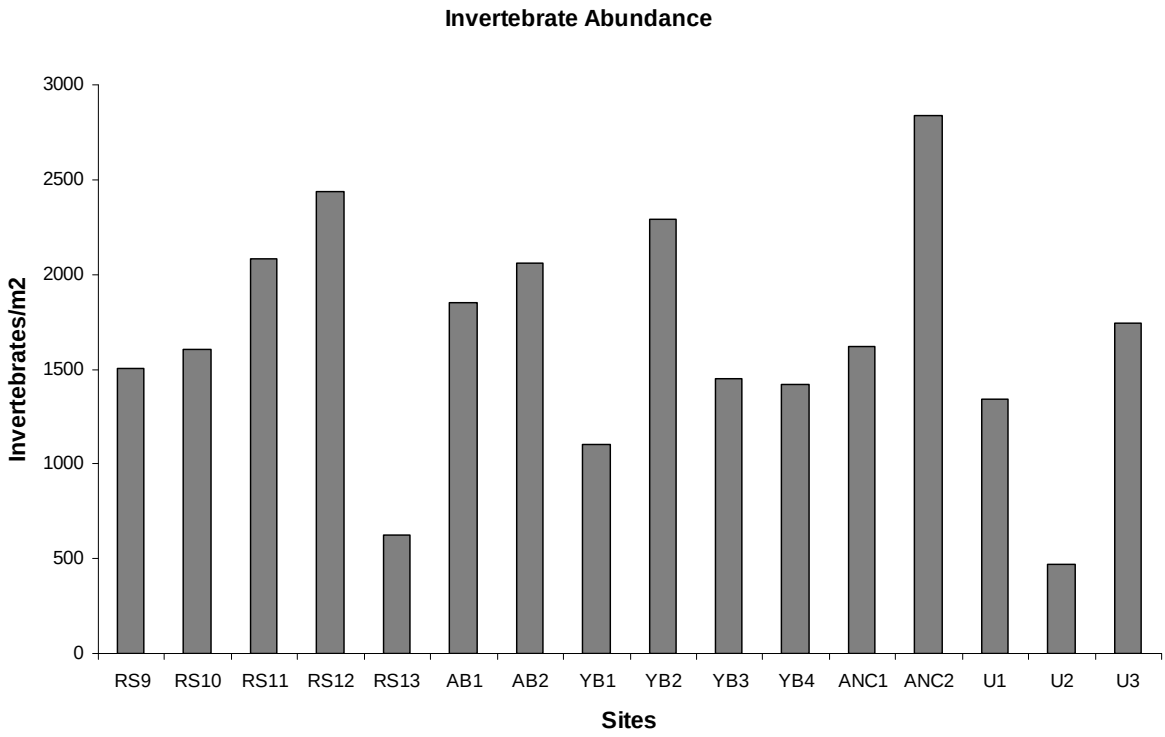


Figure 4 *Mean biomass (dry weight gm/m²) of invertebrates in Surber samples (three per site)*

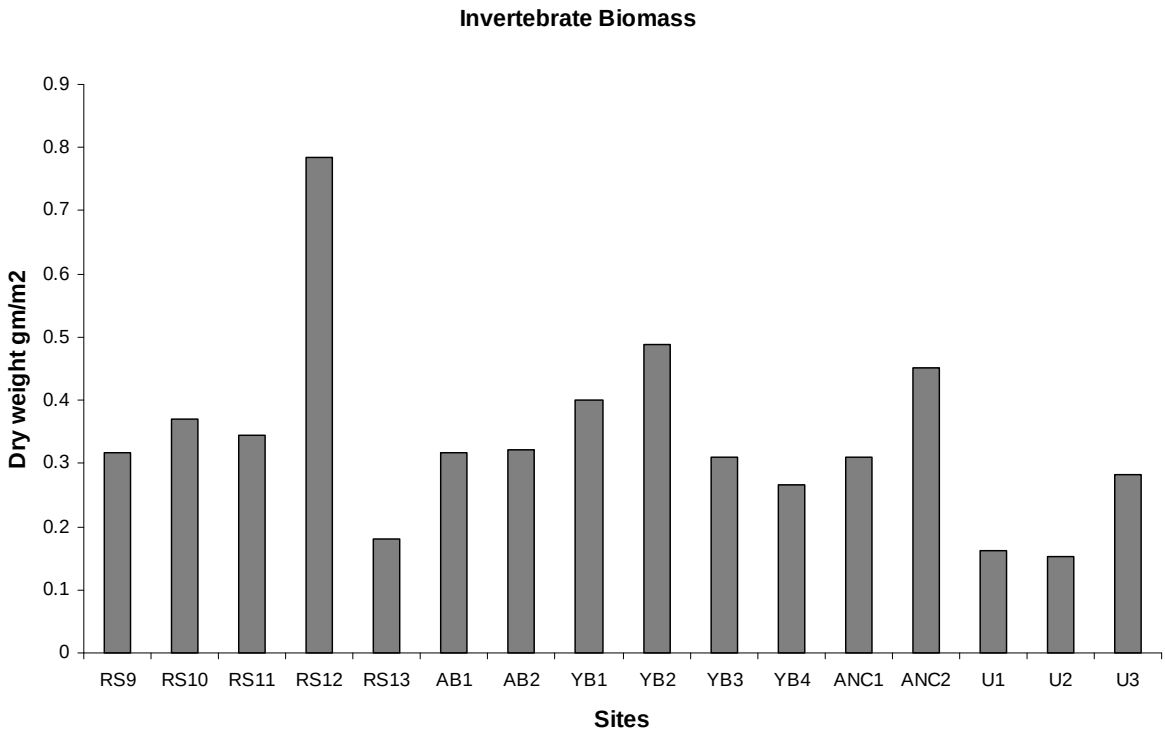


Table 1 *Invertebrate Abundances, Biological Monitoring Scores and Biomass*

Watercourse and sample codes	Sample type	Grid Reference NC		Sampling date	Total invertebrate abundance (n)	Number of Taxa Present	BMWP score	Number of scoring taxa (n)	ASPT score	Index of Acidity	Water Class	Biomass gm/m²
		East	North									
River Strathy												
RS9 K	Kick	80864	55450	04/09/2007	-	-	62	10	6.2	-	-	-
RS10 K	Kick	80635	55178	04/09/2007	-	-	91	14	6.5	-	-	-
RS11 K	Kick	80517	54727	04/09/2007	-	-	62	11	5.6	-	-	-
RS12 K	Kick	80458	53483	04/09/2007	-	-	59	11	5.4	-	-	-
RS13 K	Kick	80154	51987	06/09/2007	-	-	74	12	6.2	-	-	-
RS9 S1	Surber	80864	55450	04/09/2007	208	25	-	-	-	II	2	0.282
RS9 S2	Surber			04/09/2007	111	21	-	-	-	-	-	0.245
RS9 S3	Surber			04/09/2007	131	26	-	-	-	-	-	0.548
RS10 S1	Surber	80635	55178	04/09/2007	206	23	-	-	-	I	2	0.556
RS10 S2	Surber			04/09/2007	62	12	-	-	-	-	-	0.110
RS10 S3	Surber			04/09/2007	213	24	-	-	-	-	-	0.448
RS11 S1	Surber	80517	54727	04/09/2007	249	26	-	-	-	I	2	0.372
RS11 S2	Surber			04/09/2007	344	25	-	-	-	-	-	0.596
RS11 S3	Surber			04/09/2007	32	11	-	-	-	-	-	0.065
RS12 S1	Surber	80458	53483	04/09/2007	130	20	-	-	-	I	2	0.194
RS12 S2	Surber			04/09/2007	331	27	-	-	-	-	-	1.023
RS12 S3	Surber			04/09/2007	269	25	-	-	-	-	-	1.138
RS13 S1	Surber	80154	51987	06/09/2007	94	24	-	-	-	I	2	0.405
RS13 S2	Surber			06/09/2007	66	17	-	-	-	-	-	0.092
RS13 S3	Surber			06/09/2007	27	13	-	-	-	-	-	0.046
Allt Badian												
AB1 K	Kick	80377	51845	07/09/2007	-	-	55	10	5.5	-	-	-
AB2 K	Kick	80244	51978	07/09/2007	-	-	60	11	5.5	-	-	-
AB1 S1	Surber	80377	51845	07/09/2007	191	21	-	-	-	III	2	0.176
AB1 S2	Surber			07/09/2007	231	24	-	-	-	-	-	0.569
AB1 S3	Surber	80376	51859	07/09/2007	134	14	-	-	-	-	-	0.203
AB2 S1	Surber	80245	51983	07/09/2007	222	19	-	-	-	III	2	0.267
AB2 S2	Surber	80244	51978	07/09/2007	226	20	-	-	-	-	-	0.256
AB2 S3	Surber			07/09/2007	169	23	-	-	-	-	-	0.442
Yellowbog Burn												
YB1 K	Kick	80399	54962	06/09/2007	-	-	69	11	6.3	-	-	-
YB2 K	Kick	79670	54594	06/09/2007	-	-	66	12	5.5	-	-	-
YB3 K	Kick	79362	54198	06/09/2007	-	-	37	7	5.3	-	-	-
YB4 K	Kick	79364	52436	06/09/2007	-	-	47	9	5.2	-	-	-

Table 1 contd. *Invertebrate Abundances, Biological Monitoring Scores and Biomass*

Watercourse and sample codes	Sample type	Grid Reference NC East	Grid Reference NC North	Sampling date	Total invertebrate abundance (n)	Number of Taxa Present	BMWP score	Number of scoring taxa (n)	ASPT score	Index of Acidity	Water Class	Biomass gm/m²
Yellowbog Burn												
YB1 S1	Surber	80399	54962	06/09/2007	42	11	-	-	-	II	2	0.035
YB1 S2	Surber			06/09/2007	121	22	-	-	-	-	-	0.803
YB1 S3	Surber			06/09/2007	167	22	-	-	-	-	-	0.366
YB2 S1	Surber	79670	54594	06/09/2007	228	22	-	-	-	II	2	0.391
YB2 S2	Surber			06/09/2007	268	21	-	-	-	-	-	0.680
YB2 S3	Surber			06/09/2007	191	16	-	-	-	-	-	0.392
YB3 S1	Surber	79362	54198	06/09/2007	161	22	-	-	-	III	2	0.291
YB3 S2	Surber			06/09/2007	126	16	-	-	-	-	-	0.282
YB3 S3	Surber	79356	54183	06/09/2007	147	22	-	-	-	-	-	0.359
YB4 S1	Surber	79364	52436	06/09/2007	154	21	-	-	-	III	2	0.171
YB4 S2	Surber			06/09/2007	151	23	-	-	-	-	-	0.428
YB4 S3	Surber			06/09/2007	121	19	-	-	-	-	-	0.201
Allt nan Clach												
ANC1 K	Kick	79336	54612	06/09/2007	-	-	57	11	5.2	-	-	-
ANC2 K	Kick	79056	54507	06/09/2007	-	-	73	13	5.6	-	-	-
ANC1 S1	Surber	79336	54612	06/09/2007	132	17	-	-	-	II	1	0.286
ANC1 S2	Surber			06/09/2007	149	18	-	-	-	-	-	0.316
ANC1 S3	Surber			06/09/2007	205	21	-	-	-	-	-	0.328
ANC2 S1	Surber	79056	54507	06/09/2007	354	26	-	-	-	II	2	0.477
ANC2 S2	Surber			06/09/2007	262	20	-	-	-	-	-	0.567
ANC2 S3	Surber			06/09/2007	235	23	-	-	-	-	-	0.309
Uair												
UI K	Kick	82744	56270	07/09/2007	-	-	55	9	6.1	-	-	-
U2 K	Kick	82674	55821	07/09/2007	-	-	53	9	5.9	-	-	-
U3 K	Kick	82640	55531	07/09/2007	-	-	58	10	5.8	-	-	-
U1 S1	Surber	82744	56270	07/09/2007	113	19	-	-	-	II	2	0.113
U1 S2	Surber			07/09/2007	148	21	-	-	-	-	-	0.187
U1 S3	Surber			07/09/2007	142	17	-	-	-	-	-	0.183
U2 S1	Surber	82674	55821	07/09/2007	38	17	-	-	-	II	2	0.052
U2 S2	Surber			07/09/2007	42	20	-	-	-	-	-	0.294
U2 S3	Surber			07/09/2007	60	12	-	-	-	-	-	0.115
U3 S1	Surber	82640	55531	07/09/2007	246	24	-	-	-	II	2	0.427
U3 S2	Surber			07/09/2007	114	20	-	-	-	-	-	0.084
U3 S3	Surber			07/09/2007	163	22	-	-	-	-	-	0.333

Table 2 *Environmental variables: Kick Samples*

Sample Code	Depth (cm) 1/4	1/2	3/4	Bed Width	Wet Width	Macrophyte % cover	Clarity	Flow (ms-1)	HO (%)	SI (%)	SA (%)	GR (%)	PE (%)	CO (%)	BO (%)	BE (%)	pH	˚C	Canopy Cover %
River Strathy																			
RS9 K	43	33	27	8.7	8.7	50	clear brown	0.5	0	0	0	5	15	60	20	0	6.80	12.0	0
RS10 K	15	20	20	12.7	12.7	60	clear brown	0.66	0	0	0	0	10	70	20	0	6.78	12.3	0
RS11 K	40	32	20	6	6	60	clear brown	0.5	0	0	0	5	15	60	20	0	6.64	12.5	0
RS12 K	16	14	25	6.6	6.6	70	clear brown	0.5	0	0	0	5	5	70	20	0	6.64	13.0	0
RS13 K	30	20	15	5.1	5.1	50	clear brown	0.66	0	0	0	5	15	75	5	0	6.71	15.6	0
Allt Badian																			
AB1 K	14	17	10	1.8	1.8	25	clear brown	0.25	0	0	0	5	10	75	10	0	6.62	13.1	0
AB2 K	9	6	14	2.8	2.8	30	clear brown	0.33	0	0	0	5	15	60	20	0	6.65	13.7	0
Yellowbog Burn																			
YB1 K	14	14	11	4.3	4.3	40	clear brown	0.66	0	0	2	3	10	80	5	0	6.97	13.6	0
YB2 K	11	16	13	4.3	4.3	60	clear brown	0.4	0	0	5	5	15	70	5	0	6.70	13.4	0
YB3 K	19	14	7	3.5	3.5	70	clear brown	0.33	0	0	0	0	10	70	20	0	6.45	14.7	0
YB4 K	13	21	10	1.9	1.9	60	clear brown	0.33	0	0	0	0	10	70	20	0	6.56	15.2	0
Allt nan Clach																			
ANC1 K	8	8	17	3.6	3.6	41	clear brown	0.4	0	0	0	2	18	70	10	0	6.86	15.0	0
ANC2 K	9	12	10	3.8	3.8	80	clear brown	0.5	0	0	5	5	15	60	5	0	6.83	14.8	0
Uair																			
UI K	20	7	7	6.1	3.7	15	clear brown	0.66	0	0	0	5	20	55	20	0	6.71	16.0	0
U2 K	8	13	12	4.3	4.0	20	clear brown	0.33	0	0	5	5	10	65	15	0	6.65	15.9	0
U3 K	22	12	10	5.3	5.3	30	clear brown	0.5	0	0	0	5	10	60	25	0	6.70	16.1	0

HO = High organic SI = silt SA = sand GR = Gravel PE = Pebble CO = Cobble BO = Boulder BE = Bedrock

Table 3 *Environmental variables: Surber Samples*

Sample Code	Depth (cm)	Macrophyte % cover	Flow type	HO (%)	SI (%)	SA (%)	GR (%)	PE (%)	CO (%)	BO (%)	BE (%)
River Strathy											
RS9 S1	12	60	riffle	0	0	0	0	0	100	0	0
RS9 S2	12	40	riffle	0	0	0	0	0	100	0	0
RS9 S3	12	60	riffle	0	0	0	0	20	80	0	0
RS10 S1	6	40	riffle	0	0	0	0	20	80	0	0
RS10 S2	11	30	riffle	0	0	0	0	10	90	0	0
RS10 S3	11	50	riffle	0	0	0	0	10	90	0	0
RS11 S1	16	70	riffle	0	0	0	5	15	80	0	0
RS11 S2	12	70	riffle	0	0	0	5	15	80	0	0
S11 S3	16	60	riffle	0	0	0	5	15	80	0	0
RS12 S1	15	5	riffle	0	0	0	10	30	60	0	0
RS12 S2	12	70	riffle	0	0	0	10	10	80	0	0
RS12 S3	12	40	riffle	0	0	0	10	20	70	0	0
RS13 S1	16	40	riffle	0	0	0	5	20	75	0	0
RS13 S2	12	50	riffle	0	0	0	5	20	75	0	0
RS13 S3	16	40	riffle	0	0	5	25	25	45	0	0
Allt Badian											
AB1 S1	10	30	riffle	0	0	0	5	10	85	0	0
AB1 S2	12	5	riffle	0	0	0	5	5	90	0	0
AB1 S3	12	5	riffle	0	0	0	10	20	70	0	0
AB2 S1	10	40	riffle	0	0	0	0	10	90	0	0
AB2 S2	10	50	riffle	0	0	0	0	0	30	70	0
AB2 S3	14	40	riffle	0	0	0	0	10	90	0	0

HO = High organic SI = silt SA = sand GR = Gravel PE = Pebble CO = Cobble BO = Boulder BE = Bedrock

Table 3 contd. *Environmental variables: Surber Samples*

Sample Code	Depth (cm)	Macrophyte % cover	Flow type	HO (%)	SI (%)	SA (%)	GR (%)	PE (%)	CO (%)	BO (%)	BE (%)
Yellowbog Burn											
YB1 S1	15	40	riffle	0	0	0	5	15	80	0	0
YB1 S2	14	20	riffle	0	0	0	5	15	80	0	0
YB1 S3	13	50	riffle	0	0	0	0	0	100	0	0
YB2 S1	15	40	riffle	0	0	0	5	15	80	0	0
YB2 S2	17	60	riffle	0	0	0	5	25	70	0	0
YB2 S3	16	80	riffle	0	0	5	10	25	60	0	0
YB3 S1	16	70	riffle	0	0	0	0	20	80	0	0
YB3 S2	12	50	riffle	0	0	0	0	20	80	0	0
YB3 S3	10	40	riffle	0	0	0	0	10	90	0	0
YB4 S1	12	40	riffle	0	0	0	0	0	100	0	0
YB4 S2	10	50	riffle	0	0	0	0	10	90	0	0
YB4 S3	12	50	riffle	0	0	0	0	10	90	0	0
Allt nan Clach											
ANC1 S1	10	25	riffle	0	0	0	0	30	70	0	0
ANC1 S2	16	30	riffle	0	0	0	10	20	70	0	0
ANC1 S3	10	40	riffle	0	0	0	5	15	80	0	0
ANC2 S1	12	70	riffle	0	0	0	0	20	80	0	0
ANC2 S2	12	70	riffle	0	0	10	10	30	50	0	0
ANC2 S3	10	70	riffle	0	0	0	0	20	80	0	0
Uair											
U1 S1	8	5	riffle	0	0	0	10	40	50	0	0
U1 S2	10	10	riffle	0	0	0	0	20	80	0	0
U1 S3	9	15	riffle	0	0	0	0	20	80	0	0
U2 S1	14	0	riffle	0	0	2	3	15	80	0	0
U2 S2	12	0	riffle	0	0	0	5	15	80	0	0
U2 S3	13	0	riffle	0	0	0	0	10	90	0	0
U3 S1	14	20	riffle	0	0	0	0	0	40	60	0
U3 S2	12	30	riffle	0	0	0	0	0	100	0	0
U3 S3	12	40	riffle	0	0	0	0	10	90	0	0

HO = High organic SI = silt SA = sand GR = Gravel PE = Pebble CO = Cobble BO = Boulder BE = Bedrock

Appendix 1 *BMWP Scores for Individual Taxa*

Common Name	Family	BMWP Score
Flatworms	Planariidae	5
	Dendrocoelidae	5
Snails	Neritidae	6
	Viviparidae	6
	Valvatidae	3
	Hydrobiidae	3
	Lymnaeidae	3
	Physidae	3
	Planorbidae	3
Limpets and Mussels	Ancylidae	6
	Unionidae	6
	Sphaeriidae	3
Worms	Oligochaeta	1
Leeches	Piscicolidae	4
	Glossiphoniidae	3
	Hirudididae	3
	Erpobdellidae	3
Crustaceans	Asellidae	3
	Corophiidae	6
	Gammaridae	6
	Astacidae	8
Mayflies	Siphlonuridae	10
	Baetidae	4
	Heptageniidae	10
	Leptophlebiidae	10
	Ephemerellidae	10
	Potamanthidae	10
	Ephemeridae	10
	Caenidae	7
Stoneflies	Taeniopterygidae	10
	Nemouridae	7
	Leuctridae	10
	Capniidae	10
	Perlodidae	10
	Perlidae	10
	Chloroperlidae	10
Damselflies	Platycnemidae	6
	Coenagriidae	6
	Lestidae	8
	Calopterygidae	8
Dragonflies	Gomphidae	8
	Cordulegasteridae	8
	Aeshnidae	8
	Corduliidae	8
	Libellulidae	8

Common Name	Family	BMWP Score
Bugs	Mesoveliidae *	5
	Hydrometridae	5
	Gerridae	5
	Nepidae	5
	Naucoridae	5
	Aphelocheiridae	10
	Notonectidae	5
	Pleidae	5
	Corixidae	5
Beetles	Haliplidae	5
	Hygrobiidae	5
	Dytiscidae	5
	Gyrinidae	5
	Hydrophilidae	5
	Clambidae	5
	Scirtidae	5
	Dryopidae	5
	Elmidae	5
	Chrysomelidae	5
	Curculionidae	5
Alderflies	Sialidae	4
Caddisflies	Rhyacophilidae	7
	Philopotamidae	8
	Polycentropidae	7
	Psychomyiidae	8
	Hydropsychidae	5
	Hydroptilidae	6
	Phryganeidae	10
	Limnephilidae	7
	Molannidae	10
	Beraeidae	10
	Odontoceridae	10
	Leptoceridae	10
	Goeridae	10
	Lepidostomatidae	10
	Brachycentridae	10
	Sericostomatidae	10
True flies	Tipulidae	5
	Chironomidae	2
	Simuliidae	5

Appendix 2 *Acid intolerant indicators: Water Chemistry Status Groups and Index of Acidity Lists*

Water Chemistry

Species	**Normal Minimum pH**
Group 1	
Gammarus pulex	≥ 6.0
Glossosoma & Agapetus spp.	6.0
Ancylus fluviatilis	6.0
Limnaea peregra	6.0
Asellus aquaticus	6.0
Group 2	
Hydropsyche	5.5 - 6.0
Baetis sp.	5.5 Occasionally 5.2
Heptageniidae	5.5 Occasionally 5.2

Index of Acidity

List A taxa (absent at pH <6.0)	**List B taxa (absent at pH <5.5)**
Gammarus pulex	*Baetis rhodani*
Lymnaea peregra	*Rhithrogena semicolorata*
Ancylus fluviatilis	*Ecdyonurus spp.*
Potamopyrgus jenkinsi	*Heptagenia lateralis*
Baetis scambus	*Perlodes microcephala*
Baetis muticus	*Chloroperla bipunctata*
Caenis rivulorum	*Hydreana gracilis*
Ephemerella ignita	*Hydropsyche pellucidula*
Perla bipunctata	
Dinocras cephalotes	
Esolus parallelipipidus	
Glossosoma spp.	
Agapetus spp.	
Hydropsyche instabilis	
Silo pallipes	
Odontocerum albicorne	
Philopotamus montanus	
Wormaldia sp.	
Sericostoma personatum	

Appendix 3 *BMWP and ASPT Scoring Taxa present in Kick Samples*

Site Code	RS9	RS10	RS11	RS12	RS13	AB1	AB2	YB1	YB2	YB3	YB4	ANC1	ANC2	U1	U2	U3
Invertebrates																
Plecoptera																
Chloroperlidae		✓														
Leuctridae	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Nemouridae		✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Perlidae																
Perlodidae					✓		✓		✓						✓	✓
Ephemeroptera																
Baetidae	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Caenidae	✓	✓														
Ephemerellidae			✓	✓	✓			✓				✓	✓			
Heptageniidae	✓				✓			✓								
Siphlonuridae														✓		
Trichoptera																
Brachycentridae																
Goeridae																
Hydropsychidae	✓	✓	✓	✓	✓			✓				✓	✓		✓	✓
Hydroptilidae											✓			✓		
Leptoceridae																
Lepidostomatidae	✓	✓						✓								
Limnephilidae						✓				✓			✓		✓	
Polycentropodidae		✓				✓	✓		✓				✓			✓
Rhyacophilidae		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Sericostomatidae			✓													

Appendix 3 contd. *BMWP and ASPT Scoring Taxa present in Kick Samples*

Site Code	S9	S10	S11	S12	S13	AB1	AB2	YB1	YB2	YB3	YB4	ANC1	ANC2	U1	U2	U3
Invertebrates																
Diptera																
Chironomidae	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Simulidae	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		
Tipuloidea							✓		✓			✓				
Coleoptera																
Dytiscidae					✓		✓									
Elmidae	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Gyrinidae																
Scirtidae							✓									
Odonata																
Cordulegasteridae		✓														
Mollusca																
Ancylidae																
Lymnaeidae																
Sphaeriidae			✓	✓					✓				✓			
Oligochaeta	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

Appendix 4 *Water Chemistry Class: Indicator Taxa Present in Surber Samples*

Sample Code	**RS9 S1**	**RS9 S2**	**RS9 S3**	**RS10 S1**	**RS10 S2**	**RS10 S3**	**RS11 S1**	**RS11 S2**	**RS11 S3**	**RS12 S1**	**RS12 S2**	**RS12 S3**	**RS13 S1**	**RS13 S2**	**RS13 S3**	**AB1 S1**
Water Chemistry Class																
Group 1																
Ancylus fluviatilis																
Group 2																
Baetis sp	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heptageniidae				✓		✓	✓	✓		✓	✓	✓			✓	
Hydropsyche sp.	✓	✓	✓	✓		✓		✓	✓		✓	✓		✓		

Sample Code	**AB1 S2**	**AB1 S3**	**AB2 S1**	**AB2 S2**	**AB2 S3**	**YB1 S1**	**YB1 S2**	**YB1 S3**	**YB2 S1**	**YB2 S2**	**YB2 S3**	**YB3 S1**	**YB3 S2**	**YB3 S3**	**YB4 S1**	**YB4 S2**
Water Chemistry Class																
Group 1																
Ancylus fluviatilis																
Group 2																
Baetis sp	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heptageniidae							✓	✓	✓							
Hydropsyche sp.							✓	✓	✓	✓						

Sample Code	**YB4 S3**	**ANC1 S1**	**ANC1 S2**	**ANC1 S3**	**ANC2 S1**	**ANC2 S2**	**ANC2 S3**	**U1 S1**	**U1 S2**	**U1 S3**	**U2 S1**	**U2 S2**	**U2 S3**	**U3 S1**	**U3 S2**	**U3 S3**
Water Chemistry Class																
Group 1																
Ancylus fluviatilis					✓	✓										
Group 2																
Baetis sp	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heptageniidae		✓		✓	✓											✓
Hydropsyche sp.			✓	✓	✓		✓			✓				✓		✓

Appendix 5 *Acidity Index Classes: Indicator Taxa Present in Surber Samples*

Sample Code	**RS9 S1**	**RS9 S2**	**RS9 S3**	**RS10 S1**	**RS10 S2**	**RS10 S3**	**RS11 S1**	**RS11 S2**	**RS11 S3**	**RS12 S1**	**RS12 S2**	**RS12 S3**	**RS13 S1**	**RS13 S2**	**RS13 S3**	**AB1 S1**
Acidity Index Class																
List A																
Baetis scambus										✓					✓	
Caenis rivulorum	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			
Ephemerella ignita	✓	✓	✓		✓	✓		✓			✓	✓	✓	✓		
Agapetus fuscipes																
Silo pallipes																
Sericostoma personatum						✓	✓	✓			✓					
Esolus parallelipipidus																
Ancylus fluviatilis																
List B																
Perlodes microcephala																
Baetis rhodani										✓						
Ecdyonurus dispar	✓					✓	✓	✓		✓		✓			✓	
Hydropsyche pellucidula	✓	✓	✓	✓		✓			✓		✓	✓		✓		
Rhithrogena semicolorata				✓							✓	✓			✓	
Hydraena gracilis						✓	✓									✓

Appendix 5 contd. *Acidity Index Classes: Indicator Taxa Present in Surber Samples*

Sample Code	**AB1 S2**	**AB1 S3**	**AB2 S1**	**AB2 S2**	**AB2 S3**	**YB1 S1**	**YB1 S2**	**YB1 S3**	**YB2 S1**	**YB2 S2**	**YB2 S3**	**YB3 S1**	**YB3 S2**	**YB3 S3**	**YB4 S1**	**YB4 S2**
Acidity Index Class																
List A																
Baetis scambus																
Caenis rivulorum																
Ephemerella ignita							✓	✓	✓							
Agapetus fuscipes																
Silo pallipes																
Sericostoma personatum																
Esolus parallelipipidus																
Ancylus fluviatilis																
List B																
Perlodes microcephala																
Baetis rhodani																
Ecdyonurus dispar							✓	✓								
Hydropsyche pellucidula							✓	✓		✓						
Rhithrogena semicolorata									✓							
Hydraena gracilis									✓							

Appendix 5 contd. *Acidity Index Classes: Indicator Taxa Present in Surber Samples*

Sample Code	**YB4 S3**	**ANC1 S1**	**ANC1 S2**	**ANC1 S3**	**ANC2 S1**	**ANC2 S2**	**ANC2 S3**	**U1 S1**	**U1 S2**	**U1 S3**	**U2 S1**	**U2 S2**	**U2 S3**	**U3 S1**	**U3 S2**	**U3 S3**
Acidity Index Class																
List A																
Baetis scambus																
Caenis rivulorum				✓												
Ephemerella ignita		✓			✓											
Agapetus fuscipes																
Silo pallipes																
Sericostoma personatum						✓			✓			✓				✓
Esolus parallelipipidus																
Ancylus fluviatilis					✓	✓										
List B																
Perlodes microcephala												✓				
Baetis rhodani																
Ecdyonurus dispar		✓		✓	✓											
Hydropsyche pellucidula										✓						
Rhithrogena semicolorata																✓
Hydraena gracilis																

Appendix 6 *Invertebrate Numbers Present in Surber Samples*

Sample Code	**RS9 S1**	**RS9 S2**	**RS9 S3**	**RS10 S1**	**RS10 S2**	**RS10 S3**	**RS11 S1**	**RS11 S2**	**RS11 S3**	**RS12 S1**	**RS12 S2**	**RS12 S3**	**RS13 S1**	**RS13 S2**	**RS13 S3**	**AB1 S1**
Plecoptera																
Chloroperlidae																
Chloroperla torrentium				8			2			1	4		2			
Leuctridae																
Leuctra fusca		5	2		1	4	5	6	1	3	12	6		1	2	
L. hippopus /moselyi	7	4	7	18		1	17	12		20	50	24	6	7		26
Leuctra inermis																
Nemouridae																
Amphinemura sulcicollis	1		3	3	1		1				2	1	1	3	1	7
Nemoura cambrica																
Protonemura meyeri	18	6	12	11		18	5	16	6	1	32	38	1	2	2	70
Perlodidae																
Isoperla grammatica		2	1	1							4		2	3		2
Perlodes microcephala																
Taeniopterygidae																
Taeniopteryx nebulosa																2
Ephemeroptera																
Baetidae																
Baetis rhodani										1						
Baetis scambus										1					1	
Baetis vernus	5	4	7	32	10	22	7	11	1	25	26	27	13	5	3	3
Caenidae																
Caenis rivulorum	89	24	22	7	1	6	32	35		1	2		1			
Ephemerellidae																
Ephemerella ignita	1	2	1		3	3		1			1	2	1	3		
Heptageniidae																
Ecdyonurus dispar	2					1	1	2		3		5			1	
Rhithrogena semicolorata				1							1	1			1	
Leptophlebiidae																
Paraleptophlebia submarginata		1			1		2									

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	RS9 S1	RS9 S2	RS9 S3	RS10 S1	RS10 S2	RS10 S3	RS11 S1	RS11 S2	RS11 S3	RS12 S1	RS12 S2	RS12 S3	RS13 S1	RS13 S2	RS13 S3	AB1 S1
Trichoptera																
Brachycentridae																
Brachycentrus subnubilis	1	5	1	1		1										
Glossosomatidae																
Agapetus fuscipes																
Goeridae																
Silo pallipes																
Hydropsychidae																
Hydropsyche pellucidula	6	8	1	6		5			1		1	5		2		
Hydropsyche siltalai				1		2		5				1				
Hydroptilidae																
Hydroptila sp																
Oxyethira sp	1	2	2		2	1	2									1
Lepidostomatidae																
Lepidostoma hirtum	4	2		1		2	2					1	2	1		
Leptoceridae																
Athripsodes sp																
Limnephilidae																
Chaetopterix villosa						1										
Ecclisopteryx guttulata																
Polycentropidae																
Plectronemia conspersa		1	1			1		1			1		1			
Polycentropus flavomaculatus				4			5									10
Rhyacophilidae																
Rhyacophila dorsalis	1	2	2			2	1	4	1		3	2	1	1		5
Sericostomatidae																
Sericostoma personatum						1	2	1			1					
Diptera																
Ceratopogonidae			1													
Chironomidae	37	27	31	28	16	42	72	171	6	10	85	46	22	21	4	7
Empididae	1	1	2	1		7	2	8	1	1	11	3	1			2
Limoniidae							1		3	1		1	1			2
Muscidae		1		1				8			1			1		
Simulidae	4	6	3	14	1	16	7	15		22	15	23	1	6		

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	**RS9 S1**	**RS9 S2**	**RS9 S3**	**RS10 S1**	**RS10 S2**	**RS10 S3**	**RS11 S1**	**RS11 S2**	**RS11 S3**	**RS12 S1**	**RS12 S2**	**RS12 S3**	**RS13 S1**	**RS13 S2**	**RS13 S3**	**AB1 S1**
Coleoptera																
Dytiscidae																
Oreodytes sanmarkii																
Platambus sp																
Elmidae																
Esolus parallelipipidus																
Elmis aenea	1		1	2			6	2		4	16	16	4	3	2	18
Limnius volkmari	7		7	26		6	27	6	8	10	28	18	11		4	
Oulimnius tuberculatus	3	6	14	21	19	64	23	17	2	9	18	33	13	5	4	5
Gyrinidae																
Orectochilus villosus			1													
Hydraenidae																
Hydraena gracilis						1										1
Scirtidae																
Elodes sp.		1									1					
Odonata																
Cordulegaster boltoni			1									1				
Sialidae																
Sialis fuliginosa																
Mollusca																
Ancylidae																
Ancylus fluviatilis																
Sphaeriidae																
Pisidium sp.											3	1				
Crustacea																
Ostracoda																
Hirudinea																
Helobdella stagnalis	1		1													1
Oligochaeta																
Enchytraeidae	1						5	2	2	4			1			7
Lumbricidae	2			12			3	1			4	3	3	1		
Lumbriculidae	5	1	4	6	6	4	7	14		9	6	4	1		1	1
Naididae				1			5	2								3
Tubificidae	2							1					1			3
Nematoda	5		1					2		2	1	3	2			
Acari	3		2		1	2	7	1		2	2	4	2	1	1	15

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	**AB1 S2**	**AB1 S3**	**AB2 S1**	**AB2 S2**	**AB2 S3**	**YB1 S1**	**YB1 S2**	**YB1 S3**	**YB2 S1**	**YB2 S2**	**YB2 S3**	**YB3 S1**	**YB3 S2**	**YB3 S3**	**YB4 S1**	**YB4 S2**
Plecoptera																
Chloroperlidae																
Chloroperla torrentium	1	1	1		2		3	4			1		3			
Leuctridae																
Leuctra fusca	5		1		2		7		15	22	22	4	2	16	3	7
L. hippopus /moselyi	43	9	41	19	25	5	22	35	26	20	5	12	5	18	5	21
Leuctra inermis																2
Nemouridae																
Amphinemura sulcicollis	11	2	1	5	1			2	2	3		1	2			1
Nemoura cambrica														2		1
Protonemura meyeri	23	19	54	68	29	4	7	22	13	42	25	3	20	3	9	13
Perlodidae																
Isoperla grammatica	1			2	2			2						3	3	
Perlodes microcephala																
Taeniopterygidae																
Taeniopteryx nebulosa										1	1					
Ephemeroptera																
Baetidae																
Baetis rhodani																
Baetis scambus																
Baetis vernus	4	7	5	1	2	13	14	21	56	28	44	22	26	16	30	18
Caenidae																
Caenis rivulorum																
Ephemerellidae																
Ephemerella ignita							2	1	1							
Heptageniidae																
Ecdyonurus dispar							1	2								
Rhithrogena semicolorata									1							
Leptophlebiidae																
Paraleptophlebia submarginata	1			1	1							1				

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	**AB1 S2**	**AB1 S3**	**AB2 S1**	**AB2 S2**	**AB2 S3**	**YB1 S1**	**YB1 S2**	**YB1 S3**	**YB2 S1**	**YB2 S2**	**YB2 S3**	**YB3 S1**	**YB3 S2**	**YB3 S3**	**YB4 S1**	**YB4 S2**
Trichoptera																
Brachycentridae																
Brachycentrus subnubilis																
Glossosomatidae																
Agapetus fuscipes																
Goeridae																
Silo pallipes																
Hydropsychidae																
Hydropsyche pellucidula							1	3		2						
Hydropsyche siltalai							1	2	2	1						
Hydroptilidae																
Hydroptila sp			1	1								1				
Oxyethira sp			7	5	2				1			10		4	1	2
Lepidostomatidae																
Lepidostoma hirtum							2									
Leptoceridae																
Athripsodes sp												1			1	
Limnephilidae																
Chaetopterix villosa														1		
Ecclisopteryx guttulata		1			1											
Polycentropidae																
Plectronemia conspersa																
Polycentropus flavomaculatus	12		7	4	10		3	3				10	1	6	2	2
Rhyacophilidae																
Rhyacophila dorsalis	10		3	5	4		3	2	1	6	3	3	3	3	2	3
Sericostomatidae																
Sericostoma personatum																
Diptera																
Ceratopogonidae																
Chironomidae	6		16	10	6	3	27	23	21	18	13	28	13	25	21	15
Empididae			1	3	1		1	1		2		3		1	7	2
Limoniidae	2	2					2	3	6	2	2		4		3	2
Muscidae								1								
Simulidae	2		3	2		2		4	9	40	32	6	12	2	7	6

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	**AB1 S2**	**AB1 S3**	**AB2 S1**	**AB2 S2**	**AB2 S3**	**YB1 S1**	**YB1 S2**	**YB1 S3**	**YB2 S1**	**YB2 S2**	**YB2 S3**	**YB3 S1**	**YB3 S2**	**YB3 S3**	**YB4 S1**	**YB4 S2**
Coleoptera																
Dytiscidae																
Oreodytes sanmarkii	3			1	1											
Platambus sp																
Elmidae																
Esolus parallelipipidus																
Elmis aenea	35	27	59	60	21	2			6	8	4	4		5	14	12
Limnius volkmari	13	45	5	2	22	2	10	10	24	27	20	4	22	3		11
Oulimnius tuberculatus	21	11	7	26	12	6	8	13	27	26	11	37	8	28	26	17
Gyrinidae																
Orectochilus villosus																
Hydraenidae																
Hydraena gracilis									1							
Scirtidae																
Elodes sp.					1					1		1				
Odonata																
Cordulegaster boltoni							1									
Sialidae																
Sialis fuliginosa	1													1		
Mollusca																
Ancylidae																
Ancylus fluviatilis																
Sphaeriidae																
Pisidium sp.										1		1				
Crustacea																
Ostracoda																
Hirudinea																
Helobdella stagnalis																
Oligochaeta																
Enchytraeidae	4	1	2	1		2	2	7	1	8			3	2	1	2
Lumbricidae					1											
Lumbriculidae	1		1		1		3	4	5	8	2	2	1	1	2	2
Naididae	10								3			1	1	1	4	3
Tubificidae	4	2			7				1						1	
Nematoda	2	2		1		1	1				1			1	2	1
Acari	16	5	7	9	15	2		2	6	2	5	6		5	10	8

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	**YB4 S3**	**ANC1 S1**	**ANC1 S2**	**ANC1 S3**	**ANC2 S1**	**ANC2 S2**	**ANC2 S3**	**U1 S1**	**U1 S2**	**U1 S3**	**U2 S1**	**U2 S2**	**U2 S3**	**U3 S1**	**U3 S2**	**U3 S3**
Plecoptera																
Chloroperlidae																
Chloroperla torrentium	1			1			1		44	5	1	1		5	1	2
Leuctridae																
Leuctra fusca	5	1		1	5		1	3	4	1	1	2	7	2	1	2
L. hippopus /moselyi	37	27	8	32	53	24	36	62	0	56	10	8	27	66	23	44
Leuctra inermis														1		
Nemouridae																
Amphinemura sulcicollis	1		3	2	4	3	6	4	6	8	1		4	4	5	
Nemoura cambrica															1	
Protonemura meyeri	11		22	15	44	10	19	4	11	19	1	1		24	14	32
Perlodidae																
Isoperla grammatica		1			1			1								1
Perlodes microcephala												1				
Taeniopterygidae																
Taeniopteryx nebulosa		2			5	3	1									
Ephemeroptera																
Baetidae																
Baetis rhodani																
Baetis scambus																
Baetis vernus	18	53	33	59	42	42	29	6	14	15	4	2	8	33	17	22
Caenidae																
Caenis rivulorum				1												
Ephemerellidae																
Ephemerella ignita		1			2											
Heptageniidae																
Ecdyonurus dispar		1		1	1											
Rhithrogena semicolorata																1
Leptophlebiidae																
Paraleptophlebia submarginata		1	1						1			1				

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	**YB4 S3**	**ANC1 S1**	**ANC1 S2**	**ANC1 S3**	**ANC2 S1**	**ANC2 S2**	**ANC2 S3**	**U1 S1**	**U1 S2**	**U1 S3**	**U2 S1**	**U2 S2**	**U2 S3**	**U3 S1**	**U3 S2**	**U3 S3**
Trichoptera																
Brachycentridae																
Brachycentrus subnubilis																
Glossosomatidae																
Agapetus fuscipes																
Goeridae																
Silo pallipes																
Hydropsychidae																
Hydropsyche pellucidula										4						
Hydropsyche siltalai			2	1	1		1			1				1		2
Hydroptilidae																
Hydroptila sp					1											
Oxyethira sp	1		8	1	2	3	1		2	2						
Lepidostomatidae																
Lepidostoma hirtum									1			1	2	6	2	2
Leptoceridae																
Athripsodes sp																
Limnephilidae																
Chaetopterix villosa																
Ecclisopteryx guttulata																
Polycentropidae																
Plectronemia conspersa	2				1	1			2			5				1
Polycentropus flavomaculatus		1	2	6	13	2	7	1	2	1	4	2		4		6
Rhyacophilidae																
Rhyacophila dorsalis	4	2	1	4	3	6	3	2					1			2
Sericostomatidae																
Sericostoma personatum						1			1			1				1
Diptera																
Ceratopogonidae																
Chironomidae	8	19	21	22	58	20	49	12	11	5	2	3	3	22	10	20
Empididae	1			1	4	1	1	1	4	2				2	1	2
Limoniidae					1	1		2	2		1	2		3		2
Muscidae																
Simulidae	2	5	2	10	7	15	1	2					1	4		2

Appendix 6 contd. *Invertebrate Numbers Present in Surber Samples*

Sample Code	**YB4 S3**	**ANC1 S1**	**ANC1 S2**	**ANC1 S3**	**ANC2 S1**	**ANC2 S2**	**ANC2 S3**	**U1 S1**	**U1 S2**	**U1 S3**	**U2 S1**	**U2 S2**	**U2 S3**	**U3 S1**	**U3 S2**	**U3 S3**
Coleoptera																
Dytiscidae																
Oreodytes sanmarkii														1		
Platambus sp																
Elmidae																
Esolus parallelipipidus																
Elmis aenea	10	2	15	10	41	35	20	4	6	6	1	1	1	19	7	4
Limnius volkmari		4	2	14	16	40	12	1	5		2	2	4	8	5	9
Oulimnius tuberculatus	1	8	18	18	41	44	38	1	5	7	4	2	1	15	5	1
Gyrinidae																
Orectochilus villosus																
Hydraenidae																
Hydraena gracilis																
Scirtidae																
Elodes sp.							1								1	
Odonata																
Cordulegaster boltoni												1				
Sialidae																
Sialis fuliginosa											1			2		
Mollusca																
Ancylidae																
Ancylus fluviatilis					1	4										
Sphaeriidae																
Pisidium sp.							1									
Crustacea																
Ostracoda							1									
Hirudinea																
Helobdella stagnalis																
Oligochaeta																
Enchytraeidae	1		2	2	2				11	1	2			2	2	4
Lumbricidae																
Lumbriculidae	3	3		2	1		2		1		2	2		2	1	
Naididae	1	1	1					5	4	5	1	3		2	3	
Tubificidae	11														13	
Nematoda			1			1	1	1						1	1	
Acari	3		7	2	4	6	3	1	11	4		1	1	17	1	1

Appendix 7 *Standard Field Sheet*

Waterbody: **Date:** **Code:**

KICK SAMPLE

E **N:** **Altitude:**

wet width (m): **bed width (m):** **depth: ¼:** **½:** **¾:**

substrate

Type	*High org.*	*silt*	*sand*	*gravel*	*pebble*	*cobble*	*boulder*	*bedrock*
%								

Instream veg (%): **Clarity (cm):** **Flow**:glide/run/riffle/ torrent
speed (m.s^{-1}): **canopy cover (%):** **Photographs:**

Other (pollution, erosion etc) **pH** **Temperature**

☐ **Stone search competed**

SURBER SAMPLES

1.

E **N:**

Mean depth: **Flow**:glide / run / riffle / torrent **Instream veg (%):**

Type	*High org.*	*silt*	*sand*	*gravel*	*pebble*	*cobble*	*boulder*	*bedrock*
%								

Notes:
Photograph

2.

E **N:**

Mean depth: **Flow**:glide / run / riffle / torrent **Instream veg (%):**

Type	*High org.*	*silt*	*sand*	*gravel*	*pebble*	*cobble*	*boulder*	*bedrock*
%								

Notes:
Photograph

3.

E **N:**

Mean depth: **Flow**:glide / run / riffle / torrent **Instream veg (%):**

Type	*High org.*	*silt*	*sand*	*gravel*	*pebble*	*cobble*	*boulder*	*bedrock*
%								

Notes:
Photograph

Appendix 8 *Site Photographs*

Site RS9

Site RS10

Site RS11

Site RS12

Site RS13

Site AB1

Appendix 8 contd. *Site Photographs*

Site AB2

Site YB1

Site YB2

Site YB3

Site YB4

Site ANC1

Appendix 8 contd. *Site Photographs*

Site ANC2

Site U1

Site U2

Site U3

Strathy South Wind Farm

Strathy South Wind Farm, Report 5b: An Updated Assessment of Impacts of Access Track Construction on the Caithness and Sutherland Peatlands Special Area of Conservation

February 2013

[Revised June 2013]

Prepared by:
Matt Pannell

Reviewed by:
Dr. Simon Zisman

7 Clairmont Gardens
Glasgow
G3 7LW

Tel: 0141 332 0373
Fax: 0141 332 3182
Email www.rpsgroup.com

Planning & Development Ltd

Prepared by:	Name:	**Matt Pannell**	Title:	**Senior Ecologist**
	Signature:	Matt Pannell		
Technical Review by:	Name:	**Simon Zisman**	Title:	**Operations Director**
	Signature:	Simon Zisman		
Authorised by:	Name:	**Simon Zisman**	Title:	**Operations Director**
	Signature:	Simon Zisman		
Current Status:	**Final**			
Issue Date:	**30 June 2013**	Revision Number:	**A**	
		Revision Notes:	**-**	
Project File Path:	**S:\Strathy Projects - All Ghost Folders\7232 SEC - SSE S South Reporting WS9 Ghost Folder\Technical\Reports in Progress\Ecology Addendum Chapt 10\Final Versions\Report 5b\UK12-17181 - TA A10.6_2_ Updated Track Impact Assess Report.doc**			

This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001:2008

COPYRIGHT © RPS

The material presented in this report is confidential. This report has been prepared for the exclusive use of Scottish and Southern Energy and shall not be distributed or made available to any other company or person without the knowledge and written consent of Scottish and Southern Energy or RPS.

Please cite this report as:
RPS (2013). Strathy South Wind Farm, Report 5b: An Updated Assessment of Impacts of Access Track Construction on the Caithness and Sutherland Peatlands Special Area of Conservation. A Report for Scottish and Southern Energy Renewables.

Contents

1. Introduction 1

1.1 Background 1
1.2 SNH's Concerns Regarding SAC Impacts 1
1.3 Aim and Structure of Current Report 2

2. Route Description/Design, Updated Survey Methodology and Baseline Conditions 6

2.1 Route Description and Design 6
2.1.1 Segment 2 – Main Site Access Route 6
2.1.2 Grid Connection Route (Adjacent to Segment 2) 7
2.1.3 Segment 3 – Yellow Bog 8
2.2 Updated Assessment and Survey Methodology 9
2.3 Baseline Conditions 10
2.3.1 Current Physical Characteristics 10
2.3.2 Qualifying Habitats 10

3. Updated Assessment of the Potential Impacts on Qualifying Habitats within the SAC from Track Widening and Upgrade Works 11

3.1 Background to Estimating Potential Impacts on Qualifying Habitats 11
3.2 Methods for Estimating Potential Impacts (Direct and Indirect) on Qualifying Habitats 12
3.3 Estimates of Potential Impacts (Direct and Indirect) on Qualifying Habitats from Track Widening 14
3.4 Overall Assessment of Potential Impacts on Qualifying Habitats resulting from Track Widening and Upgrade 14

4. Assessment of Potential Impacts on Qualifying Habitats resulting from Installation of Grid Connection Cables 16

5. Updated Construction and Post-Development Mitigation / Compensation 18

5.1 Construction phase mitigation measures 18
5.2 Long-term compensation measures 18

6. Residual Assessment of Potential Impacts from Proposed Track Widening 22

7. SNH Consultation Response to Draft Version of Current Report 24

8. Appendices 27

9. Figures 28

1. Introduction

1.1 Background

Scottish Natural Heritage (SNH) raised a number of objections in response to the SSE Generation Ltd planning application submitted in 2007 to build a 77 turbine wind farm at Strathy South, Sutherland.

Commissioned by SSE Renewables (UK) Ltd (also referred to SSER) acting on behalf of the applicant, these issues have been addressed by RPS through consultation with SNH and through specifically commissioned fieldwork. A total of five reports have resulted and are being used to inform the Environmental Statement (ES) Addendum, which now comprises a scheme reduced in size to approximately 47 turbines.

Report 1 provides an overview of all five reports including a timeline of events, a summary of findings and further background information.

This report (Report 5b) provides an update to Report 5 taking into consideration the consultation response from SNH following the submission of Report 5 in November 2012. Following further consultation with SNH on a draft of the current report, SNH provided further feedback outlining key aspects of the proposals they would like to see addressed through the ES Addendum. The points raised by SNH have been addressed in Chapter A10: Ecology of the ES Addendum, however, for clarity, a response to each of the issues raised by SNH is provided in an updated Section 7 of the current report.

This report therefore seeks to further address SNH's ongoing concerns over habitat impacts on the Caithness and Sutherland Peatlands Special Area of Conservation (SAC) from access track construction and grid connection as outlined below.

1.2 SNH's Concerns Regarding SAC Impacts

In a letter to the Scottish Government dated 25th September 2007, SNH provided a detailed formal objection to the SSER Section 36 application based on a range of nature conservation issues, including *"probable adverse effects on qualifying interests of the Caithness and Sutherland Peatlands SAC, primarily relating to the access track between Strathy South and Strathy North"* and also "*in relation to the grid".*

The proposed access track between Strathy North Forest and Strathy South referred to in the 2007 ES as the 'Cnoc Meala' route crossed the Caithness and Sutherland Peatlands SAC, SPA and Ramsar site. The access was proposed to enter the north-west area of the Strathy South site.

The proposed location of the required grid connection for the wind farm, in the 2007 ES was for a new 132/33 kV substation at approximate location NC 808 515 in the Strathy South area, with the required 132/33kV infrastructure crossing the Caithness and Sutherland Peatlands SAC, SPA and Ramsar site from the east of the site.

Further information also requested by SNH included the assessment of Yellow Bog track connecting the two areas of the Strathy South Forest from any upgrade works and cable installations.

Following SNH's 2007 response, a separate aAccess Options Review[1] was undertaken to assess the options available for access to the proposed Strathy South wind farm and the potential impacts from these options. Report 5 (RPS, 2012) provided the basis to the initial consultation regarding the assessment of impacts from the preferred access route option.

The preferred site access route was chosen as it is deemed to be the least damaging to the SAC, given it follows the route of an existing track already and utilising existing infrastructure from the consented Strathy North wind farm. This route runs from Strathy North Wind Farm, through Strathy Wood to join the existing Strathy South Forest access track where it re-enters the SAC and continues to the north-east boundary of Strathy South Forest (Figure 1).

Furthermore, the grid route has now been revised also, so that the required 132/33kV infrastructure will now be located at the proposed Strathy North Wind Farm substation at or adjacent to the north-east corner of the Strathy North Wind Farm (near Dallangwell). The connecting cabling between Strathy South and North will run alongside the new proposed site access track, to reduce impacts as far as possible (outlined in figure A4.14).

For further background information regarding SNH's response to the 2007 ES and subsequent work undertaken to address the concerns, see Section 1 of Report 5 (Appendix 6).

1.3 Aim and Structure of Current Report

Report 5 sought to address a number of issues regarding impacts arising from both site access track construction activity and deer dispersal following proposed forest removal activities.

Site access track impacts were assessed for three separate segments of track:

- New track between Strathy North Wind Farm through Strathy Wood (outwith SAC) (Segment 1);
- Upgrade track from Strathy Wood to Strathy South Forest (within SAC) (Segment 2); and
- Upgrade of Yellow Bog track between the 'two arms' of Strathy South Forest (within SAC) (Segment 3).

Report 5 was submitted to SNH for consultation in November 2012. SNH's response to the report is provided below:

<u>Access Track Construction</u>
The report identifies that there will be direct and indirect impacts on SAC qualifying habitat, affecting 3.74 ha and 9.24 ha respectively. Direct impacts can be considered in most cases synonymous with 'losses'. Indirect impacts may result in loss or significant change. It is possible that mitigation measures may reduce some of these impacts, just as it is equally possible that in some areas the impacts may extend over a greater area, for example where wider trackside batters are required to accommodate areas of deeper peat. The figures provided are accepted as a reasonable indication of the likely loss and change to SAC qualifying habitats.

Within the context of the Conservation Objectives for the site, i.e. to ensure for the qualifying habitats that the following are maintained in the long term:
- Extent of the habitat on site

[1] ENVIRON (2013) Strathy South Wind Farm Access Options Review (ref: UK12-17180)

- Distribution of the habitat within the site
- Structure and function of the habitat
- Processes supporting the habitat
- Distribution of typical species of the habitat
- No significant disturbance of typical species of the habitat

These 'losses' are incompatible with the first objective regarding extent. We would suggest that the other objectives are not significantly compromised, other than within the context of the areas of habitat lost.

It could be suggested that the areas of qualifying habitat that would be lost are insignificant within the context of the SAC. That might be the case if the habitats were uniform across the SAC but it is well demonstrated and widely accepted that this is not the case. The losses may be relatively small on an areal basis, but as the peatlands in this area have already been subject to considerable loss and damage through forestry and past agricultural practice, any further loss is significant. Given the above, we would have no alternative but to maintain our objection on Natura habitat grounds.

Deer Grazing
The monitoring work regarding current deer densities within the woodlands and on the SAC are sufficient and provide a reasonable estimate of deer usage and thereby, potential populations. No attempt appears to have been made as yet to undertake Habitat Impact Assessment on the surrounding SAC habitats although this is mentioned as part of the mitigation measures set out in section 4.4 on page 20.

Key within the Deer Management Plan (DMP) will be an initial assessment of surrounding SAC habitats thereby establishing a baseline against which to measure impact levels in the future. Trampling is likely to be the more critical of impacts on bog sites. It is likely that any potential negative impacts and deer welfare issues can be mitigated through a competent DMP with a focus on these issues.

Following SNH's response, SSER, commissioned RPS to undertake further work on the access tracks and cable route in order to investigate ways in which the predicted impacts could be reduced to the satisfaction of SNH. The current report details the findings of this further work.

In order to separate out the main issues raised by SNH, the current report focuses solely on impacts due to track and cable installation related construction activity with the potential to impact on SAC qualifying habitats. The current report therefore excludes the majority of Segment 1 assessed in Report 5. However, in order to ensure the full extent of potential impacts on the SAC are assessed, track Segment 2 has been extended northwards to incorporate the portion of Segment 1 where construction activity could reasonably be expected to have a potential impact on SAC habitats.

Subsequent to the surveys and assessment presented in the current report, a change was made to the location of the preferred access track where it passes through Strathy Wood, crosses the River Strathy and joins with Strathy North Wind Farm infrastructure. This change is entirely outwith the SAC and therefore is not detailed further in this report.It should be noted that figures covering this section of track have not been updated in this report. Proposals for building or upgrading any sections of track outwith the SAC are addressed in the Strathy South ES Addendum. This report also excludes any further assessment of deer related impacts. Deer related impacts will also be dealt with in the ES Addendum.

In addition to focusing on only those sections of track with the potential to impact on the SAC, the current report presents impacts due to works associated with the grid connection separately from those associated with tracks. These two potential sources of impact are assessed separately in order to better account for the different type and nature of impacts predicted to result from each source. As presented in Report 5, it is proposed that the wind farm grid connection would run immediately adjacent to the western edge of Segment 2 between Strathy Wood and Strathy South Forest.

In summary, the current report therefore seeks to address SNH's concerns regarding the following sections of access track and grid connection only:

- Upgrade track from Strathy Wood to Strathy South Forest (extended Segment 2);
- Installation of grid connection cabling adjacent to Segment 2; and
- Upgrade of Yellow Bog track between the 'two arms' of Strathy South Forest (Segment 3) including cable installation within the upgraded track.

The current report is set out in the following Sections:

Section 2 provides a basic description of the access route and its design, outlines the survey methods used to gather more detailed information on qualifying habitats and presents the updated baseline data gathered during these surveys.

Section 3 uses the updated baseline information to assess the potential impacts on the SAC qualifying habitats in relation to the construction and upgrade of tracks (excluding cable installation) within the SAC.

Section 4 uses the updated baseline information to assess the potential impacts on the SAC qualifying habitats in relation to the proposed installation of grid connection cables within the SAC.

Section 5 details and discusses updated mitigation and compensation proposals to address potential impacts on SAC qualifying habitats.

Section 6 discusses and assesses the residual impacts on qualifying habitats from the track upgrade and widening construction proposals taking into account the mitigation and compensation measures presented.

Section 7 presents the response received from SNH following consultation on a draft of the current report and a description of how the issues raised in SNH response would be addressed.

The following appendices are included in support of this report:

- Appendix 1. Typical Access Track Diagram – showing the design of the indicative access track cross section used in assessing impacts.

- Appendix 2. Access Track Route with Chainages – showing the access track section through the SAC and chainage locations at which cross-sections were measured as shown in Appendices 3a/b.

- Appendix 3a. Segment 2 Surveyed Cross Sections 300 to 2000 – showing track cross sections at chainage locations 300 to 2000.

- Appendix 3b. Segment 2 Surveyed Cross Sections 2100 to 3600 – showing track cross-sections at chainage locations 2100 to 3600.

- Appendix 4. Typical Cable Trench Diagram – showing the design of the indicative cable trench cross-section used in assessing impacts.

- Appendix 5. Mybster-Camster Report August 2012 (Rev b) – copy of method statement and results of similar cable installation at Camster.

- Appendix 6. Relevant Sections from Report 5 – copy of all relevant sections from Report 5 which are referred to in this report.

- Appendix 7. Appendices 1 and 2 from Report 5 – habitat survey results and photographs of track sections.

2. Route Description/Design, Updated Survey Methodology and Baseline Conditions

2.1 Route Description and Design

The proposed route description of all segments of track within the SAC, remain as described in Section 2 of Report 5. For the purpose of the updated assessment however, Segment 2 has been extended north to include the southern part of Segment 1 within or adjacent to the SAC boundary (Figure 1). For clarity the segments assessed in the current report are summarised below. In addition, information is provided on the design and construction methods of the upgraded road sections and cabling.

It is proposed that method statements for both track construction and the cabling route would be agreed prior to construction and in accordance with current best practice. The aims of these method statements would be to ensure a suitable quality of track, prevention of pollution, and the meeting of ecological and hydrological objectives in accordance with the aims and assessment detailed in the current report.

2.1.1 Segment 2 – Main Site Access Route

The proposed access route from Strathy Wood to the boundary of Strathy South Forest would use the existing forestry access track. The only exception to this is a short section in the north (part of Segment 1 in Report 5) where the route crosses modified habitat between the existing track and forestry in order to avoid a sharp corner in the existing track. Track Segment 2 is 2.4 km in length and is bound on both sides by the SAC for 2.1 km with the SAC present to the east of the track for a further 0.3 km (Figure 1).

The existing track is constructed as a cut through track with substantial drains and embankments on either side. In addition, peat/mineral mix spoil piles are present on one or both side of the track for the majority of its length. These spoil piles are currently comprised of a highly modified form of the National Vegetation Classification community M25 – *Molinea caerulea – Potentilla erecta* mire. Photographs showing the current state of the track can be seen in Appendix 1 of Report 5.

For the purposes of the development, this segment of the access route will require upgrading by widening of the running surface and associated relocation of drains and batter (Appendices 2 and 3 – surveyed cross section diagrams). In addition, two passing places (15x3 m plus tapers at each end) will be required between the Strathy South Forest boundary and the point at which the existing track adjoins the edge of Strathy Wood Forest (NGR 543 813) within the SAC. The requirement for passing places was identified following the January 2013 topographic surveys. These surveys identified restrictions in ‘line of site’ along certain sections of the track which would create significant traffic management problems given the inability of these vehicles to pass one another due to the restricted width of the running surface.

Whilst, new or relocated drains may be required due to the widened running surface, no new discharge locations will be created ensuring only existing discharge points are used. In addition, improved sediment control measures (e.g. sediment traps) will be installed and maintained thereby improving water quality discharged from the drainage network.

The upgraded track will be constructed to a similar design as shown in Appendix 1 (Typical Access Track Diagram). This diagram indicates an overall width of 11.6 m. The final track footprint (including the full extent of existing running surface and drains) is predicted to vary around this figure by +/- 2 m according to the updated design (Appendices 2 and 3 - surveyed cross section information). This width includes any batter required on the down-slope side. Wherever possible, grid connection cables would be buried beneath this batter and as close to the road as possible (further detail is provided under 'Grid Connection Route' below).

Widening would be undertaken to the down-slope side (western side) of the access track as this side is considered likely to have undergone a greater degree of modification due to historic track construction activity. The only exception to this is for some minor adjustments necessary to existing drains and embankments along the eastern edge of the running surface. These adjustments would be undertaken entirely within disturbed habitats and would therefore result in minimal (<0.05 ha) additional disturbance to peatland habitats. All proposed construction upgrade works have been designed to ensure all additional land-take occurs within the disturbed non-qualifying habitats as defined by the updated January 2013 surveys (Figure 2a-d).

Construction proposals include the removal of the peat spoil heaps where this area is required for widening and cable installation. Following construction, reinstatement of these former spoil heap areas would take place, the aim of which would be to return these to similar conditions as those which support adjacent qualifying habitats.

Further detail on proposed construction methods and the total extent of the final road layout is provided in Appendix 1 and Figure 2a-d. Further detail regarding proposed modifications to drainage and runoff from the track would be provided in a Construction Environmental Management Plan (CEMP) and pre-construction method statements (a outline CEMP is included as Appendix A4.1 of the ES Addendum). These would be produced following further consultation with SNH and SEPA to ensure any modifications were designed to minimise impacts on surrounding habitats and other receptors.

Any issues regarding excavation, handling and re-use of peat (including the removal of peat spoil) would be addressed through a Peat Management Plan. More detail on peat management will also be provided in the Strathy South ES Addendum.

2.1.2 Grid Connection Route (Adjacent to Segment 2)

It is proposed that the required grid connection cabling route would run immediately adjacent to the west of the route of the Strathy Wood to Strathy South Forest track (Segment 2). Wherever possible this will be restricted to within disturbed habitat to minimise the length of cable passing through qualifying habitats. The grid connection would be comprised of four underground 33kV cable circuits installed 1.5 m apart. Each cable would be buried using a mole plough, into the peat soils to minimise disturbance to qualifying habitats. In addition, depending on the final cable drum length, an area (8x6 m) would be excavated approximately half way along the cable route within the SAC in order to provide access to allow cable jointing. Cable joints would then be located within disturbed habitat within the Strathy South Forest boundary to the south and, within disturbed/modified habitat adjacent to the most southerly section of Strathy Wood Forest to the north. The majority of work would be undertaken using machinery working from the adjacent track.

A detailed method statement from the Mybster-Camster case study (where similar techniques were used to lay cable through similar qualifying habitats within an SAC) is provided (Appendix 5 – Mybster-Camster Grid Connection Method Statement). The principles construction methods documented for the Mybster-Camster grid connection would apply to the proposed Strathy South grid connection. However, the one significant difference between methods deployed at each site concerns the lack of soft, deep peat at Strathy South. For this reason it is proposed that bog mats would not be required. The majority of machinery would operate from the access track, leaving just the tracked winch unit and cable plough to traverse the actual route of the cables. The majority (see Section 4) of the installation adjacent to track Segment 2 therefore takes place within disturbed non-qualifying habitats.

Cable placement will start within the road batter and span a width of up to 5 m (Appendix 4 – Typical Cable Trench Diagram). Installation will require a temporary working corridor of 2 m either side of the outer cables. Cables would be buried at a depth of up to 1.2 m.

Careful consideration will be given to ensuring cable-laying is undertaken in a way which minimises potential erosion and sedimentation sources. Restoration along the cable route will be undertaken immediately following cable installation in order to minimise disruption to the habitats and hydrological processes. This will include ensuring the original ground level is restored to compliment surrounding peatland habitats, and that any disturbed/bare ground is revegetated with appropriate species. Further detail on mitigation measures is provided in Section 5 and Section 7.

2.1.3 Segment 3 – Yellow Bog

The track crossing Yellow Bog is approximately 1 km in length and is bound on both sides by the SAC. Photographs showing the current state of the track can be seen in Appendix 1 of Report 5. Following the consultation response from SNH with regard to report 5, SSER have decided to drop proposals to widen this section of track to accommodate abnormal load traffic. This section of track does however, have the potential to provide significant benefit in allowing rapid access for light vehicles to the western parts of the proposed wind farm. For this reason, it is proposed that this section of track would be upgraded only to provide light vehicle access but no works will be undertaken which would result in additional land take outside of the current extent of cut through track.

In addition, it is proposed to run two cable circuits within the existing track. Running the cables within the existing track would ensure no additional impact on SAC habitats. Cable trenches would be backfilled with the original material excavated (or material of similar porosity) in order to ensure there is no potential disruption of groundwater flow.

Upgrade works will, therefore, primarily involve resurfacing of the existing running surface and burying of cables beneath the resurfaced track. Further assessment would be undertaken ahead of these works to investigate whether any potential improvements could be made to reduce the effects of the existing road. In particular, this assessment would consider the potential to enhance hydrological connectivity between habitats or reduce the width of disturbed habitats either side of this road segment.

Given the revised proposal to drop any widening of this segment, no additional site condition data is presented and no further impact assessment has been undertaken.

2.2 Updated Assessment and Survey Methodology

As detailed in Report 5, a range of habitat data has been used in assessing potential impacts. These include:

- Phase 1 habitat and National Vegetation Classification (NVC) information from the original Strathy South ES;
- Updated NVC survey for Strathy South including adjacent to Yellow Bog track; and
- Phase 1 and NVC surveys for the Strathy Wood to Strathy South Forest track.

In addition to the above data sources used in Report 5, further field based surveys were undertaken in January 2013 in conjunction with a detailed topographic survey using Differential GPS (DGPS) equipment. The boundary between qualifying and non-qualifying habitats adjacent to both Segment 2 and 3 sections of track was mapped to a high level of accuracy. In determining the extent of disturbed/modified habitats, Report 5 relied upon aerial photograph interpretation. It was felt that a higher level of accuracy could be achieved through mapping with DGPS and this was required to ensure any potential discrepancies due to aerial photo interpretation were removed. Whilst undertaking the additional surveys, it was concluded that this method of mapping provided a high level of confidence due to the visibly clear boundaries between non-qualifying habitats and qualifying habitats. Photograph 2.2.1 below shows a good example of the clear boundary between qualifying and non-qualifying habitats adjacent to track Segment 3. Unfortunately, due to poor weather conditions, photography was not taken adjacent to Segment 2, however, a similar clearly distinguishable boundary exists along this Segment.

Photograph 2.2.1 Showing the clear boundary between qualifying and non-qualifying habitats (non-qualifying habitats are present on old peat spoil in right of photo).

Whilst no updated data is presented for Segment 3, additional surveying of disturbed/modified habitats using DGPS was undertaken along this segment and this data is available on request.

2.3 Baseline Conditions

2.3.1 Current Physical Characteristics

Segment 2- Main Site Access Route

Updated mapping, based on the January topographic survey of the track and associated disturbed habitat along Segment 2, indicated a total existing disturbance area of 8.7 ha within the SAC (Figure 2a-d). Results from this survey also indicate an average disturbance (existing track and adjacent non-qualifying habitat combined) width of c. 28 m. This updated assessment indicates a greater area and width of existing impact than that estimated from aerial photography in Report 5 (4.8 ha and 21 m respectively). The increase in area is due in part to the extension of Segment 2 northward taking in additional disturbed habitat within the SAC which was previously part of Segment 1. The further increase in area and width is due to the more accurate ground based surveys which are able to pick up areas of disturbed habitat not distinguishable in aerial photography.

Grid Connection Route (Adjacent to Segment 2)

The area immediately adjacent to the western edge of the existing track, into which the grid connection cables would be laid, is comprised primarily of disturbed non-qualifying habitats. Cables will be confined to the disturbed habitat area wherever possible, however, it is expected the cable route will run through qualifying habitats in some places. Whilst it is believed habitats in these areas will have undergone some modification due to the presence of the track, there is relatively little obvious evidence of this which would suggest these habitats are resistant to the changes in hydrology brought about by the present of the track.

2.3.2 Qualifying Habitats

The qualifying habitats found adjacent to both track Segment 2 and 3 include blanket bog (a Habitats Directive Annex 1 priority habitat) and Northern Atlantic wet heaths with *Erica tetralix* (also listed on the Habitats Directive Annex 1). No other SAC qualifying habitats were mapped within 50 m of the edge of existing tracks passing through the SAC.

For further details with respect to NVC communities present in disturbed ground, undisturbed ground, and associated with watercourses adjacent to the existing track sections, refer to Section 2.3.3 and Figures 2b/3b/2c/3c of Report 5.

The results of the January 2013 surveys to update the boundary between qualifying and non-qualifying habitats are presented in Figure 2a-d.

3. Updated Assessment of the Potential Impacts on Qualifying Habitats within the SAC from Track Widening and Upgrade Works

This section re-examines the potential for direct and indirect impacts on SAC qualifying habitats due to the revised proposed track widening and upgrade works.

Given the updated proposals exclude Segment 3 from any works associated with road widening, the current report assumes there will be no additional impact on adjacent qualifying habitats along this segment over and above those impacts currently present due to historic road construction. For this reason, this segment of track is not discussed further in the assessments undertaken below.

In order to separate the potential effects from track upgrade works along Segment 2 versus cable installation adjacent to this segment, these two elements are assessed separately. Given the need to avoid impacts on SAC habitats, consideration has been given to the method of widening of track Segment 2 within the SAC's boundary and this approach is further discussed here. Other methods of mitigation in relation to track widening are also discussed.

The following section details the methods and discusses the rationale for three different approaches to calculating direct and indirect impacts from track upgrade works.

Figure 2a-d shows the construction footprint required for the creation or widening of the access track along with the current level of disturbance associated with the existing track. This figure does not show passing places (as the most appropriate location for these had not been identified at the time of writing) however, the additional area of direct and indirect impact due to passing places is included in the habitat impact calculations and overall assessment. Appendix 2 of Report 5 gives further visual information on the current levels of disturbance caused by previous construction and maintenance activities associated with the existing track within the SAC's boundary.

3.1 Background to Estimating Potential Impacts on Qualifying Habitats

Direct Impacts

The main and most obvious direct impact to SAC qualifying habitats from track widening will be long term loss due to the potential incorporation of ground containing qualifying habitats into the final track infrastructure. In addition, potential habitat modification may occur due to the presence of the road intercepting overland and sub-surface runoff, thereby reducing the natural volume of water moving through and sustaining the original wet heath and blanket bog habitats. As is discussed further in Section 3.2 to 3.4 however, this effect is already present due to the existing track and it is therefore important to separate existing effects from potential further impacts from the proposed construction activities.

As stated in Report 5, further potential also exists for changes in habitats adjacent to the track due to changes in water chemistry as a result of mineral material being transported via runoff or windborne dust generated by traffic. For details on potential impacts resulting from this process refer to Section 3.1, Report 5.

In their response to consultation regarding impact zones (email, Alec Macdonald: 25 September 2012), SNH indicated they would consider a distance of 10 m outwith

the outer edge of the construction footprint to reflect the true potential direct impact zone for SAC qualifying habitats.

Indirect Impacts
The potential indirect impact of track widening within the SAC involves modification of existing habitats, primarily as a result of changes to the surrounding hydrology (due to runoff interception and the water table drawdown effect of drains). Minor potential also exists for modification of habitats due to changes in water chemistry of peatland habitats as a result of mineral material being transported via runoff or windborne dust generated by traffic.

In their response to consultation regarding impact zones, SNH indicated they would consider a distance of 15 m outwith the outer edge of the direct impact zone (footprint plus 10 m) to reflect the true potential indirect impact zone for SAC qualifying habitats.

3.2 Methods for Estimating Potential Impacts (Direct and Indirect) on Qualifying Habitats

Given the background information above on applying a 10 m direct impact and further 15 m indirect impact zone, it is considered that there are three different methods for applying these zones. Each method and the rationale behind them are discussed below:

1. Application of the impact buffers along both sides of the full length of Segment 2 track to be upgraded within the SAC.

2. Application of the impact buffers along those lengths of track in which widening extends into areas of peatland habitats where a normal functioning water table is present i.e. to the west of the track (this may be in either disturbed or undisturbed habitat).

3. Application of the principles of a cumulative impact assessment, which takes into account existing permanent long term impacts due to the existing track infrastructure and calculates the cumulative effect of additional track widening.

Method 1 is the most conservative and hence most likely to overestimate potential impacts. This method applies a buffer regardless of what has historically occurred already and whether any additional peatland habitat land take will occur during track widening.

Method 2 only considers those sections of track where potential additional hydrological impacts may occur due to further peatland habitat land take and applies the impact zones to their full width along these sections. This approach provides a less conservative estimate without fully taking into account the historical and future impacts due to the presence of the track as per Method 3 below.

Method 3 takes into account existing baseline conditions and only considers the additional potential long term impacts over and above the historical and ongoing effects likely to occur regardless of any development proposals.

As outlined above, it is considered that Method 1 would overestimate the true long term impacts arising from track widening and is not reflective of the existing baseline conditions. The existing track was constructed in approximately 1981 (this date

assumes track construction 2 years prior to the initial plantings – it is entirely possible the track may have been constructed even earlier than this). Given that the track runs on a gentle contour for most of Segment 2, the track has therefore, been intercepting surface and sub-surface water flow for at least 32 years. This process diverts and concentrates water into a limited number of watercourses crossing the track. This has a potential effect on down-slope habitats through a reduction in water supply resulting in drier peat conditions which are likely to favour plant species less suited to peat formation.

Likewise on the uphill side of the track there is a drawdown effect due to the presence of the drainage embankment. The effect of drawing down the water-table in this way is to dry out the peat adjacent to the bank to the point where the water-table reaches its natural level at or close to the surface. In shallow (peat generally <0.5 m) wet heath peatland habitats with a relatively thin acrotelm which quickly turns to highly humified peat beneath, such as the majority of habitats adjacent to the access track, the conductivity of the peat is likely to be sufficiently low that the drawdown effect would generally extend a relatively short distance i.e. less than 5 m.

The overriding premise to track widening would be that any construction works aim to minimise loss or modification to SAC qualifying habitats. It therefore follows that construction works would be undertaken within the existing track footprint and associated disturbed ground before using ground dominated by unmodified habitat. Further to this, specific consideration has been given to the most appropriate direction of track widening within the SAC. Segment 2 would be widened to the west as this direction lies down slope from the existing track. The habitats to the west are therefore considered to have already undergone a higher level of modification due to the long term interception effects of the road on surface and sub-surface runoff.

Given the commitment to only widen the track to the west side of the existing track (generally down-slope), with only very minor works on the eastern side, Method 2 calculates potential impacts by only applying the impact zones to this side of the track. It is recognised that there may still exist potential for pollution effects from windborne dust on the uphill side however, this type of impact is considered to be negligible and can be controlled through the use of methods such as watering during construction if required.

Finally, in order to undertake a true cumulative impact assessment, Method 3 takes into account that the 10 and 25 m direct and indirect impact zones already exist due to the presence of the existing track. In addition, these zones will continue to exist and develop, under existing circumstances, given the track is likely to remain in place for the foreseeable future in order to provide access for commercial forestry activities, irrespective of any development proposals.

Impact estimates using Method 3 are therefore calculated by taking the additional footprint width (due to upgrading/widening) outwith the existing track along those sections where widening is proposed, and extending the direct and indirect impact zones by an equal amount. Using a 2 m additional footprint width as an example, the outer edge of the direct and indirect impact zones would be extended from 10 to 12 m and 25 to 27 m respectively. The direct impact area would then be calculated as a strip of ground 2 m wide along the outer edge of the direct impact zone (in this example the strip of ground between 10 and 12 m). Indirect impacts would similarly be calculated and in this example the cumulative indirect impact would therefore be the strip of ground between 25 and 27 m.

3.3 Estimates of Potential Impacts (Direct and Indirect) on Qualifying Habitats from Track Widening

Table 3.1 below shows the potential direct and indirect impacts on qualifying habitats from the three methods described above.

TABLE X. SUMMARY OF POTENTIAL IMPACTS ON QUALIFYING HABIATS			
Estimation Method	**Direct / Indirect**	**Habitat (NVC Code)**	**Impact Area (ha)**
Method 1	Direct	Wet Heath (M15)	0.66
		Blanket Bog (M17/M25)	0.37
Sub-total - Direct			1.03
	Indirect	Wet Heath (M15)	3.56
		Blanket Bog (M17/M25)	1.55
Sub-total - Indirect			5.11
Total - Method 1			**6.14**
Method 2	Direct	Wet Heath (M15)	0.29
		Blanket Bog (M17/M25)	0.37
Sub-total - Direct			0.66
	Indirect	Wet Heath (M15)	1.26
		Blanket Bog (M17/M25)	0.99
Sub-total - Indirect			2.25
Total - Method 2			**2.91**
Method 3	Direct	Wet Heath (M15)	0.24
		Blanket Bog (M17/M25)	0.35
Sub-total - Direct			0.59
	Indirect	Wet Heath (M15)	0.62
		Blanket Bog (M17/M25)	0.33
Sub-total - Indirect			0.95
Total - Method 3			**1.54**
Notes:			

The table above illustrates the significantly different results obtained dependant on which method is applied. The key results in terms of impacts on qualifying habitats from the analysis are:

- Method 1 results in c. 1 ha of direct impacts and c. 5 ha of indirect impacts.
- Method 2 results in c. 0.7 ha of direct impacts and c. 2.3 ha of indirect impacts.
- Method 3 results in c. 0.6 ha of direct impacts and c. 1 ha of indirect impacts.

3.4 Overall Assessment of Potential Impacts on Qualifying Habitats resulting from Track Widening and Upgrade

As discussed previously, it is considered likely that Method 1 would overestimate the impacts occurring within the SAC adjacent to the road as a direct result of the additional road upgrade and widening works. However, Method 1 may underestimate long term cumulative impacts as it assumes a direct relationship between track widening and cumulative impact. Taking the above into account, the current report concludes that the quantity of true long-term cumulative impact lies

between the results presented above for Methods 2 and 3, i.e. between 1.6 and 2.9 ha of overall impact.

In applying the precautionary approach to impact assessment within Natura 2000 sites, the current report concludes that the impact may be up to 2.9 ha. In addition to the overall area, it is also important to consider the type and duration of impacts. The type of impacts are likely to vary from strong modifications to existing vegetation comprising qualifying habitats to minor or imperceptible changes to these habitats within the area of impact presented above. It is important to note that no long term loss of habitat is expected due to habitat being lost under the final track footprint. All impacts therefore involve potential loss through modification rather than definite loss. In addition, it is the author's professional opinion that, whilst the potential for modification exists, a significant proportion of the habitat is unlikely to undergo change to an extent where the integrity of these habitats is affected. This applies particularly to the area of indirect impact which makes up the majority (c. 80%) of the potential 2.9 ha of habitat impact. This conclusion is reached on the basis that the existing track has been in place for c. 32 years and little or no perceivable change has occurred to wet heath or blanket bog habitats within close proximity to the track.

Taking into consideration the above assessment, it is concluded that the overall level of impact is of **low** magnitude and **moderate** significance with respect to widening of the access track.

Effects/residual effects determined as moderate or higher are considered to be significant with regard to the EIA regulations (2000). Hence, it is concluded that further directly comparable (i.e. relating to qualifying habitats) mitigation is required within the SAC in order to reduce these impacts to an acceptable level. Proposals for such mitigation are presented in Section 5 below.

4. Assessment of Potential Impacts on Qualifying Habitats resulting from Installation of Grid Connection Cables

This section identifies potential impacts resulting from the proposed installation of grid connection cables adjacent to track Segment 2. These impacts are discussed and associated mitigation measures are presented. Further detail regarding mitigation measures is provided in Appendix 5.

The calculation and assessment of potential impacts resulting from installation of the grid cables adjacent to track Segment 2 has been separated from those associated with the track due to the limited extent and short term nature of these impacts. The methods associated with laying of the grid cables outlined in Section 2.1 and Appendix 5, are designed to minimise the area and duration of disturbance to habitats along the route of the cables. The only potential for long term impact associated with the cable is due to excavation for cable jointing locations (discussed below).

Cable installation within Segment 3 is proposed directly within the existing track running surface and would therefore not contribute to any additional habitat impact. For this reason, this segment of track is not discussed further in the assessments undertaken below.

Predicted potential impacts resulting from cable installation proposals include:

1. Direct disturbance of vegetation and peat due to mechanical damage caused by the mole plough. Impacts of this nature are likely to be very localised along each cable channel. Impacts are also predicted to be temporary in nature with cable ploughing typically covering 1.5 km per day and hence, operations within the SAC would be undertaken within a relatively short space of time. It is therefore predicted that no long term change to hydrology or other conditions affecting vegetation would be expected. As far as possible, cables would be laid into disturbed habitats adjacent to the track following track upgrade and widening. It is estimated that just 0.51 ha of qualifying habitats would be affected by cable laying or traversing by vehicles/machinery (see below). This includes the width of cable installation and the 2 m temporary working area either side of the outer cables.

2. Direct disturbance of vegetation and peat can occur due to mechanical damage caused by vehicles/machinery traversing the cable route. It is proposed that a 2 m working width either side of the cable installation area will be required. The existing track will be used as far as possible to carry the cable trailer, reducing the impacts on vegetation to those caused by the cable plough and winch machinery. These effects are predicted to be localised and of temporary duration.

3. Erosion as a result of lines of weakness created in the peat along which water is channelled. This potential effect is predicted to be localised along the lines of individual cable channels. Given that the track and therefore cables run along the contour (i.e. follow gently sloping ground), the potential build up of erosive force from water travelling along the route of disturbance will be minimal. The effects are predicted to be temporary in nature as the peat soil is expected to reform around the cables. In addition, this potential effect is easily monitored and corrective measures taken should erosion become an issue.

4. Changes to hydrology as a result of excavation of cable jointing areas. It is necessary to excavate a jointing area (8 x 6 m) to a depth of c. 1.0 m (0.1 m deeper

than the installed cables). All practical steps will be taken to ensure the jointing area is located within an area of non-qualifying habitats. The area will then be reinstated immediately. It is likely this will alter the vegetation and habitat in this area. Depending on the ability to reinstate the peat and hydrological processes in this area, the effects may be long term. However, the effects are considered to be localised with the potential to impact on a total area of <0.05 ha. This assumes a 'worst case' direct impact zone of 10 m surrounding the excavated area. No indirect impacts are expected beyond the 10 m zone as the excavation does not form a continuous linear feature and therefore is unlikely to intercept and significantly alter hydrological processes beyond 10 m.

Taking the above predicted effects into account, the overall impact from cable installation through the SAC is considered to consist primarily of short term localised effects. These effects are therefore assessed as being of **low** magnitude and **minor** significance for cable installation.

5. Updated Construction and Post-Development Mitigation / Compensation

5.1 Construction phase mitigation measures

Drainage features and runoff controls will be specifically designed with the aim of reducing the current level of impact the track has on hydrological processes affecting the adjacent habitats. Further consultation would be undertaken with respect to specific methods employed to protect habitats. However, it is assumed that maintaining the existing drainage flow paths would minimise any further potential modification of habitats due to changing soil chemistry and water volume. This is particularly the case along Segment 2 where the majority of water from drains associated with the track is released into a limited number of permanent watercourses.

Further to the above, and as indicated in Report 5 and the grid connection method statement (Appendix 5), a number of specific measures would be implemented to ensure minimal disruption is caused to all protected habitats both within and outwith the SAC. These measures are designed to compliment the range of standard best practice construction methods[2,3] that would be implemented as a matter of course. More detail on all measures to be employed would be provided in the finalised CEMP and its associated Ecological Protection Plan.

Specific construction mitigation measures would include:

- Delimitation of working areas to minimise the potential zone of influence and ensure construction activity does not stray beyond this zone onto protected habitats;
- Micro-siting of track upgrade and associated works in order to maximise the use of the currently disturbed habitat corridor in order to avoid land take within undisturbed qualifying habitats; and
- Selection of appropriate direction of road widening and cable installation with respect to existing tracks and habitats in order to minimise impacts on qualifying habitat adjacent to the track footprint particularly in relation to hydrological processes.

Specific post construction mitigation and monitoring measures would include:

- Prompt restoration of all areas requiring reinstatement in order to minimise potential effects due to exposure and erosion of substrates particularly peat;
- The reuse of peat generated by track widening to assist with the reinstatement of road verges; and
- Post-construction monitoring by a qualified ecologist would be undertaken of all habitat reinstatement areas. Recommendations would be made where any further work is required to ensure the successful reinstatement of these areas.

5.2 Long-term compensation measures

Compensation measures for habitat impacts have been reviewed following the issuing of Report 5. New compensation measures are therefore proposed which will specifically target the restoration of degraded and at risk habitats within the SAC. The site targeted for this work is located in the south-west of Strathy South Forest (Figure 3) in an area thought to have been prepared for afforestation at a similar time to ground preparation operations for Strathy South Forest (1982 – 1994). This area

[2] SEPA (2012) - Land Use Planning System SEPA Guidance Note 4
[3] SNH (2010) – Good Practice During Windfarm Construction

was however, never planted, and now consists of a network of open actively eroding drains (see Photographs 5.1 and 5.2 below) in deep peat (>1.2 m). The majority of the site is situated such that it has the strong potential to intercept water from a network of typical bog pools and lochans characteristic of peatland in this part of the country (bog pools visible in Figure 3). The total area covered by these drains is estimated at 23.5 ha although their influence is likely to affect an area significantly greater than this. This area particularly lends itself to peatland restoration due to it being a flat site with relatively good access and deep peat affording good opportunities for installation of peat dams and hence a high likelihood of restoration success. Restoration proposals for this area would aim to compliment proposals for adjacent land management to be outlined in the Land Management Plan submitted as part of the Strathy South Wind Farm ES Addendum (ES Addendum Appendix 11.2).

Photographs 5.1 Showing eroding plough furrow feeding into eroding main drain

Photographs 5.2 Showing eroding plough furrow

Additional potential compensation measures
In addition to the area targeted for restoration above, there exists potential to undertake two further compensatory measures.

The first of these involves reinstating part or all of a forestry road which extends from Strathy South Forest into the SAC to the north-west of Strathy South Forest (Figure 4). This is believed to be a cut through road with aggregate used to raise the road significantly above the surrounding land. Hence, this road not only displaces qualifying habitat, but is likely to disrupt the natural hydrology within the vicinity and have a long-term impact on surrounding qualifying peatland habitats. The total footprint area covered by this road suitable for restoration is 0.39 ha with the actual

area of improvement due to its restoration likely to be significantly more than this due to hydrological impacts. This measure is not taken into account in the assessment of residual effects (Section 6) as a separate assessment would be required of the positive versus negative effects prior to undertaking works of this nature.

The second potential compensation measure involves the use of existing peat spoil mounds located adjacent to track Segments 2 and 3. Opportunities to utilise these mounds in a beneficial way would be explored in consultation with SNH and SEPA. Once again, this option is not taken into account when assessing mitigation measures and impacts as there is no certainty that this material can be used to benefit the targeted ecological receptors.

6. Residual Assessment of Potential Impacts from Proposed Track Widening

Track Impact Assessment

The current report updates RPS 2012, Report 5 on the identification and estimation of potential impacts on qualifying habitats within the SAC due to proposed access track widening and construction to be undertaken in conjunction with the proposed Strathy South Wind Farm. Steps to avoid impacts on qualifying habitats have been taken wherever possible. The main approach has been to ensure the design of upgrade works uses the existing corridor of disturbed habitat created by historical track construction and maintenance. In addition, the most appropriate direction in which to widen the track has been assessed by considering existing modification to habitats due to the existing road. These modifications are primarily to the western side of the track and therefore, further track upgrade works are preferentially directing towards this side of the road minimising further long term disruption to hydrological processes.

Due to the nature of the surrounding habitats and their reliance on hydrological processes, SNH have suggested that assessments use a potential corridor of direct impacts of 10 m beyond any upgrade works and indirect impacts of a further 15 m zone beyond this. These distances have been used as the basis of the assessment in the current report, however, three methods are presented whereby these impact zones are applied according to different concepts of existing and cumulative impacts from track upgrade works.

Method 1 formed the basis of calculated habitat impacts in Report 5 and is considered to provide a highly conservative estimate by applying these buffers to both sides of the track despite track upgrade works being designed to avoid any further impact along the eastern edge of the track. For this reason, the current report concludes that Methods 2 and 3 provide a more accurate reflection of potential impact levels by taking into account the long-term influence of the existing track and the design of upgrade works aimed at limiting further construction to one side of the track only.

In taking a precautionary approach, the current report adopts the higher level of predicted impacts (Method 2) which estimates that direct impacts on qualifying habitats (blanket bog and wet heath) within the SAC could be up to 0.7 ha and indirect impacts up to 2.3 ha giving overall impacts of c. 3 ha.

A range of design and construction mitigation measures have been documented within the current report to minimise these impacts including minimising the final track footprint, limiting the footprint to within existing disturbed habitats, widening to one side of the existing track only in Segment 2, and design of drainage features to minimise additional impacts due to runoff.

In addition to design and construction mitigation, compensatory measures are proposed which would see the restoration of a substantial area (>23 ha) of blanket bog and wet heath within the SAC, which was previously prepared and heavily drained for forest establishment (but never planted). If restoration is implemented correctly and is therefore successful, the effects could be considered to provide a net environmental gain.

Taking into consideration the predicted impact levels in association with the proposed mitigation and compensation measures (and taking into account the low risk that compensation measures may not be successful in their entirety), the residual effects

of the proposed track upgrade and widening is assessed as being of **negligible to minor significance.** However, if all compensatory mitigation measures are successful, the net residual effect would be assessed as **positive** of **moderate** significance.

7. SNH Consultation Response to Draft Version of Current Report

The following section details the formal response from SNH (in italics – email 20th March 2013) following further consultation on a draft version of the current report. Further information is provided beneath each issue raised by SNH indicating how these issues would be dealt with.

Page 5, Section 2.1.1 Segment 2 - Main Site Access Route
3rd Paragraph. Passing places. It is assumed that these will be constructed on the west side of the track and that the cables will be laid to the west of them. Encroachment into qualifying habitat should be avoided. Further details required in the Strathy South ES Addendum.

Widening and upgrading of the proposed access track seeks to avoid, or otherwise minimise, the impact of the Modified 2013 Scheme on the SAC including, where possible, siting any new track construction (including passing places), and grid connection cables, within currently disturbed ground (i.e. non-qualifying habitats). In order to do this, detailed surveys of the extent of qualifying habitats would be used as a key input to the final design and micro-siting process.

Page 6, Section 2.1.1 Segment 2 - Main Site Access Route
3rd paragraph. "Construction proposals include the removal of the peat spoil heaps where this area is required for widening and cable installation. Following construction, reinstatement of these former spoil heaps would take place...".
We support this objective. There are, however, a number of elements to the proposal which require further consideration:
• The fate of the removed spoil. It is stated in the last paragraph of this section that this will be addressed through a Peat Management Plan. It should, however, be acknowledged that this material is likely to comprise a mixture of peat and mineral soil.
• There may be implications for the operation of the cable plough of removing the spoil heaps. The cable plough will be running on a bare peat surface very close to the edge of the batter down to the track. This may have implications for stability. This should be addressed through a detailed Method Statement to complement that provided for the Mybster-Camster cable.
• Revegetation of the exposed peat. This should be undertaken at the earliest opportunity after the cables are laid. Ideally, blanket bog turf removed from other parts of the development would be used. However this may be in short supply. Options to ensure early and appropriate vegetation cover should be prepared and presented.

In upgrading and widening the access track, it may be necessary to remove the existing peat spoil heaps adjacent to the track. These spoil heaps consist of a mix of oxidised peat and, to a lesser extent, mineral soil. The fate of the spoil heaps would be confirmed post consent and detailed through the Peat Management Plan. This may require further investigation of the nature of the material in the spoil heaps and careful consideration as to its suitability for re-use within the SAC.

In removing the spoil heaps, there may be an area of bare peat exposed on which machinery may be required to pass in order to lay grid cables adjacent to the access track. Careful consideration would be given to the most appropriate means of protecting this area. Detailed methods would be provided post consent. Mitigation would include the use of bog mats where required to minimise disruption to peat and retain a flat working surface through this area. However, given the proximity of the

spoil heaps to the side of the road, any grid connection cables being ploughed into these areas is likely to be achieved by machinery working from the upgraded track.

During all works, measures will be adopted to avoid, or otherwise minimise, damage to surface vegetation. Through the use of cable ploughing and machinery operating from the upgraded track or bog mats where necessary, areas of bare peat are predicted to be restricted to the strip of ground from which peat spoil is to be removed and to areas excavated for cable jointing.

In areas where peat spoil has been removed leaving the bare peat beneath exposed, these areas will be stabilised following the completion of works using, for example, biodegradable mesh fibre laid over bare peat. This area would then be seeded with a mix of plant species appropriate to the adjacent qualifying habitats.

Page 6, Section 2.1.2 Grid Connection Route (Adjacent to Segment 2)
1st Paragraph. Excavations for cable joints. A detailed Method Statement is required which demonstrates measures to avoid direct impacts on qualifying habitat and, minimise indirect impacts. This might include using an excavator located on the track, or the use of bog mats. Consideration also has to be given to the temporary placement of excavated material to avoid damage to qualifying habitat and minimise the risk of destabilizing the roadside bank.

Cable jointing areas would be selected to avoid areas of qualifying habitat wherever possible, including locating into areas where disturbance from machinery would be avoidable or minimised. Vegetated peat turves extracted from jointing areas will be cut and stored separately to underlying excavated material. All material will be replaced in the reverse order of extraction such that peat turves are relayed over the excavated areas. Storage of peat turves will be kept to less than one week. If a longer storage period is required or, if the prevailing weather is hot enough to warrant, turves will be watered during storage to prevent drying. In addition, a detailed Method Statement would be provided demonstrating measures to avoid direct impacts on qualifying habitats and minimising indirect impacts. This might include using an excavator located on the track, or the use of bog mats. Method statements would demonstrate that temporary placement of excavated material would avoid further damage to qualifying habitat.

Page 7, Section 2.1.2 Grid Connection Route (Adjacent to Segment 2)
Final Paragraph. Identifies some of the issues mentioned above, and although these are addressed in part in Section 5, further detail will be required in the Construction Method Statement.

Noted.

Page 12, Section 3.2 Methods for Estimating Potential Impacts (Direct and Indirect) on Qualifying Habitats
3rd Paragraph. "The overriding premise to track widening would be that any construction works aim to minimize loss or modification to SAC qualifying habitats". Suggest the aim should be to avoid loss or modification, albeit accepting that there may be circumstances which determine that the aim is not achieved.

Noted – Construction Method Statements would be written with the aim being to avoid loss or modification of habitats and where this cannot be achieved, minimise loss or modification of habitats.

Pages 16 & 17, Section 4 Assessment of Potential Impacts on Qualifying Habitats resulting from Installation of Grid Connection Cables/

Re Impact 4. We advise that the cable jointing areas are selected not only to avoid areas of qualifying habitat, but always where the topography is relatively uniform, i.e. where there is little altitudinal difference between the track and the adjacent track-side bank.

See information regarding SNH comment above with respect to Page 6, Section 2.1.2.

Page 17, Section 5 Construction mitigation measures

We advise that there should be an additional measure to the effect that there will be no refuelling of the cable plough when it is operating off the constructed track. This is to reduce the risk of fuel spills affecting SAC qualifying habitat.

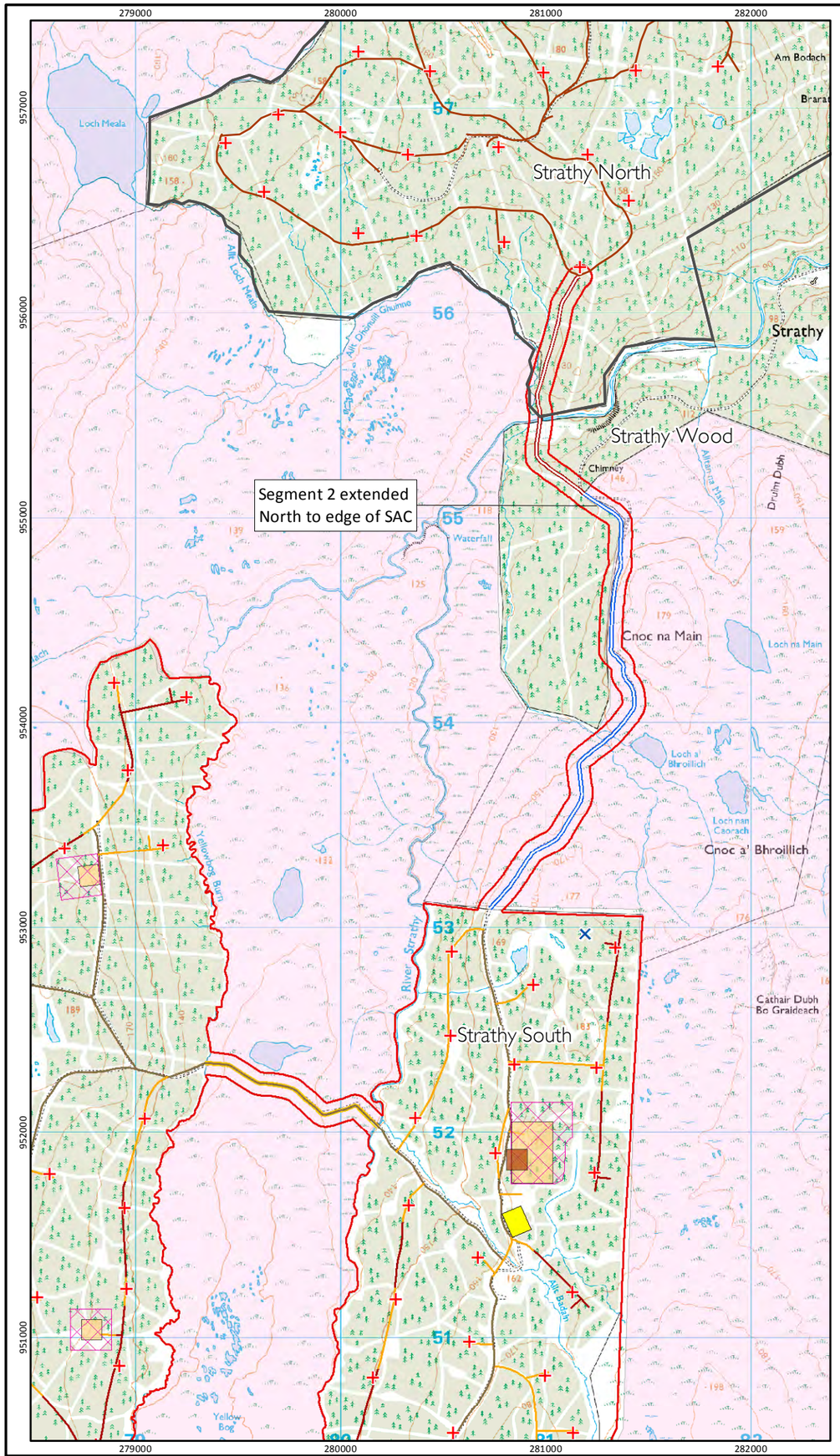
Potential pollution effects would be reduced by restricting refuelling of all plant to the track or outwith the SAC. More detail on refuelling would be incorporated into the Construction Environmental Management Plan (CEMP) of which a draft is included with the ES Addendum (Appendix A4.1) and will be detailed in pre-construction, Method Working Statements.

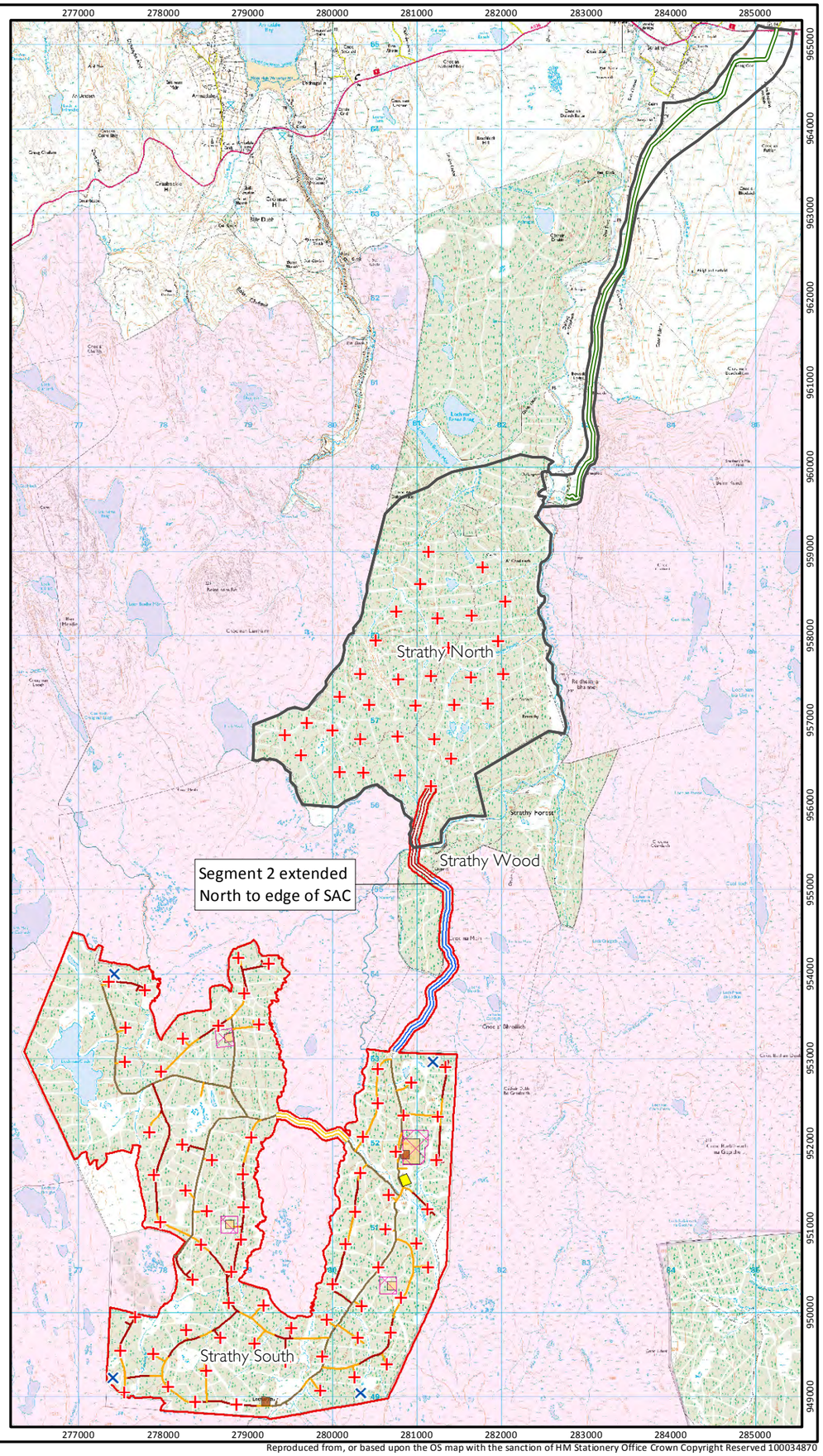
8. Appendices

Appendix 1. Typical Access Track Diagram
Appendix 2. Access Track Route with Chainages
Appendix 3a. Segment 2 Surveyed Cross Sections 300 to 2000
Appendix 3b. Segment 2 Surveyed Cross Sections 2100 to 3600
Appendix 4. Typical Cable Trench Diagram
Appendix 5. Mybster-Camster Report August 2012 (Rev b)
Appendix 6. Relevant Sections from Report 5
Appendix 7. Appendices 1 and 2 from Report 5

9. Figures

Figure 1. Strathy South Access Route Overview
Figure 2 a-d. Strathy Access Non Qualifying Habitat and Construction Disturbance
Figure 3. Strathy Access Habitat Compensation Area
Figure 4. Strathy Access Potential Further Habitat Compensation Area
[Report 5] Figures 2b/c and 3b/c. NVC Communities Adjacent to Access Track Sections





SSE Renewables

RPS

Legend

- Strathy South development boundary
- Consented Strathy North Wind Farm boundary
- Caithness and Sutherland Peatlands SPA and SAC
- Turbine location
- Permanent met masts
- Lay down area
- Borrow pit search area
- Borrow pit
- Switching Station
- Strathy North Access Route
- Cut track
- Float track
- Upgrade track

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

Scale 1:60,000 @ A3

0 0.5 1 km

N

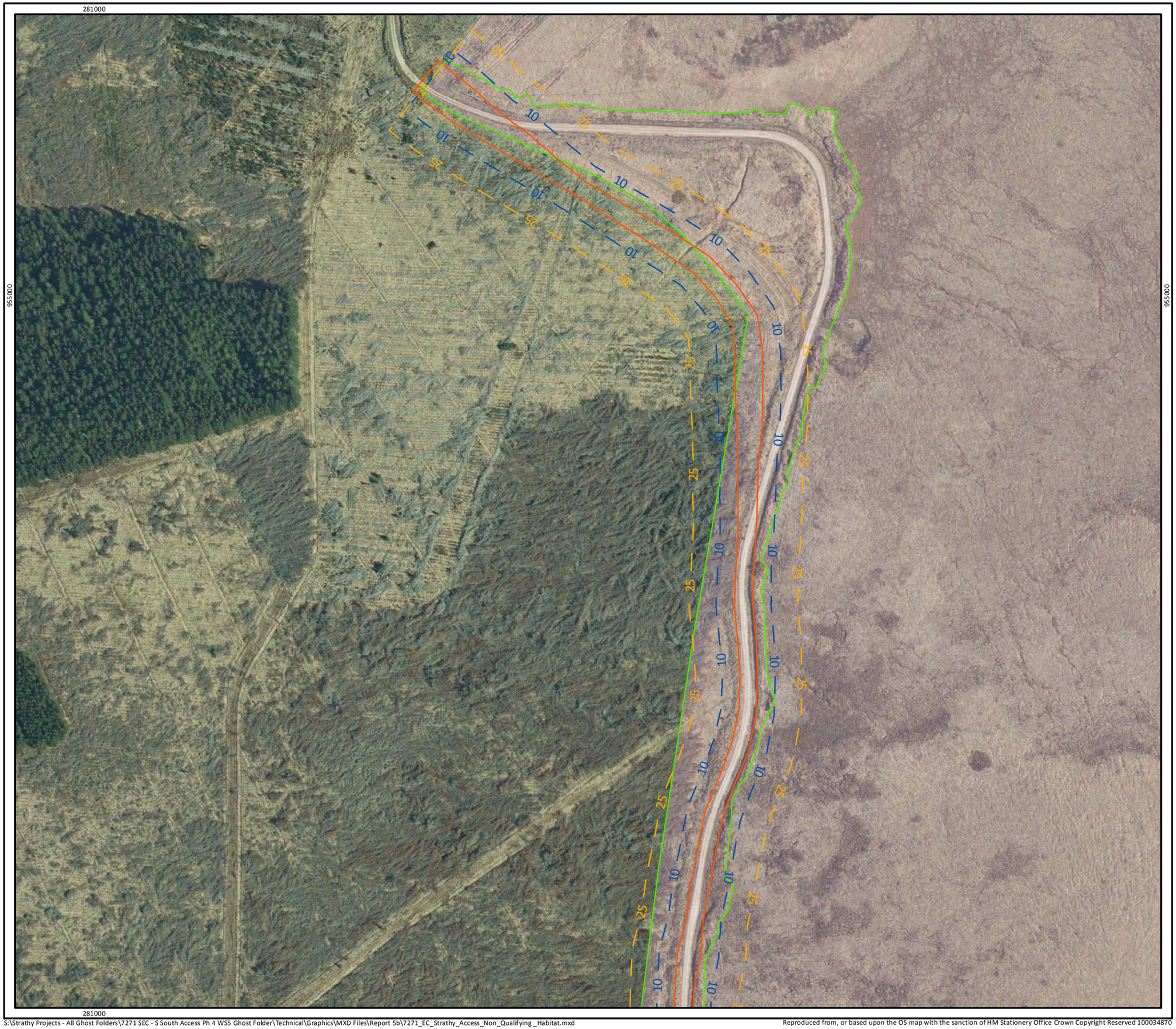
Figure 1

Access Routes Overview

Strathy South Wind Farm Access Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_South_Access_Overview.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Proposed access track final footprint
- Non-qualifying SAC habitat
- 10m buffer from edge of track
- 25m buffer from edge of track
- Caithness and Sutherland Peatlands SPA and SAC

Scale 1:2,000 @ A3

0 15 30 60 m

N

Figure 2a
Segment 2 Non-Qualifying Habitat and Construction Disturbance

Strathy South Wind Farm Access
Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_Access_Non_Qualifying _Habitat.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

SSE Renewables

RPS

Key

- Proposed access track final footprint
- Non-qualifying SAC habitat
- 10m buffer from edge of track
- 25m buffer from edge of track
- Caithness and Sutherland Peatlands SPA and SAC

Scale 1:2,000 @ A3

0 15 30 60 m

N

Figure 2b
Segment 2 Non-Qualifying Habitat and Construction Disturbance

Strathy South Wind Farm Access
Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_Access_Non_Qualifying _Habitat.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

SSE Renewables

RPS

Key

- Proposed access track final footprint
- Non-qualifying SAC habitat
- 10m buffer from edge of track
- 25m buffer from edge of track
- Caithness and Sutherland Peatlands SPA and SAC

Scale 1:2,000 @ A3

0 15 30 60 m

N

Figure 2c
Segment 2 Non-Qualifying Habitat and Construction Disturbance

Strathy South Wind Farm Access Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_Access_Non_Qualifying _Habitat.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

SSE Renewables

RPS

Key

- Proposed access track final footprint
- Non-qualifying SAC habitat
- 10m buffer from edge of track
- 25m buffer from edge of track
- Caithness and Sutherland Peatlands SPA and SAC

Scale 1:2,000 @ A3

0 15 30 60 m

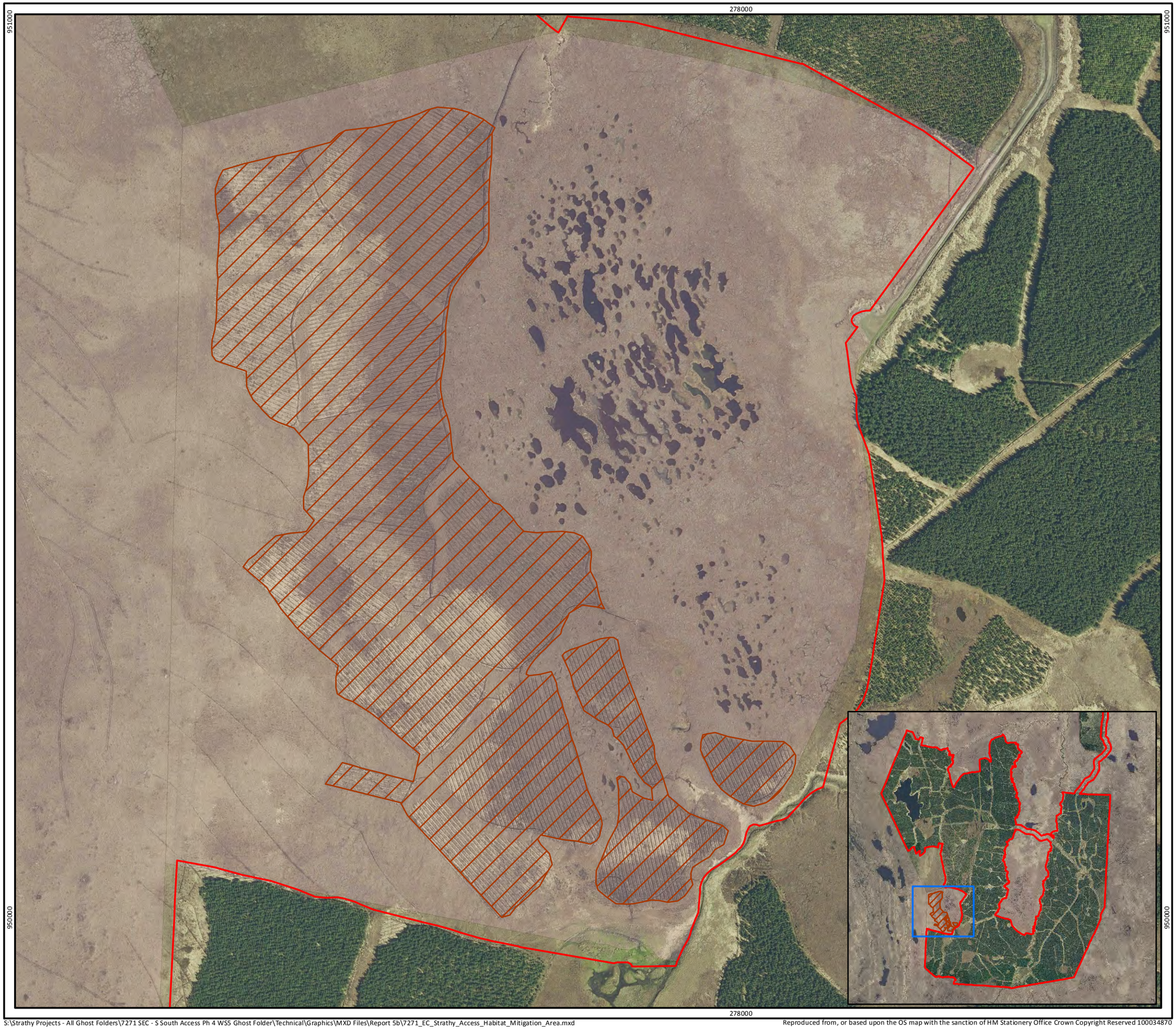
N

Figure 2d
Segment 2 Non-Qualifying Habitat and Construction Disturbance

Strathy South Wind Farm Access
Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_Access_Non_Qualifying _Habitat.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

- Site boundary
- Unplanted, ploughed areas
- Caithness and Sutherland Peatlands SPA and SAC

Scale 1:4,000 @ A3

0 25 50 100 m

N

Figure 3

Habitat Compensation Area

Strathy South Wind Farm Access Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_Access_Habitat_Mitigation_Area.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

Key

- Site boundary
- Location of potential road restoration area
- Caithness and Sutherland Peatlands SPA and SAC

Scale 1:4,000 @ A3

0 25 50 100 m

N

Figure 4
Potential Further Habitat Compensation Area

Strathy South Wind Farm Access Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_Access_Potential_Further_Mitigation_Area.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

Key

- Site boundary
- Location of potential road restoration area
- Caithness and Sutherland Peatlands SPA and SAC

Scale 1:4,000 @ A3

0 25 50 100 m

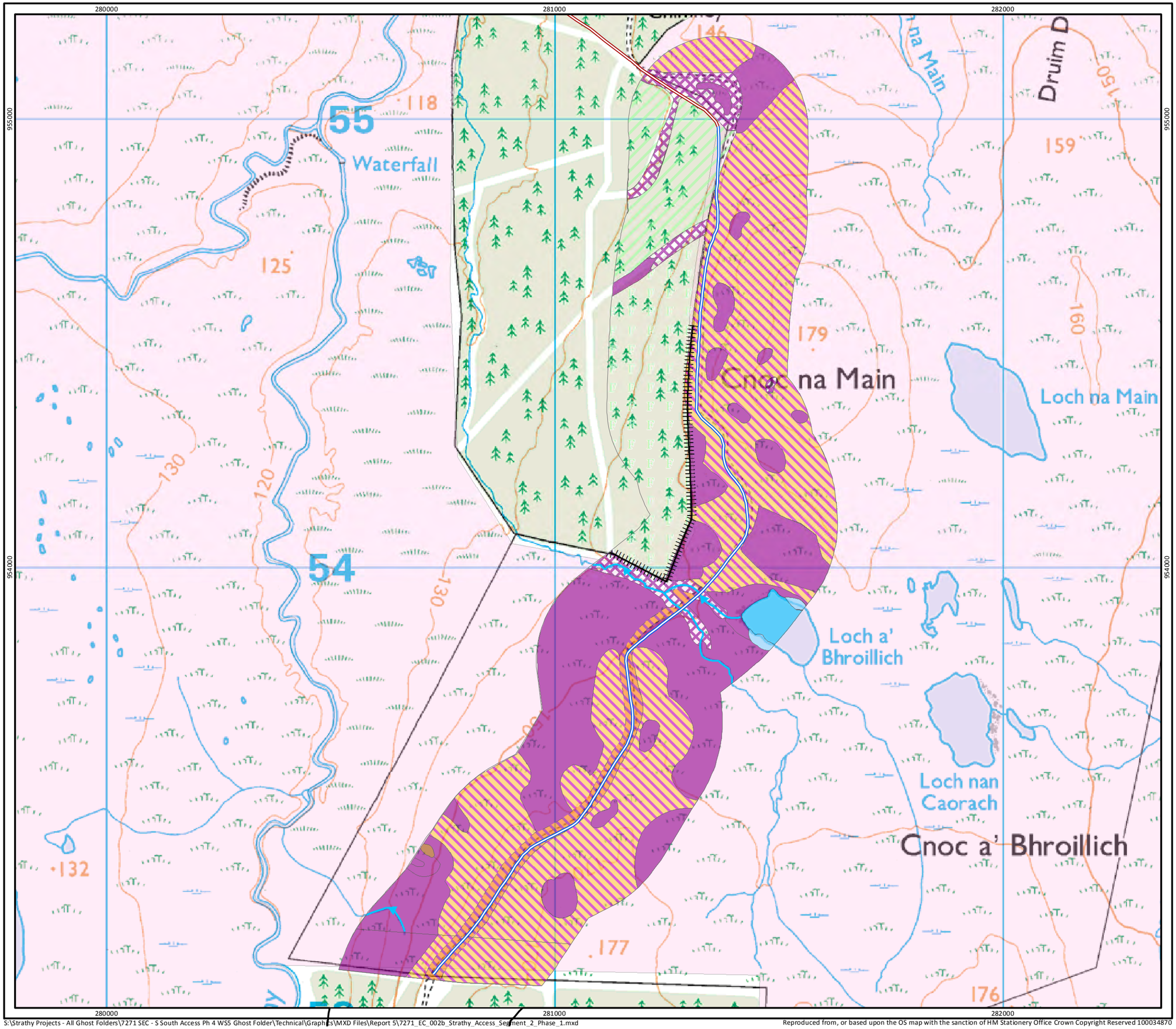
N

Figure 4
Potential Further Habitat Compensation Area

Strathy South Wind Farm Access Report 5b

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5b\7271_EC_Strathy_Access_Potential_Further_Mitigation_Area.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC
- Running water
- Fence
- Coniferous woodland - plantation
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Blanket sphagnum bog
- Wet modified bog
- Flush and spring - acid/neutral flush
- Swamp
- Standing water

Scale 1:8,000 @ A3

0 65 130 260 m

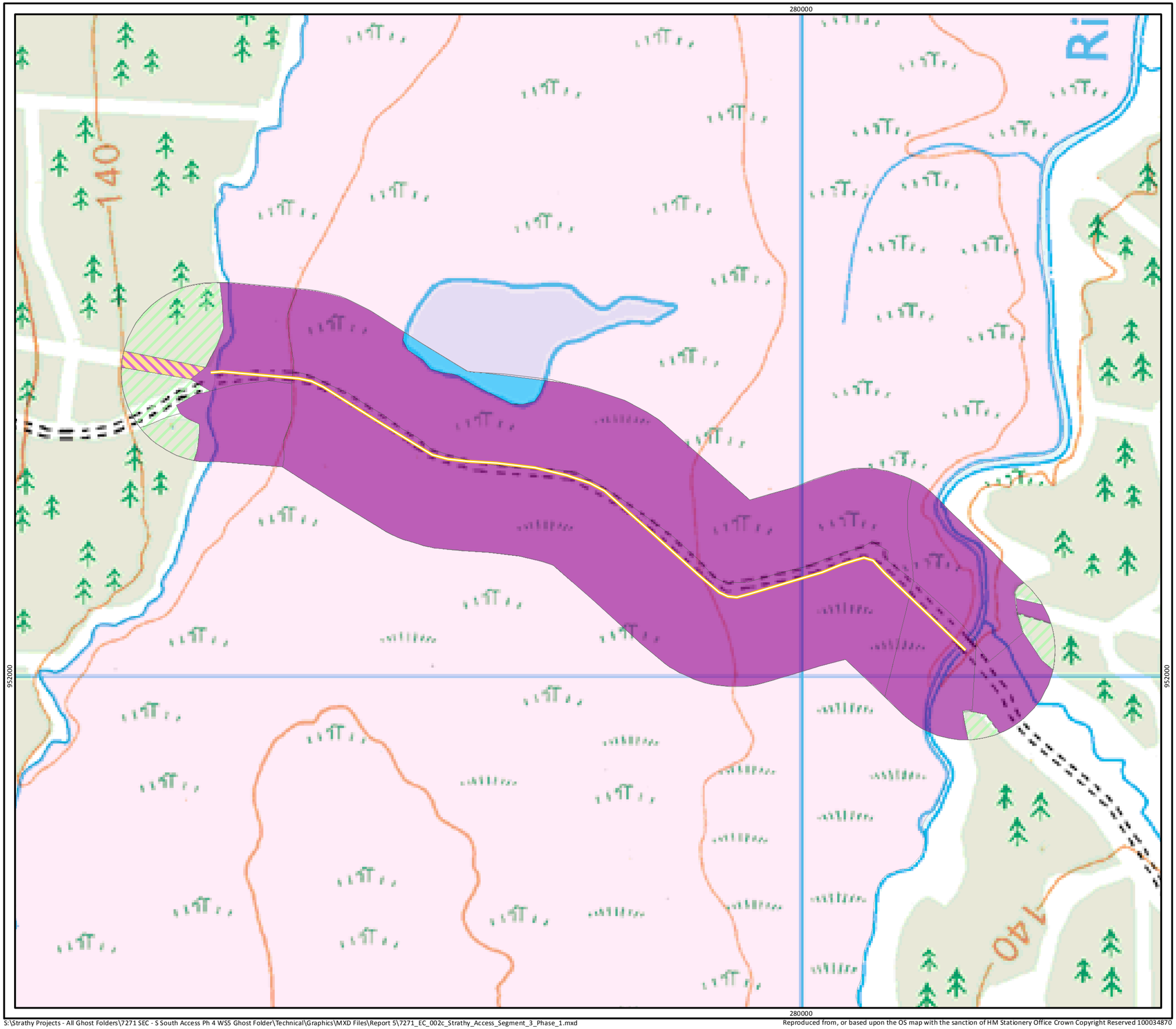
N

Figure 2b
Phase 1 Results
Access Route Segment 2

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_002b_Strathy_Access_Segment_2_Phase_1.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC
- Running water
- Fence
- Coniferous woodland - plantation
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Blanket sphagnum bog
- Wet modified bog
- Flush and spring - acid/neutral flush
- Fen - valley mire
- Standing water

Scale 1:4,000 @ A3

0 40 80 160 m

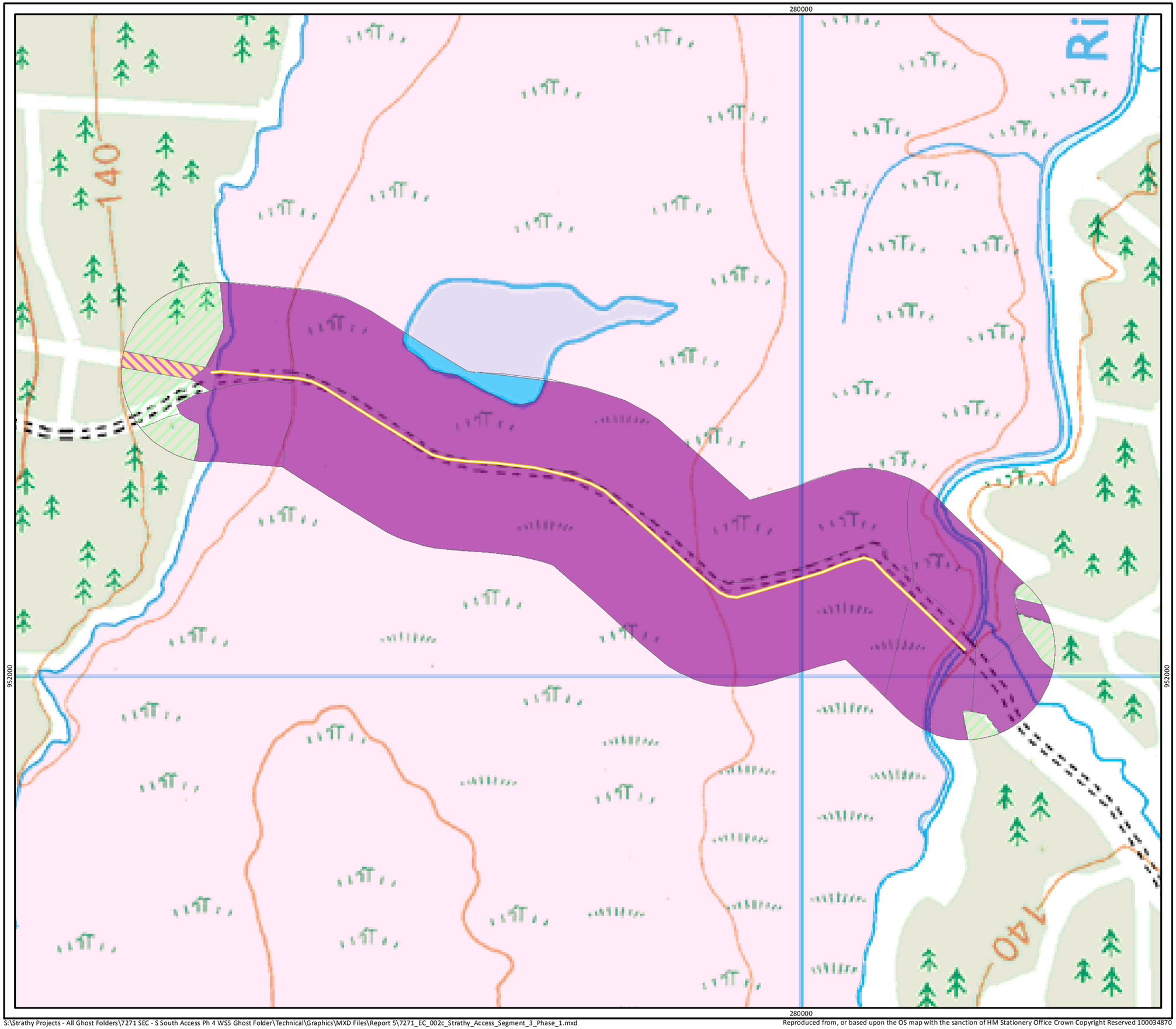
N

Figure 2c
Phase 1 Results
Access Route Segment 3

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_002c_Strathy_Access_Segment_3_Phase_1.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC
- Running water
- Fence
- Coniferous woodland - plantation
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Blanket sphagnum bog
- Wet modified bog
- Flush and spring - acid/neutral flush
- Fen - valley mire
- Standing water

Scale 1:4,000 @ A3

0 40 80 160 m

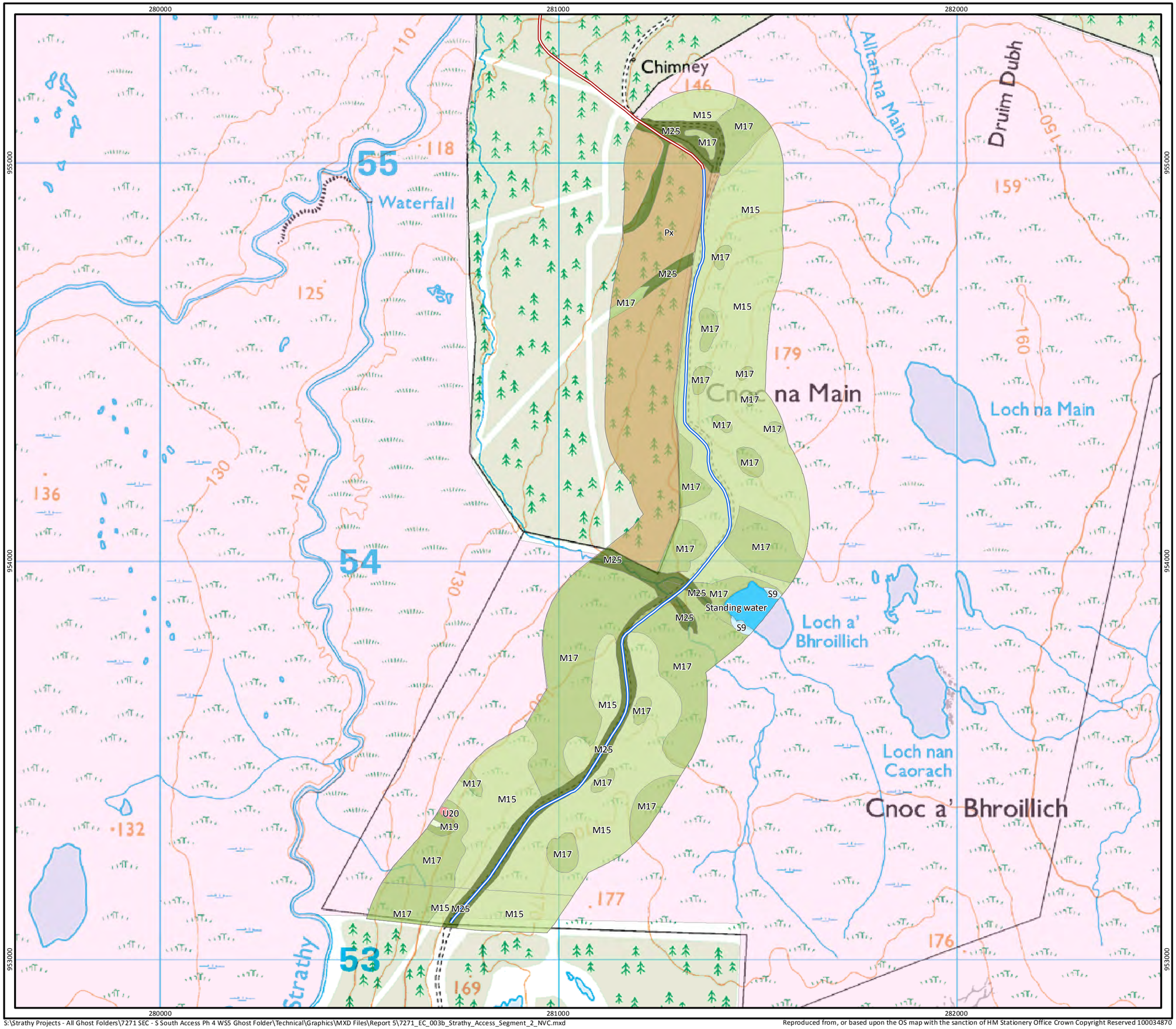
N

Figure 2c
Phase 1 Results
Access Route Segment 3

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_002c_Strathy_Access_Segment_3_Phase_1.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC

NVC habitats

- M4
- M15
- M17
- M19
- M25
- MG9
- S9
- U20
- Coniferous woodland
- Standing water

Scale 1:9,000 @ A3

0 75 150 300 m

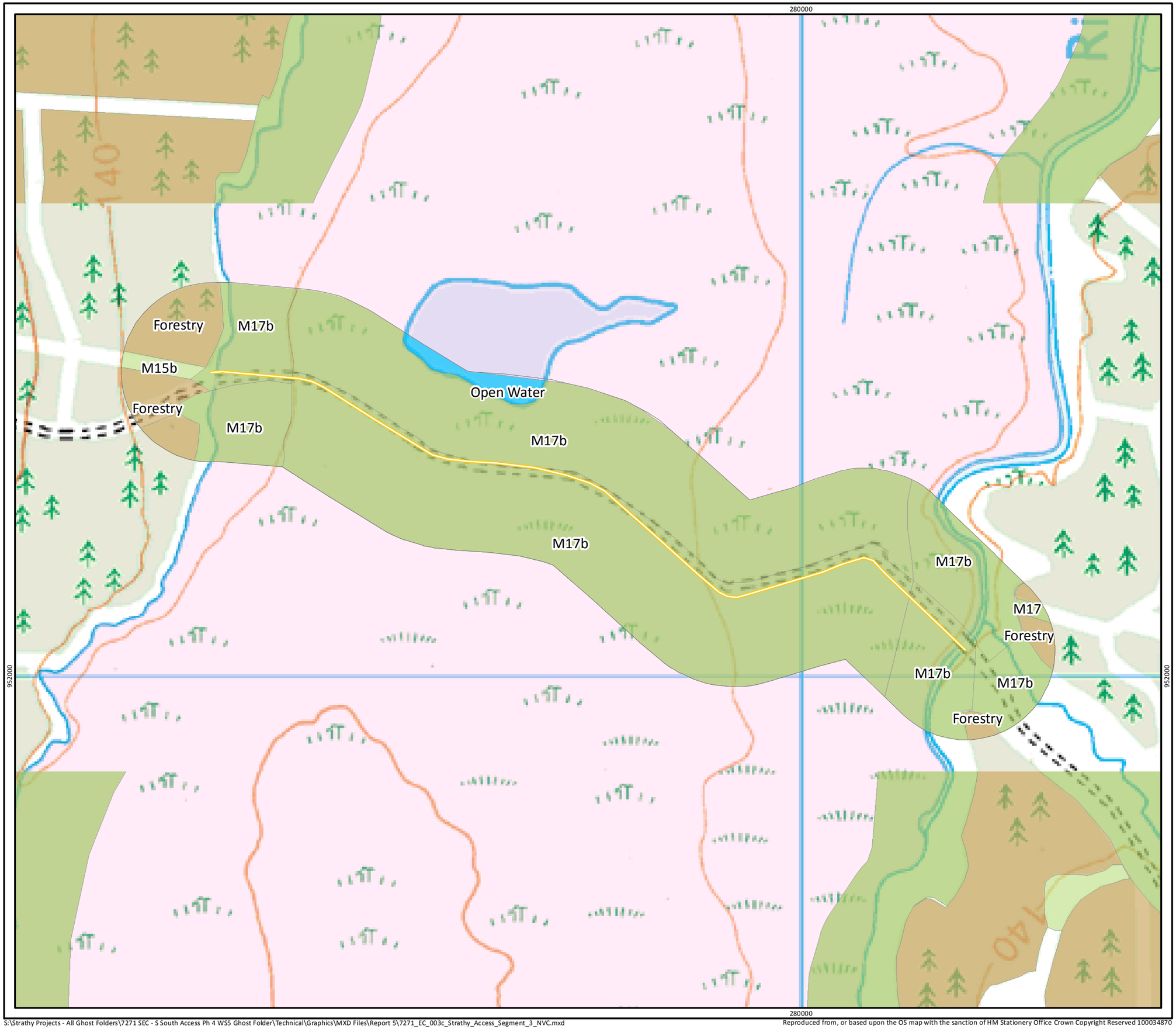
N

Figure 3b
NVC Results
Access Route Segment 2

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WSS Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_003b_Strathy_Access_Segment_2_NVC.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC

NVC habitats

- M4
- M15
- M17
- M19
- M25
- MG9
- S9
- U20
- Coniferous woodland
- Standing water

N

Scale 1:4,000 @ A3

0 40 80 160 m

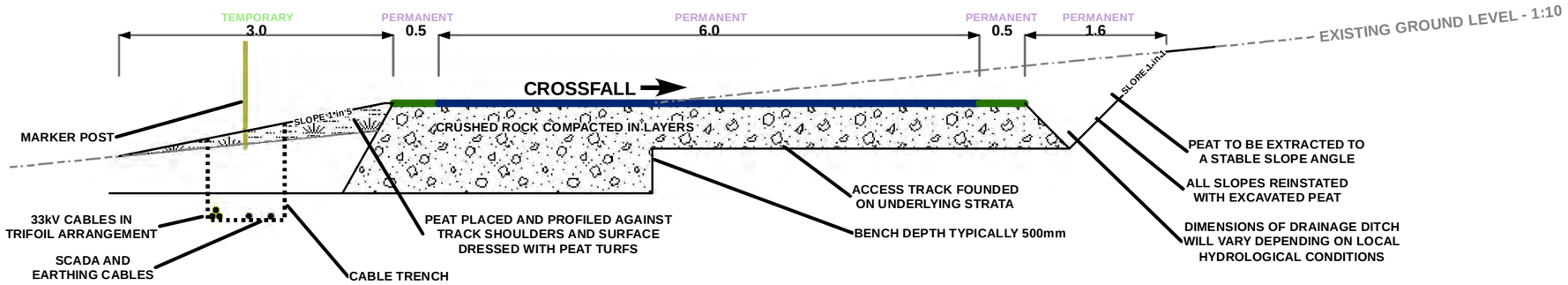
Figure 3c
NVC Results
Access Route Segment 3

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_003c_Strathy_Access_Segment_3_NVC.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

TYPICAL CUT ROAD



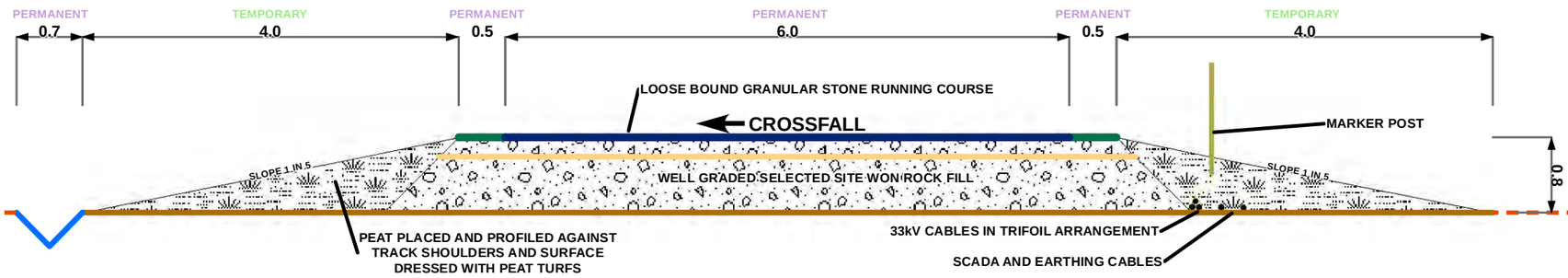
Scale 1:60

Running Surface - Wearing Course 150mm

Verge

0 1 2 3 Metres

TYPICAL FLOATING ROAD



Scale 1:60

Running Surface - Wearing Course 150mm

Verge

Drainage

Upper Layer of Geotextile

Lower Layer of Geotextile Anchored to Existing Ground Surface

Original Ground Line

0 1 2 3 Metres

Notes:

All dimensions in metres (accuracy 0.1m)

Depth of Construction of access tracks shown as typical depth. Actual depth to be finalised following detailed ground investigation

Cable arrangements shown for a single array

Figure *

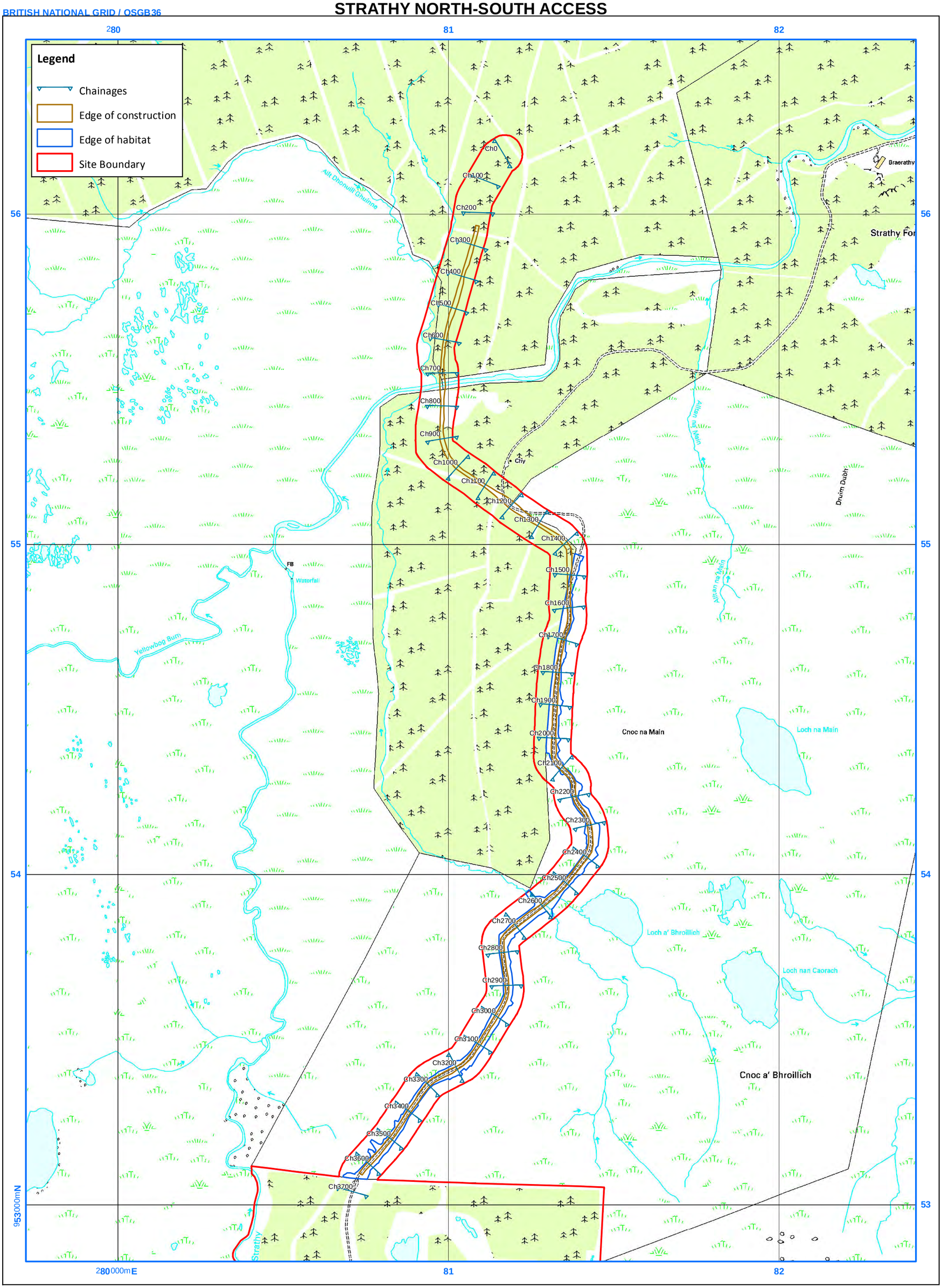
TYPICAL ACCESS TRACKS

Strathy South Wind Farm

STRATHY_009_Typical Access Tracks

BRITISH NATIONAL GRID / OSGB36

STRATHY NORTH-SOUTH ACCESS



Reproduced by permission of Ordnance Survey on behalf of HMSO.
© Crown copyright 2013. All rights reserved.
Ordnance Survey Licence number 100034870.

1:10,000 @ A3

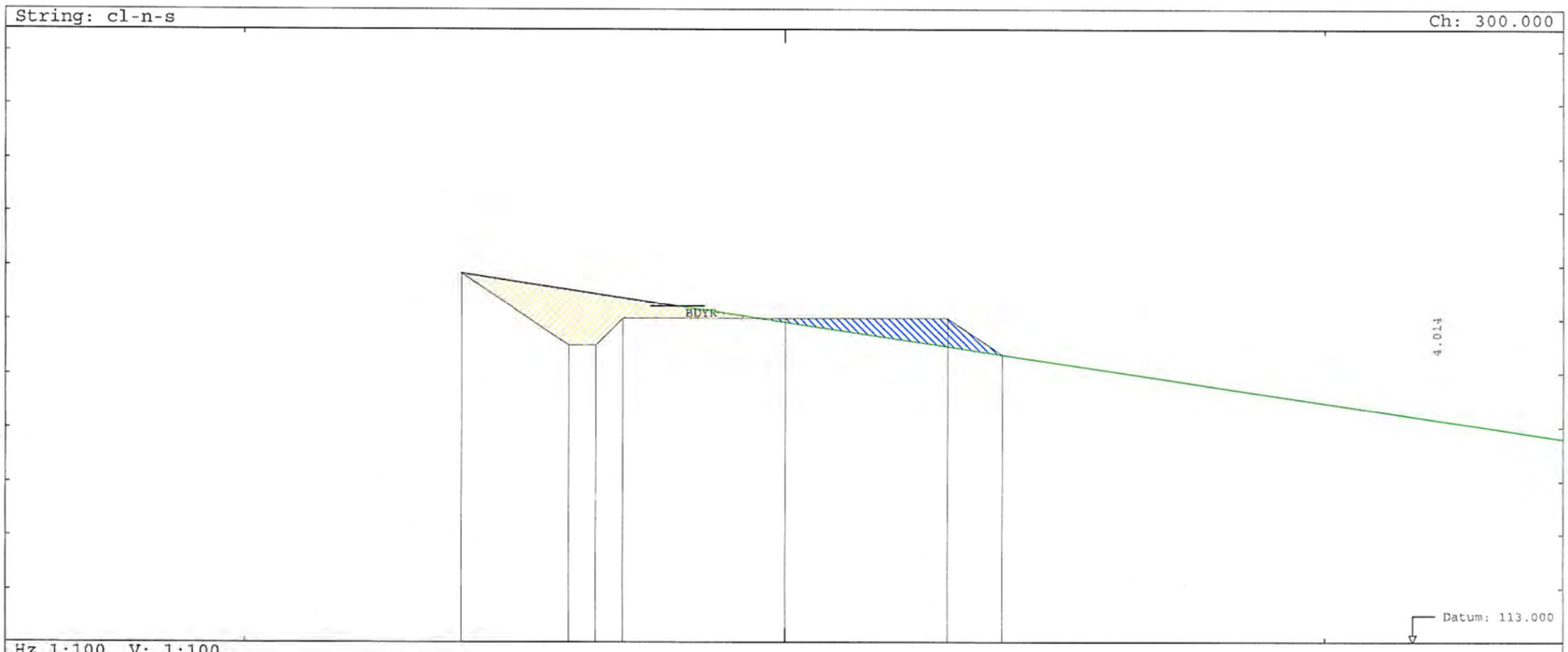
0 200 400 600 800 1,000 Meters

N

Produced by L Mills
SSE Renewables Developments (UK) Ltd
Dated: 01 Feb 13
Task No: STRATHY S_013_North South Access

String: cl-n-s

Ch: 300.000



Hz 1:100 V: 1:100

Finished Road Lev	119.854	118.525	118.525	119.024	119.025	119.025	119.025	119.025	119.025	118.349	
Original Ground L					119.252						
2											
OFFSET	-5.993	-4.000	-3.500	-3.001	-1.990	0.000		3.000		4.014	

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

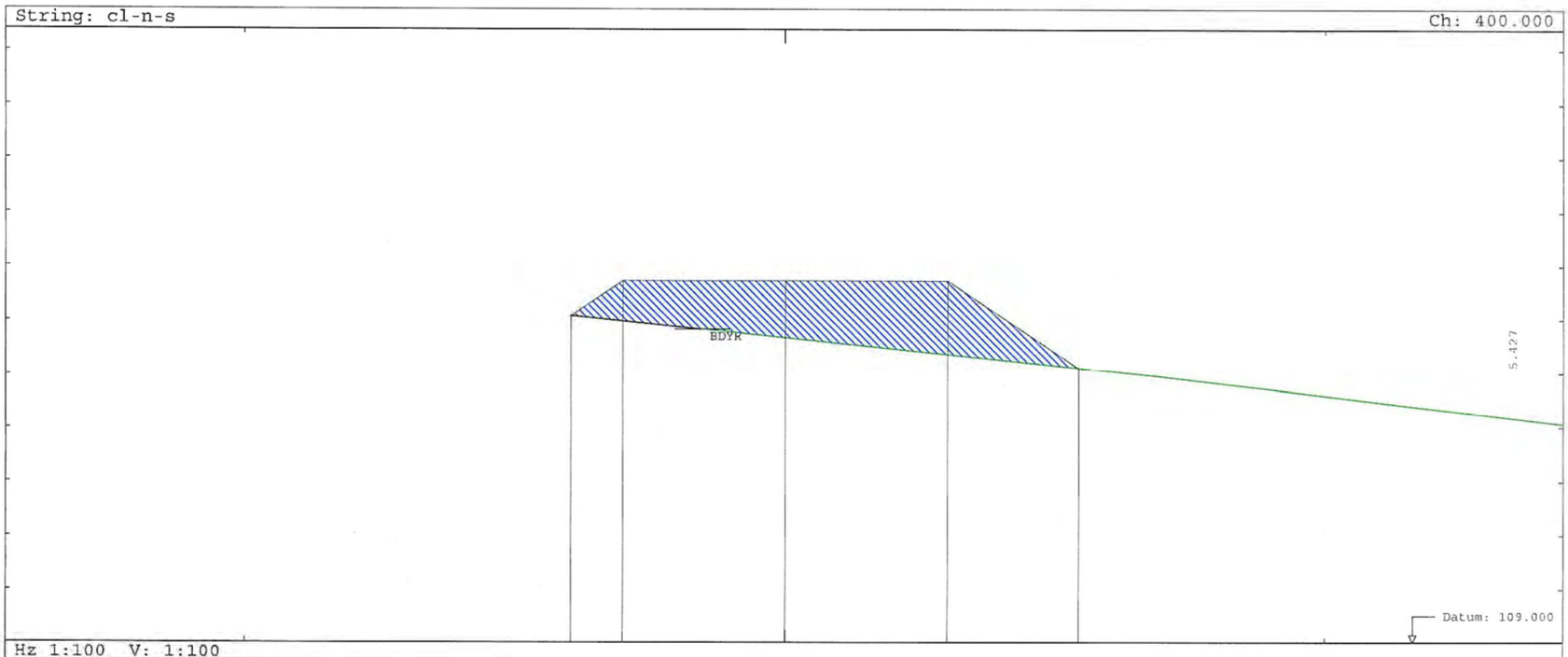
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 400.000



Hz 1:100 V: 1:100

Finished Road Lev	115.083	115.725	115.725	115.725	115.725	115.725	115.725	114.107			
Original Ground L				114.831					113.954		113.500
2											
OFFSET	-3.964	-3.001		-1.538	0.000		3.000	5.427	6.899		10.693

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

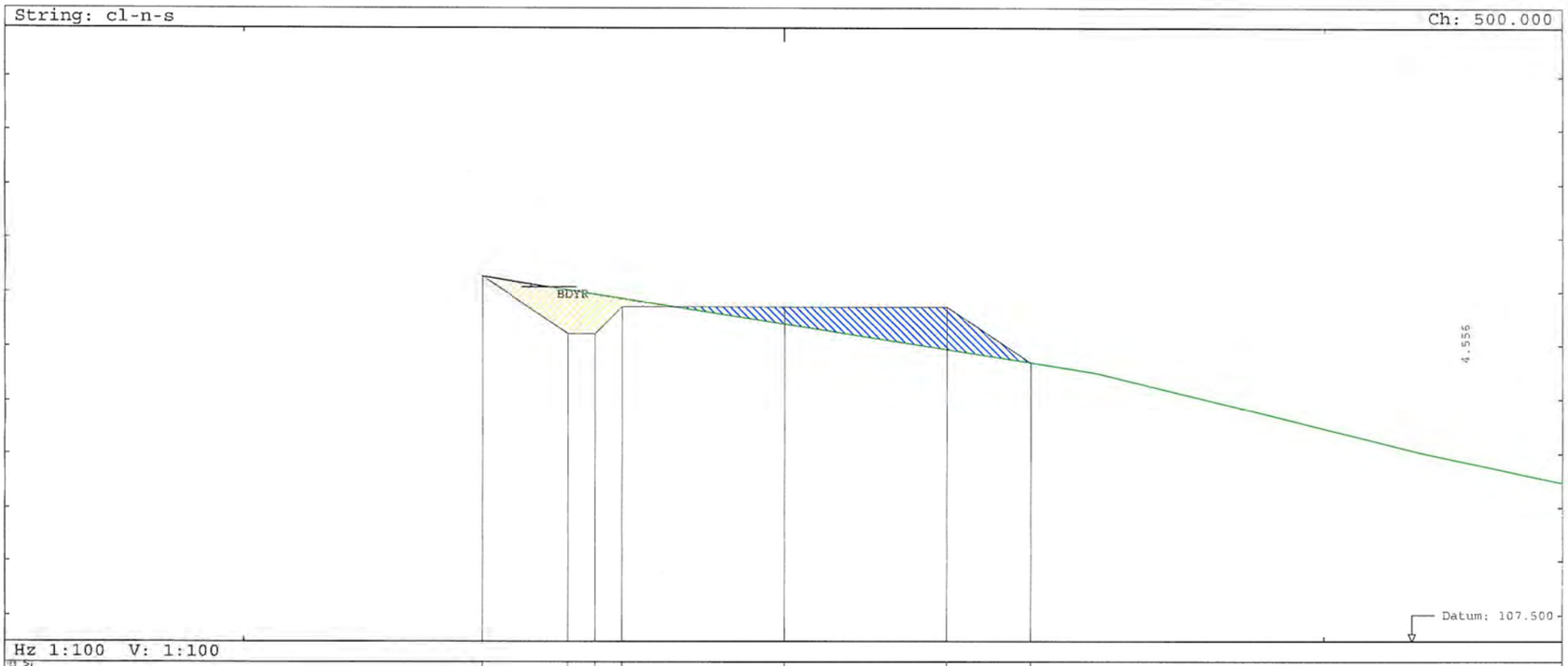
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 500.000



Hz 1:100 V: 1:100

Finished Road Lev	114.287	113.225	113.225	113.724	113.725	113.725	113.725	113.725	113.725	112.688							
Original Ground L		114.091									112.495	112.000	111.500	111.000	110.990	110.500	
2																	
OFFSET	-5.593	-4.350	-4.000	-3.500	-3.001	0.000	3.000	4.556	5.780	7.790	9.819	11.848	11.899	14.186			

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

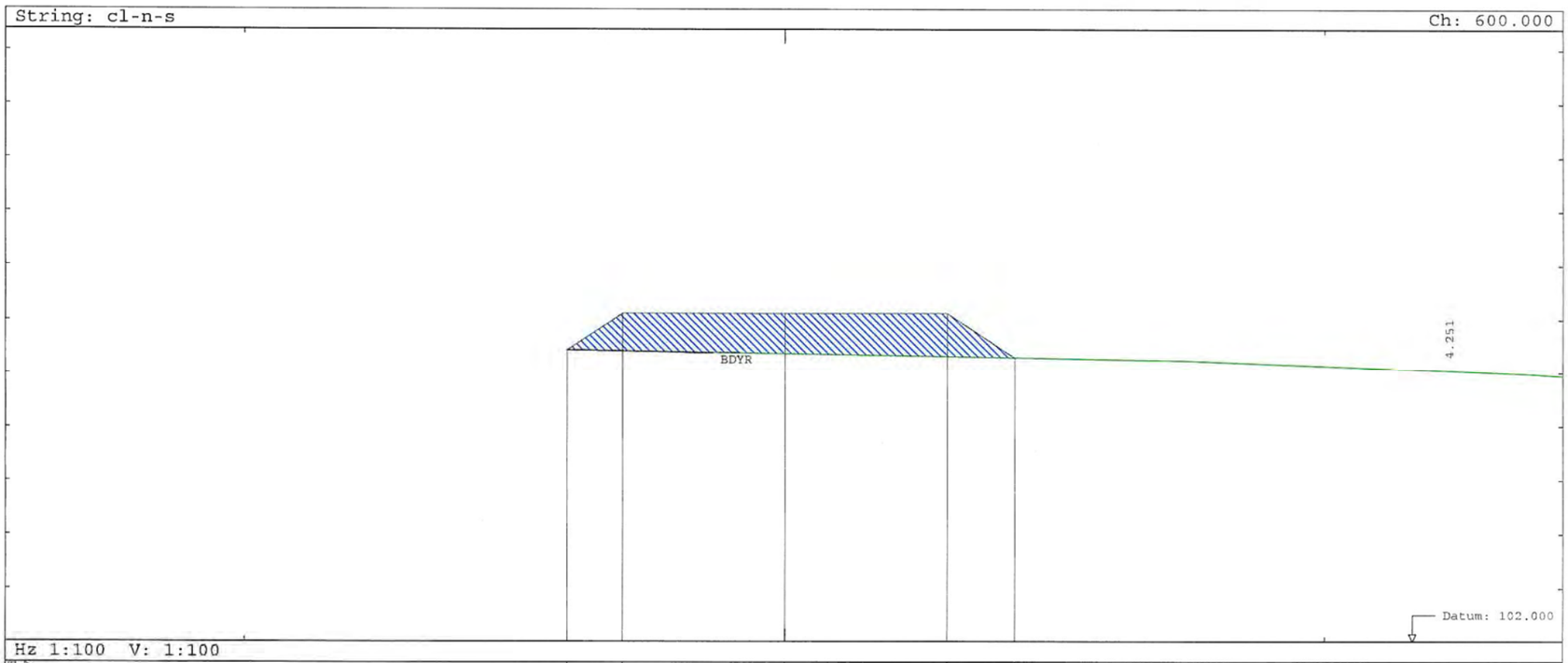
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 600.000



Hz 1:100 V: 1:100

Finished Road Lev	107.442	108.125	108.125	108.125	108.125	108.125	108.125	107.291	
Original Ground L			107.393				107.231	107.000	106.975
2									
OFFSET	-4.024	-3.001	-1.337	0.000	3.000	4.251	7.510	13.157	13.778

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

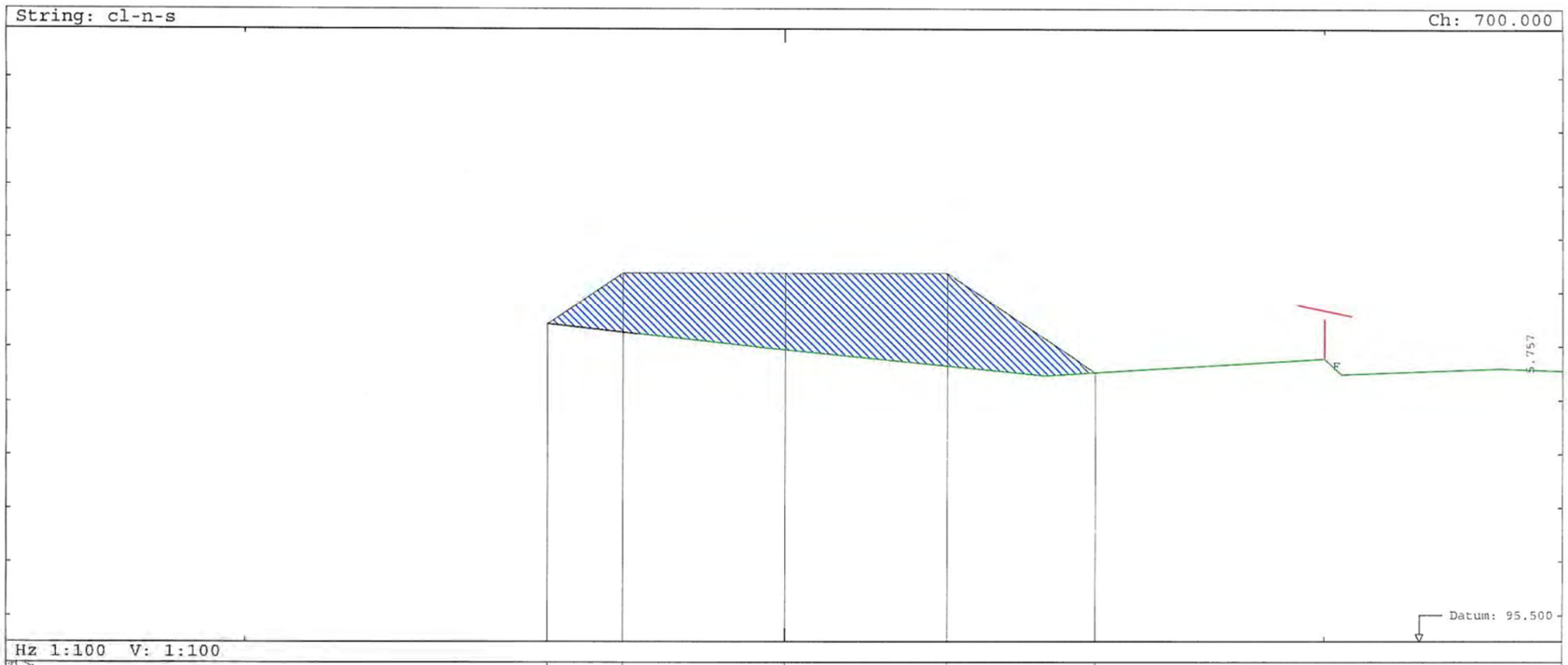
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 700.000



Hz 1:100 V: 1:100

Finished Road Lev	101.420	102.350	102.350	102.350	102.350	102.350	102.350	100.512										
Original Ground L		101.235	101.000	100.969		100.500	100.454	100.500		100.769	100.500	100.475	100.500	100.584				
2																		
OFFSET	-4.395	-3.001	-2.739	-0.633	-0.357	0.000	3.000	4.347	4.807	5.563	5.757	10.002	10.286	10.313	10.997	13.259		

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

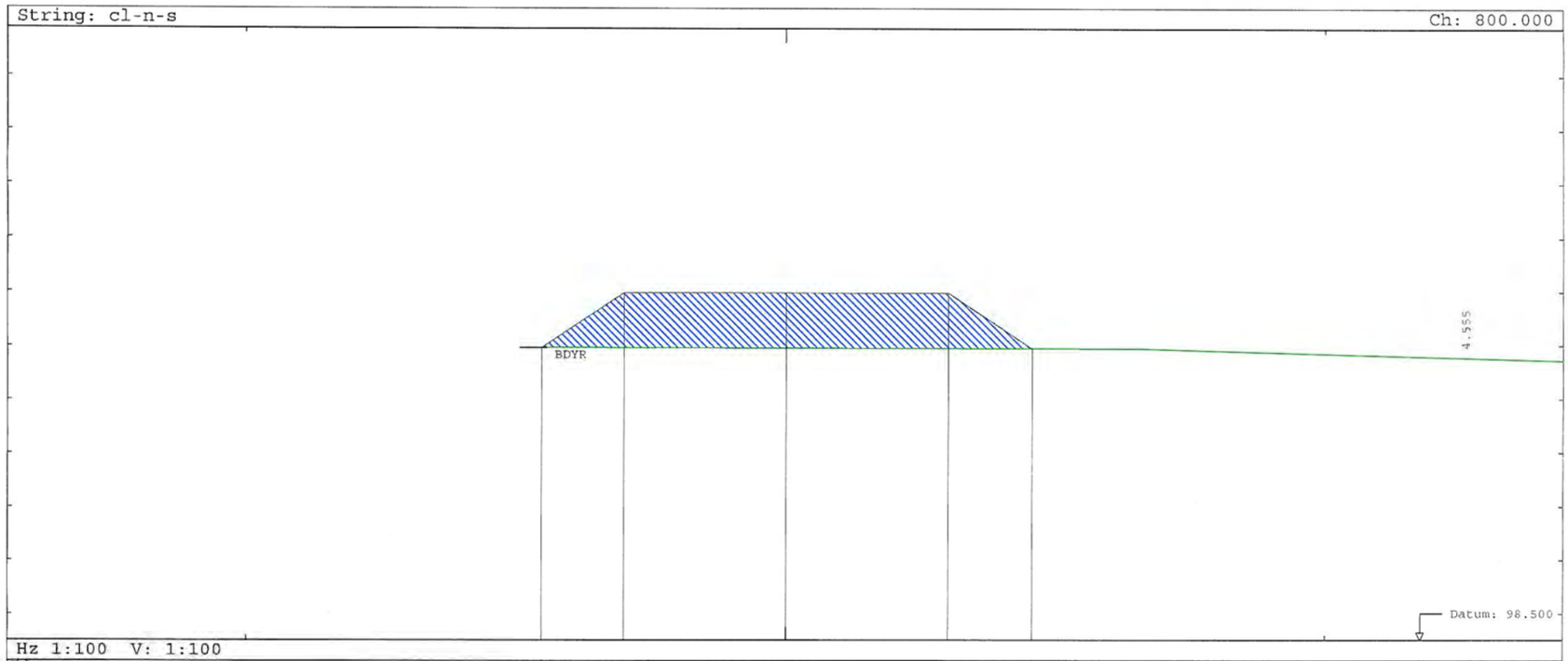
Hz:1:100. V: 1:100.

Operator NRGUser

Drawing No.

String: cl-n-s

Ch: 800.000



Hz 1:100 V: 1:100

Finished Road Lev	103.964	104.981	104.981	104.981	104.981	104.981	104.981	103.944										
Original Ground L	103.964								103.940									
2																		
OFFSET	-4.525	-4.422	-3.001	0.000	3.000	4.555	6.541											

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

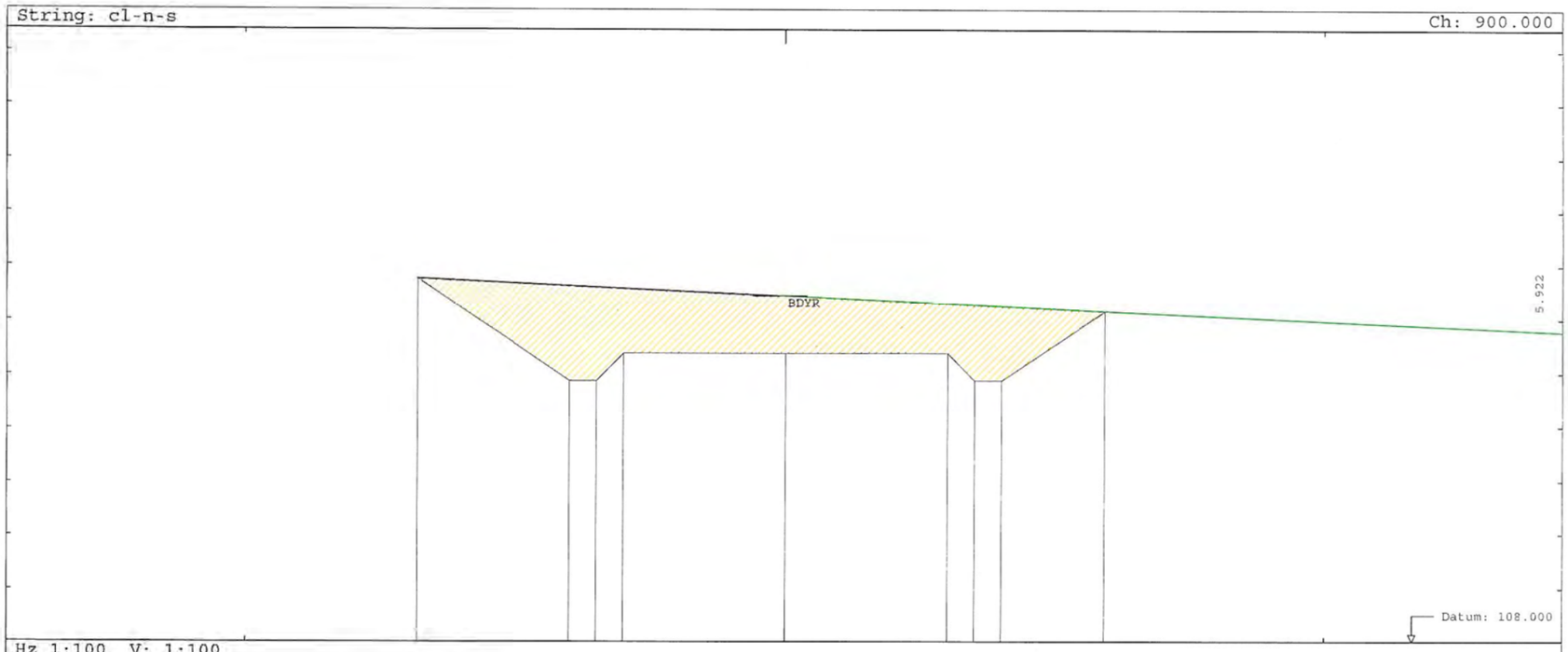
Hz:1:100. V: 1:100.

Operator NRGUser

Drawing No.

String: cl-n-s

Ch: 900.000



Hz 1:100 V: 1:100

Finished Road Lev	114.761	112.881	112.881	113.380	113.381	113.381	113.381	113.381	113.380	112.881	112.881	114.162		
Original Ground L						114.445								
2														
OFFSET	-6.819	-4.000	-3.500	-3.001		-0.102	0.000	3.000	3.500	4.000	5.922			

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

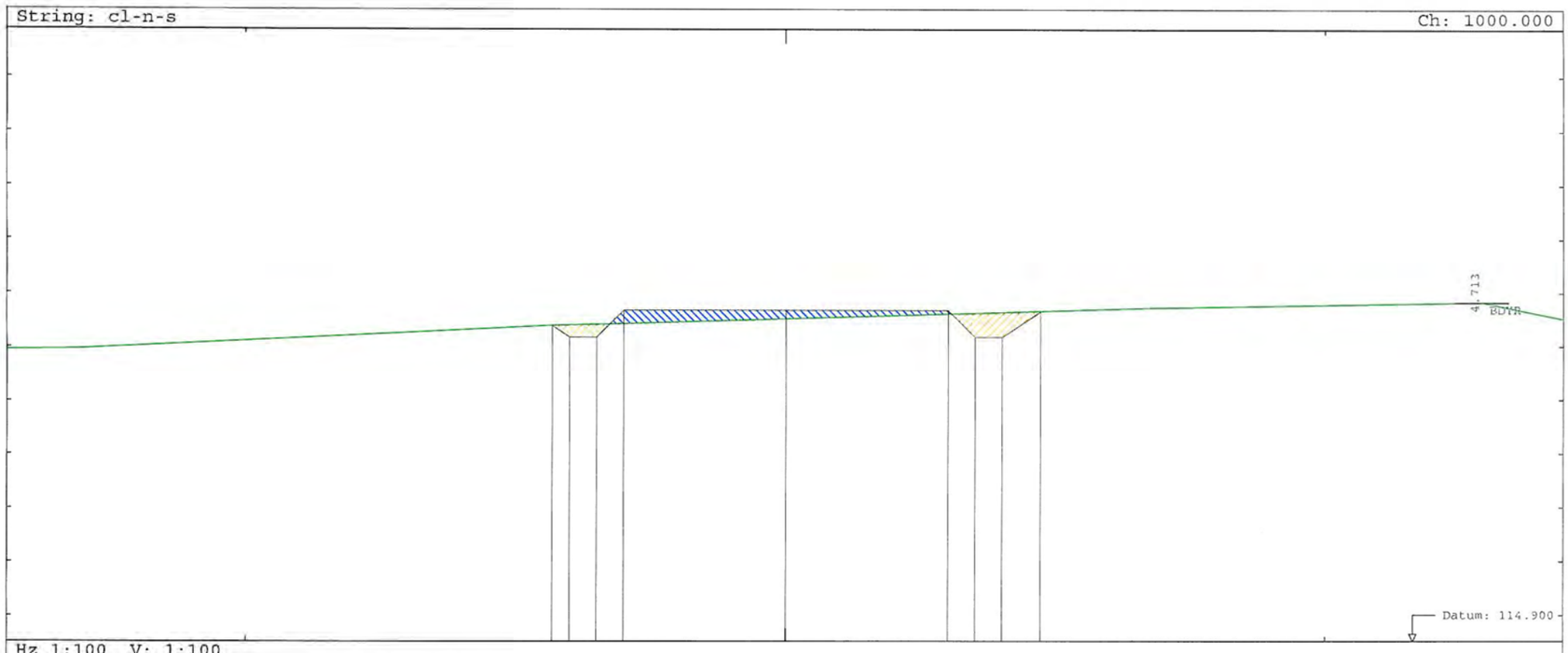
Hz:1:100. V: 1:100.

Operator NRGUser

Drawing No.

String: cl-n-s

Ch: 1000.000



Hz 1:100 V: 1:100

Finished Road Lev			119.395	119.181	119.181	119.680	119.681	119.681	119.681	119.681	119.680	119.181	119.181	119.656		
Original Ground L	118.959	119.000	119.396		119.421		119.500						119.715		119.823	
2																
OFFSET	-13.107	-12.230	-4.320	-4.292	-4.000	-3.500	-3.173	-0.513	0.000	3.000	3.500	4.000	4.713	6.681	12.899	

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

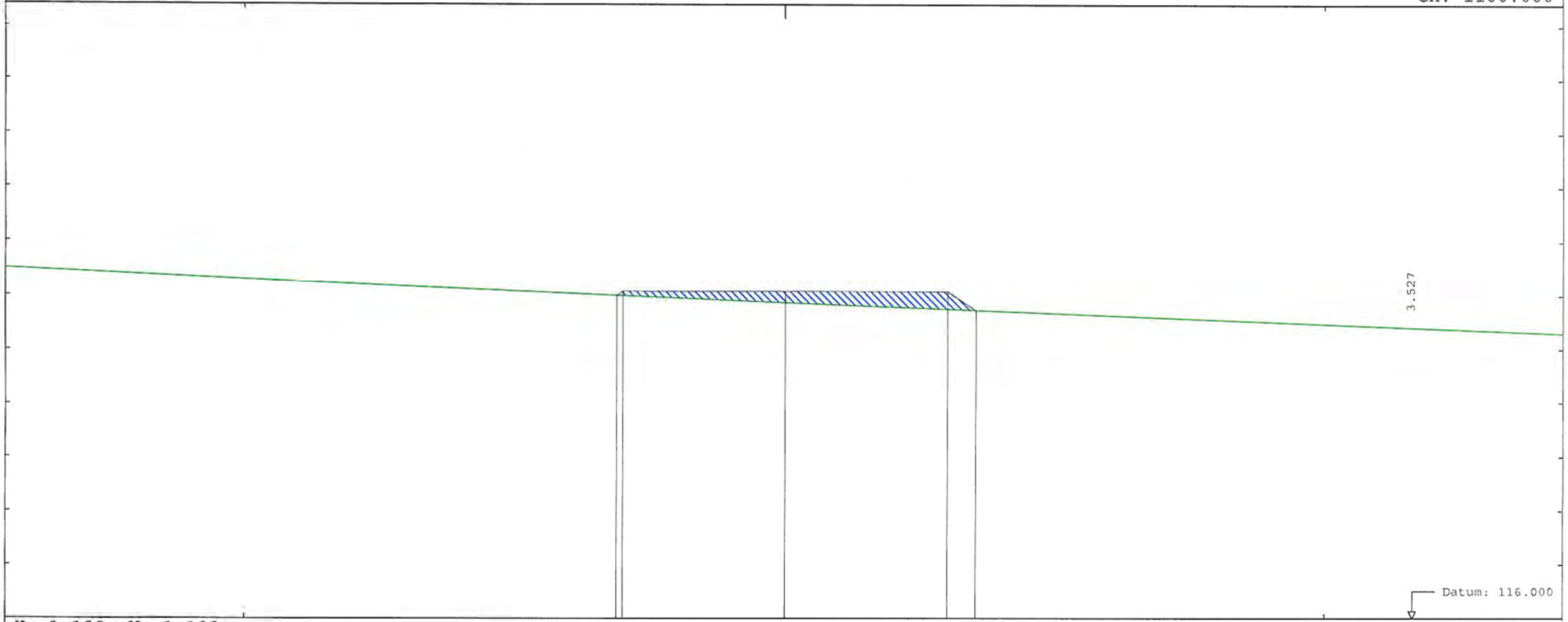
Hz:1:100. V: 1:100.

Operator NRGUser

Drawing No.

String: cl-n-s

Ch: 1100.000



Hz 1:100 V: 1:100

OFFSET	Finished Road Lev	Original Ground
-9.923		122.288
-3.117	122.003	122.000
-3.049	122.081	
0.000	122.081	
0.269	122.081	121.861
3.000	122.081	
	122.081	
3.527	121.730	
9.228		121.500
13.406		121.332

2

Notes:

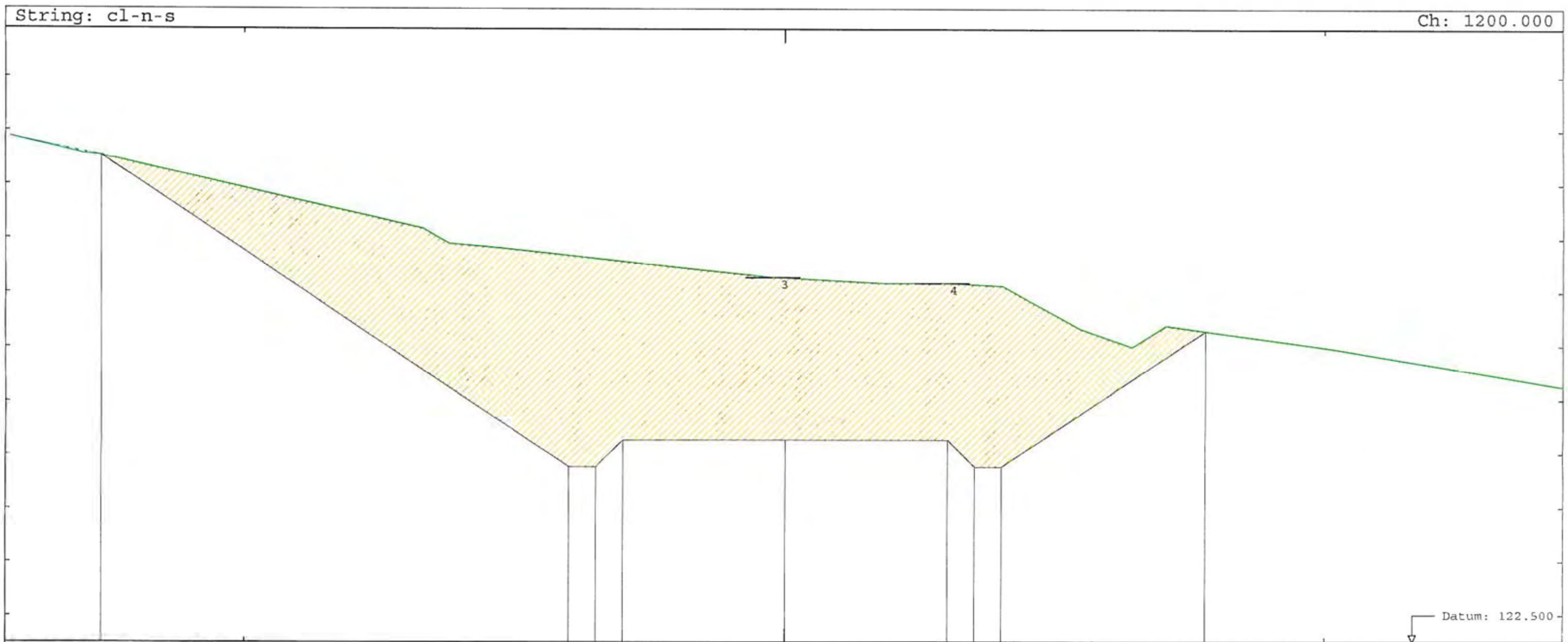
Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013
Hz:1:100. V: 1:100.
Operator NRGUser
Drawing No.

String: cl-n-s

Ch: 1200.000



Hz 1:100 V: 1:100

OFFSET	Finished Road Lev	Original Ground
-12.971		131.558
-12.648	131.532	131.529
-12.614		131.500
-10.329		131.000
-8.141		130.500
-6.702		130.171
-6.403		130.000
-6.216		129.894
-5.248		129.809
-4.000	125.767	
-3.500	125.767	
-3.001	126.266	
	126.267	
-2.320		129.500
-0.227		129.279
0.000	126.267	
	126.267	
1.820		129.171
2.899	126.267	129.173
3.000	126.266	129.161
3.500	125.767	129.119
4.000	125.767	129.000
5.152		128.500
5.448		128.338
6.391		128.000
6.424		127.988
7.052		128.389
7.781	128.287	
9.833		128.000
10.271		127.939
12.844		127.500

2

Notes:

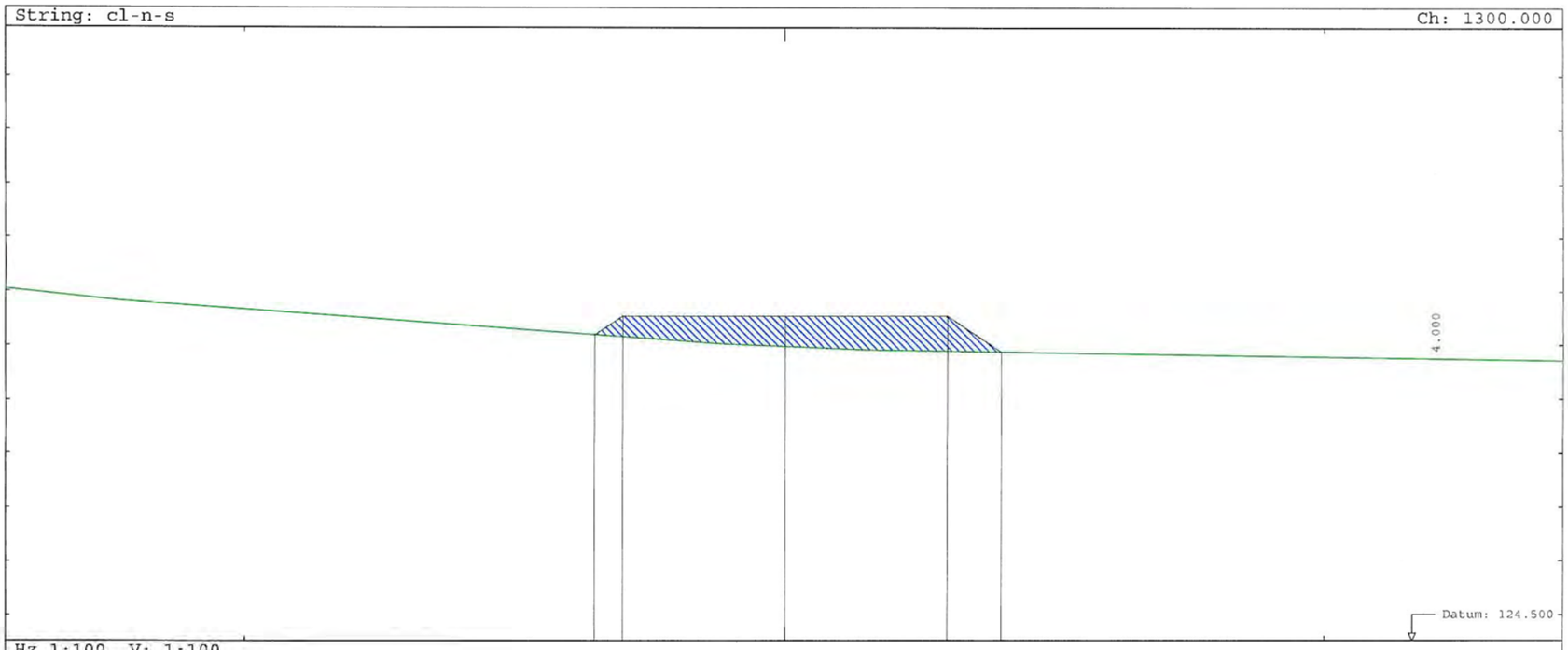
Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013
Hz:1:100. V: 1:100.
Operator NRGUser
Drawing No.

String: cl-n-s

Ch: 1300.000



Hz 1:100 V: 1:100

Finished Road Lev					130.192	130.540 130.540			130.540 130.540			130.540 130.540		129.873		
Original Ground L	110.820		110.500					130.019	130.000		129.913					
2																
OFFSET	-12.316		-7.830		-3.522	-3.001		-1.100	-0.622	0.000	1.528		3.000	4.000		

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

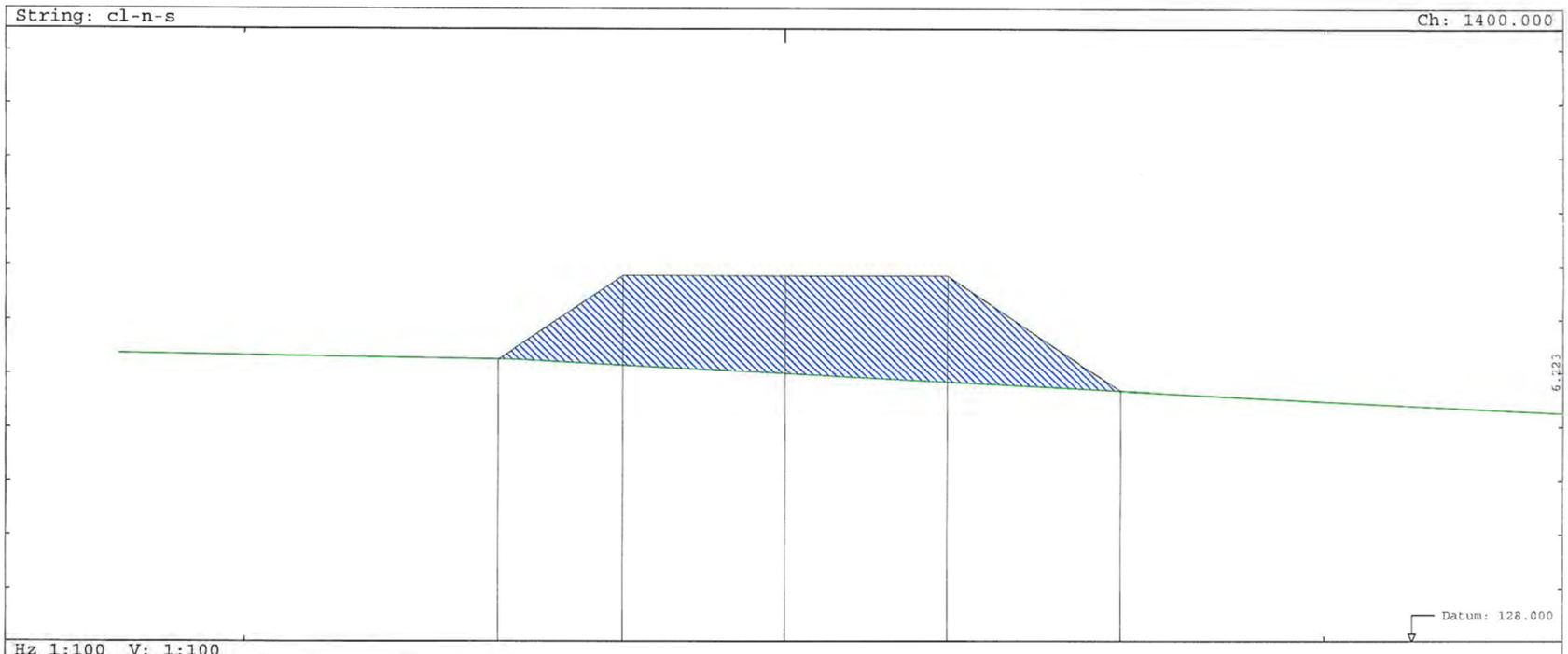
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 1400.000



Hz 1:100 V: 1:100

Finished Road Lev					133.268	134.813 134.813			134.813 134.813			134.813 134.813		132.664		
Original Ground L	133.382				133.263			133.000			132.865			132.500		132.296
2																
OFFSET	-12.332				-5.317	-4.979		-3.001		-0.177	0.000	2.289	3.000	6.223	9.431	13.116

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

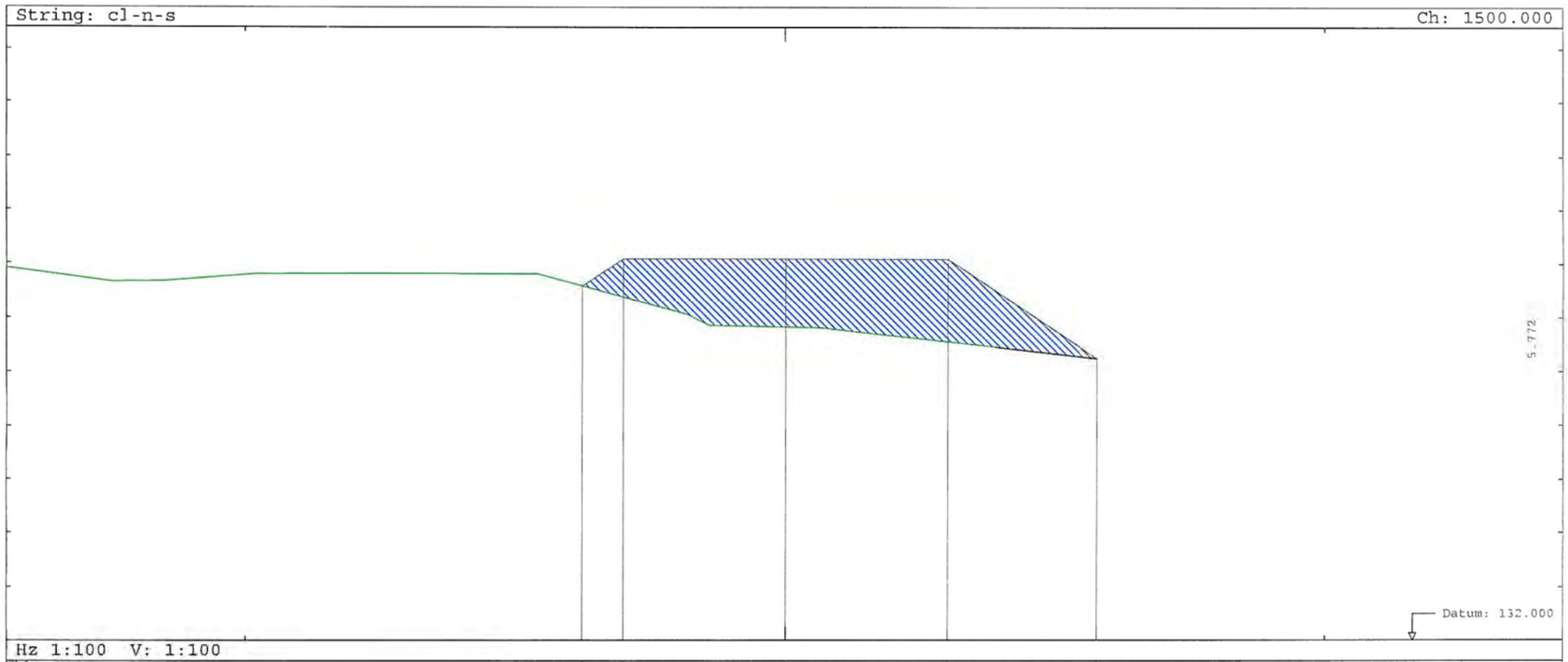
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 1500.000



Hz 1:100 V: 1:100

Finished Road Lev									138.577	139.086	139.086				139.086	139.086				139.086	139.086					137.238				
Original Ground L	138.651	138.663	138.792	138.800				138.798	138.500			138.051	138.000	137.853			137.805	137.714				137.501	137.500	137.449						
2																														
OFFSET	-12.481	-11.529	-9.810	-7.556				-4.583	-3.763	-3.475	-3.001	-1.804	-1.703	-1.414	0.000	0.662	1.460			3.000	3.426	3.893			5.772					

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

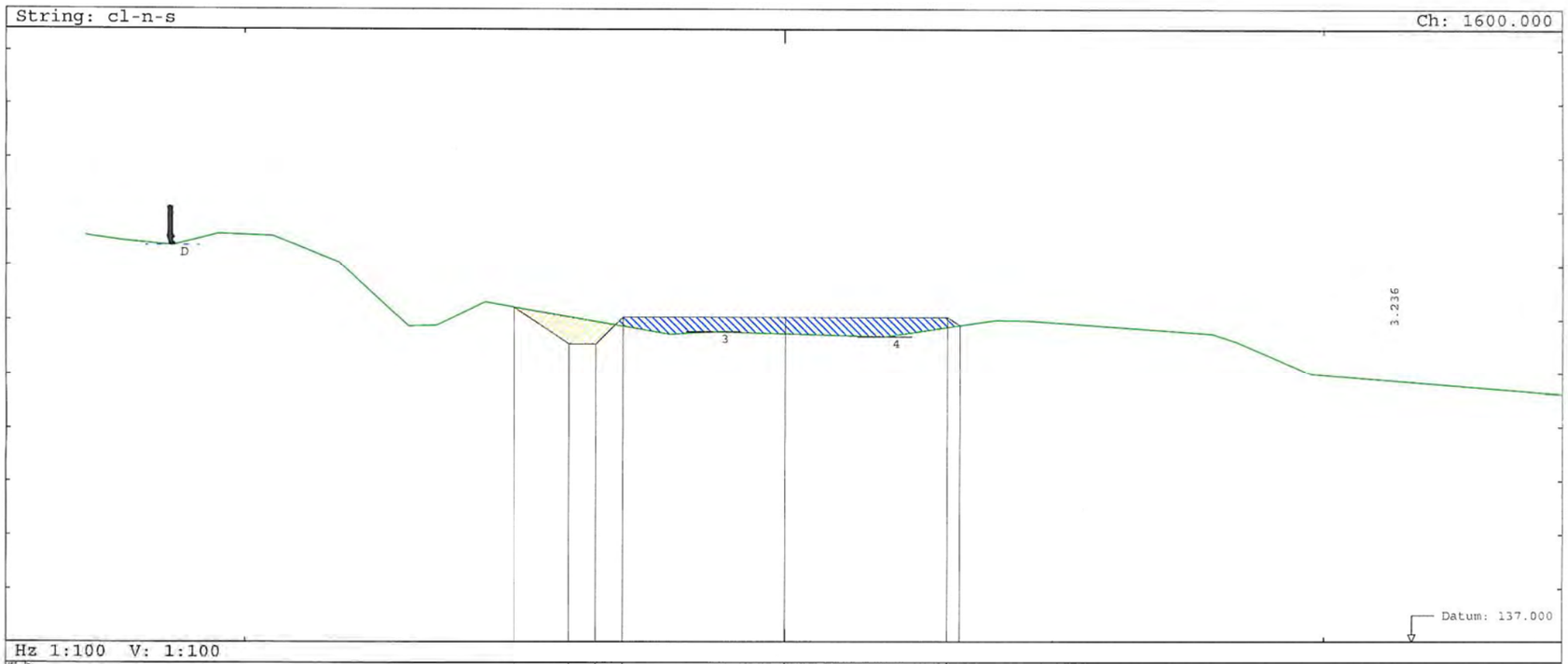
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 1600.000



Hz 1:100 V: 1:100

Finished Road Lev									143.232	142.555	142.555	143.054	143.055				143.055	143.055				143.055	143.055							
Original Ground L	144.559	144.533	144.500	144.446	144.360	144.500	144.576		144.537	144.500		144.047	144.000	143.500	143.000	142.881	142.895	143.000	143.326		143.000		142.735	142.782	142.764		142.690	142.763		142.996	142.990		142.744	142.595	142.500		142.000	141.994
2																														
OFFSET	-12.941	-12.924	-12.640	-12.243	-11.337	-10.790	-10.492		-9.484	-9.392		-8.259	-8.207	-7.656	-7.105	-6.974	-6.461	-6.242	-5.562	-5.016	-4.000	-3.667	-3.500	-3.001	-2.128	-1.323	-0.727	0.000	1.847	2.345	3.000	3.236	3.892	4.490	7.929	8.371	8.589	9.733

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:100. V: 1:100.

Operator NRGUser

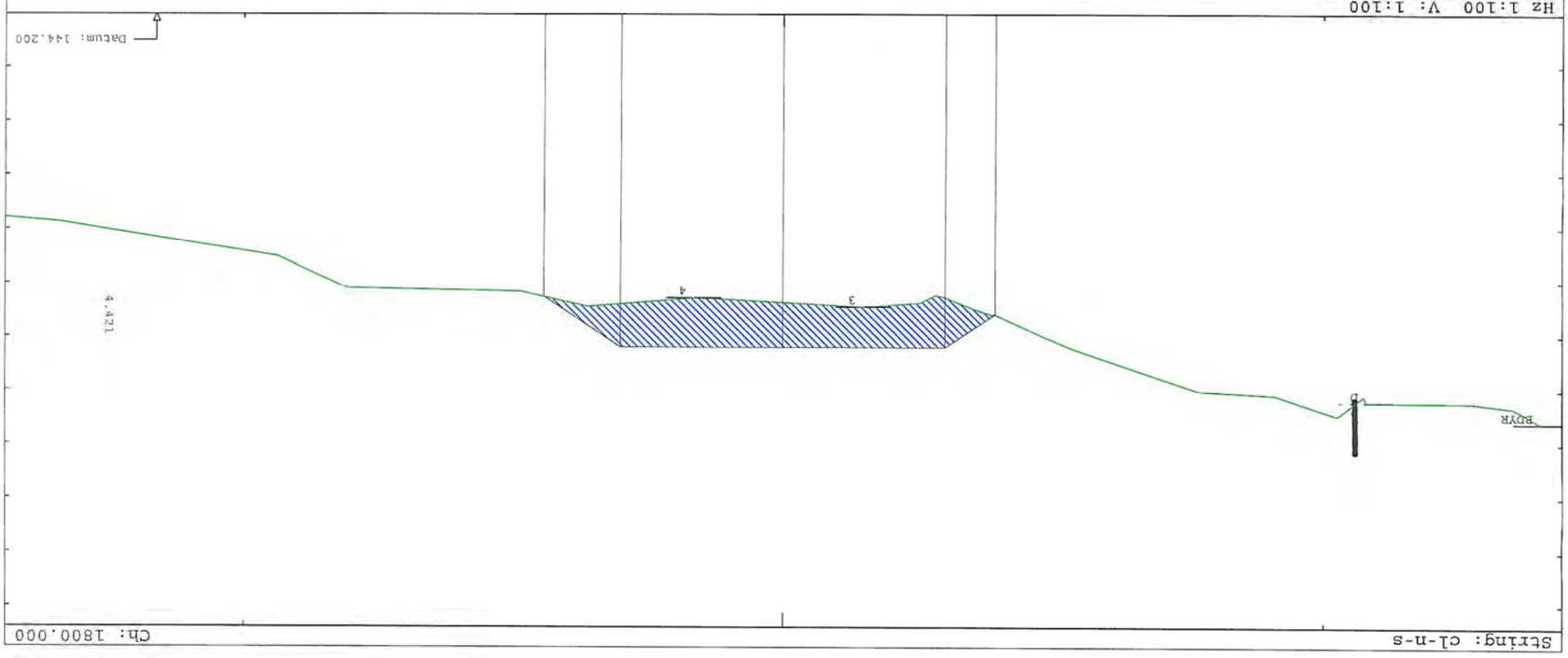
Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

Notes:

OFFSET	2	Original Ground Level	Finished Road Level
-14.018		150.500	
-13.508		150.314	
-12.747		150.220	
-10.791		150.210	
-10.743		150.100	
-10.262		150.470	
-9.097		150.083	
-7.709		150.009	
-7.682		150.000	
-6.203		149.500	
-5.363		149.216	
-4.823		149.000	
-3.923		148.581	148.590
-3.903		148.603	
-3.573		148.500	
-3.001		148.254	149.205
-2.959		148.236	149.205
-2.531		148.376	
-1.490		148.452	
0.000			149.205
1.032		148.305	
1.649		148.283	
3.000			149.205
3.607		148.441	
4.421			
4.859		148.159	148.258
8.075		148.100	
8.292		148.000	
9.359		147.507	
9.403		147.500	
12.563		147.000	
13.400		146.868	

Hz 1:100 V: 1:100



String: cl-n-s Ch: 1800.000

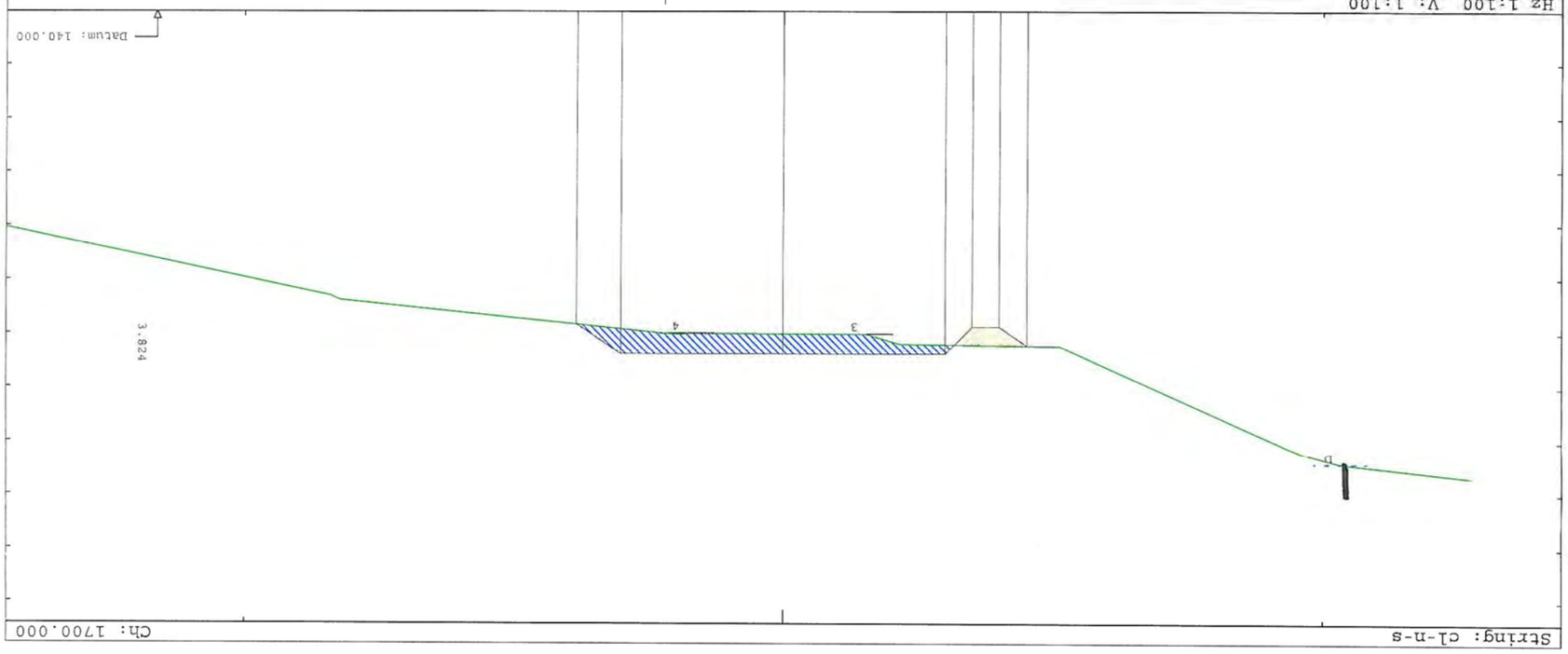
Project: strathy north wf
Date: 01/02/2013
Hz:1:100. V: 1:100.
Operator NRGUser
Drawing No.

Survey and Engineering Software
www.rgsurveys.co.uk

Notes:

OFFSET	2	Original Ground Level	Finished Road Level
-12.743		149.671	
-12.715		149.569	
-11.150		148.500	
-10.324		148.411	
-9.660		148.229	
-9.289		148.070	
-9.130		148.000	
-8.004		147.500	
-6.877		147.000	
-5.751		146.500	
-5.139		146.328	
-4.511			146.220
-4.000			145.880
-3.500			145.880
-3.001			146.379
-2.170		146.191	146.380
-1.533		146.009	
-1.355		146.008	
0.000			146.380
1.103		146.000	146.380
1.776		145.998	
1.879		146.000	
2.137		146.000	
3.000			146.380
3.824			145.830
7.066		145.500	
8.230		145.381	
8.396		145.302	
9.817		145.000	
12.172		144.500	

Hz 1:100 V: 1:100



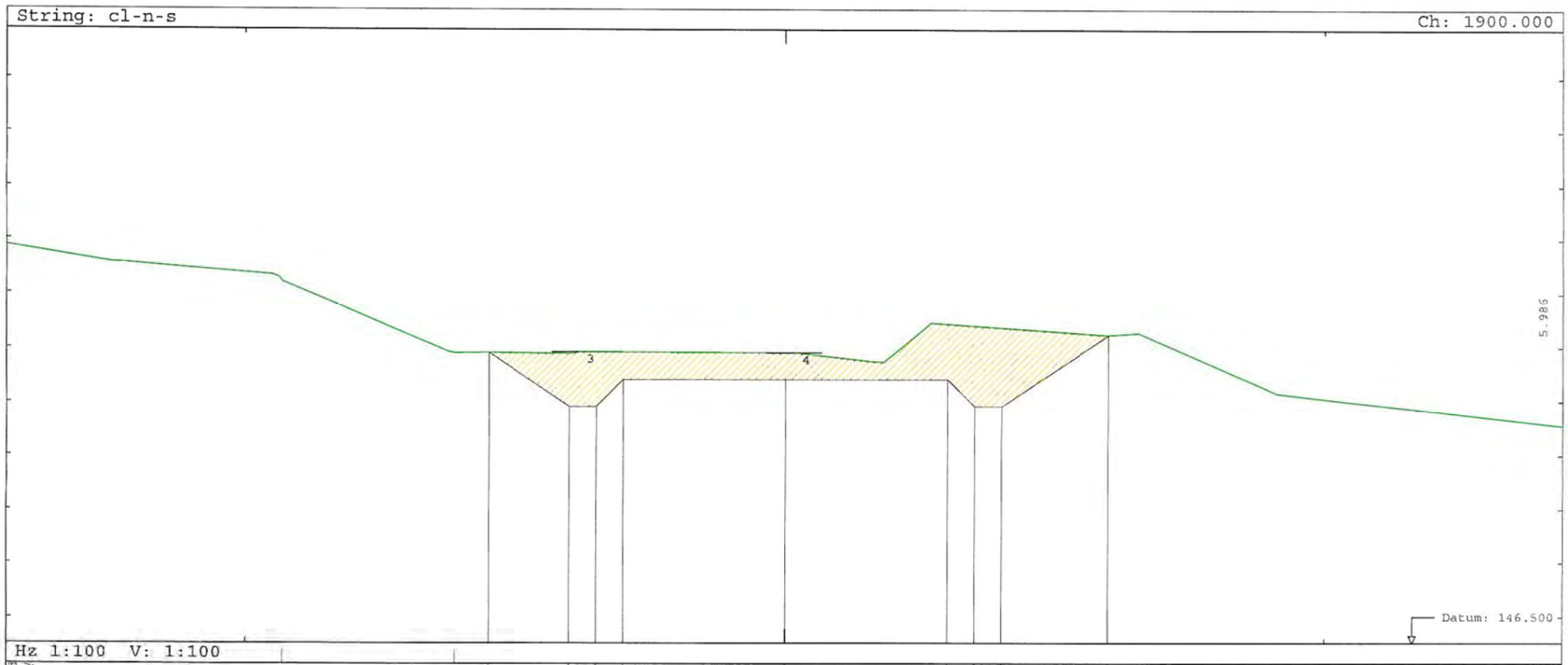
String: cl-n-s Ch: 1700.000

Project: strathy north wf
Date: 01/02/2013
Hz:1:100. V: 1:100.
Operator NRGUser
Drawing No.

Survey and Engineering Software
www.rgsurveys.co.uk

String: cl-n-s

Ch: 1900.000



Hz 1:100 V: 1:100

OFFSET	Original Ground L	Finished Road Lev
-12.471	153.564	
-12.208	153.553	
-11.563	153.500	
-9.505	153.332	
-9.387	153.288	
-8.823	153.000	
-7.631	152.500	
-6.440	152.000	
-6.229	151.912	
-5.495	151.902	151.902
-5.480		
-4.000	151.882	150.905
-3.915	151.917	150.905
-3.500	151.917	151.404
-3.001		151.405
0.000	151.898	151.405
0.171		151.405
1.606	151.737	
1.817	151.724	
2.149	152.000	
2.692	152.453	
3.000		151.405
3.500		151.404
4.000		150.905
5.983	152.229	152.229
6.553	152.269	
6.853	152.133	
7.155	152.000	
8.293	151.500	
9.113	151.140	
10.341	151.000	

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

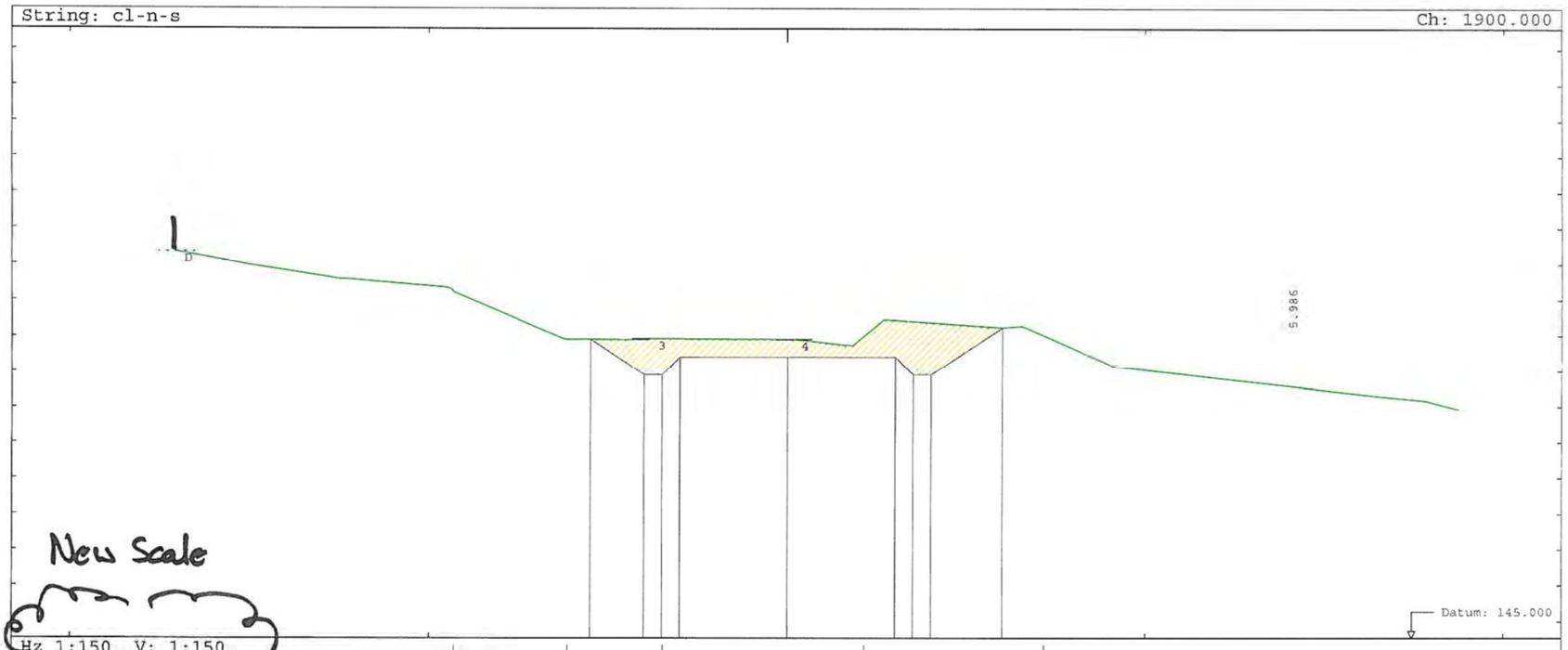
Hz:1:100. V: 1:100.

Operator NRGUser

Drawing No.

String: cl-n-s

Ch: 1900.000



New Scale

Hz 1:150 V: 1:150

OFFSET	Original Ground L	Finished Road Lev
-17.032	154.329	
-15.237	154.000	
-15.004	153.957	
-12.471	153.564	
-12.208	153.553	
-11.563	153.500	
-9.505	153.332	
-9.387	153.288	
-8.823	153.000	
-7.631	152.500	
-6.440	152.000	
-6.229	151.912	
-5.495	151.902	151.902
-4.000	151.882	150.905
-3.916	151.917	150.905
-3.500		151.404
-3.001		151.405
0.000	151.898	151.405
0.171		151.405
1.606	151.737	
1.817	151.724	
2.692	152.453	
3.000		151.405
3.500		151.404
4.000		150.905
5.983	152.229	152.229
6.553	152.269	
6.853	152.133	
8.293	151.500	
9.113	151.140	
10.341	151.000	
14.729	150.500	
16.512	150.297	
17.822	150.170	
18.452	150.000	
18.739	149.923	

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V: 1:150.

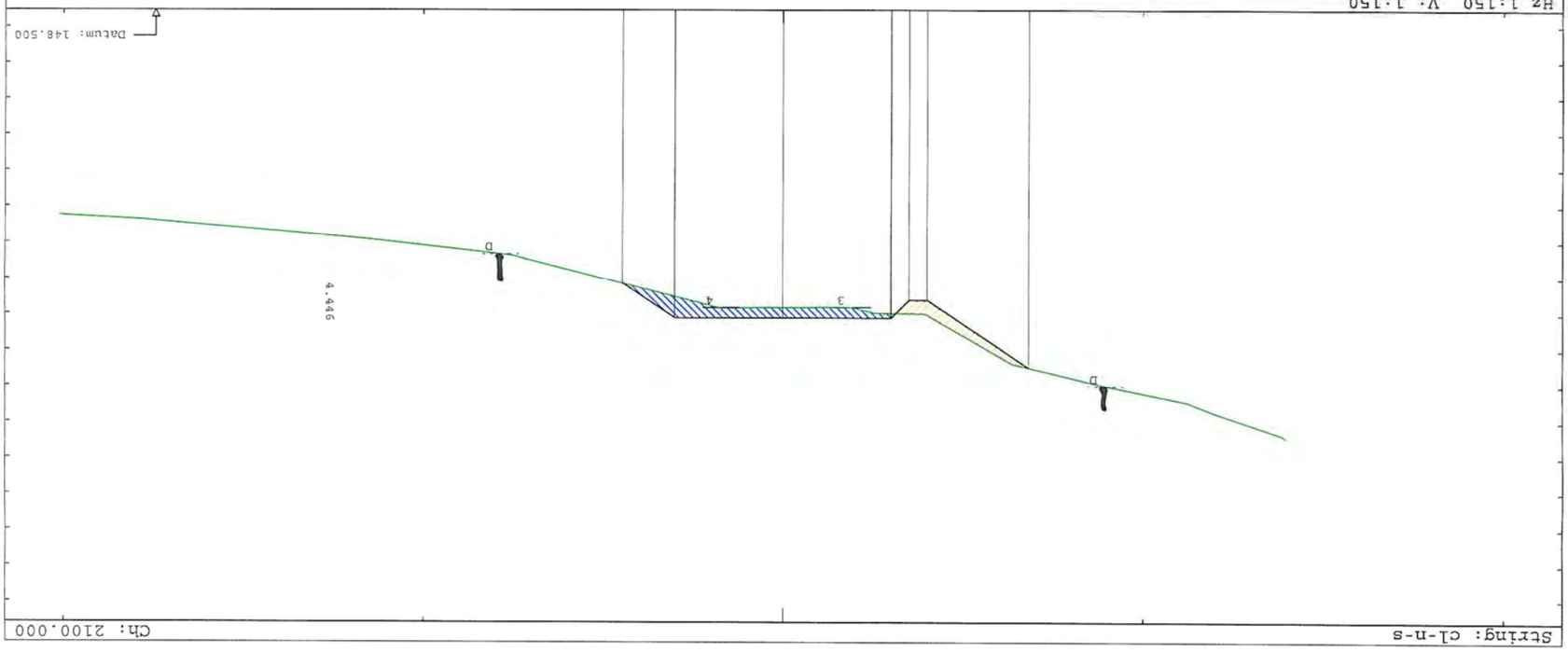
Operator NRGUser

Drawing No.

Notes:

OFFSET	2	Original Ground L	Finished Road Lev
-13.958		158.455	
-13.848		158.369	
-12.764		158.000	
-11.928		157.716	
-11.375		157.500	
-11.250		157.451	
-9.029		157.000	
-8.957		156.985	
-6.891		156.500	156.482
-6.816	156.458	156.373	
-6.349		156.000	
-5.698		155.500	
-4.826			
-4.000	154.605	155.000	154.605
-3.953	154.605	154.983	154.605
-3.500	155.104		155.104
-3.001	155.105	154.967	155.105
-2.551		154.816	
-1.931		154.808	
0.000	155.105		155.105
	155.105		155.105
1.716		154.823	
1.844		154.802	
3.000	155.105	154.500	155.105
3.033	155.105		155.105
4.446	154.141		154.141
5.000		154.000	
6.967		153.500	
7.489		153.367	
7.841		153.325	
10.719		153.000	
11.482		152.914	
16.220		152.500	
17.826		152.360	
20.045		152.244	
20.123		152.221	

Hz 1:150 Vz 1:150



String: cl-n-s Ch: 2100.000

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. Vz:1:150.

Operator NRGUser

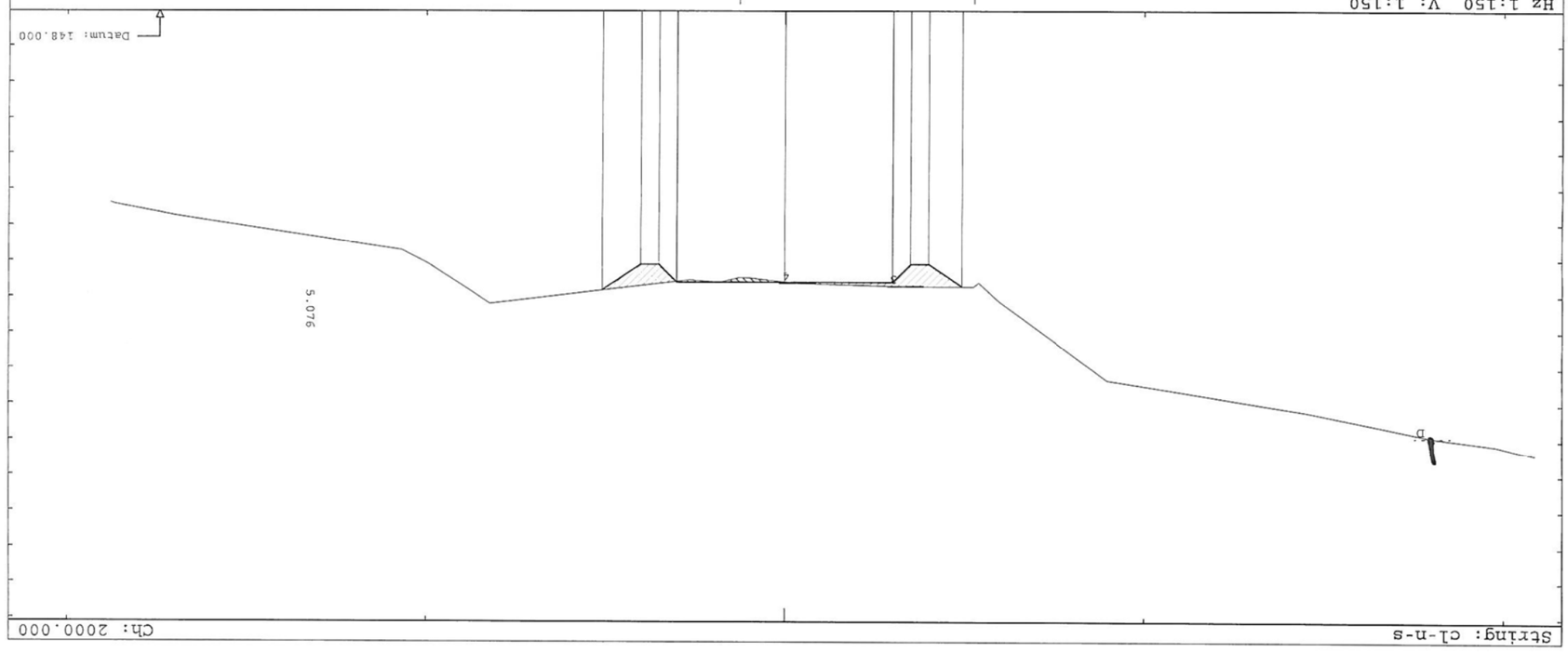
Drawing No.

Survey and Engineering Software
www.rngsurveys.co.uk

Notes:

OFFSET	2	Original Ground L	Finished Road Lev
-20.880		158.265	
-20.317		158.133	
-19.785		158.000	
-19.756		157.905	
-18.020		157.500	
-16.025		157.203	
-14.561		157.051	
-13.584		157.000	
-13.261			
-10.102		156.500	
-8.988		156.324	
-8.542		156.000	
-7.852		155.500	
-7.162		155.000	
-6.473		154.500	
-5.976		154.140	
-5.819		154.000	
-5.390		153.619	
-4.930	153.698		153.725
-4.000	153.105	153.725	153.725
-3.827	153.105	153.725	153.105
-3.349	153.604	153.718	153.105
	153.605		153.604
-1.117		153.653	153.605
-0.348	153.605	153.629	153.605
0.000	153.605		153.605
0.785		153.500	
0.985		153.477	
1.392		153.500	
1.810		153.599	
2.658		153.537	
3.000	153.605	153.604	153.605
3.500	153.105		153.105
4.000	153.105		153.105
5.076	153.822		153.822
6.585		154.000	
8.221		154.193	
8.519		154.000	
9.293		153.500	
9.931		153.088	
10.104		153.000	
10.688		152.705	
12.023		152.500	
15.285		152.000	
17.001		151.737	
18.238		151.500	
18.656		151.420	
18.794		151.377	

Hz 1:150 Vz 1:150



String: cl-n-s Ch: 2000.000

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. Vz:1:150.

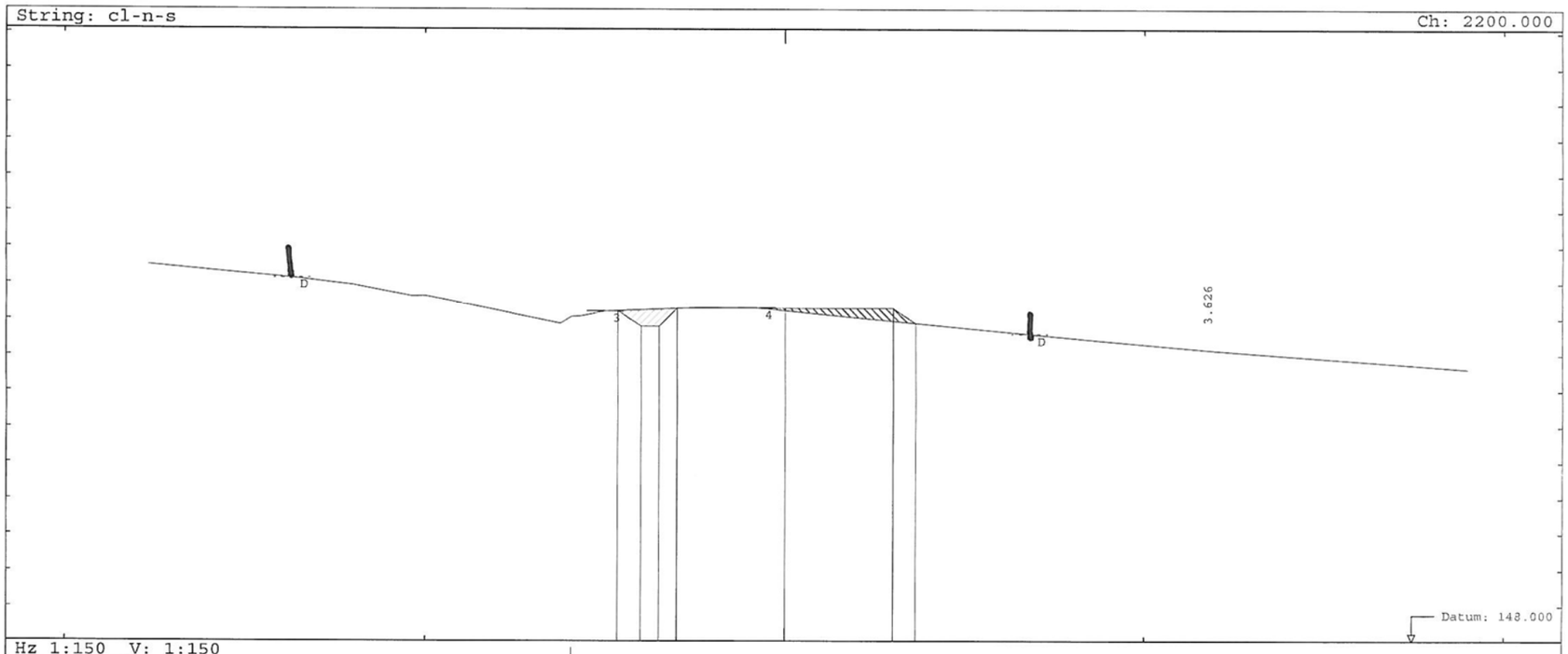
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.rngsurveys.co.uk

String: cl-n-s

Ch: 2200.000



Hz 1:150 V: 1:150

OFFSET	Original Ground Lev	Finished Road Lev
-17.665	156.501	
	156.500	
-15.353	156.283	
-13.696	156.136	
-12.538	156.000	
-12.015	155.938	
-10.382	155.632	
-10.012	155.638	
-9.322	155.500	
-6.818	155.000	
-6.233	154.883	
-6.045	155.000	
-5.644	155.091	
-4.994	155.225	155.238
-4.000		154.805
-3.500		154.805
-3.001		155.304
-2.234	155.327	155.305
-0.775	155.313	
0.000		155.305
		155.305
2.464	155.000	
3.000		155.305
3.626		155.305
		154.888
6.668	154.594	
6.791	154.580	
7.697	154.500	
11.806	154.137	
13.642	154.000	
18.986	153.601	

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

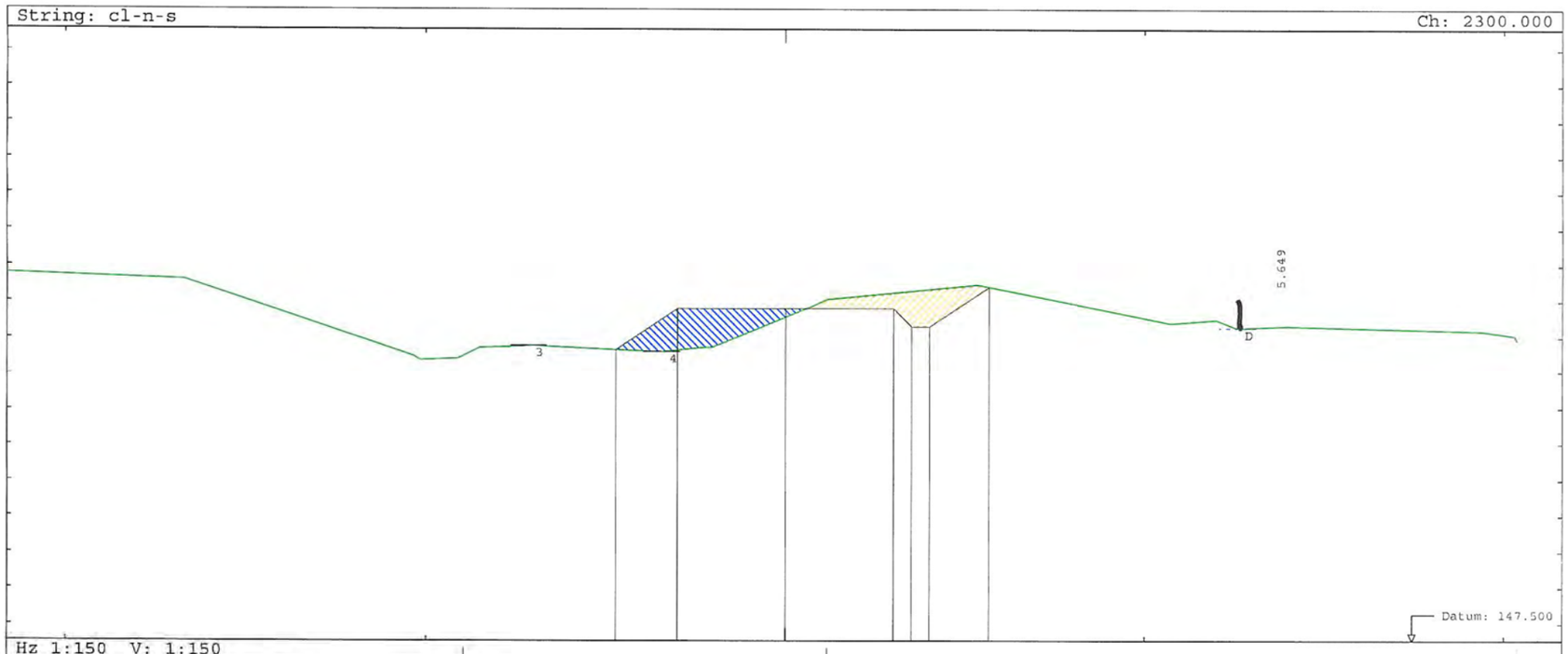
Hz:1:150. V: 1:150.

Operator NRGUser

Drawing No.

String: cl-n-s

Ch: 2300.000



Hz 1:150 V: 1:150

OFFSET	Original Ground Lev	Finished Road Lev
-16.715	155.605	
-16.394	155.500	
-14.885	155.000	
-13.376	154.500	
-11.867	154.000	
-10.357	153.500	
-10.163	153.496	
-9.175	153.423	
-9.118	153.424	
-8.509	153.722	
-7.282	153.750	
-7.148	153.779	
-4.711		153.664
-3.767	153.620	
-3.433	153.610	154.805
-3.001	153.720	154.805
-2.315	153.731	
-1.371	154.000	
-0.153	154.500	154.805
0.000		154.805
0.775	154.881	
1.029	155.000	
3.000		154.805
3.500		154.804
4.000		154.305
		154.305
5.333	155.467	
5.649		155.404
7.687	155.000	
10.209	154.500	
10.706	154.402	
10.733	154.401	
11.986	154.495	
12.573	154.264	
13.953	154.326	
19.371	154.180	
20.289	154.046	
20.316	154.000	

Notes:

Survey and Engineering Software
www.nrgsurveys.co.uk

Project: strathy north wf

Date: 01/02/2013

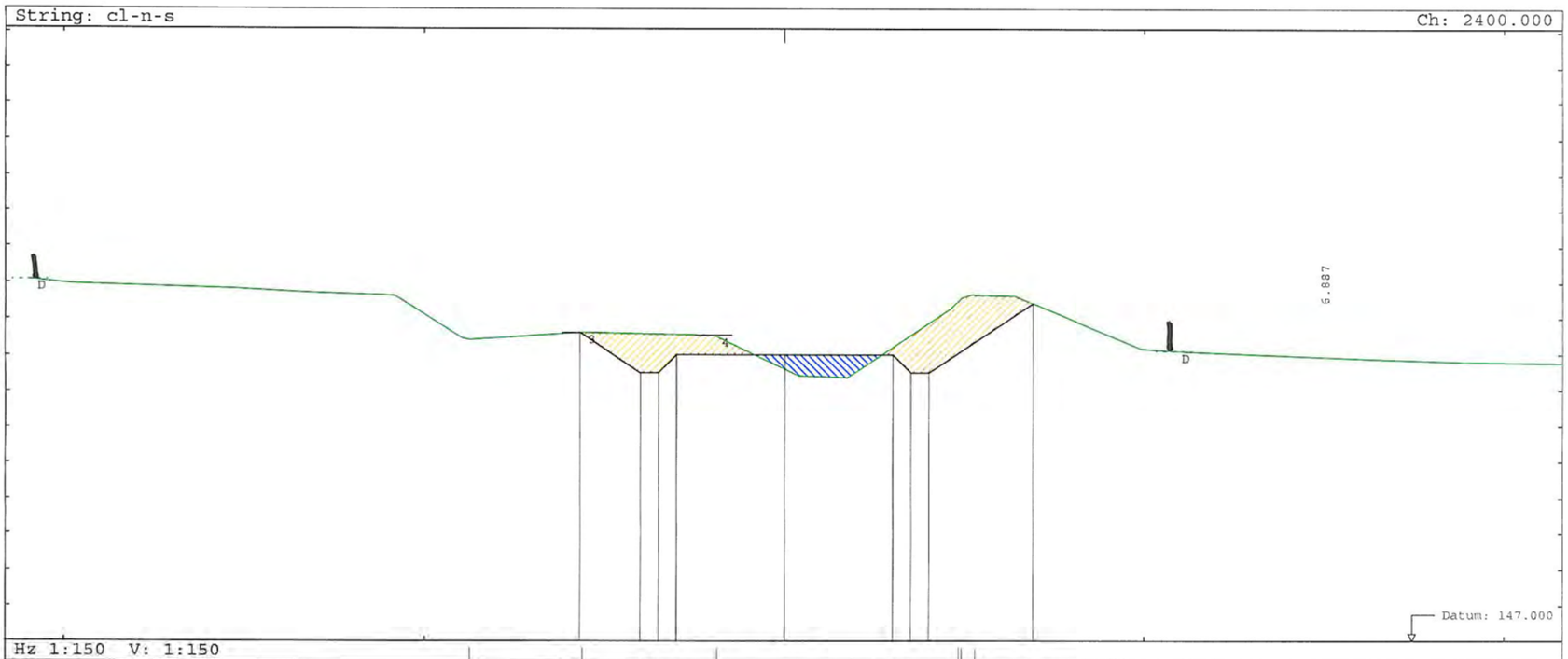
Hz:1:150. V: 1:150.

Operator NRGUser

Drawing No.

String: cl-n-s

Ch: 2400.000



Hz 1:150 V: 1:150

OFFSET	Original Ground Level	Finished Road Level
-20.952	155.000	
-20.227	154.968	
-19.781		
-15.317	154.837	
-13.261	154.732	
-10.837	154.646	
-10.606	154.500	
-9.814	154.000	
-9.022	153.500	
-8.946	153.452	
-7.461	153.500	
-5.685	153.619	153.621
-5.647	153.623	
-4.000		152.505
-3.500		152.505
-3.001		153.004
-1.963	153.544	153.005
-1.936	153.531	
-0.831	153.000	
0.000	152.500	153.005
0.210	152.414	153.005
1.742	152.360	
1.950	152.500	
2.695	153.000	153.005
3.441	153.500	153.004
4.000	154.000	152.505
4.590	154.271	152.505
5.205	154.685	
6.374	154.645	
6.720	154.500	154.430
7.913	154.000	
9.106	153.500	
9.911	153.162	
10.823	153.098	
13.26	153.000	
16.310	152.877	
18.762	152.793	
18.850	152.787	

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V: 1:150.

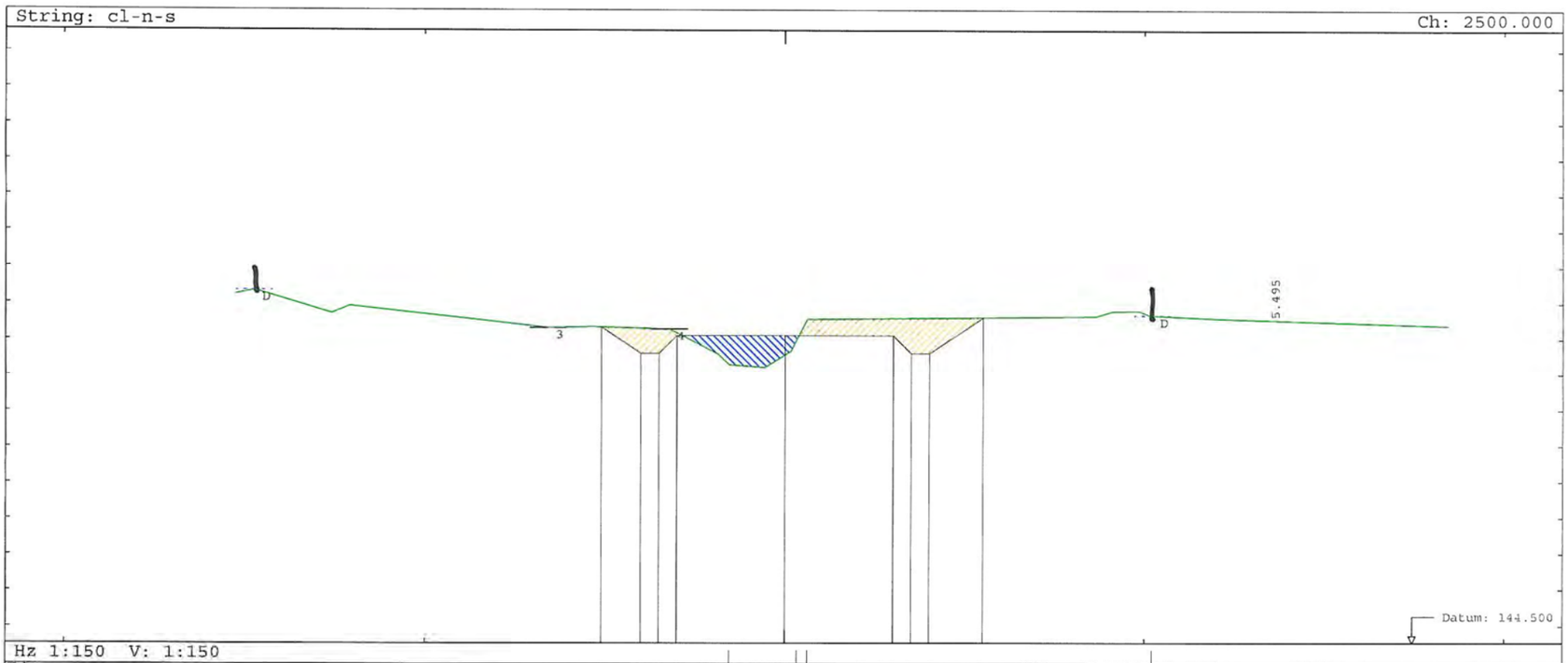
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 2500.000



Hz 1:150 V: 1:150

OFFSET	Original Ground Level	Finished Road Level
-15.259	152.231	
-14.727	152.339	
-13.556	152.000	
-12.587	151.714	
-12.081	151.920	
-8.256	151.500	
-6.569	151.315	
-5.349	151.340	151.334
-5.093		150.605
-4.000		150.605
-3.500		151.104
-3.207	151.288	151.105
-2.655	151.188	
-1.865	150.592	
-1.768	150.500	
-0.566	150.210	151.105
-0.109	150.500	151.105
0.000	150.672	
0.591	151.500	
3.000		151.105
3.500		151.104
4.000		150.605
5.495		150.605
		151.602
8.646	151.632	
9.116	151.781	
9.846	151.790	
10.169	151.656	
12.113	151.572	
14.377	151.500	
18.431	151.371	

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V: 1:150.

Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V:1:150.

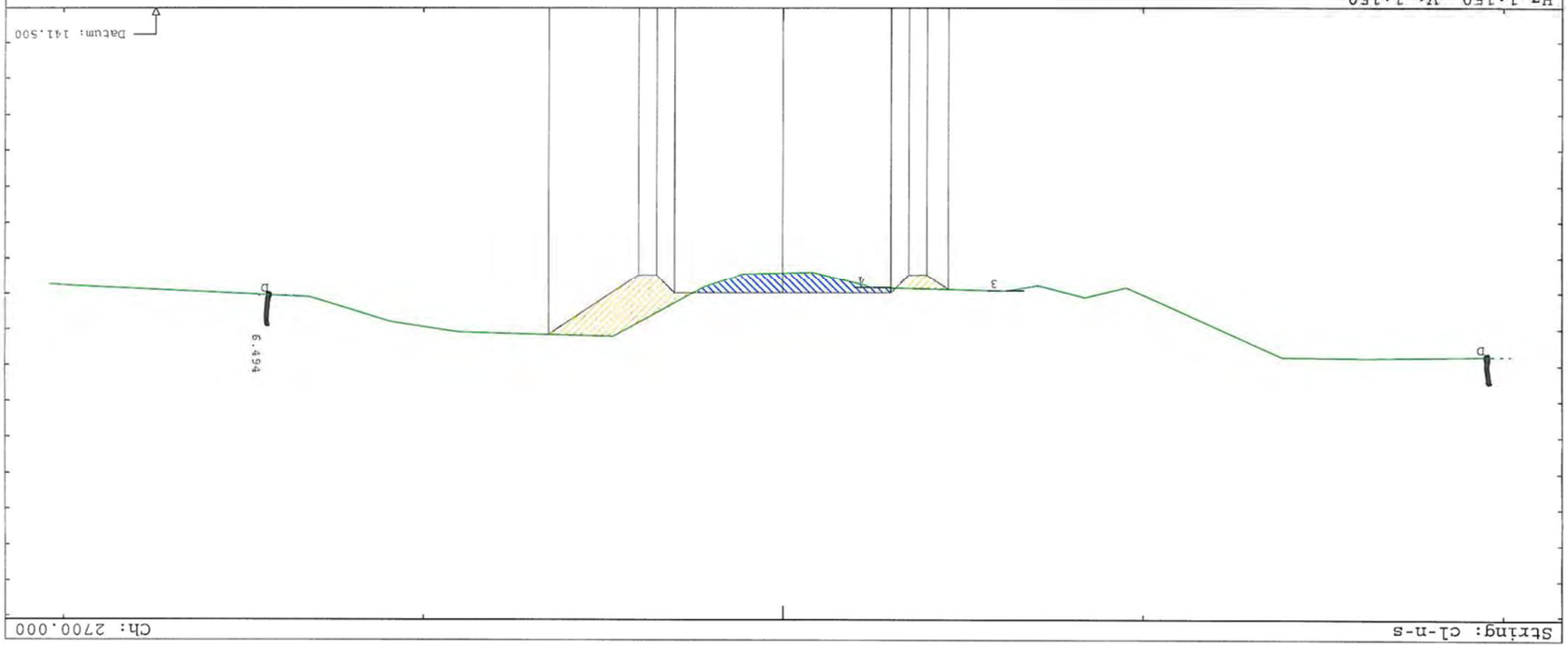
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 2700.000



Hz 1:150 V: 1:150

OFFSET	2	Original Ground L	Finished Road Lev
-19.698		150.742	150.143
-16.246		150.789	148.875
-13.864		150.762	148.480
-13.279		150.500	148.480
-12.163		150.000	148.979
-11.047		149.500	148.980
-9.930		149.000	148.980
-9.543		148.827	148.980
-8.832		149.000	148.980
-8.402		149.105	148.980
-7.989		149.000	148.822
-7.082		148.770	148.719
-6.181		148.915	148.500
-5.397		148.896	148.395
-4.593			148.500
-4.000			148.841
-3.500			148.266
-3.001			148.151
-2.497			148.497
-2.151			148.822
-1.266			148.980
-0.841			148.980
0.000			148.980
1.109			148.438
1.292			148.500
2.160			148.793
2.537			149.000
3.000			149.500
3.446			148.979
4.000			148.480
4.706			150.000
6.494			150.192
9.010			150.073
9.478			150.000
10.910			149.776
11.809			149.500
13.171			149.079
14.071			149.040
14.882			149.000
19.755			148.761
20.336			148.721
20.380			148.730

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V:1:150.

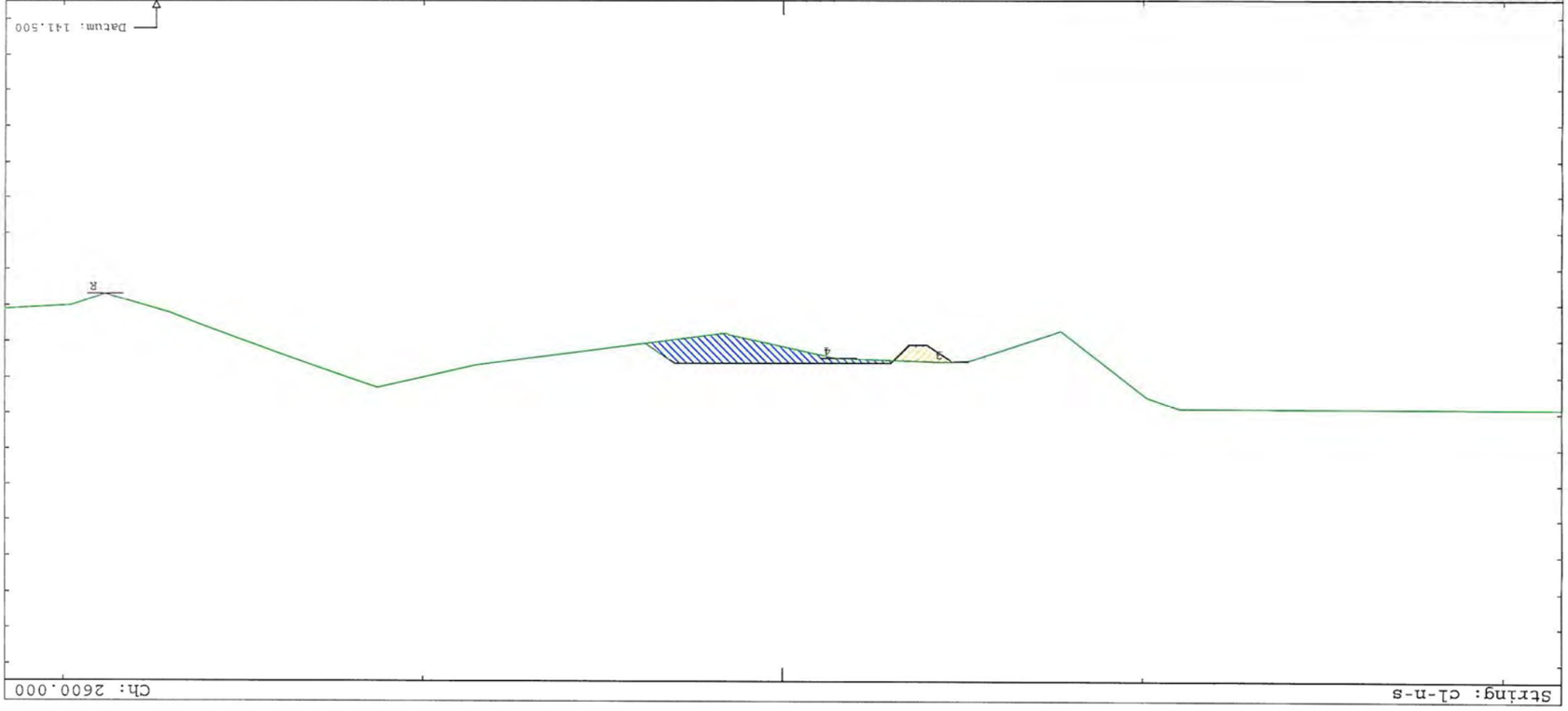
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 2600.000

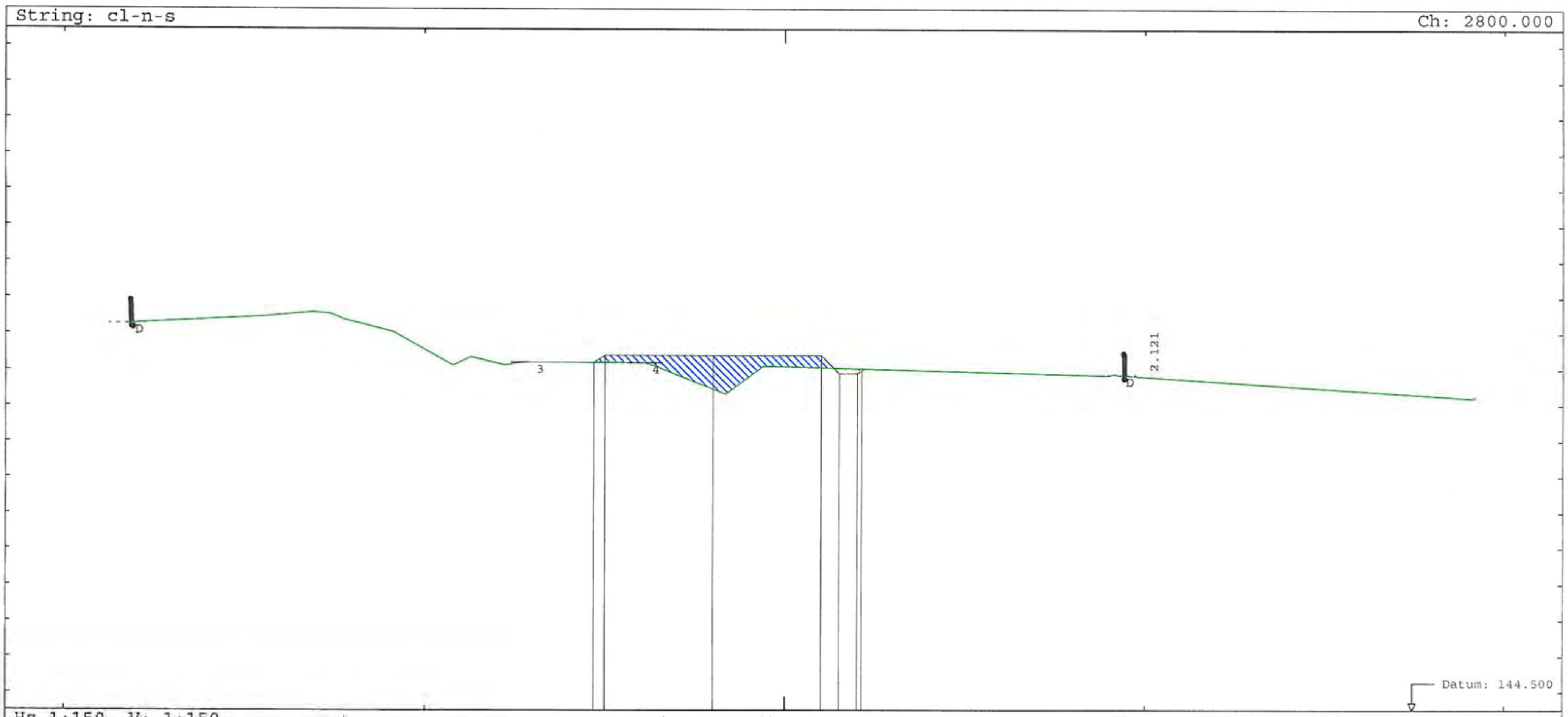


Hz 1:150 V: 1:150

OFFSET	2	Original Ground L
-11.037		149.860
-10.127		149.549
-10.063		149.500
-9.408		149.000
-8.753		148.500
-8.098		148.000
-6.864		148.000
-5.311		148.500
-5.218	148.537	148.530
-4.661	148.105	148.570
-4.158	148.105	148.565
-3.500	148.604	148.500
-3.001	148.605	148.500
-2.393		148.469
-1.554		148.457
-1.433		
0.000	148.605	148.000
0.663	148.605	148.000
1.493		147.819
1.560		147.782
3.000	148.605	148.000
3.150	148.604	
7.274		148.500
8.524		148.660
10.031		149.000
11.271		149.280
12.096		149.000
12.870		148.737
13.534		148.500
14.933		148.000
15.180		147.912
16.264		147.500
17.041		147.205
17.741		147.000
18.842		145.678
19.783		145.992
19.920		147.000

String: cl-n-s

Ch: 2800.000



Hz 1:150 V: 1:150

OFFSET	Original Ground l	2
-18.244	152.265	
-14.400	152.468	
-14.053	152.500	
-13.101	152.588	
-12.626	152.543	
-12.525	152.500	
-10.843	152.024	
-10.800	152.000	
-9.897	151.500	
-9.220	151.126	
-8.722	151.353	
-7.783	151.130	
-7.256	151.206	
-7.115	151.208	
-6.079	151.205	
-5.307		151.213
-5.001		151.396
-3.905	151.192	
-3.573	151.094	
-2.943	150.835	
-2.094	150.500	151.396
-2.000	150.327	151.396
-1.425	150.500	
-0.751	151.000	
1.000		151.396
1.500		151.395
2.000		150.896
2.121		150.896
3.248	151.000	
9.006	150.846	
9.132	150.890	
14.607	150.500	
19.152	150.197	
19.192	150.265	

Notes:

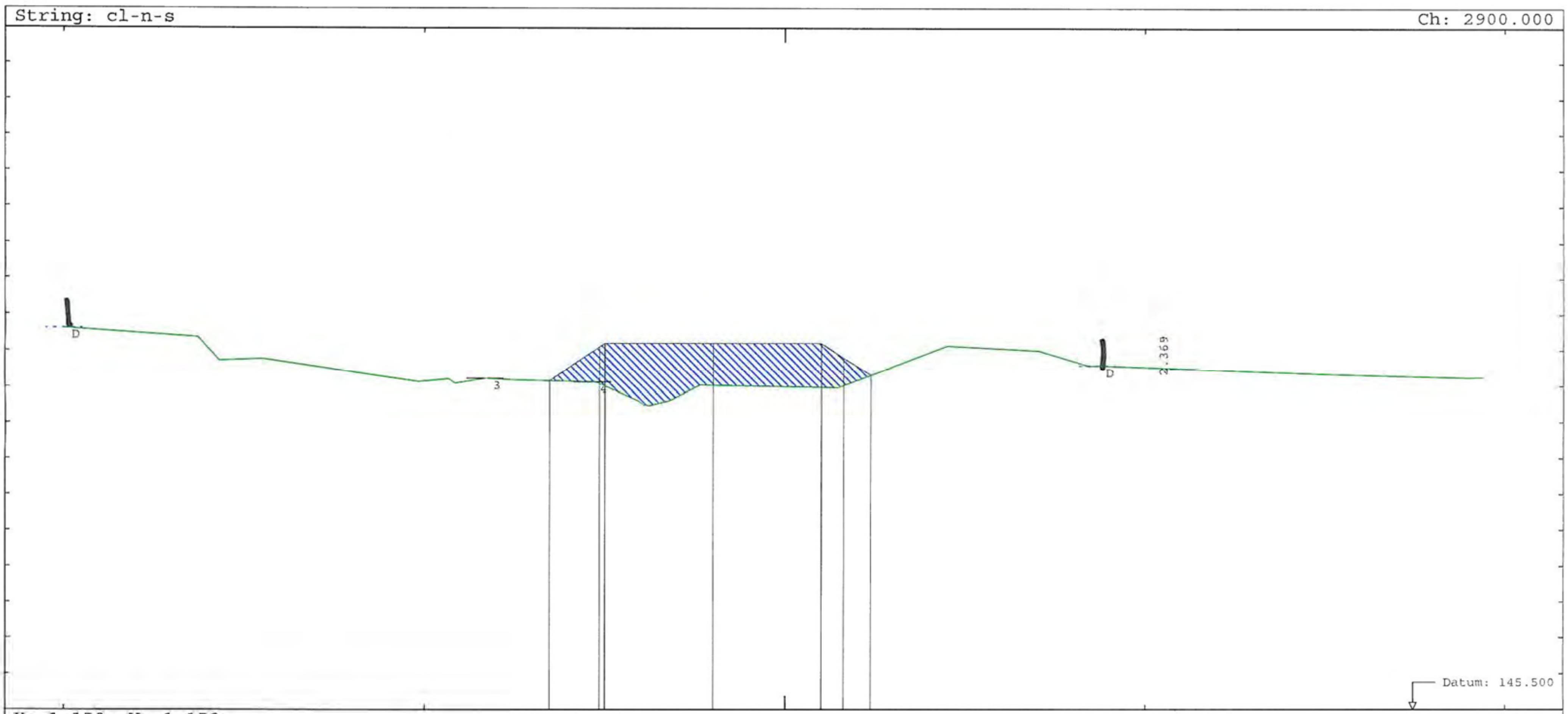
Project: strathy north wf

Date: 01/02/2013
Hz:1:150. V: 1:150.
Operator NRGUser
Drawing No.

NRG Survey and Engineering Software www.nrgsurveys.co.uk

String: cl-n-s

Ch: 2900.000



Hz 1:150 V: 1:150

OFFSET	Original Ground l	2
-19.995	154.610	
-18.366	154.500	
-16.290	154.360	
-15.950	154.000	
-14.482	153.766	
-12.654	153.500	
-10.173	153.138	
-9.344	153.212	
-9.160	153.089	
-8.327	153.225	
-7.566	153.184	
-6.534		153.165
-5.346	153.127	154.095
-5.226	153.115	154.195
-4.047	152.588	
-3.939	152.500	
-3.213	152.608	
-2.443	153.000	154.196
-2.364	153.041	154.196
-0.248	153.000	
1.000		154.196
1.469	152.967	154.196
1.556	153.000	153.785
2.369		
2.868	153.500	153.321
4.180	154.000	
4.489	154.118	
6.768	154.000	
7.018	153.987	
8.436	153.562	
8.679	153.574	
10.763	153.500	
15.224	153.342	
18.949	153.238	
19.379	153.247	

Notes:

Project: strathy north wf

Date: 01/02/2013
Hz:1:150. V: 1:150.
Operator NRGUser
Drawing No.

NRG Survey and Engineering Software www.nrgsurveys.co.uk

Notes:

Project: strathy north wf

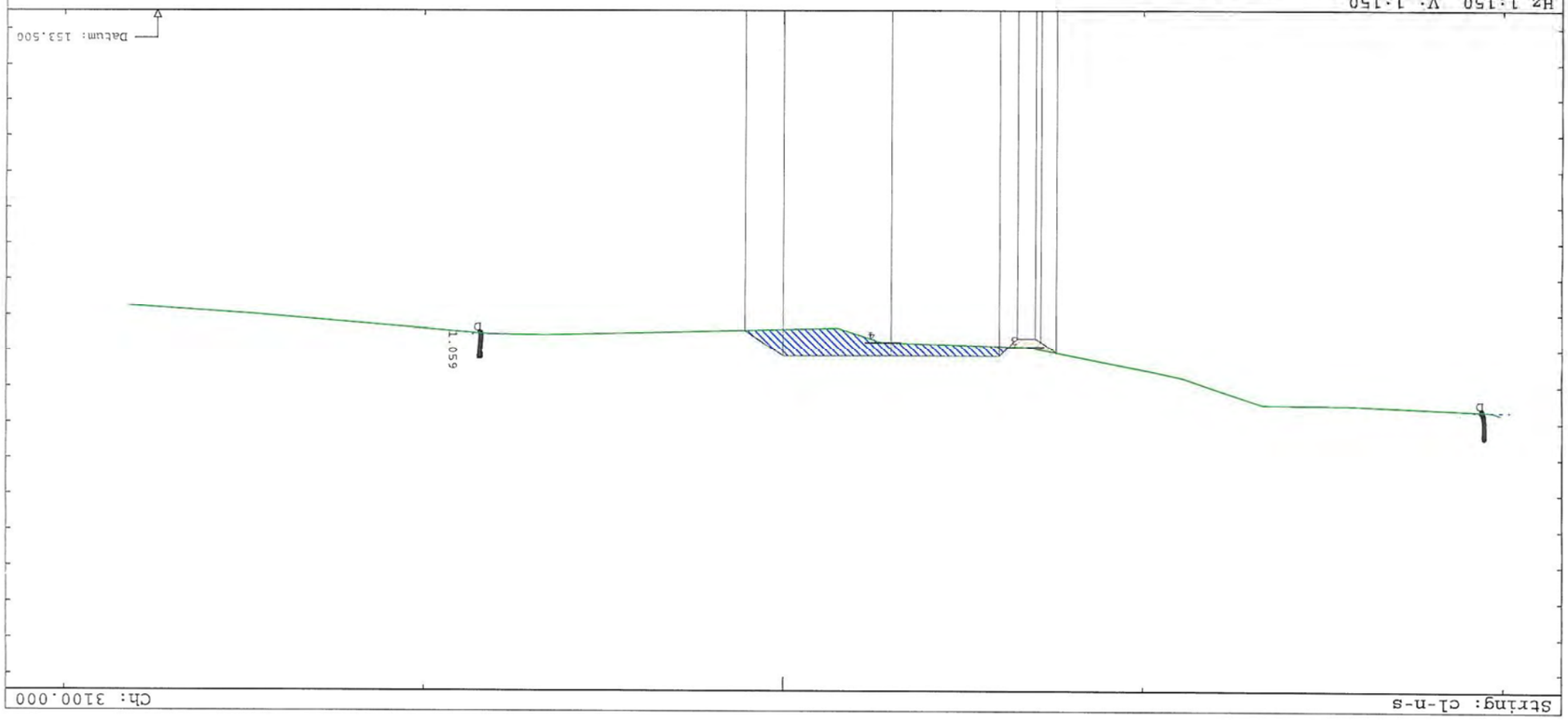
Date: 01/02/2013

Hz:1:150. V:1:150.

Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk



OFFSET	2	Original Ground L
-19.904		162.753
-19.677		162.683
-15.660		162.515
-13.600		162.500
-13.328		162.493
-12.745		162.309
-11.831		162.000
-11.125		161.761
-10.281		161.576
-9.890		161.500
-7.599	161.053	161.000
-7.316	160.746	160.887
-6.733	160.646	
-6.000	161.146	160.861
-3.000	161.146	160.761
-2.765	161.146	
-1.941		160.500
-1.513		160.364
0.000	161.146	
1.059	160.439	
4.252		160.500
6.585		160.555
8.174		160.527
8.492		160.500
14.401		160.000
14.862		159.961
18.217		159.734

String: cl-n-s Ch: 3100.000

Notes:

Project: strathy north wf

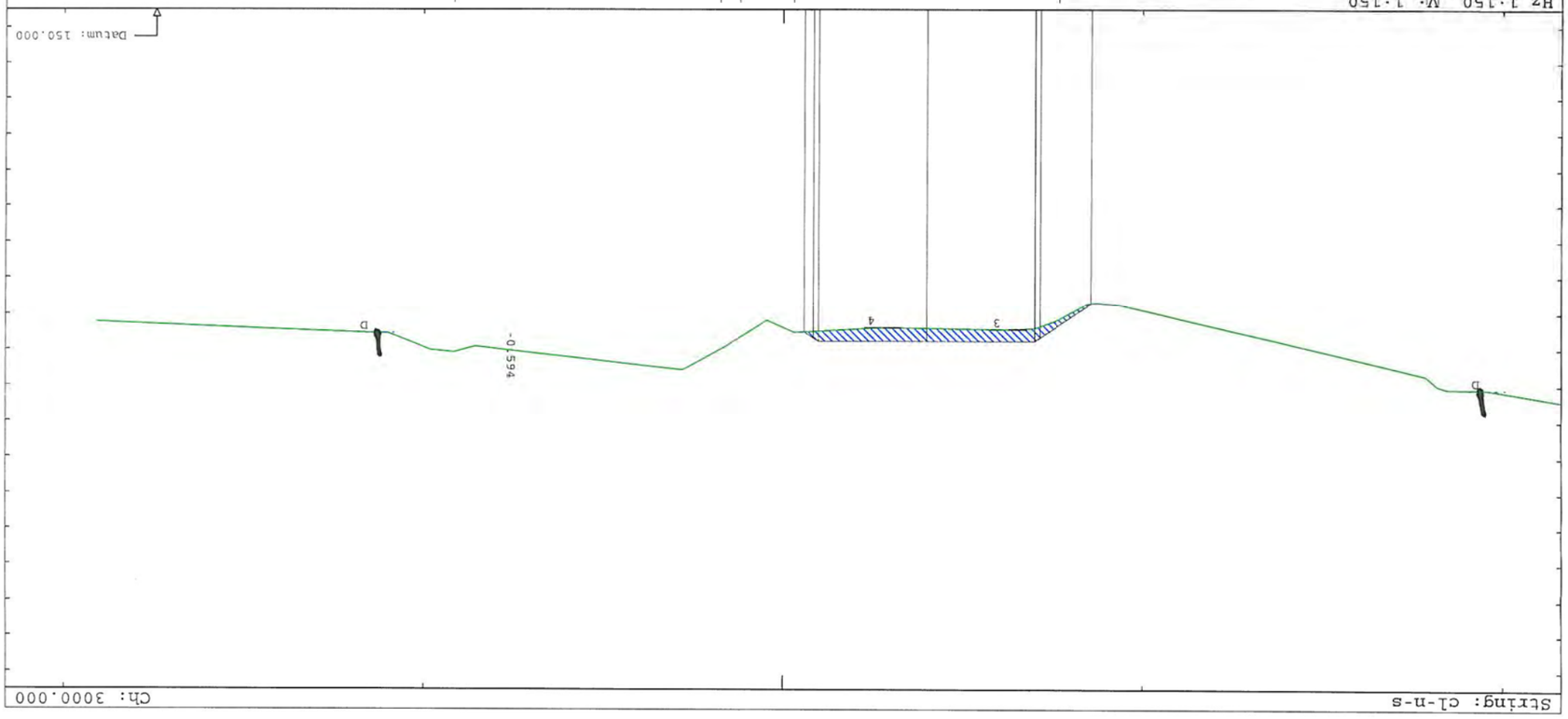
Date: 01/02/2013

Hz:1:150. V:1:150.

Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

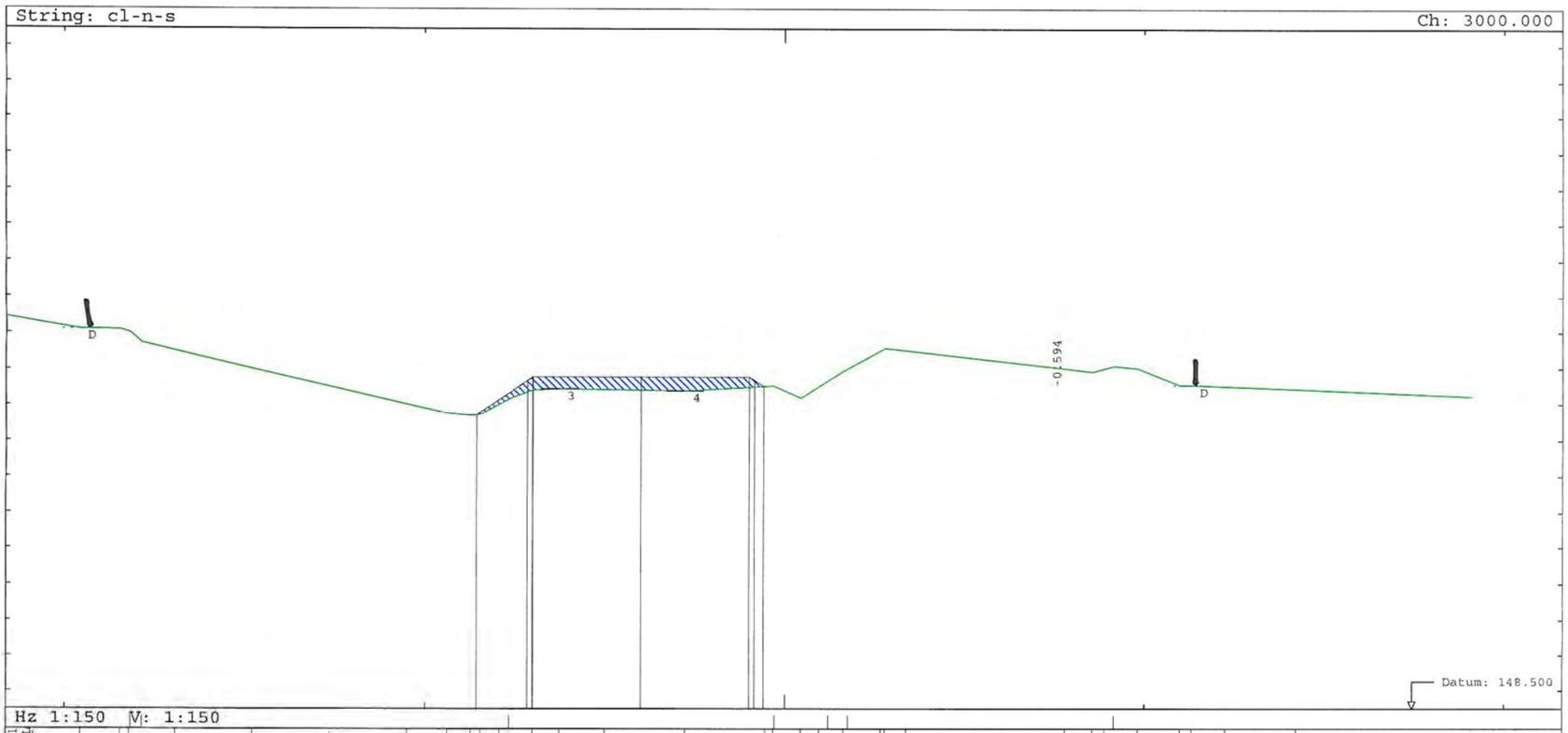


OFFSET	2	Original Ground L
-19.567		159.089
-18.458		159.076
-18.214		159.000
-16.928		158.500
-14.787		158.000
-12.646		157.500
-10.506		157.000
-9.365		156.738
-8.747	156.711	156.683
-8.579		156.708
-7.947		157.000
-7.150	157.670	157.392
-7.004	157.770	
-6.263		157.432
-4.995		157.416
-4.000	157.771	
-2.773		157.373
-1.000	157.771	
-0.850	157.771	157.500
-0.321	157.500	157.513
0.436		
0.948		157.474
1.619		157.500
1.931		
2.654		158.500
2.774		158.566
3.359		158.500
7.774		158.000
8.560		157.911
8.889		158.000
9.817		158.006
10.984		158.000
11.314		157.532
12.243		157.535
		157.500
14.214		157.426
19.081		157.214

String: cl-n-s Ch: 3000.000

String: cl-n-s

Ch: 3000.000



Hz 1:150 V: 1:150

| | | |

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V:1:150.

Operator NRGUser

Drawing No.

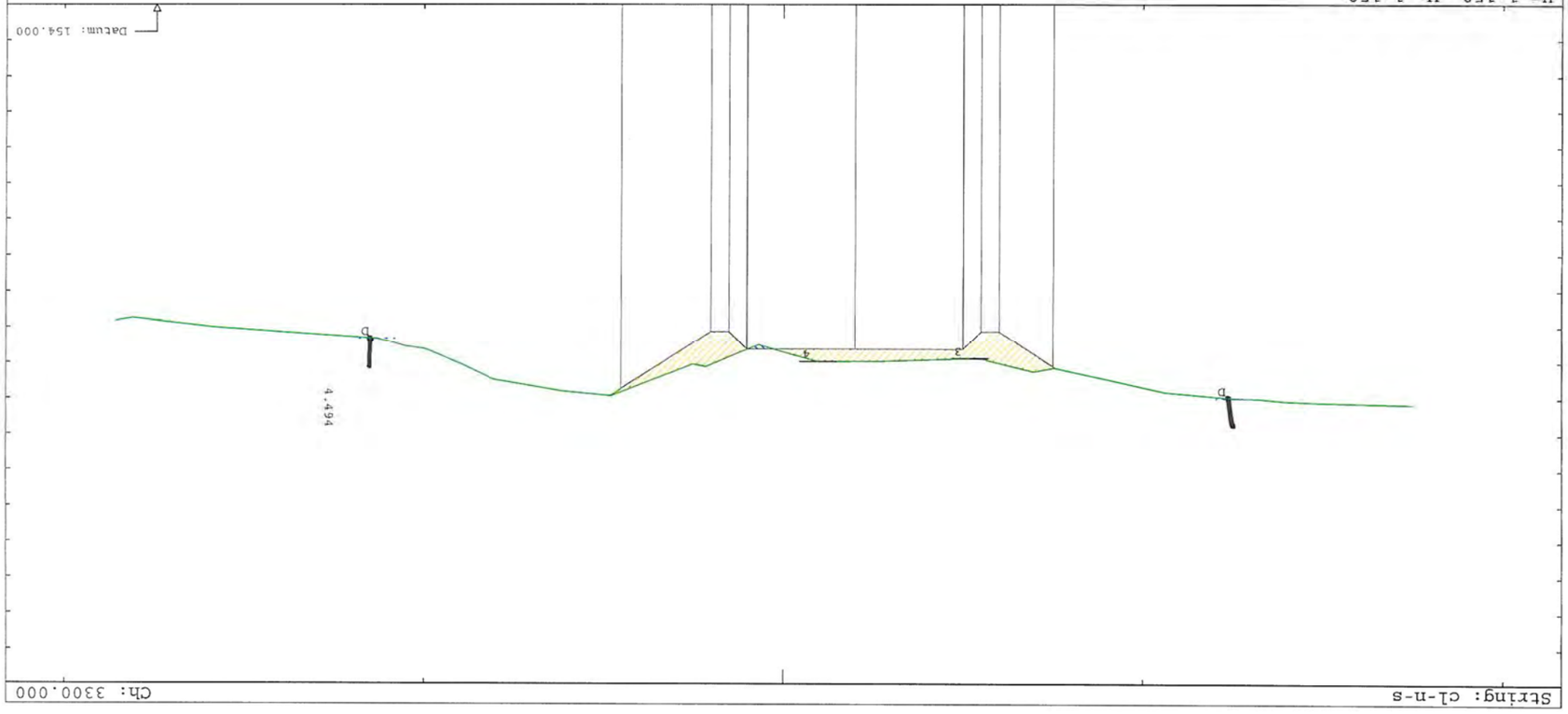
Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 3300.000

Hz 1:150 V: 1:150

OFFSET	2	Original Ground L
-17.488		165.160
-14.930		165.105
-13.934		165.063
-13.258		165.000
-13.211		164.995
-12.520		164.987
-10.627		164.817
-9.187		164.500
-7.544	164.106	164.139
-7.499		164.249
-6.953		
-6.000	163.122	164.000
-5.954	163.122	163.894
-5.527	163.621	
-5.001	163.622	163.877
-2.748		163.956
-2.000	163.622	
	163.622	
-0.966		163.964
-0.098		163.729
0.655	163.622	163.500
0.681	163.621	163.492
1.500	163.621	
1.892	163.122	
2.000	163.122	164.000
2.504		164.106
3.681		164.500
4.494	164.732	164.925
4.769		
6.116		164.802
7.899		164.500
8.053		164.474
8.950		164.047
9.060		164.000
9.961		163.617
10.528		163.531
10.650		163.500
11.298		163.322
15.797		163.007
15.861		163.000
18.089		162.75
18.559		162.828



Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V:1:150.

Operator NRGUser

Drawing No.

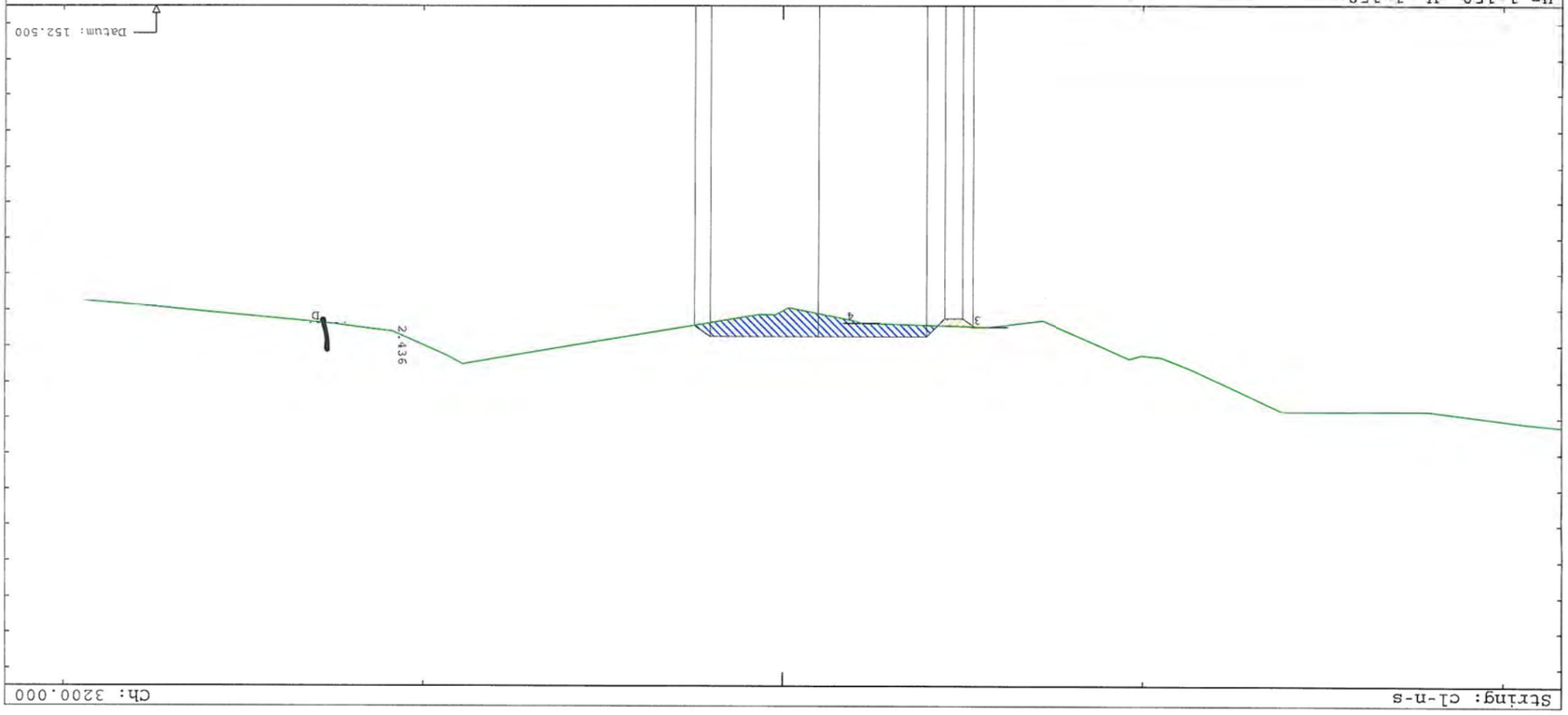
Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 3200.000

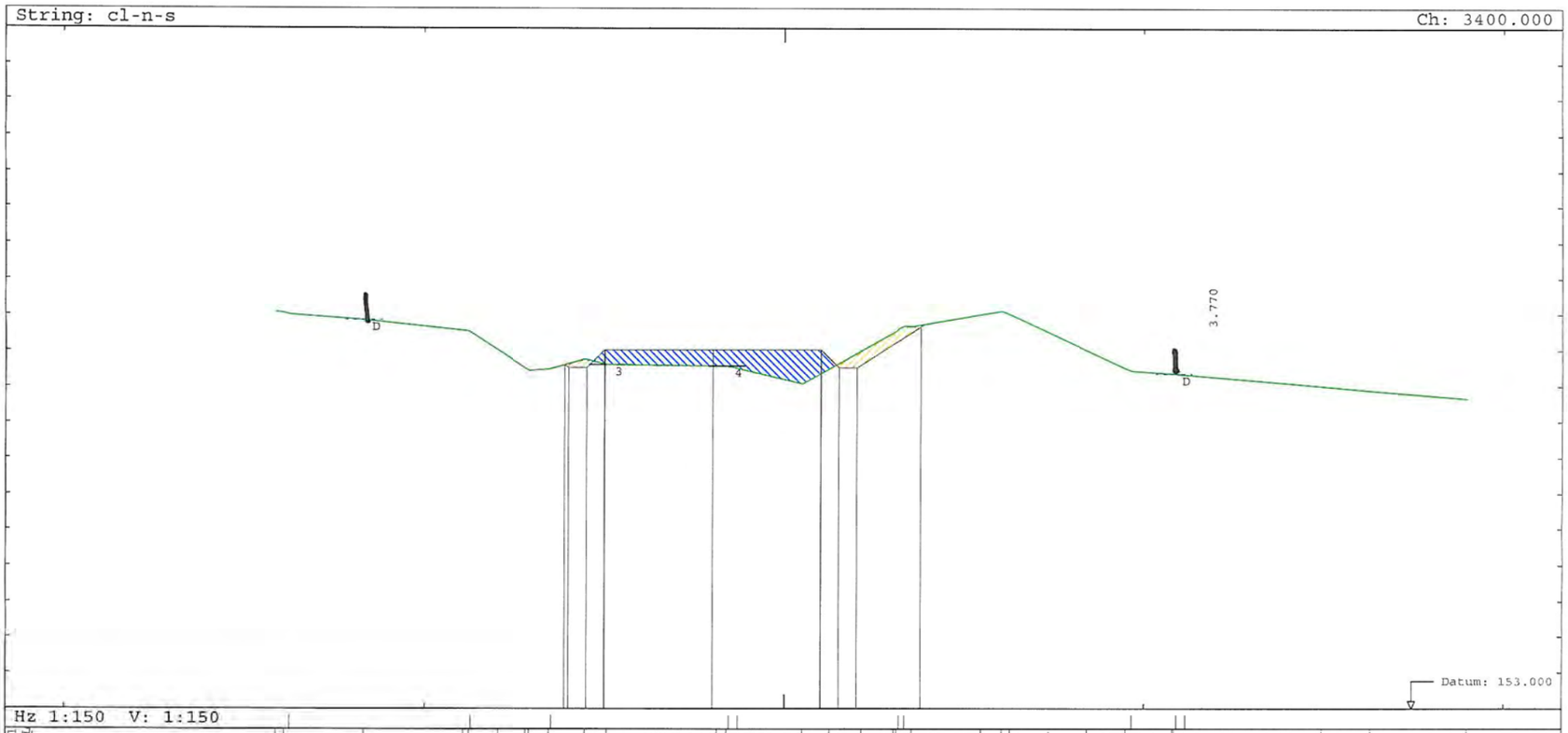
Hz 1:150 V: 1:150

OFFSET	2	Original Ground L
-20.591		164.132
-19.539		164.000
-17.911		163.796
-13.883		163.801
-13.233		163.500
-12.153		163.500
-11.354		162.630
-11.012		162.500
-10.522		162.314
-9.970		162.259
-8.831		162.000
-7.682		161.500
-7.224		161.301
-5.728		
-5.435	161.436	161.477
-5.000		161.474
-4.500	161.247	
-4.001	161.247	
	161.746	
-2.195		161.368
-2.055		
-1.000	161.747	161.320
	161.747	
-0.483		161.000
-0.207		160.943
0.192		161.135
0.651		161.127
2.000	161.747	
2.436	161.746	
2.899	161.448	161.500
5.912		162.000
8.912		162.498
9.343		162.264
9.939		162.000
10.853		161.596
11.618		161.500
12.292		161.416
12.657		161.371
16.505		161.000
18.476		160.810
19.366		160.742
		160.736



String: cl-n-s

Ch: 3400.000



Hz 1:150 V: 1:150

OFFSET	Original Ground L	2
-14.120	164.069	
-13.903	164.046	
-11.684	163.847	
-8.935	163.553	
-8.776	163.532	
-7.959	163.000	
-7.191	162.500	
-7.096	162.438	
-6.538	162.481	162.593
-6.108	162.757	162.521
-5.542	162.521	162.521
-5.001	162.603	163.020
-2.000	162.565	163.021
-1.881	162.567	163.021
-1.456		
0.489	162.074	
1.000	162.500	163.021
1.248		163.020
2.000	163.000	162.521
2.000		162.521
3.031	163.500	
3.105	163.542	
3.534	163.665	163.662
5.460	164.000	
6.040	164.101	
6.259	164.000	
7.340	163.500	
8.421	163.000	
9.502	162.500	
9.524	162.490	
10.793	162.359	
10.832	162.351	
14.948	162.000	
16.292	161.884	
18.983	161.657	

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V: 1:150.

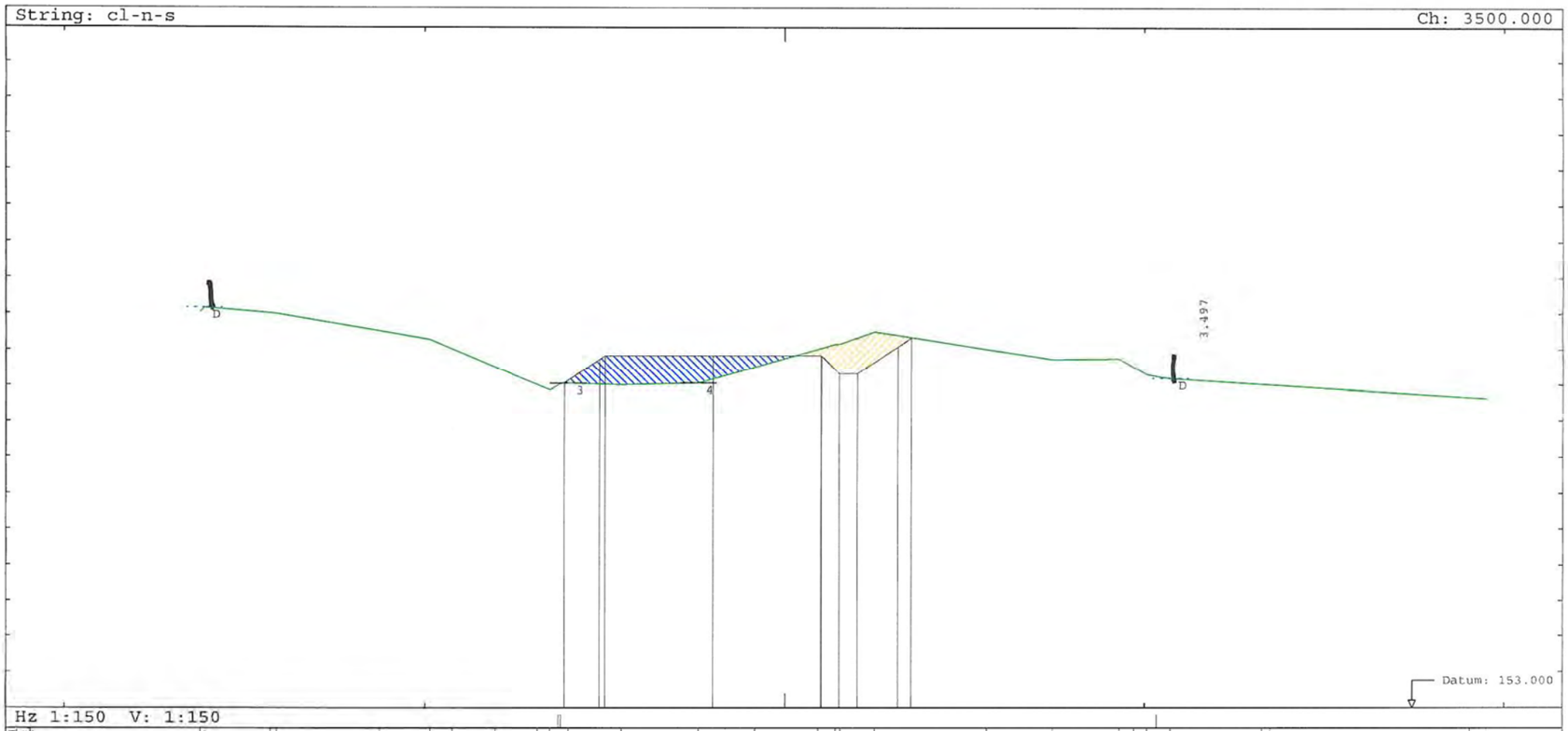
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 3500.000



Hz 1:150 V: 1:150

OFFSET	Original Ground L	2
-16.237	164.036	
-16.118	164.155	
-14.293	164.000	
-14.119	163.985	
-11.262	163.500	
-9.869	163.262	
-9.245	163.000	
-8.058	162.500	
-6.872	162.000	
-6.528	161.855	162.067
-6.129	162.048	162.721
-5.150		
-5.000	162.005	162.821
-4.542		
-2.403	162.051	
-2.000		162.821
-0.835	162.500	162.821
0.912	163.000	162.821
1.000	163.140	162.820
1.401	163.148	162.321
2.000	163.484	162.321
2.484		163.073
3.127		163.318
5.593	163.000	
7.424	162.715	
9.299	162.730	
9.702	162.500	
10.067	162.292	
10.717	162.178	
13.259	162.016	
13.503	162.000	
19.038	161.639	
19.502	161.613	

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V: 1:150.

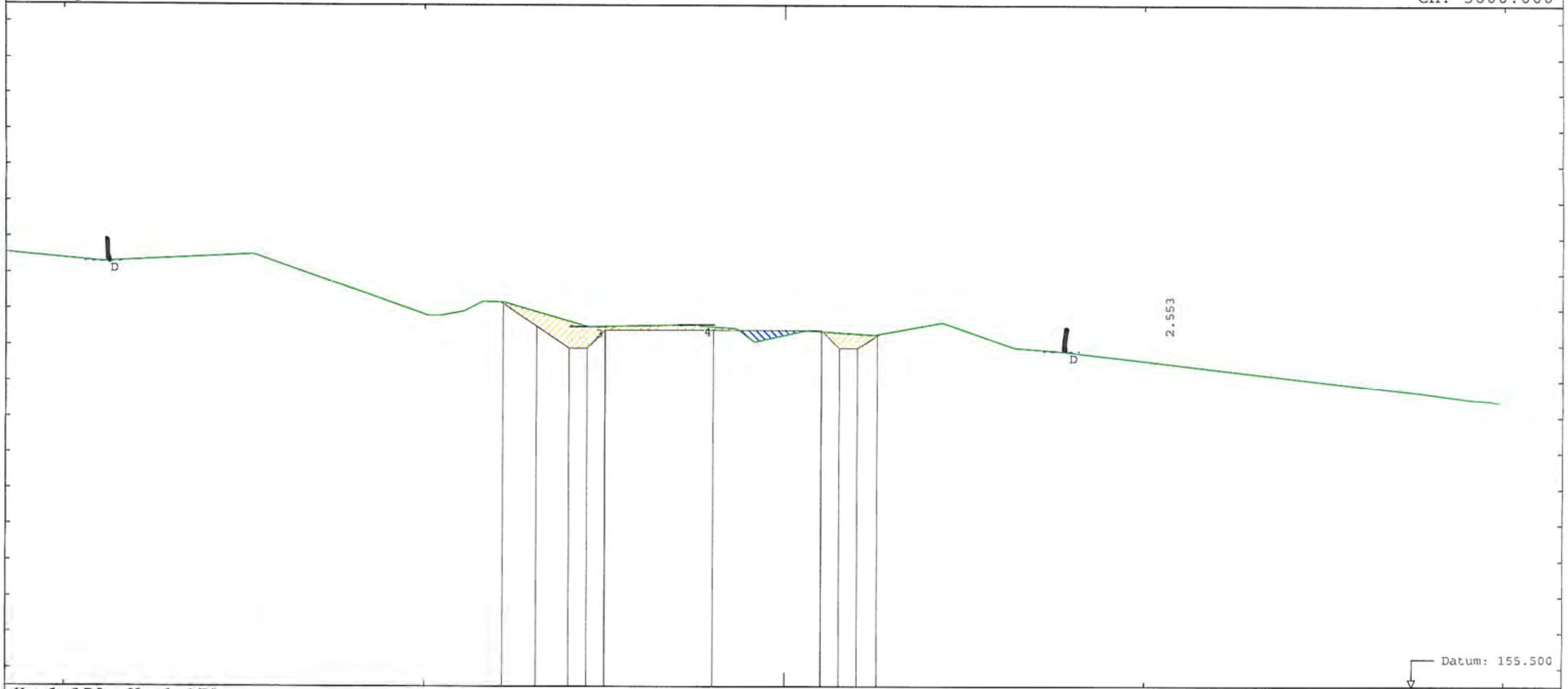
Operator NRGUser

Drawing No.

Survey and Engineering Software
www.nrgsurveys.co.uk

String: cl-n-s

Ch: 3600.000



Hz 1:150 V: 1:150

OFFSET	Original Ground L	2
-21.023		
-18.939	165.310	
-15.158	165.500	
-14.756	165.520	
-14.698	165.500	
-13.278	165.000	
-11.857	164.500	
-10.437	164.000	
-9.923	163.819	
-9.566	163.815	
-8.926	163.936	
-8.420	164.204	164.153
-7.842	164.190	
-7.163	164.000	163.524
-6.000		162.921
-5.500	163.512	162.921
-5.471		163.420
-5.001		163.421
-2.662	163.569	
-2.468	163.570	163.421
-2.000	163.500	163.421
-1.345	163.470	
-0.851	163.100	
0.574	163.411	
0.603	163.412	163.421
1.000		163.420
1.500		162.921
2.000	163.288	162.921
2.470		163.277
3.620	163.500	
4.358	163.636	
4.748	163.500	
6.182	163.000	
6.367	162.935	
7.670	162.836	
10.529	162.500	
14.788	162.000	
15.507	161.916	
17.678	161.680	
18.968	161.500	
19.074	161.485	
19.619	161.450	

Notes:

Project: strathy north wf

Date: 01/02/2013

Hz:1:150. V: 1:150.

Operator NRGUser

Drawing No.

NRG Survey and Engineering Software
www.nrgsurveys.co.uk

Strathy South
Wind Farm

Typical Cable Trench
Section Detail
T4

Contents

Working at Heights	Page 2
Method Statement for the Installation of Cable by Mole Plough	Page 4
Single Drum Loaded Direct onto Plough Unit	Page 5
Multiple Cable Drums Loaded onto Cable Trailers	Page 6
Installing Cables into Plough Chute	Page 7
Starter Hole Excavation	Page 8
Ploughing of Cables	Page 8
Winch Bond Safety	Page 9
Working on Soft Ground	Page 10
Working on Steep Slopes/Side Slopes	Page 11
Appendix 1 – Equipment List	Page 12

Working at Height During Plough Operations

Because of the design of the FSP 18/22 plough unit, the plough operator has to work in an elevated position. In order to minimise the possibility of a fall from the work position **and** to minimise the risk of injury if a fall does occur, the following will be implemented by the supervisor prior to commencement of ploughing operations.

All ploughing routes will be identified, walked and surveyed by the plough team prior to commencement of operations. This will identify the type and size of equipment to be used and any risks associated with the works, eg visibility, undulating ground, ground conditions such as rock and peat areas, ditch/stream crossings etc. Measures will be implemented to mitigate the risks identified. These will be supported by site specific risk assessment.

The Supervisor will be in contact with the Plough and Winch Operators by way of radio to ensure that communication is maintained and all instructions are known by all.

The plough operator is required to adhere to the following -

The plough operator will access the work position using the fitted steps and will maintain three points of contact when ascending or descending the ladder.

Once in the work position, the plough operator will be protected from falling by a handrail system. At this point the plough operator must either attach a seatbelt or a fall arrest system.

The seatbelt must be used during loading or off-loading of the plough unit from the lorry bed and until the plough blade is lowered into the starter hole as there may be a higher risk to the stability of the plough unit during this time.

When the plough chute is lowered into the starter hole the seatbelt can be disengaged and a fall arrest system will be clipped into the overhead attachment point at his work station.

Once the plough is in position and the chute has been lowered into the ground, the stability of the plough will be maintained, both by independent manoeuvring of the plough legs to suit the current ground conditions **and** the ground resistance acting on the plough chute under the ground.

The operator is permitted to move freely about the work position to operate the plough unit and assess the positions of the plough legs.

During loading/un-loading of cable drums it may be necessary for the operator to disconnect the fall arrest system and to walk along the plough arms/legs to aid in this operation. All walking surfaces are covered with anti-slip coverings or chequered plate to prevent slipping and industrial fall protection bags will be placed around the work area to protect the operator in the event of a fall. Where possible, all loading and unloading of cable drums will be carried out at ground level.

Ladders are available to aid in the loading/un-loading of cable drums if necessary.

Special features:
The new FSP 22 Cable Plough has a driver cabin. When ploughing the plough operator must seated. Additionally must be used the seat belt.

The Winch Operator is required to adhere to the following -

When moving the winch to predetermined pulling positions the winch must follow the route identified and marked by way of pegs and or sight poles. No deviation from this will be permitted.
The winch operator must maintain clear line of sight and maintain suitable visibility at all times during pulling operations. This will also be supplemented by use of the approved 2 way radio system.

All other personnel are to maintain exclusion zone of 3m from any moving plant. If personnel have to enter the 3m zone, the plough train should be stopped until the 3m zone is re-implemented.

Special features:
The new FWF 82 Winch has a driver cabin. When ploughing the plough operator must seated. Additionally must be used the seat belt.
The cabin is transverse to the Machine. The Winch Operator have a better all-round view, and see the full plow process.

Method Statement for the Installation of Cable by Mole Plough

The Josef Schnell plough units consists of (See Photos Below).

MAN Wheeled Winch with FSP 18 (Photo 1)
Low Loader with Doll Winch (Photo 2)
Low Loader with FSP 22 (Photo 3)
FWF-82 (Photo 4)
Doll Tracked Winch (Photo 5-6)

Photo 1; MAN Winch Truck with Plough Unit

Photo 2; Low Loader with Doll Winch

Photo 3; Low Loader with FSP 22

Photo 4; Low Loader with FWF-82

Note: In general only one winch will be used at any one time.

There may also be a tracked crawler and a number of cable trailers delivered to site. This depends on the number of cables/ducts which are to be installed.

The plough unit is delivered to site on an articulated combination which is towed by the MAN Wheeled winch or with a platform truck (Photo 1 and 3).

The Doll Tracked winch or the FWF-82 is pulled to site on another separate articulated low loader (Photo 2 and 4).

Upon arrival at site, the MAN winch unit will park in a suitable location where the plough unit is off-loaded under its own power unit. The MAN truck and trailer can then be taken to a suitable storage location and parked up.

The Doll winch or FWF-82 unit is then off-loaded at the same location and the articulated unit is driven to the storage location.

Winch choice is dependant on ground conditions/weather/location etc. This will generally be decided prior to off-loading but both MAN, FWF 82 winches may need to be used for the same purpose.

Prior to cable installation, supervising staff and the plough team will attend a briefing where work packs will be issued. The area will be checked for U/G and O/H services and a walk through of the job will be carried out. This will familiarise the plough supervisor and his operatives of the ground conditions and any possible hazards. This will also give the plough supervisor a chance to mitigate any issues / risks that may be identified.

Installation commences with the excavation of a Joint Hole approximately 5mt long x 1mtr wide and 1.5mtr deep (Refer to Joint Bay/Starter Pit Excavation Method Statement). The plough is manoeuvred over the Joint Bay/Starter Pit and the blade and chute lowered to the required depth for each specific cable or duct installation.

Each type of cable/duct arrangement has its own requirements for chute set-up and cable drum delivery. These options are noted below.

Single Drum Loaded Direct onto Plough Unit

Two hydraulic arms are fitted to the rear of the plough. These are fitted with a drum spindle which is used for carrying a cable drum.

The arms can be lowered so that the spindle can be removed either manually by the plough operatives or by choking a sling around the spindle and attaching it to a lifting device.

Note: Possible manual handling issues to be taken into account when moving spindle.

The spindle contains two tapered mounting bearings, one each end.
The bearing on one end of the spindle is removed by loosening the securing bolts.
The spindle is then pushed through the cable drum centre hole where it is centred and both tapered bearings are replaced and retightened.
The plough is then able to manoeuvre itself over the cable drum.
By manipulating the hydraulic arms, the operator can position the arms under the drum before securing the spindle back onto the lifting sockets on the arms.
The cable drum is then lifted into position for loading the cable into the plough chute.
A ladder shall be used by operatives to access the cable chute.
Once in position the cable is fed manually off the drum and down the plough chute with sufficient cable being flaked off the drum as required.

Multiple Cable Drums Loaded onto Cable Trailers

When multiple drums are required they are loaded direct onto multiple spindle cable trailers.
These will generally be loaded with a suitable excavator which is equipped for lifting or with a mobile crane.
Each cable trailer has two drum spindles therefore is capable of carrying two cable drums.
The spindles are secured onto mountings by means of a securing pin.

1) The securing pins are removed from the spindle locking points so that the drum spindles can be released.
2) The drum spindle is lifted off the trailer by using a suitable choked sling and lifting device.
3) The spindle contains two tapered mounting bearings, one each end. The bearing on one end of the spindle is removed by loosening the securing bolts.
4) The spindle is manoeuvred to the drum position and pushed through the spindle hole in the cable drum.
5) The spindle is centred and the tapered bearings are tightened.
6) The lifting device is then used to lift the cable drum onto the trailer where it is lowered into the spindle gauges. Suitable chains or slings are used and care must be taken to prevent slippage of the slings. Care must be taken to ensure that that the drums are rotated the correct way for ploughing operations.
7) Once the drum has been located in the spindle gauges, the locking pins are replaced and the slings/chains are removed from the spindle.

Note: All cable drums should be checked for protrusions, nails and damage before any cable is flaked off.

This operation is repeated until all the required drums are loaded onto the cable trailers.
Loading cable trailers is a three-man operation.

Once the cable drums are loaded, they can be installed into the plough chute as noted below.

Photo 5-6 – Tracked dozer pulling multi drum trailers

Installing Cables into Plough Chute

The outer end of the cable is released from the drum fixing and if a single drum is to be used, the cable is fed manually down the plough chute. When the cable appears at the bottom of the chute it can be pulled to its laying position where a webbed sling is choked around the cable and fixed to a suitable anchor point (normally an excavator). The cable is then ready to be installed.

If multiple drums are to be used, each cable end is released from the drum fixing. The cables are then individually choked onto the lifting device and fed from the trailers to the crawler.

The crawler will have a roller assembly attached to its roof. The cables will be fed through the roller assembly and onto the plough (the top frame of the roller opens up for easy installation of the cables). A guide or empty cable drum provides a support for the cable prior to it's entry down the plough chute.
Cable continues to be pulled off the cable drum moving towards the plough chute until sufficient cable is pulled off for loading into the chute.

At this point the webbed sling is re-positioned on the cable to support the weight of the cable whilst it is manually fed down the appropriate hole in the plough chute as directed by the plough operator.

This procedure is repeated until all cables are installed down the chute. Sufficient cable is pulled off the drum to the cable termination/jointing position. At this point a webbed sling is choked around the cables and fixed to a suitable anchor point (normally an excavator). The cable is then ready to be installed.

The correct combination of cables/fibre/earthwire and warning tapes are installed and fed down the plough chute in the correct layout.

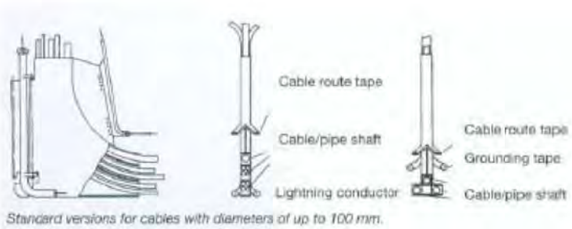


Photo 4 – General chute arrangement (Can be altered to accommodate many applications).

Starter Hole Excavation

Please refer to **Starter Pit / Joint Bay Excavation Method Statement**

Ploughing of Cables

On soft terrain, a specific on site risk assessment will be made noting any soft/bog areas prior to ploughing. The control measures may include the use of bog mats or appropriate matting to be placed to allow plough and equipment along the route. In soft/wet conditions the MAN tractor unit is replaced by the DOLL tracked winch or by the FWF-82 winch unit. **(Refer to the equipment list and ground pressure specifications in Appendix 3).**

When the plough is in place, the winch unit moves forward paying out the winch rope as it proceeds. The winch rope can be extended up to 150mtrs. The winch unit then deploys the ground anchor having ensured that no underground services can be damaged in the process.

Note: All staff and visitors must be kept clear of winch bond during pulling operations as the bond will pull straight as pressure is applied.

When the plough operator is satisfied that everything is in order he will give the order for the winch driver to start winching operations by hand signal or two way radio. The winch operator has to turn around in the winch cab before he can operate the winch. This ensures that the winch operator and plough operator are in constant eye contact. The plough is pulled forward and the cable passes down the chute into the track prepared by the cutting action of the plough leading edge.

Steering of the plough is by hydraulic pressure generated by the ploughs independent engine unit.

When the plough has moved forward 5-6 meters, sufficient ground resistance is generated to grip the cable thereby enabling the restraint mechanism to be released. Ploughing continues until the required length of cable is installed in the ground. When the inner end of the cable is approaching the last few turns on the cable drum, the cable is released from the drum securing point. The cable ends are then allowed to enter the plough chute. The plough operator and supervisor are then able to mark this position so that a joint bay can be excavated at this point.

The chute allows for feeds to pole installations to be carried out by flaking of cable or unbolting the back of the plough chute and pulling the cable out. The drum is then removed from the spindle and a new drum loaded. Once loaded, the cable installation can proceed as noted above

When multiple cable circuits are to be laid in parallel, minimum spacings must be adhered to but in general multiple circuits will be laid at least 1000mm apart.

Photo 7-8 – Plough Train in Operation on Job Site

Winch Bond Safety

The winch bond is made up of multiple layers of wrapped wire strands. If the winch bond should fail, this construction prevents the winch bond from simply snapping which would cause a shock loading on the bond and allowing the bond to "whip". Due to the nature of the bond, if it was to fail, the strands would give way one at a time causing a "slow" release of stored energy in the bond. (It looks as if the bond is stretching).This will allow the bond to fall safely to the ground. The release in pressure signals the winch operator of a problem and will therefore be investigated.

Working on Soft Ground

During ploughing operations, there may be areas of soft ground which need to be crossed. In order to cross these areas as safely and as quickly as possible, the following steps should be taken –

1) Plant operators to walk proposed route prior to taking heavy items of plant and machinery into areas of soft ground.
2) Peat probing can take place to determine depth of soft layers.
3) If depth of peat is thought to be shallow enough to carry out plough operation without a high risk of bogging, then this can proceed as normal.
4) If depth of peat is thought to add a reasonable level of risk to the task then further discussions need to take place.
5) Project Manager/Site staff to determine best way of crossing soft area – Change route, use bog mats, use low ground pressure plant, attach additional winch bonds etc.
6) In general, the plough blade can be made to "run deeper" so that the plough unit will not sink in the soft ground but will run on top of the solid lower layer of sub soil.
7) The winch unit/tracked plant can alter route and go around the area of soft ground before re-aligning with the proposed route. The winch unit can then winch the plough along the proposed route.
8) If required, prior to winching operations additional bonds can be used to attach the cable train to the plough unit so that the winch can pull all of the vehicles across the area of soft ground. When all of the vehicles are across the area of soft ground the additional bonds can be removed.
9) If any item of plant does become bogged, quick action is required BUT a RA must be discussed between all interested parties so that the bogged machinery can be de-bogged safely and quickly. Please refer to **De-Bogging of Machinery Method Statement CDM-MS-011**.

Working on Steep Slopes/Side Slopes

During ploughing operations, there may be areas of steep slopes/side slopes which need to be crossed. In order to cross these areas as safely and as quickly as possible, the following steps should be taken –

1) Plant operators to walk proposed route prior to taking heavy items of plant and machinery into areas of steep/side slopes.

2) Plant operators to assess the route and produce RA detailing issues found. Operator to determine the safe working limit for their particular machine for working on slopes. If the slope is steeper than the operating limit of the machine and the experience of the operator, then that particular machine/operator must not access that particular sloped area.

3) Alternative options when working on slopes may include –

   Option 1 - Change proposed cable / access route
   Option 2 - Excavation of access track or ramps
   Option 3 - Winching of plough from safe position on slope

4) When deciding which alternative to take, the project staff in discussion with plant operators will determine what level of risk is appropriate to each particular location of slope.

5) **Option 1** - Change proposed cable / access route to a safer route.

6) **Option 2** - Excavation of access track or ramps. A site access track or ramp will be excavated into the slope to minimise the steepness of a slope. This may need to continue for some distance but if required, will be fully reinstated on completion of cable works. The Plough train will then follow this track in order to carry out cable installation. Care must be taken not to allow any debris/boulders to roll downhill. This may mean that catch fencing may need to be installed.

7) **Option 3** - Winching of plough from safe position on slope. This can be carried out by attaching a suitable bond to an anchor point on the plough. The winching machine must be of suitable size/weight and must be positioned in a safe manner with its ground anchor fully deployed. The winch can then be released allowing the plough to be slowly lowered down the slope. The plough will lay cable as it goes with the plough blade also acting as a ground anchor.

8) When the plough reaches a safe location either at the bottom of the slope or at a safer intermediate position, the winch bond can be detached from the plough allowing the winch to reposition in a new position prior to the next winching action takes place.

Appendix 1 Equipment List

Cable Plough FSP-18

Height work:	1.84 meter
Height transport on the Trailer:	3.95 meter
Width min:	1.90 meter
Width max:	6.00 meter
Weight:	17.8 tonnes

MAN Truck FWF-70

Height:	3.95 meter
Width:	2.55 meter
Weight:	14.8 tonnes

Cable Plough FSP-22

Height work:	1.84 meter
Height transport on the Trailer:	3.95 meter
Width min:	2,15 meter
Width max:	5,50 meter
Weight:	18.5 meter

Crawler Winch FWF-82

Height:	3.43 meter
Width:	2,95 meter
Weight:	26,5 tonnes

Crawler Winch Doll

Height	2.70 meters
Width	2.95 meters
Weight	18.5 tonnes

Plough Trailer

Height:	1.35 meters
Width:	2.50 meters
Weight:	10.5 tonnes

Cable Trailer (self made)

Height:	2.30 meters
Width:	2,35 meters
Weight:	3.00 tonnes

Part Truck

Height:	3.30 meters
Width:	2.45 meters
Weight:	7.40 tonnes

Ground Pressure

Plough FSP 18	0.96 kg / cm²
Plough FSP 22	0.98 kg / cm²
Man Truck	1.35 kg / cm²
Cable Trailer	1.27 kg / cm²
Crawler Winch (Doll)	0.25 kg / cm²
Crawler Winch (FWF-82)	0.30 kg / cm²

Winch Bond Details (Doll)

Length	125 meters
Diameter	42 mm
Pull Max (single line)	70 tonnes
Speed	0.50 m per min.

Winch Bond Details (FWF-82)

Length	112 meter
Diameter	44 mm
Pull Max (single line)	80 tonnes
Speed	0.50m per min.

Appendix 6.

Relevant Sections from Strathy South Track Impact

Assessment Report 5 referred to in Report 5b.

1. Introduction

1.1 Background

Scottish Natural Heritage (SNH) raised a number of objections in response to the Scottish and Southern Energy planning application submitted in 2007 to build a 77 turbine wind farm at Strathy South, Sutherland.

These issues have been addressed by RPS through consultation with SNH and through specifically commissioned fieldwork. A total of five reports have resulted and are being used to inform the Environmental Statement Addendum, which now comprises a scheme reduced in size to 68 turbines.

Report 1 provides an overview of all five reports including a timeline of events, a summary of findings and further background information.

This report (Report 5) addresses SNH's concerns over habitat impacts on the Caithness and Sutherland Peatlands Special Area of Conservation (SAC) from access track construction, grid connection and the possible effects of increased grazing from deer displaced from Strathy South Forest following forest removal.

1.2 SNH's Concerns Regarding SAC Impacts

In a letter to the Scottish Government dated 25th September 2007, SNH provided a detailed formal objection to the SSER Section 36 application based on a range of nature conservation issues, including "probable adverse effects on qualifying interests of the Caithness and Sutherland Peatlands SAC". More specifically, SNH had concerns regarding the proposed access track between Strathy North Forest and Strathy South, the widening of the track crossing Yellow Bog connecting the two areas of Strathy South Forest, and the location and effects of the required grid connection for the wind farm:

> *"SNH's advice is that there are likely to be significant effects on the peatland habitat qualifying interests of the site* [the SAC]. *SNH's view is that as a consequence the Scottish Executive is required to undertake an appropriate assessment of the implications of the proposal for the site in view of the site's conservation objectives for its qualifying interests. SNH's appraisal of the effect of the proposal on site integrity, based on information in the ES, is as follows:*
>
> *Probable adverse effects on blanket bog as a result of the associated, though not applied for, grid connection from the proposed scheme at Strathy North and from Strathy South to the Beauly-Dounreay 275 kV line...*
>
> *...the access track and associated cabling between the Strathy North and South would fail the conservation objectives of the site and that therefore it will not be possible to ascertain that there will be no adverse effect on site integrity..."*

In their September 2007 letter, SNH also requested further information on deer management, which:

> *"...must ensure that no damage through deer grazing on the SAC will occur as a result of the proposal"* and stated that *"Monitoring, thresholds and feedback to management actions need to be agreed prior to determination in order to satisfy the requirements of the Habitats Regulations."*

A preliminary report by RPS[1] dealing with concerns raised by SNH regarding the access track from Strathy Village to Strathy North Wind Farm was submitted in March 2008. SNH responded to this by letter, dated 29 May 2008, indicating their continued concerns "...regarding track widening in the area will likely have a significant effect on the qualifying interests of the peatland habitat of the adjacent Caithness and Sutherland SAC...[and]...potential impacts on non-SAC blanket bog habitat as a result of the access track to Bowside Lodge".

Further work was carried out to address these concerns with the combined results presented in RPS (2010)[2] to the satisfaction of SNH.

The above comments regarding the proposed Strathy South Wind Farm access track presented in the 2007 ES relate to the proposed access track originating from near Loch Meala on the south-west edge of Strathy North Forest and running across the SAC to Strathy South Forest (referred to in the 2007 ES as the Knoc Meala track). Subsequent to the 2007 ES, a range of options were explored for alternative, less intrusive access routes. Results from this appraisal, which were further informed through consultation with SNH (email, Alec Macdonald: 07 May 2012), are presented in a separate report (Strathy South Access Routing Assessment Report – not available at time of writing).

Following further consultation with SNH, the Access Routing Assessment Report identified the existing forest track, which runs north from the north-east corner of Strathy South Forest, to be the least damaging option. This access route therefore forms the basis of assessment in the current report. As this route also passes through the SAC and, taking into consideration SNH's comments above regarding the segment of the then proposed Strathy North Wind Farm access track running adjacent to the SAC, it is recognised that an assessment of the potential construction related effects of the now proposed Strathy South Wind Farm access track is necessary. Similarly, due to the proposed upgrade of the existing track crossing Yellow Bog, and the fact that this track also runs through the SAC, an assessment of the impacts of this track is also required.

Report 5 will therefore seek to deal with the concerns raised by SNH regarding the widening of both the access track to Strathy South (from Strathy Wood), the possible creation of an access track from the southern area of Strathy North Wind Farm into Strathy Wood, and the track crossing Yellow Bog. The report will also address the issues raised surrounding the location of the required grid connection linking the proposed Strathy South Wind Farm to Strathy North Wind Farm.

Information on deer density at Strathy South, an assessment of likely impacts on the SAC and proposed mitigation of these impacts are also included in Report 5 (which also supersedes the previous RPS report[3] on this issue).

2. Existing and Proposed Access Tracks and Grid Connection Cabling Route

1 RPS (2008) Strathy North Wind Farm Access Track: NVC Habitat, Extent & Condition. A Report for Scottish & Southern Energy Renewables.

2 RPS (2010). Strathy North Windfarm, Report 5: An Assessment of Impacts of Access Track Construction and Deer Grazing on the Caithness and Sutherland Peatlands Special Area of Conservation. A Report for Scottish and Southern Energy Renewables.

3 RPS (2007). Strathy Wind Farm. A Deer Population Assessment. A Report for Scottish and Southern Energy Renewables.

2.1 Route Description

During the EIA process a number of options were investigated to provide access to Strathy South.

The route of the proposed access track for Strathy South Wind Farm (Figure 1) would utilise the upgraded and new infrastructure to be created for Strathy North Wind Farm, circumventing the requirement for upgrading the 3.1 km stretch of access track adjacent to the SAC which runs south of the Strathy North Forest Entrance to Strathy Wood.

A newly constructed track is proposed to connect Strathy North Wind Farm infrastructure to the current forestry access track passing through Strathy Wood. This access track would exit the southern boundary of Strathy North Wind Farm (at NC 809 555), cross a proposed new watercourse crossing over the River Strathy, and pass through part of Strathy Wood to join the existing access track at the boundary of Strathy Wood and the SAC (at NC 813 548). This part of the track will be referred to throughout Report 5 as Segment 1.

The proposed access route from Strathy Wood to the boundary of Strathy South Forest would use the existing forestry access track. This segment of track is approximately 2.1 km in length and is bound on both sides by the SAC. Details of the current characteristics of this track, and the current level of disturbance from the track's historic construction and maintenance, is presented in Section 2.3 of this report. Photographs showing the current state of the track can be seen in Appendix 1. For the purposes of the development, this segment of the access route will require upgrading and will be referred to throughout Report 5 as Segment 2.

The track crossing Yellow Bog is approximately 1 km in length and is bound on both sides by the SAC. Current characteristics of the track, and the level of disturbance due to the tracks historic construction and maintenance, are detailed in Section 2.3 of this report, with Appendix 1 showing the current state of the track. Throughout Report 5 the Yellow Bog track will be referred to as Segment 3.

Table 2.1 below shows the segments of the track, their approximate length, and their proximity to the Caithness and Sutherland Peatlands SAC.

TABLE 2.1 – Strathy South Access Track (refer to Figure 1 for locations)

Segment	Description	Length	Protected status
1	Proposed new track crossing to Strathy Wood from Strathy North Wind Farm	Circa 1.45 km	Non- SAC habitat
2	Existing track running from Strathy Wood to Strathy South	Circa 2. km	Through SAC
3	Existing track crossing Yellow Bog	Circa 0.96 km	Through SAC

It is proposed that the required grid connection cabling route would run immediately adjacent to the route of Segments 1 and 2 of the access track, thus minimising the cumulative disturbance to habitats due to this component of the development. Any cabling required across Yellow Bog will be sited within the existing track and therefore it is not considered this will create any additional impact over that considered for track upgrade works outlined in the current report.

2.3 Baseline Conditions

2.3.3 Habitats

2.3.3.1 Track Segment 1

Segment 1 is dominated by a mixture of standing and clear-felled coniferous plantation woodland, with lesser areas of wet modified and blanket bog habitats including the NVC communities M17 Trichophorum cespitosum – Eriophorum vaginatum mire and M25 Molinea caerulea – Potentilla erecta mire. Details of the composition of these communities can be seen in Appendix 2 with Figures 2a and 3a showing the locations of the individual Phase 1 habitats and NVC communities.

2.3.3.2 Track Segment 2

Habitat Survey results for Segment 2 of the access track show the surrounding SAC to be dominated by a mixture of blanket bog and wet heath habitats; M17 Trichophorum cespitosum – Eriophorum vaginatum mire and M15 Trichophorum cespitosum – Erica tetralix wet heath. As indicated in Section 2.3 above, the existing track has a footprint of approximately 4.5 m and the total width of visible disturbance including the track extends to 20.9 m. Watercourses in the area, and the habitat directly adjacent to the existing forestry track (including old peat spoil piles), are dominated by the marshy grassland / wet modified bog community M25 Molinea caerulea – Potentilla erecta mire where mesotrophic influences and disturbance have allowed a more nutriophilic sward to develop. The peat spoil piles contain little or no bog moss (Sphagnum spp.) which is uncharacteristic of the M25 community. Details of the distribution of these Phase 1 habitats and NVC communities can be seen in Figures 2b and 3b.

2.3.3.3 Track Segment 3

Segment 3 crossing Yellow Bog is surrounded by the SAC and the dominant Phase 1 habitat type is blanket bog comprised of NVC community M17 Trichophorum cespitosum – Eriophorum vaginatum mire. As with Segment 2, areas of disturbance along the track's verges where construction has influenced the species present has created a buffer of wet modified bog; NVC community M25 Molinea caerulea – Potentilla erecta mire lacking in bog moss species. Small areas of dry heath dominate where shallow soils are present. These areas are comprised primarily of NVC community H10 Calluna vulgaris – Erica cinerea dry heath. These areas represent less than 2% of the habitat coverage adjacent to the track. Details of the distribution of these Phase 1 habitats and NVC communities can be seen in Figures 2c and 3c.

3. Assessment of the Potential Impacts on Habitats of Conservation Interest

This section examines the potential for direct and indirect impacts on habitats and vegetation types of conservation interest along all segments of the access tracks and associated cabling works. Given the need to avoid impacts on SAC habitats, consideration has been given to the method of widening of the access tracks within the SAC's boundary (track Segments 2 and 3) and this approach is further discussed here. Other methods of mitigation in relation to track widening and the laying of cables are also discussed. Although only a small portion of the route of track Segment 1 passes through the SAC, limited impacts (both direct and indirect) will affect habitats found within the designated area.

Figure 1 shows the construction footprint required for the creation or widening of the access track, along with the adjacent cable route. The estimated average width of this footprint is 13 m for track Segments 1 and 2 and 8 m for track Segment 3. The assessment of potential direct impacts also includes a 10 m direct impact zone either side of proposed works and the associated grid connection (more detail on direct and indirect impact zones is provided in Sections 3.1 and 3.2). Hence, a total width of 33 m and 28 m has been used in assessing direct impacts for Segments 2 and 3 respectively. Appendix 1 details the methodology of the

habitat impact calculations in association with the assessment of impacts to habitats along all segments of the access track. Appendix 2 gives further visual information on the current levels of disturbance caused by previous construction and maintenance activities of existing tracks within the SAC's boundary.

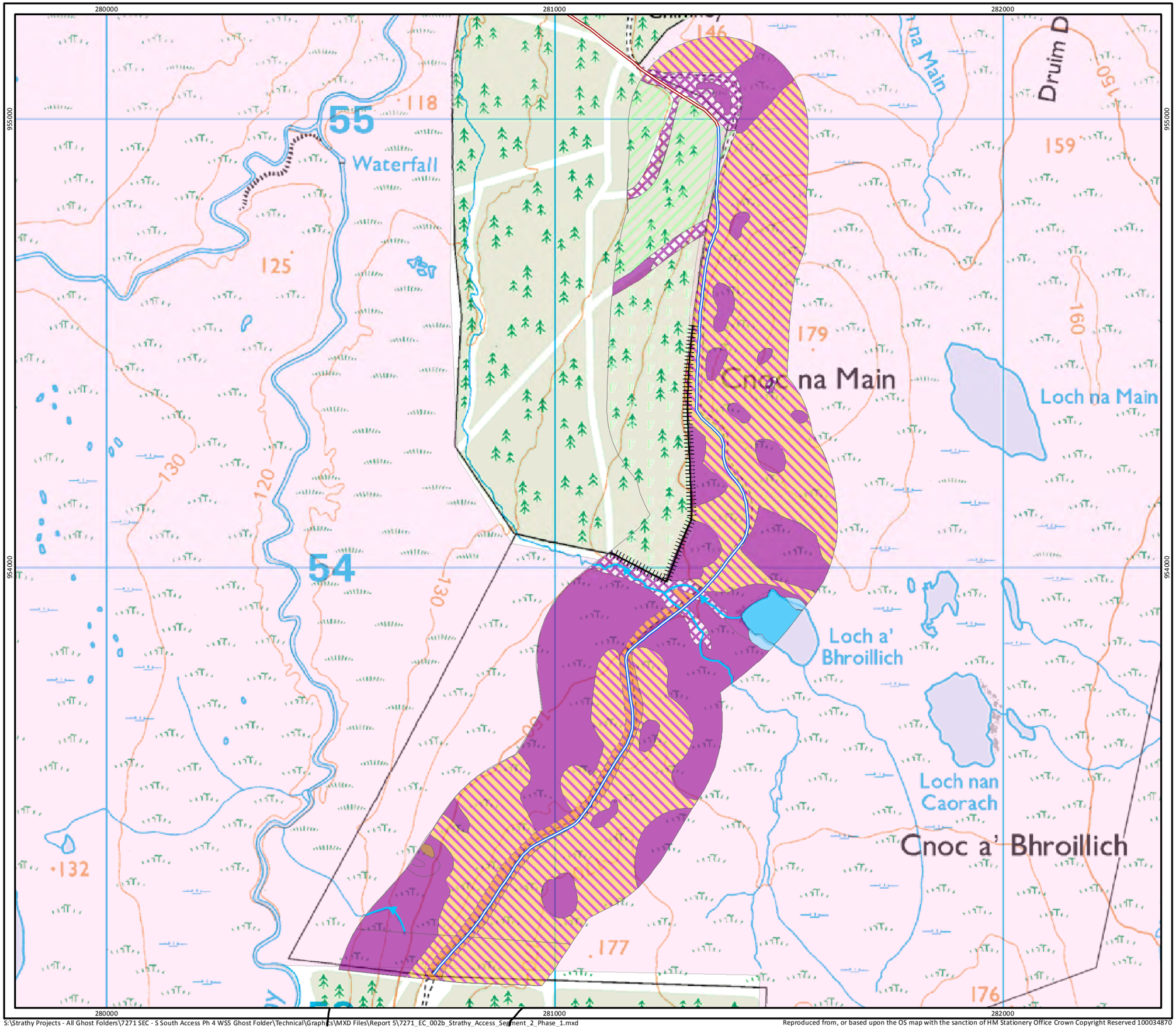
3.1 Potential Direct Impact on Habitats within the SAC

The main and most obvious direct impact to SAC qualifying habitats from track widening will be long term loss due to the incorporation of this ground into the tracks' infrastructure. In addition, habitat modification is likely to occur due to the presence of the road intercepting overland and sub-surface runoff, thereby significantly reducing the natural volume of water moving through and sustaining the original wet heath and blanket bog habitats.

Further potential also exists for changes in habitats adjacent to the track due to changes in water chemistry as a result of mineral material being transported via runoff or windborne dust generated by traffic. This particularly relates to situations where water containing mineral material and dissolved solids, drains on a regular basis on to blanket bog habitat possibly resulting in the conversion of these areas to a type of poor-fen habitat. Such changes have been observed at Farr, Scout Moor and Carno wind farms (authors personal observations and Maslen Environmental 20094). The vegetation type that typically establishes in these areas is the star sedge – bog moss mire (M6 of the NVC). The extent to which such a change in habitat will occur is dependant upon the quantity of water that issues from the drains, but it is typically only in the order of tens of square metres. This change in habitat type will result in minor loss to the quantity of qualifying habitat present in the SAC depending upon the level of modification already present in these areas from existing drains.

Drainage features and runoff controls will be specifically designed with the aim of reducing the current level of impact the track has on hydrological processes affecting the adjacent habitats. This may include creating a greater number of drainage pathways to improve the diffuse flow of water reaching habitats down slope of the track. However, consideration will also be given to the fact that historical drainage from the track has already caused changes to e.g. blanket bog habitats as outlined above. Therefore it is important that these modified habitats continue to be used as drainage pathways if this means impacts on unmodified habitats can be avoided.

4 Maslen Environmental (2009). Assessing environmental impacts of wind farm developments on blanket peatlands in England. Project Report and Guidance. Natural England, Kendal.



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC
- Running water
- Fence
- Coniferous woodland - plantation
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Blanket sphagnum bog
- Wet modified bog
- Flush and spring - acid/neutral flush
- Swamp
- Standing water

Scale 1:8,000 @ A3

0 65 130 260 m

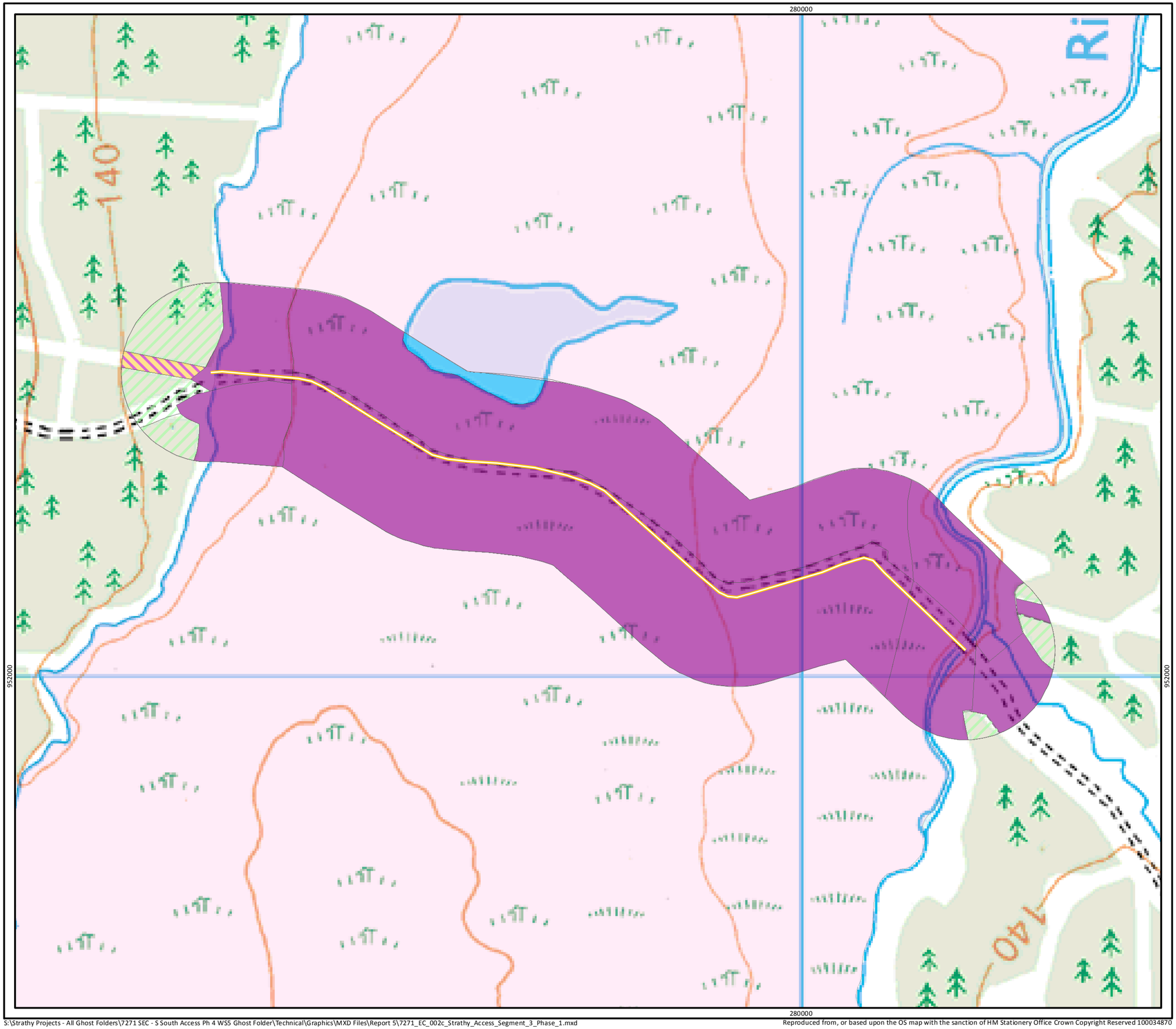
N

Figure 2b
Phase 1 Results
Access Route Segment 2

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_002b_Strathy_Access_Segment_2_Phase_1.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC
- Running water
- Fence
- Coniferous woodland - plantation
- Coniferous woodland - recently felled
- Neutral grassland - semi-improved
- Marsh/marshy grassland
- Bracken - continuous
- Wet dwarf shrub heath
- Blanket sphagnum bog
- Wet modified bog
- Flush and spring - acid/neutral flush
- Fen - valley mire
- Standing water

Scale 1:4,000 @ A3

0 40 80 160 m

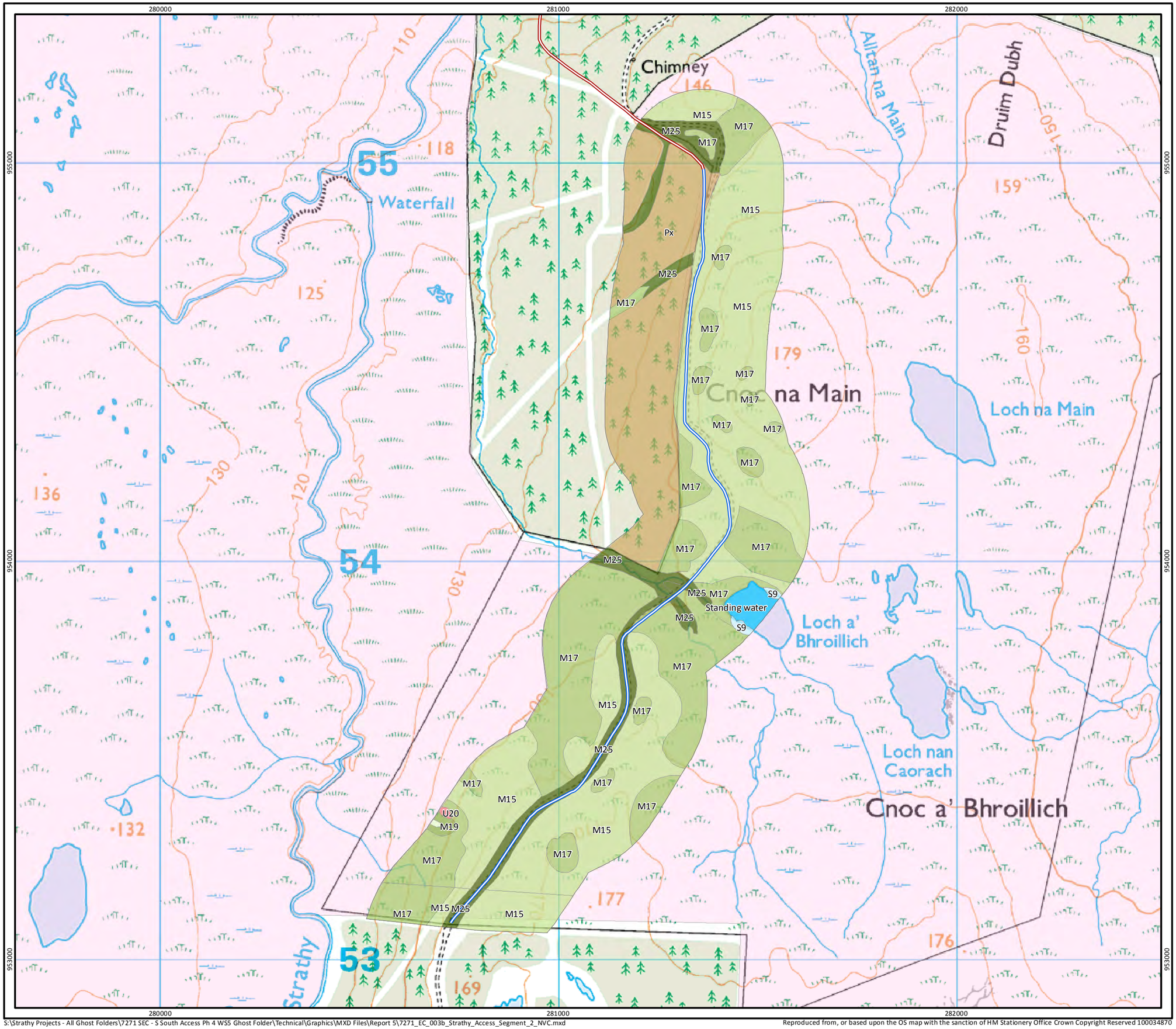
N

Figure 2c
Phase 1 Results
Access Route Segment 3

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_002c_Strathy_Access_Segment_3_Phase_1.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC

NVC habitats

- M4
- M15
- M17
- M19
- M25
- MG9
- S9
- U20
- Coniferous woodland
- Standing water

Scale 1:9,000 @ A3

0 75 150 300 m

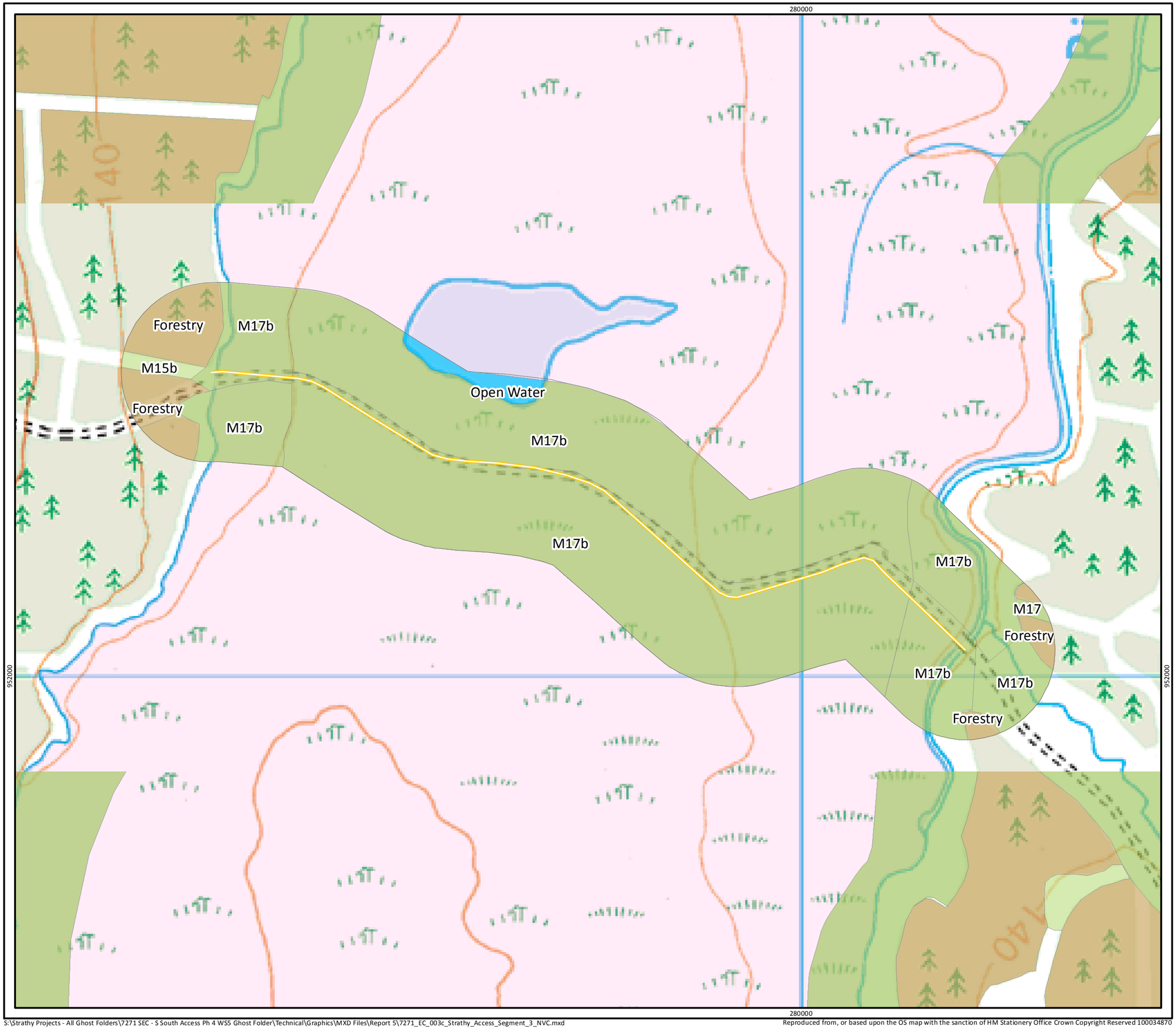
N

Figure 3b
NVC Results
Access Route Segment 2

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WSS Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_003b_Strathy_Access_Segment_2_NVC.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870



SSE Renewables

RPS

Key

Access Routes

- Segment 1: Strathy North to Strathy Wood
- Segment 2: Strathy Wood to Strathy South
- Segment 3: Yellow Bog
- Caithness and Sutherland Peatlands SPA and SAC

NVC habitats

- M4
- M15
- M17
- M19
- M25
- MG9
- S9
- U20
- Coniferous woodland
- Standing water

N

Scale 1:4,000 @ A3

0 40 80 160 m

Figure 3c
NVC Results
Access Route Segment 3

Strathy South Wind Farm Access
Report 5

S:\Strathy Projects - All Ghost Folders\7271 SEC - S South Access Ph 4 WS5 Ghost Folder\Technical\Graphics\MXD Files\Report 5\7271_EC_003c_Strathy_Access_Segment_3_NVC.mxd

Reproduced from, or based upon the OS map with the sanction of HM Stationery Office Crown Copyright Reserved 100034870

STRATHY SOUTH TRACK IMPACT ASSESSMENT REPORT
5: TECHNICAL APPENDICES 1 and 2

Appendix 1 – Previous and Current Habitat Surveys

Appendix 2 – Mapped Historical Areas of Disturbance and Current Photography of Track Segments 2 and 3

Appendix 1 – Previous and Current Habitat Surveys and Potential Habitat Loss

Habitat Surveys

In order to determine the habitat characteristics of the proposed route, a range of relevant habitat surveys were undertaken and information from these surveys has been drawn together. These surveys and their results are presented below.

Phase 1 and NVC Habitat Surveys for the ES (2004 and 2005)

Phase 1 Habitat Surveys and NVC Surveys were carried out at Strathy South, including along the access track and the original proposed access route from Strathy North Forest, in September and October 2004 and August 2005.

The results show the majority of the area to be dominated by coniferous plantation with the associated rides and clearings comprised of areas of wet dwarf shrub heath, acid flush, modified bog, marshy grassland, and blanket bog. The 500m buffer surrounding the forest and the original proposed Knoc Meala access track is dominated by blanket bog with occasional areas of wet heath.

NVC communities of note found within the survey area include the mire communities M1 *Sphagnum denticulatum* bog pools, M6 *Carex echinata – Sphagnum fallax* mire, M17 *Trichophorum cespitosum – Eriophorum vaginatum* mire, M18 *Erica tetralix – Sphagnum papillosum* mire, M19 *Calluna vulgaris – Eriophorum vaginatum* mire, M25 *Molinea caerulea – Potentilla erecta* mire, the wet heath community M15 *Trichophorum cespitosum – Erica tetralix* wet heath, the acid grassland communities U4 *Festuca ovina – Galium saxatile* acid grassland and U20 *Pteridum aquilinum – Galium saxatile* community, and the mesotrophic grassland communities or MG10 *Holcus lanatus – Juncus effusus* rush pasture and M23 *Juncus effusus / acutiflorus – Galium palustre* rush pasture.

RPS NVC Habitat Surveys (2011 and 2012)

Surveys by RPS in 2011 and 2012 gave updated descriptions of the habitats, vegetation types and plant species present within Strathy South Forest. Surveys similarly assessed considered access routes to the proposed Development including the preferred route SSE_01a (Figures 1). SSE_01a uses the infrastructure of the Strathy North Wind Farm, exiting Strathy North from its southern boundary to join the access track within Strathy Wood and continuing through Strathy Wood to the north-east entrance of Strathy South Forest.

Surveys along the proposed access track (SSE_01a) include a description of NVC and non-NVC plant communities present either side of the track along with mapped areas of existing disturbance to soils and plant communities adjacent to the track.

Methods

NVC Survey

An NVC survey was undertaken between the 5 and 9 July and 2 August 2011 of Strathy South Forest by two experienced botanical surveyors (Dr. Alistair Headley and Stephen Lockwood) to determine the NVC communities present within the proposed Strathy South Wind Farm development area, including the area adjacent to the linking track across Yellow Bog. A similar survey was conducted in August 2012 by Dr Eric Donnelly, identifying all NVC plant communities within 100 m either side of all considered access track routes.

Each definable area was individually mapped onto 1:10 000 OS mapping. These areas are referred to throughout the report as 'polygons'. Due to the complex nature of vegetation communities, there were numerous polygons in which several different communities were present forming a mosaic, each too small to be mapped individually. In these areas the composition of the communities within the mosaic was noted, including percentage cover values and the dominant community identified. Some areas within the site did not fit into the standard NVC nomenclature or the proposed revisions to the existing communities[1 2 3 4]. Where this occurred the vegetation was given a prefix for the community and the assemblage of species noted.

Aerial Photography mapping and ground-truthing to determine the existing disturbance to habitat

High resolution georeferenced aerial photography (25 cm resolution) was obtained for the Development area including areas surrounding the preferred access track SSE_01a and the track crossing Yellow Bog. Disturbance caused by the historical construction and maintenance of the existing segments of track crossing the Caithness and Sutherland Peatlands SAC (track segments 2 and 3) were highly visible due to the obvious disruption to the evident topography of the blanket mire, and the changes in colouration of habitats (purple moor grass – *Molinea caerulea* a dominant species of disturbed habitats appears white on aerial photographs, whilst ling heather – *Calluna vulgaris* dominant in dry heaths in black).

Both areas of existing track and visible patches of disturbance, where visible on the aerial photography, were digitised using ESRI ArcMap 10.1. Mapping was undertaken in a conservative fashion where photography was ambiguous, potentially under estimating the level of disturbance present. Area within the zones of disturbance and existing track were calculated giving a total area of disturbance for each segment of access track SSE_01a, and estimating the disturbance footprint caused to the SAC by the existing tracks which the upgraded tracks might be placed within.

Ground truthing of the estimations of disturbance levels were undertaken for track segment 3 (it was not deemed necessary to repeat these for segment 2 as the tracks are of similar construction through similar habitats). Results of the ground truthing can be seen in Appendix 3 along with the mapping results and photographs of the disturbance present along both track Segments 2 and 3.

Results

NVC Survey

Segment 1: Proposed new access track from Strathy North Wind Farm

This new section of the access track originates from the consented Strathy North Wind Farm infrastructure, across a proposed new bridge over the River Strathy and through Strathy Wood to join the existing Strathy South access track close to the boundary of the SAC.

[1] Rodwell, J.S., Dring, J.C., Averis. A.B.G., Proctor, M.C.F., Malloch, A.J.C., Schaminée, J.N.J., & Dargie T.C.D. (2000). *Review of coverage of the National Vegetation Classification.* JNCC Report No. 302. Peterborough: Joint Nature Conservation Committee

[2] Cooper, EA and MacKintosh, J (1996) *NVC review of Scottish grassland surveys.* SNH Review, No. 65.

[3] Wheeler, B.D., Shaw, S., & Tanner, K. (2009) *A wetland framework for impact assessment at statutory sites in England and Wales.* Environment Agency, Bristol

[4] Castle, G. and Mileto, R. (2003). Using the National Vegetation Classification (NVC) in woodland survey - 6000ha on. In: Goldberg, E. (Ed) *National Vegetation Classification – ten years' experience using the woodland section.* JNCC Report No. 335. Joint Nature Conservation Committee, Peterborough. Pages 76-86.

This section of the proposed route is dominated by forestry plantation of a mixture of standing and clear-felled areas including coniferous species such as spruce (*Picea spp.*), pine (*Pinus spp.*) and larch (*Larix spp.*). Rides within these plantation areas contain a mosaic of mire communities dependent on the peat depth, the disturbance the forestry has caused, and the hydrological influences surrounding the area. NVC communities found within these rides include M17 *Trichophorum cespitosum – Eriophorum vaginatum* mire, M15 *Trichophorum cespitosum – Erica tetralix* wet heath, and M25 *Molinea caerulea – Potentilla erecta* mire. The route of the proposed access track would require a new crossing over the River Strathy; however, there are no NVC communities of note at this location.

Segment 2: Existing access track south of Strathy Wood

This section of the access track runs south from Strathy Wood to the edge of the Strathy South Forest. The track is surrounded by the SAC on both sides for the majority of its length.

The dominant NVC communities throughout the area are:

- M17 *Trichophorum cespitosum - Eriophorum vaginatum* blanket mire communities with the M17b *Cladonia* spp. sub-community being most common, and
- M15 *Trichophorum cespitosum – Erica tetralix* wet heath communities with M15c *Cladonia spp.* typical sub-community being the most common.

M15 is the more extensive community within this section of the track. M15c is the most common sub-community and is dominated by deer grass, cross-leaved heath, and ling heather, with hare's tail cotton-grass (*Eriophorum vaginatum*) being scarce throughout, thus differentiating it from the M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire community not mapped within this section. Sphagnum mosses are rare within this community with only *Sphagnum capillofolium* being present in any measureable abundance, and only in patchy tussocks. M15c is the *Cladonia* rich sub-community, contains a short open sward of cross-leaved heath, bell heather, and deer grass. *Cladonia* lichens are frequently present throughout the sub-community as is woolly fringe moss (*Racomitrium lanuginosum*).

The M17 blanket mire community was co-dominated by deer-grass (*Trichophorum cespitosum*) and common heather (*Calluna vulgaris*). Constant species were hare's-tail cotton-grass, reindeer lichen (*Cladonia portentosa*) and cross-leaved heather (*Erica tetralix*). Cotton-grass and lichen were almost as extensive as the heather and deer-grass which therefore places the community as an M17b *Cladonia spp.* sub community. In wetter areas bog myrtle (*Myrica gale*) was present and in some cases dominated small areas. In many respects, this community appeared to be indicative of drier conditions although woolly fringe moss did not occur as frequently as could be expected in such conditions.

Areas of disturbance are present at the edges of the track where spoil and excavated peat from the construction of the cut through road have been piled. Where peat has been piled the areas have recolonised with assemblages of species similar to those of the M25 *Molinea caerulea – Potentilla erecta* community, however increased drainage within these section have not allowed for the recolonisation of Sphagnum species typically found beneath the grass sward.

Segment 3 - Yellow Bog linking track

The area surrounding the Yellow Bog linking track is dominated by the M17b *Trichophorum cespitosum – Eriophorum vaginatum, Cladonia spp.* sub-community as described above (approximately 85%). Peat depths across this area are typically between 0.5m - 1.5m in depth however there are some pockets of dry heath, NVC community H10 *Calluna vulgaris – Erica cinerea* dry heath in areas of disturbance. Other mire communities present include the M18 *Erica tetralix – Sphagnum papillosum* mire and M19 *Calluna vulgaris – Eriophorum vaginatum* mire. Spoil areas from track construction and maintenance are currently recolonising with M25 *Molinea caerulea – Potentilla erecta* mire communities dominated by purple moor grass (*Molinea caerulea*) where the peat extracted from the track's footprint has been piled. However, similar to section 2 of the access track, these areas are lacking Sphagna beneath the grass sward.

Appendix 2 – Existing Track Condition, Historical Areas of Disturbance, and Current Photography of Track Segments 2 and 3

The section below details the current existing disturbance present along the length of the access tracks passing through the SAC. Maps 2.1 – 2.4 below detail the areas of disturbance along the length of the existing tracks as described in Appendix 1, coupled with the current road layout and the predicted area of direct impact including the 10 m zone of direct impact as deemed appropriate by SNH. The current zone of disturbance is marked by the red outline, with the 10 m zone of disturbance by the blue lines.

Photographs 2.1 – 2.32 below show the existing tracks passing through the SAC, with photograph locations detailed in Table A2.1 below and marked on the road layout in Maps 2.1 – 2.4 using a yellow 'X'. In this way, the desk based mapping exercise is corroborated by ground based photography.

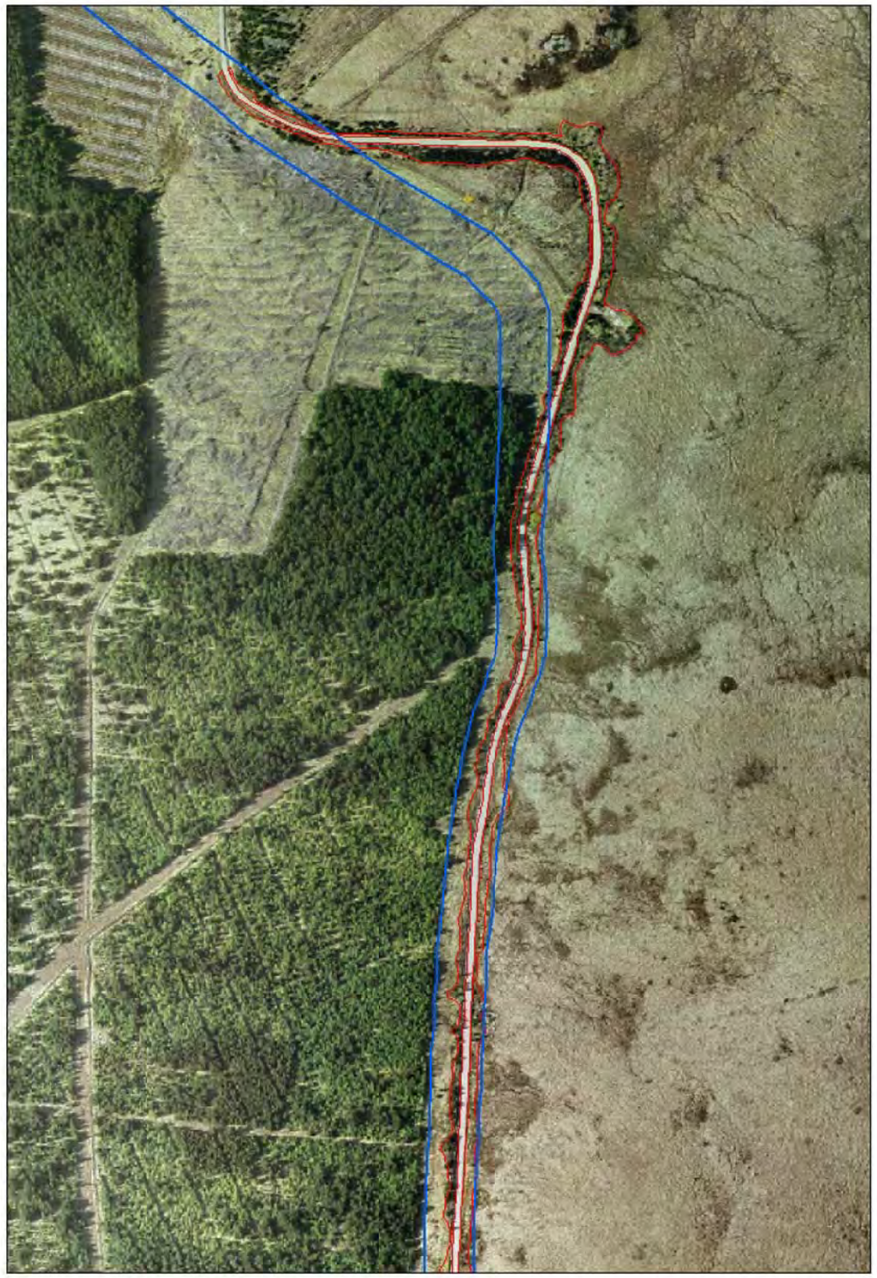
Table A2.1. Location of Photographs along the Length of the Track Segments 2 and 3

Location Number	Track Segment	easting	northing
1	**2**	281292	954335
2	**2**	281387	954168
3	**2**	281352	953991
4	**2**	281150	953816
5	**2**	281143	953607
6	**2**	281025	953427
7	**2**	280878	953300
8	**2**	280760	953138
1	**3**	280126	952791
2	**3**	230069	952098
3	**3**	279939	952054
4	**3**	279843	952121
5	**3**	279759	952187
6	**3**	279631	952209
7	**3**	279529	952249
8	**3**	279447	952298

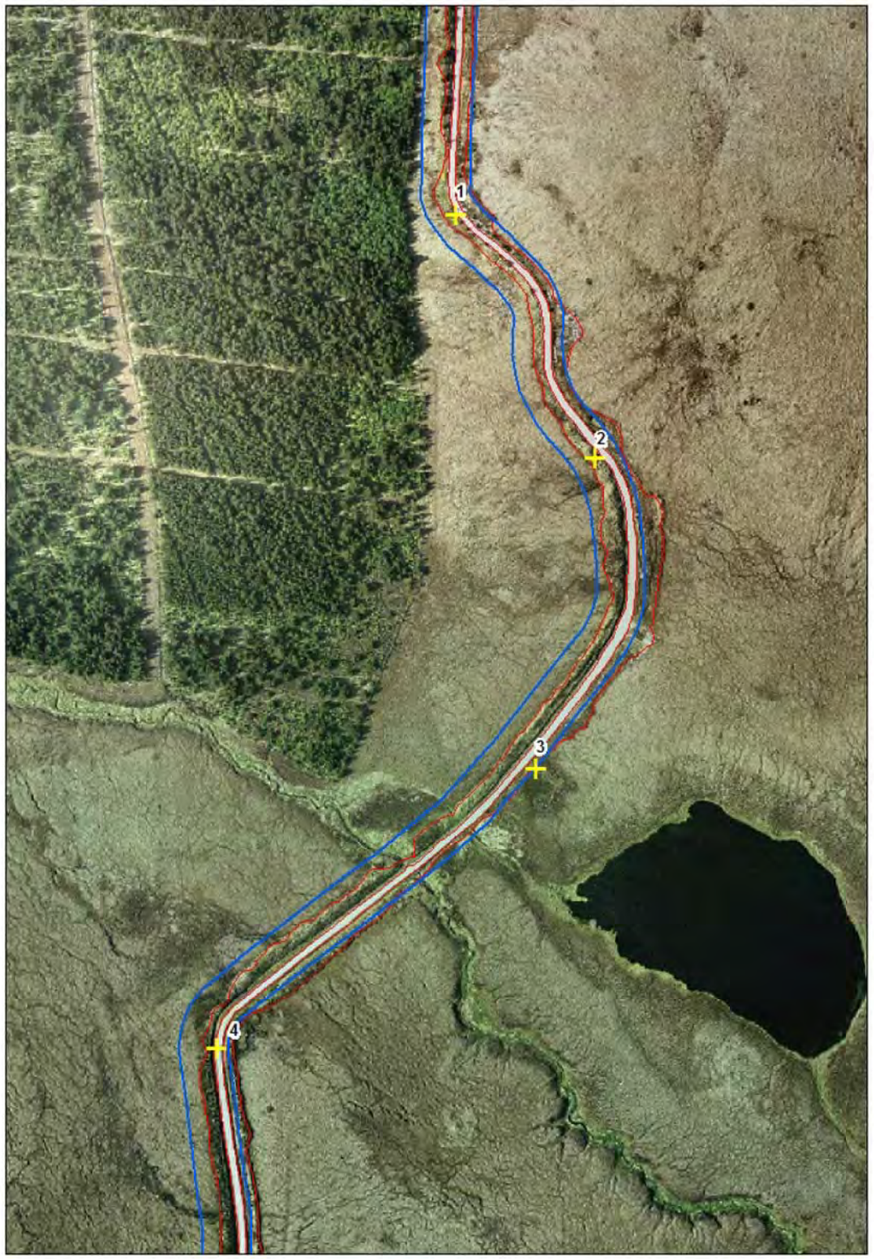
As an example of track condition, spot checks were taken every 100 m along the existing Yellow Bog track (Segment 3) (Table A2.2) in the same location as the track photographs above were taken. At each location the width of the track, the width of the existing ditches and areas of disturbance outside the ditch extent were measured.

Table A2.2. Running Width, Average Ditch Width and Average Disturbance beyond the Ditch Extent for Track Segment 3.

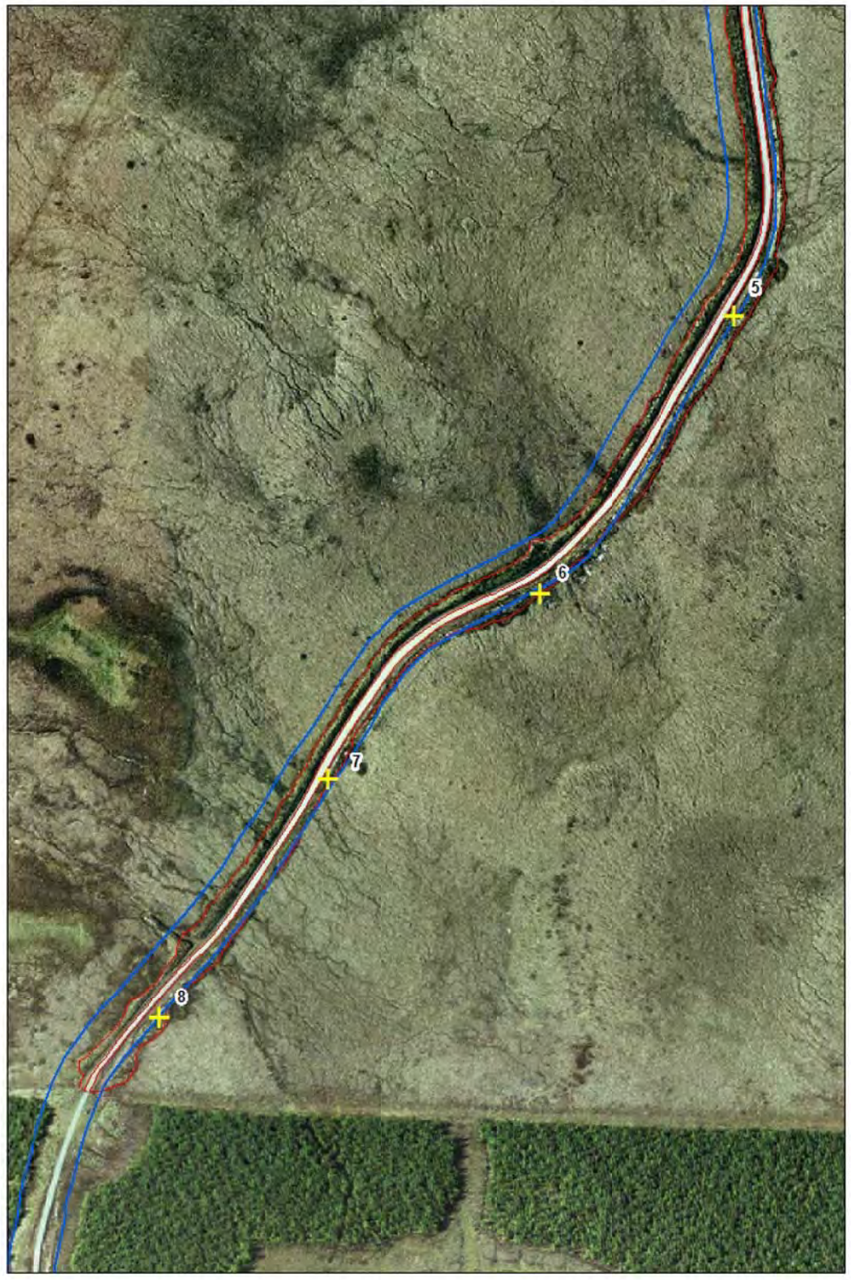
Yellow Bog Location No.	Road Width (m)	Average Ditch Width (m)	Average Width of Disturbance (m)	Total Disturbance Footprint (m)
1	3.6	0.0	9.45	22.5
2	4.6	4.0	0	12.6
3	3.6	3.4	10.95	32.3
4	4.7	3.8	7.6	27.5
5	5.2	2.8	7.35	25.5
6	4.7	3.1	4.9	20.6
7	3.8	3.2	7.5	25.2
8	3.7	3.7	10.25	31.6



Map 2.1



Map 2.2



Map 2.3

Map 2.4

Photographs 2.1 and 2.2 below showing the views south and north respectively from mapped point 1.

Photographs 2.3 and 2.4 below showing the views north and south respectively from mapped point 2.

Photographs 2.5 and 2.6 below showing the views north and south respectively from mapped point 3.

Photographs 2.7 and 2.8 below showing the views north and south respectively from mapped point 4.

Photographs 2.9 and 2.10 below showing the views north and south respectively from mapped point 5.

Photographs 2.11 and 2.12 below showing the views north and south respectively from mapped point 6.

Photographs 2.13 and 2.14 below showing the views north and south respectively from mapped point 7.

Photographs 2.15 and 2.16 below showing the views north and south respectively from mapped point 8.

Photographs 2.17 and 2.18 below showing the views north and south respectively from Yellow Bog mapped point 1.

Photographs 2.19 and 2.20 below showing the views north and south respectively from Yellow Bog mapped point 2.

Photographs 2.21 and 2.22 below showing the views north and south respectively from Yellow Bog mapped point 3.

Photographs 2.23 and 2.24 below showing the views north and south respectively from Yellow Bog mapped point 4.

Photographs 2.25 and 2.26 below showing the views north and south respectively from Yellow Bog mapped point 5.

Photographs 2.27 and 2.28 below showing the views north and south respectively from Yellow Bog mapped point 6.

Photographs 2.29 and 2.30 below showing the views north and south respectively from Yellow Bog mapped point 7.

Photographs 2.31 and 2.32 below showing the views north and south respectively from Yellow Bog mapped point 8.

Photograph 2.33 showing the track crossing Yellow Bog towards the west showing the type of habitats on which direct impact may occur due to track widening (flags are set 10 m from edge of running surface).

Photograph 2.34 showing the track crossing yellow bog towards the west showing the type of habitats of habitats present within the current 10 m zone of disturbance.

STRATHY SOUTH WIND FARM

TECHNICAL APPENDIX A11.2: MANAGEMENT AT STRATHY SOUTH: FOREST REMOVAL, HABITAT MANAGEMENT AND AN ASSESSMENT OF THE EFFECTS ON BIRDS CONNECTED WITH THE CAITHNESS AND SUTHERLAND PEATLANDS SPECIAL PROTECTION AREA

JULY 2013

NON-CONFIDENTIAL VERSION

16 July 2013

Project Number: SEC7232

RPS
Ocean Point One
4th Floor
94 Ocean Drive
Edinburgh
EH6 6JH

Tel: 0131 555 5011
Fax: 0131 555 4911
Email: zismans@rpsgroup.com

QUALITY MANAGEMENT

Prepared by:	Name:	**Matt Pannell** **Colin Ormston** **Brian Wallis** **Dr. Simon Zisman**	Title:	**Senior Ecologist** **Senior Ornithologist** **Technical Director** **Operational Director**
	Signature:			
Reviewed by:	Name:	**Matt Pannell** **Dr. Simon Zisman**	Title:	**Senior Ecologist** **Operational Director**
	Signature:			
Authorised by:	Name:	**Simon Zisman**	Title:	**Operational Director**
	Signature:			
Current Status:	**Final**			
Issue Date:	**16 July 2013**	Revision Number:	**1**	
		Revision Notes:	**-**	
Project File Path:				

This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001 : 2008

COPYRIGHT © RPS

The material presented in this report is confidential. This report has been prepared for the exclusive use of SSER and shall not be distributed or made available to any other company or person without the knowledge and written consent of SSER or RPS.

REPORT TEMPLATE

TYPE:	Technical
ISSUE DATE:	18 May 2011
REVISION NUMBER:	1
REVISION DATE:	26 April 2012

CONTENTS

1 INTRODUCTION 1

1.1 Confidentiality Request 1
1.2 Background 1
1.3 Purpose of this Technical Appendix A11.2 1
1.4 Considerations in Relation to Policy and Guidance 2
1.5 Structure of Technical Appendix A11.2 2
1.6 Qualifying Species 3

2 PHYSICAL CHARACTERISTICS OF STRATHY SOUTH 5

2.1 Landform 5
2.2 Geology 5
2.3 Soils 5
2.4 Peat Characteristics 5
2.5 Hydrogeology and Hydrology 5

3 THE NATURE OF STRATHY SOUTH HABITATS AND CONIFER PLANTATION 7

3.1 Historic Land Management of Strathy South and Its Surrounding Area 7
3.2 Current Land Management of the Surrounding Area 7
3.3 Non-Forested Habitats Within Strathy South 10
3.4 Preparation and Planting of the Strathy South Plantation 10
3.5 Aftercare of Forested Habitats 12
3.6 Composition of the Plantation 12
3.7 Strathy South Forest Condition Assessment 13

4 FOREST REMOVAL 15

4.1 Forest Removal Rationale 15
4.2 Constraints and Considerations Influencing Tree Removal Approach 16
4.2.1 Policy Considerations 16
4.2.2 Physical Considerations 17
4.3 Forest Removal and Harvesting Plan Objectives 18
4.4 Forest Removal and Harvesting Plan 19
4.4.1 Mulching 19
4.4.2 Basal Shearing 19
4.4.3 Conventional Harvesting – Shortwood Systems 20
4.4.4 Whole Tree Harvesting 20
4.4.5 Preferred Tree Removal Options 20
4.4.6 Harvesting/Forest Removal Operations 21
4.4.7 Proposed Phasing of Forest Removal 22
4.5 Conclusions in Relation to Felling 22

5 POST-CLEARANCE LAND MANAGEMENT AND THE ASSESSMENT OF ITS EFFECTS ON SPA QUALIFYING SPECIES 23

5.1 Assessing the Timescale and Nature of Vegetation Recolonisation and Succession on Mulched and Harvested Forestry at Strathy South 23
5.1.1 Mulch Thickness 23
5.1.2 Underlying Vegetation 26
5.1.3 Wetness 26
5.1.4 Slope 27
5.1.5 Soil Disturbance 27
5.1.6 Conifer Regeneration 27

5.2 Predicted Sequence and Duration of Recolonisation of the Wind Farm, and the Resulting Evolution of Bird Activity 28
5.2.1 RSPB Forsinard Flows Reserve Peatland Regeneration....28
5.2.2 Evidence of Succession Following Mulching at Rothes Wind farm....32
5.3 Management of Vegetation Following Forest Removal....33
5.4 Vegetation Management Conclusions 33
5.5 The Strathy South Outline Habitat Management Plan 34

6 CONFIDENTIAL: SPECIES ACCOUNTS: AN ASSESSMENT OF PREDICTED EFFECTS ON SPA QUALIFYING SPECIES 35

FIGURES....36

1.Figure A11.2.1 – Strathy South Forest Unit and Compartment Plan 36
2.Figure A11.2.2 – Strathy South Planting Years 36
3.Figure A11.2.3 – Strathy South Forest Yield Classes with Sub-Compartments 36
4.Figure A11.2.4 – Strathy South Forestry Yield Classes with Woodland Areas 36
5.Figure A11.2.5 – Strathy South Outline Habitat Management Plan 36

APPENDIX 1 – FORESTRY COMPARTMENT DETAILS FOR STRATHY SOUTH 37
APPENDIX 2 – FOREST SURVEY RESULTS 43
APPENDIX 3 – DETAILS OF 2009 ADDITIONAL BIRD SURVEYS 47
APPENDIX 4 – OUTLINE HABITAT MANAGEMENT PLAN 65

1 INTRODUCTION

1.1 Confidentiality Request

The original version of this report contains sensitive information on nesting locations of species protected by Schedule 1 of the Wildlife & Countryside Act 1981 (as amended) and/or Annex I of the EU Birds Directive. Its distribution has therefore been restricted to SSE, SNH and RSPB Scotland. This is the non-confidential version of the document.

1.2 Background

As explained in the Introduction of Technical Appendix A11.1, -Scottish Natural Heritage (SNH) (and the Royal Society for the Protection of Birds, RSPB Scotland) raised a number of objections and concerns in response to a SSE Generation Ltd (SSEG) proposal to build a 77 turbine (177 MW) wind farm at Strathy South, Sutherland in an area currently under commercial forestry plantation.

SSE Renewables (UK) Ltd (SSER) on behalf of SSEG (the applicant) commissioned RPS to carry out a range of studies to address SNH's requirements raised in their letters to SSE dated 25th September 2007 (dealing with habitat and protected species issues) and 2nd October 2007 (dealing with ornithological interests).

Technical Appendix A11.1 (2013 - Confidential) is responds to SNH's first set of concerns on the methods and data (items 1-6 of these from their letter).

This document, Technical Appendix A11.2 (2013) is intended to address the following forest clearance concern highlighted by SNH, specifically:-

> *'A thorough assessment of the effects of forest clearance on bird populations connected with the SPA. There is a risk, not fully explored, that forest clearance and habitat improvement works will result in SPA populations being attracted onto the site and placed at risk of collision with turbine rotors. This is a significant omission. This is because the tree felling and proposed habitat improvement plans are likely to lead to changed use and ultimately increased collision risk to a number of qualifiers. In order to pass the third Natura step outlined in Annex 1 of the letter of 25 September 2007, it will be necessary to demonstrate that the changes in environment will not lead to an increase in risk to qualifiers of the SPA'.*

Technical Appendix A11.3 (2013) presents theoretical collision risk modelling results for golden plover and greenshank to supplement collision risk estimates derived from the empirical data.

Technical Appendix A11.4 (2013) assesses the predicted impacts of the proposed wind farm on qualifying species of the Caithness and Sutherland SPA, in relation to the Conservation Objectives for the site. It provides information to inform the Appropriate Assessment by the competent authority and effectively replaces the original ornithological impact assessment contained in the 2007 Strathy North Wind Farm Environmental Statement (ES).

Finally, Technical Appendix A10.6 (2013) addresses the issues previously raised by SNH in relation to habitat impacts, notably on the Caithness and Sutherland Peatlands Special Area of Conservation (SAC) due to access track proposals.

1.3 Purpose of this Technical Appendix A11.2

This Technical Appendix provides a detailed examination of the effects of forest removal on bird species connected with the SPA, and explains how the wind farm site will be managed post-clearance to enable peatland restoration, to benefit other ecological receptors, and also to minimise collision risk to SPA qualifying species.

1.4 Considerations in Relation to Policy and Guidance

One of the main challenges in undertaking this report has been the recent shifts in policy and guidance provided by statutory consultees. Most notably, the Scottish Environmental Protection Agency's (SEPA) emerging policies on mulching has required particular consideration, to meet its requirements driven by waste management legislation, in combination with avian, non-avian and habitat interests.

Within this context, documents that have been taken into account when formulating the proposed approach to plantation removal and the Habitat Management Plan are:

- SNH (*in prep*.) A Review of the Impacts of Terrestrial Wind Farms on Breeding and Wintering Hen Harriers. Draft for Consultation (2nd Revision);
- SNH (2012) Planning for Development: What to Consider and Include in Habitat Management Plans.
- SEPA (2013) Guidance on the Management of Forest Waste.
- SEPA (*in prep*) Principles for Use of Forest Residue for Peatland Restoration.
- SNH/SEPA/FCS Joint Agency Agreement on Forest Removal and Peatland Restoration;
- FCS (2009) The Scottish Government's Policy on Control of Woodland Removal;
- FCS (2006) Managing Brash on Conifer Clearfell Sites. Practice Note;
- FCS (2005) Protecting the Environment During Mechanised Harvesting Operations. Technical Note;
- FCS (2000) Forest and Peatland Habitats. Guideline Note; and
- FCS (2012) Guidance to Landowners on Forest Set-back for the Caithness and Sutherland Peatlands Natura Site (letter to landowners).

The main implication of this evolving policy and guidance background is a greater emphasis on removal off-site of harvestable timber, with mulching restricted to areas where trees are below a particular size. Further details are provided in Sections 4 and 5 of this Technical Appendix.

1.5 Structure of Technical Appendix A11.2

Section 1 gives the introduction, after which the Technical Appendix is divided into a further five Sections.

Section 2 provides a description of the physical characteristics of the site. To avoid repetition, this information is provided by extensive reference to material presented in the Strathy South Wind Farm 2007 ES and the 2013 Addendum.

Section 3 briefly presents the information collated on the land management in place prior to afforestation, to illuminate the potential breeding bird assemblage that may have been present. The section then details the nature of the afforestation, including site preparation, planting, aftercare, and the characteristics of the current plantation in terms of its composition, structure, yield class and windthrow susceptibility in order to inform management decisions on harvesting and likely post-felling habitats.

Section 4 explains the proposed construction schedule for the wind farm, and how the forest will be cleared as part of the construction process. Several options for forest clearance have been considered, taking into account Forestry Commission Scotland (FCS) policy, ecological, hydrological, landscape, technical, sustainability and financial considerations. The forest utilisation options considered are summarised and the justification given for the approach selected. This Technical Appendix identifies mulching as the preferred method, although there is on-going consideration to diverting a proportion of suitable timber volume for road foundations, and/or for biomass generation on-site or to local schemes if they became available. Whilst technical, financial and sustainability appraisals of these possible options continue, the preliminary indications are that the most suitable approach will be to mulch the low-yield forest and harvest as much of the remainder as possible, with mulching of brash. This has been used as the current basis from which to consider post-construction land management.

Section 5 describes the 25 year programme of land management that will be put in place on site, after plantation removal is complete. The emphasis of this Section is demonstrating it is both feasible and realistic to achieve the type of vegetation sward that will prove peatland restoration benefits without significantly increasing the risk to qualifying species from turbine collisions. In formulating this approach, RPS has consulted with SEPA and SNH to take into account their objectives for tree removal.

Section 6 provides evidence to demonstrate, beyond reasonable scientific doubt, that forest clearance will avoid an increased risk to SPA qualifying species' populations from collision. This answers SNH's seventh concern, by forecasting for each species, the likely character of breeding and foraging activity on site post-clearance, drawing on evidence from:

- The species' known ecology and behaviour from available literature;
- Breeding, foraging and flight activity data from the site, adjacent moorland, and RSPB's Forsinard Flows Reserve (where forest clearance and habitat restoration has been taking place); and
- From local sites where vegetation is comparable to desired characteristics to be achieved on site.

From this combination, it is intended to provide sufficient information to determine that the forest can be cleared and subsequently managed so there is no adverse impact on the integrity of the SPA by the Modified Scheme, either alone or in combination.

This helps to inform the subsequent RPS Technical Appendices, establishing a predicted baseline of bird activity on site, from which collision risk and a full ornithological impact assessment build (Technical Appendices 3 and 4 respectively) and responding to SNH points 8, 9 and 10 (see Technical Appendix A11.1, pp. 5).

1.6 Qualifying Species

Although given in Technical Appendix A11.1, the qualifying species of the Caithness and Sutherland Peatlands SPA are also presented here for ease of reference:-

This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting the following important populations of bird species listed on Annex I of the Directive.

During the breeding season:

- Red-throated diver *Gavia stellata*, 89 pairs representing at least 9.5% of the breeding population in Great Britain (Two-year mean, 1993-1994);
- Black-throated diver *Gavia arctica*, 26 pairs representing at least 16.3% of the breeding population in Great Britain (11-year mean, 1986-1996);
- Hen harrier *Circus cyaneus*, 14 pairs representing at least 2.8% of the breeding population in Great Britain (5-year mean, 1993-1997);
- Golden eagle *Aquila chrysaetos*, 5 pairs representing at least 1.3% of the breeding population in Great Britain (Count, as at 1992);
- Merlin *Falco columbarius*, 54 pairs representing at least 4.2% of the breeding population in Great Britain (Count, as at early 1990s);
- Short-eared owl *Asio flammeus*, 30 pairs representing at least 3.0% of the breeding population in Great Britain (Count, as at mid-1990s);
- Golden plover *Pluvialis apricaria*, 1,064 pairs representing at least 4.7% of the breeding population in Great Britain (Count, as at mid-1990s);
- Wood sandpiper *Tringa glareola*, 5 pairs representing up to 50.0% of the breeding population in Great Britain (Two year mean, 1994-1995).

The site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species.

During the breeding season:

- Wigeon *Anas penelope*, 43 pairs representing <0.1% of the breeding Western Siberia/Northwestern/Northeastern Europe population (1994);
- Common scoter *Melanitta nigra*, 27 pairs representing <0.1% of the breeding Western Siberia/Western and Northern Europe/Northwestern Africa population (1996);
- Dunlin *Calidris alpina schinzii*, 1,860 pairs representing at least 16.9% of the breeding Baltic/UK/Ireland population (Count, as at 1994); and
- Greenshank *Tringa nebularia*, 256 pairs representing at least 0.4% of the breeding Europe/Western Africa population (1994/95).

Of these 12 qualifying species, there have been no records of **wigeon** during any of the 2003, 2004, 2007, 2008, 2009, 2010 and 2012 surveys. With regard to **common scoter**, sightings were made in just two years. There was a single record of a male bird on Loch Strathy (Loch ID 178) on the 27th June (although the 2007 ES does not mention the year, one of the 2003 fieldworkers does not recollect it being recorded that year, suggesting the record was from 2004). The only other records were from 2012, when two common scoter flights were recorded on 30th June and 27th July, both near to Loch ID 43 and 45, to the west of the application site (see Figure A11.1.30). No evidence of breeding was recorded in either year.

It is therefore considered valid from this evidence to conclude these species are either, not present, or very rare on site or in its hinterland, and therefore do not need to be considered further in this Technical Appendix.

2 PHYSICAL CHARACTERISTICS OF STRATHY SOUTH

2.1 Landform

The topography and physical features of Strathy South are shown in Technical Appendix A11.1 Figures A11.1.6 – A11.1.13. As can be seen, the site is relatively low lying (varying in altitude between approximately 130 m and 200 m) and is gently undulating. Its western and eastern 'arms' consist of two north/south spurs of land that converge at the site's southern end, to form the upper catchment of the River Strathy. The area surrounding Strathy South consists of open, undulating moorland dominated by blanket bog, lochans and pools.

2.2 Geology

The site's solid geology is described in the Strathy South 2007 ES, so for information, reference should be made to that document.

2.3 Soils

Soil distribution is a factor of topography, geology and drainage in the local area. Soils in the application site consist predominantly of modified blanket peat, with three main soil types:-

- Blanket peat: organic material with a consistently high water table;
- Peat gleys: slowly permeable, seasonally waterlogged clay-like soils with a peaty surface horizon; and
- Peaty podzols: leached soils with a peaty surface layer. The drainage of these soils is dependant on the level of leaching. Peaty podzols are normally free draining, however where strong leaching has occurred sufficient deposition of iron and aluminium in the lower soil horizons may cement the material into a hard impermeable layer, or ironpan, resulting in waterlogging of the profile above. The product of this is a soil intermediate between podzol and gley.

The site mainly comprises peat soils, which are of varying depths. Comprehensive additional peat survey work has been carried out for the 2013 ES Addendum, reported in Chapter A14.

2.4 Peat Characteristics

Strathy South Forest is surrounded by internationally important peatland landscapes and habitats. The site lies within an area of previously open blanket bog and heathland. The results of extensive peat probing and analysis of underlying peat depth, including a peat slide risk assessment are provided in Chapter 14. These surveys indicated that the peat deposits are variable in thickness across the site, ranging from approximately 0.1 to 4.7m.

2.5 Hydrogeology and Hydrology

Details of the hydrogeology and hydrology are contained in the 2007 ES and remain valid so will not be repeated here. In relation to bird interests, the key features are that the site has a small number of pool systems and lochans. Some of these are isolated within the forest, whilst others closer to the forest edge form part of wider wetlands that extend into the adjacent open peatland habitat.

The site lies entirely within the catchment of the River Strathy, which runs south to north through the centre of the site, fed by several small tributaries. These watercourses are flashy with high peak flows and rapid response rates during storm events, and low flows during prolonged dry spells. As shown in Figure A11.1.6 – A11.1.12, there are also a number of small pool systems, un-named and named lochs/lochans within the site boundary, the largest of which is in the north-west, Loch nam Clach.

SEPA have carried out water quality monitoring on the River Strathy which is classified A2 (good).

Anticipated climate change suggests slightly increased temperatures, an increased capacity for the atmosphere to hold water vapour and resultant increases in fluxes of precipitation and evaporation. It is thought this may result in a reduction of summer precipitation and an increase during winter. If this occurs it can be expected that the current hydrological regime of the rivers in the study area will be magnified, with lower low flows in summer and higher and more frequent peak flows in winter.

3 THE NATURE OF STRATHY SOUTH HABITATS AND CONIFER PLANTATION

Whereas Section 2 highlighted the main underlying physical characteristics of the Strathy South site, the following two sections deal with the understanding of the forest itself by also presenting information on current and previous land cover. This forms the basis for considering the options for forestry removal, also taking account of environmental, economic and legislative considerations for a Forestry Removal and Harvesting Plan.

3.1 Historic Land Management of Strathy South and Its Surrounding Area

In the decades before afforestation, the land within the application area was used mainly for deer stalking. The only significant modification over this period was digging of drainage grips and construction of the Strathy Lodge access track (please see Figures A11.1.7 – A11.1.12). Grips are visible in the aerial photos on Strathy South and are also widespread on the adjacent part of RSPB's Forsinard Flows Reserve, Yellow Bog, Skelpick and Rhifail Estate and Strathy Wood.

The introduction of large scale plantation forestry to the Flow Country occurred primarily in the post-war period. This applies to the forests found around Strathy South, which have been planted at differing times and by different landowners. The initial forest plantations were created by the Forestry Commission Scotland (FCS). The block immediately above Strathy South (Strathy Wood) was mostly planted between 1954 and 1959 with additional planting around 1966 (Source - Dornoch Forest District). A large area of forest (Achrugan Forest) was later created by the FCS north of Strathy North Forest, with planting taking place between 1968 and 1971.

Strathy South was mostly planted between 1983 and 1987. Additional planting then took place in the early part of the 1990's with the final 109 ha being planted in 1994. Planting was undertaken by Fountain Forestry and the forest has been under their management since this time. These plantations were established in line with national forest policy during this period that encouraged the expansion of commercial forests to reduce the UK's reliance on imported timber. Tax concessions in place at the time provided woodland owners with additional incentives to plant commercial plantations. Further details are provided below (Sections 3.4 to 3.7).

In recognition of the remaining habitat value of parts of the non-afforested land at Strathy South, two areas in the south-west section of Strathy South have been subject to conservation management agreements between the land owners and SNH (see Section 3.3 for further details).

3.2 Current Land Management of the Surrounding Area

Before describing the Strathy South site itself, information is presented on the adjacent land at Strathy Wood because the land management here, and the resulting bird activity, overlaps with Strathy South.

The large forest blocks in Strathy Wood, directly to the north-west of Strathy South Forest (which can be seen in Figure A11.1.4), have mainly been felled as part of grant-aided forest-to-bog restoration management (Plate A11.2.1). This has been relatively recently, for the purpose of establishing peatland habitat and some native woodland. Natural regeneration from the seed banks created by lodgepole pine (*Pinus contorta*) and Sitka spruce (*Picea sitchensis*), along with areas of planted birch (*Betula spp.*), are now found over some of this area (Plate A11.2.2). The lodgepole pine and occasional Sitka spruce are now common throughout and have exploited the disturbed ground.

Significant areas of Strathy Wood have been felled and the trees left *in situ* (Plate A11.2.3). These dead trees are being left, at present, to decay naturally, although there is a desire to have the material removed. Currently, the felled trees are providing highly suitable nesting habitat for hen harriers, but are also likely to be preventing regeneration of the ground flora (Plate A11.2.4).

Plate A.11.2.1. Strathy Wood planted and regenerated birch, with some regeneration of lodgepole pine, looking east

Plate A11.2.2 Strathy Wood lodgepole regeneration

Plate A11.1.3. Strathy Wood felled area looking west

Plate A11.2.4. Area of felled forestry in Strathy Wood which is potentially suitable for nesting raptors

Open moorland surrounds the site on all remaining sides, all of which is designated for peatland and bird interests. The land is not agriculturally grazed, although deer stalking may take place

on occasion. Along the southern and eastern boundary, the land under RSPB ownership is managed for nature conservation. SNH have a number of management agreements in place with SPA land owners, covering the open ground surrounding Strathy South.

The River Strathy and a number of lochans around about the application site have fishing interests. Further information regarding fish interests is provided in Technical Appendix A10.4: Assessment of Fish Habitats and Populations.

3.3 Non-Forested Habitats Within Strathy South

The extent and structure of non-forested habitats within the Strathy South application area have been surveyed for the 2007 ES and more recently to ground-truth and up-date these data. The resulting information is presented in Chapter 10 of the 2007 ES and Chapter 10 of the ES Addendum. In summary, of the approximately 1,620 ha application area, 487 ha (30%) is non-forested, with the remainder comprising plantation, of which all but 6.7 ha is conifer.

An example of open vegetation along the existing forest track is shown in Plate A11.2.5 below. Open habitats within Strathy South, along rides and un-planted areas, are predominantly wet dwarf shrub heath, blanket bog and modified bog (see Figures A10.4, A10.5, A10.8 and A10.9 in Chapter 10: Ecology of the ES Addendum). The habitat survey results show the forest to be primarily surrounded by blanket bog with a lesser extent of wet heath.

Plate A11.2.5 Typical ride vegetation adjacent to forest track within Strathy South

In recognition of the residual habitat value of remaining non-forested areas in the south-west of the site (within Plot 3 of the land ownership, as shown in Figure A11.1.4), these areas are covered by management agreements between SNH and the land owners.

3.4 Preparation and Planting of the Strathy South Plantation

A process of ploughing was used to provide raised planting positions in order to improve the establishment of trees (visible in Figure A11.1.8 – A11.1.12). The species planted are mainly a self-thinning mix of lodgepole pine and Sitka spruce (Plate A11.2.6), planted in various combinations within rectangular blocks, depending on soil quality. Lodgepole pine is generally planted in monoculture on the poorest soils, and used as a fast-growing ‘nurse crop’ for spruce on deep peat; whereas spruce is planted alone on areas of better soil.

Plate A11.1.6. Typical self-thinning mix of spruce and lodgepole pine

The mixed plantations have all been planted on ridges, the result of deep ploughing by single and double mouldboard ploughs. The trees have been mostly planted in lines of three Sitka spruce then three lodgepole pine. This pattern of planting was seen as providing a self-thinning mix with the faster growing Sitka spruce shading out the lodgepole pine, thus providing the final timber tree as Sitka spruce.

There are a small number of compartments where Japanese larch was also planted, and 6.7 ha of broadleaves in Coille Am Sealbach. The progression of planting from thirty to nineteen years ago is shown in Diagram A11.2.1.

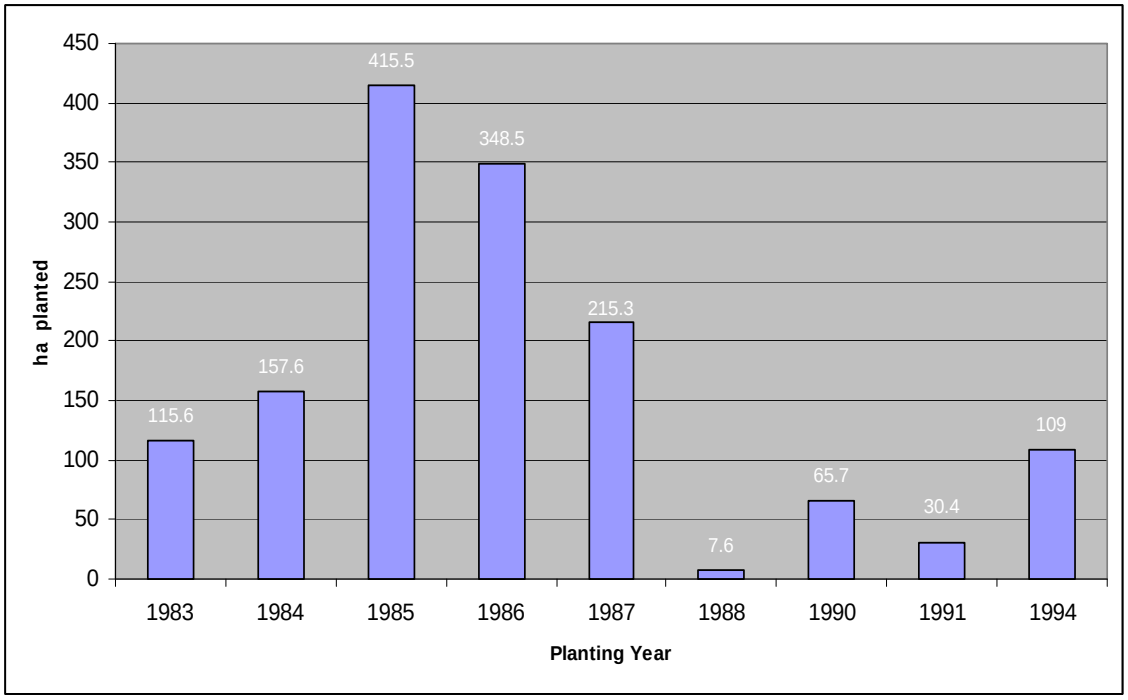


Diagram A11.2.1. Strathy South planting progression

3.5 Aftercare of Forested Habitats

Aftercare work at Strathy South is currently the responsibility of Fountain Forestry. The main works that have taken place since planting are drainage, deer fencing, and road maintenance.

No further planting has taken place since the initial programme finished in 1994. No manual thinning work has been required and there is no agreed felling plan in place.

Deer management takes place within the forest, where there is an annual cull in line with consultations and advice from SNH.

Of note is the fact that, in order to produce a commercially viable crop at Strathy South, it would be necessary to carry out additional drainage and the application of fertiliser.

3.6 Composition of the Plantation

The forest areas of Strathy South consist of eight forest units: Bad Collie, Coille Saobhaidhe, Coille Buidhe, Coille Am Sealbach, Coille Fada, Coille Meadhonach, Coille Nan Clach and Coille An Reidhe (Figure A11.2.1). Each forest unit is broken up into compartments and sub-compartments of varying size and species composition. The compartments are separated by rides and wider fire breaks. Full details are provided in Appendix 1 (by Forest Unit, sub-compartment, planted area per sub-compartment, planting year, species mix and yield class). Data for each forest unit and sub-compartment has been given by planting year and species composition in Appendix 2 – Forest Planting Years and Composition. Summary details of planting year are found in Table A11.2.1 and overall composition in Table A11.2.2.

Table A11.2.1: Summary Information on Planting Years of Strathy South Forest (areas in hectares)

Forest Unit	Planting Year								
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1990**	**1991**	**1994**
Bad Coille			183.7						
Coille Saobhaidhe	65.8	55.6	88.5	100.2					
Coille Buidhe		6.2	8.4	98.2	49.8		65.7	30.4	
Coille Am Sealbach		11.1	26.1	57.6	58.6				109.0
Coille Fada		52.8	37.9	26.8	27.6				
Coille Nan Clach	32.4	5.2	22	14.5	42.3	7.6			
Coille Meadhonach		18.6	20.6	19.5					
Coille An Reidhe	17.4	8.1	28.3	31.7	37				
Totals	115.6	157.6	415.5	348.5	215.3	7.6	65.7	30.4	109.0

Table A11.2.2: Summary Information on Composition of Strathy South Forest (area in hectares)

Forest Unit	Composition							
	Sitka Spruce (ha)	**Sitka Spruce/ Lodge-pole Pine (ha)**	**Sitka Spruce / Peters-burg Lodge pole Pine Mix**	**Sitka Spruce / Lodge-pole Pine Mix/ Scots Pine/ Japan-ese Larch**	**Sitka Spruce / Lodge pole Pine Mix/ Japanese Larch**	**Sitka Spruce / Peters-burg Lodge-pole Pine / Scots Pine/ Japan-ese Larch Mix**	**Broad-leaves (ha)**	**Un-planted (ha)**
Bad Coille		183.7						3.8
Coille Saobhaidhe		310.1						5.6
Coille Buidhe		218.9	39.8					45.1
Coille Am Sealbach		139.5	101.8	7.9		5.4	6.7	77.9
Coille Fada	6.3	138.8						
Coille Nan Clach	2.8	113.7		.0	7.5			14.1
Coille Meadhonach		58.7						0.6
Coille An Reidhe		91.8	30.7					7.8
Totals	**9.1**	**1225,2**	**172.3**	**7.9**	**7.5**	**5.4**	**6.7**	**154.9**

Note: There is also 1.1 ha of Dunkeld Larch planted in Coille Am Sealbach

As illustrated in Diagram A11.2.1, this information shows the majority of the forest was planted between 1983 and 1987 (the aerial photos shown in A11.1.8 – A11.1.12 were taken in 1988), with a second phase of planting taking place in 1990 to 1994. These consisted in the most part, of a mixed plantation of lodgepole pine and Sitka spruce (Figures A11.2.2 and A11.2.3, Tables A11.2.1 and A11.2.2).

As highlighted above, the mixed plantations have all been planted on ridges, mostly planted in lines of three Sitka spruce then three of lodgepole pine. Currently this has had mixed results and in many compartments both Sitka spruce and lodgepole pine have been equally competitive. Local conditions have been influential in the success of each species with lodgepole pine being more successful on poorer sites. Each compartment's growth potential can vary within as little as 20 m, as local wet areas will inhibit growth and create stunted trees.

Broadleaved trees have been planted in some compartments and with one exception have failed to establish. Compartment 1d of Coille Buidhe (described on the planting plan as a deer lawn) has established broadleaved trees present, but growth is slow and mostly stunted. Where at the time of planting, the landowners tried to establish individual broadleaved trees in groups, the tree shelters used (height 1.2 m) are too small to stop browsing by red deer, and the few that have grown, are now being browsed off at the top of the shelter.

3.7 Strathy South Forest Condition Assessment

Predicted Yield Classes

Details of the 1,133 ha of forestry to be potentially felled were gathered on a compartment and sub-compartment basis, during a site visit by RPS's chartered forester in August 2010. Survey results are provided in Appendix A11.2.1 and Appendix A11.2.2.

The forest condition varies throughout and is influenced by local conditions, particularly local water table that provides differing soil moisture levels. This has had a direct influence on tree growth. Areas where drainage is impaired or those with higher water tables have produced poor growth and as a result this has produced checked and stunted trees. A few compartments have achieved reasonable growth rates of in excess of yield class 10 to 12, dependant on species and local conditions. Sitka spruce can normally obtain considerably higher yield classes in more suitable conditions, and the values obtained on this site are a direct reflection of the poor site growing conditions. Low yield class values indicate slow growth, and in the case of commercial plantations, will indicate poor economic return on investment.

To obtain the yield class for individual compartments, Forestry Commission Yield Models for Forest Management Handbook Booklet 48 have been used. Yield class is a direct correlation between species/variety, top height and age. The figure obtained gives a mean average increase in stand volume (m^3) per hectare per annum.

Access to many compartments throughout Strathy South is difficult due to tree density and branching. Therefore, an assessment of trees by a chartered forester was used to gain average tree information that can then be extrapolated into compartment yield classes. Tree heights were obtained mainly using edge trees with regard to the requirements expected when measuring the Top Height of plantation trees. Obviously, these are average values of best judgement and not accurate top height values that would be obtained in a detailed forest tariff.

During August 2010 the forest was visited by a Chartered Forester and a large number of data points (173) collected to allow a yield class analysis to take place. The survey took in a large part of the forest but further desktop analysis was undertaken using aerial photograph to establish approximate growth rates and thus yield classes for all the forest unit compartments. This produced a range of values that could be used to analyse the condition and productivity of the forest compartments.

A tree grading system based on yield classes was then produced. This related forest condition to yield class information as below (Diagram A11.2.2 and Table A11.2.3). Areas of bare ground were included in the mapping analysis to complete the forest plan.

Once the grading had been completed, a Forest Condition Plan (Figure A11.2.3) was produced. The information gathered provided the basis of yield volume assessments using FC Production Forecast Tables (Normal Yield Tables for Species/Variety, Yield Class and Age – Forest Management Tables FC Booklet 34).

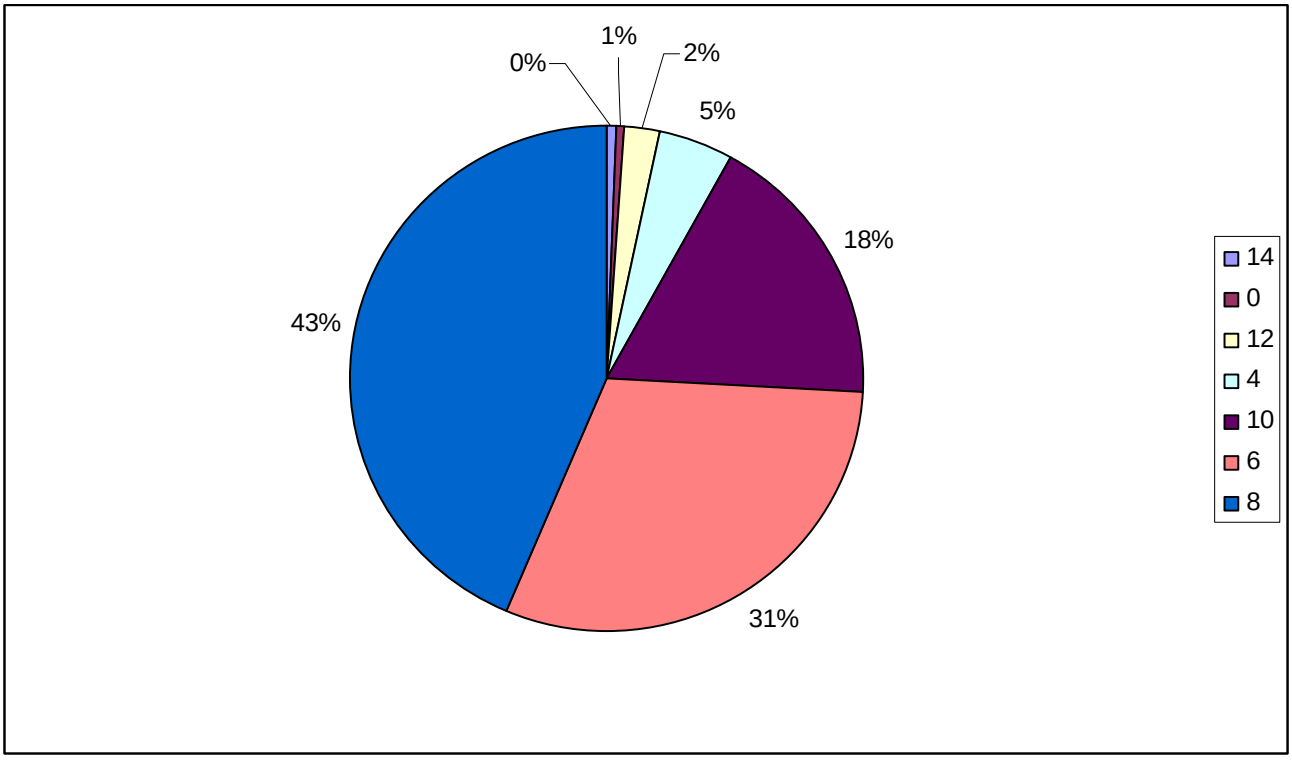


Diagram A11.2.2. Percent Composition of Strathy Forest by Yield Class (figures rounded to nearest whole percent)

Table A11.2.3: Forest Condition Assessment of Sitka Spruce for Strathy South Forest			
Yield Class	**Condition Category**	**Ha**	**% of the Total Planted Area**
14	Good	5.52	0.49
12	Moderate	24.67	2.18
10	Moderate	200.07	17.66
8	Poor	492.97	43.51
6	Poor	347.50	30.67
4	Very Poor	55.96	4.94
0	Very Poor	6.34	0.56
Total		1,133.03	

4 FOREST REMOVAL

4.1 Forest Removal Rationale

Removal of 1,133ha of plantation within Strathy South is required in preparation for the construction of the wind farm and associated infrastructure. This wind farm footprint will occupy 24ha of habitat (beyond which is already occupied by existing forest tracks). In addition, in common with many other plantations in the Flow Country, it is evident that the area would now be regarded as unsuitable for planting, due to the widespread presence of important habitat, and consequently such an area would not meet current planting guidelines. The removal of the plantation for the wind farm, therefore, enables the implementation of a 25 year programme of peatland restoration, whilst ensuring this avoids increasing the risk to qualifying species of the adjacent SPA.

Using the information obtained in Sections 2 and 3, the options considered for tree removal were (a) whole tree harvesting and extraction which involves the cutting and removal of the whole tree for processing; (b) conventional harvesting (shortwood systems) which involves trees being harvested and timber extracted; with residual brash and stumps being mulched, and (c) mulching of trees and brash. In general, the most appropriate approach will be applied to the whole sub-compartment but as variable tree growth within sub-compartments is typical for the area, a combination of approaches may be used.

Based on the constraints described in this Technical Appendix, it was concluded that mulching was the most suitable option for the sub-compartments where tree growth has been limited, and Yield Class is 8 or less. Restricting the extent of mulching to these sub-compartments ensures the volume of woody material is sufficiently small, and thinly spread, to (a) avoid suppressing regeneration of peatland vegetation, and (b) avoid a harmful short-term increase in nitrate and phosphate leachate into natural watercourses or groundwater. In addition, mulching enables tree removal with minimum ground disturbance and damage to existing peatland vegetation.

Where trees are generally of greater yield class (Yield Class 10 or above), it has been concluded that conventional harvesting is generally the most appropriate tree removal option, extracting stemwood off-site (potentially for the local biomass market) and mulching brash residues *in situ*.

Whilst a Yield Class of 10 or greater would generally be used to identify the most appropriate forest compartments for harvesting, flexibility is required in this approach to allow for pockets of poorer forming trees which occur in a mosaic within such compartments. Conversely, this flexibility would also allow for harvesting of trees with better growth within compartments of Yield Class 8 or less.

The aim of this combined approach is to enable restoration of peatland habitats, informed by recent experience of SNH and RSPB Scotland in particular. This approach is, however, dependent on SNH agreeing that this does not result in an increased mortality risk to qualifying species of the adjacent SPA being attracted into the wind farm area.

The Harvesting Plan for Strathy South Forest has therefore been designed to favour suitable management of resultant habitat whilst accommodating the wind farm's construction.

This approach to removal of the forest is in line with the Scottish Government's desire to address *'negative environmental legacies from the previous century. Examples include poorly designed forests that have yet to be 'restructured', plantations on inappropriate sites such as raised bogs or important blanket bogs'* (Scottish Forestry Strategy 2006)[1].

The Plan makes certain assumptions as to the composition and current individual compartment growth rates as they have not been fully surveyed. However, the forest was planted within a short time period and has similar species composition (see Table A11.2.1). This has led to a

[1] Scottish Executive (2006). The Scottish Forestry Strategy. Report SE/2006/155. http://www.forestry.gov.uk/forestry/INFD-6AGGZW

forest structure that is fairly typical of a commercial forest in this area and found on this soil structure.

As part of the development of the harvesting plan, comments have been taken into account from SNH's, SEPA's and FCS's responses to the 2007 ES, as well as more recent consultations. The Harvesting Plan (Section 4.4) provides greater information regarding the method and approach that will be adopted in the forest removal.

4.2 Constraints and Considerations Influencing Tree Removal Approach

Strathy South has a variety of constraints that have been considered as part of the harvesting plan. The tree condition was discussed above, whilst policy, physical and economic constraints are detailed below.

4.2.1 Policy Considerations

Guiding Principles

The Scottish Government has, through their Policy on Control of Woodland Removal[2] made "*a strong presumption in favour of protecting Scotland's woodland resources*" (Guiding Principles) and has placed constraints with regard to woodland removal.

'Woodland Removal' is defined in the Policy as "*the permanent removal of woodland for the purposes of conversion to another type of land use*" (in this case the wind farm development accompanied by restoration of the heath and blanket bog previously dominant on the site). This will only be allowed where it would achieve significant and clearly defined additional public benefits. In appropriate cases, a proposal for compensatory planting may form part of this balance. Approval will usually be conditional on the undertaking of actions to ensure full delivery of the defined additional public benefits.

Planning conditions and agreements are used to mitigate the environmental impacts arising from wind farm development and FCS will also encourage their application to development-related woodland removal.

Criteria for Determining the Acceptability of Woodland Removal

The woodland removal policy states that, woodland removal, without a requirement for compensatory planting, is most likely to be appropriate where it would contribute significantly to:

- Enhancing priority habitats and their connectivity;
- Enhancing populations of priority species;
- Enhancing nationally important landscapes, designated historic environments and geological SSSIs;
- Improving conservation of water or soil resources; or
- Public safety.

There is broad guidance on meeting the acceptability criteria for woodland removal. These criteria are listed below with sections in bold where the wind farm development at Strathy South will meet the acceptable criteria.

Enhancing Priority Habitats and their Connectivity

- **Within the boundaries of priority habitats.**
- **Contributes to the functional connectivity of priority and associated habitats without adverse impact on priority woodland habitats or connectivity.**
- **Availability of 'seed banks' from previous land use and adjacent land use.**

[2] Forestry Commission Scotland (2009). The Scottish Government's Policy on Control of Woodland Removal. http://www.forestry.gov.uk/pdf/fcfc125.pdf/$FILE/fcfc125.pdf

Enhancing Populations of Priority Species

- **Woodland is detrimental to nationally significant concentrations of Biodiversity Action Plan species**.

Enhancing Nationally Important Landscapes and Historic Environments

- **Current landscape character in National Parks and National Scenic Areas compromised significantly by the woodland.**
- Condition or context of Scheduled Monuments, Listed Buildings, Conservation Areas and Gardens & Designed Landscapes compromised significantly by woodland.

Improving Conservation of Soil and Water Resources

- Agreed as a measure to address Significant Water Management Issues identified in River Basin Management Plans more effectively than woodland.
- Significantly reduces water loss from woodland in an area of high water demand and low water supply but without impacting on flooding.
- **Restoration of peat bogs where the removal of woodland would prevent the significant net release of greenhouse gases.**

Also, as mentioned above, the removal of Strathy South Forest is in line with the Scottish Government's Scottish Forest Strategy 2006 that identifies the desire to address '*negative environmental legacies from the previous century. Examples include poorly designed forests that have yet to be 'restructured', plantations on inappropriate sites such as raised bogs or important blanket bogs'*.

It can be seen that the case for forest removal at Strathy South is strong and in line with the aspirations of the Scottish Government. It is also in line with the wider initiatives in the Flow Country of seeking to secure peatland habitat restoration through removal of exotic conifer plantations.

Requirements of the Scottish Environment Protection Agency

In addition to these policy considerations, attention has also been paid to ensuring the approach to forest removal has fully taken into account the requirements of the Scottish Environment Protection Agency (SEPA). This has been achieved through consultations on Strathy South but also liaison during 2012 and 2013 to enable finalisation of the Strathy North Habitat Management Plan. Over this same period, SEPA evolved and published its February 2013 Guidance on the Management of Forestry Waste. In cognisance of this Guidance and its objectives, particular consideration has been given to identifying forest removal options and potential off-site uses of marketable timber.

4.2.2 Physical Considerations

Ground Conditions

The forest is planted within a large area of blanket bog and as such the ground conditions are extremely variable throughout the site. Peat depths have been extensively surveyed (see Technical Appendix A14.1: Peat Landslide Hazard Assessment), revealing depths of between 0.1 and 4.7 metres. These conditions have created extremely wet areas with high moisture levels, but the degree of wetness is variable throughout, creating access and travel issues across considerable parts of the forest.

To establish the forest trees, the site was ploughed prior to planting to create the raised planting positions. It is clear from the areas of natural regeneration along the edges of tracks that, without the ground disturbance and creation of raised areas of peat, tree establishment would have failed.

Harvesting machinery will need to take account of these issues and be adapted for working in peatland environments. Low ground pressure tracks will be the preferred option. Some areas

may be difficult even for this type of machinery. The options for machinery to be used for tree removal has been a key consideration in determining how best to enable forest removal, but at the same time, minimise damage to any residual peatland vegetation or the peat itself. This is because the minimisation of ground disturbance is an important factor in peatland restoration, as well as minimising run-off issues and reducing the extent of disturbed ground conditions that encourages natural regeneration of conifers.

Slope

With the exception of a few areas within the forest, the ground slopes gradually and it is not seen as being a particular issue for modern harvesting machinery. The few areas of steep ground can be worked around and are also mostly devoid of trees.

Windthrow

Windthrow can be predicted using various methods developed by the Forestry Commission. The prediction of Terminal Height of the crop provides the height and thus age that the stand will become liable to wind throw and thus the approximate rotation of the crop. The Forestry Commission has produced various systems to predict the Terminal Height, and for the assessment of Strathy South Forest, their ForestGALES programme was used, which calculates the risk of damage over a typical rotation from stand characteristics contained in yield models. Providing the information required to predict failure allows an estimate to be produced of the likely life expectancy of the forest crop.

Whilst occasional pockets of wind-throw can be located within the woodland, these tend to be the direct result of localised soil conditions on the edge of the plantation.

The ForestGALES Prediction Model shows that for the average Sitka spruce with a top height of 8 m and an average stem diameter of 12 cm (as obtained from the survey) has a return period of 200 years. A similar return period is predicted for lodgepole pine of top height 6 m and stem diameter of 12 cm. This reflects the poor yield class being obtained on the site and the estimated time it will take for these trees to obtain their terminal height.

The conclusion reached therefore, is that due to the age and the slow growth rates, were the wind farm not to proceed, windthrow within Strathy South Forest would be highly unlikely to occur over the lifespan of the proposed development.

4.3 Forest Removal and Harvesting Plan Objectives

The forest plantations at Strathy South were planted as commercial timber crops. It was planned that blocks would be felled just before terminal height was reached, and then replanted. From the forest condition survey, it is evident that tree growth has been poorer than expected, and as such, the removal of the forest is in line with the Scottish Forestry Strategy 2006 to address the legacy of 'inappropriate' planting from the previous century on important habitats including blanket bog sites.

The combination of poorer than anticipated growth, wet/soft ground conditions, and distance to processing facilities, therefore, conspire to make commercial harvesting for timber uneconomic for the great majority of the plantation.

The proposed development of the wind farm provides an opportunity to harvest, take off-site or mulch the plantation and to allow for the restoration of heath and peatland habitats in the long term.

Therefore the objectives of the Harvesting Plan for Strathy South are:

- To describe and plan for the forest removal of the entire site;
- To manage the forest removal in an environmentally sensitive way to ensure the effective restoration of the original landscape whilst not damaging intact blanket bog within or adjacent to the site;

- To comply with all relevant guidance produced by the FCS with regards the harvesting operations;
- To comply with all relevant guidance produced by SEPA with regards the harvesting operations and management of forestry waste;
- To consider within the harvesting plan the utilisation of timber as biomass, to local markets and supply chains, where possible;
- To complete the harvesting component of forest removal within the 24 month construction period.; and
- To complete the removal in such a way as to allow managed restoration and re-colonisation of the former forest area for habitats whilst avoiding increased risk to qualifying birds from the adjacent SPA.

4.4 Forest Removal and Harvesting Plan

The decision to harvest a forest is normally based on its economic return. In the case of Strathy South, as elsewhere in the Flow Country, the planting of trees in such soils as blanket bog has proved problematic, inappropriate and unlikely to provide economic volumes of quality timber. As evident from the extent of poor or very poor yield classes in Figure A11.2.3, the great majority of the plantation is unlikely to reach a utilisable size that could be considered for harvesting. This fact, combined with the difficult ground conditions for tree removal, has largely dictated the options for harvesting.

4.4.1 Mulching

This method of forest removal is considered in areas where uneconomic or small trees are located, particularly on soft and wet ground. It involves a base unit with a high powered flail that chips the tree to fragments. This forms a mulch on the ground that can decompose and/or be subsumed by growing peatland vegetation (notably mosses in wetter areas). The flail head can also reduce the stump to ground level. Mulching will have an expected ‘out-turn’ (work rate) of half a hectare per day per machine. This method has been used successfully on other site restoration projects, including Strathy North and Gordonbush.

Strengths – fewer machine movements on the site reduces the impact on the soils and minimises carbon emissions. Most economic method of reducing uneconomic and inappropriate trees from a site. Residue consists of decomposable material. Woodchips tend to infill drainage ditches, leaving a more even surface that is more amenable to the future management of vegetation that subsequently develops. No timber traffic on local road network.

Weaknesses – mulch is not utilised for any economic product, and hence is purely a cost to the landowner.

4.4.2 Basal Shearing

This method for forest removal has been considered by the Forestry Commission and used by the RSPB and others. Using a specially designed hydraulic shear cutting head, lower yield class trees (generally Yield Class 4 and 6) can be severed at ground level and the whole tree (providing it is of sufficiently small size) can then be used by pushing or laying into drains created by ploughing, to start the process of impeding drainage and restoring the bog’s water table. The brash is kept to a height that should not exceed 0.5 m in height, but ideally would be below the current maximum ground level. This can be followed by peatland restoration activities such as drain blocking to further control nutrient release and run-off issues.

Strengths – leaves minimal ground disturbance and requires fewer vehicle movements. Stumps are removed to ground level, avoiding the need to re-visit with stump grinder or mulching head.

Weaknesses – no economic use of timber. Whole tree left on site. Needle drop could potentially be concentrated and contribute to nutrient enrichment, depending on conditions.

4.4.3 Conventional Harvesting – Shortwood Systems

This harvesting method involves the trees being harvested by forestry mechanical harvesters or by chainsaw operators, then the timber is extracted by forwarders to roadside for removal from the forest by HGV units.

Strengths – machinery readily available. Machine movements on brash mats reduce damage to soil structure. Provides a utilisable product that may have a market value.

Weaknesses – large amount of vehicle movements on site, leading to potential ground damage and siltation, particularly where trees are small and brash-mats are limited. Expensive on low yield tree volume sites. Large size/amount of residue left on site.

Plate A11.2.7 – Example of harvested trees in Yield Class 10 Forest at Strathy North to illustrate the approach

4.4.4 Whole Tree Harvesting

This method involves felling the entire tree (branches, main stem and top) and extracting this to ride/road side for processing. The processing method usually consists of chipping the complete tree into a container then removing the containers from site to be utilised by board manufacturers or as biomass wood fuel.

Strengths – little residue left on site. Utilises the whole tree and maximises biomass volumes.

Weaknesses – large number of machine movements, and traffic movements. No brash mats to reduce impact on site from machinery travel. Limited machinery available - currently very specialised machinery required. Few markets for the product, including the current local biomass market which is not established to accept this whole tree product.

4.4.5 Preferred Tree Removal Options

The matrix underpinning this assignment of felling approaches to each sub-compartment is provided in Appendix A11.2.1.

Based on a combination of compartment condition, underlying ground conditions and habitat management objectives, the appropriate method applicable to harvesting the majority of the site is considered to be mulching. This would generally be applied to sub-compartments with a Yield Class of 8 or less. This equates to 80% of the 1,133 ha to be removed (i.e. approximately 903 ha).

In areas of higher yield (10 or above), which comprises the remaining 20% of the 1,133 ha (i.e. approximately 230 ha), the applicant is committed to exploring the most recent evolution of harvesting machinery and approaches to maximise environmental benefit. Provided this machinery proves economic and is available, and providing peat depth/wetness does not prevent machine access, one example of this may be harvesting equipment that has a cutting tool for basal shearing, combined with an otherwise standard harvesting head. This would reduce any need for mulching stumps and therefore running machinery across the peatland for a second time.

It enables whole tree harvesting, after which various options would be considered, such as processing the tree *in situ* in which case the brash mat would subsequently be mulched, or to process the trees in windrows, so that brash is concentrated in these areas, keeping the intervening ground free of brash to potentially aid peatland restoration. One further possible option could be removing the whole tree for processing at the roadside. All these options have potential pros and cons, and the final decision will be made depending on the balance of these, and whether or not other options have emerged by the time felling would be required.

4.4.6 Harvesting/Forest Removal Operations

Harvesting operations at Strathy South will be in accordance with the UK Forestry Standard 2011[3] and underlying FC/FCS guidance on best practice methods to be implemented, including:

- UK Forest Standard – Forests and soil requirements and guidelines;
- UK Forest Standard – Forests and water requirements and guidelines;
- UK Forest Standard – Forests and biodiversity requirements and guidelines;
- Managing brash on conifer clearfell sites (FC, 2006)[4];
- Guidance on site selection for brash removal (Forest Research, 2009)[5];
- Forestry practice : Handbook 6 (Hibberd, 1991)[6];
- Whole-tree harvesting: a guide to good practice (Nisbet *et al*, 1997)[7];
- Soft ground harvesting: review of methods to minimise site damage (Spencer, 1991)[8];
- Extraction route evaluation on deep peat (Saunders, 2001)[9]; and
- Protecting the environment during mechanised harvesting operations (Murgatroyd, 2005)[10].

SSER will also adhere to any additional published new guidance that emerges prior to, or during, forest works.

Given the on-going development of machinery and approaches to forest removal, including for peatland habitat restoration, SSER will continue to investigate any new options for forest clearance.

[3] Forestry Commission (2011). The UK Forestry Standard. Forestry Commission, Edinburgh.
[4] Moffat, A., Jones, B. and Mason B. (2006). Managing Brash on Conifer Clearfell Sites. Forestry Commission Practice Note, Forestry Commission, Edinburgh.
[5] Forest Research (2009). Guidance on Site Selection for Brash Removal. Forest Research Agency of the Forestry Commission.
[6] Hibberd B.G. (1991). Forest Practice. Forestry Commission Handbook No. 6. Forestry Commission.
[7] Nisbet T., Dutch J. and Moffat A. (1997). Whole-Tree Harvesting: A Guide to Good Practice. Forestry Practice Guide, Forestry Commission.
[8] Spencer, J.B. (1991). Soft ground harvesting review of methods to minimise site damage. Technical Development Report 35/91. Forestry Commission, Ae.
[9] Saunders, C.J. (2001). Extraction route evaluation on deep peat. Technical Development Internal Project Information Note 03/01. Forestry Commission, Ae.
[10] Murgatroyd, I., Saunders, C. (2005), FCTN011 Protecting the Environment during Mechanised Harvesting Operations. Forestry Commission, Edinburgh.

As part of the preparatory works for future felling, if the wind farm is consented, SSER propose to commission a LIDAR survey in order to up-date the Yield Class mapping, and provide finalised tree heights, mulch volumes and harvest areas for consultees. The LIDAR data will also be used to assist with detailed planning of drain blocking on open habitats.

4.4.7 Proposed Phasing of Forest Removal

It is proposed that the two-year timescale for removal of the Strathy South Forest is phased as follows:-

Phase One would cover clearance to accommodate the initial wind farm infrastructure (tracks, borrow pits, switching station, laydown areas and turbine bases), as has been done at Strathy North. To ensure peatland restoration is started as early as possible, Phase One also includes removal of plantation forest that has significant underlying peatland vegetation remaining. This is in accordance with the expressed feedback from SNH, and will focus on areas of lowest yield class.

Phase Two will be the clearance of the remainder of the site for the turbine envelope.

Phase Three will involve the removal of all remaining conifer plantation.

The subsequent control of any conifer regeneration on site would take place as part of the implementation of HMP proposals.

4.5 Conclusions in Relation to Felling

The following conclusions have been drawn from analysis of the forest clearing options.

- Forest removal at Strathy South is in line with current Scottish Government Policy regarding woodland removal and the Scottish Forestry Strategy.
- The assessment of the forest's condition has confirmed that only a small proportion of the forest is of a size whereby harvesting can be considered as an option.
- Where harvesting is carried out, options such as basal shearing will be considered along with any further practical and cost-effective techniques/equipment that leave a ground surface conducive to peatland restoration.
- Mulching will be the most widespread forest removal method on site given the small size of the trees, underlying ground conditions, and the lack of any economically viable or environmentally beneficial alternative use.
- Forest removal will be phased, with equal priority given to removal of those sub-compartments where there is significant remaining peatland vegetation. This early removal is in response to consultation with SNH and aims to halt any further damage to peatland habitats from tree growth/canopy closure in these areas, and initiate restoration as early in the process as possible.
- SSER will continue to explore alternative options for off-site use of timber, where these are economically viable and would generate additional environmental benefits.

5 POST-CLEARANCE LAND MANAGEMENT AND THE ASSESSMENT OF ITS EFFECTS ON SPA QUALIFYING SPECIES

5.1 Assessing the Timescale and Nature of Vegetation Recolonisation and Succession on Mulched and Harvested Forestry at Strathy South

Recolonisation of vegetation is influenced by a range of factors, notably the nature, age and volume of the previous forest, the thickness of needle cover, the nature of the underlying vegetation, the age of the seed bank present, the degree of soil disturbance during forest operations, the soil type, slope, and wetness.

Published results on the influence of these and re-colonisation rates are limited, however, largely because mulching at this scale is a relatively recent land management technique. There has also been relatively limited compilation of monitoring data from mulched sites, or it is held privately by developers.

To access the information that does exist, SNH staff are directed to E.ON (for Rosehall) and Scottish Power (specifically Peter Robson, Ecologist), as they are funding post-mulching vegetation studies at Black Law (Central Scotland), Whitelee (Central Scotland), and Beinn an Tuirc (Argyll). This data is held in commercial confidence and was not therefore directly accessible for the purposes of this Report.

Information from three North Scotland sites (Rothes, Gordonbush and preliminary data from Strathy North) is available, together with data from RSPB forest clearance on their Forsinard Flows Reserve. Results are discussed in more detail below, to inform the likely recolonisation influences and outcomes at Strathy South.

5.1.1 Mulch Thickness

The thickness and degree of continuous cover provided by mulch has an influence on the speed and evenness of regeneration. The compartments with the highest yield class forestry (Figure A11.2.3) will generate the largest thickness of mulch chips, which will subsequently suppress vegetation for a longer period of time compared to equivalent sites with shallower depths of chips. Vegetation will then develop dependant a range of local variables such as soils, slope and wetness.

During the mulching process, experience from other sites shows that mulch tends to infill existing depressions, leading to a smoothing of micro-topography. This is compounded by the movement of machinery back and forward over planting ridges and furrows, whilst mulching trees, resulting in a degree of evening out of the ground surface.

Photos of mulched areas from Strathy North are shown below, to illustrate the different mulch volumes resulting from different Yield Classes (Plates A11.2.8 – A11.2.11).

Plate A11.2.8 – Small tree size (Yield Class 0 – 4) showing incomplete canopy closure

Plate A11.2.9 – Small tree size (Yield Class 0 – 4) – no harvestable produce and minimal mulch produced.

Plate A11.2.10 - Tree height <10 m (Yield Class 6) – no harvestable produce and minimal mulch produced.

Plate A11.2.11 - Tree height approximately 10 m (Yield Class 8) – no harvestable produce.

The predicted mulch depths for Strathy South, derived from measurements of mulch depth from different yield classes at Strathy North (sub-compartment 2A and other sub-compartments) are shown below in Table A11.2.4.

Table A11.2.4 Strathy South Forest Yield Data

Yield Class	Clearance Method	Planting Year	Age at 2013	Tree height 2013	Area (ha)	Material from mulching mean depth (avg) cm
0	Small tree - mulch	1990	23	<3	1.6	negligible
		1994	19	<3	2.9	negligible
		Unknown		<3	0.5	negligible
4	Small tree - mulch	1983	30	7	2.2	negligible
		1984	29	7	4.3	negligible
		1985	28	6	23.3	negligible
		1987	26	6	9.8	negligible
		1994	19	6	16.3	negligible
6	Small tree - mulch	1984	29	8	79.9	9.5
		1985	28	8	169.2	9.0
		1986	27	8	25.3	8.6
		1987	26	8	26.0	8.0
		1988	25	9	1.0	7.5
		1990	23	9	2.2	negligible
		1994	19	9	43.9	negligible
8	Small tree - mulch	1983	30	10	33.9	11.7
		1984	29	10	66.6	11.1
		1985	28	9	97.3	10.6
		1986	27	9	173.9	10.0
		1987	26	9	37.6	9.5
		1988	25	9	2.0	9.0
		1990	23	9	39.3	7.9
		1991	22	8	23.9	7.3
		1994	19	7	14.7	5.8
8	Potential harvest	1987	26	10	3.7	Not applicable
10	Potential harvest	1983	30	14	22.3	Not applicable
		1984	29	13	13.6	Not applicable
		1985	28	13	14.5	Not applicable
		1986	27	13	55.2	Not applicable
		1987	26	14	85.0	Not applicable
		1990	23	14	9.5	Not applicable
12	Potential harvest	1985	28	14	4.9	Not applicable
		1986	27	14	19.8	Not applicable
14	Potential harvest	1985	28	15	2.0	Not applicable
		1987	26	15	4.8	Not applicable
Total					**1133.0**	

5.1.2 Underlying Vegetation

Previous studies indicate a strong correlation between vegetation development and existing plant species within the forest, providing mulch depth is insufficient to suppress these species. Areas where the mulch layer is thinner, or where more existing vegetation remains, will enable more rapid restoration of peatland vegetation, whereas this process will take significantly longer where peatland vegetation has been shaded out, and a thick needle layer and mulch are present.

5.1.3 Wetness

Experience from mulched areas to date shows that, depending on slope, certain types of vegetation generally develops significantly more quickly (generally within one to two growing seasons) where ground conditions are wet. Rushes and grasses dominate this early growth, producing a mosaic of wet peat, peat pools, and small patches of rushes and grasses.

To halt and reverse the drying out effect of forest drains (and remaining suitable hill drains) a key element of peatland restoration will also be drain blocking, to increase water table levels.

In relation to habitats and birds, evidence of nesting preference shows that both hen harrier and short-eared owl preferentially nest in rushy patches set in a wider matrix of heather-dominated moorland. Harriers have also been recorded nesting in bracken, and brash (as is evident from Strathy Wood, for example). Therefore, as part of overall vegetation monitoring, targeted surveys will check extent of such preferential nesting habitats and their height. This information will feed into decisions on whether any vegetation control would be needed to achieve the HMP objectives (specifically, and only if this remains a requirement of SNH, the prescription to minimise the development of suitable nesting locations that would lead to flight activity likely to cause an unacceptable collision risk to hen harriers or short-eared owls).

5.1.4 Slope

The importance of slope, in terms of vegetation succession, is its effect on drainage and soils. In light of emerging experience referred to above, it is important to note that the majority of the main wind farm area has a limited or gentle gradient (see Technical Appendix A11.1, Figure A11.1.7). Where slopes are steeper, depending on soil conditions, natural and artificial drainage will tend to have led to greater tree growth (with resulting increased needle depth, less residual moorland vegetation and greater mulch depth).

5.1.5 Soil Disturbance

It has been shown that the presence of an unbroken layer of pine needles suppresses vegetation development after forest felling. The disturbance created by forest harvesting operations helps break up this needle layer, exposing bare soil and creating better conditions for the seed bank or windborne seed to germinate.

Machinery used for mulching does not create the same level of ground disturbance as normal forwarders and harvesters under similar conditions. Nonetheless, some ground disturbance would be inevitable, particularly where a shallower depth of needles has accumulated and trees are a low yield class.

5.1.6 Conifer Regeneration

Regeneration of conifers is dependant on a number of factors including tree species, tree age, soil type, soil wetness, soil disturbance, and proximity of seed trees. Sitka spruce produce relatively small amounts of seed under the age of 20 years (Brown and Neustein, 1974[11], Ruth, 1965[12]) becoming more active from this age onwards. Large volumes of seed are not produced by Sitka spruce until after 35 years (Harris, 1991[13]). Lodgepole pine can produce seed as early as five to ten years of age (Lotan and Critchfield, 1990[14]). Trees within Strathy South have an average age of approximately 28 years, but vary between 19 and 30 years. Hence, both species are likely to produce enough seed prior to harvesting to result in the presence of a viable seed bank. Sitka spruce is known to have 'mast' seeding years whereby trees synchronize seeding and produce heavier crops in those years. For Sitka spruce this is generally on a four to five year return period (Pfeifer, 1991[15]). Heavy seed years in lodgepole pine may be more often than this (Lotan and Critchfield, 1990). The timing of mast years will contribute to determining the level of seed bank present.

Dry or intermediate soil wetness will improve the chance of seedling germination and establishment as Sitka spruce is relatively intolerant of wet soils. However, lodgepole pine does regenerate in wetter conditions. Both species prefer mineral or shallow peat soils (Harris, 1991) but on deeper peat soils, where elevated nutrient levels have been created by the presence of a previous crop, or where peat is disturbed causing drying or mineral mixing, this will increase regeneration. Soil disturbance aids germination by creating micro-climates, although, indications

[11] Brown, J.M.B. and Neustain, S.A. 1974. *Natural regeneration on conifers in the British Isles*. Proc. Roy. Hort. Soc. 3rd Conf.:29-30.

[12] Ruth, Robert H. 1965. *Sitka spruce (Picea sitchensis (Bong.) Carr.)*. In Silvics of forest trees of the United States. p. 311-317. H. A. Fowells, comp. U.S. Department of Agriculture, Agriculture Handbook 271. Washington, DC.

[13] Harris, A.S. 1991. *Conifers: Picea sitchensis*. In: Silvics of North America, Vol.1. USDA Forest Service Handbook no. 654:260-267.

[14] Lotan, J.,E., Critchfield, W., B., 1990. " *Pinus contorta*" In. Silvics of North America. Edited by R.M. Burns and B.H. Honkala. USDA forest Service Agriculltural Handbook 654. Volume 1.

[15] Pfeifer, A. 1991. *Relationship between some climatic factors and seed production*. Unpublished study. Research and Development, Coillte Teo., Sidmonton Place, Bray, Co.Wicklow.

from some sites show germination can occur on non-disturbed peat soils providing they are relatively dry.

Sitka spruce and lodgepole pine seed generally last less than two years in the seed bank (Von Ow *et al*, 1996[16]). This creates an initial pulse of seedlings in the years following forest removal. Beyond three years, any subsequent regeneration will only occur where parent trees remain in close proximity to the site. Both Sitka spruce and lodgepole pine seed are relatively large and heavy and therefore windborne seed dispersal is mainly limited to within 100 m of source trees (Nixon and Worrell, 1999[17]). However, smaller amounts of seed may disperse further in high winds or through mammal/bird dispersal.

Given the nature of the site and current crop within Strathy South, it is likely some level of regeneration will occur. This will be greater in more sloping, better drained areas where an older more mature crop currently exists.

5.2 Predicted Sequence and Duration of Recolonisation of the Wind Farm, and the Resulting Evolution of Bird Activity

In light of the above range of influences and observations of mulching elsewhere (such as Gordonbush and Black Law Wind Farms), the evidence indicates that where wet conditions prevail, even under a moderate initial thickness of mulch (up to approximately 10-20 cm), rapid vegetation recolonisation dominated by rushes may occur within one to two seasons, dependant on other local variables. Re-growth will be relatively slow in higher yield class areas, particularly on slopes with a deep needle layer, taking in the region of three to five years before a near-continuous ground cover develops.

In low yield class areas where conditions are flatter (therefore more poorly drained), there will be more residual vegetation cover remaining and the layer of mulch will be less. Dependant upon the type of species and soils present, vegetation in these areas could develop relatively quickly. On the basis of this evidence, areas of the turbine envelope could support vegetation suitable for mammalian and avian prey, and raptor nesting within three to four years after felling, particularly if large rush patches or other relatively tall vegetation develops and are not suppressed/cut.

The vegetation that will develop over the majority of the site in the longer term is likely to reflect that on adjacent moorland surrounding the site, and to a degree, the vegetation on site in forest rides and open areas. The match will be influenced by the differences in drainage and soil nutrients that have respectively resulted from creation of forest drains and enrichment due to historical application of forest fertiliser.

5.2.1 RSPB Forsinard Flows Reserve Peatland Regeneration

Insights into the evolution of bird populations following different forms of tree removal can be gained from the peatland restoration and subsequent monitoring at RSPB's Forsinard Flows Reserve. Moorland bird surveys were carried out by RSPB in eight areas of clear-fell across the RSPB Forsinard reserve in 2008, as part of an ongoing monitoring programme in relation to the Caithness and Sutherland Peatlands LIFE project[18]. Drain blocking, forest removal restoration work and other ongoing management including grazing effects on the condition of the peatland habitats have been monitored by RSPB since felling began.

The effects of felling work were studied at two sites in particular - Talaheel, a conifer plantation felled in 1998 during the first LIFE-funded project in the Flow Country, and Lonielist, a plantation felled in 2003-04 during the second LIFE-funded project in the area. The effects of hill drain blocking were studied at Cross Lochs Hill site.

[16] Von Ow, F., Joyce, P. and Keane, M. (1996). *Factors affecting the establishment of natural regeneration Sitka spruce.* (*Picea sitchensis* (Bong.) Carr.) in Ireland . Ir. For. 53, 2 – 18.
[17] Nixon, C.J. and Worrell, R. (1999). *The Potential for the Natural Regeneration of Conifers in Britain*. Bulletin 120. Forestry Commission, Edinburgh.
[18] Robinson, K. (2008). Restoring Active Blanket Bog of European Importance in North Scotland: Monitor effectiveness of habitat restoration works completed on RSPB land. LIFE Project Ref: LIFE00NAT/UK/7075

Talaheel

Talaheel plantation was purchased by the RSPB in 1997 after 15 years of tree growth. The trees were felled soon after the purchase as part of a wider LIFE Nature funded project, in order to restore the area to open blanket bog. Trees were felled to waste into the forestry furrows where the brash helps to impede the drainage of water from the site. Prior to tree removal in spring 1998, a long-term monitoring scheme was set up for the site. Overall the vegetation on the site appears to be recovering well with bog species such as hare's tail cotton-grass (*Eriophorum vaginatum*), common cotton-grass (*Eriophorum angustifolium*) and *Sphagnum* species increasing throughout the site with *Sphagnum* cover overall equivalent to open bog cover scores. The decrease in heather (*Calluna vulgaris*) is also indicative of a move towards wetter conditions.

West Cross Lochs Hill Drain Monitoring

This area was not forest but an area of open blanket bog. Typically in the region, large areas of blanket bog were damaged by drainage schemes as part of an agricultural initiative to improve areas of moorland for grazing and game. This included drainage ditches cut in rows 50-90 cm deep in average. The RSPB has been attempting to reverse the impacts by installing dams in these drains. Dams were first installed on the reserve under the first LIFE Peatlands Project in March 1996. The two materials used for damming hill drains were peat and recycled plastic piles.

The results of the data collected show that six years after the instalment of dams, a few signs of recovery were seen in the hydrology and vegetation:

- The dams improved water table and its resilience to dry weather; and
- The decrease in bare ground, heather and lichens, together with the increase in *Sphagnum* mosses, common cotton-grass, bog asphodel (*Narthecium ossifragum*) and liverworts are signs that the ground is getting wetter across the dammed area and that bog vegetation may be recovering.

Lonielist

As part of the Peatlands LIFE-funded project, work at the RSPB's Lonielist Plantation was carried out to ascertain what methods would ultimately lead to faster habitat restoration process (Plates A11.2.12 and A11.2.13. For the location of Lonielist, see Technical Appendix A11.1, Figure A11.1.1). A study was set up to compare the restoration of sites felled by mulcher to those of the standard methods of felling to waste, namely, hand felling by chainsaw and the hydraulic shear machine. No monitoring results were available within the report, although 2009 bird surveys by RPS indicate that, at least one pair of breeding hen harrier and one pair of breeding short-eared owl, nested either on or beside clear-fell areas where the method of felling to waste was used. Although far too soon to draw any conclusions, by comparison, no such nesting took place on or adjacent to mulched areas.

Plate A11.2.12. Lonielist Plantation (Forsinard Flows Reserve) – forest removal and restoration works.

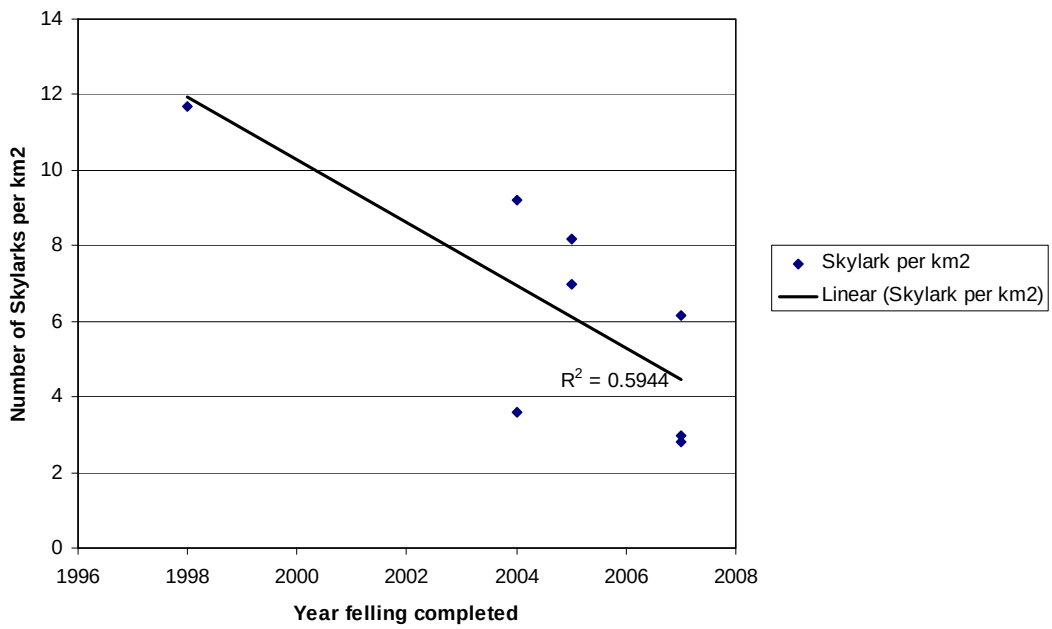
Plate A11.2.13. Lonielist Plantation - felled brash.

Results from RSPB's moorland bird surveys in felled areas across the Forsinard Flows Reserve show that, in general, there are a wide range of densities of breeding birds recorded during each survey, from 4-44 territories per km^2, or 15 to 73 birds recorded per km^2. Common prey species were also very variable in abundance, with 6.5-43.2 meadow pipits per km^2 and 3.6-11.7 skylarks per km^2 (peak counts of individuals, not territories).

Areas that were surveyed were clear-felled between 1998 and 2007, and analysis showed that, in general, there was no significant relationship between date of felling and bird density, territory density or species diversity. This was thought to be primarily due to differences in overall habitat types between plots, particularly tree/scrub cover. In some cases woodland species recorded on site and in adjacent land were included, which would increase overall numbers.

There was however, an indication that skylark density (peak counts of individuals) increased with time since felling (Diagram 2), suggesting that over time, clear-fell habitat becomes increasingly suitable for skylark (an open moorland breeder).

Diagram 2: Skylark Abundance based on End Date of Clear-felling Procedures



Vole Surveys

The nature, distribution and availability of prey items for raptors are predicted to undergo a significant change once the Strathy South plantation is removed. The abundance of avian prey, notably small passerines inhabiting the forest environment, would be replaced by more open moorland species (notably meadow pipit).

In addition to avian prey, the abundance and distribution of voles will also change as the forest is removed and peatland vegetation re-colonises the formerly planted area. Since prey abundance is potentially an important influence of raptor distribution and productivity[19], vole sign surveys were therefore conducted in 2009 in relation to Strathy North. Sample plots were located at rides within the Strathy North Forest, adjacent grazed grassland, adjacent moorland and clear-felled forestry at Lonielist Plantation, Forsinard. A control was not considered necessary within closed canopy forest as it was assumed voles are absent from this habitat. Results from the 2009 comparative surveys showed that, as with passerines, vole signs were most common in forest rides. Forest rides contained over twice the density compared to the Lonielist clearfell area and three times the density on open moorland (Table A11.2.5 and Diagram A11.2.3). Vole signs within grassland were so low, density could not be estimated reliably.

[19] Lambin, X., Petty, S.J. and MacKinnon, J.L. (2000) Cyclic dynamics in field vole populations and generalist predation. Journal of Animal Ecology, 69, 106–118.

TABLE A11.2.5 – EVIDENCE OF VOLES AT STRATHY AND FORSINARD, 2009							
	Sward Height (cm)	**Droppings**	**Old Clippings**	**Fresh Clippings**	**Tunnels**	**Total**	**Density**
Strathy North Rides	55	17	10	7	3	37	19.7 per m^2
Open Moorland Plot 1(b)	34	5	4	1	0	10	5.3 per m^2
Lonielist Plantation	24	8	2	5	0	15	8.0 per m^2

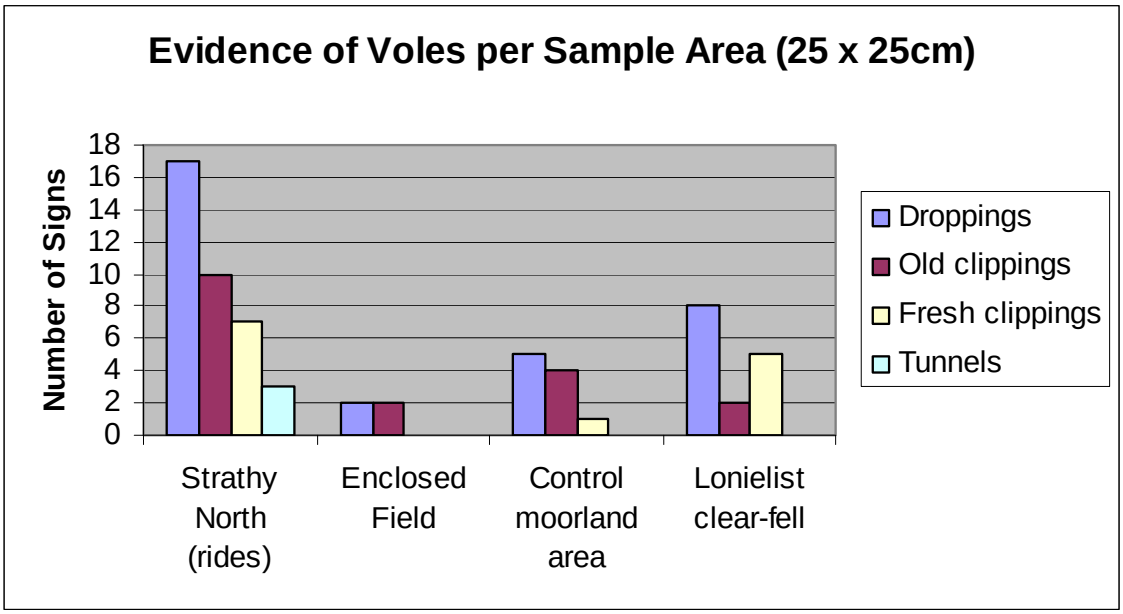


Diagram A11.2.3. Vole Signs at Strathy North and Forsinard

Further data were collected at Strathy North in 2011 and 2012. This data included a newly mulched area (mulched in 2011) within Strathy North Forest while sample plots within Lonielist Forest were not repeated. Preliminary analysis of this data indicates a similar distribution to 2009 data with forest rides containing the highest level of vole sign and the mulched area having the lowest. Vole sign in grassland and moorland areas increased markedly between 2009 – 2012 which may reflect changes over the vole abundance cycle or changing management regimes e.g. less intense grazing. In addition, vole densities within forest rides more than doubled between 2011 and 2012. This is likely to reflect the highly dynamic nature of vole densities within and across seasons in response to environmental variables such as conifer tree mast seeding years and weather conditions.

It is clear that vegetation structure and height within forest rides provide greater opportunities for voles, with significantly higher levels of abundance within rides at Strathy North, as well as possible lower predation rates compared to other habitats surveyed. At Lonielist, although vole density was higher than in open moorland, there was very little recovery of vegetation between plough lines in clear-fell areas. All signs of vole were therefore recorded on rides, although again sward height was comparatively low either due to shading before trees were felled or possible suppression due to grazing, and hence density was lower than at Strathy North Forest. This shows that, post-felling at Strathy South, raptor foraging is likely to be more focussed on existing rides than it would be prior to forest removal. Foraging within mulched or harvested areas is likely to be considerably lower until appropriate vegetation recolonises.

5.2.2 Evidence of Succession Following Mulching at Rothes Wind farm

There is a growing body of information from other sites on vegetation succession and, to a lesser extent, bird usage in the years after mulching (due to post-treatment monitoring of bird activity being less frequently undertaken). The SNH staff who are considering the Strathy South submission are therefore referred to their various colleagues who have access to this data (as SSE do not, for reasons of commercial confidentiality).

Information from the Rothes Wind Farm has been included below, on the success of the mulching regime, in terms of its effects on raptor prey availability. It is important to note that the objective of the associated Rothes Wind Farm Habitat Management Plan was to create suitable habitat for harriers, rather than prevent them breeding. Hence, there were no measures to check vegetation growth or to make the area unsuitable for nesting or foraging.

Vegetation regeneration at the wind farm has been monitored annually[20]. Results have shown that hare's tale cotton-grass and rushes (*Juncus spp.*) were quick to grow back in wetter areas. Heather has also recovered well but its rate of growth has been inhibited by deer and hare grazing. On average the heather measured 15 cm in height after 4 years of regeneration.

A vole sign survey was carried out in an area of mulched coniferous plantation forestry (Sitka spruce and lodgepole pine; four years after mulching) and an adjacent area of blanket bog (NVC habitat M19a). Of 120 sample points in each habitat, field signs were recorded at 26 points in the bog habitat, and at only two points in the mulched area (both runways in tall grass patches). The developing habitat is therefore still largely unsuitable for voles four years after mulching.

Moorland breeding bird surveys, using the Brown and Shepherd (1993)[21] technique, were carried out in the mulched area to provide details of meadow pipit and red grouse numbers. Meadow pipit numbers were low in the first year after mulching, compared to an adjacent area, but were similar to this area in the subsequent three years, when vegetation began to regenerate. Red grouse numbers were also low in the first year after mulching, compared to the adjacent area, with some recovery in subsequent years, but numbers were still lower than in the adjacent area.

The implications of these early trends in prey abundance are that the rates of increase in avian and mammalian prey abundance evidently vary on areas of mulched forest. Not surprisingly, they also show that initially avian and mammalian prey abundance is higher on adjacent moorland, than on mulched plantation, but that this variance diminishes relatively rapidly for meadow pipit (a key prey item for hen harriers).

5.3 Management of Vegetation Following Forest Removal

In contrast to Strathy North, SNH have indicated (via their email of 7th June 2013) that blanket bog restoration would be the preference, wherever possible, instead of restricting the attractiveness of the turbine envelope to breeding SPA qualifying birds. The focus of vegetation management after tree removal will not therefore be the uniform restriction of sward height through grazing and/or mechanical cutting. As highlighted in the HMP section below, the emphasis will be on peatland restoration, accompanied by the targeted control of any particular areas of vegetation that SNH consider would attract nesting by key species, and therefore lead to flight activity levels that would put birds at unacceptable risk of collision.

The management of Strathy South following forest removal would therefore be a combination of measures to (i) restore peatland habitats (notably drain blocking and removal of conifer regeneration, with consideration also given to mulching of brash mats and stumps in harvested areas, depending on the harvesting approach that was ultimately used), combined with (ii) targeted management of any taller vegetation in proximity to turbines (such as rush and/or bracken control) where it was considered necessary by SNH to minimise the risk of nesting, and consequently of collision. The timing of any vegetation management would be subject to approval from SNH.

5.4 Vegetation Management Conclusions

Ground cover will be monitored and any potential management intervention will be identified. This may initially comprise mulching of brash mats and conifer stumps in any harvested areas (although the need for this will depend on the tree removal approach finally selected). This would be followed by removal of any conifer regeneration over the lifetime of the wind farm, and

[20] Sharp, C. (2007). Field vole survey on Rothes wind farm Report for SSE.
[21] Brown, A.F. and Shepherd, K.B. 1993. A method of censuring upland breeding waders. Bird Study 40: 189-195.

potentially the targeted control of rushes, where this is considered necessary for the restoration of peatland habitat and/or reduction in collision risk for key species.

5.5 The Strathy South Outline Habitat Management Plan

The Strathy South Outline Habitat Management Plan (HMP) has been produced to set out the habitat management measures to be implemented if consent was granted. The measures would be targeted in management compartments, which are shown in Appendix 4 (Figure A11.2.5).

In light of consultation responses from SNH, and the findings of RPS' work for the 2013 ES Addendum, and given the proximity of designated sites, the overriding goal of this HMP is to restore and enhance peatland habitats typical of the adjacent SAC and the SSSI's features of scientific interest. The HMP's second goal is to avoid any unacceptable effects arising on the SPA's qualifying species.

The Outline HMP therefore has the following aims. These are:

1. To encourage at appropriate locations active peat-forming vegetation, to contribute to the restoration of blanket bog and wet heath habitats.

2. To maintain and improve peatland habitats within non-forested land units adjacent to the wind farm.

3. Within the wind farm envelope, reduce collision risk to breeding and foraging divers, raptors and waders associated with the Caithness and Sutherland Peatlands SPA (specifically red-throated divers, hen harrier, short-eared owl and greenshank).

4. To mitigate collision risk for breeding divers by provision of diver rafts at suitable locations off site, in consultation with SNH...

Figure A11.2.5 shows the layout of the habitat management areas. In particular, of note are:

- Peatland Restoration – identification of comparatively wetter areas (generally corresponding to, but not limited to, deep peat areas) outwith the turbine envelope. The map identifies areas where peatland restoration is considered to have a earlier likelihood of success. Areas are also identified which are adjacent to pool systems on the neighbouring open moorland with the aim of placing particular emphasis on assisting to re-establish the hydrological links and integrity of these wetlands.

- Peat Restoration, with Option for Targeted Vegetation Control to Reduce Suitability for Nesting by Key Species – peat restoration will remain the priority within the turbine envelope. However, where required, and in response to site vegetation monitoring, targeted control of vegetation will be undertaken, where deemed necessary, to reduce the suitability for nesting within the turbine envelope by key bird species.

Finalisation of the extent of these areas and methods used to maintain them in an optimal condition will be achieved through consultation with SNH, RSPB and other relevant parties. Consultation will be informed by targeted site surveys both prior to and following forest removal. The aim is to evolve the Outline HMP into a detailed prescriptive document that will be implemented through an appropriate and binding mechanism. Initial prescriptions for each of the HMP's aims are given in Appendix 4.

The Strathy South HMP is intended to be fully integrated with the HMP for Strathy North, and has complimentary aims, thereby mitigating the risk of cumulative impacts and helping to achieve integrated landscape-scale restoration of peatland habitats.

6 CONFIDENTIAL: SPECIES ACCOUNTS: AN ASSESSMENT OF PREDICTED EFFECTS ON SPA QUALIFYING SPECIES

This section is confidential. Please contact Jamie Watt at SSER (Email: jamie.watt@sserenewables.com)
.

FIGURES

List of Figures:

1. Figure A11.2.1 – Strathy South Forest Unit and Compartment Plan
2. Figure A11.2.2 – Strathy South Planting Years
3. Figure A11.2.3 – Strathy South Forest Yield Classes with Sub-Compartments
4. Figure A11.2.4 – Strathy South Forestry Yield Classes with Woodland Areas
5. Figure A11.2.5 – Strathy South Outline Habitat Management Plan

APPENDIX 1 – FORESTRY COMPARTMENT DETAILS FOR STRATHY SOUTH

Forest Unit	Sub-compartment	Species	Planting Year	Yield Class	Planted Area (ha)	Proposed Forest Removal
Bad Coille	1a	Sitka Spruce / Lodgepole Pine Mix	1985	8	8.23	Small tree - mulch
Bad Coille	1b	Sitka Spruce / Lodgepole Pine Mix	1985	6	4.62	Small tree - mulch
Bad Coille	1c	Sitka Spruce / Lodgepole Pine Mix	1985	6	3.37	Small tree - mulch
Bad Coille	1d	Sitka Spruce / Lodgepole Pine Mix	1985	6	0.71	Small tree - mulch
Bad Coille	2a	Sitka Spruce / Lodgepole Pine Mix	1985	8	5.19	Small tree - mulch
Bad Coille	2b	Sitka Spruce / Lodgepole Pine Mix	1985	4	2.62	Small tree - mulch
Bad Coille	2c	Sitka Spruce / Lodgepole Pine Mix	1985	8	2.10	Small tree - mulch
Bad Coille	2d	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.76	Small tree - mulch
Bad Coille	2e	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.89	Small tree - mulch
Bad Coille	2f	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.26	Small tree - mulch
Bad Coille	2g	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.12	Small tree - mulch
Bad Coille	2h	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.31	Small tree - mulch
Bad Coille	2i	Sitka Spruce / Lodgepole Pine Mix	1985	6	3.53	Small tree - mulch
Bad Coille	3a	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.85	Small tree - mulch
Bad Coille	3b	Sitka Spruce / Lodgepole Pine Mix	1985	6	3.05	Small tree - mulch
Bad Coille	3c	Sitka Spruce / Lodgepole Pine Mix	1985	4	3.05	Small tree - mulch
Bad Coille	3d	Sitka Spruce / Lodgepole Pine Mix	1985	8	1.75	Small tree - mulch
Bad Coille	4a	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.85	Small tree - mulch
Bad Coille	4b	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.17	Small tree - mulch
Bad Coille	4c	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.19	Small tree - mulch
Bad Coille	4d	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.58	Small tree - mulch
Bad Coille	4f	Sitka Spruce / Lodgepole Pine Mix	1985	6	5.03	Small tree - mulch
Bad Coille	4g	Sitka Spruce / Lodgepole Pine Mix	1985	6	3.42	Small tree - mulch
Bad Coille	4h	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.06	Small tree - mulch
Bad Coille	5a	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.44	Small tree - mulch
Bad Coille	5b	Sitka Spruce / Lodgepole Pine Mix	1985	6	5.18	Small tree - mulch
Bad Coille	5c	Sitka Spruce / Lodgepole Pine Mix	1985	6	3.08	Small tree - mulch
Bad Coille	5d	Sitka Spruce / Lodgepole Pine Mix	1985	6	4.57	Small tree - mulch
Bad Coille	6a	Sitka Spruce / Lodgepole Pine Mix	1985	10	5.51	Potential harvest
Bad Coille	6b	Sitka Spruce / Lodgepole Pine Mix	1985	14	1.27	Potential harvest
Bad Coille	6c	Sitka Spruce / Lodgepole Pine Mix	1985	8	4.19	Small tree - mulch
Bad Coille	6d	Sitka Spruce / Lodgepole Pine Mix	1985	6	0.89	Small tree - mulch
Bad Coille	7a	Sitka Spruce / Lodgepole Pine Mix	1985	4	3.28	Small tree - mulch
Bad Coille	7b	Sitka Spruce / Lodgepole Pine Mix	1985	4	0.82	Small tree - mulch
Bad Coille	7c	Sitka Spruce / Lodgepole Pine Mix	1985	6	3.23	Small tree - mulch
Bad Coille	7d	Sitka Spruce / Lodgepole Pine Mix	1985	6	4.80	Small tree - mulch
Bad Coille	7e	Sitka Spruce / Lodgepole Pine Mix	1985	4	2.68	Small tree - mulch
Bad Coille	8a	Sitka Spruce / Lodgepole Pine Mix	1985	6	4.36	Small tree - mulch
Bad Coille	8b	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.83	Small tree - mulch
Bad Coille	8c	Sitka Spruce / Lodgepole Pine Mix	1985	8	6.26	Small tree - mulch
Bad Coille	8d	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.93	Small tree - mulch
Bad Coille	8e	Sitka Spruce / Lodgepole Pine Mix	1985	14	0.73	Potential harvest
Bad Coille	8f	Sitka Spruce / Lodgepole Pine Mix	1985	12	4.88	Potential harvest
Coille Saobhaidhe	1a	Sitka Spruce / Lodgepole Pine Mix	1983	10	9.64	Potential harvest
Coille Saobhaidhe	1b	Sitka Spruce / Lodgepole Pine Mix	1983	10	2.28	Potential harvest
Coille Saobhaidhe	1c	Sitka Spruce / Lodgepole Pine Mix	1983	10	6.97	Potential harvest
Coille Saobhaidhe	1d	Sitka Spruce / Lodgepole Pine Mix	1983	10	3.38	Potential harvest
Coille Saobhaidhe	2a	Sitka Spruce / Lodgepole Pine Mix	1983	8	7.77	Small tree - mulch
Coille Saobhaidhe	2c	Sitka Spruce / Lodgepole Pine Mix	1983	8	3.54	Small tree - mulch
Coille Saobhaidhe	2e	Sitka Spruce / Lodgepole Pine Mix	1983	8	13.93	Small tree - mulch
Coille Saobhaidhe	2f	Sitka Spruce / Lodgepole Pine Mix	1983	8	4.87	Small tree - mulch
Coille Saobhaidhe	2g	Sitka Spruce / Lodgepole Pine Mix	1983	8	0.90	Small tree - mulch
Coille Saobhaidhe	2h	Sitka Spruce / Lodgepole Pine Mix	1985	6	6.59	Small tree - mulch
Coille Saobhaidhe	3a	Sitka Spruce / Lodgepole Pine Mix	1984	8	3.33	Small tree - mulch
Coille Saobhaidhe	3b	Sitka Spruce / Lodgepole Pine Mix	1984	6	4.04	Small tree - mulch
Coille Saobhaidhe	3c	Sitka Spruce / Lodgepole Pine Mix	1984	8	5.07	Small tree - mulch
Coille Saobhaidhe	3d	Sitka Spruce / Lodgepole Pine Mix	1984	8	5.86	Small tree - mulch
Coille Saobhaidhe	3e	Sitka Spruce / Lodgepole Pine Mix	1984	8	1.45	Small tree - mulch
Coille Saobhaidhe	3f	Sitka Spruce / Lodgepole Pine Mix	1984	8	2.10	Small tree - mulch
Coille Saobhaidhe	3g	Sitka Spruce / Lodgepole Pine Mix	1984	8	0.46	Small tree - mulch
Coille Saobhaidhe	2b	Sitka Spruce / Lodgepole Pine Mix	1983	8	2.87	Small tree - mulch
Coille Saobhaidhe	4a	Sitka Spruce / Lodgepole Pine Mix	1984	8	0.33	Small tree - mulch
Coille Saobhaidhe	4b	Sitka Spruce / Lodgepole Pine Mix	1984	8	2.49	Small tree - mulch
Coille Saobhaidhe	4c	Sitka Spruce / Lodgepole Pine Mix	1984	8	7.05	Small tree - mulch
Coille Saobhaidhe	4d	Sitka Spruce / Lodgepole Pine Mix	1984	8	6.04	Small tree - mulch
Coille Saobhaidhe	4e	Sitka Spruce / Lodgepole Pine Mix	1984	6	4.12	Small tree - mulch
Coille Saobhaidhe	4f	Sitka Spruce / Lodgepole Pine Mix	1984	6	1.74	Small tree - mulch
Coille Saobhaidhe	5a	Sitka Spruce / Lodgepole Pine Mix	1985	6	5.03	Small tree - mulch
Coille Saobhaidhe	5b	Sitka Spruce / Lodgepole Pine Mix	1985	6	3.16	Small tree - mulch

Forest Unit	Sub-compartment	Species	Planting Year	Yield Class	Planted Area (ha)	Proposed Forest Removal
Coille Saobhaidhe	5c	Sitka Spruce / Lodgepole Pine Mix	1985	6	4.50	Small tree - mulch
Coille Saobhaidhe	6a	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.67	Small tree - mulch
Coille Saobhaidhe	6b	Sitka Spruce / Lodgepole Pine Mix	1985	6	7.50	Small tree - mulch
Coille Saobhaidhe	6c	Sitka Spruce / Lodgepole Pine Mix	1985	8	2.22	Small tree - mulch
Coille Saobhaidhe	6d	Sitka Spruce / Lodgepole Pine Mix	1985	8	4.92	Small tree - mulch
Coille Saobhaidhe	6e	Sitka Spruce / Lodgepole Pine Mix	1985	8	3.75	Small tree - mulch
Coille Saobhaidhe	7a	Sitka Spruce / Lodgepole Pine Mix	1985	8	8.64	Small tree - mulch
Coille Saobhaidhe	7b	Sitka Spruce / Lodgepole Pine Mix	1985	8	2.07	Small tree - mulch
Coille Saobhaidhe	7c	Sitka Spruce / Lodgepole Pine Mix	1985	8	2.85	Small tree - mulch
Coille Saobhaidhe	7d	Sitka Spruce / Lodgepole Pine Mix	1985	10	4.23	Potential harvest
Coille Saobhaidhe	7e	Sitka Spruce / Lodgepole Pine Mix	1985	8	5.83	Small tree - mulch
Coille Saobhaidhe	7f	Sitka Spruce / Lodgepole Pine Mix	1985	8	3.44	Small tree - mulch
Coille Saobhaidhe	7g	Sitka Spruce / Lodgepole Pine Mix	1985	8	2.76	Small tree - mulch
Coille Saobhaidhe	8a	Sitka Spruce / Lodgepole Pine Mix	1986	10	3.95	Potential harvest
Coille Saobhaidhe	8b	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.15	Small tree - mulch
Coille Saobhaidhe	8c	Sitka Spruce / Lodgepole Pine Mix	1986	12	8.44	Potential harvest
Coille Saobhaidhe	8d	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.58	Small tree - mulch
Coille Saobhaidhe	8e	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.04	Small tree - mulch
Coille Saobhaidhe	8f	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.10	Small tree - mulch
Coille Saobhaidhe	8g	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.27	Small tree - mulch
Coille Saobhaidhe	9a	Sitka Spruce / Lodgepole Pine Mix	1986	12	3.89	Potential harvest
Coille Saobhaidhe	9b	Sitka Spruce / Lodgepole Pine Mix	1986	10	4.93	Potential harvest
Coille Saobhaidhe	9c	Sitka Spruce / Lodgepole Pine Mix	1986	8	5.56	Small tree - mulch
Coille Saobhaidhe	9d	Sitka Spruce / Lodgepole Pine Mix	1986	10	5.31	Potential harvest
Coille Saobhaidhe	9e	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.34	Small tree - mulch
Coille Saobhaidhe	9f	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.11	Small tree - mulch
Coille Saobhaidhe	9g	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.80	Small tree - mulch
Coille Saobhaidhe	9h	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.94	Small tree - mulch
Coille Saobhaidhe	10a	Unplanted	Unknown	0	0.30	Small tree - mulch
Coille Saobhaidhe	10b	Sitka Spruce / Lodgepole Pine Mix	1986	10	4.65	Potential harvest
Coille Saobhaidhe	10c	Sitka Spruce / Lodgepole Pine Mix	1986	6	4.28	Small tree - mulch
Coille Saobhaidhe	10d	Sitka Spruce / Lodgepole Pine Mix	1986	10	4.61	Potential harvest
South Strathy	1a	Sitka Spruce / Lodgepole Pine Mix	1984	10	4.92	Potential harvest
South Strathy	1b	Sitka Spruce / Lodgepole Pine Mix	1985	6	4.72	Small tree - mulch
South Strathy	1c	Sitka Spruce / Lodgepole Pine Mix	1985	8	1.77	Small tree - mulch
South Strathy	2a	Sitka Spruce / Lodgepole Pine Mix	1986	8	6.05	Small tree - mulch
South Strathy	2b	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.44	Small tree - mulch
South Strathy	2c	Sitka Spruce / Lodgepole Pine Mix	1986	8	7.05	Small tree - mulch
South Strathy	2d	Sitka Spruce / Lodgepole Pine Mix	1986	8	6.11	Small tree - mulch
South Strathy	2e	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.72	Small tree - mulch
South Strathy	2f	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.95	Small tree - mulch
South Strathy	3a	Sitka Spruce / Lodgepole Pine Mix	1986	10	4.79	Potential harvest
South Strathy	3b	Sitka Spruce / Lodgepole Pine Mix	1986	10	4.11	Potential harvest
South Strathy	3c	Sitka Spruce / Lodgepole Pine Mix	1986	10	3.24	Potential harvest
South Strathy	3d	Unknown	Unknown	0	0.18	Small tree - mulch
South Strathy	4a	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.98	Small tree - mulch
South Strathy	4b	Sitka Spruce / Lodgepole Pine Mix	1986	8	5.04	Small tree - mulch
South Strathy	4c	Sitka Spruce / Lodgepole Pine Mix	1986	8	1.00	Small tree - mulch
South Strathy	4d	Sitka Spruce / Lodgepole Pine Mix	1986	8	0.74	Small tree - mulch
South Strathy	4g	Sitka Spruce / Lodgepole Pine Mix	1986	8	0.31	Small tree - mulch
South Strathy	4h	Sitka Spruce / Lodgepole Pine Mix	1986	8	0.76	Small tree - mulch
South Strathy	5a	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.60	Small tree - mulch
South Strathy	5b	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.05	Small tree - mulch
South Strathy	5c	Sitka Spruce / Lodgepole Pine Mix	1986	8	1.25	Small tree - mulch
South Strathy	5d	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.98	Small tree - mulch
South Strathy	5e	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.84	Small tree - mulch
South Strathy	5f	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.74	Small tree - mulch
South Strathy	5g	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.81	Small tree - mulch
South Strathy	6a	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	8	3.90	Small tree - mulch
South Strathy	6b	Sitka Spruce / Lodgepole Pine Mix	1987	8	5.19	Small tree - mulch
South Strathy	6c	Sitka Spruce / Lodgepole Pine Mix	1987	8	0.49	Small tree - mulch
South Strathy	6d	Sitka Spruce / Lodgepole Pine Mix	1987	8	1.20	Small tree - mulch
South Strathy	7a	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	2.70	Potential harvest
South Strathy	7b	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	6	3.84	Small tree - mulch
South Strathy	7c	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	4.81	Potential harvest
South Strathy	7d	Sitka Spruce / Petersburg Lodgepole	1987	8	7.13	Small tree - mulch

Forest Unit	Sub-compartment	Species	Planting Year	Yield Class	Planted Area (ha)	Proposed Forest Removal
		Pine Mix				
South Strathy	7e	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	8	6.39	Small tree - mulch
South Strathy	8a	Sitka Spruce / Lodgepole Pine Mix	1990	0	1.64	Small tree - mulch
South Strathy	8c	Sitka Spruce / Lodgepole Pine Mix	1990	8	8.35	Small tree - mulch
South Strathy	8d	Sitka Spruce / Lodgepole Pine Mix	1990	10	5.03	Potential harvest
South Strathy	8e	Sitka Spruce / Lodgepole Pine Mix	1990	8	4.42	Small tree - mulch
South Strathy	8f	Sitka Spruce / Lodgepole Pine Mix	1990	8	2.18	Small tree - mulch
South Strathy	8g	Sitka Spruce / Lodgepole Pine Mix	1990	8	4.95	Small tree - mulch
South Strathy	8i	Sitka Spruce / Lodgepole Pine Mix	1990	8	4.77	Small tree - mulch
South Strathy	8j	Sitka Spruce / Lodgepole Pine Mix	1990	6	2.16	Small tree - mulch
South Strathy	8l	Sitka Spruce / Lodgepole Pine Mix	1990	10	4.50	Potential harvest
South Strathy	8m	Sitka Spruce / Lodgepole Pine Mix	1990	8	3.52	Small tree - mulch
South Strathy	8n	Sitka Spruce / Lodgepole Pine Mix	1990	8	3.98	Small tree - mulch
South Strathy	8o	Sitka Spruce / Lodgepole Pine Mix	1990	8	2.22	Small tree - mulch
South Strathy	9a	Sitka Spruce / Lodgepole Pine Mix	1991	8	4.07	Small tree - mulch
South Strathy	9b	Sitka Spruce / Lodgepole Pine Mix	1991	8	2.40	Small tree - mulch
South Strathy	9c	Sitka Spruce / Lodgepole Pine Mix	1991	8	2.52	Small tree - mulch
South Strathy	9d	Sitka Spruce / Lodgepole Pine Mix	1991	8	2.60	Small tree - mulch
South Strathy	9e	Sitka Spruce / Lodgepole Pine Mix	1991	8	3.18	Small tree - mulch
South Strathy	9f	Sitka Spruce / Lodgepole Pine Mix	1991	8	2.20	Small tree - mulch
South Strathy	9g	Sitka Spruce / Lodgepole Pine Mix	1991	8	3.20	Small tree - mulch
South Strathy	9h	Sitka Spruce / Lodgepole Pine Mix	1991	8	3.74	Small tree - mulch
South Strathy	9i	Sitka Spruce / Lodgepole Pine Mix	1990	8	4.88	Small tree - mulch
South Strathy	7f	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	3.88	Potential harvest
Coille Am Sealbach	1a	Sitka Spruce / Lodgepole Pine Mix	1984	8	1.40	Small tree - mulch
Coille Am Sealbach	1b	Sitka Spruce / Lodgepole Pine Mix	1984	8	6.98	Small tree - mulch
Coille Am Sealbach	1c	Sitka Spruce / Lodgepole Pine Mix	1985	6	6.11	Small tree - mulch
Coille Am Sealbach	1d	Sitka Spruce / Lodgepole Pine Mix	1985	4	7.93	Small tree - mulch
Coille Am Sealbach	1e	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.65	Small tree - mulch
Coille Am Sealbach	1f	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.21	Small tree - mulch
Coille Am Sealbach	1g	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.45	Small tree - mulch
Coille Am Sealbach	2a	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.04	Small tree - mulch
Coille Am Sealbach	2b	Sitka Spruce / Lodgepole Pine Mix	1986	6	2.76	Small tree - mulch
Coille Am Sealbach	2c	Sitka Spruce / Lodgepole Pine Mix	1986	8	4.38	Small tree - mulch
Coille Am Sealbach	2d	Sitka Spruce / Lodgepole Pine Mix	1986	8	1.99	Small tree - mulch
Coille Am Sealbach	2e	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.86	Small tree - mulch
Coille Am Sealbach	2f	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.69	Small tree - mulch
Coille Am Sealbach	3a	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.02	Small tree - mulch
Coille Am Sealbach	3b	Sitka Spruce / Lodgepole Pine Mix	1986	8	5.29	Small tree - mulch
Coille Am Sealbach	3c	Sitka Spruce / Lodgepole Pine Mix	1986	6	3.96	Small tree - mulch
Coille Am Sealbach	3d	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.45	Small tree - mulch
Coille Am Sealbach	3e	Sitka Spruce / Lodgepole Pine Mix	1986	12	5.21	Potential harvest
Coille Am Sealbach	3f	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.71	Small tree - mulch
Coille Am Sealbach	3g	Sitka Spruce / Lodgepole Pine Mix	1986	8	1.34	Small tree - mulch
Coille Am Sealbach	4a	Sitka Spruce / Petersburg Lodgepole Pine / Scots Pine / Japanese Larch Mix	1987	8	3.21	Small tree - mulch
Coille Am Sealbach	4b	Sitka Spruce / Lodgepole Pine Mix	1987	10	4.62	Potential harvest
Coille Am Sealbach	4c	Sitka Spruce / Lodgepole Pine Mix	1987	8	3.75	Potential harvest
Coille Am Sealbach	4d	Sitka Spruce / Lodgepole Pine Mix	1987	10	3.92	Potential harvest
Coille Am Sealbach	4e	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	4	0.50	Small tree - mulch
Coille Am Sealbach	4f	Sitka Spruce / Lodgepole Pine Mix	1987	4	9.33	Small tree - mulch
Coille Am Sealbach	5b	Sitka Spruce / Lodgepole Pine Mix	1987	10	2.85	Potential harvest
Coille Am Sealbach	5c	Sitka Spruce / Lodgepole Pine Mix	1987	8	3.52	Small tree - mulch
Coille Am Sealbach	5d	Sitka Spruce / Petersburg Lodgepole Pine / Scots Pine / Japanese Larch Mix	1987	6	5.55	Small tree - mulch
Coille Am Sealbach	5e	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	4	1.41	Small tree - mulch
Coille Am Sealbach	5f	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	4	0.96	Small tree - mulch
Coille Am Sealbach	7a	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	8	4.94	Small tree - mulch
Coille Am Sealbach	7b	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	1.18	Small tree - mulch
Coille Am Sealbach	7c	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	3.37	Small tree - mulch

Forest Unit	Sub-compartment	Species	Planting Year	Yield Class	Planted Area (ha)	Proposed Forest Removal
Coille Am Sealbach	7d	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	2.13	Small tree - mulch
Coille Am Sealbach	7e	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	1.13	Small tree - mulch
Coille Am Sealbach	7f	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	3.52	Small tree - mulch
Coille Am Sealbach	7g	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	8	5.12	Small tree - mulch
Coille Am Sealbach	7h	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	8	4.69	Small tree - mulch
Coille Am Sealbach	7i	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	4.32	Small tree - mulch
Coille Am Sealbach	7j	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	3.32	Small tree - mulch
Coille Am Sealbach	7k	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	3.12	Small tree - mulch
Coille Am Sealbach	8a	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	2.77	Small tree - mulch
Coille Am Sealbach	8b	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	3.41	Small tree - mulch
Coille Am Sealbach	8c	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	2.81	Small tree - mulch
Coille Am Sealbach	8d	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	3.22	Small tree - mulch
Coille Am Sealbach	8f	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	4	3.94	Small tree - mulch
Coille Am Sealbach	8g	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	4	5.43	Small tree - mulch
Coille Am Sealbach	9a	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	2.55	Small tree - mulch
Coille Am Sealbach	9b	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	2.24	Small tree - mulch
Coille Am Sealbach	9c	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	3.26	Small tree - mulch
Coille Am Sealbach	9d	Mixed Broadleaves	1994	0	0.82	Small tree - mulch
Coille Am Sealbach	9e	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	4	4.58	Small tree - mulch
Coille Am Sealbach	9g	Mixed Broadleaves	1994	0	1.74	Small tree - mulch
Coille Am Sealbach	9h	Mixed Broadleaves	1994	0	0.38	Small tree - mulch
Coille Am Sealbach	5a	Sitka Spruce / Lodgepole Pine Mix	1987	10	7.57	Potential harvest
Coille Am Sealbach	7m	Sitka Spruce / Petersburg Lodgepole Pine Mix	1994	6	1.55	Small tree - mulch
Coille Fada	1a	Sitka Spruce / Lodgepole Pine Mix	1984	6	13.26	Small tree - mulch
Coille Fada	1b	Sitka Spruce / Lodgepole Pine Mix	1984	8	5.20	Small tree - mulch
Coille Fada	1c	Sitka Spruce / Lodgepole Pine Mix	1984	8	6.37	Small tree - mulch
Coille Fada	2a	Sitka Spruce / Lodgepole Pine Mix	1984	6	4.18	Small tree - mulch
Coille Fada	2b	Sitka Spruce / Lodgepole Pine Mix	1984	6	4.62	Small tree - mulch
Coille Fada	2c	Sitka Spruce / Lodgepole Pine Mix	1984	6	5.24	Small tree - mulch
Coille Fada	2d	Sitka Spruce / Lodgepole Pine Mix	1984	6	5.91	Small tree - mulch
Coille Fada	3a	Sitka Spruce / Lodgepole Pine Mix	1985	10	3.43	Potential harvest
Coille Fada	3b	Sitka Spruce / Lodgepole Pine Mix	1985	10	1.32	Potential harvest
Coille Fada	3c	Sitka Spruce / Lodgepole Pine Mix	1985	6	6.01	Small tree - mulch
Coille Fada	3d	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.81	Small tree - mulch
Coille Fada	3e	Sitka Spruce / Lodgepole Pine Mix	1985	6	6.79	Small tree - mulch
Coille Fada	3f	Sitka Spruce / Lodgepole Pine Mix	1985	6	0.60	Small tree - mulch
Coille Fada	3g	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.79	Small tree - mulch
Coille Fada	3h	Sitka Spruce	1985	4	2.90	Small tree - mulch
Coille Fada	3i	Sitka Spruce	1985	6	1.26	Small tree - mulch
Coille Fada	4a	Sitka Spruce / Lodgepole Pine Mix	1986	10	6.38	Potential harvest
Coille Fada	4b	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.81	Small tree - mulch
Coille Fada	4c	Sitka Spruce / Lodgepole Pine Mix	1986	10	3.68	Potential harvest
Coille Fada	4e	Sitka Spruce / Lodgepole Pine Mix	1986	10	1.93	Potential harvest
Coille Fada	4f	Sitka Spruce / Lodgepole Pine Mix	1986	12	2.24	Potential harvest
Coille Fada	4d	Sitka Spruce / Lodgepole Pine Mix	1986	6	3.31	Small tree - mulch
Coille Fada	5a	Sitka Spruce / Lodgepole Pine Mix	1987	8	6.56	Small tree - mulch
Coille Fada	5b	Sitka Spruce / Lodgepole Pine Mix	1987	10	5.17	Potential harvest
Coille Fada	5c	Sitka Spruce / Lodgepole Pine Mix	1987	10	4.78	Potential harvest
Coille Fada	5d	Sitka Spruce / Lodgepole Pine Mix	1987	14	4.78	Potential harvest
Coille Fada	5e	Sitka Spruce / Lodgepole Pine Mix	1987	10	1.51	Potential harvest
Coille Nan Clach	1a	Sitka Spruce / Lodgepole Pine Mix	1984	6	3.99	Small tree - mulch

Forest Unit	Sub-compartment	Species	Planting Year	Yield Class	Planted Area (ha)	Proposed Forest Removal
Coille Nan Clach	1b	Sitka Spruce / Lodgepole Pine Mix	1984	6	0.53	Small tree - mulch
Coille Nan Clach	1c	Sitka Spruce / Lodgepole Pine Mix	1984	4	4.33	Small tree - mulch
Coille Nan Clach	1d	Sitka Spruce / Lodgepole Pine Mix	1984	6	3.23	Small tree - mulch
Coille Nan Clach	1e	Sitka Spruce	1983	4	2.19	Small tree - mulch
Coille Nan Clach	1f	Sitka Spruce / Lodgepole Pine Mix	1984	6	6.11	Small tree - mulch
Coille Nan Clach	1g	Sitka Spruce / Lodgepole Pine Mix	1984	6	4.78	Small tree - mulch
Coille Nan Clach	2a	Sitka Spruce / Lodgepole Pine Mix	1985	6	5.32	Small tree - mulch
Coille Nan Clach	2b	Sitka Spruce / Lodgepole Pine Mix	1984	6	4.23	Small tree - mulch
Coille Nan Clach	2c	Sitka Spruce / Lodgepole Pine Mix	1985	6	9.43	Small tree - mulch
Coille Nan Clach	2d	Sitka Spruce / Lodgepole Pine Mix	1985	6	2.47	Small tree - mulch
Coille Nan Clach	2e	Sitka Spruce / Lodgepole Pine Mix	1985	6	1.58	Small tree - mulch
Coille Nan Clach	3a	Sitka Spruce / Lodgepole Pine Mix	1986	6	5.05	Small tree - mulch
Coille Nan Clach	3b	Sitka Spruce / Lodgepole Pine Mix	1986	6	3.75	Small tree - mulch
Coille Nan Clach	3c	Sitka Spruce / Lodgepole Pine Mix	1986	6	2.17	Small tree - mulch
Coille Nan Clach	4a	Sitka Spruce / Lodgepole Pine Mix	1987	6	1.20	Small tree - mulch
Coille Nan Clach	4b	Sitka Spruce / Lodgepole Pine Mix	1987	6	1.24	Small tree - mulch
Coille Nan Clach	4c	Sitka Spruce / Lodgepole Pine Mix	1987	6	1.90	Small tree - mulch
Coille Nan Clach	4d	Sitka Spruce / Lodgepole Pine Mix	1987	6	3.54	Small tree - mulch
Coille Nan Clach	4e	Sitka Spruce / Lodgepole Pine Mix	1987	6	2.78	Small tree - mulch
Coille Nan Clach	4f	Sitka Spruce / Petersburg Lodgepole Pine / Japanese Larch Mix	1987	6	5.89	Small tree - mulch
Coille Nan Clach	5a	Sitka Spruce / Lodgepole Pine Mix	1988	8	1.95	Small tree - mulch
Coille Nan Clach	5b	Sitka Spruce / Lodgepole Pine Mix	1987	10	5.96	Potential harvest
Coille Nan Clach	5c	Sitka Spruce / Lodgepole Pine Mix	1987	10	9.42	Potential harvest
Coille Nan Clach	5d	Sitka Spruce / Lodgepole Pine Mix	1988	6	1.04	Small tree - mulch
Coille Meadhonach	1a	Sitka Spruce / Lodgepole Pine Mix	1984	10	0.71	Potential harvest
Coille Meadhonach	1b	Sitka Spruce / Lodgepole Pine Mix	1984	8	5.90	Small tree - mulch
Coille Meadhonach	1c	Sitka Spruce / Lodgepole Pine Mix	1984	10	4.47	Potential harvest
Coille Meadhonach	1d	Sitka Spruce / Lodgepole Pine Mix	1984	10	3.46	Potential harvest
Coille Meadhonach	2a	Sitka Spruce / Lodgepole Pine Mix	1985	8	0.51	Small tree - mulch
Coille Meadhonach	2c	Sitka Spruce / Lodgepole Pine Mix	1985	8	0.81	Small tree - mulch
Coille Meadhonach	3a	Sitka Spruce / Lodgepole Pine Mix	1985	8	2.45	Small tree - mulch
Coille Meadhonach	3b	Sitka Spruce / Lodgepole Pine Mix	1985	8	1.78	Small tree - mulch
Coille Meadhonach	3c	Sitka Spruce / Lodgepole Pine Mix	1985	8	3.60	Small tree - mulch
Coille Meadhonach	3d	Sitka Spruce / Lodgepole Pine Mix	1985	8	4.09	Small tree - mulch
Coille Meadhonach	4a	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.13	Small tree - mulch
Coille Meadhonach	4b	Sitka Spruce / Lodgepole Pine Mix	1986	8	6.45	Small tree - mulch
Coille Meadhonach	4c	Sitka Spruce / Lodgepole Pine Mix	1986	10	7.62	Potential harvest
Coille Meadhonach	2b	Sitka Spruce / Lodgepole Pine Mix	1985	8	1.96	Small tree - mulch
Coille Meadhonach	4d	Sitka Spruce / Lodgepole Pine Mix	1986	8	0.10	Small tree - mulch
Coille An Reidhe	1a	Sitka Spruce / Lodgepole Pine Mix	1984	6	6.95	Small tree - mulch
Coille An Reidhe	1b	Sitka Spruce / Lodgepole Pine Mix	1984	6	6.99	Small tree - mulch
Coille An Reidhe	2a	Sitka Spruce / Lodgepole Pine Mix	1984	8	6.61	Small tree - mulch
Coille An Reidhe	2b	Sitka Spruce / Lodgepole Pine Mix	1985	6	6.47	Small tree - mulch
Coille An Reidhe	3a	Sitka Spruce / Lodgepole Pine Mix	1985	8	4.00	Small tree - mulch
Coille An Reidhe	3b	Sitka Spruce / Lodgepole Pine Mix	1985	8	6.53	Small tree - mulch
Coille An Reidhe	3c	Sitka Spruce / Lodgepole Pine Mix	1985	8	5.63	Small tree - mulch
Coille An Reidhe	4a	Sitka Spruce / Lodgepole Pine Mix	1986	8	5.39	Small tree - mulch
Coille An Reidhe	4b	Sitka Spruce / Lodgepole Pine Mix	1986	8	5.67	Small tree - mulch
Coille An Reidhe	4c	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.18	Small tree - mulch
Coille An Reidhe	4d	Sitka Spruce / Lodgepole Pine Mix	1986	8	0.95	Small tree - mulch
Coille An Reidhe	4e	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.86	Small tree - mulch
Coille An Reidhe	4f	Sitka Spruce / Lodgepole Pine Mix	1986	8	3.68	Small tree - mulch
Coille An Reidhe	4g	Sitka Spruce / Lodgepole Pine Mix	1986	8	2.61	Small tree - mulch
Coille An Reidhe	5a	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	3.18	Potential harvest
Coille An Reidhe	5b	Sitka Spruce / Lodgepole Pine Mix	1987	10	4.55	Potential harvest
Coille An Reidhe	5c	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	5.93	Potential harvest
Coille An Reidhe	5d	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	7.33	Potential harvest
Coille An Reidhe	5e	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	4.02	Potential harvest
Coille An Reidhe	5f	Sitka Spruce / Petersburg Lodgepole Pine Mix	1987	10	2.82	Potential harvest
Total Area Planted					1133.03	

APPENDIX 2 – FOREST SURVEY RESULTS

Forest Unit	Sub-compartment	Species	Planting Year	DBH (cm)	Top Height (M)	Condition
Bad Coille	1c	Lodgepole Pine	1985	10	6	Poor
Bad Coille	1c	Sitka Spruce	1985	15	8	Poor
Bad Coille	2a	Sitka Spruce	1985	10	7	Poor
Bad Coille	2b	Lodgepole Pine	1985	8	6	Stunted
Bad Coille	2c	Sitka Spruce	1985	14	7	Poor
Bad Coille	2c	Lodgepole Pine	1985	12	6	Poor
Bad Coille	2d	Lodgepole Pine	1985	11	6	Poor
Bad Coille	2d	Sitka Spruce	1985	13	7	Poor
Bad Coille	2i	Sitka Spruce	1985	10	7	Poor
Bad Coille	2i	Lodgepole Pine	1985	8	6	Stunted
Bad Coille	3b	Sitka Spruce	1985	14	7	Average
Bad Coille	3b	Lodgepole Pine	1985	10	6	Poor
Bad Coille	3c	Lodgepole Pine	1985	10	6	Poor
Bad Coille	3d	Sitka Spruce	1985	10	6	Poor
Bad Coille	3d	Sitka Spruce	1985	11	7	Poor
Bad Coille	3d	Lodgepole Pine	1985	10	6	Poor
Bad Coille	4c	Sitka Spruce	1985	15	10	Average
Bad Coille	4c	Lodgepole Pine	1985	12	6	Poor
Bad Coille	4d	Sitka Spruce	1985	15	10	Average
Bad Coille	4d	Lodgepole Pine	1985	12	6	Poor
Bad Coille	4e	Sitka Spruce	1985	14	9	Poor
Bad Coille	4e	Lodgepole Pine	1985	10	6	Poor
Bad Coille	6a	Sitka Spruce	1985	15	11	Average
Bad Coille	6a	Lodgepole Pine	1985	12	8	Average
Bad Coille	6b	Sitka Spruce	1985	12	6	Stunted
Bad Coille	6b	Lodgepole Pine	1985	10	6	Stunted
Bad Coille	6c	Sitka Spruce & Lodgepole Pine	1985	13	7	Poor
Bad Coille	8a	Lodgepole Pine	1985	10	8	Poor
Bad Coille	8b	Sitka Spruce	1985	12	8	Poor
Bad Coille	8b	Lodgepole Pine	1985	16	8	Poor
Bad Coille	8e	Sitka Spruce	1985	17	12	Average
Coille Am Sealbach	3b	Sitka Spruce & Lodgepole Pine	1986	10	6	Poor
Coille Am Sealbach	3c	Sitka Spruce	1986	6	5	Stunted
Coille Am Sealbach	3d	Sitka Spruce & Lodgepole Pine	1986	15	10	Average
Coille Am Sealbach	3d	Sitka Spruce & Lodgepole Pine	1986	10	6	Poor
Coille Am Sealbach	3e	Sitka Spruce & Lodgepole Pine	1986	14	10	Average
Coille Am Sealbach	3g	Sitka Spruce & Lodgepole Pine	1986	13	8	Good
Coille Am Sealbach	4b	Sitka Spruce & Lodgepole Pine	1987	12	7	Poor
Coille Am Sealbach	4c	Sitka Spruce & Lodgepole Pine	1987	10	6	Poor
Coille Am Sealbach	4d	Sitka Spruce & Lodgepole Pine	1987	15	7	Average
Coille Am Sealbach	4f	Lodgepole Pine	1987	14	7	Poor
Coille Am Sealbach	5a	Sitka Spruce & Lodgepole Pine	1987	13	8	Average
Coille Am Sealbach	5a	Sitka Spruce	1987	15	9	Average
Coille Am Sealbach	7a	Sitka Spruce & Lodgepole Pine	1994	6	4	Stunted
Coille Am Sealbach	7c	Sitka Spruce & Lodgepole Pine	1994	5	3	Stunted
Coille Am Sealbach	7d	Sitka Spruce & Lodgepole Pine	1994	5	3	Stunted
Coille Am Sealbach	7e	Sitka Spruce & Lodgepole Pine	1994	5	3	Stunted
Coille Am Sealbach	7f	Sitka Spruce & Lodgepole Pine	1994	5	3	Stunted
Coille Am Sealbach	7g	Sitka Spruce & Lodgepole Pine	1994	5	4	Stunted
Coille Am Sealbach	7h	Sitka Spruce & Lodgepole Pine	1994	6	4	Stunted
Coille Am Sealbach	8a	Sitka Spruce & Lodgepole Pine	1994	5	3	Stunted
Coille Am Sealbach	8b	Sitka Spruce & Lodgepole Pine	1994	5	3	Stunted
Coille Am Sealbach	8d	Sitka Spruce & Lodgepole Pine	1994	6	3	Stunted
Coille Am Sealbach	9d	Broadleaved	1994	no data	no data	Dead
Coille Am Sealbach	9e	Lodgepole Pine	1994	6	4	Stunted
Coille Am Sealbach	9g	Sitka Spruce & Lodgepole Pine	1994	6	5	Poor
Coille Am Sealbach	9h	Broadleaved	1994	no data	no data	no data
Coille An Reidhe	1a	Sitka Spruce & Lodgepole Pine	1983	10	6	Poor
Coille An Reidhe	2b	Sitka Spruce & Lodgepole Pine	1985	10	6	Poor
Coille An Reidhe	5b	Sitka Spruce	1987	14	10	Average
Coille An Reidhe	5f	Sitka Spruce	1987	14	10	Average
Coille Buidhe	1a	Sitka Spruce & Lodgepole Pine	1984	14	10	Average
Coille Buidhe	1b	Sitka Spruce & Lodgepole Pine	1985	10	5	Poor
Coille Buidhe	1c	Sitka Spruce	1985	12	7	Poor

Forest Unit	Sub-compartment	Species	Planting Year	DBH (cm)	Top Height (M)	Condition
Coille Buidhe	1c	Lodgepole Pine	1985	10	5	Poor
Coille Buidhe	3b	Sitka Spruce & Lodgepole Pine	1986	15	9	Average
Coille Buidhe	3b	Broadleaved	1986	no data	3	Poor
Coille Buidhe	3c	Sitka Spruce & Lodgepole Pine	1986	13	9	Average
Coille Buidhe	4b	Sitka Spruce & Lodgepole Pine	1986	12	8	Average
Coille Buidhe	5c	Sitka Spruce & Lodgepole Pine	1986	12	7	Average
Coille Buidhe	5f	Sitka Spruce & Lodgepole Pine	1986	12	7	Average
Coille Buidhe	5g	Sitka Spruce & Lodgepole Pine	1986	15	9	Average
Coille Buidhe	5g	Sitka Spruce & Lodgepole Pine	1986	12	8	Average
Coille Buidhe	6b	Sitka Spruce & Lodgepole Pine	1987	11	6	Poor
Coille Buidhe	6c	Sitka Spruce & Lodgepole Pine	1987	11	6	Poor
Coille Buidhe	6c	Sitka Spruce & Lodgepole Pine	1987	10	7	Average
Coille Buidhe	7a	Sitka Spruce & Lodgepole Pine	1987	12	7	Average
Coille Buidhe	7b	Sitka Spruce	1987	10	4	Stunted
Coille Buidhe	7c	Sitka Spruce & Lodgepole Pine	1987	13	7	Average
Coille Buidhe	7e	Sitka Spruce & Lodgepole Pine	1987	10	7	Poor
Coille Buidhe	7f	Sitka Spruce & Lodgepole Pine	1987	10	7	Poor
Coille Buidhe	8d	Sitka Spruce & Lodgepole Pine	1990	10	6	Poor
Coille Buidhe	8e	Sitka Spruce & Lodgepole Pine	1990	10	6	Poor
Coille Buidhe	8g	Sitka Spruce & Lodgepole Pine	1990	10	5	Poor
Coille Buidhe	8i	Sitka Spruce & Lodgepole Pine	1990	10	6	Poor
Coille Buidhe	8j	Sitka Spruce & Lodgepole Pine	1990	10	5	Poor
Coille Buidhe	8l	Sitka Spruce & Lodgepole Pine	1990	10	4	Poor
Coille Buidhe	8n	Sitka Spruce & Lodgepole Pine	1990	10	6	Poor
Coille Fada	2b	Sitka Spruce	1984	13	8	Average
Coille Fada	2b	Lodgepole Pine	1984	12	6	Average
Coille Fada	3a	Sitka Spruce & Lodgepole Pine	1985	14	9	Average
Coille Fada	3b	Sitka Spruce & Lodgepole Pine	1985	14	9	Average
Coille Fada	3c	Sitka Spruce	1985	12	7	Average
Coille Fada	3c	Lodgepole Pine	1985	12	6	Poor
Coille Fada	3e	Sitka Spruce	1985	13	8	Average
Coille Fada	3e	Lodgepole Pine	1985	13	6	Poor
Coille Fada	3g	Sitka Spruce & Lodgepole Pine	1985	8	5	Poor
Coille Fada	3h	Sitka Spruce	1985	6	3	Stunted
Coille Fada	3i	Sitka Spruce & Lodgepole Pine	1985	5	5	Stunted
Coille Fada	4a	Sitka Spruce & Lodgepole Pine	1986	14	9	Average
Coille Fada	4b	Sitka Spruce & Lodgepole Pine	1986	12	8	Average
Coille Fada	4b	Sitka Spruce & Lodgepole Pine	1986	14	8	Average
Coille Fada	4c	Sitka Spruce & Lodgepole Pine	1986	14	9	Average
Coille Fada	4d	Sitka Spruce	1986	10	6	Poor
Coille Fada	4d	Lodgepole Pine	1986	9	5	Poor
Coille Fada	4e	Sitka Spruce & Lodgepole Pine	1986	14	9	Average
Coille Fada	4f	Sitka Spruce & Lodgepole Pine	1986	14	10	Average
Coille Fada	5c	Sitka Spruce & Lodgepole Pine	1987	16	10	Average
Coille Fada	5e	Lodgepole Pine	1987	15	10	Average
Coille Meadhonach	1b	Sitka Spruce & Lodgepole Pine	1984	10	7	Poor
Coille Meadhonach	1b	Sitka Spruce & Lodgepole Pine	1984	16	10	Average
Coille Meadhonach	1c	Sitka Spruce & Lodgepole Pine	1984	15	10	Average
Coille Meadhonach	1d	Sitka Spruce & Lodgepole Pine	1984	16	10	Average
Coille Meadhonach	3a	Sitka Spruce & Lodgepole Pine	1985	12	7	Average
Coille Meadhonach	3b	Sitka Spruce & Lodgepole Pine	1985	12	8	Average
Coille Meadhonach	3c	Sitka Spruce	1985	10	7	Poor
Coille Meadhonach	3d	Sitka Spruce & Lodgepole Pine	1985	13	8	Average
Coille Meadhonach	4a	Sitka Spruce & Lodgepole Pine	1986	13	8	Average
Coille Meadhonach	4b	Sitka Spruce & Lodgepole Pine	1986	12	8	Average
Coille Meadhonach	4c	Sitka Spruce & Lodgepole Pine	1986	15	9	Average
Coille Nan Clach	1a	Sitka Spruce & Lodgepole Pine	1983	10	6	Poor
Coille Nan Clach	1b	Sitka Spruce & Lodgepole Pine	1983	10	6	Poor
Coille Nan Clach	1c	Sitka Spruce	1983	12	7	Poor
Coille Nan Clach	1c	Lodgepole Pine	1983	10	6	Poor
Coille Nan Clach	1d	Sitka Spruce & Lodgepole Pine	1983	10	6	Poor
Coille Nan Clach	1e	Sitka Spruce & Lodgepole Pine	1983	6	4	Stunted
Coille Nan Clach	1f	Sitka Spruce & Lodgepole Pine	1983	10	6	Poor
Coille Nan Clach	1g	Sitka Spruce & Lodgepole Pine	1983	7	6	Poor
Coille Nan Clach	4a	Sitka Spruce	1987	no data	no data	Stunted
Coille Nan Clach	4a	Sitka Spruce & Lodgepole Pine	1987	8	5	Poor
Coille Nan Clach	4a	Sitka Spruce & Lodgepole Pine	1987	8	6	Poor
Coille Nan Clach	5b	Sitka Spruce	1987	10	8	Poor

Forest Unit	Sub-compartment	Species	Planting Year	DBH (cm)	Top Height (M)	Condition
Coille Nan Clach	5c	Sitka Spruce & Lodgepole Pine	1987	10	8	Poor
Coille Nan Clach	5d	Sitka Spruce & Lodgepole Pine	1988	8	4	Poor
Coille Saobhaidhe	10a	Lodgepole Pine	1986	14	6	Poor
Coille Saobhaidhe	10c	Sitka Spruce & Lodgepole Pine	1986	13	7	Poor
Coille Saobhaidhe	10c	Sitka Spruce & Lodgepole Pine	1986	no data	4	Stunted
Coille Saobhaidhe	10d	Sitka Spruce & Lodgepole Pine	1986	14	9	Average
Coille Saobhaidhe	1a	Sitka Spruce & Lodgepole Pine	1983	15	10	Average
Coille Saobhaidhe	2a	Sitka Spruce & Lodgepole Pine	1983	12	7	Poor
Coille Saobhaidhe	2e	Sitka Spruce & Lodgepole Pine	1983	13	8	Poor
Coille Saobhaidhe	3e	Sitka Spruce & Lodgepole Pine	1984	13	8	Poor
Coille Saobhaidhe	4c	Sitka Spruce & Lodgepole Pine	1984	10	7	Poor
Coille Saobhaidhe	4d	Sitka Spruce & Lodgepole Pine	1984	12	8	Poor
Coille Saobhaidhe	4e	Sitka Spruce & Lodgepole Pine	1984	10	6	Poor
Coille Saobhaidhe	5b	Sitka Spruce & Lodgepole Pine	1985	10	6	Poor
Coille Saobhaidhe	5c	Sitka Spruce & Lodgepole Pine	1985	12	6	Poor
Coille Saobhaidhe	6a	Sitka Spruce & Lodgepole Pine	1985	10	6	Poor
Coille Saobhaidhe	6b	Sitka Spruce & Lodgepole Pine	1985	10	6	Poor
Coille Saobhaidhe	6c	Sitka Spruce & Lodgepole Pine	1985	10	7	Poor
Coille Saobhaidhe	6e	Sitka Spruce & Lodgepole Pine	1985	12	8	Average
Coille Saobhaidhe	7b	Sitka Spruce & Lodgepole Pine	1985	10	7	Poor
Coille Saobhaidhe	7c	Sitka Spruce & Lodgepole Pine	1985	12	8	Average
Coille Saobhaidhe	7c	Sitka Spruce & Lodgepole Pine	1985	12	8	Average
Coille Saobhaidhe	7d	Sitka Spruce & Lodgepole Pine	1985	12	9	Average
Coille Saobhaidhe	7e	Sitka Spruce & Lodgepole Pine	1985	13	7	Poor
Coille Saobhaidhe	7f	Sitka Spruce & Lodgepole Pine	1985	12	7	Poor
Coille Saobhaidhe	7g	Sitka Spruce & Lodgepole Pine	1985	13	7	Poor
Coille Saobhaidhe	8a	Sitka Spruce & Lodgepole Pine	1986	14	9	Average
Coille Saobhaidhe	8b	Sitka Spruce & Lodgepole Pine	1986	12	7	Average
Coille Saobhaidhe	8c	Sitka Spruce & Lodgepole Pine	1986	15	10	Average
Coille Saobhaidhe	8d	Sitka Spruce & Lodgepole Pine	1986	12	7	Average
Coille Saobhaidhe	8e	Sitka Spruce & Lodgepole Pine	1986	12	8	Poor
Coille Saobhaidhe	8f	Sitka Spruce & Lodgepole Pine	1986	12	8	Poor
Coille Saobhaidhe	9a	Sitka Spruce & Lodgepole Pine	1986	15	10	Average
Coille Saobhaidhe	9c	Sitka Spruce & Lodgepole Pine	1986	12	7	Poor
Coille Saobhaidhe	9d	Sitka Spruce & Lodgepole Pine	1986	11	7	Poor
Coille Saobhaidhe	9d	Sitka Spruce & Lodgepole Pine	1986	16	10	Average
Coille Saobhaidhe	9e	Sitka Spruce & Lodgepole Pine	1986	12	8	Average
Coille Saobhaidhe	9f	Sitka Spruce & Lodgepole Pine	1986	10	7	Poor
Coille Saobhaidhe	9f	Sitka Spruce & Lodgepole Pine	1986	13	8	Average
Coille Saobhaidhe	9g	Sitka Spruce & Lodgepole Pine	1986	10	7	Poor
Coille Saobhaidhe	9h	Sitka Spruce & Lodgepole Pine	1986	14	8	Average

APPENDIX 3 – DETAILS OF 2009 ADDITIONAL BIRD SURVEYS

1. Common Prey Surveys

6.

7. For Strathy North, where a short sward was the target habitat after forest removal, survey work was carried out in 2009 to determine the characteristic prey assemblage likely to evolve on that more heavily managed 'short sward' target habitat. For Strathy South, where SHN have clearly stated their preference for peatland restoration, this short sward information is no longer relevant. Comparable information on prey abundance on peatland habitats was also collected in 2009, however, and this is relevant to the habitat management objective for Strathy South,

8.

9. Therefore, this information (specifically, the survey methods for common prey items, and the results) are presented below.

10.

1.1 Comparative Breeding Bird Surveys

11. ***Introduction***

The breeding bird assemblage that may develop at Strathy South is of interest in its own right, but it is also important because of its potential influence on raptors coming on site to forage or breed. As a result, some species of conservation interest may therefore be at increased risk of collision with wind turbines compared to current levels, depending on the relative availability of prey items (as well as other factors, such as distance from nest location etc.).

12. ***Methods***

A series of breeding bird surveys were therefore carried out between April and June 2009 inclusive (comparative breeding bird and specific meadow pipit/skylark surveys), within two moorland sample plots which are detailed below:

Plot 1b – Open moorland at NC838 634, looking SW with Strathy forest to the right(area 5.24 ha)

13. *Plot 1b – Open moorland – M17/M19 NVC Blanket mire*

The sample plot was dominated by common heather and deergrass, with abundant hare's-tail cotton grass, reindeer lichen and cross-leaved heather. There was approximately 10% cover of soft rush. In wetter areas, bog myrtle was present. Other species included tufted hair grass, *Sphagnum spp.*, bog asphodel and tormentil. There was evidence of light cattle grazing. Average sward height was less than 10cm.

Plot 2b – open moorland at NC837622, looking SSW with Strathy Forest on right (area 11.36 ha)

14. *Plot 2b – Open Moorland M17/M19 Blanket Mire and Upland Rough Grassland mix*

The sample plot was a mixture of blanket mire and upland rough grassland, and contained around 33% common heather coverage, with the remainder including fescues, common bent, bog myrtle, bog asphodel mat-grass and tormentil. No rushes were present. Sward height reached up to 20cm, and no obvious livestock grazing was evident. This area shows signs of some fire damage.

For both survey types, three survey visits were made on 30 April (visit one), 12 May (visit two) and 24 June (visit three) in order to ensure that key phases of the breeding cycle are not missed.

Breeding bird surveys to record species diversity and abundance were conducted on Plot 1b, based on the standard Brown and Shepherd (1993)[22] survey methodology. This method normally requires a standardised survey effort per unit area (20-25 minutes per 500 m x 500 m square), but since sample plots were considerably smaller than this, one transect per plot was carried out for each survey on the same day. A single surveyor walked a pre-determined transect route ensuring that all parts of the survey area were approached to within 100 m. A handheld GPS unit was used to ensure that the survey route was maintained and repeated between surveys. The location and behaviour of all birds encountered during the survey visits were recorded.

Whilst the Brown and Shepherd method was originally designed for recording wader species in upland habitats, it is commonly used to provide indices of upland passerine breeding activity, although it may produce under-estimates in the numbers of some species such as skylark and meadow pipit. A separate series of transect surveys were therefore carried out to record these two species, based on methodology by

[22] Brown, A.F. and Shepherd, K.B. 1993. A method of censuring upland breeding waders. Bird Study 40: 189-195.

Thirgood *et al* (1995)[23]. Plot 1b was again surveyed, but to obtain broader data, a second survey plot was surveyed in May and June (Plot 2b). During these surveys a transect was walked within each plot, and the number, location and breeding evidence of birds was recorded.

Meadow pipit and skylark transects were located as follows:

- Plot 1b (open moorland): NC83883 63602 to NC83750 63259;
- Plot 2b (open moorland): NC83802 62233 to NC83772 61765.

For both survey types, the location and behaviour of birds were recorded in the field on 1:10,000 scale maps. Records from all three visits were combined to allow an estimate of comparative numbers of species and individuals within each sample plot. Breeding evidence was also recorded to show whether a species uses the habitat potentially for nesting, foraging or non-breeding purposes. In the absence of any of these indicative behaviours, a pair observed together in suitable habitat was considered to represent a breeding pair. Other records were considered to be of non-breeding birds.

Within visits, duplicate records of passerines separated by less than a threshold distance of 200 m were as standard considered to correspond to birds of the same pair, while those separated by more than this threshold distance were considered to be from different pairs. Exceptions to this are where the surveyor recorded that birds seen within this threshold distance of each other represented different pairs and vice versa. Appropriate annotations were made on the field maps to indicate whether this was the case.

Estimates of the number of pairs/territories were derived by comparing the three visit maps. Passerine breeding records or territories were generally considered to be separate from each other if they were over 200 m apart.

15. *Results*

Results of comparative breeding surveys within the Plot 1b show that six species were recorded in the open moorland sample plots (Tables 4.A.1 and 4.A.2). No SPA species were recorded in either plot.

TABLE 4.A.1 - PLOT 1B (OPEN MOORLAND) – SWARD HEIGHT = 34 CM

Species	Visit 1	Visit 2	Visit 3	Estimated Breeding Pairs
Redpoll sp.	2	-	-	0
Siskin	1	-	-	0
Meadow pipit	6	6	7	3
Skylark	3(1)	3(2)	1	3
Red grouse	1	2	-	1
Snipe	-	1(1)	-	1

Table 4.A.3 below summarises the results of common prey surveys (skylark and meadow pipit), and estimates of breeding pairs per sample plot.

TABLE 4.A.2 – RESULTS OF 2009 COMMON PREY SURVEYS

	Skylark	Meadow Pipit	Notes
Plot 1b (open moorland)			
Visit 1	3(1)	6	possible 3 MP territories, but only 1 record of singing; 3 singing S
Visit 2	3(2)	6	2 singing MP and 3 alarm calls; 1 singing and 2 calling S
Visit 3	1	7	3 singing MPs; one singing S
Estimated Breeding Pairs	**3**	**4**	
Plot 2b (open moorland)			
Visit 1	n/s	n/s	
Visit 2	4	2	4 singing S; 2 MPs only 1 calling
Visit 3	4	4	4 singing S; one MP singing with 2 possible juveniles
Estimated Breeding Pairs	**4**	**2**	

[23] Thirgood, S J, Leckie, F M and Redpath, S M (1995). Diurnal and seasonal variation in line transect counts of moorland passerines. Bird Study 42: 257-259.

1.2 Field Vole Surveys

16. ***Introduction***

The distribution and abundance of voles on site is a notable influence on the presence of raptors, particularly short-eared owl and hen harrier. These raptors would be attracted to the wind farm area if prey density was higher than surrounding areas, putting them at increased risk of collision.

The felling of forest blocks will lead to alterations in prey abundance and availability within the wind farm area, and the aim of these surveys was to help predict what possible relative densities of vole abundance could be found, depending on future habitat management decisions.

A set of vole surveys were conducted to demonstrate comparative levels of presence in different habitats at Strathy North and on the RSPB Forsinard reserve.

17. ***Methodology***

Vole surveys were undertaken on 28th and 29th May 2009 within the Strathy North plantation, and in adjacent moorland 1b sample site (see above) at approximately NC837 637. All quadrats within the forest were placed in rides or open areas. Although no vole surveys have been carried out at Strathy South, they are likely to be relatively comparable to Strathy North.

On 15th June 2009 an area of the clear-felled Lonielist plantation on RSPB land was also surveyed for vole signs. This area was selected as it is known to host at least one pair each of breeding hen harrier and short-eared owl, so helps provide an example of what levels of vole abundance can support raptor species.

A series of 30 quadrats (25 x 25 cm) were randomly placed during each survey, in order to establish the presence and density of field voles.

Quadrats were searched for the presence and absence of vole signs (as per Lambin, Petty and MacKinnon 2000)[24]. These include runways, fresh clippings and fresh droppings. Vole sign indices have generally been shown to be linearly related to actual vole densities based on snap-trapping methods and are widely used to estimate vole abundance. In order to determine population estimates, the number of quadrats containing fresh clippings is counted. A calibration method is then employed to determine the density of field voles.

Whilst these methods were developed in clearfell blocks within commercial plantations in northern England, Wheeler (2002)[25] also recommends using feeding signs for statistical analysis of field vole abundance in upland grass areas.

Results from the vole surveys carried out at all plots are shown in Table 4.A.3 below:

TABLE 4.A.3 – EVIDENCE OF VOLES AT STRATHY AND FORSINARD, 2009

	Sward Height (cm)	Droppings	Old Clippings	Fresh Clippings	Tunnels	Total
Strathy North Rides	**55**	**17**	**10**	**7**	**3**	**37**
Open Moorland	**34**	**5**	**4**	**1**	**0**	**10**
Lonielist	**24**	**8**	**2**	**5**	**0**	**15**

Results from vole presence surveys showed that abundance in the forest rides was highest, with the second highest being at Lonielist felled forest.

18. ***Conclusions***

Surveys of breeding birds reveal that the diversity and abundance of the potential avian prey species important for raptors were at moderate abundance on the open moorland. For field voles, it appears that rides can support relatively high vole densities, and this differential may lead to preferential foraging once the forest has been removed.

[24] Lambin, X., Petty, S.J. and MacKinnon, J.L. (2000) Cyclic dynamics in field vole populations and generalist predation. Journal of Animal Ecology, 69, 106–118.
[25] Wheeler P (2002). The distribution of mammals across the upland landscape Unpublished Ph.D. thesis, University of Manchester.

Comparative Vantage Point Surveys

Introduction

Bird usage and therefore flight activity patterns may vary between habitats. As such, bird activity post-felling at the Strathy South Wind farm site is expected to be different from previously observed activity over forestry. The aim of this survey was to examine potential future activity, particularly flight height, over the clear-felled wind farm site, by conducting a comparative study of flight activity over a wooded and an un-wooded slope with similar underlying physical characteristics at Strathy North. Whilst this work was not done specifically for Strathy South, it was considered that the pre-existing information was sufficiently transferable between sites.

Methods

Simultaneous vantage point surveys were conducted by two observers, back-to-back, from one point located at NC828 585 alongside the access track to the east of Strathy Forest, in the valley between east-facing (wooded) and west-facing (un-wooded) hill slopes. This site was selected as both sides of the valley are of comparable topography. Conducting simultaneous surveys helped negate any differences that may be down to factors other than habitat, such as weather and time of day.

A series of surveys were carried out during the breeding season, between April and July 2009 inclusive, to accurately determine flight activity of target species. Methodology was based on standard VP methodology described by SNH (2005)[Error! Bookmark not defined.].

Each survey was undertaken in conditions of good visibility. Watches were limited to three hours duration by any single observer, with a break of at least one hour between surveys on any day. Four experienced ornithological surveyors were used – Julian Smith (JS), Martyn Elwell (ME), Graeme Cook (GAC) and Rob Martin (RM).

During each watch, the landscape was scanned continuously until a target species was detected. Once detected, the bird was observed until it landed or flew out of sight. The time of first detection was noted, and the flight height was recorded for each 15 second period that the bird was in view, as one of one of five height bands: <10 m, 10-20 m, 20-40 m, 40-100 m and >100 m. The paths of all observed flights (flight lines) were drawn onto 1:10,000 scale maps in the field.

A map showing the flight lines for each target species was compiled in a Geographic Information System (GIS) (ArcView v9.3), with each flight line linked to its associated flight duration and height information held in a Microsoft Access database.

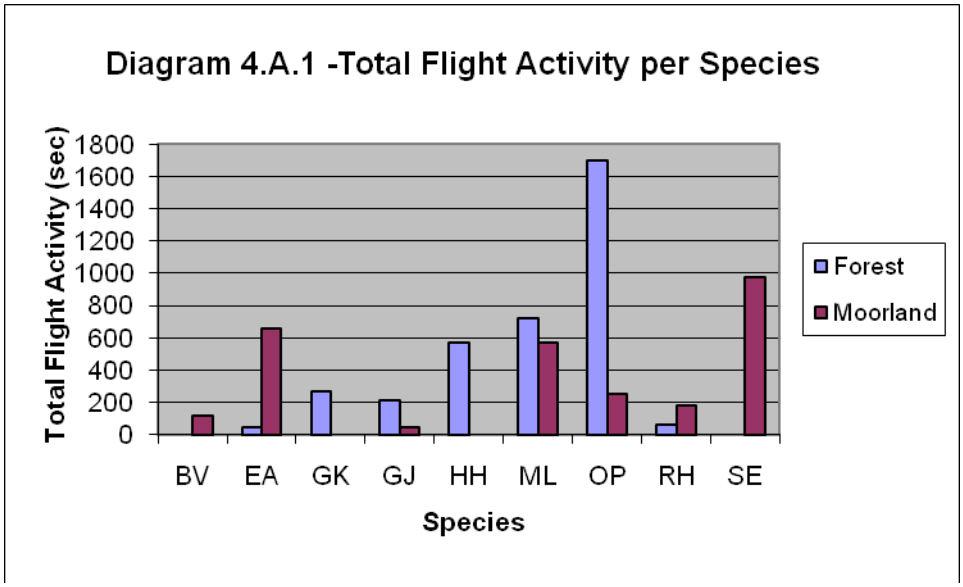
Results

A total of 60 hours of survey per vantage point direction (east and west facing) was conducted. From these surveys, a total of nine target species were recorded – black-throated diver, golden eagle, greylag goose, greenshank, hen harrier, merlin, osprey, red-throated diver and short-eared owl (Table 4.A.4).

TABLE 4.A.4 Numbers of flight events per species, per habitat

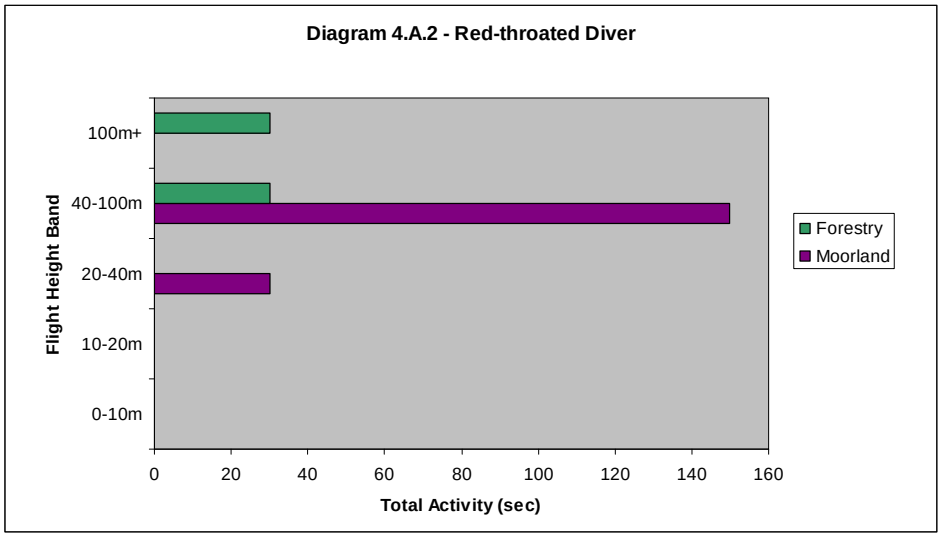
Species	Flights over Forestry	Flights over Moorland
Black-throated diver	0	1
Golden eagle	1	3
Greylag goose	0	1
Greenshank	2	0
Hen harrier	5	0
Merlin	2	4
Osprey	2	3
Red-throated diver	2	2
Short-eared owl	0	4

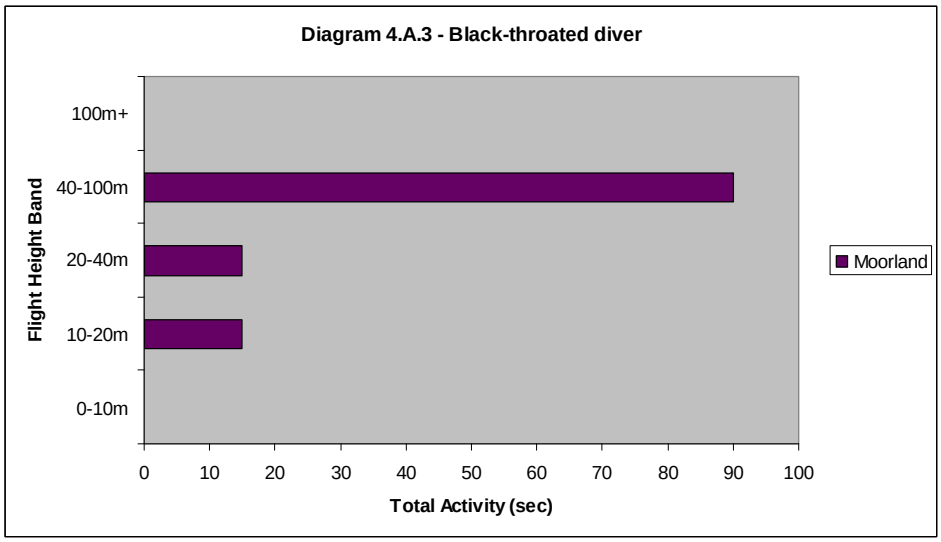
From the 60 hours of surveying per vantage point, a total of 38 flight events were recorded. Of these, 19 flight events each were recorded over forestry and moorland slopes. Records show that there were differences in occurrence for each species, as shown below in Diagram 4.A.1.



BV = black-throated diver; EA = golden eagle; GK = greenshank; GJ = greylag goose; HH = hen harrier; ML = merlin; OP = osprey; RH = red-throated diver; SE = short-eared owl

Differences in flight height distribution per habitat for each species are shown below in Diagrams 4.A.2 to 4.A.11.





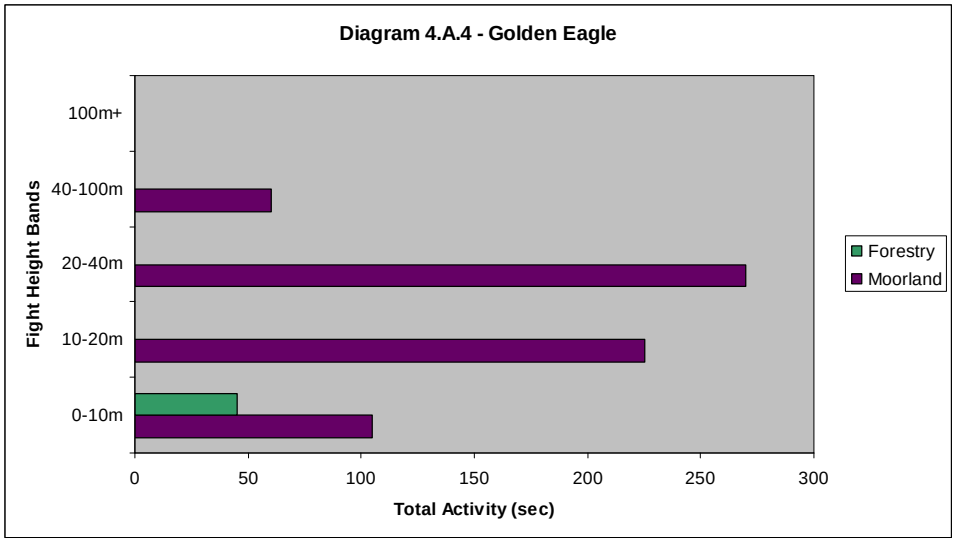


Diagram 4.A.4 - Golden Eagle
Fight Height Bands
100m+
40-100m
20-40m
10-20m
0-10m
0
50
100
150
200
250
300
Total Activity (sec)
Forestry
Moorland

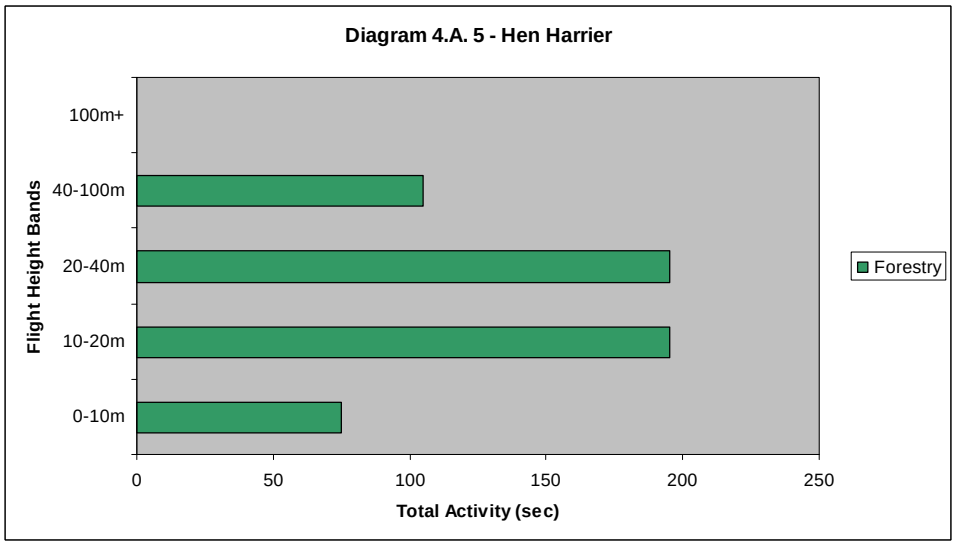


Diagram 4.A. 5 - Hen Harrier
Flight Height Bands
100m+
40-100m
20-40m
10-20m
0-10m
0
50
100
150
200
250
Total Activity (sec)
Forestry

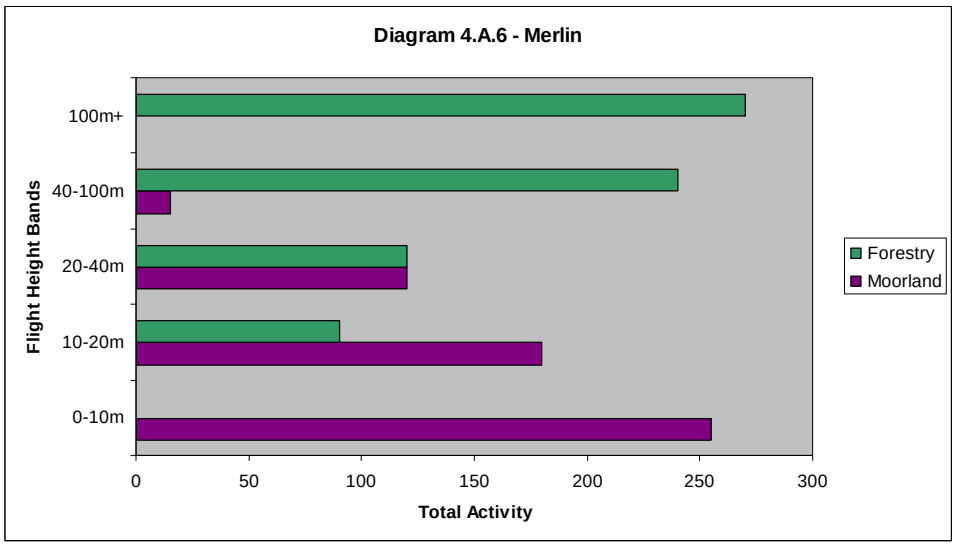


Diagram 4.A.6 - Merlin
Flight Height Bands
100m+
40-100m
20-40m
10-20m
0-10m
0
50
100
150
200
250
300
Total Activity
Forestry
Moorland

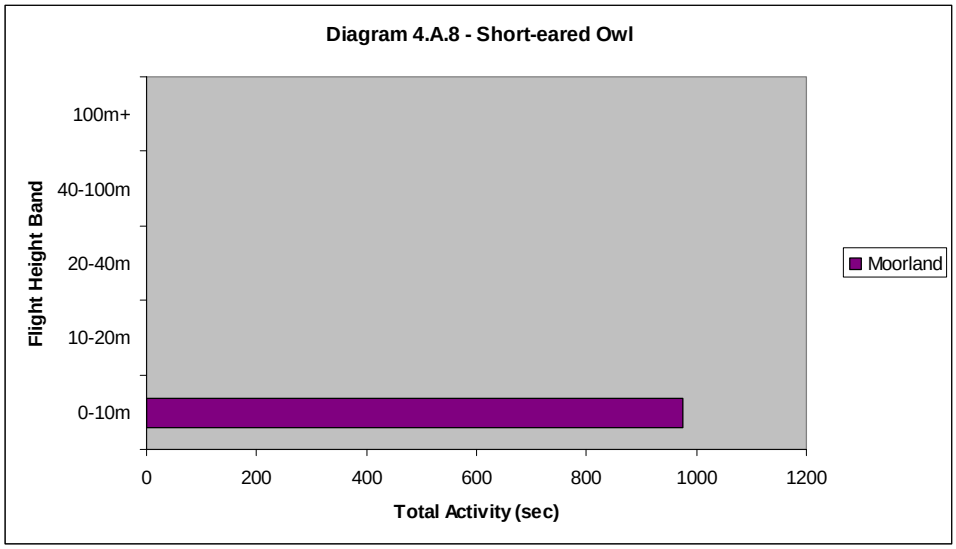


Diagram 4.A.8 - Short-eared Owl
Flight Height Band
100m+
40-100m
20-40m
10-20m
0-10m
0
200
400
600
800
1000
1200
Total Activity (sec)
Moorland

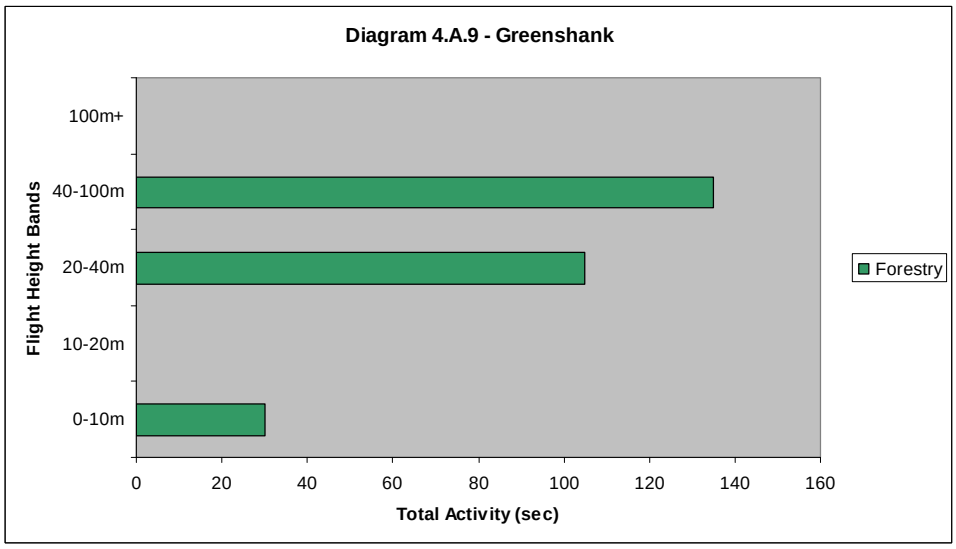


Diagram 4.A.9 - Greenshank
Flight Height Bands
100m+
40-100m
20-40m
10-20m
0-10m
0
20
40
60
80
100
120
140
160
Total Activity (sec)
Forestry

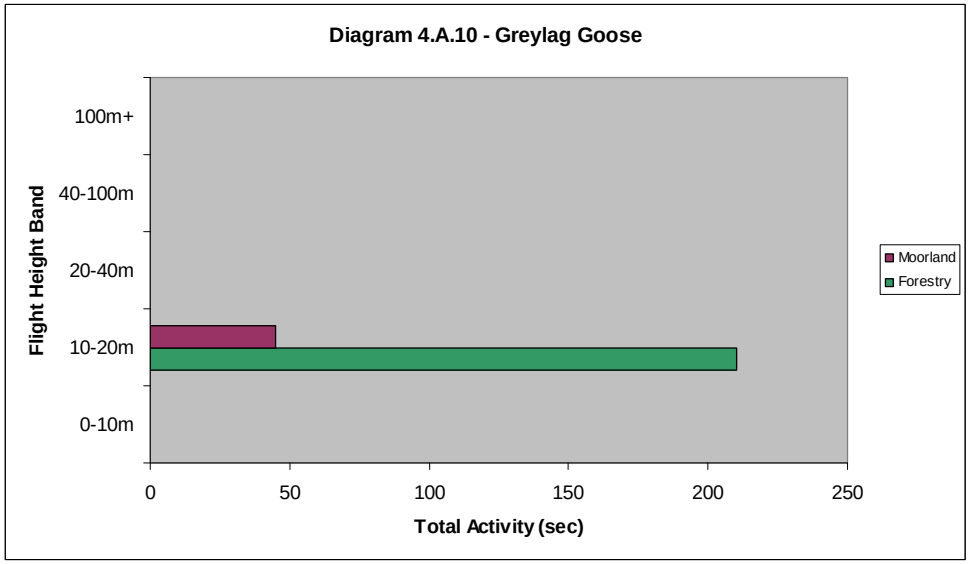


Diagram 4.A.10 - Greylag Goose
Flight Height Band
100m+
40-100m
20-40m
10-20m
0-10m
0
50
100
150
200
250
Total Activity (sec)
Moorland
Forestry

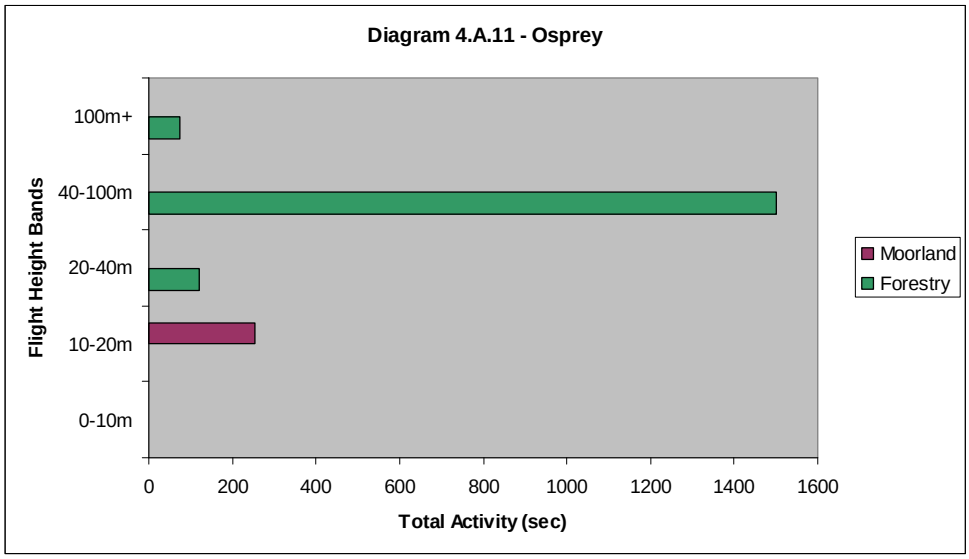


Diagram 4.A.11 - Osprey
Flight Height Bands
100m+
40-100m
20-40m
10-20m
0-10m
0
200
400
600
800
1000
1200
1400
1600
Total Activity (sec)
Moorland
Forestry

Nocturnal Wader Surveys

Background to the Study

This report documents the methods, results and analysis of a RPS survey of the nocturnal activity of breeding wader species carried out for Strathy North Wind Farm. The study location was to the north of Strathy South, but nonetheless of relevance since (a) it quantified the extent of nocturnal flight activity around a characteristic pool system supporting breeding waders, and (b) any commuting flights to the north would have been identified.

Wader Activity

To address the question of whether target species present perform flights at collision risk height during hours of darkness above the forestry a similar method to that developed by RPS for surveying nightjar[26] was employed. This involves using a combination of a thermal imaging camera to sample a section of the sky at risk height and image intensifiers to assess activity levels of target species within the vicinity.

The principal target species for the study were greenshank and golden plover, with red-throated and black-throated diver also target. Secondary species included dunlin, greylag goose and any other waterbirds.

Thermal Imaging Technology

Thermal imaging in nocturnal avian surveys is becoming a steadily more attractive means of observing bird activity at night. Unaffected by varying light levels and object colour, thermal imaging is highly suited to monitoring bird activity at night.

Objects radiate heat if their temperature is above 0° Kelvin or -273°C. Thermal imaging cameras operate in the infrared spectrum, and measure heat emitted. Images produced from thermal imaging cameras typically show heat detected in a scene through differing intensities. Bird targets have a different heat emittance compared to the background they are flying against, typically at ambient temperature, and can be seen with a thermal imaging camera.

As with all survey methods, there are limitations. Thermal imaging limitations for this survey are as follows:

Range and field of view – Due to the limited resolution available with thermal imagers, the field of view available is much smaller in comparison to normal 'light' digital cameras. There is either a choice of a long range and a narrow field of view, or a wide field of view and a short observation range. These choices are dependent also on the species being observed. The larger the species, the wider the field of view can be without compromising on range. This is also true of image intensifiers, and to some extent radar.

Occlusion –thermal imaging is unable to observe targets that are occluded by objects such as trees, hedges and dense vegetation. To observe a target, a clear line of sight is required.

There is also a small reduction in detection range with thermal imaging cameras, due to fog and a medium reduction due to heavy precipitation.

Image intensifier – an image intensifier operates by magnifying the available light in a scene and providing the operator with the magnified-lit scene image. Image intensifiers typically rely on a certain amount of ambient light to be available in the scene to operate, such as a clear night with a full moon. Poor weather conditions, overcast nights, and partial moon may result in very poor visibility with image intensifiers. To boost the effectiveness of image intensifiers, a strong infrared lamp can be used to illuminate the scene however this can have an influencing affect on observed targets[27].

Study Area

The Strathy North study area consists of a coniferous forestry block surrounded by blanket bog with scattered pools. Greenshank, golden plover and dunlin breed on the blanket bog within 500 m of the

[26] RPS (2007). Project Alaska Wind farm Breeding Bird Report 2007. RPS Cambs.
[27] Beason, R.C. (1999). The bird brain: magnetic cues, visual cues, and radio frequency (RF) effects. Avian Mortality at Communications Towers Workshop. www.towerkill.com/index.html

southern edge of the forestry (Plate 4.A.1). It is hypothesised that these species make flights from their breeding sites to foraging sites that will take them over the forestry block, potentially at collision risk height.

Observations with the image intensifiers will provide a general baseline of target species nocturnal activity both within the blanket bog habitat and flying above the forestry block. The thermal imager will be used to attempt to quantify how many flights are recorded within a sample of the area within the collision risk zone, i.e. above 20 m altitude and within the proposed development footprint.

Comparison of the activity recorded in both habitats and an assessment of the flight data from the thermal imager will provide a guide to the levels of potential collision risk for the target species present within the proposed wind farm area.

Plate 4.A.1 – Southern boundary of Strathy North Forest looking east from survey area. Moorland where towards Strathy South is to the right, across a pool complex used by breeding waders both (out of picture).

Methods

Thermal Imaging Camera Survey

A FLIR systems camera with a 12° objective lens was used to conduct the thermal imaging camera survey.

Two experienced ornithologists undertook the surveys. The study area was visited in daylight prior to the survey to identify the most suitable locations for positioning the camera equipment and resolve any access issues.

A location at the southern edge of the forestry was chosen to provide a view to the northeast over the forest within close proximity of several pairs of breeding greenshank and golden plover within the bog habitat. It was considered that if these birds, or birds from Strathy South, were travelling from their nest sites over the forests to feeding locations they would cross the forest at this point. Plate 4.A.1 shows the location used for the thermal imaging camera survey.

Due to the extended period of dusk and dawn and limited period of actual darkness experienced in northern Sutherland during the time of the surveys a survey period of 6 hours per night was chosen to thoroughly cover the dark period.

Two different start periods were used. An early start between 21:05 and 21:15 for three nights and a late start between 22:00 and 22:05 for the other three nights. This was in case of differences in

activity levels between dusk and dawn and to cover as long a period as possible. The dark period was entirely covered each night. In order to ensure that the equipment was ready to begin recording at sunset surveyors were on site at least an hour prior to beginning recording.

For all fieldwork the thermal imager was set up using the continuous adjust function, to ensure that an appropriate range of temperatures was being employed at all times. Continuous adjust is particularly good for clear skies, however when there is patchy, fast moving cloud it can result in large areas of the image being assigned the warmest temperature, within which targets become indistinct.

To ensure that data was captured at various heights at which targets may be considered at risk of collision (between 20-100 m) the thermal imager was moved in the vertical plane at a pre-determined periodicity to a series of different heights. Activity of targets can be assessed at different height bands that can be related to areas of differing risk, as in the collision-risk model used for assessing potential impacts from wind farm developments.

Marks relating to different vertical angles were made on the tripod head prior to the surveys. The angles used were 34 degrees, 25 degrees and 16 degrees. The pivot point of the tripod head was used as the central location of the set-up for measuring the angles.

The time that video-capture began and ended was recorded. The temperature, cloud cover, wind direction and strength, and precipitation were recorded at the start of each recording section and immediately after ending video-capture.

During the surveys the starting angle of the camera was recorded. The angle was changed every 40 minutes, cycling through 34, 25, 16 degrees. For a six-hour survey period this gave 2 hours of data at each angle per night. The times that the imager spent at each angle was also recorded, with the start and finish times. The starting angle was changed each night to ensure that the time of night did not confound any effects of angle. Many species show a peak in activity around dawn and dusk.

A shower curtain was used to protect the camera during light rain showers. In this way video-capture could continue while precipitation was light. If rain was persistent or became heavier then capture was ended and the imager was brought inside the tent until conditions improved. The time of each suspension and restart was recorded, with the capture continuing from the position at which it was abandoned.

Light Intensifying Binocular Vantage Point Survey

To compliment the thermal imaging camera survey additional data was collected using light intensifying binoculars. The equipment used to undertake these surveys was as follows:

Data capture:

- Two Thales image intensifying Nightsights with spare AA batteries and hard carry cases

The ‘Midi-Binokite’ Image Intensified Goggle used by RPS is a passive night vision device that may be used in the hand or mounted on a tripod. Powered by two double AA batteries it amplifies available light from the sky and presents a bright picture of the scene, which the observer sees through two eyepieces. The eyepieces are adjustable for separation and dioptric setting to suit individual users.

A Vantage Point (VP) based methodology was used. Two vantage points were established, one at the thermal camera location and one approximately 60 m to the northwest. These were located so as to cover the area underneath the thermal imager sample point and to cover the greatest extent of forest edge without requiring extensive walking during darkness.

Given the eyestrain caused by prolonged use of image-intensifying equipment a maximum of 30 minutes use in an hour per observer was agreed.

Two experienced ornithologists shared the VP duties during the night. VP watches were started once the camera was known to be correctly recording. Six repetitions were made during the night.

During each VP the observer used the Image Intensifiers to scan an approximate 180-degree field of view. Any birds picked up on these scans were recorded onto a Microsoft Word Mobile document using a handheld PDA device. An estimate of flight height and duration was recorded along with time of the observation and any additional field observations were recorded. All species detected were recorded, including calls.

Survey Effort

Table 2.1 gives the dates and start and finish times for the thermal imager survey.

Table 2.1 Dates, starting angle and start/finish times for thermal imager survey

Date	Starting angle	Start time	Finish time	Duration
23rd June 2009	16 degrees	22:06	04:06	6:00
24th June 2009	16 degrees	21:15	03:15	6:00
25th June 2009	25 degrees	21:05	03:05	6:00
26th June 2009	25 degrees	21:55	04:15	6:00*
27th June 2009	34 degrees	22:05	04:05	6:00
28th June 2009	34 degrees	21:21	03:38	6:00†
				36:00

** Recording suspended between 01:20 and 01:40 due to rain.*
† Recording suspended between 02:36 and 02:53 due to connection fault.

Table 2.3 lists the survey effort at each image intensifier VP together with the number of hours of data collected. Observers spent a total of almost 51 hours on the VPs over the course of the six nights.

Table 2.3 Image intensifier VPs survey effort

Date	VP		Total (mins)
	1	2	
23rd June	210	210	420
24th June	209	270	479
25th June	270	270	540
26th June	270	270	540
27th June	270	270	540
28th June	270	270	540
Total (mins)	1499	1560	3059

Camera Data Analysis

After each survey, the video collected was analysed using software that identifies any contacts made during the survey period. All targets identified by the software were segmented from the video.

Once all of the segments from all of the visits had been collated, an experienced ornithologist looked through the segments and identified the observed targets. Identification was based on general shape of the bird, flight pattern and size of bird. Where birds could not be identified to species, they are noted down to family level. Where necessary, video clips were slowed down using video viewing software.

Having identified the flights, the captured images were analysed to identify the flight height. The approach taken for the flight height calculations is presented in Appendix B.

The DHMT (Distance Height Measuring Tool) software can be used to obtain an estimate target height and distance from camera, based on a focussed target under ideal conditions. A frame clipped from the ANADAS programme can be opened in DHMT and the surveyor enters the lens used, camera angle of elevation, camera height from ground and average bird length of the identified target

Survey Limitations

The survey results do not represent data from the full season when the target species are present in the study area and as such can only represent their activity during the mid-summer period. Furthermore due to the limitations of the thermal imaging technology the survey data collected is taken from a relatively small section of the study area.

Identification of contacts is dependent upon a sufficient duration of contact and clarity of image being obtained. Due to the attenuation of the heat signal and the varying efficacy of a bird's thermal insulation the image obtained may not be identifiable, particularly if the target is distant. Birds of similar size and weight may look virtually identical and for some groups generic identification is the best that can be achieved.

The following have been identified as the main sources of error when using the calculations in Appendix B: elevation angle; pixel width of target, reflecting target position relative to camera; and actual target length.

Possible errors can occur in the calculation and measurement of angles A and θ (Appendix B). It is expected that the error calculating A will be negligible. The biggest area for error is from θ. The elevation angle was measured as accurately as possible using a precision tripod and spirit level to minimise the impact of the error.

The length of the bird target measured in pixels is subject to variance based on how the length is measured, bird posture and whether the bird is exactly parallel with the camera or at an angle. Measurements used are taken from several different frames to provide the range of heights within which the target has been detected.

As actual target length cannot be measured, a reference source for bird species length is required. Bird lengths can span between minimum and maximum measured lengths, hence there is likely to be a degree of uncertainty with target distance. Height is therefore calculated with both the maximum and minimum length given for a particular species, and the range in flight height that results in incorporated into the figure presented. Lengths used are those given in Perrins and Snow (1997)[28].

Weather was suitable for survey throughout the survey period, apart from a rain shower between 01:20 and 01:40 during the recording period that began the evening of 26th June 2009.

Results

Thermal Imaging Camera Surveys

A total of 3 records were identified using the thermal imaging camera following of observation. Table 3.1 presents data for all confirmed and possible target species records from the thermal imaging survey at the Strathy study area.

Table 3.1 Target species records from thermal imaging survey

Date	Time	Considered Identification	Size range used (cm)	Flight Height (metres above ground level)
23rd June 2009	01:34:15	Medium sized wader; likely greenshank	30-33	23-26m
26th June 2009	01:15:09	Possible diver	53-73	54-75m
28th June 2009	00:19:42	Prob. Wader (greenshank or golden plover)	26-33	36-45m

The images obtained were difficult to identify to species level. Due to the similarities in size between greenshank and golden plover it was not considered possible from the video clip alone to separate these. The possible diver was a considerable distance from the camera and it was therefore difficult to discern an accurate shape of the target. Wingbeat repetition rate was used along with flight style. Additionally a diver call was heard immediately prior to this recording.

Table 3.2 Other species record from thermal imaging survey

Date	Time	Considered Identification	Size range used	Flight Height (metres above ground level)
24th June 2009	21:19:05	Large gull spp.	53 -78	70-100 m

One other bird image was obtained from the thermal imaging survey, considered to be a large gull species.

28 Perrins, C. M. and Snow, D. W. (1997). The Birds of the Western Palearctic: Concise Edition. Oxford University Press, Oxford.

Image Intensifier View Point Surveys

A total of 47 greenshank flights were record during the image intensifier VPs. Table 3.2 presents the data collected for greenshank during the image intensifier VPs.

One flight took place over the forest, at a maximum height of 30 metres above ground level. The maximum flight height recorded was approximately 40 metres above ground level in the bog habitat. The 46 flights observed over the bog habitat lasted a total of 650 seconds, an average of 14.1 seconds per flight. Many of the flights were 'short-hops' between tussocks lasting only a few seconds.

Table 3.2 Greenshank flights from image intensifier VP surveys

Date (night of)	Number of flights		Max. flight duration (seconds)		Total flight duration (s)		Max. flight height (metres above ground level)	
	Bog	Forest	Bog	Forest	Bog	Forest	Bog	Forest
24th June 2009	5	0	20	0	65	0	<5	-
25th June 2009	10	0	120	0	290	0	40	-
26th June 2009	9	1	<15	15	60	15	15	30
27th June 2009	12	0	30	0	150	0	20	-
28th June 2009	10	0	25	0	85	0	<20	-
	46	1	120	15	650	15	40	30

A total of 4 golden plover flights were recorded during the image intensifier VPs. Table 3.3 present the data collected for golden plover during the image intensifier VPs.

Table 3.3 Golden Plover flights from image intensifier VP surveys

Date (night of)	Number of flights		Max. flight duration (seconds)		Total flight duration (s)		Max. flight height (metres above ground level)	
	Bog	Forest	Bog	Forest	Bog	Forest	Bog	Forest
23rd June 2009	0	0	0	0	0	0	-	-
24th June 2009	1	0	10	0	10	0	<3	-
25th June 2009	1	0	45	0	45	0	40	-
26th June 2009	1	1	10	5	10	5	5	20
27th June 2009	0	1?	0	?	0	?	-	?
28th June 2009	0	0	0	0	0	0	-	-
	3	2	45	5	65	5	40	20

? = Heard only, considered to be in flight above the forest, but not visible from the vantage point location.

Only 3 golden plover flights were recorded over the bog habitat, with potentially two flights over the forestry. The average duration of flights over the bog habitat was 21.7 seconds. The maximum height of flights was 40 m over the bog habitat and 20 m above ground level in the forest habitat. The one confirmed flight over the forest lasted 5 seconds. The other flight over the forest was not seen; consequently no further information could be derived.

Supplementary Observations

One further observation was made outside of the VP watches. A greenshank was observed over the forest at 21:37 on 26th June 2009, for 10 seconds with a maximum altitude of 20 m before flying across the bog for 10 seconds at a maximum height of 15m and landing. This was during the time taken to set-up the thermal imager.

Secondary and Other Species

A total of 6 flights of non-target species were recorded. Table 3.4 presents the non-target flights observed during the VPs.

Table 3.4. Non-target flights recorded during image intensifier VP surveys					
Date (night of)	**Species**	**Habitat**	**Number of flights**	**Max. flight duration (seconds)**	**Max. flight height (metres above ground level)**
24th June 2009	BZ	Forest	1	120	25
24th June 2009	T.	Bog	1	<5	3
25th June 2009	H.	Bog	1	60	20
26th June 2009	DN	Bog	1	5	3
28th June 2009	DN	Bog	1	5	3
28th June 2009	DN	Bog	1	2	2

Three flights of dunlin (DN) were observed over the bog habitat. All were individuals located on call and observed immediately prior to landing, rather than for full flights. Single flights of buzzard (BZ), teal (T.) and grey heron (H.) were also recorded.

Survey Data Evaluation

The numbers of flights by target species recorded during the surveys are presented below:

- Thermal imaging camera survey …….3 in 36 hours
- Image intensifier VPs ……..….52 in 51 hours
- Supplemental observations ……..……..1

Over the course of 86 hrs 59 mins of data collection 56 flights of target species were recorded - 48 of these were greenshank. There were five records of golden plover flights, two flights of likely greenshank/golden plover and one flight of a probable diver species.

Due to the similarities in size between greenshank and golden plover it was not considered possible from the recordings made by the thermal imager to separate these species.

97.8% of definite greenshank flights were recorded over the bog habitat close to their nests.

Three out of the four definite golden plover flights were also recorded over the bog habitat, with one heard only flight record also being considered to be over the forest.

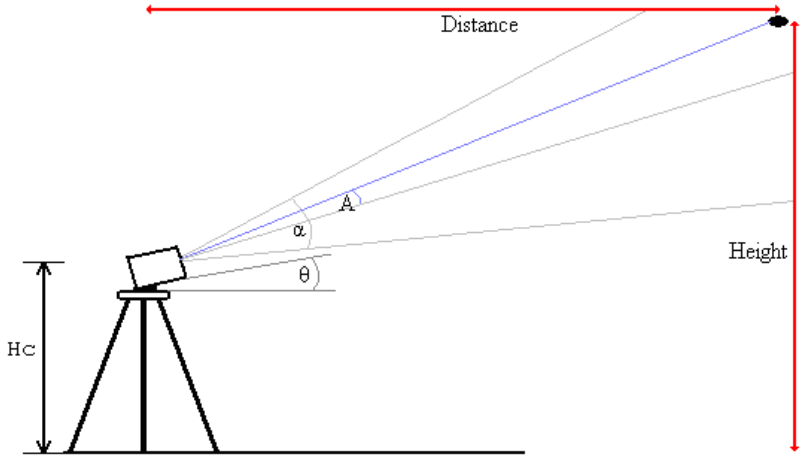
Both of the expected target species were recorded making flights over the forest during the survey. Greenshank appeared to make largely incidental flights over the forest, passing over as part of circular flights around the nest sites on the bog habitat.

Golden plover appeared to make more purposeful flights across the forestry out to the nest site on the bog habitat, suggesting that adults may be feeding beyond the forestry and returning over the forestry to the nest sites.

The diver species recorded was a considerable distance from the camera, but was considered likely to be at collision risk height, at between 54 and 75m altitude. This would not have been recorded without the thermal imager being present. However the image obtained is not clear and is not certainly that of a diver, but the balance of available evidence suggests this is the likely identification. This displays both the strength and weakness of the thermal imager, being excellent for picking up targets but poor for providing sufficient information by itself to arrive at a specific identification.

Calculation of Target Flight Heights from Thermal Imaging Camera Surveys

The below method is based on optimal conditions, defined as low humidity, target is in focus and is lengthwise parallel with camera. The target is the same as indicated from a reputable field guide. Landscape is uniform and flat. Target flies unobstructed across a clear sky and there is no motion drag. It is assumed the camera is in standard landscape position.



θ = Camera elevation angle
α = Lens
S = Spot size
V = Number of vertical pixels from target to frame mid point
x = Vertical distance from target to frame mid point in metres
H_{FOV} = Number of pixels in horizontal field of view
H_C = Height of camera from ground
A = Angle of object from frame mid point

$$A = \arctan\left(\tan\left(\frac{\alpha}{2}\right)\cdot\frac{2V}{H_{FOV}}\right)$$

$$S = \frac{target\ length\ (metres)}{target\ length\ (pixels)}$$

$$x = SV$$

If a target appears in top half of the frame

$$Height = H_c + \frac{x}{\sin A}\cdot\sin(A+\alpha+\theta)$$

$$Distance = \frac{x}{\sin A}\cdot\cos(A+\alpha+\theta)$$

If a target appears in bottom half of the frame

$$Height = H_c + \frac{x}{\sin A}\cdot\sin(\alpha+\theta-A)$$

$$Distance = \frac{x}{\sin A}\cdot\cos(\alpha+\theta-A)$$

APPENDIX 4 – OUTLINE HABITAT MANAGEMENT PLAN

Introduction

In light of the measures prescribed in the Strathy South 2007 ES Appendix 4.1 - Landscape/Ecology Mitigation Strategy, the findings of the subsequent additional reports presented in support of the 2013 ES Addendum, and the proximity of designated sites, the overriding goal of this Outline HMP is to benefit peatland habitats typical of the SAC and the SSSIs' features of scientific interest. Ancillary goals include mitigating any adverse effects on the SPA's qualifying species. These goals are also in line with recent consultation undertaken with SNH (email 17th May 2013) whereby SNH indicated a preference for blanket bog restoration where possible over reduction in site attractiveness to raptors and waders.

In pursuing the above goals, the HMP incorporates the issues raised in post-submission responses from SNH and RSPB Scotland, and the recent policy position of SEPA on forest waste. The HMP also recognises the need to deliver landscape enhancement and to promote public access.

HMP Aims, Objectives and Prescriptions

In view of the mitigation required for the 2013 Modified Scheme, and considering Peatlands of Caithness and Sutherland Management Strategy (2005-2015)[29], UKBAP and Sutherland Local Biodiversity Action Plan (2003) objectives, the HMP has the following aims. These are:-

1. To encourage, at appropriate locations, active peat-forming vegetation, to contribute to the restoration of blanket bog and wet heath habitats.

2. To maintain and improve peatland habitats within non-forested land units adjacent to the wind farm.

3. To reduce collision risk to breeding and foraging raptors (in particular hen harrier and short-eared owl), and waders (greenshank) associated with the Caithness and Sutherland Peatlands SPA; and

4. To mitigate collision risk for breeding divers by provision of diver rafts at suitable locations off site, in consultation with SNH.

Figure A.11.2.5 shows indicative areas which would be targeted for peatland restoration (Aim 1). These areas are indicative until more detailed site data can be collected post forest removal. These areas are currently based on a number of characteristics including: low slope angle; low forest productivity; areas of deeper peat (assumed to coincide with wetter areas on shallow slope); and, proximity to areas of open habitat comprised primarily of 'encapsulated bog' or SAC habitats. Although Figure A.11.2.5 highlights targeted peatland restoration areas, all areas within Strathy South Forest would be considered for peatland restoration if conditions were suitable.

Where required and in keeping with other aims, vegetation would be controlled in targeted areas in order to reduce the attractiveness to nesting and foraging raptors and waders (Aim 2). Specifically, vegetation would be controlled in proximity to turbines (or particular turbines) where it may result in habitats becoming attractive to these species or their prey, and provided control does not interfere with other aims of the HMP. In practice, control is likely to focus on unwanted plant species, for example, regenerating conifer trees and rushes on blanket bog and wet heath. Management of this vegetation would contribute to Aim 1 and Aim 2. Vegetation may also be controlled where non-peatland habitats characterised by deep swards (e.g. dry heath, grasslands or tall ruderal vegetation) develop in proximity to turbines.

Land management units adjacent to the north and west of Strathy South will be managed for their peatland interests (Aim 3). This will include the control of unwanted vegetation (notably regenerating conifer trees) and blocking of any appropriate drains.

Finalisation of the extent of these areas and methods used to maintain them in an optimal condition will be achieved through consultation with SNH, RSPB and any other relevant parties. The aim is to

29 http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFileandrep=fileandfil=Peatlands%20 management%20Strategy.pdf

evolve the Outline HMP into a detailed prescriptive document that will be implemented through an appropriate and legally binding mechanism. Initial prescriptions for each of the Outline HMP's three aims are given below. Issues involving grazing by deer will be dealt with in a separate Deer Management Plan, the primary aim of which will be to ensure deer grazing does not impact on SAC qualifying habitats due to displacement during or following construction activities.

The objectives of the Outline HMP aims are detailed below. The associated prescriptions are based on the information presented in Technical Appendix A11.2.

Aim 1. To encourage, at appropriate locations, active peat-forming vegetation, to contribute to the restoration of blanket bog and wet heath habitats.

Objective 1.1. To raise water table levels across appropriate areas.

Prescriptions:

Pscr. 1.1. Mulch trees or harvest trees and mulch remaining brash and stumps across all areas. These operations will be undertaken in order to remove the influence of trees (lowering water table levels and shading out peat forming vegetation) and restore the homogeneity of the ground surface.

Pscr. 1.2. Block active drainage ditches. Following tree removal, a site survey will identify appropriate locations and methods of drain blocking.

Objective 1.2. To control non-peat forming vegetation where this impacts on peatland restoration.

Prescriptions: Pscr. 1.3. Control unwanted species including regenerating conifer trees and rushes where these are likely to reduce the long-term effectiveness of restoration activities. Control methods will be dependant upon the type of vegetation present and is likely to include use of manual, mechanical and/or light grazing techniques.

Aim 2. To maintain and improve peatland habitats within non-forested land units adjacent to the wind farm.

Objective 2.1 To improve conditions for peatland plant species where appropriate.

Prescriptions:

Pscr. 2.1. Identify and block active drainage ditches if present.

Pscr. 2.2. Control unwanted species including regenerating conifer trees where these are likely to impact on the development and function of peatland habitats.

Aim 3. Within the wind farm, reduce the collision risk to breeding and foraging divers, raptors and waders associated with the Caithness and Sutherland Peatlands SPA (specifically red-throated divers, hen harrier, short-eared owl and greenshank);

Objective 3.1. Restrict suitable nesting habitat for raptors or waders in proximity to all wind turbines, or those considered to pose higher collision risk.

Prescriptions:

Pscr. 3.1. Mulch trees, or harvest trees and mulch remaining brash and stumps, across all areas in order to improve homogeneity of the ground surface and subsequent ability to manage vegetation sward structure.

Pscr. 3.2. Monitor vegetation height on a monthly basis from March to July within 250 m of turbines to assess its recovery after conifer removal.

Pscr. 3.3. Control vegetation height and species composition providing this does not impact on the ability to achieve Objectives associated with Aim 1. This is likely to include the control of regenerating conifer trees, treatment of brash mats and conifer stumps, and

localised rush control. It may also include light grazing or mechanical control of grass and heath species.

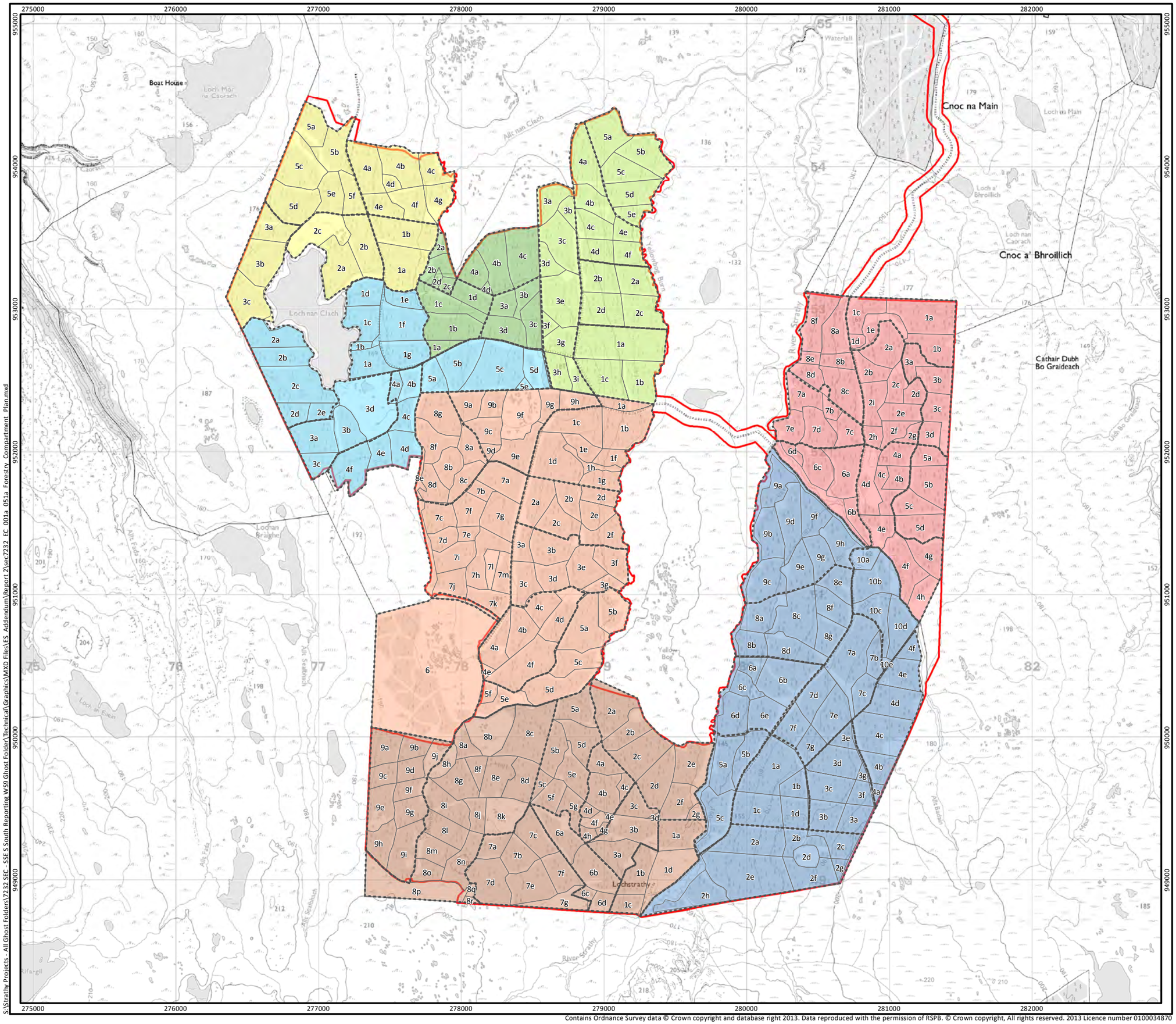
Pscr. 3.4. Divert breeding attempts by red-throated divers onto the SPA by ensuring there are no suitable nesting lochans on site.

Aim 4. To mitigate collision risk for breeding divers by provision of diver rafts at suitable locations off site, in consultation with SNH.

Objective 4.1 To improve breeding success and productivity of red and black-throated divers at selected locations in the SPA, and potentially also elsewhere in North Scotland.

Prescriptions:

Pscr. 4.1. Provide and maintain diver rafts over the lifetime of the wind farm, with the number of rafts based on feedback from SNH, in combination with site suitability, access and the level of potential nesting benefit assesses at each potential location.



Key

- Site Boundary
- Forest Sub-compartment
- Forest Compartment

Forest Unit

- Bad Coille
- Coille Am Sealbach
- Coille An Reidhe
- Coille Fada
- Coille Meadhonach
- Coille Nan Clach
- Coille Saobhaidhe
- South Strathy

The labels refer to the forestry subcompartments

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

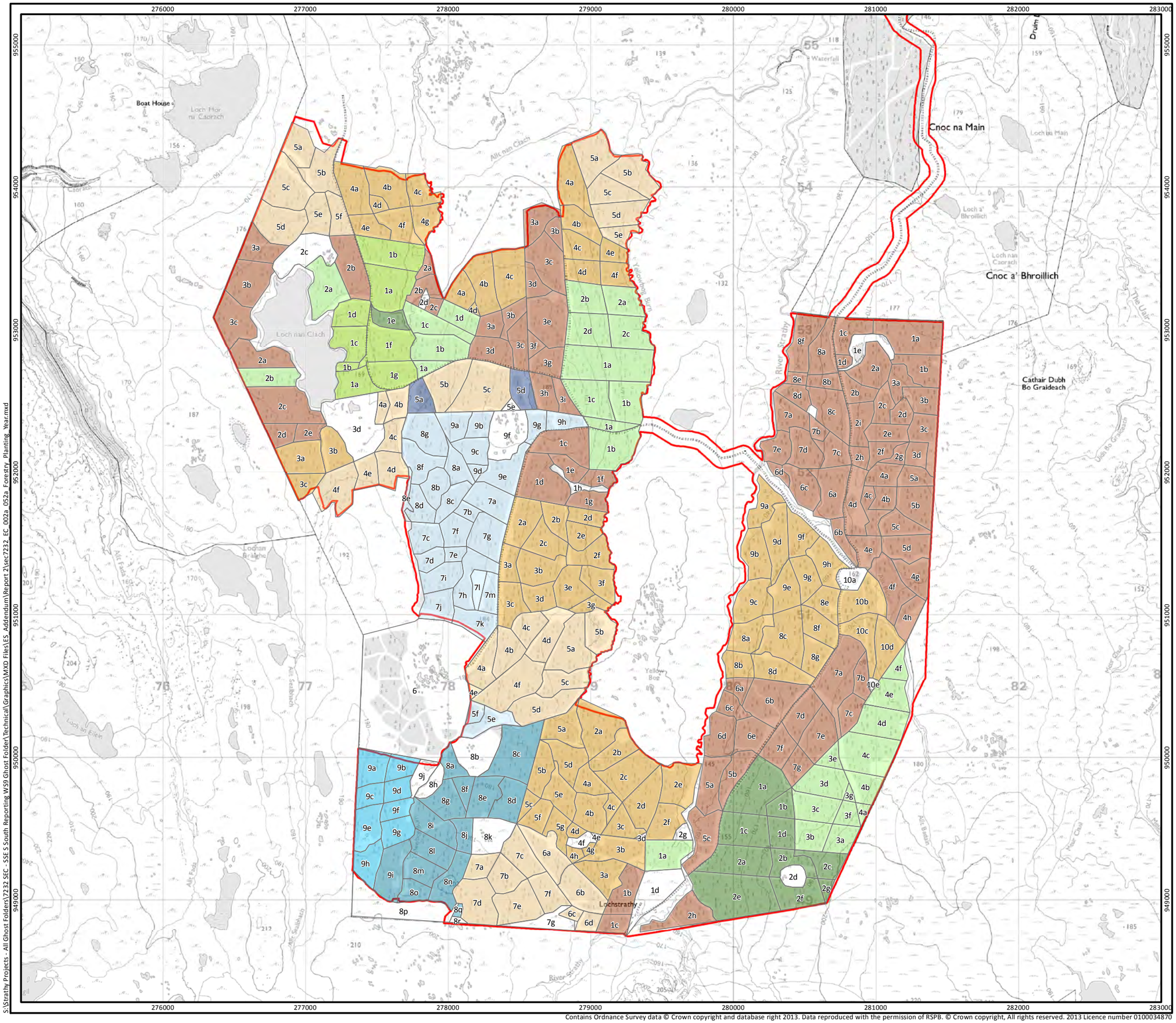
N

Figure A11.2.1
Forestry Compartment Plan

Strathy South Wind Farm
Environmental Statement Addendum

Contains Ordnance Survey data © Crown copyright and database right 2013. Data reproduced with the permission of RSPB. © Crown copyright, All rights reserved. 2013 Licence number 0100034870

S:\Strathy Projects - All Ghost Folders\7232 SEC - SSE S South Reporting W59 Ghost Folder\Technical\Graphics\MXD Files\ES Addendum\Report 2\sec7232 EC 001a 051a Forestry Compartment Plan.mxd



Contains Ordnance Survey data © Crown copyright and database right 2013. Data reproduced with the permission of RSPB. © Crown copyright, All rights reserved. 2013 Licence number 0100034870

S:\Strathy Projects - All Ghost Folders\7232 SEC - SSE S South Reporting WS9 Ghost Folder\Technical\Graphics\MXD Files\ES Addendum\Report 2\sec7232_EC_002a_052a_Forestry_Planting_Year.mxd

SSE Renewables

RPS

Key

- Site Boundary
- Forest Sub-compartment

Planting Year

- Unplanted
- 1983
- 1983/84
- 1984
- 1985
- 1986
- 1987
- 1988
- 1990
- 1991
- 1994

The labels refer to the forestry subcompartments

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

N

Figure A11.2.2
Forestry Planting Year

Strathy South Wind Farm
Environmental Statement Addendum

Getmapping plc. RGB Aerial Photography - © GeoPerspectives

S:\Strathy Projects - All Ghost Folders\7232 SEC - SSE S South Reporting W59 Ghost Folder\Technical\Graphics\MXD Files\ES_Addendum\Report 2\sec7232_EC_003a_053a_Forestry_Yield_Class.mxd

SSE Renewables

RPS

Key

Site Boundary

Yield Class

- 0
- 4
- 6
- 8
- 10
- 12
- 14

The labels refer to the forestry subcompartments

Scale 1:25,000 @ A3

0 0.25 0.5 1 km

N

Figure A11.2.3
Forestry Yield Classes

Strathy South Wind Farm
Environmental Statement Addendum

Getmapping plc. RGB Aerial Photography - © GeoPerspectives

SSE Renewables

RPS

Key

Site Boundary

Yield Class

- 0
- 4
- 6
- 8
- 10
- 12
- 14

The labels refer to the woodland area of each subcompartment in hectares

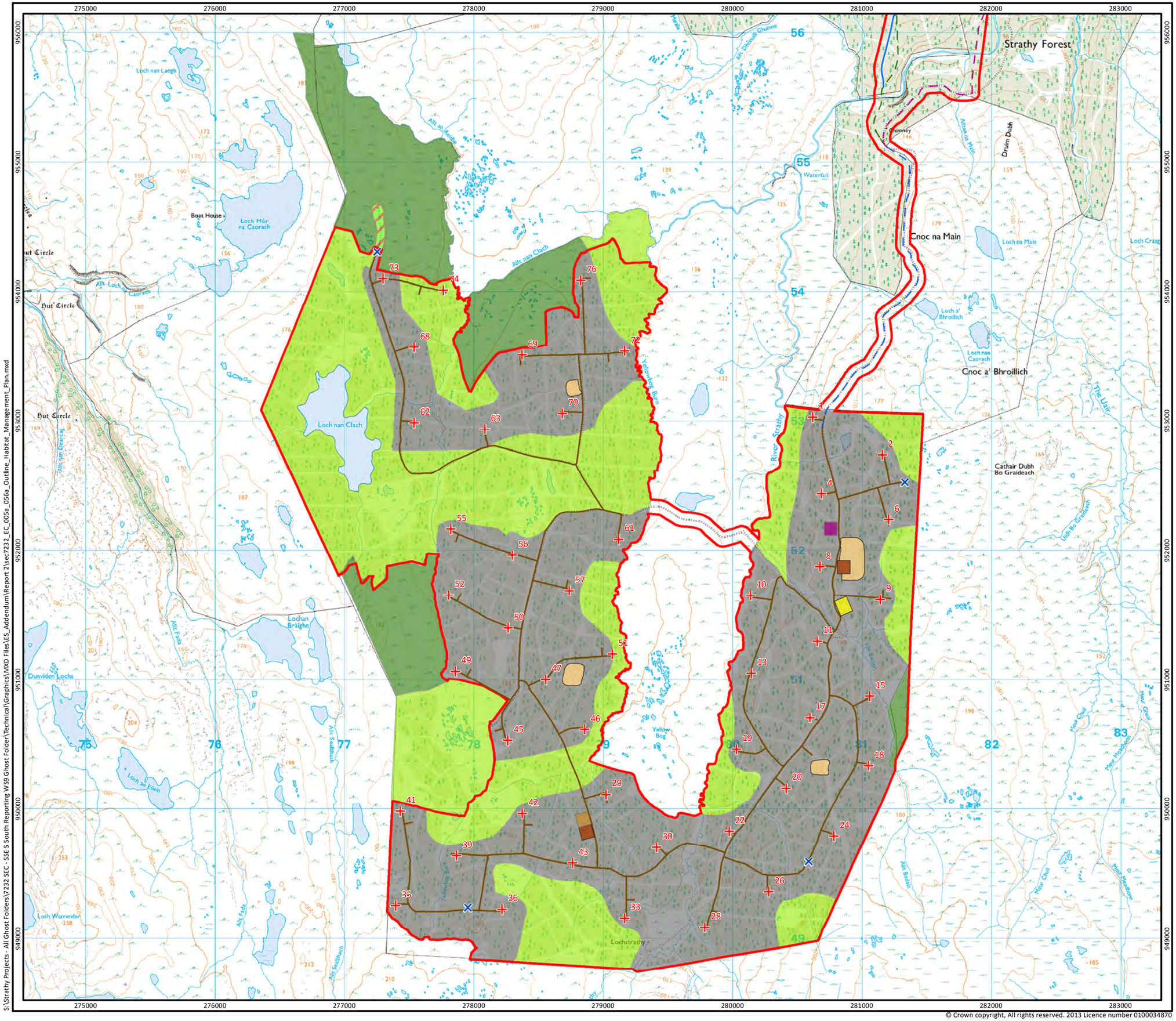
Scale 1:25,000 @ A3

0 0.25 0.5 1 km

N

Figure A11.2.4
Forestry Yield Classes With Woodland Area (ha)

Strathy South Wind Farm
Environmental Statement Addendum



© Crown copyright, All rights reserved. 2013 Licence number 0100034870

S:\Strathy Projects - All Ghost Folders\7232 SEC - SSE S South Reporting W59 Ghost Folder\Technical\Graphics\MXD Files\ES_Addendum\Report 2\sec7232_FC_005a_056a_Outline_Habitat_Management_Plan.mxd

SSE Renewables

RPS

Key

- Turbine
- Permanent Met Mast
- Site Boundary
- Indicative Cable Route
- Tracks
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Borrow Pit
- Concrete Batching Plant
- Construction Compound
- Lay Down Area
- Switching Station

Habitat Management Plan

- Peatland Management
- Peatland Restoration (Indicative)
- Peatland Restoration Of Exisiting Track
- Peat Restoration, with Option for Targeted Vegetation Control to Reduce Suitability for Nesting by Key Species

N

Scale 1:27,500 @ A3

0 0.5 1 km

Figure A11.2.5
Outline Habitat Management Plan

Strathy South Wind Farm
Environmental Statement Addendum

STRATHY SOUTH WIND FARM:

TECHNICAL APPENDIX 11.3: EFFECTS OF DISTANCE ON RECORDED WADER FLIGHT ACTIVITY AND POTENTIAL CONSEQUENCES FOR COLLISION RISK ESTIMATES

JULY 2013

15 July 2013

Project Number: SEC7232

RPS
Ocean Point One
4th Floor
94 Ocean Drive
Edinburgh
EH6 6JH

Tel: 0131 555 5011
Fax: 0131 555 4911
Email: murray.grant@rpsgroup.com

QUALITY MANAGEMENT

Prepared by:	Name:	**Dr. Murray Grant**	Title:	**Principal Ornithologist**
	Signature:			
Authorised by:	Name:	**Dr. Simon Zisman**	Title:	**Operational Director**
	Signature:			
Current Status:	**Final**			
Issue Date:	**15 July 2013**	Revision Number:	**- 1**	
		Revision Notes:	**-**	
Project File Path:	**D/: Strathy South Rept3**			

This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001 : 2008

COPYRIGHT © RPS

The material presented in this report is confidential. This report has been prepared for the exclusive use of SSER and shall not be distributed or made available to any other company or person without the knowledge and written consent of SSER or RPS.

REPORT TEMPLATE

TYPE:	Technical
ISSUE DATE:	18 May 2011
REVISION NUMBER:	1
REVISION DATE:	26 April 2012

CONTENTS

1 INTRODUCTION 1

2 METHODS 2

2.1 Assessing Effects of Distance on the Flights 2
2.1.1 Data Extraction and Treatment 2
2.1.2 Analytical Approach to Determining Effects of Distance 2
2.2 Correcting Estimates of Flight Activity Density 3

3 RESULTS AND IMPLICATIONS FOR THE ESTIMATION OF COLLISION RISK 4

3.1 Effects of Distance and Other Factors on Recorded Flight Activity 4
3.2 Correcting Estimates of Flight Activity Density 4
3.3 Implications for the Estimation of Collision Risk at Strathy South 5
3.3.1 Re-estimation of Potential Collision Risk 5
3.3.2 Causes of Distance Effects on Recorded Flight Activity and the Interpretation of the Re-estimated Collision Risks 6

1 INTRODUCTION

The estimation of collision risk by standard methods (SNH 2010) for certain small to medium sized wader species during the breeding season may be affected by the under-recording of flight activity[1]. This is because vantage point (VP) surveys are based upon recording activity up to 2km from the VP location, and detection of flights by these small to medium sized waders may be low at such distances.

This issue was raised by SNH in relation to the submission of the Environmental Statement for the Original 2007 Strathy South Wind Farm application, with specific reference to the flight data used for estimating collision risk of greenshank and golden plover. In response to these concerns, it is therefore necessary to take account of possible reductions in the detection of flights with distance from the VP location in order to more reliably assess the likely collision risk for these two species at Strathy South. However, factors other than detectability may also cause flight activity to vary with distance from the VP location, and associated habitat variation is also of potential importance in this respect. In particular, the Strathy South site is located within an afforested area (largely unsuitable greenshank and golden plover), whilst it is surrounded by blanket bog habitats, which provide the main breeding sites these species (see Technical Appendix A11.1).

This, Technical Appendix A11.3 addresses the issue of the applicability of the flight activity data for the estimation of collision risk at the proposed Strathy South wind farm by examining the extent to which recorded flight activity of greenshank and golden plover varies with distance from the VP location. Findings are interpreted in relation to potential habitat effects, as well as variation in detectability, and corrections to account for distance effects are produced, so enabling a re-estimation of flight activity (and hence collision risk). It therefore specifically responds to SNH's concerns, from its 2nd October 2007 response letter.

[1] SNH 2010. *Use of Avoidance Rates in the SNH Wind Farm Collision Risk Mode*l. Scottish Natural Heritage, September 2010. http://www.snh.gov.uk/docs/B721137.pdf

2 METHODS

2.1 Assessing Effects of Distance on the Flights

2.1.1 Data Extraction and Treatment

Flight activity data for greenshank and golden plover were extracted from standard flight activity surveys undertaken at the Strathy South site (Technical Appendix A11.1), extracting data from all vantage point (VP) locations used in three different years (i.e. 2007, 2010 and 2012). Data were extracted from different years to enable testing of between-year differences in the relationship between distance and recorded flight activity, selecting these years because of their relatively high level of recorded flight activity.

To provide a first assessment of variation in flight activity in relation to distance, data were treated according to whether they were recorded within 1km of the viewshed or at 1 – 2km. To achieve this, the area of each viewshed within these two distance bands was calculated (in ArcGIS), and the flight activity recorded during each survey was expressed as a density measure by dividing the number of seconds of flight activity by the area (km^2) in each distance band. This measure is subsequently referred to as flight activity density (FAD). Surveys recording no flights by either of the two species were excluded from consideration, so that the data on flight activity were derived from 53 individual surveys at 13 different VP locations. Five of these surveys included data on both species, giving 42 surveys providing flight activity data on greenshank and 16 on golden plover.

The initial investigation of FAD in the two distance bands indicated a lower recorded flight activity at 1-2km from the VP, and so the same process was repeated but using three distance bands, i.e. <0.5km, 0.5-0.99km and 1-2km.

2.1.2 Analytical Approach to Determining Effects of Distance

To determine whether distance had an effect on the recorded flight activity during surveys, FAD was made the response variable in a general linear mixed model (GLMM) fitted using the maximum likelihood method[2]. Distance band was entered as a three level factor, whilst species (greenshank or golden plover) and year were included as two-level and three-level factors, respectively. The interactions between, (i) species and distance band and (ii) species and year were also entered, to test for the possibility that any effects of species on FAD varied with either distance band or year. Multiple surveys were undertaken from each VP, and these may not have been independent. To account for this possibility, VP was entered into the analysis as a random effect[1].
The analysis assumed a normal error distribution and was undertaken by initially fitting all terms and then producing a minimal adequate model (MAM) by sequential removal of terms until only those that caused a statistically significant change in model deviance (at the $P \leq 0.05$ level) remained. Testing for sequential removal of terms was undertaken on interactions before main effects. At each step the least significant term was removed and the fit of resulting model tested against that of the model containing that term. This process was carried out until only terms that produced a statistically significant change in model fit remained.

The analysis was carried out in the R statistical software package (version 2.14.1 - http://www.r-project.org/).

[2] Crawley, M.J. 2007. *The R Book*. John Wiley & Sons Ltd, Chichester.

2.2 Correcting Estimates of Flight Activity Density

To account for the possibility that any effects of distance on FAD were due to reduced detectability of flights at greater distances from VP locations, it was necessary to apply a correction to the flight activity data to determine the potential effects on the collision risk estimates for greenshank and golden plover (provided in Technical Appendix A11.1 and its underlying GIS and flight activity datasets). Using the data collated as described above (2.1.1), the overall FAD for each of the three distance bands was calculated for greenshank and golden plover combined (see 3.1 below) by summing values across the individual surveys. The proportional difference in the summed FADs was then calculated for each distance band and used to produce correction factors for values of FAD at 0.5-0.99km and 1-2km. These correction factors were then applied to the data from each individual survey to allow re-estimation of FAD within the two furthest distance bands.

To determine the effect of applying this correction to the estimated FAD for each survey it was necessary to account for the area within each distance band that was encompassed by the survey (i.e. the viewshed coverage). Thus, FAD for each survey was calculated by;

(i) first, multiplying the FAD for each distance band by the area of land within that band
(ii) summing the figures from (i) across the three bands, and
(iii) dividing the figure from (ii) by the total area of land encompassed within the viewshed for that particular survey.

Values were then summed across surveys to produce an overall ‘corrected’ FAD for each of the two species, and this was compared with the uncorrected value to determine the effect of the correction on the estimated flight activity.

3 RESULTS AND IMPLICATIONS FOR THE ESTIMATION OF COLLISION RISK

3.1 Effects of Distance and Other Factors on Recorded Flight Activity

Of the terms included in the GLMM to examine variation in FAD, distance band was the only one to be statistically significant (change in deviance = 20.1, d.f. = 2, $P < 0.0001$). Thus, the final minimal adequate model (MAM) included distance band only, with the parameter estimates showing that FAD declined with distance from the VP (Table A11.3.1).

TABLE A11.3.1 – PARAMETER ESTIMATES AND ASSOCIATED OUTPUT FOR THE MINIMAL ADEQUATE MODEL RESULTING FROM THE GENERAL LINEAR MODEL TO EXAMINE VARIATION IN FLIGHT ACTIVITY DENSITY

Parameter	Value (S.E.)	D.F.	t-value
Intercept	31.27 (4.88)	159	6.41***
Distance band 2 (0.5-0.99km)	-14.91 (6.31)	159	2.36**
Distance band 3 (1-2km)	-28.93 (6.31)	159	4.59***

Notes: *indicate level of statistical significance as follows - ** *P*<0.01, * *P*<0.001**

None of the other terms considered within the GLMM approached statistical significance, suggesting that they were of little importance in explaining variation in FAD (change in deviance < 1.45, $P < 0.22$ in all cases). Thus, for surveys in which flights of greenshank or golden plover were recorded, FAD did not differ between years or species, nor did the relationship between FAD and distance band vary according to species.

3.2 Correcting Estimates of Flight Activity Density

Given that findings of the GLMM analysis indicated a strong effect of distance on the level of flight activity recorded during surveys (see 3.1), it was important to assess the potential effect of this on the estimated flight activity for the two species of concern. Assuming that such distance effects were due a reduction in the detectability of flights at greater distances (as opposed to other factors such as associated habitat variation – see Introduction), then a corrected estimate of FAD was produced by the approach outlined in 2.2 above.

Thus, across all surveys in which greenshank or golden plover were recorded the total FAD recorded within 0.5km of VP locations was 1.9 and 12.1 times greater than that recorded within the 0.5-0.99km and 1-2km distance bands, respectively. Applying these correction factors to the flight activity data from the two furthest distance bands, and following the calculations described above (see 2.2), produced corrected FADs for each survey (Table A11.3.2). Summing these values across surveys gave estimates of FAD that were 4.4 and 4.3 times greater than the uncorrected values for greenshank and golden plover, respectively.

TABLE A11.3.2 – CORRECTED AND UNCORRECTED ESTIMATES OF FLIGHT ACTIVITY DENSITY FOR SURVEYS IN WHICH EITHER GREENSHANK OR GOLDEN PLOVER (OR BOTH) WERE RECORDED

Species	Survey code	Area (km^2) of viewshed at:			Flight activity (s) at:			[1]Uncorrected flight activity density (s/km^2)	[2]Corrected flight activity density (s/km^2)
		<0.5km	0.5-.99km	1-2km	<0.5km	0.5-.99km	1-2km		
Greenshank	92	0.36	1.12	4.59	16.6	13.4	0.0	1.6	2.3
	114	0.40	1.20	4.78	0.0	61.2	28.8	4.7	24.2
	115	0.38	1.15	3.97	0.0	15.0	0.0	0.9	1.7
	117	0.39	1.17	4.11	0.0	27.5	630.6	38.7	450.9
	118	0.39	1.17	4.11	0.0	35.0	100.0	7.9	74.9
	127	0.39	1.17	4.56	0.0	240.0	0.0	13.1	24.8
	132	0.40	1.20	4.78	258.9	109.9	1.4	19.3	25.2
	140	0.39	1.17	4.11	0.0	87.6	0.0	5.1	9.8
	141	0.38	1.15	3.97	0.0	0.0	15.0	0.9	11.0
	142	0.38	1.15	3.97	0.0	140.9	39.1	10.9	44.8
	151	0.40	1.20	4.78	15.7	109.9	0.0	6.5	11.7
	155	0.39	1.17	4.21	0.0	45.0	18.2	3.6	17.6

TABLE A11.3.2 – CORRECTED AND UNCORRECTED ESTIMATES OF FLIGHT ACTIVITY DENSITY FOR SURVEYS IN WHICH EITHER GREENSHANK OR GOLDEN PLOVER (OR BOTH) WERE RECORDED									
	159	0.40	1.20	4.78	0.0	245.0	70.0	16.4	68.4
	167	0.39	1.17	4.11	49.5	10.5	0.0	3.5	4.1
	170	0.39	1.17	4.56	25.4	29.7	0.0	3.0	4.4
	187	0.39	1.17	4.56	6.2	46.8	15.0	3.7	15.0
	188	0.39	1.17	4.11	0.0	0.0	15.0	0.9	10.7
	202	0.39	1.17	4.11	0.0	23.9	0.0	1.4	2.7
	204	0.38	1.15	3.97	14.5	90.5	0.0	6.4	11.3
	216	0.40	0.98	3.44	2.0	23.1	5.2	2.1	7.5
	413	0.39	1.17	4.67	83.8	52.9	0.0	7.3	9.9
	414	0.38	1.14	3.86	0.0	0.0	13.8	0.9	10.3
	426	0.39	1.17	4.67	0.0	91.1	99.9	10.2	74.0
	436	0.38	1.14	3.86	49.4	6.8	0.0	3.5	3.9
	438	0.39	1.17	4.67	233.3	380.9	149.4	40.9	148.0
	448	0.39	1.17	4.67	44.8	24.0	36.1	25.3	127.1
	475	0.39	1.17	4.67	45.0	0.0	0.0	2.4	2.4
	539	0.36	0.90	3.70	0.0	20.3	53.7	7.8	72.2
	737	0.36	0.90	3.70	0.0	149.4	0.6	7.6	14.6
	742	0.36	0.86	3.67	96.4	65.5	0.0	11.0	15.1
	743	0.38	1.16	4.34	102.1	62.9	0.0	9.3	12.5
	750	0.39	1.17	4.67	5.5	45.0	0.0	4.1	7.3
	751	0.36	1.12	4.59	60.0	0.0	0.0	4.9	4.9
	752	0.36	0.90	3.70	0.0	99.2	5.8	10.6	26.0
	753	0.38	1.14	3.86	0.0	24.7	0.0	2.3	4.4
	771	0.36	0.90	3.70	9.2	15.2	0.0	1.6	2.5
	794	0.36	1.12	4.59	11.9	14.5	3.4	1.6	4.4
	843	0.36	1.12	4.59	60.4	47.2	27.2	8.9	31.5
	846	0.36	0.90	3.70	0.0	0.0	45.0	4.5	54.8
	896	0.39	1.17	4.67	0.0	53.9	21.1	4.0	19.2
	897	0.39	1.17	4.67	36.6	0.0	0.0	2.0	2.0
	900	0.39	1.17	4.67	247.8	62.5	0.0	16.6	19.6
Golden plover	16	0.38	1.15	3.97	17.6	0.0	0.0	1.1	1.1
	115	0.38	1.15	3.97	14.5	130.0	95.5	14.5	85.8
	119	0.40	0.98	3.44	10.7	1.4	0.0	0.8	0.9
	120	0.40	0.98	3.44	17.6	6.7	0.0	1.7	2.1
	124	0.40	1.18	4.64	15.0	0.0	0.0	0.8	0.8
	129	0.40	1.18	4.64	193.8	196.0	60.2	24.2	69.4
	139	0.39	1.17	4.11	27.6	0.0	0.0	1.6	1.6
	141	0.38	1.15	3.97	60.0	0.0	0.0	3.6	3.6
	413	0.39	1.17	4.67	0.0	47.2	41.6	4.8	31.7
	414	0.38	1.14	3.86	13.0	48.5	35.9	6.0	33.4
	423	0.38	1.14	3.86	21.4	0.0	0.0	1.3	1.3
	436	0.38	1.14	3.86	23.1	0.0	0.0	1.4	1.4
	440	0.38	1.14	3.86	5.3	0.0	0.0	0.5	0.5
	442	0.36	0.86	3.67	0.0	33.7	11.3	2.3	10.2
	449	0.39	1.17	4.67	0.0	46.5	148.4	7.8	75.6
	908	0.39	1.17	4.67	16.3	43.7	0.0	3.2	5.3

Notes:
[1]Uncorrected values are derived directly from the measured flight activity during surveys.
[2]Corrected values are derived as described in section 2.2.

3.3 Implications for the Estimation of Collision Risk at Strathy South

3.3.1 Re-estimation of Potential Collision Risk

Estimates of collision risk for the different target bird species in the Strathy South ornithology Addendum (Technical Appendix A11.1) have been derived by the standard methods outlined in SNH guidance (Band 2000, Band *et al.* 2007)[3] [4]. Using these methods, the estimated collision

[3] Band, W. 2000. Windfarms and Birds: Calculating a Theoretical Collision Risk Assuming No Avoiding Action. Scottish Natural Heritage Guidance Note. http://www.snh.gov.uk/planning-and-development/renewable-energy/onshore-wind/assessing-bird-collision-risks/

risk (for any given wind farm scenario) varies in proportion to the extent of 'at risk' flight activity (i.e. flights within the wind farm polygon at potential collision height). Therefore, based upon the above calculations (see 3.2), it is reasonable to conclude that the collision risk estimates produced for greenshank and golden plover at Strathy South are underestimated, potentially by a factor of c.4 – 5. This assumes that the relationship between distance and flight detectability does not differ markedly between 'at risk' flights and other flights.

The existing collision risk estimates (used with the recommended avoidance rate – SNH 2010[1]) for the proposed Strathy South wind farm predict an average of 0.03 greenshank collisions per year, whilst for golden plover too few 'at risk' flights were recorded to justify generating collision estimates (Technical Appendix A11.1). Applying the correction factor derived here for the potential underestimate of flight activity, gives a predicted 0.12 – 0.15 greenshank collisions per year (equivalent to the collision of one greenshank every six to eight years). The lack of an estimate for golden plover collisions prevents re-estimation after correcting for the potential underestimation of flight activity, but it can be assumed that the predicted collision rate would be lower than that for greenshank (given the small number of 'at risk' flights recorded).

3.3.2 Causes of Distance Effects on Recorded Flight Activity and the Interpretation of the Re-estimated Collision Risks

Given the relatively small size of greenshank and golden plover, together with the fact that during the breeding season many flights of these species are of single birds as opposed to flocks, it seems probable that variation in the detectability of flights is a major cause of the observed decline in recorded flight activity with increasing distance from the VP location. However, as detailed in the Introduction, other factors such as habitat may vary with distance from VP locations, and these may also contribute to the observed relationship.

An examination of the flight activity survey viewsheds in relation to habitat suggests that the proportion of afforested land within the viewsheds increases with distance from the respective VP locations (see Figures A11.1.13 - A11.1.19 in Technical Appendix A11.1). Breeding greenshank and golden plover will be scarce or absent within afforested land, so that flight activity by these species will be lower over such habitat, and this is likely to have contributed to the lower flight activity recorded at greater distances from VP locations. The analyses undertaken for this report did not consider such variation in habitat (or indeed in the breeding densities of the two species) and the correction applied to the flight activity data assumes that the distance-effect is due solely to a decline in the detectability of flights. Therefore, the corrections applied to the flight activity data are likely to result in overestimation of overall flight activity.

Forest clearance is planned to occur as part of the proposed Strathy South development and this may cause increases in the densities of greenshank and golden plover on the site (due to an increase in the open-ground habitat preferred by these species). A consequence of this is that the (uncorrected) collision risk estimates produced from the survey data may not be applicable because they are derived from a situation in which these species are less abundant than they would be following wind farm construction. However, the re-estimated collision estimates produced in this report assume that flight activity levels throughout the entire viewshed are equivalent to those recorded within 0.5km of the VP location, where the extent of afforested land is already relatively low. Given this, it is likely that the re-estimated collision risk estimates produced in this report would be applicable to a situation in which greenshank and golden plover abundance increased at the Strathy South site as a result of forest clearance.

[4] Band, W., Madders, M., and Whitfield, D.P. 2007. Developing Field and Analytical Methods to Assess Avian Collision Risk at Wind Farms. In: de Lucas, M., Janss, G.F.E. and Ferrer, M. (eds.) *Birds and Wind Farms: Risk Assessment and Mitigation*, pp. 259-275. Quercus, Madrid.

STRATHY SOUTH WIND FARM:

TECHNICAL APPENDIX A11.4: AN ASSESSMENT OF IMPACTS FROM STRATHY SOUTH WIND FARM ON THE QUALIFYING BIRDS OF THE CAITHNESS AND SUTHERLAND PEATLANDS SPA

JULY 2013

NON-CONFIDENTIAL VERSION

15 July 2013

Project Number: SEC7232

RPS
Ocean Point One
4th Floor
94 Ocean Drive
Edinburgh
EH6 6JH

Tel: 0131 555 5011
Fax: 0131 555 4911
Email: zismans@rpsgroup.com

QUALITY MANAGEMENT

Prepared by:	Name:	**Colin Ormston**	Title:	**Senior Ornithologist**
		Rafe Dewar		**Principal Ornithologist**
		Martin Scott		**Principal Ornithologist**
		Dr. Simon Zisman		**Operational Director**
	Signature:			
Authorised by:	Name:	**Dr. Simon Zisman**	Title:	**Operational Director**
	Signature:			
Current Status:	**FINAL**			
Issue Date:	**15 July 2013**	Revision Number:	**(2)**	
		Revision Notes:	**(-)**	
Project File Path:	**D\Report 4 15 7 13**			

This report has been prepared within the RPS Planning and Development Quality Management System to British Standard EN ISO 9001 : 2008

COPYRIGHT © RPS

The material presented in the original version of this report is confidential. This is the non-confidential version. This report has been prepared for the exclusive use of SSER and shall not be distributed or made available to any other company or person without the knowledge and written consent of SSER or RPS.

REPORT TEMPLATE

TYPE:	Technical
ISSUE DATE:	18 May 2011
REVISION NUMBER:	1
REVISION DATE:	26 April 2012

CONTENTS

1 INTRODUCTION 1

1.1 Legislation and Guidance 1

2 APPROACH TO THE ASSESSMENT OF IMPACTS OF THE PROPOSED WIND FARM ON THE CAITHNESS AND SUTHERLAND PEATLANDS SPA 3

2.1 Appropriate Assessment and Habitats Regulations 3
2.2 Likely Significant Effect and the Conservation Objectives of the Site 4
2.3 The Conservation Objectives and the Assessment of Effects on the Qualifying Features of the Caithness and Sutherland Peatlands SPA 6
2.4 The Potential Effects on the Notified Features of the SPA 7
2.5 Species Accounts: Appraisal of the Implications for the Site In View Of the Site's Conservation Objectives 9
2.6 Access Track Impact Assessment 25
2.7 Conclusions of the Assessment of the Strathy South Modified 2013 Scheme's Effect on Site Integrity 26

3 CUMULATIVE EFFECTS 28

3.1 Red-throated Diver 28
3.2 Black-throated Diver 29
3.3 Hen Harrier and Merlin 29
3.4 Golden Eagle 30
3.5 Greenshank 31
3.6 Golden Plover 32
3.7 Other Species 33

4 UPDATED ORNITHOLOGICAL IMPACT ASSESSMENT 36

4.1 Assessment of Significance 36
4.2 Assessment Conclusions 37

5 MITIGATION 38

6 RESIDUAL EFFECTS 40

6.1 Statements of Significance 44

1 INTRODUCTION

The main part of this Technical Appendix A11.4 assesses the predicted impacts of the Modified 2013 Scheme to determine whether or not it can be concluded beyond reasonable scientific doubt that the wind farm, alone or in combination, will have no adverse effect the integrity of the Caithness and Sutherland Special Protection Area (SPA). In order to carry out this assessment, it considers the effects of the Modified Scheme on the Conservation Objectives[1] for the site. It explains the predicted effects on qualifying species during construction, operation and decommissioning of the wind farm, taking into account land take, disturbance, displacement, barrier effects and collision risk. It also attempts to determine the cumulative impact of this predicted mortality on the qualifying features of the SPA where information has been provided by Scottish Natural Heritage (SNH), in order to take account of 'in combination' effects on the SPA. The assessment of effect on site integrity is completed with no mitigation, and then with mitigation taken into account.

In the same way as was done for Strathy North therefore, this report will therefore provide information to inform the Appropriate Assessment by the competent authority and address SNH's points from their written response, relating to wind farm, its cumulative impacts and to the assessment of predicted impacts on all qualifying interests of the SPA (see Technical Appendix A11.1 (Confidential) for further details).

The second part of this report updates the original ornithological impact assessment section of the 2007 Strathy South Wind Farm Environmental Statement (ES), as it considers the amended 47 turbine layout, and makes use of the available data gathered on SPA species since the original ES.

The majority of the content of this Technical Appendix, and the conclusions drawn with regards to the Appropriate Assessment and ornithological impact assessment, are informed by Technical Appendices A11.1, A11.2 and A11.3, which address the sequence of issues raised in SNH's response letter. It is therefore the overriding aim of this Technical Appendix to summarise this body of work to resolve SNH's issues from their October 2007 response, and to thereby demonstrate there will be no adverse impact on site integrity of the Caithness and Sutherland Peatlands SPA. This is the same approach used for the consented Strathy North Wind Farm.

1.1 Legislation and Guidance

This assessment takes into account the requirements of the following legislation, regulations and other guidance:

- *Council Directive 79/409/EEC on the Conservation of Wild Birds (EU Birds Directive) as amended by Directive 94/24/EC;*
- *Council Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Flora and Fauna (the "Habitats Directive");*
- *Conservation (Natural Habitats &c.) Regulations 1994 (the "Habitats Regulations");*
- *Conservation (Natural Habitats &c.) Amendment (Scotland) Regulations 2007;*
- *Conservation of Habitats and Species Regulations 2010 (as regards reserved matters in Scotland);*
- *Wildlife and Countryside Act 1981 (as amended);*
- *Nature Conservation (Scotland) Act 2004;*
- *Electricity Works (Environmental Impact Assessment) Scotland Regulations 2000 (EIA Regulations);*
- *Scottish Executive Ecological Advisers Unit Guidance (ref EJ K1-3);*

1 http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8476

- *National Planning Policy Guideline 14: Natural Heritage 1999;*
- *Planning Advice Note 60 Planning for Natural Heritage 2000;*
- *Guidelines on the Environmental Impacts of Wind Farms and Small Scale Hydroelectric Schemes. SNH Natural Heritage Management Series, Battleby;*
- *Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM, 2005/06)*[2 3]*; and SNH Guidance on Survey Methods for Assessing the Impacts of Onshore Wind Farms (2005 - revised 2010)*
- *Assessing the Cumulative Impact of Onshore Wind Farm Developments (2012)*
- *SNH Guidance on Monitoring the Impact of Onshore Wind Farms on Birds in Scotland (January 2009)*
- *SNH Guidance on Methods for Monitoring Bird Populations at Onshore Wind Farms (2009)*
- *SNH Guidance on Post-construction Management of Wind Farms on Clear Felled Forestry Sites: Reducing the Collision Risk for Hen Harrier, Merlin and Short-eared Owl from Special Protection Areas (revised 2012)*
- *SNH Guidance on Assessing Connectivity with Special Protection Areas (SPAs) (2012)*
- *SNH Guidance on Environmental Statements and Annexes of Environmentally Sensitive Bird Information (2009)*

2 Institute of Ecology and Environmental Management (2005) Guidelines for Ecological Impact Assessment in the United Kingdom (version 6 July 2005).
3 Institute of Ecology and Environmental Management (2006) Guidelines for Ecological Impact Assessment in the United Kingdom (version 7 July 2006) http://www.ieem.org.uk/ecia/index.html

2 APPROACH TO THE ASSESSMENT OF IMPACTS OF THE PROPOSED WIND FARM ON THE CAITHNESS AND SUTHERLAND PEATLANDS SPA

2.1 Appropriate Assessment and Habitats Regulations

Regulation 48 of the Habitats Regulations provides that an Appropriate Assessment must be undertaken by a "competent authority" where any plan or project:

- either alone or in combination with other plans or projects would be likely to have a significant effect on a SPA; and
- is not directly connected with the management of the site for nature conservation.

The Appropriate Assessment is required to be undertaken before the determination of the application for permission for the plan or project. Annex E, Appendix B of Revised Circular 6/95 outlines the steps to be undertaken whilst carrying out an Appropriate Assessment. A flow diagram illustrating these steps (taken from this Circular) is reproduced in Diagram 1.

The European Commission has provided guidance in relation to the Appropriate Assessment process. This guidance sets out the procedure for an Appropriate Assessment, and provides help in defining the terms used in the Habitats Directive. An Appropriate Assessment is required if there is a likely significant effect on an SPA from a development. If this is the case, an assessment must be made of the implications on the Conservation Objectives for that site.

The need for an Appropriate Assessment is determined not by whether or not a plan or project lies within the SPA, nor how close it may be to the boundaries of the SPA, but whether it is likely to have a significant effect on its qualifying interests, Conservation Objectives, and therefore its integrity. Once it has been established that an Appropriate Assessment is required then a competent authority is required to follow the provisions of Regulation 48.

The purpose of this Technical Appendix is to provide information to assist the competent authority in reaching a decision on whether there is a likelihood of a significant effect on the SPA arising from development. The approach taken is therefore to set out each of the Conservation Objectives for the site in question, and provide information to assess whether any of these objectives will be compromised by the development.

The Scottish Government has provided guidance on the questions to be addressed in an Appropriate Assessment of this nature. This report follows the principles set out in this guidance (SEERAD 2000).

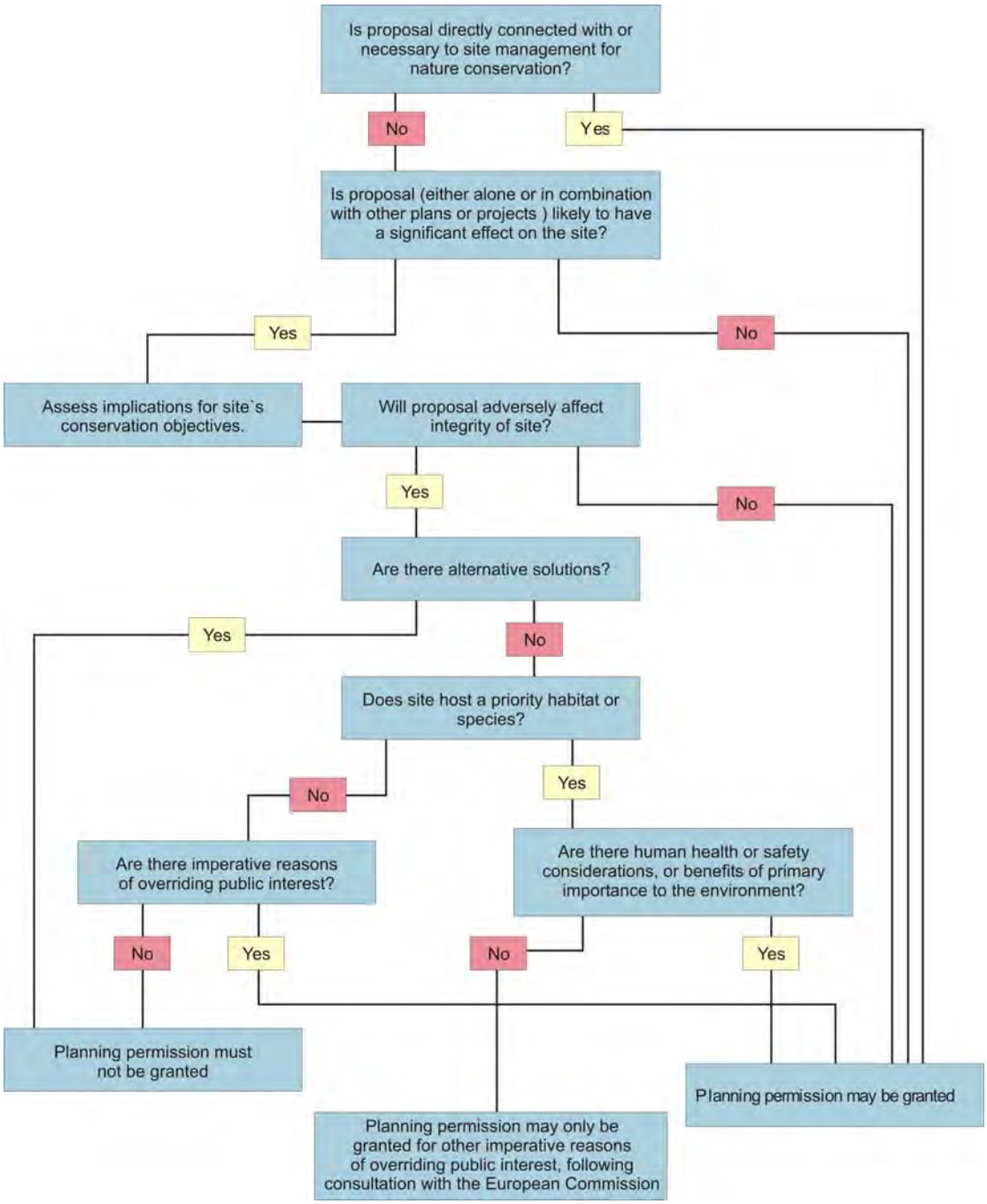


Diagram A11.5.1. Flowchart Showing Considerations of Development Proposals Affecting SPAs. Source: Revised Circular 6/95.

2.2 Likely Significant Effect and the Conservation Objectives of the Site

Likely Significant Effect

It would not be correct to say that any effect is a likely significant effect. The test should filter out effects that are clearly trivial or inconsequential. It is impossible to set thresholds to determine what is a likely significant effect - because it is quite feasible that a proposal affecting 0.01% of the area of a qualifying habitat or a 0.01% of a population of a qualifying species within a Natura site could be significant in certain circumstances - or less for that matter. An example from the Natura guidance is that of the planned construction of a slipway within Chichester Harbour SPA which covered 0.0000774% of the site area. This was considered not only to have a likely significant effect, but also an adverse effect on site integrity (because of increased access and disturbance). The examples given in paragraph 4.5 in the SNH Natura casework guidance are

used to illustrate both positive and negative conclusions to the adverse effect on site integrity test, but all of them were first judged as having a likely significant effect.

To conclude a likely significant effect, there must be a link between the proposal's effects and the qualifying interest(s) and it must be reasonable to suggest that the effect is likely. Having established this, only where the effects are obviously trivial or inconsequential and this judgment can be clearly and easily justified, should no likely significant effect be concluded.

The Waddenzee judgement[4] states clearly that any proposal which is likely to undermine the site's Conservation Objectives for the qualifying interest in question should be considered likely to have a significant effect. In circumstances, where the scale of 'undermining' is difficult to determine (i.e. it is not clear whether the effect is likely to be significant or not) but the potential to affect the Conservation Objectives *is* clear and may require detailed analysis to determine the scale of the impact, then an Appropriate Assessment should be carried out (i.e. a significant effect should be considered likely). Detailed analysis of complex interactions would not normally be part of the process to determine likely significant effect - it is supposed to be a coarse first filter to remove those effects that are *obviously* insignificant.

A judgment of likely significant effect in no way presupposes a judgment of adverse effect on site integrity. They are two quite separate tests and should not be conflated.

The Requirement for Conservation Objectives and Need to Maintain Site Integrity

To comply with the Habitats Directive (Article 6.2) it is the obligation of Member States to ensure within Natura sites (SPA and SAC) that appropriate steps are taken to avoid deterioration of habitats, and habitats of species, as well as significant disturbance of species. As part of the process for ensuring compliance with Article 6.2, new plans and projects require to be assessed “in view of the site’s Conservation Objectives” (Habitats Directive Article 6.3). In general, a plan or project can only be permitted if it does not adversely affect the integrity of the site. Conservation Objectives thus have a legal status as set out in Article 6.3. The term also appears in the Natural Habitats Regulations, 1994, particularly Regs. 48(1); 50(2); and 20(1).

The Habitats Directive, Article 2.2, requires that measures taken should be designed to maintain or restore natural habitats and species at Favourable Conservation Status (FCS). Article 3.1 indicates that the network of Natura sites should enable FCS to be maintained or restored. Achieving the obligations of Article 6.2 on individual sites will thus contribute to the fulfillment of the wider aims of Articles 2.2 and 3.1 to achieve FCS for Annex I habitats and Annex II species. FCS does not apply directly to birds. The equivalent aims in the Birds Directive are set out in Articles 2 and 3 of that Directive, and are not as specifically defined as FCS. Where in this note there is reference to FCS, for bird interests this should be taken to mean the bird equivalent.

What are Conservation Objectives?

The term ‘Conservation Objectives’ is not defined in the Directives, making its precise meaning open to debate and possible further legal resolution. The Scottish Executive Circular 6/95 (as amended, Annex E, Appendix A) describes them as “the reasons for which the site was classified”. The European Commission provides little further clarification but advises that the Conservation Objectives should be based upon the information contained within the data forms transmitted with each site. As well as stating the qualifying interests, the forms include limited data on extent of habitat, numbers of individuals etc.

The Conservation Objectives are intended to be a yardstick against which plans and projects are to be assessed in order to determine whether they will not have an adverse effect upon site integrity. They should ensure that the obligations of the Directive in relation to Natura sites are met; that is, there should not be deterioration or significant disturbance of the qualifying interests

4 Case C-127/02 of the European Court of Justice (the “Waddenzee” case), Netherlands, 2004,

based upon their condition at time of formal identification (see below). This will also ensure that the integrity of the site is maintained and that the site continues to make a full contribution to achieving FCS or its Birds Directive equivalent for its qualifying interests. Where a qualifying interest, or one or more of its supporting processes, requires to be restored, then the Conservation Objectives should set this out. Any other elements (e.g. non-qualifying interests, landscape, access, interpretation etc) can not be included in Conservation Objectives, although they may feature as part of the overall management considerations for a site.

2.3 The Conservation Objectives and the Assessment of Effects on the Qualifying Features of the Caithness and Sutherland Peatlands SPA

In light of the above, an assessment has been made of the potential impacts of the Modified 2013 Scheme, alone and in combination, on the qualifying features of the SPA, specifically in relation to the SPA's Conservation Objectives.

In order to avoid an adverse effect on the integrity of the SPA therefore, the development (including any mitigation) must comply with these conservation objectives. Furthermore, in accordance with the Waddenzee ruling[4], this compliance must be beyond reasonable scientific doubt.

The Conservation Objectives for the SPA are to:-

1. Avoid deterioration of the habitats of the qualifying species, and

2. Avoid significant disturbance to the qualifying species;

thus ensuring the integrity of the site is maintained; and ensure for the qualifying species that the following are maintained in the long term:

3. Population of the species as a viable component of the SPA.

4, Distribution of the species within the SPA.

5. Distribution and extent of habitats supporting the species.

6. Structure, function and supporting processes of habitats supporting the species, and

7. No significant disturbance of the species.

As the first two objectives are delivered through the subsequent five, their assessment is incorporated (as it was for Strathy North) into the assessment of objectives 3 to 6, and 7 respectively. This assessment covers each of the SPA's qualifying species. However, in order to provide information for the Appropriate Assessment in a systematic format, the summary at the end of this Technical Appendix does repeat the findings for each of the seven Conservation Objectives, for each qualifying feature recorded.

The Notified Features of the SPA Where Appropriate Assessment May Be Required

Detailed consideration of SPA population numbers and status for all the key qualifying features has been described in Technical Appendices A11.1, A11.2 and A11.3. These documents provide the information and reasoning to ascertain that the Modified 2013 Scheme will not have an adverse impact on site integrity i.e. the Conservation Objectives for the qualifying species will be met and that their favourable conservation status will be maintained.

This reasoning in particular, has aimed to demonstrate that once the Strathy South plantation is removed, the turbines erected, and the wind farm area is gradually restored through the Habitat Management Plan (HMP), the mitigation including the facility to undertake targeted vegetation control to ensure SPA qualifying species are not exposed to avoidable significant risk of collision, will ensure that all SPA Conservation Objectives are met. It utilises direct site-specific field observations of target species around Strathy South up to 2012 (see Technical Appendix A11.1 for details of surveys and results), as well as other sites in Caithness and Sutherland,

together with published data on nesting and foraging preferences of each species in northern Scotland or beyond.

The species highlighted as being of concern by SNH in their previous responses have been **red-throated diver, black-throated diver, hen harrier, golden eagle, greenshank, golden plover** and **dunlin**. For completeness other SPA and key species recorded during surveys at Strathy South have been assessed for potential impacts on all SPA populations. These are **merlin, short-eared owl, wigeon, common scoter and wood sandpiper**.

2.4 The Potential Effects on the Notified Features of the SPA

The nature of the potential effects of the Modified 2013 Scheme is outlined in this section, in relation to the three main phases of the proposed development: construction, operation and decommissioning.

Land-take Effects

Direct habitat loss through wind farm construction is generally considered to be of minor magnitude, as construction usually only involves loss of land associated with turbine bases, maintenance tracks and other infrastructure. Land take resulting in definite non-forestry habitat loss for the Strathy South installation which consists of the turbine bases, control building, borrow pits, lay down area, crane pads and new and upgraded forest tracks is minimal (c. 18.5 ha) in relative scale. Notably, maximum use has been made of existing tracks to reduce habitat loss. In total the wind farm will result in the loss of approximately 18.5 ha and a further 6.5 ha of direct impacts (i.e. hydrological effects beyond the construction footprint) of land within the approximately 1,600 ha application site. This equates to habitat impacts of 25 ha or 1.6% of the total area. For the target species, the potential for a direct effect resulting from such limited land take is generally considered to be negligible, with impacts that are not significant under the terms of the EIA Regulations. Where an impact may occur from land-take, this is addressed.

Construction Effects

Disturbance caused by construction operations may directly displace birds from breeding sites and or foraging areas thus potentially affecting breeding success or survival. In addition to these possible effects on individuals and populations, any wind farm construction work undertaken during the bird breeding season (April to July, inclusive, stretching to the end of August for divers) carries a risk of illegal destruction, damage or disturbance to occupied bird nests. The nests of nearly all bird species are protected by the law and it is necessary to take measures to ensure compliance with the appropriate legislation.

Operational Effects

Disturbance/Displacement and Barrier Effects

The displacement effects attributable to wind farms are variable and are species, season and site specific. As displacement effectively leads to exclusion from areas of suitable habitat, effectively it is the same as habitat loss in its effect on birds. For breeding birds, the displacement from nesting habitat can lead to abandonment of the territory; the loss of foraging habitat leads to a reduction in food supply, which in turn, can lead to reduced breeding success, individual survival or abandonment of the territory. The implications of such displacement at the population scale, in terms of the effect on the viability of the population, depends on the importance of the area from which birds are displaced and the capacity of alternative habitats to support displaced birds.

Operational disturbance effects are far less intensive than during the construction phase. Review studies have shown that in general, bird species are not disturbed beyond 800 m from

turbines and in some cases, birds have not been disturbed at all[5 6]. Individual turbines or the wind farm as a whole, however, may present a barrier to the movement of birds, restricting or displacing birds from much larger areas. The effect this would have on a population is subtle, and difficult to predict with any certainty. If birds regularly have to fly over or around obstacles or are forced into sub-optimal habitats, this may result in greater energy expenditure. By implication, this will reduce the efficiency with which they accumulate reserves, potentially affecting their survival or breeding success. During the lifetime of the wind farm, there is some evidence that birds may habituate to the presence of turbines, however, and so this effect is likely to be greatest in the short-term.

Collision with Turbines

Collision of a bird with the turbine rotors is almost certain to result in the death of the bird. The impact of an individual loss on a population is influenced by several characteristics of the affected population, notably its size, density, recruitment rate (additions to the population through reproduction and immigration) and mortality rate (the natural rate of losses due to death and emigration). In general, the impact of an individual lost from the population will be greater for species that occur at low density, are relatively long-lived and reproduce at a low rate. Such species include divers, wildfowl and the larger raptors. Conversely, the impact will often be insignificant for short-lived species with high reproductive rates found at high densities, including most passerines.

In broad terms, the number of collisions during a given period (e.g. a year) is the product of two factors:

1. the number of birds flying through the rotor-swept area or volume during the period (the number of rotor transits). The number of rotor transits is influenced by the frequency with which a species flies through the wind farm area and, crucially, the probability that any bird on a collision course will take avoiding action (the avoidance rate); and

2. the probability that a bird will be struck by the rotors on any given transit. The probability of collision for a bird passing through the rotors is mainly determined by the size of the bird, its mode of flight (flapping or gliding) and its flight speed, along with the dimensions of the rotors and the speed at which they rotate.

Collision risk is perceived to be higher in birds that spend much of the time in the air, such as foraging raptors and those that have regular flight paths between feeding and breeding/roosting grounds (e.g. divers and geese). Vulnerability to collision is also influenced by factors such as the flight manoeuvrability of a species and its tendency to fly in conditions of reduced visibility (e.g. at night or in fog).

The size and location of the turbine array in relation to local topography can also influence collision rate greatly. It is, however, considered that the application site at Strathy South contains no topographical factors that are likely to increase the risk of bird collision (see Technical Appendix A11.1 Figure A11.1.7).

It should be noted that operational disturbance and collision risk effects can be mutually exclusive in a spatial sense, i.e. a bird that avoids the wind farm area cannot be at risk of collision with the turbine rotors at the same time. However, they are not mutually exclusive in a temporal sense; a bird may initially avoid the wind farm, but habituate to it, and would then be at risk of collision. The estimated collision risk figures given in Technical Appendix A11.1 were calculated under the assumption that flight activity during the operational phase will be similar to pre-development levels. Greenshank and golden plover may have been under-recorded during

5 Langston, R.H.W. and Pullan, J.D. 2003 Wind Farms and Birds: An Analysis of the Effects of Wind Farms on Birds, and Guidance on Environmental Assessment Criteria and Site Selection Issues. Report by Birdlife International on Behalf of the Bern Convention. RSPB, Sandy.

6 Pearce-Higgins, J.W., Stephen, L.H., Langston, R.H.W., Bainbridge, I.P., and Bullman, R. 2009 The Distribution of Breeding Birds Around Upland Wind Farms. Journal of Applied Ecology. **46**: 1323-1331

flight activity surveys, and so recorded activity may be lower than actual levels. Collision risk modelling based on predicted activity levels during the operational phase (i.e. post-felling) is therefore considered in Technical Appendix A11.3.

Decommissioning Effects

Potential disturbance effects associated with decommissioning are assumed to be the same as those identified for construction. This assumes that there is no permanent displacement of birds from the wind farm due to disturbance effects. Decommissioning effects are not considered separately for each species.

2.5 Species Accounts: Appraisal of the Implications for the Site In View Of the Site's Conservation Objectives

Technical Appendix A11.2 discusses in detail the approach to forest removal and subsequent management. This includes the facility to control vegetation so that breeding SPA qualifying species are not attracted to breeding locations which will put them at unacceptable risk of collision with turbines. The Technical Appendix also explains why birds nesting nearby on the SPA itself will not be significantly disturbed or displaced and why the site will not therefore compromise the Conservation Objectives of the SPA. In addition, it presents a combination of site-specific and regional data to demonstrate beyond reasonable doubt that there will be no adverse impact on site integrity of the SPA. This information is summarised below in relation to the Conservation Objectives for each of the qualifying features of the Caithness and Sutherland Peatlands SPA. Consideration has been given to predicted land use changes on site and in adjacent areas during the lifetime of the wind farm, in particular the removal of forest habitat and conversion to a more open landscape. Specifically, this has examined whether or not these changes are likely to affect the breeding distribution, abundance and flight activity of the qualifying features of the SPA over the Strathy South Wind Farm site post construction.

Red-Throated Diver

- Population Of The Species As A Viable Component Of The Site

The survey of the whole of Scotland in 1994 found 935 breeding pairs, with a suggested upper limit of 1,500 pairs[7]. Since then, results from the 2006 national survey have shown red-throated diver numbers have increased significantly in a national context, to 1,255 breeding pairs with an upper limit of 1,551 pairs.

The Caithness and Sutherland Peatlands SPA is one of ten SPAs that together hold 42% of the red-throated diver breeding population in Great Britain. The SPA is one of the main strongholds of the species on mainland Britain with 89 pairs (two-year mean: 1993-1994; 9.5% of British breeding population[8]). This is therefore equivalent to an average density of 6.1 pairs per 100 square km in the SPA. In the Caithness and Sutherland region in 2006 however, an estimated 39 pairs were considered to be breeding (range of 15-62 pairs)[9] which suggests a potential significant decline in the SPA breeding population since the mid-1990s citation, although these differences may be due to annual fluctuations and local redistributions in populations. The most recent site condition monitoring for the SPA, produced by SNH, concluded that the red-throated diver population was in favourable, maintained condition[8].

Collision risk modelling for Strathy South, detailed in Technical Appendix A11.1 showed that using a precautionary 98% avoidance rate, without mitigation, one red-throated diver collision is

[7] Gibbons, D. W., Bainbridge, I. P., Mudge, G. P., Tharme, A. P. and Ellis, P. M. (1997). The Status and Distribution of the Red-throated Diver *Gavia stellata* in Britain in 1994. Bird Study 44: 194-205.
[8] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8476
[9] Dillon, I.A., Smith, T.D., Williams, S.J., Haysom, S. and Eaton, M.A. (2009). Status of Red-throated Divers *Gavia stellata* in Britain in 2006. Bird Study 56: 147-157.

predicted to occur every 5.4 years (0.19 birds per year), or approximately 4-5 collisions over the 25-year lifespan of the proposed wind farm.

This collision rate of 0.19 birds per year equates to 0.24% (0.19 / 78 birds) of the SPA population if, as estimated in the most recent national survey, 39 pairs are considered to be breeding in Caithness and Sutherland (this is considered to be a minimum number, based on survey limitations and movements of pairs between years). Assuming that non-breeding individuals within the population are roughly 33%, then the population would be approximately 104 birds. The loss of 0.19 birds every year would therefore equate to 0.18% of the 2006 local population per year (0.19 / 104 birds). Alternatively, using the 'at designation' population in the SPA citation, the loss of 0.19 birds a year equates to 0.08% (i.e. 0.19/ (89 x 2 x 1.33)) of the total SPA population (including non-breeding birds).

Even though red-throated divers are long-lived and reproduce at a low rate, in practice losses at this level are not considered to represent a significant addition to background levels of mortality. Furthermore, it is reasonable to conclude that lost birds would be replaced from the non-breeding population, assuming the population continued to be in favourable condition. The survey results from Strathy South, Strathy Wood and Strathy North do indicate that there are non-breeding birds present, and therefore a non-breeding population pool that would continue to sustain the number of breeding pairs.

One last consideration is the validity of the 98% avoidance rate for this species. There is growing evidence, albeit largely from offshore wind farms, that macro avoidance of turbines is common. In a terrestrial situation such as Strathy South, divers are much more constrained in their flight paths than they are at sea, because of the need to start or end at a loch. However, the evidence from offshore wind farms does indicate the birds are able to detect turbines, in a variety of light conditions, and take avoiding action. In addition, observations at Burgar Hill, Orkney, show that red-throated divers will fly between a linear array of turbines, and to date, no diver collisions have been recorded at this site. Overall therefore, evidence is accumulating that 98% is a somewhat a precautionary figure for collision risk modelling for this species. Therefore, the predicted mean of 0.19 collisions a year is likely to be an over-estimate.

On the basis of the above, it is concluded that, even without mitigation, the population of red-throated diver will therefore be maintained as a viable component of the SPA in the long term.

- **Distribution Of The Species Within The Site**

Forest clearance is not expected to result in the creation of any additional breeding or feeding habitats for red-throated divers. It is therefore considered that no SPA-breeding pairs will be attracted to the wind farm, regardless of habitat management measures. As a precaution, and depending on further consultation with SNH, mechanisms could be explored for deploying diversion techniques and devices on non-SPA lochans within the site to further discourage divers from nesting or utilising the wind farm.

The abundance of other lochs and lochans in the Strathy area, outwith the recognised precautionary 1 km displacement zone[10], and previously recorded lochans being used by red-throated divers, suggests that the pair, if displaced, and even without mitigation, would be able to breed at another location within the SPA and therefore the SPA breeding population would be unaffected by the proposed wind farm development.

As explained below, no birds nesting nearby within the SPA will be displaced by the presence of turbines. The distribution of red-throated divers within the SPA will therefore be maintained in the long term.

[10] Bright J.A, Langston, R.H.W, Bullman, R., Evans, R.J., Gardner, S., Pearce Higgins, J. and Wilson, E. (2006) Bird Sensitivity Map to Provide Locational Guidance for Onshore Wind Farms in Scotland. RSPB, The Lodge, Sandy, Beds.

- **Distribution And Extent Of Habitats Supporting The Species**

The effects of direct habitat loss on divers due to wind farms are generally considered to be inconsequential, unless favoured breeding lochans are negatively affected either by drainage or pollution. This will not be the case for Strathy South, and no breeding lochs would be impacted directly or indirectly by the development. Whether red-throated divers from Strathy South feed predominantly in the marine environment (in this case likely at Strathy Bay or Bettyhill), or on local lochs, there will be no impact from the Modified 2013 Scheme on their foraging habitat (given the pollution control measures that would be incorporated into the project, notably through its Construction and Environment Management Plan).

As a result, there will be no direct or indirect effects on the distribution or extent of any of the habitats supporting red-throated diver so they will be maintained in the long term.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

There is to be no loss of diver habitat in the SPA and there will be no negative impacts on the hydrology of the breeding lochans or foraging sites for red-throated diver (particularly when mitigation measures outlined in Section 5 of this Technical Appendix are implemented). Therefore, the structure, function and supporting processes of habitats supporting red-throated diver are maintained in the long term.

- **No Significant Disturbance Of The Species**

Detailed consideration has been given to avoiding the risk of disturbance, with measures to ensure this is the case for breeding divers and all breeding birds, given that this is a requirement of wildlife legislation. Disturbance will therefore be avoided through the implementation of a Breeding Bird Protection Plan, to cover construction, operation and decommissioning.

Comprehensive recent work has been completed on diver responses to humans, and this has refined the previous knowledge of characteristic disturbance distances. Red-throated divers reportedly do not show indications of disturbance by human activity on foot at 500–750 m and the large majority are probably not disturbed when an observer is 500 m away[11]. During feeding flights on commutes between lochans and the sea, flying red-throated divers appear to be insensitive to the presence of an observer on the ground unless the observer is spotted close to the nest (<300–400 m) when the bird can become agitated (D. Jackson pers. comm.). This suggests that there will be no construction impacts.

During operation, exact disturbance-displacement distances from wind turbines are unknown, but evidence at Burgar Hill[12] [13] suggests that red-throated divers can continue to breed successfully in close proximity (c. 300 m and therefore closer than recorded at Strathy South) to turbines, and this is particularly likely if the nest site is at the edge of the turbine array, as is the case at Strathy South, thereby negating any barrier effects.

It is therefore considered likely that a pair will be able to continue to breed without any undue effects, as the turbines will be placed at sufficient distance away from breeding lochans to negate disturbance-displacement effects.

It is therefore considered that the presence of wind turbines would not represent significant disturbance to red-throated divers.

[11] Ruddock, M. and Whitfield, D.P. (2007) A Review of Disturbance Distances in Selected Bird Species. Report to SNH.
[12] Meek, E. R., Ribbands, J. B., Christer, W. G., Davey, P. R. and Higginson, I. (1993) The Effects of Aerogenerators on Moorland Bird Populations in the Orkney Islands, Scotland. Bird Study 40: 140-143
[13] Haworth, P. (2002). Replacement Wind Turbine Burgar Hill Orkney: Assessment of Ornithological Impact. NEG Micon

Black-throated Diver

- **Population Of The Species As A Viable Component Of The Site**

Sixty-one percent of 183 breeding black-throated diver pairs found during the survey of Britain in 1994 were within a Scottish SPA for which the species is a qualifying interest[14].

Monitoring has shown that the population may be slowly increasing in the north of Scotland with moderate potential for further expansion[15]. The 1994 total of 183 pairs represented a modest increase over the known population of 151 pairs in 1985, but whether this reflected a true increase or just improved survey effort is unclear[16]. Successful conservation efforts are thought to have helped the black-throated diver increase its numbers by 16% in the last 12 years to 217 pairs in 2007[17].

The Sutherland region holds approximately 64 pairs, whilst the Caithness region holds approximately 12 pairs. Recent data from SNH puts the Peatlands of Caithness and Sutherland NHZ population at 68. The Caithness and Sutherland SPA citation figure is for 26 pairs, representing at least 16.3% of the breeding population in Great Britain (11-year mean, 1986 - 1996)[18]. This is equivalent to an average density of 1.8 pairs per 100 square km. Compared to latest figures for the Caithness and Sutherland NHZ, this is considered to be an underestimate of the true current SPA population, but will be used as a precautionary value.

Using the 98% avoidance rate at Strathy South, and including unidentified divers in calculations, one bird collision every 20 years (0.05 per year) equates to a loss of 0.1% of the cited SPA population per year (0.05 / 52) (so this excludes any non-breeding birds in the SPA population).

Assuming that non-breeding individuals within the population are roughly similar to those in red-throated diver populations (approximately 33%), then the population would in reality be around 70 birds. This means the loss of one bird every 20 years would equate to 0.07% per year of the SPA population.

Even though black-throated divers are long-lived and reproduce at a low rate, the loss of one bird every 20 years would be compensated for by replacement from a non-breeding birds, assuming the population continues to be stable at least, as is currently thought to be the case.

Such low levels of annual mortality are most unlikely to negatively impact on the SPA population so it can be concluded that the population of black-throated divers will be maintained as a viable component of the site.

- **Distribution Of The Species Within The Site**

Forest clearing is not expected to result in the availability of any additional breeding or feeding habitats for black-throated divers, due to the small size of forest lochans within Strathy South compared to known species preferences. It is therefore considered that no additional SPA-breeding pairs will be attracted to the wind farm, and no nearby SPA pairs will be lost. The distribution of black-throated divers within the SPA will therefore be maintained in the long term.

[14] Stroud, D.A., Chambers, D., Cook, S., Buxton, N., Fraser, B., Clement, P., Lewis, P., McLean, I., Baker, H. and Whitehead, S. (Eds) (2001). The UK SPA Network: Its Scope and Content. JNCC, Peterborough.
[15] Jackson, D.B. (2005). Environmental correlates of lake occupancy and chick survival of black-throated divers *Gavia arctica* in Scotland. Bird Study 52: 225-236.
[16] Whyte, C., Hancock, M., Bainbridge, I. and Jackson, D. (1995). The 1994 Black-throated Diver *Gavia arctica* survey. Unpublished report. RSPB.
[17] http://www.telegraph.co.uk/earth/wildlife/3305769/Black-throated-and-red-throated-diver-numbers-on-the-increase.html
[18] http://www.jncc.gov.uk/pdf/SPA/UK9001151.pdf

- **Distribution And Extent Of Habitats Supporting The Species**

There is to be no loss of diver habitat within the SPA and it is unlikely that divers will make use of the habitat within the wind farm area due to lochan size. Therefore the distribution and extent of habitats supporting black throated divers will be maintained in the long term.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

There is to be no impact on diver habitat within the SPA and there will be no negative impacts on the hydrology of the breeding lochs or foraging sites used by black-throated diver, particularly as standard pollution prevention measures would be implemented as part of the project. Therefore the structure, function and supporting processes of habitats supporting the species will be maintained in the long term.

- **No Significant Disturbance Of The Species**

At its closest point from the nearest turbine, [redacted], the nearest breeding loch to the proposed turbines [redacted] is beyond the limit of considered disturbance distances in a review by Ruddock and Whitfield (2007)[11], and near the upper limit considered as a precaution by Bright *et al.* (2006). It can therefore be concluded that there will be no significant disturbance to black throated diver.

Hen Harrier

- **Population Of The Species As A Viable Component Of The Site**

National surveys have shown that the UK hen harrier population remained fairly stable at 578-700 breeding pairs over the twenty years leading up to the early 21st century[19]. The most recently published national survey, conducted in 2004, indicated a 41% increase in the UK hen harrier population during the six years since the previous survey[20]. For Scotland, the 2004 survey estimated 633 territorial pairs were located, a 32% increase over the 1998 estimate[20].

Up to date information on the hen harrier population, specifically in the Peatlands of Caithness and Sutherland, is difficult to obtain. The North Highlands in general are not regularly monitored for raptors, primarily due to the remoteness of much of the area[21]. The Scottish Raptor Monitoring Scheme classifies this area of the North Highlands as receiving '*poor coverage: with casual monitoring of a few pairs*'[21]. It is therefore likely that there are a considerable number of additional pairs of hen harrier and non-breeders, which remain unrecorded outwith designated sites.

In the North Highlands area (Highland and Caithness), the 2004 population was estimated at 102 territorial pairs, an increase of 240% since the 1998 estimate, although it is recognised that there was a large discrepancy between the two survey methods used for calculating trends in this area[20]. Data provided by SNH for cumulative effects on hen harriers suggests that the total NHZ population is considered to be 115 pairs.

The Caithness and Sutherlands SPA designation indicates 14 pairs (approximately 2.8% of the GB population) within 145,517 ha, based on data from 1993-1997[22]. This is therefore equivalent to an average density of 1 pair per 100 square km in the SPA. These data are however recognised as being outdated due to recent increases noted by the 2004 national survey[20] and the more recent SPA population figure provided by SNH is 20 pairs.

[19] Bright, J.A., Langston, R.H.W., Bullman, R., Evans, R.J., Gardner, S., Pearce-Higgins, J. and Wilson, E. (2006). Bird Sensitivity Map to Provide Locational Guidance for Onshore Wind Farms in Scotland. RSPB, The Lodge, Sandy, Bedfordshire.
[20] Sim, I.M.W., Dillon, I.A., Eaton, M.A., Etheridge, B., Lindley, P., Riley, H., Saunders, R., Sharpe, C. and Tickner, M. (2007). Status of the Hen Harrier *Circus cyaneus* in the UK and Isle of Man in 2004, and a Comparison with the 1988/89 and 1998 Surveys. Bird Study. 54, Number 2: 256-267
[21] Etheridge, B., Holling, M., Riley, H.T, Wernham, C. and Thompson, D.B.A. (eds.) (2008). Scottish Raptor Monitoring Scheme Report 2006. Scottish Ornithologists' Club, Aberlady.
[22] www.snh.org.uk

The conservation status of hen harrier in both the North Highlands region and the Caithness and Sutherland Peatlands SPA is therefore thought to be currently positive/favourable, with a sizeable increase indicated by the data collated for the national 2004 survey[23].

Population modelling conducted by Whitfield (2008)[24] for the proposed Camster Wind Farm, Caithness, and presented in Technical Appendix A11.2, demonstrated that even with a theoretical 7.5 females being killed per year the harrier population would remain stable at pre-wind farm levels. The loss of a mean of 0.11 birds per year at Strathy South is therefore not likely to significantly affect the integrity of the SPA.

It is also important to note that this predicted collision rate is derived from vantage point observations with the forest, which increases the flight time at collision risk height. From survey results of hen harrier foraging activity over clear-fell sites (see Technical Appendix A11.2 where for example, 98.9% of flights over an area of clear fell at Forsinard Flows RSPB reserve were below rotor height), this inflates the rate of collision. In addition to raising flight heights, the presence of the forest also evidently has greatly increased the amount of flight activity, in comparison to 'normal' flight levels over adjacent open moorland. Consequently, taking both these factors into account, then the actual collision risk to harriers once the forest is removed is likely to be negligible. In light of the results of the above population modelling, the small level of additional mortality is not considered likely to affect the favourable conservation status of hen harrier on the SPA therefore the population of the species as a viable component of the site will be maintained in the long term.

- **Distribution Of The Species Within The Site**

There is considerable evidence in Technical Appendix A11.2 to show that the clear-felling and subsequent habitat management will not displace existing harrier nesting locations in the SPA, and will not draw in hen harriers into the wind farm to breed. Consequently, the distribution of harriers nesting within the SPA will not be affected. If any change is likely, it is that the removal of the forest and subsequent management will promote greater nesting activity within the SPA, helping to re-establish the pre-afforestation nesting distribution of this species in the Flow Country. It can therefore be concluded that the distribution of the species within the site will be maintained in the long term.

- ***Distribution And Extent Of Habitats Supporting The Species***

The effects of direct habitat loss on harriers due to wind farms are generally considered to be inconsequential because the birds are wide ranging, although could be important if a development removes a traditionally-used nesting area[25]. This is not the case with Strathy South.

In terms of the size of hunting area required by breeding hen harriers, estimates have varied widely between studies, no doubt influenced by the distribution and availability of prey in relation to nest sites. Estimates of the size of hunting range around the nest differ for males and females but as a crude, but useful, measure of distance from the nest, average hunting ranges are equivalent to radii around the nest of 1.3-2.3 and 0.7-2.2 km^2 for males and females, respectively. Assuming a 2 km threshold around the nest as being the most important hunting zone to nesting harriers, there would theoretically be habitat loss due to construction of turbines and associated access tracks around the nest sites used in 2003, 2007 – 2012. However, the land take is small scale, and not all of this would involve good harrier hunting habitat. Indeed, part is already pre-existing forest track, or increasingly mature, closed canopy forest that is of decreasing habitat value for harriers. It is also clear from evidence from post-construction monitoring at Scottish wind farms such as Edinbane and Cruach Mhor, that harries can

[24] Whitfield, P. 2008. An Assessment of Effects of the Proposed Camster Wind Farm on Hen Harriers and Merlins of Caithness and Sutherland Peatlands SPA under the Habitats Regulations 1994. Revision.
[25] Thompson, D. (2007) Principal Precognition: Achany/Invercassley Conjoined Public Local Inquiry

successfully forage within operational wind farms, so the habitats therein are not lost to the birds.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

There is to be no significant loss of hen harrier habitat within the SPA and there will be no negative impacts on the hydrology of the habitats where hen harriers currently breed, particularly when mitigation measures are implemented. Therefore the structure, function and supporting processes of habitats supporting hen harrier will be maintained in the long term.

- **No Significant Disturbance Of The Species**

Ruddock and Whitfield (2007)[11] have noted that operational wind farms typically do not appear to displace foraging harriers through disturbance. Hen harriers will nest at 200 – 300 m from an operational wind turbine[26] or closer, with further evidence cited in Technical Appendix A11.1 and A11.2, demonstrating the ability of harriers to breed successfully in proximity to turbines.

As highlighted above in relation to disturbance prevention for other species, the Modified 2013 Scheme has incorporated measures to ensure no breeding birds are disturbed, as required by wildlife legislation, through a Breeding Bird Protection Plan.

Golden Eagle

- **Population Of The Species As A Viable Component Of The Site**

Golden eagle is a qualifying feature of the Caithness and Sutherland Peatlands SPA as it was reported to hold five breeding pairs, forming up to 1.3% of the British population as counted in 1992[27]. This is equivalent to an average density of 0.3 pairs per 100 square km in the SPA. Whitfield *et al*. (2007)[27] considered there to be 31 known or potential golden eagle territories across the Peatlands of Caithness and Sutherland NHZ, of which 13 were known to be occupied in 1992 and 18 occupied in 2003. It is therefore considered that the SPA citation is an underestimate of the true current population figure. The average fledging rate for golden eagles in this NHZ, at 0.32 chicks per pair (data from 1982, 1992 and 2003 censuses), is considered to be relatively good and sufficient to maintain a stable population in this region.

There are two breeding pairs within the wider area, the nearest being approximately [redacted] and the second [redacted]. Low activity levels at Strathy South, combined with the results of PAT modelling, show the site is not an important part of a home range of the southern or north-western birds and it is therefore concluded that breeding will not be affected by the change in land use (given that evidence has demonstrated that golden eagles tend to avoid forested areas when foraging, as they do wind farms).

The collision risk mortality calculations for golden eagle in Technical Appendix A11.1 show that at an accepted avoidance rate of 99% the modelling of the combined flight activity observations of 2003 to 2012 predicts approximately one collision every 71-72 years. Evidence presented in Technical Appendix A11.2 suggests that these low activity levels will remain unchanged post-felling, with occasional high territorial flights being unaffected by turbines. Whitfield *et al.* (2007)[27] considered the average fledging rate of the regional population to be relatively good and sufficient to maintain a stable population in this region. And with a pool of non-breeding adult `floaters' acting as a buffer against adverse population impacts[28], such a low level of mortality will not affect the population of golden eagle as a viable component of the site. It is therefore expected that the population will be maintained in the long term, even if the habitat changes.

[26] Madders, M and Whitfield, D.P. (2006). Upland Raptors and the Assessment of Wind Farm Impacts. Ibis, 148, 43–56.

[27] Whitfield, D.P., Fielding, A.H., McLeod, D.R.A, Morton, K., Stirling-Aird, P. and Eaton, M.A. (2007). Factors constraining the distribution of Golden Eagles *Aquila chrysaetos* in Scotland. Bird Study 54: 199-211.

[28] Eaton, M.A., Dillon, I.A., Stirling-Aird, P.K., Whitfield, D. P. (2007). Status of Golden Eagle *Aquila chrysaetos* in Britain in 2003. Bird Study, 54(2), 212-220

- **Distribution Of The Species Within The Site**

The wind farm would not have an effect on the species' distribution in comparison to the baseline. The current nesting locations are sufficiently distant not to be at risk from displacement by the wind farm, and as described, the Strathy South area is not a key part of the eagle's core foraging range at present. PAT modelling reveals that this would also be the case in the absence of the forest. The site and surrounding topography at Strathy South consists of level or gently undulating features, and on the basis of Ordnance Survey maps there are evidently no suitable nesting sites within 2.5 km from the application site. It is therefore evident that post-clearance, no golden eagles will be attracted to breed within or closer to the wind farm area. The distribution of the species would therefore be maintained within the SPA.

- **Distribution And Extent Of Habitats Supporting The Species**

Throughout the 2003 to 2012 survey period, golden eagle flight activity levels above and adjacent to Strathy South Forest have been low, reflecting the distance from the core ranging area of the nearest breeding pairs, the likely consequences of topography (as revealed by PAT modelling), and the unsuitability of the habitat for hunting main prey items (grouse, lagomorphs, deer and sheep carcasses).

Given the limited use of the Strathy South area, the loss of habitat associated with the Modified 2013 Scheme's access track is insignificant, being so small scale and also beyond the foraging range of both eagle ranges.

For the wind farm area itself, for the birds from the [redacted] territory, the site is within the [redacted] edge of their foraging range but PAT modelling confirms this occupies an area of low probable foraging activity, both in absolute terms and relative to elsewhere in their range.

For the [redacted] territory, the presence of the wind farm, depending on the extent of any avoidance buffer that is applied, could potentially reduce the extent of 'accessible' habitat. However, even taking into account the focus of survey effort being between the territory and Strathy South, the flight activity recorded from VPs over the 2003 to 2012 period still consistently shows the majority of foraging activity by these birds is (i) close to the nest location and (ii) predominantly to the east, west or south of the territory. This is supported by the findings of the PAT modelling, which confirm the majority of the higher probability foraging habitat spans an arc south of the nesting area.

The effect of the wind farm is therefore not considered significant in terms of the distribution and extent of the habitat supporting this species. Removal of forested areas and peatland restoration is therefore expected to result in a negligible net difference in the amount of area available for golden eagles to forage. The construction of the wind farm itself and subsequent habitat management would not therefore affect the distribution and extent of habitats within the SPA for golden eagles.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

There will be no direct or indirect effects on golden eagle breeding or foraging habitat within the SPA as a result of wind farm construction or post construction habitat management, therefore the structure, function and supporting processes of habitats supporting the species will be maintained in the long term.

- **No Significant *Disturbance* Of The Species**

Displacement from territories held by breeding golden eagles, and from habitat utilised by sub-adult birds have been highlighted as potential responses to wind farms. Ruddock and Whitfield (2007)[11] concluded that golden eagles are potentially affected by disturbance to an upper limit of 750-1,000m. From a series of peer reviews, no reviewer recommended a distance of greater than 2km. Based on this upper limit, no nest sites past or present at Strathy South have been located within this disturbance buffer. Further to this evidence from the Beinn a Tuirc Wind Farm

suggests that eagles will actively avoid wind turbines, and alter their home ranges accordingly without any noticeable impacts on occupancy or productivity[29].

There is therefore firm evidence to demonstrate that there will be no significant effects on breeding pairs caused by operational turbines or construction activities, as the location of the nearest possible nest site is well beyond upper limits of reported disturbance distances, and consequently the wind farm area is relatively unimportant for the species.

Greenshank

- **Population Of The Species As A Viable Component Of The Site**

The European greenshank population is believed to have been stable in recent decades, apart from local decreases in European Russia[30]. Similarly in Britain, whilst there are little robust data on national population trends, local declines have been reported in certain parts of Scotland, arising mainly from loss of breeding habitat to afforestation[30]. These declines include the Caithness and Sutherland Peatlands where numbers of greenshank were estimated to have decreased by 17% due to the afforestation that occurred there after 1945[31]. There is however, little evidence that this decline has continued in recent decades, with one study showing a non-significant decline of 3% per annum during the period 1979–1994[32] and another study indicating stability between 1988 and 1995[33]. Indeed, recent evidence highlighted below has shown that the population may have increased, although this may at least be partly explained by increased survey effort.

Hancock *et al* (1997)[34] estimated that 530 greenshank pairs were breeding in Sutherland and Caithness. Figures gathered from site condition monitoring across the Caithness and Sutherland peatlands (Simon Cohen, SNH, pers. comm.) show an estimated NHZ population of 1,082 pairs, with the SPA population considered to be 653 breeding pairs, a significant increase over the original citation of 256. This is equivalent to an average density of 0.4 pairs per km^2 in the SPA.

At Strathy South, as habitat will almost certainly have some influence on predominant greenshank flight height when forestry has been removed, future flight activity and predicted potential additional mortality during the operational wind farm's lifespan was considered in Technical Appendices A11.1 and A11.3. Flight height distributions were similar between habitats at Strathy North and Strathy South (with most flights at potential collision risk heights) and this may be at least partly influenced by the presence of forestry[35]. When comparing these distributions to those in the more open habitats at Forsinard (where all breeding stages were covered) and Modsary (chick-rearing), at least two thirds of flights were below collision risk height in these sites.

Surveys conducted throughout the 2010, 2011 and 2012 breeding seasons at the constructed Achany Wind Farm, Sutherland showed that the majority of flights (a three year mean of 68%) were below collision height.

[29] Walker, D., McGrady, M., McCluskie, A., Madders, M. and McLeod, D. R. A. (2005). Resident Golden Eagle ranging behaviour before and after construction of a wind farm in Argyll. Scottish Birds 25:24-40.

30 Nethersole-Thompson and Nethersole-Thompson (1979). Greenshanks. T and A.D. Poyser, Berkhamstead.

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

32 Whitfield, DP. 1997. Waders (Charadrii) on Scotland's Blanket Bogs: Recent Changes in Numbers of Breeding Birds. In: Conserving Peatlands (Eds. L Parkyn, RE Stoneman and HAP Ingram), pp. 103-111. CAP International, Wallingford.

33 Hancock, M. and Avery, M. 1998 Changes in Breeding Bird Populations in Peatland and Young Forestry in North East Sutherland and Caithness between 1988 and 1995. Scottish Birds: 19, 195-205.

34 Hancock, M. H., Gibbons, D. W. and Thompson, P. S. (1997) The Status of Breeding Greenshank *Tringa nebularia* in the United Kingdom in 1995. Bird Study 44: 290-302

35 It should be noted that a large proportion of flights were recorded at 10-20m at Forsinard and Modsary, which would have been categorised within the 10-100m height band at Strathy North and South. Therefore flights at Strathy between 10-20m would be included as being at risk height, even though in practice they would be below rotor tip height. This is likely to overestimate the percentage of flights at risk height.

As established by fieldwork results from nocturnal surveys at Strathy North in 2009, undertaken using specialised equipment, nocturnal activity from greenshank is very low and restricted mainly to short hops around breeding sites. The likelihood of collisions is therefore considered negligible during hours of darkness.

As detailed in Technical Appendix A11.1 and Technical Appendix A11.3, the predicted collision rate for greenshank at Strathy South, taking into account the effect of distance detection, is 0.12 – 0.15 birds a year. This is equivalent to one collision every 6-8 years or around 3 to 4 over the lifetime of the proposed wind farm. This equates to an additional annual loss of 0.01% of the SPA population, based on the recent SPA estimate of 653 pairs.

Given this predicted mortality rate and the fact that not all of their individuals would be from breeding pairs, it is concluded that the population as a viable component of the SPA will be maintained in the long term.

- **Distribution Of The Species Within The Site**

Surveys from 2003-2012 at Strathy South have shown that no greenshank nesting or nesting/chick rearing territories were within 200 m of any turbine. Only two territories fell within [redacted], giving a mean of one territory occurring within [redacted] of turbines every two years.

Within [redacted], the range of territories was from zero or one (depending on interpretation of the 2003 results) to a maximum of five to six territories (recorded in 2012), but at these distances, the birds would not be expected to be displaced.

In a situation where displacement of greenshank did occur (from feeding locations for example), at the closer distances recorded for these activities, results from the 2003 to 2012 surveys at Strathy South, and further supported by the survey results for 2003 – 2009 for Strathy North, show that contrary to some published studies of greenshank nest site fidelity between years, pairs at Strathy South have not bred at the same locations in consecutive years, and this may be related to comparatively moderate breeding densities within and adjacent to the forest. In 2004, a site-condition monitoring census of 19 survey plots across the constituent SSSIs forming the Caithness and Sutherland Peatlands, found 102 pairs of greenshank[36]. Fifteen of the 19 sites had a density exceeding 0.5 pairs per km^2, with the highest population density found at Forsinard Bogs SSSI (2.22 pairs per km^2). The closest site to Strathy South at West Halladale, had a density of 0.23 pairs per km^2.

This evidence and information collated for Technical Appendix A11.1 suggests that the surrounding SPA moorland would be expected to be able to absorb any birds that may be displaced. It is shown that across survey years, birds have used different sites for breeding and feeding, and seemingly suitable territories have lain empty in a particular year. Beyond the site and 200 m buffer, numbers and distribution would therefore remain unchanged. As such the risk of changes in distribution of greenshank is not considered significant at an SPA level in the long term.

The likelihood that feeding birds would be displaced is, however, also considered limited based on surveys conducted at Achany Wind Farm for example, Whilst data show considerable inter-annual variation, these show greenshanks still utilising areas of suitable habitat in close proximity to turbines.

The distribution of the species would therefore be maintained in the long term.

- **Distribution And Extent Of Habitats Supporting The Species**

36 Just Ecology Ltd. (2005). Site condition monitoring of breeding aggregations on the Caithness and Sutherland Peatlands SSSIs, SPA and RAMSAR site. Scottish Natural Heritage Commissioned Report F02AC305.

The effects of direct habitat loss on waders due to wind farms are generally considered to be inconsequential, unless favoured breeding pools or lochans are negatively affected. Because of the current limited habitat suitability and the revised wind farm layout which retains access corridors to pools and boggy areas used by greenshank, there will be no direct or indirect effects on the distribution or extent of any of the habitats supporting greenshanks so they will be maintained in the long term. Greenshank has not been recorded using, or in close proximity, to the habitat that would be lost to access track widening.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

The effects of indirect habitat loss on waders due to wind farms are generally considered to be inconsequential, unless favoured breeding pools or lochans are negatively affected either by drainage or pollution. There is to be no significant land take within the boundary of the SPA and there will be no negative impacts on the hydrology of the breeding lochans or foraging sites for greenshanks. Therefore it is expected that the structure, function and supporting processes of habitats supporting the species will be maintained in the long term.

- **No Significant Disturbance Of The Species**

Table A11.1.42 of Technical Appendix A11.1 (Confidential) summarises the number of pairs found breeding within 500 m of the nearest proposed turbines between 2003 and 2012. Ruddock and Whitfield (2007)[11] proposed a range of disturbance between 150 m and 300 m (for wood sandpiper). SNH have applied a 200 m disturbance buffer in relation to wind turbines and greenshank[25]. Since none of the nesting or nesting/chick rearing locations recorded between 2003 and 2012 were within 200 m of the nearest proposed turbine, there is considered to be no risk of significant disturbance.

Surveys carried out at the constructed Achany Wind Farm by RPS in 2010 to 2012 show that greenshank continue to commute and feed in close proximity to turbines, and therefore no other birds at Strathy South will be disturbed to any significant extent.

It can be determined that no significant disturbance to greenshank will occur within the context of the SPA population.

Golden Plover

- **Population Of The Species As A Viable Component Of The Site**

Although there has been a historic decline in golden plover populations in Britain, the most recent breeding population estimate of 22,600 pairs[37] suggests that the core populations in upland Scotland remain strong, albeit at a lower level than in the 19th century. Breeding densities in Scotland of 2-7 pairs per square km are among the highest anywhere in the species' range[38].

Twenty-six percent of British breeding golden plover are found within seven SPAs, including the Caithness and Sutherland Peatlands SPA which supports 1,064 pairs, 4.7% of the British total[14]. This is equivalent to an average density of 0.73 pairs per square km in the SPA. There is however, evidence of a significant population decline within the Caithness and Sutherland Peatlands SPA, including a 39% decline between 1988 and 1995 (per Bright *et al.* 2006)[19].

A total of 3,760 pairs were estimated (average density of 1.43 pairs per square km) in the Peatlands of Caithness and Sutherland by SNH in 1996[39] although more recent NHZ estimates have placed this figure at 2,048 pairs. A site-condition monitoring census in 2004, covering 19 survey plots across the constituent SSSIs forming the Caithness and Sutherland Peatlands SPA, found 254 pairs of golden plover. Four of the 19 sites had a density exceeding 2.6 pairs per

37 Baker, H., Stroud, D. A., Aebischer, N. J., Cranswick, P. A., Gregory,R. D., McSorley, C. A., Noble, D.G and Rehfisch, M. M. (2006) Population Estimates of Birds in Great Britain and the United Kingdom. British Birds 99: 25-44.
38 Byrkjedal and Thompson. 1998. Tundra Plovers. T and A.D. Poyser, London.
39 http://www.snh.org.uk/publications/on-line/advisorynotes/53/53.pdf

square km, with the highest population density found at Budanloch Bog SSSI (4.85 pairs per square km)[36]. The closest survey area to Strathy South (West Halladale) produced a density of 0.88 pairs per square km.

This Caithness and Sutherland Peatlands SPA population nests in the blanket bog habitat of the SPA but breeding and some non-breeding adults may also spend time foraging on heavily-grazed, rushy pastures outside of the designated area where the damp conditions favour high densities of leatherjacket (tipulid larvae) prey[40].

Golden plovers and other waders were not considered by Langston and Pullan (2003)[5] to have a high collision risk, and from flight activity surveys in 2003-2012, there is no evidence to suggest that golden plovers fly across the proposed wind farm on a regular basis and no reason to believe that it will represent a significant barrier to their normal movements within the wider area, either day or night. Recorded flight activity during all surveys was too low to model accurately, suggesting very low level of collision risk. However, as flights may have been under-recorded due to small size of birds, further consideration was given to collision risk mortality in Technical Appendix A11.3. However, even taking detection decay effects into account, flight activity remained sufficiently low that predicted collision rates were still negligible, and therefore would have no effect on the SPA population, with the Caithness and Sutherland Peatlands SPA supporting 1,064 pairs. Given this negligible level of mortality for golden plover, the population of the species as a viable component of the SPA would be maintained.

- **Distribution Of The Species Within The Site**

There were no breeding golden plover territories recorded in any survey year within 200 m of any turbine, and within [redacted], there were only two territories in 2003, and one in 2010. Based on evidence from operational sites, golden plover can successfully breed in close proximity to turbines, less than 200 m away, although some research suggests displacement, at least in the early stages of operation, may extend to approximately 300 m. On this basis, three territories might be displaced by the wind farm. As the removal of approximately 32 km of forest edge would reduce the 'edge effect' along this boundary, it is considered that the net effect is negligible, or potentially positive, leading to a broader distribution of the species within the SPA.

Therefore the distribution of the species within the site will be maintained in the long term.

- **Distribution And Extent Of Habitats Supporting The Species**

The effects of direct habitat loss on golden plovers due to wind farms are generally considered to be inconsequential. The SPA habitat that will be lost for the access track widening has not had breeding golden plovers in proximity in any of the survey years, and therefore no habitat supporting this species will be lost for this element of the development. Results from each year of surveys show that golden plovers do not use the application site for breeding, but are regularly found utilising the surrounding moorland, albeit at distances considered to be primarily beyond displacement distances from turbines. As highlighted above, the removal of approximately 32 km of forest edge would reduce the 'edge effect' along its boundary, potentially increasing the distribution and extent of supporting habitat within the SPA. The distribution or extent of habitats supporting golden plover will therefore be maintained in the long term.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

The effects of indirect habitat loss on waders due to wind farms are generally considered to be inconsequential, unless favoured breeding pools or lochans are negatively affected either by drainage or pollution. A range of design and mitigation measures have been identified to ensure there would no negative impacts on the hydrology of the breeding lochans or foraging sites for golden plover.

40 Whitfield, D.P. and Thomas, C.J. (2006) Analysis of a Survey of Golden Plover Around the Caithness and Sutherland Peatlands Special Protection Area. Scottish Natural Heritage Commissioned Report No. 181.

The habitat management activity on the site is not expected to alter existing breeding and foraging habitat within the SPA itself by indirect effects on hydrology. Therefore it is expected that the structure, function and supporting processes of habitats supporting the species will be maintained in the long term. The removal of the forest, accompanied by drain blocking along the SPA boundary, would, in fact, be expected to help restore the structure, function and supporting processes of the habitats supporting golden plover.

- **No Significant Disturbance Of The Species**

Results from surveys conducted at Strathy South in 2003-2012 show that a maximum of three pairs of golden plover have bred within [redacted] of a proposed turbine, and none within 200 m. Given this distribution, and with the measures included in the Breeding Bird Protection Plan, it is evident that disturbance to any breeding golden plover would be avoided during construction, in the longer term, once the site was operational, evidence of sustained golden plover breeding at other wind farms suggest no disturbance to golden plover would occur. No significant disturbance would therefore result.

Dunlin

- **Population Of The Species As A Viable Component Of The Site**

An estimated 9,150-9,900 pairs of dunlin breed in Great Britain, representing 83% of the population of the sub-species *schinzii*[37]. This most recent estimate dates from the 1980s, however, and needs to be updated.

Although no NHZ population estimates are available, Whitfield (1997)[32] (per JNCC species account[41]) found that numbers fell on five of 12 sites in Caithness and Sutherland surveyed in the period between 1979 and 1987, and in 1993-4. The overall numbers fell by 2.4% per year. A decline has also been demonstrated for the Caithness and Sutherland Peatlands SPA, where numbers of breeding dunlin were estimated to have fallen by 17% since 1945 (due to afforestation). Numbers have continued to decline despite the cessation of conifer planting in the area (per Bright *et al.* 2006[19]). The SPA population represents an estimated 1,860 pairs representing at least 16.9% of the breeding Baltic/UK/Ireland population (count, as at 1994). This is equivalent to an average density of 1.3 pairs per square km in the SPA.

A site condition monitoring census in 2004, of 19 survey plots across the constituent SSSIs forming the Caithness and Sutherland Peatlands SPA, found 207 pairs of dunlin[36]. The breeding density at West Halladale was recorded as 1.25 pairs per square km.

Dunlins, along with other waders, were not considered by Langston and Pullan (2003)[5] to have a particularly high collision risk and no turbine collisions have been reported to date. No dunlins were recorded in flight over the site during the 2003 – 2012 vantage point surveys. Nocturnal surveys in 2009 also showed that there is no evidence to suggest that birds commute northwards from the wind farm to feed elsewhere. Due to their small size and manoeuvrability, and propensity for low flight heights, collision risk for this species within the application site is evidently negligible within the current habitat despite the chance of some flights going unrecorded due to the small size of the species. With negligible additional mortality of SPA connected dunlin likely to occur, the population as a viable component of the site will be maintained in the long term.

- **Distribution Of The Species Within The Site**

Since surveys began in 2003, dunlin have not been recorded using the application site for breeding or feeding. The main limiting factor is likely to be the conifer plantation plus the limited extent of pool systems, which are this species preferred habitat. Whilst forest clearance would

41 http://www.jncc.gov.uk/pdf/UKSPA/UKSPA-A6-67A.pdf

increase the accessibility of these pool systems, there is no ecological reason to anticipate that dunlin would be preferentially attracted into the wind farm area from surrounding moorland. Therefore the risk of the wind farm attracting dunlin is negligible. As there have also been no dunlin territories recorded in any survey year within 350 m of turbines, no displacement of SPA pairs nesting is considered likely. As with golden plover, the removal of the plantation is, in fact, predicted to increase the distribution of dunlin within the SPA.

- **Distribution And Extent Of Habitats Supporting The Species**

The effects of direct habitat loss on waders due to wind farms are generally considered to be inconsequential. The SPA habitat that will be lost for the access track widening has not had breeding dunlin in proximity in any of the survey years, and therefore no habitat supporting this species will be lost for this element of the development. Results from each year of surveys show that dunlin do not use the application site for breeding, but are regularly found utilising the surrounding moorland, albeit at distances considered to be primarily beyond displacement distances from turbines. As highlighted above, the removal of approximately 32 km of forest edge would reduce the 'edge effect' along its boundary, potentially increasing habitat availability. The distribution or extent of habitats supporting dunlin will therefore be maintained in the long term.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

There is to be no land take within the boundary of the SPA and there will be no negative impacts on the hydrology of the breeding lochans or foraging sites for dunlin. The habitat management activity on the site is not expected to alter existing breeding and foraging habitat within the SPA itself either by direct land take or by indirect effects on hydrology. Therefore it is expected that the structure, function and supporting processes of habitats supporting the species will be maintained in the long term. Removal of the Strathy South plantation would be accompanied by drain blocking to aid peatland regeneration, and this work would contribute to this objective.

- **No Significant Disturbance Of The Species**

Results from surveys conducted at Strathy South over 2003-2012 show that no dunlin bred within 350 m of a proposed turbine. Given this distribution, and with the measures included in the Breeding Bird Protection Plan, it is evident that disturbance to any breeding dunlin would be avoided during construction. In the longer term, once the site was operational, there is no evidence to suggest breeding dunlin will be disturbed, particularly taking into account the measures to prevent disturbance taking place. Dunlin breed in Scotland in proximity to a range of human activities, including traffic, recreation, peat extraction and agriculture so there is no evidence to suggest that significant disturbance would result from the wind farm in the long term.

Merlin

- **Population Of The Species As A Viable Component Of The Site**

In Britain, merlin breeds on moorland notably in the Scottish Highlands and Islands, the Welsh mountains, the English Pennines and the Scottish Southern Uplands. There are an estimated 1,330 breeding pairs of merlin in the UK[42].

The Scottish merlin breeding population is estimated at approximately 800 pairs, with a winter population of 3,000+ birds. This latter figure includes Icelandic birds overwintering in Scotland[31].

There are no available data on the number of breeding merlin within the Peatlands of Caithness and Sutherland NHZ. Data for the area of the Caithness and Sutherland Peatlands SPA, which covers approximately 28% of the NHZ (totalling 5,200 square km), show that the density of birds

42 Baker, H., Stroud, D.A., Aebischer, N. Cranswick, P.A., Gregory, R.D., McSorley, C.A., Noble, D.G. and Rehfisch, M.M. (2006). Population Estimates of Birds in Great Britain and the United Kingdom. British Birds 99: 25-44.

is relatively low, with 54 pairs of merlin occurring in an area of 1,455 square km - equivalent to an average density of 3.7 pairs per 100 square km[43]. This population forms up to 4.2% of the British population (count in early 1990s).

In the new atlas of breeding birds (1988-91)[44], it is evident that the SPA holds the two areas of highest concentration of abundance for this species in Caithness and Sutherland, and so it can be reasonably concluded that outwith the SPA there is a comparatively lower breeding density. Assuming a density of 50% to 75% of the SPA for the rest of the NHZ will therefore produce an estimated population range of 123 to 158 pairs for the whole NHZ.

During flight activity surveys from 2003-2012 at Strathy South, insufficient merlin flights were recorded for any meaningful collision risk analysis. Whilst it is acknowledged that possible under-recording can result from this species' flight characteristics and small body size, the level of flight activity across all years is so low that negligible additional mortality is predicted.

Even in the unlikely circumstances of merlin foraging within the wind farm area, from known merlin flight behaviour in the literature and observed behaviour at Strathy South there is strong evidence that flight heights will be predominantly below collision risk height. The population of merlin as a viable component of the SPA will therefore be maintained in the long term.

- **Distribution Of The Species Within The Site**

It is evident from the survey results over 2003 – 2012 that the site has not been used by breeding merlin in recent years, and that previous possible breeding locations were likely to have been in the plantation. Once the plantation is cleared therefore, the relatively flat topography at Strathy South suggests that most of the site is unsuitable for nesting, as merlins prefer heather-clad slopes. Habitat management plan prescriptions will provide the facility to control heather growth and maintain vegetation below a preferred height, if SNH consider it necessary. Removal of forestry will also remove potential opportunities for tree-nesting pairs.

On the adjacent moorland, the closest recorded territory has been monitored over several years and is approximately [redacted] of the [redacted] corner of the site.

Therefore the distribution of the species within the SPA will be maintained in the long term.

- **Distribution And Extent Of Habitats Supporting The Species**

Combined data from 2000 to 2012 show that generally the application site is not important for foraging merlin, and so there will be no significant supporting habitat loss associated with the development. Therefore, there will be no direct effects on the distribution or extent of any of the habitats supporting merlin so they will be maintained in the long term.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

There is to be no indirect negative impacts on the hydrology of the breeding locations or foraging sites for merlin. The structure, function and supporting processes of habitats supporting merlin will therefore be maintained in the long term.

- **No Significant Disturbance Of The Species**

Results from surveys conducted at Strathy South over 2003-2012 show that confirmed or possible breeding has been scarce. Given this distribution, and with the measures included in the Breeding Bird Protection Plan, it is evident that disturbance to any breeding merlin would be avoided during construction, In the longer term, once the site was operational, there is no

43 Rebecca, G.W. and Bainbridge, I.P. (1998). The Breeding Status of the Merlin *Falco columbarius* in Britain in 1993-94. Bird Study 45: 172-187.
44 Gibbons, D.W., Reid, J.B. and Chapman, R.A. (1993). The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991. London: T.and A.D. Poyser.

evidence to suggest breeding merlin will be disturbed, particularly taking into account the mitigation measures to prevent disturbance, and the lack of suitable nesting habitat on site once the plantation is removed. The SPA territory that has been consistently present on the adjacent moorland is almost [redacted] from the nearest turbine, well beyond the upper range of potential disturbance.

An expert opinion survey by Ruddock and Whitfield (2007)[11] showed that maximum disturbance distances for merlin are likely to range from 300 m to 500 m, and RPS surveys at wind farms in central Scotland have shown that merlins have attempted to breed at around [redacted] from turbines. In light of this, it can be concluded that there will be no significant disturbance to merlin.

Short Eared Owl

- **Population Of The Species As A Viable Component Of The Site**

The Scottish short-eared owl population is estimated as being between 125-1,250 pairs, which accounts for 77% of the British breeding population[30]. The Scottish wintering population varies between 300 and 3,000 birds[30]. Breeding short-eared owls form part of the SPA species citation for the Caithness and Sutherland Peatlands SPA, where around 30 pairs form up to 3% of the British population (count mid-1990s). This is equivalent to an average density of 2.1 pairs per 100 square km in the SPA.

There is annual variation in breeding numbers at most sites due to changes in small mammal prey availability, which tend to fluctuate cyclically. This can lead to short-eared owls being absent from many areas of apparently suitable habitat. In general, because of surveying difficulties, short-eared owl populations are poorly monitored, with only casual records being included in Scottish Raptor Study Group annual reports. As such there is no NHZ-level population estimate.

Short-eared owl is a rare visitor to Strathy South and as a result has a negligible predicted collision rate. Evidence gathered from Strathy North, other sites, and in the scientific literature, suggests that with the application site clear-felled, any short-eared owl flight heights would be predominantly below collision risk height. Future levels of additional mortality based on these findings will therefore continue to be negligible and the population will be maintained as a viable component of the SPA.

- **Distribution Of The Species Within The Site**

The combined data collected since the late 1990s provides evidence that short-eared owl has not used the wind farm site for nesting since at least this date, and has not attempted to breed in the surrounding area, where it is an extremely scarce visitor. As a result, the wind farm is not predicted to have any adverse effect on the distribution of these species within the SPA.

- **Distribution And Extent Of Habitats Supporting The Species**

The extent of habitat loss supporting this species is negligible and therefore there would be no direct or indirect effects on the extent of habitats supporting short-eared owls within the SPA, and therefore the population distribution will be maintained in the long term.

- **Structure, Function And Supporting Processes Of Habitats Supporting The Species**

As there will be no indirect effects on the habitats supporting breeding and foraging short-eared owl, the structure, function and supporting processes will be maintained in the long term.

- **No Significant Disturbance Of The Species**

No recent or historical breeding activity has been recorded within 500 m of the proposed wind farm. Five hundred metres is the maximum disturbance distance suggested for short-eared owl in Ruddock and Whitfield (2007)[11]. There will, therefore, be no significant disturbance to short-eared owl.

Wigeon, Wood Sandpiper and Common Scoter

Wigeon were not recorded on any of the surveys. Common scoter were recorded very rarely, and were not considered to be breeding within 2 km of the site. Occasional infrequent observations of wood sandpiper comprised mainly single birds considered to be on passage. No breeding of this conspicuous wader was recorded at any point on site or within any survey buffers. It can therefore be confidently concluded that for these species all of the Conservation Objectives can be maintained in the long term.

2.6 Access Track Impact Assessment

Following the change in proposed access track for Strathy South, surveys over 2007, 2010 and 2012 (plus targeted up-dates in 2013) show that certain SPA qualifying species (or SSSI breeding bird assemblage) do breed in close proximity to preferred and alternative tracks. Any birds that are present could potentially be affected by two main factors as a result of the construction/upgrade of the access track, namely direct habitat loss and displacement-disturbance. The Modified 2013 Scheme would result in approximately 2.9 ha of habitat loss or direct impact (excluding forestry habitats and the existing track surface) within the SPA due to track widening. Each species is assessed for these factors in this section.

Red-throated Diver

Whilst there would be no direct or indirect effects on the lochans that provide breeding and feeding habitat for this species, there is the scope for disturbance. However, the detailed measures set out in Table A11.4.6 would ensure there are no effects on this species from the access track.

Hen Harrier

For hen harriers a disturbance free zone of 500-600 m is recommended[45] During wind farm construction, hen harrier displacement has also been suggested potentially to occur up to 500 m with some disruption up to 1000 m[46] (depending on lines of sight). There have been several nest locations in recent years [redacted], and therefore particular attention has been paid to measures that will ensure there is no disturbance to breeding harriers (or any other breeding birds). Through these measures described in Table A11.4.8, there would be no negative effects on the SPA hen harrier population from the preferred or alternative access tracks.

Merlin

No merlin were recorded breeding or foraging in proximity to the preferred or alternative access tracks. As such any additional impacts caused by access track construction will be avoided and there will be no impact on the SPA population.

Golden Plover

Golden plovers nest on open moorland but there were no territories within 250 m of the tracks.

Two studies[47] [48] have shown the mean size of golden plover's 'home range' (the area of moorland used by both adults from the start of the incubating phase to the end of the fledging

[45] Petty, S. J. (1998). Ecology and Conservation of Raptors in the Forests. Forestry Commission Bulletin 118. The Stationery Office, London

[46] Madders, M. (2004). The Ecology of Hen Harriers in Scotland in Relation to Wind Farms. Report on Penbreck and Carmacoup Proposed Wind Farm. Cited in Bright, J.A., Langston, R.H.W., Bullman, R., Evans, R.J., Gardner, S., Pearce-Higgins, J. and Wilson, E. (2006). Bird sensitivity map to provide locational guidance for onshore wind farms in Scotland. RSPB Research Report 20.

[47] O'Connell et al. (1996). Cited in Byrkjedal, I. and Thompson, D.B.A. 1998. Tundra Plovers: The Eurasian, Pacific and American Golden Plovers and Grey Plover. London: T. and A.D. Poyser.

period) in Sutherland and Caithness to be between 106 to 110 hectares (though a wide range of 14 to 393 hectares was found depending on habitat quality).

Thus, based on these mean values, the 2.9 ha habitat loss due to the access track is equivalent to a negligible proportion of the home range of one pair of golden plovers and as such will have a minimal adverse effect in terms of breeding and foraging habitat.

Studies have shown that breeding golden plover avoid heavily disturbed footpaths to a distance of 200 m[49]. Further recent studies at wind farms across Scotland found a similar displacement of 200 m from turbines and also possible avoidance of tracks [50].

Data collected from 2003-2012 shows that there have been no pairs, as highlighted above. Therefore there will be no additional significant effects on the SPA population.

Greenshank

Within [redacted] of the existing track through Strathy Forest and Strathy Wood, records suggest that at most, there is [redacted] disturbance would be avoided through the Breeding Bird Protection Plan.

The amount of land lost during the upgrading of the existing tracks to provide access will be minimal and as such is considered to be insignificant in terms of nesting or foraging habitat for greenshanks. With mitigation measures in place (ECoW and Best Practice construction methods), there are no anticipated significant changes to local hydrology which may alter breeding and/or feeding habitats. No effects are therefore predicted for greenshank from the preferred or alternative access track.

2.7 Conclusions of the Assessment of the Strathy South Modified 2013 Scheme's Effect on Site Integrity

None of the Conservation Objectives for the qualifying features of the SPA discussed above will be compromised by the Modified 2013 Scheme. It can therefore be concluded that, with respect to impacts on: red-throated diver, black-throated diver, hen harrier, golden eagle, greenshank, golden plover, dunlin, merlin, short eared owl, wigeon wood sandpiper and common scoter, the proposals will not adversely affect the integrity of the SPA. These conclusions are summarised in Table A11.4.1.

TABLE A11.4.1 – SUMMARY OF THE APPRAISAL OF THE WIND FARM'S IMPACT ON THE SPA

Conservation Objective	Expected Impact
1. To ensure that populations are maintained as a viable component of the SPA.	None. The evidence shows collision risk is low or negligible for all species and is too small to affect the SPA's populations.
2. To ensure that the distribution of populations is maintained within the SPA.	None. The proposed development site is of sufficient distance from significant SPA populations to avoid significant influences on population distribution.
3. To ensure that the distribution and extent	None. The habitats of the SPA will not be affected as the proposed

[48] Environmental Resources Management. 2006. Gordonbush Wind Farm Environmental Statement: Further Information on Ornithological Interests.

[49] Finney, S.K., Pearce-Higgins, J.W. and Yalden, D.W. (2005). The Effect of Recreational Disturbance on an Upland Breeding Bird, the Golden Plover Pluvialis apricaria. Biological Conservation. 121: 53-63. Cited in Pearce-Higgins, J.W., Stephen, L., Langston, R.H.W., and Bright, J.A. (2008).

[50] Pearce-Higgins, J.W., Stephen, L., Langston, R.H.W., and Bright, J.A. (2008) Assessing the Cumulative Impacts of Wind Farms on Peatland Birds: A Case Study of Golden Plover *Pluvialis apricaria* in Scotland. Mires and Peat. 4: 1-13.

TABLE A11.4.1 – SUMMARY OF THE APPRAISAL OF THE WIND FARM'S IMPACT ON THE SPA	
Conservation Objective	**Expected Impact**
of supporting habitats is maintained within the SPA.	development site is outside the SPA.
4. To ensure that the structure, function and supporting processes of habitats supporting SPA species are maintained within the SPA.	None. The development will not affect any physical features or processes linking the SPA.
5. To ensure that there is no significant disturbance to the SPA species populations.	Disturbance during construction will be avoided through a range of measures, including the implementation of a Breeding Bird Protection Plan, which will be implemented under the supervision of a suitably qualified Ecological Clerk of Works. None. Distance from Wind Farm to breeding locations is sufficient to exclude significant disturbance effects. Disturbance from operational and decommissioning activities will not be significant due to distance from breeding locations.
Overall effects	**None.**

3 CUMULATIVE EFFECTS

The above sections have considered the implications of the wind farm in isolation from potential effects of other developments. The EIA Regulations require cumulative impacts to be assessed, to determine whether or not joint impacts are significant. The Habitats Regulations also require proposed development impacts to be assessed together, taking into account relevant plans and projects (in what is generally referred to as an 'in combination' assessment). This is so that combined effects on Conservation Objectives and therefore the SPA's integrity can be identified.

Strathy South Wind Farm has therefore been considered in combination with other developments that are likely to occur. This includes both projects under construction (and whose impacts are therefore not part of the baseline) and projects in the planning process. As was the case with Strathy North, having considered the potential in combination plans and projects affecting the SPA, the only relevant developments are other wind farms. Information on these has been provided by SNH, in the form of their cumulative spreadsheet, albeit with their caveat that further up-dates would need to be sought and taken into account.

Given their proximity, particular attention has been paid to the joint impact of Strathy North, now under construction (taking into account its mitigation and Detailed HMP) and Strathy South. The cumulative impacts of Strathy Wood, however, depend to such a high degree on the final submitted layout, that at this stage it not sufficiently evident whether it would or would not have cumulative implications for Strathy South. At this stage, therefore, as the Strathy Wood wind farm is only at Scoping stage, the quantitative information is not available to include in the cumulative/in combination assessment.

Additional SNH generic guidance on cumulative assessment (SNH 2005[51] and SNH 2012[52]) has been considered. It recommends a five stage process to aid the cumulative ornithological assessment. These are:-

1. Define the species to be considered;
2. Consider the limits or 'search area' of the study;
3. Decide the methods to be employed;
4. Review the findings of existing studies; and
5. Draw conclusions of cumulative effects within the study area.

Target species considered in this assessment are those qualifying species of the SPA where potential impacts have been identified. This information was provided by SNH in May 2013. Follow ups on other projects to obtain further details (i.e. Bettyhill) failed to result in additional data being sourced.

The information provided by SNH allowed an estimation of the number of pairs of each species connected to the SPA population that might be disturbed and/or displaced among all of the built or prospective wind farms close to the SPA.

3.1 Red-throated Diver

Of the range of potential impacts from other wind farms, it is only collision risk that could potentially generate cumulative/in combination effects for this species, as no other contemporaneous effects are predicted. The predicted collision risk for Strathy North (using a 98% avoidance rate) is a mean of 0.07 birds a year. Combined with the mean rate of 0.19 a year before mitigation for Strathy South, this gives a combined rate of 0.26 red-throated divers a year, equivalent to approximately one every four years, or six to seven divers over the life-time of the wind farm. Of the estimated 104 red-throated divers in the SPA, the 0.26 cumulative/combined

[51] SNH (2005) Cumulative Effects on Wind Farms: Version 2. Scottish Natural Heritage.

[52] SNH (2012) Assessing the Cumulative Effects of Onshore Wind Energy Development.

birds a year equates to 0.25% of the SPA population, before mitigation. This level of added annual mortality is not considered to be significant or to have an adverse impact on the viability of the population or integrity of the SPA.

Currently, there is no predicted collision figure available from Strathy Wood. This will depend on the final submitted layout, together with any mitigation proposed as part of the development. It is therefore not possible to confirm whether or not Strathy Wood will add to the cumulative collision risk, although given the level of red-throated diver flights, some additional collision risk would seem likely.

3.2 Black-throated Diver

The predicted collision risk for Strathy North (using a 98% avoidance rate) is a mean of 0.05 birds a year. Combined with the mean rate of 0.05 a year before mitigation for Strathy South, this gives a combined rate of 0.10 black-throated divers a year, equivalent to approximately one every 10 years, or two to three divers over the life-time of the wind farm. Of the estimated 69 black-throated divers in the SPA (based on 26 pairs and 33% non-breeding birds), the 0.10 cumulative/combined birds a year equates to 0.14% of the SPA population, before mitigation. This level of added annual mortality is not considered to be significant or to have an adverse impact on the viability of the population or integrity of the SPA.

Currently, there is no predicted collision figure available from Strathy Wood. This will depend on the final submitted layout, together with any mitigation proposed as part of the development. It is therefore not possible to confirm whether or not Strathy Wood will add to the cumulative collision risk, although given the level of black-throated diver flights, additional collision risk would seem to be negligible.

3.3 Hen Harrier and Merlin

The combined collision risk was based on calculations using a 99% avoidance rate for hen harrier and a precautionary 95% avoidance rate for merlin (flight activity was so low, there was no real benefit in up-dating to 98% avoidance rate). Current SPA populations are taken to be 20 hen harrier pairs and 54 merlin pairs. Results from these cumulative collision risk assessment are shown below in Table A11.4.2.

TABLE A11.4.2 – CUMULATIVE PREDICTED ANNUAL TURBINE COLLISIONS FOR HEN HARRIER AND MERLIN IN CAITHNESS AND SUTHERLAND

Species	Wind Farm	Number of collisions per annum
Hen Harrier	Achairn	0.0013
	Baillie Hill	0
	Braemore	0.07
	Bettyhill	0.01
	Bower Quarry	Superseded below
	Bower Quarry 2	0.00
	Burn of Whilk	0.03
	Camster	0.60
	Flex Hill	0.00
	Forss	No data in planning application
	Forss 2	0.00
	Halsary	0.03
	Rumster	0.01
	South Shebster	0.00
	Spittal Hill	Not calculated
	Strathy North	0.38
	Strathy South	**0.11**
	Torranshondall	0.01
	Wathegar	0.05
	Westfield 2	0.00
		1.30 All
TOTAL		**1.23 SPA**
Merlin	Achairn	0.0014
	Baillie Hill	0
	Bower Quarry	Superseded below

TABLE A11.4.2 – CUMULATIVE PREDICTED ANNUAL TURBINE COLLISIONS FOR HEN HARRIER AND MERLIN IN CAITHNESS AND SUTHERLAND		
Species	**Wind Farm**	**Number of collisions per annum**
	Bower Quarry 2	0
	Camster	0
	Flex Hill	0
	Forss	No data in planning application
	Forss 2	0
	South Shebster	0
	Spittal Hill	0
	Strathy North	Too few flights for analysis
	Strathy South	**Too few flights for analysis**
	Westfield 2	0
TOTAL		**0.0014**

Shaded rows represent sites where SNH consider that species are connected, or possibly connected, to the Caithness and Sutherland SPA population. Source: SNH

When Strathy South Wind Farm predicted annual additional mortality is included with other wind farm estimates, the cumulative mortality for hen harrier and merlin are 1.23 and 0.0014 birds per annum respectively.

Taking the current hen harrier SPA population to be 20 pairs, in line with national survey evidence and modelling by Whitfield (2008)[24], with a total population of 46 individuals, the loss equates to 2.67% of the population. This is considered to overestimate the likely cumulative risks. The relatively high collision rate predicted at the Camster Wind Farm will be reduced considerably when forestry is mulched, mitigation and habitat management measures are implemented, and a habitat enhancement area will encourage hen harriers to selectively forage away from the wind farm. Evidence suggests the same will be the case for Strathy North and it is also considered that the predicted collision risk for Strathy South gives a highly precautionary figure. These all add further credence to the conclusion that the cumulative/in combination impact of these wind farms will not be significant or have an adverse impact on the integrity of the SPA.

The collision risks to merlin at Strathy North are negligible and so the additional risk calculated at Achairn Wind Farm (and Strathy South Wind Farm) will not contribute to an adverse effect on the SPA (0.001% of the SPA population).

These levels of mortality for both species would not therefore have an adverse impact on the site integrity of the SPA.

Currently, there is no predicted collision figure available from Strathy Wood for either hen harrier or merlin. This will depend on the final submitted layout, together with any mitigation proposed as part of the development. It is therefore not possible to confirm whether or not Strathy Wood will add to the cumulative collision risk. Given the level of merlin activity, additional collision risk would not be anticipated, whilst for hen harrier, additional collision risk would seem likely.

3.4 Golden Eagle

The predicted annual number of collisions was summed for these projects using data primarily from the SNH spreadsheet, derived from a 99% avoidance rate. Sites refused planning (e.g. Dunbeath and Dalnessie) were excluded. On the basis of the available information, one golden eagle is predicted to collide with turbines every 6.25 years across Caithness and Sutherland. For birds connected to the Caithness and Sutherland Peatland SPA the cumulative predicted mortality was one bird every 17.5 years (Table A11.4.3). No data are currently available for certain sites but information available on these wind farms suggests that golden eagle is not an issue. Boulfruich Wind Farm is operational, and the impact on ornithology was considered to be

'negligible'[53]. South Shebster Wind Farm was refused, partly on ornithological grounds, but this was due to impacts on greylag goose[54].

Given the increasing number of occupied territories and the currently favourable conservation status of golden eagles within the SPA[55], it is considered that the loss of one bird every 17 years will not be significant within the context of the SPA population.

TABLE A11.4.2 – CUMULATIVE PREDICTED ANNUAL TURBINE COLLISIONS FOR GOLDEN EAGLE IN CAITHNESS AND SUTHERLAND, ASSUMING A 99% AVOIDANCE RATE [56]

Site	Planning Status	Connection with SPA population	Predicted annual collisions	Comments
Achany	In construction	No	0	Assumed by SNH
Rosehall	Consented	Possible	0	
Melness	Approved	Possible	0	
Gordonbush	Consented	No	0.066	
Kilbraur	Operational	Possible	0	Assumed by SNH
Flex Hill	Operational	No	0	
Baillie Hill	Consented	No	0	
Achairn	Operational	Possible	0	
Boulfruich	Operational	Possible	No data	
Causeymire	Operational	Possible	0	Assumed
Lower Camster	Consented	Possible	0	Assumed
Stroupster	Public inquiry	Possible	0	*"few flights"* (SNH)
Lairg Estate	Approved	No	0.025	*"likely close to zero"* (SNH)
South Shebster	Appeal	No	No data	
Strathy North	Application	Yes	0.039	
Strathy South	**Application**	**Yes**	**0.014**	
Burn of Whilk	Application	?	0.012	
Bettyhill [57]	Approved	Yes	0.004	
TOTAL: ALL SITES WITH DATA			**0.160**	Equivalent to the loss of one bird every 6.25 years
TOTAL: SITES WHERE POPULATION CONNECTED OR POSSIBLY CONNECTED TO SPA POPULATION			**0.057**	Equivalent to the loss of one bird every 17.5 years

Shaded rows represent sites where SNH consider that golden eagles are connected, or possibly connected, to the Caithness and Sutherland SPA population. Source: SNH

Currently, there is no predicted collision figure available for golden eagle from Strathy Wood. This will depend on the final submitted layout, together with any mitigation proposed as part of the development. It is therefore not possible to confirm whether or not Strathy Wood will add to the cumulative collision risk, although given the level of golden eagle flights, some additional collision risk would seem likely.

3.5 Greenshank

For waders, the risk from collision has tended to be comparably lower than for other SPA qualifying species. Waders do, however, tend to breed at higher densities than these other birds. As a result of these different characteristics, displacement of breeding territories, rather than collision risk, has tended to be considered as the more important potential cumulative issue.

Based on the data available, there are at least 8 nesting pairs across Caithness and Sutherland that could be potentially disturbed/displaced by wind turbines (Table A11.4.3). Of these, 6 pairs are at sites where breeding greenshanks are considered by SNH to be connected or possibly connected to the SPA population (Table A11.4.3). This equates to 0.9% of the population of the Caithness and Sutherland Peatlands SPA (latest SNH estimate is 653 pairs).

53 http://www.boulfruich.com/
54 http://www.highland.gov.uk/NR/rdonlyres/08DB97EB-C970-4890-9135-488D1BFCE8A7/0/Item5.pdf
55 Eaton, M.A., Dillon, I.A., Stirling-Aird, P.K., Whitfield, D. P. (2007). Status of Golden Eagle *Aquila chrysaetos* in Britain in 2003. Bird Study, 54(2), 212-220
56 Source: Scottish Natural Heritage.
57 Estimate assuming 95% avoidance at Bettyhill site, adjusted to 98%

This level of displacement effect is not considered significant within the context of the SPA population, the reason being it is considered realistic to conclude that displaced greenshank will not be lost to the SPA population, but will relocate and occupy the many unoccupied territories available each breeding season.

TABLE A11.4.3.3 – CUMULATIVE GREENSHANK PAIRS POTENTIALLY DISTURBED/DISPLACED BY WIND TURBINES IN CAITHNESS AND SUTHERLAND[58]

Site	Planning Status	Connection with SPA population	Pairs considered by SNH to be subject to possible displacement/disturbance due to:	
			Construction	Operation
Achany	In construction	yes	1	1
Rosehall	Consented	possible	1	1
Melness	Approved	unlikely	0	0
Gordonbush	Consented	no	1	1
Kilbraur	Operational	no	0	0
Dunbeath	Application	possible	0	0
Flex Hill	Operational	no	no data	no data
Baillie Hill	Consented	no	0	0
Achairn	Operational	possible	no data	no data
Buolfruich	Operational	possible	no data	no data
Causeymire	Operational	possible	no data	no data
Lower Camster	Consented	yes	0	0
Stroupster	Public inquiry	possible	0	0
Lairg Estate	Approved	no	0	0
South Shebster	Appeal	No	no data	no data
Strathy North*	Application	Yes	1	1
Strathy South*	**Application**	**Yes**	**1**	**3 (mean)**
Burn of Whilk	Application	possible	0	0
Bettyhill	Approved	unlikely	1	1
TOTAL			**Approximately 5 pairs**	**Approximately 8 pairs**
TOTAL: SITES WHERE POPULATION CONNECTED OR POSSIBLY CONNECTED TO SPA POPULATION			**Approximately 4 pairs**	**Approximately 6 pairs**

** The data for Strathy South and Strathy South have been updated from that supplied by SNH to reflect the surveys reported here*

Shaded rows represent sites where SNH consider that greenshanks are connected or possibly connected to the Caithness & Sutherland SPA population. Source: SNH, 2007

The cumulative collision risk to greenshank is considered to be negligible, based on the data from Strathy North and South, and the details provided by SNH.

Currently, there is no predicted collision or displacement figure available for greenshank from Strathy Wood. This will depend on the final submitted layout, together with any mitigation proposed as part of the development. It is therefore not possible to confirm whether or not Strathy Wood will add to the cumulative collision risk, although given the level of greenshank activity, only limited additional collision or displacement risk would seem likely.

3.6 Golden Plover

Based on the data available, there are 65-67 pairs across Caithness and Sutherland generally that would be nesting within 200 m of a turbine or proposed turbine site and which may be disturbed/displaced (Table A11.4.4). This figure represents 3.3% of the population of the NHZ (latest SNH estimate is 2,048 pairs). However, only a maximum of 5 of these pairs are judged by SNH to be connected or possibly connected to the SPA population (Table A11.4.4). Thus, wind farm projects have the potential to disturb/displace a maximum of 0.2% of the SPA population. This level of effect is not considered to be significant within the context of the SPA population.

58 Source: Scottish Natural Heritage data, 2007.

TABLE A11.4.4 – CUMULATIVE GOLDEN PLOVER PAIRS, POTENTIALLY DISTURBED/DISPLACED BY WIND TURBINES IN CAITHNESS AND SUTHERLAND[59]				
Site	**Planning Status**	**Connection with SPA population**	**Pairs considered by SNH to be subject to possible displacement/disturbance (within 200m) due to:**	
			Construction	**Operation**
Achany	In construction	Yes	5, of which 1 pair is on SPA	5, of which 1 pair is on SPA
Rosehall	Consented	possible	2, but neither likely to be SPA connected	0
Melness	Approved	unlikely	2-4 pr (within 500m)	2 pairs inferred within 200m
Gordonbush	Consented	unlikely	28	17
Kilbraur	Operational	No	1	1
Dunbeath	Application	No	10	6
Flex Hill	Operational	No	No data	No data
Baillie Hill	Consented	No	0	0
Achairn	Operational	possible	0	0
Buolfruich	Operational	possible	0	0
Causeymire	Operational	unlikely	3	3
Lower Camster	Consented	unlikely	2	2
Stroupster	Public inquiry	possible	2	1
Lairg Estate	Approved	No	8	5
South Shebster	Appeal	No	0	0
Strathy North	Application	Yes	0	0
Strathy South	**Application**	**Yes**	**0**	**1 (mean)**
Burn of Whilk	Application	possible	1	0
Bettyhill	Approved	possible	1	0
TOTAL			**65-67 pairs**	**43 pairs**
TOTAL: SITES WHERE POPULATION CONNECTED OR POSSIBLY CONNECTED TO SPA POPULATION			**5 pairs**	**3 pairs**

Shaded rows represent sites where SNH consider that golden plovers are connected or possibly connected to the Caithness and Sutherland SPA population. Source: SNH, 2007.

For golden plover, there is no predicted collision risk from Strathy South. By definition therefore, it cannot have a cumulative collision impact, and this impact is therefore not considered further.

Currently, there is no predicted collision or displacement figure available for greenshank from Strathy Wood. This will depend on the final submitted layout, together with any mitigation proposed as part of the development. It is therefore not possible to confirm whether or not Strathy Wood will add to the cumulative collision risk, although given the level of golden plover activity, only limited additional collision or displacement risk would seem likely.

3.7 Other Species

The predicted collision risk and/or displacement are not anticipated to have any significant cumulative/in combination impact for any other species recorded at Strathy South. Wildfowl collision risk was either near zero or zero for whooper swan and greylag geese over-winter. The predicted breeding season rate for greylag was 0,08 birds per breeding season (based on a 99.8% avoidance rate). Predicted effects on peregrine, dunlin, wood sandpiper, wigeon and common scoter at Strathy South are negligible, and from the information provided by SNH, there are no other developments that have predicted effects on these species.

[59] Source: Scottish Natural Heritage, 2007.

4 UPDATED ORNITHOLOGICAL IMPACT ASSESSMENT

This section updates the impact assessment part of Chapter 11 of the 2007 ES in light of the additional information gathered since its submission, for Technical Appendices A11.1 to A11.3 and above, and the Modified 2013 Scheme.

4.1 Assessment of Significance

Assessment of the significance of impacts on ornithological interests was broadly based on the staged process outlined in the 2005 version of the IEEM guidelines for ecological impact assessments. In the most recent 2006 version of these guidelines, a more flexible system is advocated that allows for a greater degree of professional judgement by the ecologist when assessing the significance of effects. In this assessment, the 2005 IEEM method was followed as outlined below, except where this formal approach led to an assessment result that seemed inappropriate in the professional judgement of RPS.

The stages in the 2005 IEEM process are as follows:

1. determine the nature conservation value of the ornithological interests present within the study area;
2. identify the potential impacts based on the nature of the proposed development;
3. determine the scale and magnitude of those effects;
4. determine the significance of those effects based on the magnitude and duration of the effects on the nature conservation value of the bird populations affected;
5. identify and assess mitigation measures required to address significant adverse effects; and
6. determine the significance of any residual effect once the benefits of the prescribed mitigation measures have been assessed.

Evaluation of all SPA qualifying species, defined as the 'Valued Ornithological Receptors' (VORs) has been guided by the 2006 revision of the IEEM Guidelines. As interests of an internationally-important designated site, all VORs in this case are considered to be of **International nature conservation value**.

The potential effects are determined through understanding how each VOR is affected by a development. The elements used to define the scale of the effect of a development include determining:

- the potential duration, whether short-term (< 5 years), medium-term (5 - 15 years) or long-term (15 - 25 years or longer);
- the scale/magnitude of the effect (Table A11.4.3); and
- whether there are any cumulative impacts that may affect the long-term integrity of the ecosystem(s) at the site.

TABLE A11.4.3 – DEFINING THE MAGNITUDE OF EFFECT ON VALUED ORNITHOLOGICAL RECEPTORS

Magnitude	Description
Total/near-total	Would cause the loss of a major proportion or whole feature/population, or cause sufficient damage to a feature to immediately affect its viability. Irreversible.
High	Major effects on the feature/population, which would have a sufficient effect to irreversibly alter the nature of the feature in the short-to-long term and affect its long-term viability, for example more than 20% habitat loss or damage.
Medium	Effects that are detectable in short and long-term, but which should not alter the long-term viability of the feature/ population, for example between 10 - 20% habitat loss or damage.
Low	Minor effects, either of sufficiently small-scale or of short duration to cause no long-term harm to the feature/population, for example less than 10% habitat loss or damage.
Neutral	A potential impact that is not expected to affect the feature/population in any way; therefore no effects are predicted.

It has also been established whether the identified effects are:

- direct, indirect, and/or cumulative;
- positive or negative;
- short, medium or long-term; and
- permanent or temporary.

The significance of a potential effect on each VOR was determined by considering the magnitude and duration of the effect (Table A11.4.3) in relation to the conservation importance of the VOR. Significance is described as Major, Moderate, Minor or Negligible, or within a range e.g. Major – Moderate as given in Table A11.4.4.

Effects or residual effects are considered to be significant under the relevant Environmental Impact Assessment Regulations if they are at a level of Moderate or Major as described in Table A11.4.4. Effects of minor, slight or negligible are not considered to be significant in the sense used in the EIA Regulations.

TABLE A11.4.4 – SIGNIFICANCE OF THE EFFECTS AS DEFINED BY THE RELATIONSHIP BETWEEN THE NATURE CONSERVATION VALUE AND EFFECT MAGNITUDE

Effect Magnitude	Nature Conservation Value				
	International	National	Regional	Local	Negligible
Total/near total	Major	Major	Major	Moderate	Slight
High	Major	Major	Major - Moderate	Moderate	Slight
Medium	Major	Major –Moderate	Moderate	Moderate - Minor	Minor
Low	Moderate - Minor	Moderate - Minor	Moderate -Minor	Minor	Minor
Neutral	No/ Negligible Effect				

For each species considered in Section 2.5, a level of significance (pre-mitigation will be applied, based on the magnitude of effects on the SPA or regional (Caithness and Sutherland Natural Heritage Zone) populations.

Following the application of mitigation measures, the magnitude of change needs to be re-established and the significance values reassessed. The significance criteria listed in Table A11.4.3 have been used to predict the residual significance of each potential effect following mitigation measures.

4.2 Assessment Conclusions

Based on the information presented earlier and in Technical Appendices A11.1 - A11.3, and the methodology described above, all predicted impacts resulting from the construction, operation and decommissioning of the proposed Strathy South Wind Farm are considered to be no greater than Minor, in relation to habitat loss, disturbance-displacement, barrier effects, and collision risks. Therefore, no impacts are considered as being significant under the terms of the EIA Regulations (2000), and the levels of significance do not conflict with the conclusions in the Appropriate Assessment section (i.e. no adverse impacts on the integrity of the SPA). The rationale behind these decisions is summarised in Table A11.4.5.

5 MITIGATION

Whilst there is no formal requirement to mitigate any of the potential effects of the development on any VORs, given they are all minor or less, there is however, a need to follow best practice during the construction of the wind farm and to ensure compliance with the legislation concerning disturbance to breeding birds.

Red-throated Diver Mitigation

In order to reduce collision risk to breeding red-throated divers, the potential diversion of breeding attempts from the non-SPA lochan within Strathy South will be considered in consultation with SNH. The purpose of this (the lochan was used once for breeding out of the five years it was monitored), is to reduce the 'at risk' flight activity and thereby enable the predicted collision risk to this species to reduced from a mean of 0.19 birds a year to an estimated 0.14 birds a year (a reduction in risk of over 26%).

To supplement this measure, it is also proposed to provide diver rafts within the SPA, to help increase breeding success. The number and location of rafts would be dependent on advice from SNH, and subject to their agreement, and would be for the life-time of the wind farm, if this was considered necessary.

Best Practice Regarding Breeding Birds

Under the Wildlife and Countryside Act 1981 as amended by the Nature Conservation (Scotland) Act 2004, it is an offence with only limited exceptions, to:

- intentionally or recklessly take, interfere with, damage or destroy the nest of any wild bird whilst it is in use or being built;
- intentionally or recklessly take, interfere with or destroy the egg of any wild bird; and
- intentionally or recklessly disturb any wild bird listed on Schedule 1 while it is nest building, or at (or near) a nest containing eggs or young, or disturb the dependent young of such a bird.

Best practice will be necessary to reduce the possibility of illegal, damage, destruction or disturbance to occupied bird nests during the construction phase. Three best practice measures will be adopted: timing, pre-construction surveys and the use of an Ecological Clerk of Works (ECoW).

Timing of Construction Activities

If feasible, site clearance and construction activities will be timed to take place outside of the main breeding bird season from mid-March to August inclusive (and ideally from February onwards for crossbills), so as to avoid nest destruction and disturbance to breeding. If work during the breeding season is unavoidable, a range of detailed measures have been identified to ensure there is no disturbance to breeding birds, and these will be implemented through a Breeding Bird Protection Plan.

Pre-construction Surveys

Surveys will be undertaken by experienced ornithologists to locate nesting birds in the vicinity of construction works to ensure nesting birds are not disturbed. If species are found nesting, the work will either be re-scheduled or the nest site cordoned-off and disturbance prevented. These will comprise a detailed Breeding Bird Protection Plan that will specify the range of measures (such as screening, access control, buffer distance enforcement, vehicle speed etc.) to ensure disturbance is avoided in compliance with the law.

Ornithological Clerk of Works

SSE will appoint a suitably experienced ornithologist to work along side the ECoW to locate any active nests close to construction works shortly before these commence. Any active nests found will be cordoned off to a suitable distance for the species concerned (as highlighted) and the bird protection plans referred to above will be fully implemented. There will be a clear line of responsibility for ensuring these measures are adhered to.

Habitat Mitigation

As set out in Technical Appendix A11.2, the Modified 2013 Scheme includes an Outline Habitat Management Plan (see Technical Appendix A11.2, Appendix 4). Further details will be agreed in consultation with SNH, RSPB Scotland and any other relevant parties. The aims of this enhancement for birds will be to combine appropriate measures to encourage peatland restoration (to off-set the project's habitat impacts) and manage to risk of key bird species breeding at locations that would put them at risk of collision with turbines. .

6 RESIDUAL EFFECTS

Although no significant impacts were predicted even without mitigation and best practice measures, residual effects are summarised in Table A11.4.5. The effective implementation of these measures will ensure compliance with the law and maintain or reduce any impact to a level that is not significant.

TABLE A11.4.5 – SUMMARY OF IMPACT EFFECTS					
Potential Impacts	**Magnitude**	**Pre-mitigation Significance**	**Rationale**	**Mitigation Required**	**Residual Effects**
Red-throated diver					
Loss of habitat	Neutral	No effect	No SPA land take and no loss of breeding lochans or feeding waterbodies	None	Not significant
Disturbance/displacement from breeding sites	Low	Minor	Nearest breeding location will be outside of likely disturbance zone.	None	Not significant
Disturbance/displacement from feeding sites	Neutral	No effect	Feeding will be unaffected as foraging takes place in coastal waters (Strathy Bay and Bettyhill)	None	Not significant
Barrier effects	Low	Minor	Embedded mitigation leaving corridor free of turbines in north-west of the site. Breeding sites are on seaward and westward side of wind farm.	None	Not significant
Collision risk	Low	Minor	Loss of approximately one bird every five to six years from the SPA population, although even this is likely to be over-estimate.	Possible diversion of breeding attempts, and provision of diver rafts	Not significant
Black-throated diver					
Loss of habitat	Neutral	No effect	No SPA land take and no loss of suitably-sized lochs	None	Not significant
Disturbance/displacement from breeding sites	Low	Minor	Nearest breeding loch is beyond likely disturbance distance so any pair will not be affected.	None	Not significant
Disturbance/displacement from feeding sites	Low	Minor	Only regular feeding loch within 1km is at very edge of maximum disturbance distance so any pair will not be affected.	None	Not significant
Barrier effects	Neutral	Negligible	Only minimal 'at-risk' flights recorded over wind farm during all flight activity surveys	None	Not significant
Collision risk	Low	Minor	Loss of approximately one bird every 20 years from the SPA population each year, although even this is likely to be over-estimate.	None	Not significant
Golden Eagle					
Loss of habitat	Neutral	No effect	No suitable nesting or foraging habitat within wind farm area	None	Not significant
Disturbance/displacement from breeding sites	Neutral	No effect	Nearest nest site is well beyond disturbance distances	None	Not significant
Disturbance/displacement from foraging sites	Neutral	Negligible	Application site is an unimportant area for foraging due to forestry cover. In the absence of the forest, PAT modelling shows use of this part of the home range has a relatively low use for foraging.	None	Not significant
Barrier effects	Low	Minor	Flight activity over wind farm is low, and flight routes are used between the existing forest blocks.	None	Not significant

TABLE A11.4.5 – SUMMARY OF IMPACT EFFECTS					
Potential Impacts	**Magnitude**	**Pre-mitigation Significance**	**Rationale**	**Mitigation Required**	**Residual Effects**
Collision risk	Neutral	Negligible	One collision predicted every 71 years	None	Not significant
Hen Harrier					
Loss of habitat	Low	Minor	Minor loss of foraging habitat	None	Not significant
Disturbance/displacement from breeding sites	Low	Minor	Nesting distances within tolerances shown at other operational sites (in all but one 2003 location, not used since).	None	Not significant
Disturbance/displacement from foraging sites	Low	Minor	Minor foraging habitat lost, but only likely to be <100m of turbines.	None	Not significant
Barrier effects	Neutral	Negligible	Site is not important migratory route, and majority of flights will be below rotor height	None	Not significant
Collision risk	Low	Minor	At worst, one collision every nine years will not affect SPA population. Actual collision rates predicted to be considerably lower when forestry removed.	None	Not significant
Greenshank					
Loss of habitat	Low	Minor	Pools and lochans will remain intact. Loss of very small areas of boggy ground within forestry, depending partly on micro-siting.	None	Not significant
Disturbance/displacement from breeding sites (mating, nesting and chick-rearing)	Low	Minor	Loss of up to five to six nesting or nesting/chick rearing territories from within forestry and surrounding moorland predicted, applying highly precautionary 500 m buffer. This would not be significant in terms of SPA population, as adjacent moorland could absorb this number of displaced pairs.	None	Not significant
Disturbance/displacement from foraging sites	Low	Minor	Included in the above.	None	Not significant
Collision risk	Low	Minor	Negligible collision risk, even taking account of distance detection effects.	None	Not significant
Golden Plover					
Loss of habitat	Neutral	No effect	Habitat loss would be relatively very small. Loss of 32km of forest edge adjacent to SPA would off-set this.	None	Not significant
Disturbance/displacement from breeding sites	Low	Minor [access track]	Mean of one pair may be displaced to other moorland areas away from site.	None	Not significant
Disturbance/displacement from foraging sites	Neutral	Negligible	Covered by above.	None	Not significant
Collision risk	Neutral	Negligible	Negligible collision risk, even taking account of distance detection effects.	None	Not significant
Dunlin					
Loss of habitat	Neutral	No effect	Habitat loss would be relatively very small. Loss of 32km of forest edge adjacent to SPA would off-set	None	Not significant

TABLE A11.4.5 – SUMMARY OF IMPACT EFFECTS					
Potential Impacts	**Magnitude**	**Pre-mitigation Significance**	**Rationale**	**Mitigation Required**	**Residual Effects**
			this.		
Disturbance/displacement from breeding sites	Neutral	Negligible	Up to one pair displaced to other moorland areas away from site.	None	Not significant
Disturbance/displacement from foraging sites	Neutral	Negligible	Covered by above.	None	Not significant
Collision risk	Neutral	Negligible	No at-risk flights recorded. Small low flying species unlikely to be affected by collisions	None	Not significant
Merlin					
Loss of habitat	Neutral	No effect	Limited nesting or foraging use of the site.	None	Not significant
Disturbance/displacement from breeding sites	Low	Minor [access track]	Limited nesting or foraging use of the site.	None	Not significant
Disturbance/displacement from foraging sites	Low	Minor [access track]	Limited nesting or foraging use of the site.	None	Not significant
Barrier effects	Neutral	Negligible	Limited nesting or foraging use of the site.	None	Not significant
Collision risk	Neutral	Negligible	Very low level of flight activity over application site, resulting in negligible collision risk.	None	Not significant
Short-eared owl					
Loss of habitat	Neutral	No effect	No nesting and negligible foraging use of the site.	None	Not significant
Disturbance/displacement from breeding sites	Neutral	No effect	No nesting and negligible foraging use of the site.	None	Not significant
Disturbance/displacement from foraging sites	Neutral	Negligible	No nesting and negligible foraging use of the site.	None	Not significant
Barrier effects	Neutral	Negligible	No nesting and negligible foraging use of the site.	None	Not significant
Collision risk	Neutral	Negligible	Very low level of flight activity over application site, resulting in negligible collision risk.	None	Not significant
Peregrine					
Loss of habitat	Neutral	No effect	No nesting and negligible foraging use of the site.	None	Not significant
Disturbance/displacement from breeding sites	Neutral	No effect	No nesting and negligible foraging use of the site.	None	Not significant
Disturbance/displacement from foraging sites	Neutral	Negligible	No nesting and negligible foraging use of the site.	None	Not significant
Barrier effects	Neutral	Negligible	No nesting and negligible foraging use of the site.	None	Not significant
Collision risk	Neutral	Negligible	Very low level of flight activity over application site, resulting in negligible collision risk.	None	Not significant

6.1 Statements of Significance

Information to Inform the Appropriate Assessment

An assessment has been made of the likely effects of the proposed Strathy South Wind Farm during the construction, operation and decommissioning stages. Following detailed considerations of the implications of the wind farm for the Conservation Objectives of the Caithness and Sutherland Peatlands SPA, alone and in combination with other plans and projects, it is concluded beyond reasonable scientific doubt that there will be no adverse impact on the integrity of this Natura 2000 site. The information to inform the Appropriate Assessment is provided in Tables A11.4.6 to A11.4.14, including before and after mitigation.

These tables consider the effect of the Strathy South 2013 Modified Scheme alone. However, the only potential in combination effect from other plans and projects that could potentially cause additive impacts are barrier effects, displacement or collision risk, and even then, these would only be for particular qualifying species. Whilst a wide range of sites has been considered for the cumulative/in combination assessment, the key wind farms were Strathy North and Strathy Wood given their proximity and potential for over-lapping impacts, including on the same individual birds in some cases. Whilst full details were available for Strathy North, the fact that Strathy Wood is at Scoping stage means there is, as yet, no finalised layout or quantified data on possible displacement or collision risk. It may or may not therefore contribute to cumulative/in combination impacts, depending on the layout, and this is has been reflected in the species accounts above.

Barrier effects could potentially effect birds, but there is now growing consistent evidence that the additional energy levels expended for birds to make relatively short deviations in flight path, flight height, or both, are not significant in biological terms, and therefore do not reduce breeding of foraging success to a degree that leads to effects on population viability. For golden eagles, their flight activity shows that birds use the corridor between Strathy North Forest and Strathy South Forest, and this would be expected to remain the case once the forests were removed and if both wind farms were operational (the spacing between the nearest turbines from the two sites being well over 2 km). For red and black-throated divers, the orientation of the main flight paths also indicates that if both wind farms were operational, barrier effects would not necessitate major flight deviations from the main breeding to feeding areas.

The overall effect of displacement on golden plover or greenshank is not considered to prejudice any of the conservation objectives of the SPA. This is for two reasons, firstly that there is clearly capacity within the SPA to absorb the displaced breeding pairs (given the high variation in breeding densities, and the patterns of territory distribution recorded over 2003 to 2012). Secondly, as a number of the wind farm developments involve removal of forests adjacent or within the SPA (and also taking account of the forest-to-bog restoration by other organisations including RSPB, Plantlife and the FCS), there is additional effective habitat within the SPA as well.

The only ‘in combination’ effect that is considered to have the potential for additive impacts is from collision risk. Having examined the predicted collision data available, and also provided by SNH, the in combination effect of predicted collisions is, for all species, below that which would significantly add to background natural mortality levels.

Ornithological Impact Assessment

It is concluded that, with the mitigation measures and best practice to avoid disturbance to breeding birds, there will be no major or moderate impacts on any SPA qualifying species, and therefore there will be no significant impacts (based on EIA regulations). The possible displacement of any breeding birds is considered to be not significant with respect to SPA populations, and will be further reduced when best practice measures and habitat mitigation are considered. Calculated collision risks to each species are not considered significant within the context of SPA populations. Therefore with at worst minor effects, the integrity of the SPA will not be adversely affected (as per Appropriate Assessment conclusions).

It is therefore considered that the impacts on red-throated diver, black-throated diver, hen harrier, golden eagle, greenshank, golden plover, dunlin, merlin, short-eared owl, wigeon, wood sandpiper and common scoter will be not significant in the context of the SPA.

TABLE A11.6: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: RED-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	No deterioration of diver habitat within the SPA.	None	None	None	High
	Operation	No deterioration of diver habitat within the SPA	None	None	None	High
	Decommission	No deterioration of diver habitat within the SPA	None	None	None	High
2. To avoid significant disturbance to the qualifying species	Construction	There is a risk of disturbance [redacted] from access track widening, forest and construction traffic in and out of Strathy South. There is also the potential risk of disturbance [redacted] although both are >1 km from the Loch. This loch complex is consistently used by red-throated diver breeding within 1km of Strathy South. It is important therefore to ensure disturbance is prevented. Other locations where there is a slight disturbance risk to [redacted] (a) breeding has not been confirmed at this site, and (b) there is screening from the [redacted]). Loch [redacted] has also been used by the divers but no breeding has been recorded at this location.	Risk of disturbance at one consistently used breeding location, plus some risk at less-frequently used lochans.	The construction of the bridge across Strathy River, from Strathy North, and the link track from the bridge to the Strathy Wood track, would be needed early on during construction, to enable forestry machinery onto Strathy South. Widening of the existing Strathy Wood track from there to Strathy South would not be required until larger plant needed site access. Therefore, for the majority of the construction period, until such point as the track needs to be widened for larger construction vehicles, the predicted traffic along the Strathy Wood track [redacted] would be relatively limited, limited to initial one-off mobilisation of forestry machinery, caravans, fuel storage plant etc. to enable tree removal. After this, plant will remain on site until all the work is completed, returning eventually (after 18 months/two years) [redacted]. In between, traffic would comprise daily movement (primarily in the morning and early evening) of 4x4 vehicles and vans travelling on and off-site. After the initial forestry works to open up the footprint for wind farm infrastructure, site investigation plant would need access, but again the volume of traffic will be relatively limited, and comprise mainly 4x4 trucks plus drilling rig/s. The landform [redacted] means that [redacted] are likely to be screened [redacted]. The risk of visual disturbance therefore only arises from [redacted]. In addition to this mitigation, a Breeding Bird	None	High

TABLE A11.6: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: RED-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
				Protection Plan will impose strict traffic control measures throughout the divers' breeding season (i.e. no stopping, no engine revving or blasting of horns, no flashing lights, no personnel to get out of vehicles) over this 1 km stretch. There will also be a strict site induction requirement for all staff coming on to site, to communicate the need to adhere to the above traffic control measures during the breeding season. This will be reinforced by road-side signage over this period. These traffic control measures will remain in place throughout all April to August months (inclusive) for the construction period. [redacted] construction [redacted] would only be done outside the diver breeding season, unless intensive monitoring confirms the lochs are not being used at all over the breeding period. [redacted] this mitigation would ensure disturbance is avoided. As part of the above measures, the ECoW [redacted] ensure there is no disturbance to divers during construction [redacted] This combination of mitigation measures through the relevant phases of construction will ensure there is no		

TABLE A11.6: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: RED-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
				disturbance [redacted]). To help prevent disturbance to any divers [redacted] buffer would be retained [redacted]) for the duration of construction, adjacent to the track. [redacted]		
	Operation	A low risk that maintenance traffic causes disturbance to the breeding divers at the above locations.	Low risk of disturbance and breeding failure at any location.	A strict site induction requirement for all staff coming on to site, [redacted] will be scheduled outside the April to August breeding season. SNH would be notified if any emergency works were required [redacted]	None	High
	Decommission	As for construction, except the extent of disturbance would be reduced, as there would be no widening of tracks required.	Intermediate risk of disturbance and breeding failure.	As for construction.	None	High
3. Population of the species as a viable component of the site is maintained in the long term	Construction	None, as the risk of disturbance and nest failure will be prevented through the disturbance-prevention measures for the Conservation Objective above. Consequently, there will be no risk to the viability of the SPA population from construction.	None	None	None	High
	Operation	Collision risk modelling, based on a precautionary 98% avoidance rate, and incorporating a 200 m buffer around the risk area, gives a predicted average collision rate of approximately one bird every five years (0.19 collisions a year). This mean is derived from annual rates of predicted collision from 0.00 to 0.58 collisions a year (2003 = 0.00, 2004 = 0.00, 2007 = 0.35, 2010 = 0.00 and 2012 0.58 collisions per	The addition of an average of 1 diver collision every five years is not judged significant addition to	In recognition of the need to minimise collision risk where possible, a dual approach to mitigation is proposed. The first is to reduce the level of risk itself, [redacted] This would be achieved [redacted] in consultation with SNH.	None	Moderate to High

TABLE A11.6: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: RED-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
		year). The highest predicted collision rate was in 2012, when the divers bred [redacted] leading to a flight pattern that generated a higher collision risk. The SNH assessed condition of this qualifying feature is favourable maintained (2006).	existing levels of background mortality, and would not threaten the viability of the SPA population being maintained in the long term.	By diverting the occasional use of this [redacted] lochan for breeding (recorded one year out of five), the chance of 'at risk' flight activity is reduced and the collision risk would also be reduced. The accompanying positive mitigation measure that would be used, if required by SNH, and in consultation with them, is the sustained provision of diver rafts aimed at increasing breeding success and productivity of red (and black) throated divers. A variety of locations are being considered for these rafts, at sufficient distance from the wind farm to avoid any additional risk. If considered necessary for mitigation, it is proposed to provide funding and staff resources to construct, deploy, maintain and monitor between diver rafts, depending on site availability and SNH requirements. By avoiding breeding at [redacted] and assuming the diverted birds bred locally, leading to flight patterns in 2007 (the next highest predicted collision rate), the mean predicted collision rate would fall from 0.19 to 0.14, equivalent to going from 1 every 5.3 years to 1 every 7.1 years. This would mean a reduction from approximately 4.7 collisions over the lifetime of the wind farm, to approximately 3.5 birds. If the 98% avoidance rate for red-throated divers proves to be over-precautionary, as emerging evidence would seem to suggest, then the frequency of collisions would be lower. The extent to which the provision of diver rafts would generate additional birds (i.e. the difference in the number of young fledged, compared to the number of young fledged without the diver rafts) would be considered in liaison with SNH. The aim would be to enable sufficient additional fledged birds, so that, allowing for natural mortality of these offspring, there would be sufficient birds entering the adult breeding population to mitigate. This is considered to be a realistic and achievable outcome.		
	Decommission	None, as the risk of disturbance and nest failure will be prevented. Consequently, there will be no risk of any effect on the viability of the SPA population.	None	None	None	High

TABLE A11.6: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: RED-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
4. Distribution of the species within site is maintained in the long term	Construction	None, as the risk of disturbance would be avoided through the measures described above.	None	None	None	High
	Operation	The consistent presence of successfully breeding red-throated divers in close proximity (within 300m) to the Burgar Hill Wind Farm, in Orkney, indicates the distribution of breeding red-throated divers will be maintained in the long term.	None	Provision of diver rafts aims to increase breeding opportunities (and success).Therefore in the long-term, this would support the distribution of this species within (and beyond) the SPA.	None	Moderate
	Decommission	None, as the risk of disturbance would be avoided through the measures described above.	None	None	None	High
5. Distribution and extent of habitats supporting the species is maintained in the long term	Construction	No effects on the distribution and extent of diver habitat within the SPA.	None	None.	None	High
	Operation	No effects on the distribution and extent of diver habitat within the SPA.	None	Provision of diver rafts aims to increase breeding opportunities (and success). Therefore in the long-term, this would support the distribution and extent of habitats supporting this species within (and beyond) the SPA.	None	High
	Decommission	No effects on the distribution and extent of diver habitat within the SPA.	None	None	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	No effects on the structure, function and supporting processes of habitat supporting divers within the SPA.	None	None	None	High
	Operation	No effects on the structure, function and supporting processes of habitat supporting divers within the SPA.	None	None	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting divers within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Operation	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Decommission	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High

TABLE A11.7: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: BLACK-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	No deterioration of diver habitat within the SPA.	None	None	None	High
	Operation	No deterioration of diver habitat within the SPA	None	None	None	High
	Decommission	No deterioration of diver habitat within the SPA	None	None	None	High
2. To avoid significant disturbance to the qualifying species	Construction	Risk of disturbance to breeding black-throated divers on [redacted] There is also a risk to birds using [redacted]. They have been present most survey years, although possible breeding only was recorded once at this location. These lochs are over [redacted] km from the nearest turbine and therefore the risk of disturbance is negligible.	Risk of disturbance to one consistently used breeding location within 2 km, plus very slight risk at less-frequently used lochans.	To prevent disturbance to any breeding divers on [redacted] depending on the timing of any consent and the resulting construction programme, the presence of divers (and other breeding birds) using this loch complex will be monitored, and work timed to avoid risk of disturbance. During [redacted] watching brief will also be maintained (if this is in the breeding season) to ensure there is no disturbance to breeding birds on the loch. To further reduce the risk of disturbance, forest sub-compartment [redacted] un-felled buffer for the duration of construction, adjacent to [redacted] The forest buffers retained to help prevent disturbance to red-throats [redacted] would also serve to prevent disturbance to the [redacted] black-throated divers (and any other species). To prevent disturbance to any breeding divers on [redacted] as an additional precaution, there would be a watching brief to ensure there was no disturbance during construction [redacted].	None	High
	Operation	A low risk that maintenance traffic causes disturbance to the breeding divers at the above locations.	Low risk of disturbance and breeding failure at any location.	A strict site induction requirement for all staff coming on to site, which will include briefing on need to adhere to the above traffic control measures during the breeding season. Supplemented by road-side signage. Any non-emergency road maintenance of the [redacted] will be scheduled outside the April to August breeding season. SNH would be notified if any emergency works are required to the track or cables along this section, and a suitable protocol put in place immediately to minimise the risk of any disturbance.	None	High
	Decommission	As for construction, except the extent of disturbance	Intermediate	As for construction.	None	High

TABLE A11.7: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: BLACK-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
		would be reduced, as there would be no widening of tracks required.	risk of disturbance and breeding failure.			
3. Population of the species as a viable component of the site is maintained in the long term	Construction	None, as the risk of disturbance and nest failure will be prevented through the disturbance prevention measures for the Conservation Objective above. Consequently, there will be no risk to the viability of the SPA population from construction.	None	None	None	High
	Operation	Collision risk modelling, based on a precautionary 98% avoidance rate, and incorporating a 200 m buffer around the risk area, gives a predicted average collision rate of approximately one bird every 20 years (0.05 collisions a year). This mean is derived from annual rates of predicted collision from 0.00 to 0.12 collisions a year (2003 = 0.00, 2004 = 0.00, 2007 = 0.17, 2010 = 0.00 and 2012 0.10 collisions per year). The highest predicted collision rate was in 2007, when there were higher levels of flight activity to the west of the turbine array than in other survey years. The SNH assessed condition of this qualifying feature is unfavourable declining (2007).	The addition of an average of 1 diver collision over the lifetime of the wind farm is not a significant addition to existing levels of background mortality, and would not threaten the viability of the SPA population being maintained in the long term.	Whilst mitigation Is not required for this species, provision of diver rafts has been proven to increase breeding success and productivity of black-throated divers, and they would therefore benefit from the rafts provided as mitigation provided for red-throated divers.	None	High
	Decommission	None, as the risk of disturbance and nest failure will be prevented. Consequently, there will be no risk of any effect on the viability of the SPA population.	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	None, as the risk of disturbance would be avoided through the measures described above.	None	None	None	High
	Operation	Although there is no comparable examples where black-throated divers are successfully nesting in proximity to an operational wind farm, the consistent presence of successfully breeding red-throated divers in close proximity (within 300m) to the Burgar Hill Wind Farm, in Orkney, does suggest the distribution of breeding black-throated divers will be maintained in	None	Whilst specifically to mitigate effects on red-throated divers, provision of diver rafts would also increase breeding opportunities (and success) for this species. Therefore in the long-term, this would support the distribution of black-throated divers within (and beyond) the SPA.	None	Moderate

TABLE A11.7: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: BLACK-THROATED DIVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
		the long term. There are no known behavioural differences between the two species that would suggest black-throats cannot nest in equally close proximity to an operational site.				
	Decommission	None, as the risk of disturbance would be avoided through the measures described above.	None	None	None	High
5. Distribution and extent of habitats supporting the species is maintained in the long term	Construction	No effects on the distribution and extent of diver habitat within the SPA.	None	None.	None	High
	Operation	No effects on the distribution and extent of diver habitat within the SPA.	None	Whilst specifically to mitigate effects on red-throated divers, provision of diver rafts would also increase breeding opportunities (and success) for this species. Therefore in the long-term, this would support the distribution of black-throated divers within (and beyond) the SPA.	None	High
	Decommission	No effects on the distribution and extent of diver habitat within the SPA.	None	None	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	No effects on the structure, function and supporting processes of habitat supporting divers within the SPA.	None	None	None	High
	Operation	No effects on the structure, function and supporting processes of habitat supporting divers within the SPA.	None	None	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting divers within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Operation	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Decommission	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High

TABLE A11.8: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: HEN HARRIER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	No deterioration of habitat within the SPA.	None	None	None	High
	Operation	No deterioration of habitat within the SPA	None	None	None	High
	Decommission	No deterioration of habitat within the SPA	None	None	None	High
2. To avoid significant disturbance to the qualifying species	Construction	There is a risk of disturbance to breeding hen harriers occurs [redacted], where there have been up to three nest locations in close proximity to [redacted]. Although these nesting areas are all outside the SPA, given their proximity, there is clear connectivity and these are SPA-associated birds as a result. The risk of disturbance to these nests comes from construction [redacted].	Risk of disturbance to up to three breeding [redacted]. There is also a risk of disturbance to one nest site within [redacted], which is [redacted] Previous nest locations in and adjacent to Strathy South have not been used in recent years.	The presence of hen harriers (and other breeding birds) would be checked by pre-construction surveys, and depending on results, bridge building, track construction, and track widening, would be timed and managed to avoid any risk of disturbance, In addition, the Breeding Bird Protection Plan will impose strict [redacted] measures throughout the harrier breeding season [redacted]. There will also be a strict site induction requirement for all staff coming on to site, to communicate the need to adhere to the above traffic control measures during the breeding season. This will be reinforced by road-side signage over this period and monitored by the ECoW. The same combined approach would be taken within the site to prevent disturbance to any harriers nesting in [redacted] namely there would be a watching brief during the track widening/construction works to ensure there was no disturbance to breeding birds, and the same [redacted] measures would be applied. To help prevent disturbance to any breeding harriers in this [redacted], a watching brief would be maintained during construction [redacted] if this was during the breeding season. Based on evidence of hen harrier nesting during construction at other wind farms this is considered to be sufficient mitigation to prevent disturbance to breeding hen harriers (at the Cruach Mhor Wind Farm in Argyll, during construction it appears nesting took place in 2003 and 2004 within 300 m of turbine locations (Scottish Power Renewables, 2009, Robson 2012). At Paul's Hill Wind Farm in north-east Scotland nesting harrier numbers near the wind farm were higher during construction than post-construction, with one nest at 110 m from construction activities (Forrest *et al*. 2011). The closest	None	High

TABLE A11.8: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: HEN HARRIER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
				nest to a turbine during construction was 61 m (*ibid.*). The proximity of the nearest turbine at this location in Strathy South was approximately [redacted] nest location, [redacted]		
	Operation	A risk that maintenance traffic causes disturbance to the breeding harriers at the above locations.	Risk of disturbance and breeding failure at any location.	A strict site induction requirement for all staff coming on to site, which will include briefing on need to adhere to the above [redacted] measures during the breeding season. Supplemented by [redacted] signage. Any non-emergency road maintenance [redacted] within 500 m of [redacted] will be scheduled outside the April to July breeding season. SNH would be notified if any emergency works are required [redacted] and a suitable protocol put in place immediately to minimise the risk of any disturbance.	None	High
	Decommission	As for construction, except the extent of disturbance would be reduced, as there would be no widening or construction of tracks required.	Intermediate risk of disturbance and breeding failure.	As for construction.	None	High
3. Population of the species as a viable component of the site is maintained in the long term	Construction	None, as the risk of disturbance and nest failure will be prevented through the disturbance prevention measures for the Conservation Objective above. Consequently, there will be no risk to the viability of the SPA population.	None	None	None	High
	Operation	Collision risk modelling, based on 99% avoidance rate, and incorporating a 200 m buffer around the risk area, gives a predicted average collision rate of approximately one bird every nine years (0.11 collisions a year). This mean is derived from annual rates of predicted collision from 0.04 to 0.24 collisions a year (2003 = 0.24, 2004 = 0.06, 2007 = 0.07, 2010 = 0.04 and 2012 0.12 collisions per year). The SNH assessed condition of this qualifying feature is favourable maintained (2003).	The addition of an average of approximately 1 harrier collision every 9 years. This is not judged a significant addition to existing levels of background mortality, and would not threaten the viability of the SPA population being	None	None	High

TABLE A11.8: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: HEN HARRIER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
			maintained in the long term.			
	Decommission	None, as the risk of disturbance and nest failure will be prevented. Consequently, there will be no risk of any effect on the viability of the SPA population.	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	None, as the risk of disturbance would be avoided through the measures described above.	None	None	None	High
	Operation	From the breeding and flight activity surveys completed over 2003 to 2012 (and including work at Strathy North and Strathy Wood), it is evident that harriers are using [redacted] for nesting and foraging in preference [redacted]. This rather artificial situation is significant in terms of this conservation objective, because it is the presence of the forest plantation that is influencing the distribution of the harriers within the SPA. From the 2003 to 2012 survey results, and up-dated information from 2013, all but one of the nest locations recorded at Strathy South were at greater distances from turbines that birds have been recorded elsewhere, nesting in proximity to operational turbines. The exception was the 2003 nest location, which would be approximately [redacted] from the nearest turbine. In light of this evidence and the distances recorded elsewhere of nesting locations from turbines, in general no nest sites used since 2003 are considered likely to be displaced, and on this basis, it is concluded that overall, within the context of the SPA, displacement from one previous (2003) nesting location would not adversely effect the distribution of harriers within the site in the long term. The removal of the conifer plantation may act to ensure a more normalised pattern of distribution on SPA open habitats, however.	None	Removal of plantation forestry at Strathy South using mulching and harvesting (rather than felling trees *in situ*) is aimed at peatland restoration, with the facility to carry out targeted management of vegetation. The aim of this approach is to avoid creating preferential nesting conditions that would risk drawing in nesting harriers from the SPA (since there are none, at least within 2 km). As a result, there is not considered to be any risk of preventing the distribution of the species within the site being maintained in the long term.	None	High
	Decommission	None, as the risk of disturbance would be avoided through the measures described above.	None	None	None	High
5. Distribution and extent of habitats	Construction	No effects on the distribution and extent of harrier habitat within the SPA.	None	None.	None	High
	Operation	No effects on the distribution and extent of	None	None. Post-construction monitoring from numerous	None	High

TABLE A11.8: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: HEN HARRIER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
supporting the species is maintained in the long term		harrier habitat within the SPA.		operational sites has shown that harriers continue to actively use habitat within wind farms, so although outside the SPA, the habitat within Strathy South will still be available to this species.		
	Decommission	No effects on the distribution and extent of harrier habitat within the SPA.	None	None	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	No effects on the structure, function and supporting processes of habitat supporting harriers within the SPA.	None	None	None	High
	Operation	No effects on the structure, function and supporting processes of habitat supporting harriers within the SPA.	None	None	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting harriers within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Operation	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Decommission	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High

TABLE A11.9: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GOLDEN EAGLE						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	No deterioration of habitat within the SPA.	None	None	None	High
	Operation	No deterioration of habitat within the SPA. PAT modelling has also shown that the site is of relatively low suitability for foraging for these territories, even with the forest removed.	None	None.	None	High
	Decommission	No deterioration of habitat within the SPA	None	None	None	High
2. To avoid significant	Construction	The two territories are well over 2 km from the site and beyond the risk of disturbance.	None	None	None	High

TABLE A11.9: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GOLDEN EAGLE						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
disturbance to the qualifying species	Operation	The two territories are well over 2 km from the site and beyond the risk of disturbance.	None	None	None	High
	Decommission	The two territories are well over 2 km from the site and beyond the risk of disturbance.	None	None	None	High
3. Population of the species as a viable component of the site is maintained in the long term	Construction	None, as there is no risk of disturbance.	None	None	None	High
	Operation	Collision risk modelling, based on 99% avoidance rate, and incorporating a 200 m buffer around the risk area, gives a predicted average collision rate of approximately one bird every 71 years (0.014 collisions a year). This mean is derived from annual rates of predicted collision from 0.00 to 0.02 collisions a year (2003 = 0.02, 2004 = 0.01, 2007 = 0.02, 2010 < 0.00 and 2012 0.02 collisions per year). (Collision risk in the non-breeding season is negligible. The SNH assessed condition of this qualifying feature is favourable maintained (2003).	The addition of an average of approximately 1 golden eagle every 71 years is not considered a significant addition to background mortality, and would not threaten the viability of the SPA population being maintained in the long term.	None.	None	High
	Decommission	None, as there is no risk of disturbance.	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	There will not be any impact on the distribution of the species within the site in the long term.	None	None	None	High
	Operation	There will not be any impact on the distribution of the species within the site in the long term.	None	None.	None	High
	Decommission	There will not be any impact on the distribution of the species within the site in the long term.	None	None	None	High
5. Distribution and extent of habitats supporting the species is	Construction	No effects on the distribution and extent of habitat within the SPA.	None	None.	None	High
	Operation	No effects on the distribution and extent of habitat within the SPA. PAT modelling has also shown that the site is of relatively low suitability	None	None.	None	High

TABLE A11.9: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GOLDEN EAGLE						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
maintained in the long term		for foraging for these territories, with the forest removed.				
	Decommission	No effects on the distribution and extent of habitat within the SPA.	None	None.	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	No effects on the structure, function and supporting processes of habitat supporting golden eagles within the SPA.	None	None	None	High
	Operation	No effects on the structure, function and supporting processes of habitat supporting golden eagles within the SPA.	None	None	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting golden eagles within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Operation	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Decommission	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High

TABLE A11.10: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: MERLIN						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	The Modified 2013 Scheme would avoid deterioration of merlin habitat within the SPA.	None	None	None	High
	Operation	The Modified 2013 Scheme would avoid deterioration of merlin habitat within the SPA.	None	None	None	High
	Decommission	The Modified 2013 Scheme would avoid deterioration of merlin habitat within the SPA.	None	None	None	High
2. To avoid significant disturbance to the qualifying	Construction	One nesting area has been recorded but is over [redacted] km from the site, sufficiently distant for there to be no risk of disturbance. In 2003 and 2007, SPA-associated birds possibly bred on	There is a risk of disturbance if birds return to nest in	None. Pre-commencement breeding raptor surveys, together with pre-felling checks by ornithologists and the implementation of the Breeding Bird Protection Plan would ensure there is no disturbance to breeding	None	High

TABLE A11.10: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: MERLIN						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
species		the edge of the site but no breeding activity has been recorded in recent years.	Strathy South,	merlin.		
	Operation	Removal of the plantation will reduce the risk of disturbance during operation.	None	None. Breeding raptor monitoring that would be carried out in Year 1, 2, 3, 5, 10 and 15 will help determine whether or not any breeding is taking place on site or within a 2 km buffer. If breeding is confirmed, then an appropriate protocol would be put in place to avoid any disturbance, through the Breeding Bird Protection Plan.	None	High
	Decommission	There are not likely to be nesting merlin on site, and the nearest breeding current territory is over 1 km from the site, sufficiently distant for there to be no risk of disturbance.	None	Pre-decommissioning breeding raptor surveys by ornithologists and the implementation of the Breeeding Bird Protection Plan would ensure there is no disturbance to nesting merlin.	None	High
3. Population of the species as a viable component of the site is maintained in the long term	Construction	None, as there is no risk of disturbance, and therefore no risk of an impact on breeding success.	None	None	None	High
	Operation	There was negligible 'at risk' flight activity recorded across the site in any survey year. Even taking into account any risk of under-recording, it is clear that collision risk to breeding merlin from the proposed wind farm would be negligible, and would not have any effect on the population. The SNH assessed condition of this qualifying feature is favourable maintained (2004).	None	None	None	High
	Decommission	None, as there is no risk of disturbance.	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	Breeding sites within the SPA are beyond displacement distance from the wind farm so there will not be any impact on the distribution of the species within the site in the long term.	None	None	None	High
	Operation	Breeding sites within the SPA are beyond displacement distance from the wind farm so there so there will not be any impact on the distribution of the species within the site in the long term.	None	None	None	High
	Decommission	The decommissioning process would be relatively short-term, during which measures would be put in place to prevent disturbance to	None	None	None	High

TABLE A11.10: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: MERLIN						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
		any nesting merlin. There decommissioning will not therefore have any impact on the distribution of the species within the site in the long term.				
5. Distribution and extent of habitats supporting the species is maintained in the long term	Construction	No effects on the distribution and extent of merlin habitat within the SPA.	None	None.	None	High
	Operation	It is evident from the 2003 to 2012 breeding results that the main merlin nesting locations are distant from the wind farm, and that the birds make minimal use of Strathy South. It is therefore evident that the wind farm would not have any effects on the distribution and extent of merlin habitat within the SPA.	None	None.	None	High
	Decommission	No effects on the distribution and extent of merlin habitat within the SPA.	None	None	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	No effects on the structure, function and supporting processes of habitat supporting merlin within the SPA.	None	None	None	High
	Operation	No effects on the structure, function and supporting processes of habitat supporting merlin within the SPA.	None	None	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting merlin within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	This is already covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Operation	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Decommission	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High

TABLE A11.11: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GOLDEN PLOVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	The Modified 2013 Scheme would avoid deterioration of golden plover habitat within the SPA.	None	No mitigation is required because there is no impact on this conservation objective. However, the removal of the conifer plantation at Strathy South will help reverse deterioration of adjacent SPA (and SAC) habitats caused by forest edge effects, and which currently extend along more than 32km of the adjoining SPA (and SAC) boundary. In addition to the removal of this forest impact on breeding bird distribution, there will be indirect linear localised benefits to peatland hydrology, from the removal of this forest and accompanying blocking of active forest drains and any remaining historic hill grips,	None	High
	Operation	The Modified 2013 Scheme would avoid deterioration of golden plover habitat within the SPA.	None	None	None	High
	Decommission	The Modified 2013 Scheme would avoid deterioration of golden plover habitat within the SPA.	None	None	None	High
2. To avoid significant disturbance to the qualifying species	Construction	No golden plover have been recorded breeding or foraging on site during the 2003 to 2012 survey years. Results show between 0 – 2 breeding territories within 500 m of turbines.	Displacement of up to 2 territories.	None. Pre-commencement breeding bird surveys, together with the Breeding Bird Protection Plan would ensure there is no disturbance to breeding golden plover.	None	High
	Operation	The distribution of breeding golden plover will be monitored during Years 1, 2, 3, 5, 10 and 15, and will ensure information is available to site staff on the breeding distribution of this species over the early years of its operation.	None	None. Breeding monitoring that would be carried out in Year 1, 2, 3, 5, 10 and 15 will help determine whether or not any breeding is taking place on site or within a 500 m buffer. If breeding is confirmed, then an appropriate protocol would be put in place to avoid any disturbance. Staff will also be given an annual briefing on the need to comply with wildlife legislation, and provided with training and reference material on this species, to help ensure any breeding activity is recognised and the appropriate Breeding Bird Protection Plan is put in place.	None	High
	Decommission	The distribution of breeding golden plover will be monitored prior to any decommissioning.	None	None. Pre-decommissioning breeding surveys by ornithologists and the implementation of the Breeding Bird Protection Plan would ensure there is no disturbance to breeding golden plover.	None	High
3. Population of the species as a viable component of the site is maintained in	Construction	None, as there is no risk of disturbance and therefore no impact on breeding success.	None	None	None	High
	Operation	There was negligible 'at risk' flight activity recorded across the site in any survey year. Taking account of potential under-recording of flight activity, predicted collision rates are still	None. The negligible collision nor the potential	None required. However, the removal of approximately 32 km of conifer plantation edge, including at least approximately 3 km where the nearest turbine would be at least 500 m away, will improve habitat which has	None	High

TABLE A11.11: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GOLDEN PLOVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
the long term		negligible. From these findings, it is concluded that collision risk to this species from the Modified 2013 Scheme would be negligible, and would not have any effect on the population. Based on survey results from 2003 to 2012, between 0 to 2 territories would be displaced, assuming displacement occurred up to 500 m from turbines. It is considered over-precautionary to assume that these will be lost to the SPA population, given the extent of potential habitat and the varying densities recorded by site condition monitoring. It is considered that there is sufficient carrying capacity within the SPA to absorb these birds, if displacement did occur. The SNH assessed condition of this qualifying feature is unfavourable declining (2009).	displacement are not considered to adversely effect the long term viability of the SPA population.	previously been compromised by forest edge effects. One element of this edge effect is potentially from higher predation near to forest edge, so removal of this predation pressure will potentially have benefits for breeding success of wader territories in proximity to the former forest edge.		
	Decommission	None, as there is no risk of disturbance.	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	There will not be any impact on the distribution of the species within the site in the long term, as disturbance to breeding birds will be avoided, and also as construction is relatively short-term.	None	None	None	High
	Operation	The 2003 to 2012 data, supplemented by records from RSPB over a longer period, show consistent locations of records for this species, from which to determine breeding distribution. Based on these survey results, between 0 to 2 territories would be displaced (depending on the survey year), assuming displacement occurred up to 500 m from turbines. Given that there is evidence of golden plover nesting relatively close to turbines, and the low numbers of golden plover within 500 m of the site, it is concluded there will not be any impact on the distribution of the species within the site in the long term.	None, given the low numbers within potential displacement distance (0 -2 territories within 500 m) and that there is sufficient carrying capacity within the SPA to absorb these birds, if displacement did occur.	None required. However, the removal of approximately 32 km of conifer plantation edge, including at least approximately 3 km where the nearest turbine would be at least 500 m away, will improve habitat which has previously been compromised by forest edge effects. As SNH/RSPB/FCS evidence shows, the removal of forest edge is expected to have benefits for golden plover and potentially increase territory abundance within the SPA.	None	High
	Decommission	There will not be any impact on the distribution of the species within the site in the long term.	None	None	None	High
5. Distribution and extent of	Construction	No effects on distribution and extent of habitat within the SPA.	None	None.	None	High

TABLE A11.11: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GOLDEN PLOVER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
habitats supporting the species is maintained in the long term	Operation	No effects on distribution and extent of habitat within the SPA.	None	None. Note the potential beneficial impact that would result for habitat extent, described under the 3rd Conservation Objective above.	None	High
	Decommission	No effects on distribution and extent of habitat within the SPA.	None	None	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	No effects on the structure, function and supporting processes of habitat supporting golden plover within the SPA.	None	None	None	High
	Operation	No effects on the structure, function and supporting processes of habitat supporting golden plover within the SPA.	None	None. However, the removal of the conifer plantation at Strathy South will help reverse deterioration of adjacent SPA (and SAC) habitats caused by forest edge effects, and which currently extend along more than 32km of the adjoining SPA (and SAC) boundary. In addition to the removal of this forest impact on breeding bird distribution, there will be indirect linear localised benefits to peatland hydrology, from the removal of this forest and accompanying blocking of active forest drains and any remaining historic hill grips,	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting golden plover within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	Covered under the 2nd Conservation Objective, above.	See the 2nd Conservation Objective.	See the 2nd Conservation Objective	None	High
	Operation	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Decommission	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High

TABLE A11.12: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GREENSHANK						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	The Modified 2013 Scheme would avoid deterioration of greenshank habitat within the SPA.	None	No mitigation is required because there is no impact on this conservation objective. However, there will be indirect localised benefits to peatland hydrology from the removal of approximately 32 km of forest edge and accompanying blocking of active forest drains and any remaining historic but active hill grips,	None	High

TABLE A11.12: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GREENSHANK						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
				In addition, as part of peatland mitigation measures, there will be further targeted additional drain blocking on previously un-planted areas that will also benefit this species, by increasing localised water table levels and pools.		
	Operation	The Modified 2013 Scheme would avoid deterioration of greenshank habitat within the SPA.	None	None. The measures above will continue to provide evolving benefits, as the measures take effect.	None	High
	Decommission	The Modified 2013 Scheme would avoid deterioration of greenshank habitat within the SPA.	None	None. The measures above will provide on-going benefits, as the measures continue take effect.	None	High
2. To avoid significant disturbance to the qualifying species	Construction	There were no greenshank nesting or nesting/chick rearing territories identified within 200 m of any turbines in any year surveyed. Only two territories were within [redacted] m over this period, 1 in 2007 (at [redacted] m) and 1 in 2010 (at [redacted] m). This gives a mean of only 1 territory occurring within 350 m of a turbine every two years.	None	None. Pre-commencement breeding surveys, together with open ground checks by ornithologists and the implementation of the Breeding Bird Protection Plan would ensure there is no disturbance to breeding greenshank. Staff will also be given site inductions on the need to comply with wildlife legislation, and provided with training and reference material on this species, to help ensure any breeding activity is recognised and the appropriate actions put in place.	None	High
	Operation	The distribution of breeding greenshank will be monitored during Years 1, 2, 3, 5, 10 and 15 and will ensure information available to site staff on the breeding distribution of this species over the early years of its operation. The location of activity has been relatively consistent, which helps ensure any potentially disturbing activities can be planned with this information in mind.	None	None. Breeding monitoring that would be carried out in Year 1, 2, 3, 5, 10 and 15 will help determine whether or not any breeding is taking place on site or within a 500 m buffer. If breeding is confirmed, then an appropriate protocol would be put in place to avoid any disturbance. Staff will also be given an annual briefing on the need to comply with wildlife legislation, and provided with training and reference material on this species, to help ensure any breeding activity is recognised and the appropriate actions put in place.	None	High
	Decommission	The occurrence of breeding greenshank will be monitored prior to any decommissioning.	None	None. Pre-decommissioning breeding surveys by ornithologists and the implementation of the Breeding Bird Protection Plan would ensure there is no disturbance to breeding greenshank.	None	High
3. Population of the species as a viable component of the site is maintained in	Construction	Results show use of the site as a nesting and nesting/chick rearing territory for up to five to six within [redacted] m of turbines.	There is a risk of inadvertent harm to nests or chicks from trampling or by machinery.	The same measures used as mitigation for the 2nd Conservation Objective above will also apply here.	None	High

TABLE A11.12: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GREENSHANK						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
the long term	Operation	SNH in their October 2nd response letter, suggested that any territories within 500 m of turbines should be considered lost to the population (from collision). This is considered to be over-precautionary. There was low 'at risk' flight activity recorded across the site. Taking account of potential under-recording of flight activity, predicted collision rates are still negligible. In addition, removal of the forest plantation is predicted to reduce average flight height and therefore lower the predicted collision rate even lower. Therefore, if greenshank were not displaced from the site, the risk of collision from these findings, would be negligible, and would certainly not have any effect on the population. In their 2nd October 2007 response SNH propose that all greenshank territories within 200 m of turbines should be considered lost to the population. As noted above, there were no territories recorded within 200 m. Only two nesting or nesting/chick rearing territories have ever been recorded within 350 m but it is not accepted that these birds will be lost to the SPA population. It is considered certain that there is sufficient carrying capacity within the SPA to absorb these birds, if displacement did occur. The SNH assessed condition of this qualifying feature is favourable maintained (2009).	None, as it is assumed that if the highly precautionary predicted 6 territories were displaced, the SPA has the carrying capacity to support these birds.	Whilst no mitigation is judged to be necessary, it is noteworthy that elements of the modified scheme and its associated mitigation for peatland impacts will benefit this species on the adjacent SPA. Primarily, the removal of the conifer plantation will potentially reduce mammalian predation, and increase connectivity between foraging areas. There will also be localised benefits on and adjacent to the site from improvements to peatland hydrology resulting from the removal of approximately 32 km of forest edge and the accompanying blocking of active forest drains and any remaining historic but active hill grips along this SPA/SAC boundary, In addition, as part of peatland mitigation measures, there will be further targeted additional drain blocking on 23.5 ha of previously un-planted areas that will also benefit this species, by increasing localised water table levels and pools. On the basis of its breeding requirements, it is reasonable to infer that these habitat improvement measures will have some benefit to the quality and extent of breeding habitat for this species, and although it would be difficult to predict and quantify at this stage, there is potential that it will counter-balance any potential displacement pressure from the presence of the turbines.	None	High
	Decommission	None, as there is no risk of disturbance.	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	There will not be any impact on the distribution of the species within the site in the long term, as disturbance will be avoided in order to comply with wildlife legislation.	None	None	None	High
	Operation	There are no nesting or nesting/chick rearing territories within 200m of any turbine, and only two territories have been recorded within 350 m. If a highly precautionary 500 m disturbance buffer was been applied, a peak of up to 5 to 6	Displacement of up to 6 territories, based on a highly	Whilst no mitigation is judged to be necessary, the measures for the 3rd Conservation Objective above would benefit this species.	None	High

TABLE A11.12: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: GREENSHANK						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
		nesting or nesting/chick rearing territories would be displaced, based on the greatest number of territories recorded over the 2003 to 2012 period. It is considered that there is sufficient carrying capacity within the SPA to absorb these birds, if displacement did occur.	precautionary 500 m displacement distance from turbines.			
	Decommission	If displacement had taken place, decommissioning would result in re-establishment of territories in the long term.	None	None	None	High
5. Distribution and extent of habitats supporting the species is maintained in the long term	Construction	No effects on the distribution and extent of habitat within the SPA.	None	None.	None	High
	Operation	No effects on the distribution and extent of habitat within the SPA.	None	None. Note the potential beneficial impact that would result for habitat extent, described under the 3rd Conservation Objective above.	None	High
	Decommission	No effects on the distribution and extent of habitat within the SPA.	None	None	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	Removal of the plantation accompanied by blocking of active forest drains and any active historical hill grips would enhance peatland hydrology along approximately 32 km of the SPA boundary.	None	None. Note the potential beneficial impact that would result for habitat extent, described under the 3rd Conservation Objective above.	None	High
	Operation	Removal of the plantation accompanied by blocking of active forest drains and any active historical hill grips would enhance peatland hydrology along approximately 32 km of the SPA boundary.	None	None. Note the potential beneficial impact that would result for habitat extent, described under the 3rd Conservation Objective above.	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting greenshank within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Operation	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Decommission	Covered under the 2nd Conservation Objective, above.	None.	See the 2nd Conservation Objective	None	High

TABLE A11.13: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: DUNLIN						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	The Modified 2013 Scheme would avoid deterioration of dunlin habitat within the SPA.	None	No mitigation is required because there is no impact on this conservation objective. However, there will be indirect localised benefits to peatland hydrology from the removal of approximately 32 km of forest edge and accompanying blocking of active forest drains and any remaining historic but active hill grips, In addition, as part of peatland mitigation measures, there will be further targeted additional drain blocking on previously un-planted areas that will also benefit this species, by increasing localised water table levels and pools.	None	High
	Operation	The Modified 2013 Scheme would avoid deterioration of dunlin habitat within the SPA.	None	None. The measures above will continue to provide evolving benefits, as the measures take effect.	None	High
	Decommission	The Modified 2013 Scheme would avoid deterioration of dunlin habitat within the SPA.	None	None. The measures above will provide on-going benefits, as the measures continue take effect.	None	High
2. To avoid significant disturbance to the qualifying species	Construction	No dunlin was recorded breeding on site. Off site, there were from 0 to 3 breeding territories recorded within 500 m of turbines.	None	Pre-commencement breeding surveys, together with open ground checks by ornithologists and the implementation of the Breeding Bird Protection Plan would ensure there is no disturbance to breeding dunlin. Staff will also be given site inductions on the need to comply with wildlife legislation, and provided with training and reference material on this species, to help ensure any breeding activity is recognised and the appropriate Breeding Bird Protection Plan is put in place.	None	High
	Operation	The distribution of breeding dunlin will be monitored during Years 1, 2, 3, 5, 10 and 15 and will ensure information available to site staff on the breeding distribution of this species over the early years of its operation. The location of activity has been relatively consistent, which helps ensure any potentially disturbing activities can be planned with this information in mind.	None	Breeding monitoring that would be carried out in Year 1, 2, 3, 5, 10 and 15 will help determine whether or not any breeding is taking place on site or within a 500 m buffer. If breeding is confirmed, then an appropriate protocol would be put in place to avoid any disturbance. Staff will also be given an annual briefing on the need to comply with wildlife legislation, and provided with training and reference material on this species, to help ensure any breeding activity is recognised and the appropriate Breeding Bird Protection Plan is put in place.	None	High

TABLE A11.13: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: DUNLIN						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
	Decommission	The distribution of breeding dunlin will be monitored prior to any decommissioning.	None	Pre-decommissioning breeding surveys by ornithologists and the implementation of the Breeding Bird Protection Plan would ensure there is no disturbance to breeding dunlin.	None	High
3. Population of the species as a viable component of the site is maintained in the long term	Construction	Results show no breeding on site but up to three pairs within 500 m of turbines.	None	The same measures used as mitigation for the 2nd Conservation Objective above will also apply here.	None	High
	Operation	There was negligible 'at risk' flight activity recorded across the site. A displacement impact up to 500 m has been applied, in accordance with SNH's response, but it is not accepted that these birds will be lost to the SPA population. It is considered certain that there is sufficient carrying capacity within the SPA to absorb these birds, if displacement did occur. The SNH assessed condition of this qualifying feature is favourable maintained (2009).	None, as it is assumed that if the highly precautionary predicted 3 territories were displaced, the SPA has the carrying capacity to support these birds.	Whilst no mitigation is judged to be necessary, it is noteworthy that elements of the modified scheme and its associated mitigation for peatland impacts will benefit this species on the adjacent SPA. Primarily, the removal of the conifer plantation itself will potentially reduce mammalian predation, and increase connectivity between foraging areas. There will also be localised benefits on and adjacent to the site from improvements to peatland hydrology resulting from the removal of approximately 32 km of forest edge and the accompanying blocking of active forest drains and any remaining historic but active hill grips along this SPA/SAC boundary, In addition, as part of peatland mitigation measures, there will be further targeted additional drain blocking on previously un-planted areas that will also benefit this species, by increasing localised water table levels and pools. On the basis of its breeding requirements, it is reasonable to infer that these habitat improvement measures will have some benefit to the breeding productivity of this species (although it would be difficult to predict and quantify).	None	High
	Decommission	If displacement had taken place, decommissioning would result in re-establishment of territories in the long term.	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	There will not be any impact on the distribution of the species within the site in the long term, as disturbance will be avoided in order to comply with wildlife legislation.	None	None	None	High
	Operation	If displacement from turbines occurred to a precautionary 500 m disturbance, this would	Displacement of up to 3	Whilst no mitigation is judged to be necessary, the measures for the 3rd Conservation Objective above	None	High

TABLE A11.13: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: DUNLIN						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
		mean up to three territories could be displaced. It is considered certain that there is sufficient carrying capacity within the SPA to absorb these birds, if displacement did occur.	territories, based on a highly precautionary 500 m displacement distance from turbines.	would benefit this species.		
	Decommission	If displacement has taken place, decommissioning would result in re-establishment of territories in the long term.	None	None	None	High
5. Distribution and extent of habitats supporting the species is maintained in the long term	Construction	No effects on the distribution and extent of habitat within the SPA.	None	None.	None	High
	Operation	No effects on the distribution and extent of habitat within the SPA.	None	None. Note the potential beneficial impact that would result for habitat extent, described under the 3rd Conservation Objective above.	None	High
	Decommission	No effects on the distribution and extent of habitat within the SPA.	None	None	None	High
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	Removal of the plantation plus blocking of active forest drains and any active historical hill grips would enhance peatland hydrology along approximately 32 km of the SPA boundary.	None	None. Note the potential beneficial impact that would result for habitat extent, described under the 3rd Conservation Objective above.	None	High
	Operation	Removal of the plantation plus blocking of active forest drains and any active historical hill grips would enhance peatland hydrology along approximately 32 km of the SPA boundary.	None	None. Note the potential beneficial impact that would result for habitat extent, described under the 3rd Conservation Objective above.	None	High
	Decommission	No effects on the structure, function and supporting processes of habitat supporting dunlin within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Operation	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Decommission	Covered under the 2nd Conservation Objective, above.	None.	See the 2nd Conservation Objective	None	High

TABLE A11.14: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: WOOD SANDPIPER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
1. To avoid deterioration of the habitats of the qualifying species	Construction	No deterioration of wood sandpiper habitat within the SPA.	None	No mitigation is required because there is no impact on this conservation objective.	None	High
	Operation	No deterioration of wood sandpiper habitat within the SPA.	None	None. The measures above will continue to provide evolving benefits, as the measures take effect.	None	High
	Decommission	No deterioration of wood sandpiper habitat within the SPA.	None	None. The measures above will provide on-going benefits, as the measures continue take effect.	None	High
2. To avoid significant disturbance to the qualifying species	Construction	No wood sandpiper was recorded breeding on or off site.	None	None	None	High
	Operation	The distribution of breeding wood sandpiper will be monitored during Years 1, 2, 3, 5, 10 and 15 (see Table A11.4) will ensure information available to site staff on the breeding distribution of this species over the early years of its operation. The location of activity has been relatively consistent, and it not anticipated this species will breed on site as it has been recorded as a transient species only.	None	Breeding monitoring that would be carried out in Year 1, 2, 3, 5, 10 and 15 will help determine whether or not any breeding is taking place on site or within a 500 m buffer. If breeding is confirmed, then an appropriate protocol would be put in place to avoid any disturbance. Staff will also be given an annual briefing on the need to comply with wildlife legislation, and provided with training and reference material on this species, to help ensure any breeding activity is recognised and the appropriate Breeding Bird Protection Plan is put in place.	None	High
	Decommission	The distribution of wood sandpiper will be monitored prior to any decommissioning.	None	None	None	High
3. Population of the species as a viable component of the site is maintained in the long term	Construction	Results show no breeding on site or within 500 m of turbines.	None	None	None	High
	Operation	There was no 'at risk' flight activity recorded across the site. The SNH assessed condition of this qualifying feature is favourable maintained (2004).	None	None	None	High
	Decommission	This has no implications..	None	None	None	High
4. Distribution of the species within site is maintained in the long term	Construction	There will not be any impact on the distribution of the species within the site in the long term as it is either absent or extremely infrequent in the Strathy South area.	None	None	None	High
	Operation	There will not be any impact on the distribution of the species within the site in the long term as it is either absent or extremely infrequent in the Strathy South area.	None	None	None	High
	Decommission	There will not be any impact on the distribution of the species within the site in the long term as it is either absent or extremely infrequent in the Strathy South area.	None	None	None	High
5. Distribution and extent of habitats supporting the species is	Construction	No effects on distribution and extent of habitat within the SPA.	None	None.	None	High
	Operation	No effects on distribution and extent of habitat within the SPA.	None	None.	None	High
	Decommission	No effects on the distribution and extent of	None	None	None	High

TABLE A11.14: SUMMARY OF INFORMATION TO INFORM THE APPROPRIATE ASSESSMENT: WOOD SANDPIPER						
Conservation Objective	**Project Phase**	**Findings in Relation to This Conservation Objective for the Project Alone and In Combination**	**Impact Before Mitigation**	**Mitigation**	**Impact After Mitigation**	**Degree of Certainty**
maintained in the long term		habitat within the SPA.				
6. Structure, function and supporting processes of habitats supporting the species is maintained in the long term	Construction	No effects on the structure, functioning and supporting processes within the SPA.	None	None.	None	High
	Operation	No effects on the structure, functioning and supporting processes within the SPA.	None	None.	None	High
	Decommission	No effects on the structure, functioning and supporting processes within the SPA.	None	None	None	High
7. No significant disturbance of the species is maintained in the long term	Construction	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Operation	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High
	Decommission	Covered under the 2nd Conservation Objective, above.	None	See the 2nd Conservation Objective	None	High

There are no summary tables for short-eared owl, common scoter or wigeon as these species have not been recorded breeding, or in the cases of these waterfowl, in flight, at Strathy South, over the 2003 to 2012 period. It is therefore self-evident that the modified scheme will have no effect on the SPA's conservation objectives for these species.

TECHNICAL APPENDIX A12.1: NOISE PREDICTION METHODOLOGY

A12.1 NOISE PREDICTION METHODOLOGY

The noise predictions methodology is based on International Standard ISO 9613*, Acoustics – Attenuation of Sound During Propagation Outdoors,* with the modifications suggested by the best practice guidance contained with the Institute of Acoustics (IoA) Acoustics Bulletin Vol 34 no. 2 article *Prediction and Assessment of Wind Turbine Noise*. The propagation model described in Part 2 of ISO 9613 provides for the prediction of sound pressure levels based on either short-term downwind (i.e. worst-case) conditions or long-term overall averages. Only the worst-case downwind condition has been considered in this assessment, that is – for wind blowing from the proposed turbine towards the nearby houses. When the wind is blowing in the opposite direction noise levels would be significantly lower, especially where there is any shielding between the turbine and the houses.

The ISO propagation model calculates the predicted sound pressure level by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

$$\text{Predicted Octave Band Noise Level} = L_W + D - A_{geo} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$$

- L_W – Source Sound Power Level
- D – Directivity Factor
- A_{geo} – Geometrical Divergence
- A_{atm} – Atmospheric Attenuation
- A_{gr} – Ground Effect
- A_{bar} - Barrier Attenuation
- A_{misc} – Miscellaneous Other Effects

The predicted octave band levels from the turbine are summed together to give the overall 'A' weighted predicted sound level.

A12.1.1 L_W Sound Power Level

The sound power level (L_W) of a noise source is expressed in dB re:1 pW., The sound power levels and turbine types used for the assessment are detailed within the ES main text.

A12.1.2 D – Directivity Factor

The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a downwind direction, corresponding to the worst-case propagation conditions considered here and needs no further adjustment.

A12.1.3 A_{geo} – Geometrical Divergence

The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in attenuation depending on distance according to:

$$A_{geo} = 20 \times \log(d) + 11$$

Where d = distance from the turbine

The wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

A12.1.4 A_{atm} - Atmospheric Absorption

The atmospheric absorption accounts for the frequency dependant linear attenuation with distance of sound power over the frequency spectrum according to:

$$A_{atm} = d \times \alpha$$

where α = the atmospheric absorption coefficient of the relevant frequency band

Published values of 'α' from ISO9613 Part 1 have been used, corresponding to a temperature of 10ºC and a relative humidity of 70%, the values specified in the IoA Acoustics Bulletin article which give relatively low levels of atmospheric attenuation, and subsequently worst case noise predictions, as given in Table TA12.1.

Table TA12.1: Atmospheric Absorption Coefficients

Octave Band Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient (dB/m)	0.0001	0.0004	0.0010	0.0019	0.0037	0.0097	0.0328	0.1170

A12.1.5 A_{gr} - Ground Effect

Ground effect (A_{gr}) is the interference of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects are inherently complex and depend on the source height, receiver height, propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The IoA Acoustics Bulletin article agreement states that use of G = 0.5 and a receptor height of 4 m will generally result in realistic estimates of noise emission levels at receptor locations downwind of wind turbines where predictions are based on manufacturers warranted noise data.

Predictions in this report are based on G = 0.5 with a receptor height of 4 m. Due the additional margin for uncertainty in using the declared apparent sound power level for the proposed and consented turbines, this approach provides additional confidence in the predicted noise levels.

A12.1.6 A_{bar} - Barrier Attenuation

The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under downwind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of site between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of site. It should be noted that no barrier attenuation has been used in any of the noise predictions carried out here since there is no significant shielding at this site. IoA Acoustics Bulletin article states that "*Generally, no account should be taken of barrier attenuation by the landform unless there is no line-of-sight between the receptor and the highest point on the rotor*."

A12.1.7 A_{misc} – Miscellaneous Other Effects

ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

Aim: Explain how to use wind turbine data based on measurement report(s), warranted or unwarranted data provided by the manufacturer.

Action: Contact wind turbine manufacturer and ask for as many turbine test reports in accordance with IEC 61400-11 [1] as available.

Calculate the K value in accordance with IEC 61400-14 [2] with the amount of measurement reports available. The methods are detailed in the order of preference.

How WT noise data are declared:

1. At least **3 measurement reports** available

Check hub heights in measurement report. If they are for different hub heights, carry out a hub height conversion according to [2] Annex A first. Data can only be averaged for the same hub height unless it is the sound power level at rated power. Results suitable for deriving the declared sound power level need to have been obtained from measurements of the same wind turbine type with the same hub height and operational mode, and components from the same blade and gear-box manufacturer.

Declaration of apparent sound power level:

For wind turbines of the same type, tower (steel or concrete, tubular or lattice) and same hub height, the mean value is calculated with

$$\bar{L}_W = \frac{1}{n}\sum_{i=1}^{n} L_i \qquad (1)$$

$\bar{L}_W$: mean sound power level of *n* measurement results on *n* individual wind turbines

n: number of individual measurement results

L_i: individual sound power level

The standard deviation of the average is calculated with equation (2).

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(L_i - \bar{L}_W)^2} \qquad (2)$$

s: standard deviation

The standard deviation σ used for the declaration is determined by

$$\sigma = \sqrt{\frac{1+n}{n}\left(\sigma_R^2 + \sigma_P^2\right)} \qquad (3)$$

σ: standard deviation of declaration

σ_P: standard deviation of production (here σ_P = s)

σ_R: standard deviation of reproducibility (here σ_R = 0.9 dB)

An estimate of σ_R is 0.9 dB as suggested in [2], based on typical uncertainties given in [1] Annex D.

σ_P is taken to be equal to the standard deviation s.

Declared apparent sound power level L_{Wd}:

$$L_{Wd} = \bar{L}_W + K = \bar{L}_W + 1.645 \cdot \sigma \qquad (4)$$

L_{Wd}: declared sound power level

K: confidence level (using K=1.645*σ represents a probability of 95% that results from sound power level measurements performed in accordance with [2] do not exceed the declared sound power level L_{Wd}).

(K=1.28*σ for a 90% probability)

Declaration of Tonality:

Results of the tonality assessment cannot be declared in the same way as the sound power level. Tonality and the frequency at which the tone occurs have to be reported for each measurement.

2. <u>Only **1 or 2 measurement report(s)** available</u>

If only one or two measurement reports are available, the confidence level is estimated using the following procedure:

- a typical standard deviation of reproducibility of **σ_R = 0.9 dB** and
- an average maximum standard deviation of production of **σ_P = 1 dB**, derived from a number of calculations carried out under paragraph 1 above for various turbine types.
  Using the average maximum standard deviation is a conservative assumption to allow for the uncertainty when there is only one or two measurement reports available. This value is subject to change if more measurement reports become available.

Thus it follows that:

σ (*n*=1) = 1.9 dB and K(95%) = 3.1 dB
σ (*n*=2) = 1.6 dB and K(95%) = 2.7 dB.

K(95%) is added to the measured sound power level as stated in the acoustic performance test.

Declaration of Tonality:

Results of the tonality assessment cannot be declared in the same way as the sound power level. Tonality and the frequency at which the tone occurs have to be reported for each measurement.

3. **No measurement report** available but **Manufacturer's Warranty**

If warranted data is available, use the warranted data plus the uncertainty as declared by the manufacturer to allow for measurement uncertainty and production variability. In the absence of a statement about uncertainty, use 2 dB. This is to allow for the usual practice of a wind turbine manufacturer subtracting the measurement uncertainty from the measured sound power level when assessing compliance with the warranty.

4. **No measurement report** available

If no warranty is issued, use data supplied by the manufacturer for predictions plus an uncertainty margin of 3.1 dB as derived above, treating it as if one acoustic performance test is available.

Preferred Method:

To determine the declared sound power level it is preferred to use method 1. If an insufficient number of measurement reports are available, the further approach is detailed in the order of preference above.

Update:

-

Additional Information:

-

Reference:

[1] BS EN 61400-11:2003 Incorporating Amendment A1:2006 -*Wind turbine generator systems - Part 11: Acoustic noise measurement techniques*, International Electrotechnical Commission

[2] IEC/TS 61400-14:2005 *Wind turbine - Part 14: Declaration of apparent sound power level and tonality values*, International Electrotechnical Commission

[3] pr EN 50376:2001 *Declaration of sound power level and tonality values of wind turbines*, European Committee for Electrotechnical Standardization

NOISE ASSESSEMENT GUIDANCE FOR WIND FARMS

This advice note applies to planning applications for wind farms and large individual wind turbines i.e. those with a rotor diameter greater than 16m. The purpose of the document is to ensure sufficient information is provided with each planning application to enable the potential noise impact to be assessed against relevant guidance.

The current guidance against which all such applications are assessed is ETSU-R-97 *The Assessment & Rating of Noise from Wind Farms* hereafter referred to simply as ETSU. In addition, the Institute of Acoustics has set up a working group to look at various aspects of noise from wind farms with a view to producing guidance. It is expected that such guidance will complement ETSU and together will form best practice for the assessment of noise from wind farms.

Required Information
Applications must include the following information: -

1. A detailed map showing the proposed position of turbines (including grid references) and all noise sensitive locations within 3km of any turbine. This includes all dwellings and also non-domestic property which could be adversely affected by noise such as schools, hospitals, offices etc. The locations summary sheet in Appendix 4 should be completed.

   The map should also indicate the position of any existing, consented or proposed wind turbine development within 3km of any mutually affected noise sensitive location.

   NB It is for the Planning Authority to determine whether a property has a financial involvement in a wind farm development. The application must identify **all** dwellings and if a financial involvement claim is being made the applicant must provide details to the Planning Authority.

2. The distance from each noise sensitive location to the nearest turbine.

3. The make, model and mast height of the turbine. Please state whether this is the actual turbine proposed for this development or a specimen used for the purposes of the assessment.

4. The sound power levels used in any calculations. The status of these levels must be clearly identified i.e. whether they are warranted levels, test levels, generic levels etc. This will determine the exact methodology for predicting noise levels at receptors.

5. A warranty from the turbine supplier and/or manufacturer for the absence of tonality of the turbines, as determined in accordance with ETSU.

6. A noise impact assessment undertaken in accordance with ETSU and applying the methods described in the article published in the IOA Bulletin March/April 2009 entitled “Prediction and Assessment of Wind Turbine Noise” (hereafter referred to as PAWTN) regarding the acquisition and analysis of background noise data and the prediction of wind turbine noise immission levels. The noise assessment must demonstrate compliance with either the simplified noise condition or the composite noise condition. Please refer to Appendices 1&2 of this Advice Note for full text of these conditions.

7. Appendix 3 to this advice note contains a checklist of the minimum information required.

Simple Assessment

Where a noise assessment demonstrates that noise immission levels at any noise sensitive location will not exceed 35 dB LA90 it may not be necessary to undertake a background noise survey. However, if there is any likelihood of expansion or secondary development at a later stage, a background survey will be required.

Background/Baseline Survey

A background survey is required to identify the baseline noise level and establish operational noise limits for the wind farm. It will require the simultaneous monitoring of noise levels at noise sensitive locations and wind speeds at the proposed wind farm site. It should be noted that the same wind speed monitoring locations will be need to be used in the event that compliance monitoring has to be undertaken. This can have implications where a second development is relying on wind speed figures measured at another wind farm.

The background survey should be carried out in accordance with ETSU and best practice guidance with the following clarifications :-

1. The location of noise and wind speed measurement locations to be agreed with the Planning Authority prior to commencing.

2. ETSU recommends a minimum noise measurement period of two weeks however, the actual duration will be dependent on weather conditions and the data collected. The survey must provide sufficient data across the range of wind directions and speeds up to 12m/s in order to produce accurate best fit curves. In some cases two weeks may not be enough and discussions should therefore be held with Environmental Health prior to surveying taking place.

3. Background measurements are required for both quiet daytime and night time periods.

4. Noise data affected by rainfall or extraneous noise sources such as dawn chorus, aircraft noise or occasional agricultural activities etc. should be excluded from calculations.

5. Background measurements should be expressed as best fit curves in accordance with ETSU.

6. Appropriate measures to minimise wind induced microphone noise must be taken and detailed in the survey report.

7. Wind speed measurements must take into account wind shear conditions and should be carried out in accordance with the method described in Part 2 of the aforementioned PAWTN article.

8. The applicant should submit a time history graph showing background noise levels; wind speed measurements; wind direction and rainfall.

Amplitude Modulation (AM)

Research is currently being undertaken into the occurrence of amplitude modulation from wind farms i.e. the noticeable swish or thud often heard in close proximity to wind turbines. In a small number of cases, this phenomenon is being experienced at much greater distances than expected leading to complaints. It is intended that guidance will be produced in due course which will form best practice as to how AM is dealt with.

It is accepted that AM is very difficult to predict at the planning stage, however the applicant should be aware that if the wind farm noise is found to have a distinct and intrusive AM element, this will be taken into account should complaints arise. In such cases, regardless of whether noise levels comply with planning conditions, the noise could constitute a statutory nuisance in terms of the Environmental Protection Act 1990.

Noise Impact Assessment

The prediction of wind turbine noise levels at receptor locations should be carried out in accordance with ISO 9613-2 as described in Part 3 of the PAWTN article. The assessment should specify what parameters and what propagation formula have been used and any attenuation claimed.

The noise levels for each location should be expressed in the following table format. Any breaches of the permitted level should be highlighted.

Location: _____

(Daytime 35dB or 5dB above background)

	1m/s	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Background												
Permitted Level												
Predicted Level												

Location: _____

(Night time 38dB or 5dB above background)

	1m/s	2m/s	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Background												
Permitted Level												
Predicted Level												

Cumulative Effect

Any noise assessment must take into account the potential cumulative noise impacts from any existing, consented or proposed developments in the vicinity. In general, the cumulative noise levels should not exceed the simplified or composite noise standards.

If the application is simply an extension of an existing wind farm the process of predicting cumulative noise levels should be fairly straightforward as the applicant should have access to previous background and wind speed data. Otherwise, there can be problems in terms of the availability and suitability of data such as background surveys and wind speed measurement. In addition, compliance monitoring becomes more complicated. The applicant's noise impact assessment should clarify these issues explaining how and where background and wind speed data has been obtained.

One of the particular issues is obtaining background measurements with an existing wind farm in situ. In general, it is not acceptable to discount all data from a certain wind direction on the grounds that background levels may be contaminated from the existing development.

Subsequent applicants should be aware that the initial wind farm will be bound only by the terms of its own noise condition. Therefore, subsequent noise assessments should take into account predicted levels from the first wind farm **and consented levels.**

For applications where there is more than one wind farm involved, the assessment should indicate the predicted and consented levels from each separate development and the cumulative level at each noise sensitive location. In the case of concurrent applications, it is strongly recommended that applicants liaise with one another regarding noise data and calculations.

Compliance Monitoring and Mitigation

In the event of a complaint to the Planning Authority the operator may be required to undertake monitoring to assess compliance with the set limits.

In general, compliance monitoring should be undertaken in accordance with ETSU and other best practice guidance however, there may be particular difficulties in relation to cumulative conditions. In such cases, the applicant will be required to submit a plan showing how compliance monitoring will be carried out.

Where compliance monitoring indicates a breach of conditions mitigation measures will be required and these should be included in the plan.

APPENDIX 1 – SIMPLIFIED CONDITIONS

APPENDIX 2 – COMPOSITE CONDITIONS

APPENDIX 3 – CHECKLIST

Turbine

Checkpoint	Applicant's Response	Office Use
Make & model of turbine:		
Apparent sound power level:		
Declared sound power level:		
Has a manufacturer's warranty been submitted demonstrating that the turbine does not have a tonal element?		

Methodology

Have noise propagation calculations been carried out in accordance with best practice as detailed in IOA Bulletin "*Prediction & Assessment of Wind Turbine Noise*"		
Have wind speed measurements been carried out in accordance with best practice as detailed in IOA Bulletin "*Prediction & Assessment of Wind Turbine Noise"*		
Have background levels been taken at suitable locations?		
Is there sufficient background data over a range of wind speeds and directions?		
Has any data been removed from calculations e.g. due to rainfall or extraneous noise? Give details.		

Cumulative Impact

Are there any existing, consented or proposed wind turbine developments within 3km of any noise sensitive location listed in Appendix 4? Give details>		

APPENDIX 4 – LOCATION SUMMARY

All residential Properties and other noise sensitive locations within 3km of any turbine.

Address 1	Address 2	Grid Co-ordinates	Monitoring Location Y/N

Turbine Locations

Turbine No.	Grid co-ordinates

Wind Speed Monitoring Locations

Anemometer	Grid Co-ordinates

global environmental solutions

Strathy South Wind Farm

Peat Landslide and Hazard Risk Assessment

SLR Ref: 405.00660.00018

May 2013

Version: 1

CONTENTS

1.0 INTRODUCTION ... 1
- **1.1 Background ... 1**
- **1.2 Objectives of Report ... 1**
- **1.3 Wind Farm Proposal ... 2**
- **1.4 Site Location and Description ... 2**

2.0 DESK STUDY REVIEW ... 5
- **2.1 Site History ... 5**
- **2.2 Site Geology ... 5**
- **2.3 Hydrology ... 7**
- **2.4 Hydrogeology ... 8**
- **2.5 Aerial Photographs ... 8**
- **2.6 Existing Information ... 9**

3.0 PEAT INSTABILITY ... 10
- **3.1 Background Information Regarding Peat ... 10**
- **3.2 Peat Stability – Factors to be considered. ... 12**
- **3.3 Peat Mass Stability ... 13**

4.0 SITE RECONNAISSANCE AND GEOMORPHOLOGICAL MAPPING ... 15
- **4.1 Site Work ... 15**
- **4.2 Methodology ... 15**

5.0 GROUND CONDITIONS ... 18
- **5.1 Peat ... 18**
- **5.2 Substrate ... 20**

6.0 RISK AND HAZARD ASSESSMENT ... 22
- **6.1 Risk Score Development ... 22**
- **6.2 Hazard Score Development ... 30**
- **6.3 Hazard Ranking ... 32**
- **6.4 Results ... 33**

7.0 CONSTRUCTION ISSUES ... 37
- **7.1 Turbine Locations and Crane Pads ... 37**
- **7.2 Access Tracks ... 37**
- **7.3 Cable Routes ... 38**
- **7.4 Substation ... 39**
- **7.5 Switching Station and Temporary Construction Compound ... 39**
- **7.6 Borrow Pits ... 39**

8.0 CONCLUSIONS AND RECOMMENDATIONS ... 40
- **8.1 Conclusions ... 40**
- **8.2 Recommendations ... 40**
- **8.3 Further Work ... 42**

TABLES

Table 6-3 Water Content 20
Table 6-1 Coefficients for Slope Gradients 23
Table 6-2 Coefficients for Peat Thickness and ground conditions 24
Table 6-3 Coefficients for Substrate 25
Table 6-4 Risk Rating 25
Table 6-5 Stability Risk Rating for each turbine 27
Table 6-6 Coefficients for Impact Feature Ranking 30
Table 6-7 Coefficients for Impact Feature Distance 31
Table 6-8 Coefficients for Impact Feature Elevation 31
Table 6-9 Impact Rating 31
Table 6-10 Rating Normalisation 32
Table 6-11 Hazard Ranking 32
Table 6-12 Stability Hazard Ranking 35
Table 6-13 Summary Hazard Assessment 36

DRAWINGS

Drawing No.1 Site Location
Drawing No.2 Geomorphological Features overlying Aerial Photograph
Drawing No.3 Superficial and Bedrock Geology Plan
Drawing No.4 Slope Plan
Drawing No.5 Interpreted Peat Thickness
Drawing No.6 Interpreted Substrate
Drawing No.7 Stability Risk Rating
Drawing No.8 Peat Probing Locations

APPENDICES

Appendix A Probe Locations, Peat Thickness And Risk Rating

EXECUTIVE SUMMARY

SLR Consulting Ltd (SLR) was commissioned by SSE Renewables Developments (UK) Ltd (SSE Renewables) to undertake a peat slide risk assessment for the proposed Strathy South Wind Farm Environmental Statement (ES) Addendum. SLR supplemented the available data, supplied by SSE Renewables with additional site investigation and geomorphological mapping data to facilitate an initial slope stability risk assessment.

The peat assessment has been the product of a number of phases of investigation to modify turbine locations and routing based on a number of constraints, including, ecology, slope, hydrogeology and landscape. This peat assessment is the final assessment based on the wind farm layout defined in the Environmental Statement (ES) Addendum Report and with some supplementary information undertaken in June, September 2012 and May 2013.

Throughout the layout design process any area where peat stability was considered a risk, the design of the layout has been modified to avoid these areas where possible. The risk assessment identified a limited number of locations where there was considered to be sufficient risk that a hazard assessment should be undertaken to identify appropriate mitigation measures. Areas where a risk of peat instability was identified relate only to access tracks.

The methodology adopted in this risk and hazard assessment closely follows the guidance prepared by the Scottish Executive[1]. The methods are aimed specifically at assessing the risk and consequences of peat instability and consider the impact of failure on a number of receptors including the general public, on and off-site infrastructure and the environment, including watercourses. Due to the extent of forestry on the site, the investigation concentrated along existing roads, forestry rides and clearings, with probes taken within at least 100 metres of every turbine location. Of the 47 turbine locations; 38 probes have been taken within 50 metres and 26 are within 20 metres.

The purpose of the assessment was to determine the risk of peat slope instability resulting from construction activities associated with the entire wind farm infrastructure. The Scottish Executive guidance requires the risk of instability to be determined and subsequently the possible impact of any instability to be assessed. The hazard is determined in terms of the impact on potential receptors such as infrastructure, communities and environment.

The investigation has shown that of the 47 turbine locations; 7 are located on peaty soil/ topsoil or rock and are not at risk from peat instability; 40 are located on peat (>0.50m) with no turbines having a risk rating greater than low risk for peat instability.

A number of locations along the access track were assessed as having a ‘medium’ risk of instability; further consideration and identification of appropriate mitigation measures has reduced the hazard to an acceptable insignificant hazard rating.

Mitigation measures have been discussed and recommendations for further work made. It is important to note that this risk assessment is the first phase in the development of a fundamental understanding of the sub-strata relationships at the Strathy South site. This risk assessment should be further informed by more detailed site investigations and used to ensure the appropriate detailed design of access tracks, hard standings and turbine foundations.

[1]Scottish Executive. Peat Hazard Landslide Risk Assessment. December 2006

It is concluded that the layout with the current turbine positions and track alignment, along with the construction of the wind farm would not result in any unacceptable hazards from potential peat instability.

1.0 INTRODUCTION

SLR Consulting Ltd (SLR) was commissioned by SSE Renewables Developments (UK) Ltd (SSE Renewables) to undertake a peat slide risk assessment at the proposed Strathy South Wind Farm near Strathy, Scotland (Drawing No.1).

The purpose of this Report was to consider the potential risk of peat slides occurring at the Site such that suitable controls and appropriate methodologies can be employed during construction and commissioning of the wind farm to mitigate against these risks. This report is an Addendum Report and incorporates previous data undertaken in 2007, by MouchelParkman and included in the previous submission. The initial report did not sufficiently cover the extent of the site, so this additional report was to maximise the peat assessment and coverage for the site.

This Report presents the findings of the peat depth probing and site reconnaissance surveys which were undertaken following a desk study review of existing literature and map information for the Site area.

The methods adopted for the assessment follow the best practice guidance[2] issued by the Scottish Executive for the investigation, assessment and reporting for wind farms in peat areas. (Where deviations from this guidance have occurred, this is highlighted in the text).

This report has been compiled to reflect SLR's understanding of the potential effect the peat may have on the development of the site. The information contained herein should be used in the civil engineering design associated with turbine construction and associated infrastructure.

1.1 Background

The importance of assessing the stability of peat deposits in relation to wind farm development came to the fore as a result of peat failures during the construction of the Derrybrien Wind Farm[3] in Ireland in 2003. Although no fatalities were associated with these failures, there was a significant environmental impact. Wind farms tend to be constructed in high moorland areas which are commonly associated with significant peat deposits (typically blanket bogs). There is a potential for peat instability to occur, particularly where deposits are in excess of 1 m deep. Peat instability is a natural occurrence which is influenced by many factors including, but not limited to, peat thickness, hill slope gradient, under lying geology and subsurface hydrology.

1.2 Objectives of Report

This Peat Stability Assessment is primarily concerned with the influence of the peat on the development of the wind farm.

The main objective is to assess the potential peat stability at the wind farm site, identify areas of potential concern and identify mitigation measures to ensure the maintenance of peat stability before, during and after construction. All aspects of construction should be based on ensuring minimum disruption to the peat areas.

[2] Scottish Executive. Peat Hazard Landslide Risk Assessment. December 2006

[3] Lindsay, R.A. and Bragg, O., (2004), 'Windfarm and Blanket Peat, The Bog Slide of 16th October 2003 at Derrybrien, Co. Galway, Ireland'. University of East London

The objectives will be achieved by completion of the following:

- a desk study of available reports which include geological, hydrological and topographical information;
- geomorphological mapping of the site to identify the prevailing conditions influencing the potential for, or any evidence of, active, incipient or relict peat instability, including identification of the location and photographic record, as appropriate;
- Reporting on evidence of any active, incipient or relict peat instability, and the potential risk of future instability, describing the likely causes and contributory factors;
- Identification potential controls to be imposed on the Contractors for the Works to minimise the risk of peat instability occurring at the Strathy South Wind Farm Site;
- Provide recommendations for further work or specific construction methodologies to suit the ground conditions at the Strathy South Wind Farm Site to mitigate any unacceptable risk of potential peat instability;

This Report summarises the findings of the Desk Study and Site Reconnaissance surveys and provides an assessment of the prevailing ground conditions as they relate to peat stability issues.

1.3 Wind Farm Proposal

The proposed wind farm comprises 47 wind turbines with approximately 33 km of new access tracks, including existing tracks within the turbine site, which will require upgrading. The wind farm will include a switching station and substation in the permanent works. The temporary works will include a construction compound, a temporary site establishment compound and laydown area.

1.4 Site Location and Description

The proposed Strathy South Wind Farm Site is located within the Strathy South Forest block, approximately 12 km south of Strathy village and 30-35 km west of Thurso. Access to the Wind Farm Site is gained via an existing estate track originating from Strathy and enters the north eastern side of the proposed wind farm. The track is currently used as part of the main access to the estate.

The proposed wind farm includes the following:

- Forty Seven (47) wind turbines with a maximum tip height of up to 135 m;
- Permanent foundations supporting the wind turbines and associated crane hard standings (used during construction, operational repair and decommissioning);
- An external transformer at the base of each turbine;
- Permanent tracks into the site from the public highway, through Strathy North Wind farm and between turbines, including both cut and floating track sections;
- Eighteen (18) water crossings;
- Underground cabling within the wind farm site, and to a new substation at Dallangwell;
- Four anemometry mast and associated foundations and hardstandings;
- An electrical metering and site switching station;

- A 33kV/ 132kV substation including external transformers, substation control building, , is no longer required on the site and will be located adjacent to the north east corner of the Strathy North Wind Farm, near Dallangwell.

3.1.1 In addition, the following activities are required during the construction phase of the project:

- Establishment of two temporary site laydown areas/construction compound;
- Establishment of a construction compound and concrete batching plant;
- Extraction of stone from up to four (4) borrow pits;
- Tree removal of the plantation forest via harvesting and mulching methods; and
- Removal and management of material during foundation and track construction.

The ground elevation is between 130 m at Turbine 72 to 200 m AOD in the vicinity of Turbine 36 and the application site occupies an area of about ~1600 hectares. The area is open and gently undulating in character, with extensive blanket bog, lochs and pools Strathy South Forest is a commercial conifer plantation and occupies most of the forest between Loch nam Breac Mor and the River Strathy.

Figure 1 River Strathy (NGR 2810 9555)

Peaty soil and peat deposits cover most of the site and variously overly glacially derived soils such as glacial till comprising, sand and gravels and in places bedrock. There are exposures of bedrock and where exposed is seen to be metasedimentary rocks over the entire site.

1.4.1 Extent of Peat Coverage's

The extent of peat coverage is presented in Drawing 2 which is a summary of the geology taken from the available British Geological Survey (BGS) maps, site data and photo interpretation of the site. The peat is mapped as being developed over the whole of the turbine site where the peat is extensively draped over existing glacial till and bedrock. The peat has been subject to limited erosion from fluvial activity and localised erosion, causing minor hagging and ponding on the peat. The peat in the application site is generally a blanket type peat overlying the underlying strata, dissected by distinct watercourses, with thicker peat (deeper isolated peat) at the stream head of the River Strathy to the south of the site.

2.0 DESK STUDY REVIEW

Desktop data was provided to SLR by SSE Renewables, including aerial photographs and OS 1:25,000 mapping for the site. The aerial photography consisted of ortho-rectified colour images; no stereoscopic aerial photographs were available for the site.

Other information was available from previous studies completed as part of initial site appraisal including peat depth and peat assessment for the site undertaken by MouchelParkman in 2007.

2.1 Site History

The application site is currently used for commercial forestry and recreational use (fishing) and limited rough grazing. The application site forms a roughly U-shaped boundary and occupies most of the forest between Loch nam Breac Mor and the River Strathy with the River Strathy flowing through the centre of the site to the north. The land immediately adjacent to the site principally comprises open peatlands and moorland.

There are no mining or quarrying activities within the site application area.

2.2 Site Geology

The geology of the superficial deposits and bedrock at Strathy South have been determined by a review of existing geological information published by the BGS, geological information obtained from previous work provided by SSE Renewables and site inspection of the ground.

Extracts from the British Geological Survey Superficial and Bedrock Geological maps are shown as Drawing 3. There were no geological memoirs available for the site.

2.2.1 Superficial Deposits

The BGS Sheet 115W, Bedrock and Superficial Deposits (Strathy Point) confirms that the superficial geology at site is recorded as being predominantly Recent to Quaternary peat. Peat is extensively developed over the application site which in turn entirely overlies bedrock. There is no evidence of any glacial deposits on site, which are recorded as being predominantly glaciofluvial and hummocky glacial deposits developed to the north of the site.

Peat is extensively developed over the application site which in turn entirely overlies bedrock. There are two distinct layers within a peat bog, the upper acrotelm and the lower catotelm. The acrotelm is the fibrous surface to the peat bog[4], typically less than 0.5 m thick; which exists between the growing bog surface and the lowest position of the water table in dry summers. Below this are various stages of decomposition of the vegetation as it slowly becomes assimilated into the body of the peat. The peat in this area is generally fibrous and shows quite low levels of decomposition in the top 100 cm. The peat is generally flat lying with very little erosion or hagging associated with it. Where the peat was found to be deeper (>1.5 m) the level of decomposition was far more evident with increased humification and higher moisture content.

Extracts from the BGS Superficial and Bedrock Geological maps are shown as Drawing 3.

[4] Ingram, H.A.P., (1978), 'Soil layers in mires: function and terminology'. Journal of Soil Science, 29, 224-227.

2.2.2 Bedrock Geology

The BGS Sheets 115W confirms that the solid geology at site is almost entirely underlain by Moine age strata. The site can broadly be characterised by two areas, comprising Moine metasediments of the Bettyhill Formation across the western portion of the site and the Kirktomy Gneisses across the eastern portion of the site. The site is divided by the Swordly Thrust Fault which is orientated in a north northwest to south southeast orientation, displacing the younger Kirktomy Gneisses over the older Bettyhill Gneisses. There is no clear evidence of the Swordly Thrust Fault on the site.

A number of outcropping granitic rocks occur as sheets on the site, these are seen in the area where rock outcrops at surface. The granitic sheets are divided as those outcropping the west of the Swordly Fault and those to the east of the fault. These areas have been selected as potential borrow pit sites, as they appear to form slight ridges of outcropping rock at or close to surface.

The proposed development is located either side of the River Strathy which forms the western boundary of the eastern limb of the site.

Figure 2 Peat over weathered rock over bedrock (NGR 2775 9526)

2.3 Hydrology

The majority of the application site lies within the headwaters of the River Strathy catchment, principally drained at site via the River Strathy, and its contributing watercourses. The area rises to the south where the topography is steeper and comprises hilly moorland. The River

Strathy flows through the site, and there are a number of water bodies on the site, including Loch nan Clach, as well as a number of unnamed water bodies (pools and small lochs).

2.4 Hydrogeology

The site is underlain by impervious rock generally without groundwater except at shallow depth or in fractures. A review of aquifer characteristics confirms that water is likely to be retained in the peat and that groundwater may be present within sand and gravel horizons within the Glacial Till (if present) and within fractures or fault zones within the bedrock deposits. It is also probable that there will be limited groundwater storage and movement at the weathered interface of the Glacial Till and bedrock. Groundwater flow in upland areas typical of much of the application site tends to follow flow paths from high ground to adjacent valleys.

2.5 Aerial Photographs

The site is almost entirely covered in forestry which limits photo interpretation. The aerial photography indicates very limited changes in vegetation on the ground, but it is however possible to identify stream courses, ditches, areas of localised ponding and roads/tracks from the photographs. The aerial photographs were used in conjunction with the site topographic survey to identify the major geomorphological features, mainly as breaks of slope. The site was further assessed during site visits when more detailed mapping of the site was also undertaken.

2.5.1 Method

Interpretation of available aerial photographs was undertaken to assess and identify evidence of historic peat instability. The photographs were examined using various techniques to highlight features of interest such as:

- Possible extension and/or compression features;
- Areas of historic failure scars and debris
- Evidence of peat creep;
- Areas with apparently poor drainage;
- Areas with concentrations of surface drainage networks;
- Steeply incised stream cuttings within peat deposits;
- Areas with peat drift recorded on steep slopes.

Selected photographs are used to illustrate the mapping and interpretation, however only poor drainage and concentrations of surface water networks were evident. Areas on steeper forest rides were also investigated for potential peat drift; however there was no significant evidence of movement.

2.5.2 Feature Categories

From the aerial photograph and topographic survey interpretation a number of locations were inspected during the site reconnaissance. Areas considered susceptible to further peat instability were identified such as the major breaks of slope where peat is present and areas of peat hagging/erosion and ponding occur. These locations were generally avoided during site selection based on the anticipated ground conditions and the nature of the features seen in the photographs. These feature types, together with brief notes from the site reconnaissance are described below and are shown in Drawing 2.

Extension /Compression Features

There was no evidence visible in the aerial photographs of any extension or compression features in the peat. It was not possible to identify evidence of any significant historic peat failures or slides from the aerial photographs. Ground investigation proved that there were no significant features of this nature in the vicinity of the wind farm area and no slumping of peat was evident along track corridors.

Natural Drainage

Drainage across the site is characterised by a number of streams feeding into the River Strathy. There are also approximately eight areas of ponding on the site, indicating the saturated nature of the peat and impermeable nature of the substrate, predominantly bedrock.

There is a number of man-made drainage ditches in the peat across the site, which appears to be related to the forestry activities in these areas. The ditches have been constructed to facilitate drainage in the forestry and link up via the natural and man-made drainage channels in the peat to small streams which ultimately link up to the River Strathy. The drainage ditches inspected during the site reconnaissance were all constructed in the peat, i.e. the ditches were not excavated into the subsoil material beneath the peat, although erosion indicated that mainly bedrock was immediately below the surface.

2.6 Existing Information

A preliminary peat assessment undertaken by MouchelParkman (2007)[5] has been reviewed as part of the current assessment. Peat probing data over a limited area was undertaken and used to produce the preliminary assessment contained in their report designed to inform peat characteristics at a general level. The data was used by SLR to help identify areas of concern, and has been included with SLR's data in the peat slide risk assessment, as it partly covers the main areas SSE Renewables are now targeting. SLR has validated the data where the data proves final depth of peat; most of the information has been included in this stability assessment.

The methods used in the preliminary risk assessment are discussed in greater detail in Section 6.0 which addressed the complete methodology for the risk assessment and hazard ranking.

[5] Peat Desk Study & Site Reconnaissance Report, August 2007 MouchelParkman Ltd

3.0 PEAT INSTABILITY

This section reviews the nature of peat and how current and past activities can influence stability.

The factors which are likely to influence the potential for peat instability are:

- Significant peat depths over impermeable bedrock or minimal soil;
- The presence of slope gradients greater than 4° (approximately) and general topography;
- Natural drainage paths;
- Evidence of past failures, including soil creep;
- Drainage features at the base of slopes which could lead to undercutting;
- Forestry plantations and artificial drainage;
- Recent climate patterns.

It should be noted that peat instability is not a recent phenomena and there is documentary evidence of peat landslides dating back over 500 years[6] . Many landslides that involve peat have no human interference that could be considered as a trigger and this should be borne in mind when considering the susceptibility of a site to potential instability.

3.1 Background Information Regarding Peat

Peat is found in extensive areas in the upland and lowland regions of the UK and is defined as the partly decomposed plant remains that have accumulated in-situ, rather than being deposited by sedimentation. When peat forming plants die, they do not decay completely as their remains become water logged due to regular rainfall. The effect of water logging is to exclude air and hence limit the degree of decomposition. Consequently, instead of decaying to carbon dioxide and water, the partially decomposed material is incorporated into the underlying material and the peat 'grows' in-situ.

Peat is characterised by low density, high moisture content, high compressibility and low shear strength, all of which are related to the degree of decomposition and hence residual plant fabric and structure. To some extent, it is this structure that affects the retention or expulsion of water in the system and differentiates one peat from another.

Lindsay[7] defined two main types of peat bog, raised bog and blanket bog, which are prevalent on the west coast of Europe along the Atlantic seaboard. In Britain the dominant peat land is blanket bog which occurs on the gentle slopes of upland plateaux, ridges and benches and is predominantly supplied with water and nutrients in the form of precipitation. Blanket peat is usually considered to be hydrologically disconnected from the underlying mineral layer.

There are two distinct layers within a peat bog, the upper acrotelm and the lower catotelm. The acrotelm is the fibrous surface to the peat bog[8], typically less than 0.5 m thick; which exists between the growing bog surface and the lowest position of the water table in dry

[6] Smith, L.T., (Ed) (1910), 'The literary of John Leland in or about the years 1535-1543.' Vol.5, Part IX. London: AF Bell and Sons.

[7] Lindsay, R.A., (1995), 'Bogs: The ecology, classification and conservation of Ombrotrophic Mires.' Scottish Natural Heritage, Perth

[8] Ingram, H.A.P., (1978), 'Soil layers in mires: function and terminology'. Journal of Soil Science, 29, 224-227.

summers. Below this are various stages of decomposition of the vegetation as it slowly becomes assimilated into the body of the peat.

For geotechnical purposes the degree of decomposition (humification) can be estimated in the field by applying the 'squeezing test' proposed by von Post and Grunland[9] (1926). The humification value ranges from H1 (no decomposition) to H10 (highly decomposed). The extended system set out by Hobbs[10] provides a means of correlating the types of peat with their physical, chemical and structural properties.

The relative position of the water table within the peat controls the balance between accumulation and decomposition and therefore its stability, hence artificial adjustment of the water table by drainage requires careful consideration.

3.1.1 Peat Shear Strength

In geotechnical terms, the shear strength of a soil is the physical characteristic that provides stability and coherence to a body of soil. For mineral soils such as clays or sands, such strength is variously given by an inter-particle friction value and cohesion. Depending whether the mineral soil is predominantly cohesive (clay) or non-cohesive (sand) governs which of the components of strength control the behaviour of the soil.

For peat soils, where the major constituent is organic and there is likely to be little or no mineral component, the geotechnical definition of shear strength does not strictly apply. At present there is no real alternative method for defining the shear strength of peat, therefore the geotechnical definition is generally adopted, in the knowledge that it should be used with great caution.

As noted before, the acrotelm or near surface peat comprises a tangle of fresh and slightly rotted roots and vegetable fibres. These roots and fibres impart a significant tensile shear strength capacity to the material which provides it with a significant load carrying capacity. The acrotelm is, in effect, a fibre reinforced soil.

In the more decomposed catotelm, the tensile shear strength is reduced as the roots and fibres become more rotted. However, the loss in strength due to decomposition is off-set to a limited degree, by a gain in strength due to the overburden pressure. In geotechnical engineering there is an established relationship for recently deposited soils, between the shear strength of a sample and the thickness of overburden above it.

Consequently it is almost impossible to predict a shear strength profile in peat and attempts to measure the shear strength using normal geotechnical methods can be misleading. Typical values of shear strength from hand shear vanes would be in the range 20-60 kPa although values over 100 kPa have been recorded in peat elsewhere. The higher strengths are almost certainly the influence of roots or other non-decomposed material. It is believed that the strength of peat should be quoted as a cohesion value as there are few, if any, discrete particles to give the material a significant frictional resistance. It should be noted, however, that any quotation of shear strength for peat should be treated with extreme caution.

[9] Von Post, L. and Grunland, E., (1926), 'Sodra Sveriges torvillganger 1' Sverges Geol. Unders. Avh., C335, 1-127.

[10] Hobbs, N.B., (1986), 'Mire morphology and the properties and behaviour of some British and foreign peats.' Quarterly Journal of Engineering Geology, London, 19, 7-80.

3.2 Peat Stability – Factors to be considered.

There is considerable observational information relating to debris and peat flows although the actual mechanisms involved in peat instability are not fully understood. The main influences on slope stability are geological, geotechnical, geomorphic, hydrological, topographic, climatic, agricultural and human influences such as drainage and construction activity. Peat is affected to a degree by changes in any of the above list and it is vital to appreciate that changes to the existing equilibrium will affect the level of slope stability during construction and operation of the scheme.

Some of the contributory factors to peat instability are summarised below:

1. The geographical limits which could be affected by potential instability are not confined to the artificial boundaries imposed by land ownership; landslip occurring above a site could affect the site and property down slope or downstream of the site for several kilometres.

2. Agriculture and grazing has a significant effect on peat areas and this can be compounded in areas that have been managed to improve grazing. Grazing compacts the peat surface reducing the rainwater infiltration and the additional nutrients change the ecological balance of the original peat bog. Agricultural management can include surface drainage and periodic burning, both of which can leave the surface of the peat bare for a period of time resulting in temporary desiccation of the surface. Subsequent wetting of the peat and resumption of peat accumulation results in the former desiccated and possibly ash covered surface being incorporated into the body of the peat which introduces a weak discontinuity in the profile; this in turn becomes another unknown factor in the stability assessment.

3. Forestry has a significant effect on slope stability particularly in the early stages as the creation of a forest involves disruption of the natural equilibrium and drainage of the slopes and the installation of artificial drains by deep ploughing. The construction of access tracks further disrupts the drainage and concentrates groundwater flow into narrow, fast flowing erosive streams. The work by Winter el al[11] noted that forest tracks can act to retard or concentrate the down slope flow of water and thus aid its penetration into the slope below. Such a mechanism has been observed at a number of recent landslips that have affected the road network in Scotland.

4. Natural Drainage – some of the precipitation falling onto a natural upland peat bog will be absorbed into the low permeability catotelm peat. However, most of the water will run-off as sheet flow through upper, high permeability acrotelm. Thus the water is transmitted to the lower slopes in a reasonably controlled manner through a range of interconnections that operate at different scales and speed[3]. Failure to understand this and to disrupt the transmission process for the groundwater could result in instability.

5. Artificial Drainage - Where agricultural drainage has been used to improve the quality of the grazing or to promote forestry it reduces the overall volume of water entering the bog and transfers this water to the edges more rapidly. This can result in ditches and streams becoming enlarged, causing increased erosion and a greater silt burden in the stream water.

[11] Winter, M.R., Macgregor, F. and Shackman, L. (2005a), 'Scottish tracks networks landslide study' Trunk tracks: network management division, published report series. The Scottish Executive.

3.3 Peat Mass Stability

The principal surface indicator of peat slide potential is cracking of the peat land surface and it is the identification of crack patterns in the field and the attendant causes of the cracking that is fundamental to a peat stability assessment.

Sites that have exhibited natural instability in the past are likely to be more susceptible to future instability during and following construction of a wind farm, therefore it is important to identify such instability as part of the Peat Stability Assessment.

3.3.1 Types of failure

The result of instability in peat is the down-slope mass movement of the material; there are a number of definitions of peat instability which are used to characterise the type of failure. A brief description is given below:

- Bog Bursts or Bog Flows – the emergence of a fluid form of well humified, amorphous peat from the surface of a bog, followed by the settling of the residual peat, in-situ[12].
- Peat Slides – the failure of the peat at or below the peat/ substratum interface leading to translational sliding of detached blocks of surface vegetation together with the whole underlying peat stratum[12].
- Bog slide – an intermediate form of instability where failure occurs on a surface within the peat mass with rafts of surface vegetation being carried by the movement of a mass of liquid peat.

3.3.2 Bog Bursts

Accounts of bog bursts are generally associated with very wet climates or areas which have received storm rainfall events. Bog bursts can be associated with particularly wet peat landscapes; therefore it is possible to identify broad regions of a higher susceptibility to these failures. The constraints used to identify the areas of higher susceptibility to bog burst failure are given below:

- Peat thickness in excess of 1.5 m with no upper limit[2]
- Shallow gradients from 2° to 10° (peat thicker than 1.5 m is generally not observed on slopes steeper than 10°, also moisture content is generally reduced on steeper slopes due to drainage)[2];
- Ground which is annually waterlogged to within the upper 1 m below ground level, (the groundwater level may rise above this but rarely falls below)[13];
- Greater humification of the lower catotelm within the waterlogged ground;
- Lower surface tensile strength of the fibrous peat and vegetation.

The humified mass can be considered as analogous to a heavy liquid and the stability of this mass is maintained by the strength of the surface or acrotelm peat. Should the surface become weakened through erosion or desiccation or the construction of a surface drainage ditch for agricultural or forestry reasons or through turbary (peat cutting), failure is made more likely.

[12] Dykes, A.P and Kirk, K.J., (2001), 'Initiation of a multiple peat slide on Cuilcagh Mountain, Northern Ireland.' Earth Surface Processes and Landforms, 26, 395-408.

[13] Crisp, D.T., Dawes, M. & Welch, D. (1964), 'A Pennine Peat Slide', The Geographical Journal, Vol 130, No4, pp519-524.

There is evidence to indicate that periods of relative drought can predispose the peat mass to a bog burst failure3 as desiccated peat appears less able to re-absorb moisture, resulting in failure due, in part, to buoyancy.

A heavy rainfall event can lead to a surge in the volume of water retained in the bog, resulting in high water pressures and an effective bursting of the peat surface. These types of failure have only been described in Ireland.

3.3.3 Peat Slides

Peat slides tend to be translational failures with a defined shear surface at or close to the interface with the substrate.

The factors generally considered to influence susceptibility to peat slide failures are listed below:

- Peat depth up to 2 m;
- Slope gradients between 5° and 15°;
- Natural or artificial drainage cut into the surrounding peat landscape;
- Greater humification of the lower catotelm within the waterlogged ground;
- Lower surface tensile strength of the fibrous peat and vegetation.

It will be noted that some of the factors causing instability are common to both bog bursts and peat slides.

The peat – substrate interface is the primary zone of failure and is enhanced by elevated water content at this boundary and softening or weathering of the lower mineral surface. For this reason, any investigation or probing should try to distinguish the nature of the lower mineral substrate.

3.3.4 Bog Slides

A variation on a peat slide where part of the peat mass is subject to movement, usually on an internal layer of material, which may be more prone to movement, such as an interface between the acrotelmic and catotelmic layer.

3.3.5 Natural Instability

The stability of a peat mass is maintained by a complex interrelationship of many factors, some of which may not be immediately obvious. Significant factors include sloping rock head and proximity to a water body. Rainfall often acts as the trigger after the slope has already been conditioned to fail by natural processes.

It should also be remembered that peat bogs are growing environments and that there will come a time, on sloping ground, where the forces causing instability, i.e. the weight of the bog, can no longer be resisted by the internal strength of the peat and its interface with the underlying mineral surface. At this point, failure will occur.

The weight of the peat bog or any soils mantling steep hill slopes will be increased during periods of very heavy rain and it is common to see landslips occurring following extreme rain events. This may be a concern for future developments where one of the predicted effects of global warming will be a greater frequency of extreme weather, intense storms being one element.

4.0 SITE RECONNAISSANCE AND GEOMORPHOLOGICAL MAPPING

A programme of site reconnaissance was undertaken during June, August 2012 and May 2013 to verify the conditions indicated by the desk study, and allow observation of the features highlighted by the aerial photography and those areas identified from the preliminary assessment as being potentially susceptible to instability. The reconnaissance was undertaken to establish areas of potential concern from a number of constraints including ecological, landscape, hydrogeological and peat risk. This allowed the potential risk to these receptors from the construction of turbine locations, access tracks and associated infrastructure to be evaluated.

The reconnaissance also provided the opportunity to record any visible feature of historic peat instability, drainage features, changes in vegetation, land management practices and general geomorphological features. Based on a combination of physical constraints, (mainly ecological and hydrogeological) potential areas were investigated to establish suitable development areas. These were areas where the peat was either not present, if present not extensively hagged, avoiding steep slopes or away from thick valley mire type deposits. The geomorphological interpretation map (Drawing 2) show areas which were avoided as part of the site selection.

The reconnaissance and mapping were undertaken by experienced geotechnical and hydrogeological engineers. This section provides a commentary and discussion of the site and the issues arising from observations made during the site reconnaissance.

Features identified in the aerial interpretation and the site reconnaissance are presented in Drawing No.. The key findings from the mapping exercise are discussed in Section 5.0, below; the desk and field observations are presented in Section 5.3.

4.1 Site Work

All the identified peat areas were inspected and confirmation probing and sampling was undertaken to build on the data contained in the MouchelParkman report. The inspection was limited to the existing tracks, forest rides and clearings and included observations of areas both up-slope and down-slope of the turbine sites, the proposed access tracks (where applicable), the cabling track to the sub-station, the construction laydown area, switching station and sub-station. Limitations due to extensive forestry restricted detailed mapping around each turbine, however every effort was made to access as close to every turbine as physically possible. The network of existing tracks and forest rides allowed SLR to complete a comprehensive grid of data around most of the infrastructure, turbines and tracks. The site is generally flat with only moderate undulations. As can be seen from Drawing 4 the predominant slopes on site are generally less than 4° and therefore pose low risk

4.2 Methodology

The thickness of the peat was assessed using a graduated aluminium rod, approx 6 mm diameter and 225 cm long (Avalanche Probe) as well as using a graduated fibre glass peat probe, which can be extended to over 10m depth. This was pushed vertically into the peat to refusal and the depth recorded, together with a unique location number and the coordinates from a handheld Global Positioning System instrument (GPS). The accuracy of the GPS was quoted as ±4 m, which was considered sufficiently accurate for this preliminary reconnoitre. All data was uploaded to a PC for incorporation into various drawings and analysis assessments.

Where the peat probing met refusal on a hard substrate, the 'feel' of the refusal can provide an insight into the nature of the substrate. The following criteria were used to assess likely material:

- Solid and abrupt refusal – rock;
- Solid but less abrupt refusal with grinding or crunching sound – sand or gravel;
- Rapid and firm refusal – clay
- Gradual refusal – dense peat or soft clay

An assessment of the substrate was made and recorded at each probe hole.

The relative stiffness of the peat was also assessed from the resistance to penetration of the probe and in particular to the effort required to extract the probes (retrieval of the probe was often impossible for one person). Some areas, especially on slopes, were a little drier, resulting in the peat being stiffer and more difficult to fully penetrate. In all instances refusal was met on obstructions allowing identification of subsurface geology.

A peat auger was used to recover disturbed samples from a range of depths for moisture content analysis. The auger was also used to determine the thickness of the peat and to recover samples of the substrate when the material is cohesive. There was no cohesive material on the site.

Over 2400 peat probes have been carried out within the application site. The location of the probes was chosen by consideration of the data from the desk study and site reconnaissance in combination with the turbine locations and access track. The positions were verified on site by the use of a GPS. This includes over 700 data points undertaken by MouchelParkman.

Figure 3 Peat overlying glacial till (NGR 2780 9526)

5.0 GROUND CONDITIONS

The ground conditions were assessed from the probing exercise, sample descriptions and descriptions of in situ peat observed in streams and drainage ditches.

5.1 Peat

The peat was found to vary across the site in terms of thickness, surface slopes and apparent characteristics. Peat thickness varies from zero to 5.0 m in the application area. Accumulations of peat up to 0.5m thick are considered to be too thin to be classified as true peat deposits and are often classified as organic soils or peaty soils. The peat thickness identified on this site falls within the range that requires a formal risk and hazard assessment as defined in the Scottish Executive guidance[2]. The peat thickness was examined by review of the probe information from the investigation and is discussed below.

The geomorphology of the peat areas varies between large, flat expanses of apparently thick peat with high moisture content and smaller areas of thinner drier deposits blanketing the moderate undulating slopes.

The peat thickness at each location was recorded and the data used to draw the interpreted peat thickness map, presented as Drawing No.5. The colour scale was selected to aid the identification of areas of similar peat thickness.

A total of 2462 probe holes were undertaken, with the following results.

Table 5-1

Number of Probes	Peat Thickness
163	>3.0 metres
720	1.5 -3.0 metres
1068	0.5-1.5 metres
511	<0.5 metres

Despite the concerns expressed in Section 3.1.1 regarding the determination and assessment of shear strength of peat, there is merit in having a standard strength descriptor that is recognisable by geotechnical engineers, providing that they understand the limitations attached to the implied strength. For the purposes of this investigation, the undrained shear strength descriptors from the Eurocode 7[14] (EC7) have been adopted.

The shear strength of the peat was assessed from inspection of natural exposures and recovered samples, to be in the range very soft to firm (<10-50 kPa).

The strength of the peat in the upper acrotelm is significantly influenced by the root and fibres that are abundant in this layer. As noted previously, there are many influences on the

[14] BS EN ISO 14688-1:2002 Eurocode 7 – Geotechnical Investigation and Testing – Identification and classification of soil.

stability of the peat and observing or measuring high shear strength should not be used to assume a high degree of stability.

The probing investigation identified the following profiles within the peat:

- Soft to firm from surface to base of peat;
- Relatively firmer, vegetative root system at surface to approximately 50 cm, underlain by slightly softer, partially waterlogged peat to base, and
- Vegetation still present to base of peat and clearly identifiable

Peat has been described using the von Post[9] Classification throughout this document which is briefly summarised in Table 5-2 below:

Table 5-2
von Post Classification for Peat Humification

Degree of humification	Decomposition	Plant structure	Content of amorphous material	Material extruded on squeezing	Nature of residue
H_1	None	Easily identified	None	Clear, colourless water	
H_2	Insignificant	Easily identified	None	Yellowish water	
H_3	Very slight	Still identifiable	Slight	Brown, muddy water; no peat	Not pasty
H_4	Slight	Not easily identifiable	Some	Dark brown, muddy water; no peat	Somewhat pasty
H_5	Moderate	Recognisable but vague	Considerable	Muddy water and some peat	Strongly pasty
H_6	Moderately strong	Indistinct (more distinct after squeezing)	Considerable	About ⅓ peat squeezed out; water dark brown	Fibres and roots more resistant to decomposition
H_7	Strong	Faintly recognisable	High	About ½ peat squeezed out; any water very dark brown	
H_8	Very strong	Very indistinct	High	About ⅔ peat squeezed out; also some pasty water	
H_9	Nearly complete	Almost unrecognisable		Nearly all the peat squeezed out as a uniform	

Degree of humification	Decomposition	Plant structure	Content of amorphous material	Material extruded on squeezing	Nature of residue
				paste	
H_{10}	Complete	Not discernible		All the peat passes between the fingers; no free water visible	

The water content of the peat is estimated on a scale from 1 (dry) to 5 (very high), designated as B_1 to B_5 and is often used in combination with the van Post classification to characterise peat.

As a general guide, the following limits have been applied:

Table 5-3
Water Content

B_1	dry
B_2	<500%
B_3	500-1000%
B_4	1000-2000%
B_5	>2000%

The moisture content was interpreted visually and confirmed with laboratory testing as B_3 – B_4 range as described above and there is a general trend for a slight increase in moisture content with depth, within a broad range. The laboratory data is included in Appendix A of this report. Sampling for carbon content is included; these samples were collected in August 2012. The carbon content returned was 46% which is within the generally accepted range of 45-65% for Scottish peatlands. A number of bulk density samples were collected but these returned values which were unacceptably low for typical peat deposits.

Based on field descriptions most of the shallow peat would be classified as between H_3 and H_4 in the von Post classification, showing slight decomposition with some amorphous material. The deeper peat generally in excess of 1.5 m is more decomposed and would be in the range of H_5 to H_7.

5.2 Substrate

Where possible, in the SLR investigation, an assessment of the substrate was made, as described previously. From the evidence of the probing and sampling (where available), the substrate falls into one of two principal categories:

1. Sand and/or gravel, again of glacial origin and occasionally interbedded with silty sands;

2. Rock, no rock samples were recovered from the probe locations although where exposed, the rock was seen to be strong to very strong metasedimentary rocks

ranging from psammites through to gneisses. The bedding dip and discontinuity spacing could not be determined at this stage, but evidence from outcrops confirms the metasediments are folded and exhibit variable bedding orientations and should be subject to further investigation for the design of the turbine foundations.

3. No clay horizons were encountered and evidence from the site walkovers did not encounter cohesive clay materials on site.

6.0 RISK AND HAZARD ASSESSMENT

The method of risk and hazard assessment has been developed with reference to the Scottish Guidance[2]. Key factors which may have an effect on the stability of the peat deposits have been identified leading to an assessment of the RISK of instability. The potential impact of any instability, the HAZARD, was then considered for identified potential receptors. Scores were attributed to the key factors that have the greatest influence on peat stability. Risk scores were determined, which, when combined with an assessment of vulnerability of potential targets, were developed into an assessment of the hazard.

In order to differentiate between risk and hazard, the following nomenclature has been adopted.

Risk	Hazard
Negligible	Insignificant
Low	Significant
Medium	Substantial
High	Serious

This section outlines the approach taken and the scores allocated for various factors relevant to peat stability.

At this stage in the development of the proposed wind farm, the objective is to determine those peat areas that will have an effect on the wind farm and to set out the mitigation that could be adopted and incorporated into the overall development plan to ensure that due cognisance is taken in this regard.

The level of slope is normally assessed by reference to the factor of safety which is expressed, numerically, as the degree of confidence that exists, for a given set of conditions, against a particular failure mechanism occurring. It is commonly expressed as the ratio of the load or action which would cause failure against the actual load or actions likely to be applied during service. This is readily determined for some types of analysis (e.g. limit equilibrium slope stability analyses). The following sections present a brief discussion on some of the issues relating to stability and risk assessment.

6.1 Risk Score Development

The stability of peat is a complex subject and there are numerous inter-relationships that affect the stability.

A quantitative assessment requires a numerical input and such an analysis cannot account for the unquantifiable input required for a comprehensive peat stability assessment. For this reason a purely quantitative assessment should only be considered as a guide and a qualitative assessment of stability should be used to inform the final recommendations.

The characteristics of the peat failure phenomena described in Section 3.3 have been incorporated in a stability risk assessment to evaluate the risk of instability occurring within the peat areas. The main factors controlling the stability of the peat mass are the surface gradients, the depth and condition of the peat at each location and the type of substrate.

The natural moisture content and undrained shear strength of the peat are important; however, it is generally accepted that where present, the peat will be saturated and have a very low strength. It is believed to be unrealistic to rely on specific values of shear strength to maintain stability when back analysis of failed slopes indicates that there is often a significant discrepancy between measured strength in peat and stability. Therefore shear strength has been assumed to be constant and worst case, throughout this assessment. It has also been assumed, as a worst case, that the groundwater level is coincident with the ground surface.

The key factors identified as being critical to stability and the development of a risk rating system is:

- A – Slope gradient
- B – Peat thickness
- C – Substrate type or condition
- D – Historic instability

The risk scores are multiplied together to generate a risk rating which is a measure of the likelihood of peat instability.

6.1.1 Slope Gradients

The slope gradients were assessed by reference to the mapping and particularly the Digital Terrain Model which was used to generate a gradient map (Drawing No.4), from which the gradient at each probe location could be determined and input into the risk rating spread sheet (Appendix A). The gradient quoted at each location was based on the average gradient over a 5 m grid. Significant effort has gone into reducing slopes along routes and at turbine bases, it is evident from the Slope Plan that the majority of the tracks and turbines are on areas with flatter gradients (<4°).

Table 6-1 presents the slope angle coefficients.

Table 6-1
Coefficients for Slope Gradients

SLOPE ANGLE (^{o})	SLOPE ANGLE COEFFICIENTS
Slope <2°	1
2°≤ Slope <4°	2
4°≤ Slope <8°	4
8°≤ Slope <12°	6
>12° Slope	8

Coefficients for slope gradient have been assigned to ensure the potential for both peat slides (gradients of 4-15°) and bog slides (gradients of 2-10°) are addressed.

By simple inspection it is clear that steeper slopes pose a greater risk of instability than shallow gradients. Therefore a graduated gradient scale from 0° to >12° (the practical maximum gradient on which peat is commonly observed) has been applied.

6.1.2 Peat Thickness and Ground Conditions

The ground conditions were assessed by peat depths recorded during peat probing. Thin peat was classed as being 0.5 m to 1.5 m thick, with deposits in excess of this being classed as thick. The thickness ranges used are intended to reflect the risk of instability associated with both peat slides (in thin peat) and bog slides. Where the probing recorded peat less than 0.5m thick, this has been considered to be an organic soil rather than peat. Table 6-2 below, gives the coefficients applied to the various ground conditions.

In addition to peat thickness, the presence of existing landslip debris or indicators of meta-stable conditions such as tension cracks or slumping in the peat suggest the material is likely to become even less stable should the existing ground conditions change. Where evidence of historical slips, collapses, creep or flows is seen, a separate coefficient has been applied

Table 6-2
Coefficients for Peat Thickness and ground conditions

GROUND CONDITIONS	GROUND CONDITION COEFFICIENTS
Peaty or organic soil (<0.5 m)	1
Thin Peat (0.5 – 1.5 m)	2
Thick Peat (>1.5 m)	3*
Slips /collapses / creep / flows	8

* - Note that thicker peat generally occurs in areas of shallow gradient and records indicate that thick peat does not generally occur on the steeper gradients.

Based on the aerial photo interpretation and site reconnaissance, evidence of historic instability is sparse.

The interpolated peat thickness is presented in Drawing No.5.

6.1.3 Substrate

As noted above, most failures in thin peat layers occur at the interface with the underlying substrate; the nature of the substrate has a very large influence on the probable level of stability[3].

Where sand and/or gravel (derived from glacial till) form the substrate, the effective strength of the interface can be considered to be good with comparatively high friction values. Under these conditions, failure is likely to occur in a zone within the peat, just above the interface. Further factors are necessary to cause a failure of this nature (increased pore pressures within the peat) and occurrence of such events is rare.

Where clay forms the interface, there is likely to be a significant zone of softening in the clay (due to saturation at low normal stresses, poor or none existent vertical drainage and the effect of organic acids), resulting in either very low undrained shear strength or low effective shear strength parameters. The result is that potential shearing could occur either in the peat, on the interface or in the clay; all three possibilities have been documented in the past.

A rock substrate provides a high strength stratum, however, the rock surface can be smooth, and, depending on the dip orientation of the strata, it can provide a very weak interface. For these reasons, at this stage, a rock interface has been given the same risk rating as clay.

Table 6-3
Coefficients for Substrate

SUBSTRATE CONDITIONS	SUBSTRATE COEFFICIENTS
Sand/gravel	1
Clay	2
Rock	2
Not proven	3
Slip material (Existing materials)	5

If the overall thickness of the peat had not been proven, the risk associated with the significant thickness and the unknown substrate would have been given a high rating to accommodate the unknown factors. This was not found at Strathy South where the total thickness of peat was always proven.

Drawing No.6 presents the recorded substrate and provides a limited interpolation around each known point to permit a realistic estimate of the substrate over the greater part of the access track.

6.1.4 Risk Rating

The risk rating coefficient was derived by multiplying the coefficients for slope angle / gradient, peat thickness, and the ground / substrate conditions together which highlights possible areas of concern.

For the stability risk assessment, the following Potential Stability Risk classes were applied:

Table 6-4
Risk Rating

RISK RATING COEFFICIENT	POTENTIAL STABILITY RISK (PRE-MITIGATION)	ACTION
<5	NEGLIGIBLE	No mitigation action required although slide management and monitoring shall be employed. Slide management shall include the development of a site specific construction and management plan for peat areas which will detail the requirements for inspections and recording of instrumentation.
5 - <15	LOW	As for negligible condition plus Further investigation to refine the assessment combined with detailed quantitative risk assessment to determine appropriate mitigation to reduce the risk.
15 - <31	MEDIUM	As for Low condition plus Develop long term site monitoring regime.
>31	HIGH	Unacceptable level of risk, the area should be avoided. If unavoidable, detailed investigation and quantitative assessment required to determine stability and sensitivity to minor changes in strength and groundwater regime combined with long term monitoring.

The rating system outlined above differs slightly from that proposed in the SE Guidance[2] as the system adopted here incorporates three inputs compared to two in the guidance, with the potential impact of substrate added in this section.

Drawing No.7 present the interpreted risk of peat instability based on the multiplication of the coefficients discussed and using the limiting criteria in Table 6-4. Risk of peat instability is shown across all areas of the development. The Stability Risk Rating for each turbine is summarised below in Table 6-5.**.**

Table 6-5
Stability Risk Rating for each turbine

Turbine No.	X	Y	Peat Depth (m)	Slope (^{0})	Stability Risk at Turbine	Comment
1	280619	953031	0.25	11.7	Low	Steeper slope locally, micrositing will mitigate risk
2	281155	952737	0.73	0.0	Negligible	Thin peat on flat site, position acceptable
4	280687	952437	0.59	4.3	Low	Thin peat on flat site, position acceptable
6	281205	952237	0.38	2.4	Negligible	Peaty soil, position acceptable
8	280675	951871	0.48	2.6	Negligible	Peaty soil, position acceptable
9	281141	951618	2.96	3.9	Low	Thick peat on flat site, position acceptable
10	280139	951650	1.54	0.0	Negligible	Thick peat on flat site, position acceptable
11	280653	951295	0.75	1.8	Negligible	Thin peat on flat site, position acceptable
13	280144	951050	0.60	3.3	Negligible	Thin peat on flat site, position acceptable
15	281058	950872	0.73	1.7	Negligible	Thin peat on flat site, position acceptable
17	280598	950707	1.40	2.3	Low	Thin peat on flat site, position acceptable
18	281049	950334	2.47	3.5	Low	Thick peat on flat site, position acceptable
19	280030	950461	2.77	1.0	Low	Thick peat on flat site, position acceptable
20	280413	950162	0.94	2.7	Low	Thin peat on flat site, position acceptable
22	279973	949829	1.13	2.6	Negligible	Thin peat on flat site, position acceptable

Turbine No.	X	Y	Peat Depth (m)	Slope (^{0})	Stability Risk at Turbine	Comment
24	280781	949792	0.41	2.3	Negligible	Peaty soil, position acceptable
26	280279	949361	0.48	1.4	Negligible	Peaty soil, position acceptable
28	279786	949085	0.72	2.4	Low	Thin peat on flat site, position acceptable
29	279022	950112	2.24	0.2	Negligible	Thick peat on flat site, position acceptable
30	279413	949703	0.79	2.5	Negligible	Thin peat on flat site, position acceptable
33	279165	949159	3.29	2.9	Low	Thick peat on flat site, position acceptable
35	277397	949254	1.09	0.0	Negligible	Thin peat on flat site position
36	278217	949225	1.52	3.0	Low	Thick peat on flat site position acceptable
39	277866	949638	1.37	0.0	Negligible	Thin peat on flat site position acceptable
41	277431	949983	0.95	3.5	Negligible	Thin peat on flat site, position acceptable
42	278375	949964	2.08	2.0	Low	Thick peat on flat site, position acceptable
43	278763	949581	1.66	1.3	Low	Thick peat on flat site, position acceptable
45	278263	950529	1.38	4.5	Low	Thin peat on flat site, position acceptable
46	278855	950613	1.61	2.5	Negligible	Thick peat on flat site, position acceptable
49	277856	951064	2.24	1.6	Negligible	Thick peat on flat site position acceptable
47	278555	951001	0.90	2.4	Negligible	Thin peat on flat site, position acceptable

Turbine No.	X	Y	Peat Depth (m)	Slope (^{0})	Stability Risk at Turbine	Comment
50	278264	951400	1.06	0.0	Negligible	Thin peat on flat site, position acceptable
51	279071	951197	1.83	0.6	Negligible	Thick peat on flat site, position acceptable
52	277806	951652	3.41	0.0	Low	Thick peat, position acceptable
57	278737	951687	2.45	2.1	Low	Thick peat on flat site, position acceptable
55	277821	952164	2.95	1.8	Negligible	Thick peat on flat site, position acceptable
56	278297	951962	1.50	3.9	Low	Thin peat on flat site, position acceptable
61	279119	952086	0.31	6.8	Negligible	Peaty soil, position acceptable
62	277539	952985	0.51	2.6	Negligible	Thin peat, position acceptable
63	278086	952935	0.32	1.2	Negligible	Peaty soil on flat site, position acceptable
68	277537	953569	0.74	3.1	Negligible	Thin peat on flat site, position acceptable
69	278372	953507	2.09	2.2	Negligible	Thick peat on flat site, position acceptable
70	278683	953059	0.60	2.7	Negligible	Thin peat on flat site, position acceptable
72	279165	953538	2.81	3.0	Low	Thick peat on flat site position acceptable
73	277299	954098	0.85	4.4	Negligible	Thin peat on flat site, position acceptable
74	277764	954011	2.41	0.0	Negligible	Thick peat on flat site, position acceptable
76	278825	954085	0.76	2.7	Negligible	Thin peat on flat site position acceptable

As can be seen from the table, all of the turbine positions fall within the 'negligible' or 'low' risk classification with only one turbine influenced by steeper slopes, this can be mitigated by micrositing.

The consequences of the risk rating and the mitigation measures are discussed below in Section 6.2.

6.2 Hazard Score Development

Following assessment of the risk of peat instability within a particular area, a further assessment of the likely impacts of a failure is necessary. It should be noted that the impact assessment is primarily concerned with impacts that affect the environmental, ecological, public or infrastructure not associated with the wind farm development, both on site and potentially off-site. These assessments do not consider the detailed ecological impact of construction induced peat instability; however, the majority of the on-site receptors are the watercourses and thus the inferred ecological and environmental issues are addressed. The proposed mitigation measures will limit the potential for any slope failures into watercourses and drainage features and hence limit such impacts.

The effect of failure on the construction site and infrastructure can be easily identified and remediation is likely to be straight forward with quantifiable cost. However the effect of an instability event due to construction on features not associated with the development is harder to predict.

In order to address this effect it is not considered appropriate to assess the effect at every potential vulnerable location close to a site; but rather to assess the effect a particular construction feature (track, turbine, substation, etc) will have on the structures or features surrounding it. By adopting such an approach the assessment of features where a risk ranking of 'negligible' or 'low' (assessed in the stability risk assessments described above) is discounted at an early stage.

6.2.1 Feature Ranking

Once features with a 'medium' or higher risk rating for instability have been identified it is then necessary to identify potential impact receptors. These are nearby structures or features that may be affected by peat movements caused during or following construction. Generally, only receptors down gradient of the construction feature would be affected by peat instability therefore the first phase of feature ranking requires topographic ridges and valleys to be identified across the site and surrounding area. From this, receptors at risk from particular features can be identified. However, should instability occur on a steep slope, there is the risk of the back scarp of the instability migrating up-slope, there-by affecting areas previously considered to be not at risk.

Following identification of receptors at risk, features are ranked according to their size and a relative assessment of likely cost of repair or reconstruction. Table 6-6, below, presents the coefficients placed on particular receptor types.

Table 6-6
Coefficients for Impact Feature Ranking

NATURE OF FEATURE	FEATURE COEFFICIENT
Non-critical infrastructure (minor/private roads, tracks)	1
Watercourses and critical infrastructure (pipelines, motorways, dwellings and business properties etc)	3

NATURE OF FEATURE	FEATURE COEFFICIENT
Sub-Community (settlement 1-10 residents)	6
Community (settlement of >10 residents)	8

6.2.2 Feature Proximity

The proximity of an impact receptor is also critical in assessing the likely level of disruption it may suffer following an instability event. Based on this, two further coefficients – distance from construction feature and relative elevation - are applied in deriving an impact ranking. Table 6-7 and Table 6-8, below, present the coefficients derived for distance and elevation of impact features.

Table 6-7
Coefficients for Impact Feature Distance

DISTANCE FROM CONSTRUCTION FEATURE	DISTANCE COEFFICIENT
>1 km	1
100 m-1 km	2
10-100 m	3
0-10 m	4

Table 6-8
Coefficients for Impact Feature Elevation

RELATIVE ELEVATION OF FEATURE	ELEVATION COEFFICIENT
0-10 m	1
10-50 m	2
50-100 m	3
>100 m	4

6.2.3 Impact Rating

The impact rating coefficient is derived by multiplying the feature ranking coefficient by the distance coefficient and the elevation coefficient for each impact receptor associated with a particular construction feature. Based on the results of this assessment the following potential impact ratings are applied, as presented in Table 6-9:

Table 6-9
Impact Rating

IMPACT RATING COEFFICIENT	POTENTIAL IMPACT (PRE-MITIGATION)	EXPECTED IMPACT OF INSTABILITY EVENT
<10	VERY LOW IMPACT	Little or no effect on surrounding features due to an instability event.
11 - 20	LOW IMPACT	Effect will be minimal – remediation costs low minimal disruption to on- and off-site activities.
21 - 50	HIGH IMPACT	An instability event has the potential to cause damage or disruption resulting in remediation costs that are significant – 10-100% of total project budget.
>51	VERY HIGH IMPACT	Major effect caused by an instability event. Extensive disruption to off-site activities with

	remediation costs in excess of the total budget of the project.

6.3 Hazard Ranking

The SE Guidance[2] recommends that the hazard ranking is assessed using the following formula:

Hazard Ranking = Hazard x Exposure

This philosophy can be applied to the assessment carried out so far in the following approach:

Hazard Ranking = Risk Rating x Impact Rating

In order to achieve a meaningful, and manageable result from the hazard ranking the results of the Stability Risk Assessment and Impact Assessment have been normalised to a standard numerical scale (Table 6-10, below).

Table 6-10
Rating Normalisation

RISK RATING	
Current Scale	**Normalised Scale**
Negligible <5	1
Low 5 - <15	2
Medium <15 - 31	3
High 31 - 50	4
Very High >51	5

IMPACT RATING	
Current Scale	**Normalised Scale**
Very Low <10	1
Low 11 - 20	2
High 21 - 30	3
Very High 31-50	4
Extremely High >51	5

The method of assessing risk, impact and hazard developed by SLR incorporates additional critical elements such as the substrate interface and coefficients for the receptor position, distance and elevation and as such is considered to be more rigorous than the assessment scheme proposed by the SE. Whilst the scales used in the SLR method deviate from the SE Guidance (with risk and impact rating scales from 1-4 rather than 1-5), the ultimate Hazard Ranking scale does equate to the SE scale, with hazard rankings divided over four hazard ranking zones.

A simple multiplication of these coefficients would result in potentially large and unwieldy risk and impact rating numbers. Therefore, SLR has opted to normalise these values to bring them in line with the values used in the SE Guidance, as illustrated in Table 6-10 above

Table 6-11
Hazard Ranking

HAZARD RANKING	HAZARD RANKING ZONE	ACTION
1-4	INSIGNIFICANT	No mitigation action required although slide management and monitoring shall be employed. Slide management shall include the development of a site specific construction plan for peat areas.
5 - 10	SIGNIFICANT	As for Insignificant condition plus Further investigation to refine the assessment combined with

HAZARD RANKING	HAZARD RANKING ZONE	ACTION
		detailed quantitative risk assessment to determine appropriate mitigation through relocation or re-design.
11 - 16	SUBSTANTIAL	Consideration of avoiding project development in these areas should be made unless hazard mitigation can be put in place without significant environmental effect.
17-25	SERIOUS	Unacceptable level of hazard; development within the area should be avoided.

6.4 Results

The stability risk assessment has demonstrated that the majority of the Strathy South site lies within an area of negligible to low risk with regards to stability based on Drawing No.7. Those areas that have been identified as being at Medium risk of instability have been considered in a hazard impact assessment.

There are no communities of any description within the application area or within 1 km of any down slope regions of the site. The tributaries and the River Strathy are designated as a Special Area of Conservation (SAC) and there are sporting activities in the form of fishing and grouse shooting as well as public access rights within the site boundary.

Elevations are not significant within the site with the maximum change of 60m between turbine elevations, although local height differences between the various items of infrastructure and possible on-site receptors are typically less than 15m. The proposed infrastructure within the site is limited to the turbines, access tracks and cable routes, the switching station and the construction compound (temporary). Local receptors include the River Strathy and its tributaries and non-adopted forestry tracks which cross the central parts of the site.

The stability risk assessment results are presented in Table 6-12 in a tabulated format, together with the coefficients used and the probable risk potential. Table 6-12 shows the calculated hazard ranking associated with every location where there is a stability risk of medium risk. The particular mitigation measures to reduce the risk of instability occurring are dependent upon location and the type of proposed structure. Proposed mitigation measures and actions already undertaken to reduce the risk of peat instability occurring are also identified in Table 6-12, together with the associated, revised hazard ranking. A more detailed discussion of the possible mitigation measures are presented in Section 7.0.

The table of results shows that 2462 probe locations were identified within the extent of the Digital Terrain Model where peat was present (Drawing 8). The stability risk rating identified the following:

- Negligible risk at 1107 probe locations
- Low risk at 1156 probe locations
- Medium risk at 190 probe locations and
- High risk at 9 probe locations
- No peat was recorded at 29 locations, hence no risk.

Nine areas have been identified with a high risk of peat instability; these are all in thick areas of flat lying peat, which have been avoided through design, and neither turbines, infrastructure or tracks are located close to these locations.

Of the medium risk probe locations, 6 areas were considered to have either a potential impact on the wind farm infrastructure or could have an impact on the local watercourses. These areas are shown on Drawing No.7 and listed in Table 6-12 and were considered further. All of these risks could be mitigated by micrositing.

6.4.1 Hazard Rated Locations

As noted in Table 6-4, where the risk assessment has identified a Negligible or Low risk of peat instability, no specific mitigation measures are necessary. However, in order to ensure best practise is employed, there will be a need for careful monitoring and the construction management must include careful design of both the permanent and temporary works appropriate for peat soils; these are discussed further in Section 7.0.

The areas of the infrastructure that were rated as Medium risk were subjected to a Hazard assessment; any other areas rated as Medium risk were previously discounted as they were located off the proposed access track and do not fall within influencing distance of any of the key proposed site infrastructure.

The procedure adopted was to review Drawing No.7 and identify those areas with a Medium risk that were in close proximity or influencing distance of any of the proposed infrastructure. Those risk areas where there is no development will not affect the natural stability of the peat. The risk areas and receptors, together with the major geomorphological features are presented in Table 6-12.

Table 6-12
Stability Hazard Ranking

LOCATION[1]	RISK RATING	IMPACT RATING	HAZARD RANKING	COORDINATES		MITIGATION		REVISED HAZARD RANKING (Post action and mitigation)
				X	Y			
1	Medium	Very Low Impact	Insignificant	280763	952693	Thick peat. Existing track, upgrading the track will not be greatly impacted by peat, no mitigation required.	Access Track between T1 and T4	Insignificant
2	High	Very Low Impact	Insignificant	281001	951621	Thick peat influenced by presence of steep slope near proposed track, micrositing will mitigate risk.	Access Track near T9	Insignificant
3	Medium	Very Low Impact	Insignificant	277503	949410	Thick peat on proposed track, micrositing will mitigate risk	Access Track near T35	Insignificant
4	Medium	Very Low Impact	Insignificant	278827	952931	Thick peat. Existing track, upgrading the track will not be greatly impacted by peat, no mitigation required	Access Track near T70	Insignificant
5	Medium	Very Low Impact	Insignificant	278493	950977	Thick peat on proposed track, micrositing will mitigate risk	Access Track near T47	Insignificant
6	Low*	Very Low Impact	Insignificant	278263	950529	Thin peat. Slope to the east influencing the overall risk rating in Drawing 7. Micrositing will mitigate risk.	Access Track near T45	Insignificant

Notes 1 Taken from Drawing 7
*The probe point located closest to the turbine falls into the low risk category, however a localised slope to the east increases the risk rating to medium in the area near the turbine, as can be seen in Drawing 7.

Table 6-13
Summary Hazard Assessment

HAZARD RANKING	LOCATIONS	POST MITIGATIONACTION
Insignificant	All the above areas	No further specific mitigation action (outside that already identified) required although slide management and monitoring shall be employed as a good construction practice. Slide management shall include the development of a site specific construction plan for peat areas.
Significant	None	As for Insignificant condition plus- Further investigation to refine the assessment combined with detailed quantitative risk assessment to determine appropriate mitigation to reduce the risk.
Substantial	None	As for Significant condition plus- Develop long term site monitoring regime.
Serious	None	Unacceptable level of risk, the area should be avoided. If unavoidable, detailed investigation and quantitative assessment required to determine together with long term monitoring.

Based on the assessment of peat slide risk, all turbines are located in areas of low or negligible risk. On that basis, the turbine locations have not been considered further in the assessment of hazard ranking.

Similarly, where realignment of the proposed access track has been made, the new tracks have also been assessed as an Insignificant Hazard.

In practice the sections of track that may be influenced by peat instability are limited. The access to Turbines T70 and T4 have areas of peat which also coincide with steeper slopes. These sites however lie on the current access track, this is to be upgraded and given that much of the peat has already been modified there is no mitigation is required.

Modifications to routing have already been undertaken through the iterative layout design process, to avoid areas of concern, identified as part of the peat assessment.

7.0 CONSTRUCTION ISSUES

It has been shown that excavation, drainage and general construction activities can have a destabilising influence on peat and that design should allow for the delicate and susceptible condition of the peat. There is no extensive evidence for past peat instability at Strathy South, however areas on the access track to Turbines T35, T47 and T9 require minor micrositing and/or designed and constructed using techniques to mitigate the peat risk at these locations.

The following sections highlight the construction issues that should be considered for each general area of construction. Many of these issues also need to be incorporated into the construction management plan for the site.

7.1 Turbine Locations and Crane Pads

There is a presumption that all foundations for the turbines and heavy lift locations will be pad foundations bearing on a hard stratum at some depth below the base of the peat.

In general, the bearing stresses imposed by a turbine are relatively low and the main requirement of the base is to resist the overturning moments generated by the wind acting on the turbine. Gravity base foundations are designed to control bearing pressures to a level appropriate to the local ground conditions and provide stability against turbine loading.

The excavations for turbine bases and crane pads should be kept to a minimum but it is likely that the required hard stratum will be typically 1 m below the base of the peat, removing any weathered or soft materials, unless directly on rock. The very soft nature of the peat means that unsupported cut or excavated slopes could be unstable unless shallow gradients are used. The overall width of such an excavation could be up to 22 m and over 25 m at the original ground surface, depending on the thickness of the peat and appropriate methods of stabilising the temporary slopes should be considered. In general, areas of thicker peat have been avoided and the average depth of peat at turbine locations is 1.34 m

Foundation excavation will still produce a volume of peat and this should be reused across the site in an environmentally acceptable manner. Peat will not be used to back fill the excavation void within the footprint of the foundation as it will have a very low strength and the bulk density is insufficient. Peat can be used as backfill outside the foundation footprint and also to dress verges to tracks and around turbine bases, in line with current Waste Management guidance.

7.1.1 Specific Locations

All of the turbine locations were identified as either negligible or low risk resulting in an Insignificant hazard assessment. However, it is proposed that turbine T47 may benefit from the flexibility to micro-site within planning limitations following detailed site investigation, to avoid or minimise the need for excavations in sloping ground and thick peat which would increase the risk of construction induced instability.

7.2 Access Tracks

The general principles regarding the construction of the access tracks in peat that minimises the risk of instability and environmental effects are discussed below.

In order to maintain the current level or improve the stability of the peat mass on the slopes around the access track, it is necessary to ensure that the construction methods do not

seriously disrupt the established drainage and that no areas are surcharged, either by water discharge or spoil.

Wherever possible, the following principles should be adopted:

- Access tracks in areas of peat greater than 1.0 m thick should 'float' on the peat; it is noted that 'floating' tracks on peat settle with time and there will be an on-going requirement for repair and maintenance.
- Where possible, all floating access tracks on peat should cross contours perpendicularly to limit the need for cut and fill operations on side-long ground.
- It is generally not possible to float the tracks on moderate to steep-side-long ground, and where sidelong tracks cannot be avoided the peat should be stripped to a sound founding stratum.
- Maintenance of existing drainage is critical. Therefore all existing drainage tracks used for the development must be maintained and where necessary, channelled below the proposed track construction. Upslope side drainage ditches to the track will be required on side-long ground; the ditches should be constructed with small dams and cross drains where necessary so that:
    - Water can pass below the track at regular intervals,
    - Scour and erosion is avoided in the side ditches due the limited volume and velocity, concentrated discharges to the peat on the down slope side of the track are avoided;
- The camber of the track should encourage surface water to drain to the up slope side drainage ditch.
- Track gradients to be maintained at the recommended gradients from the turbine supplier, typically shallower than 1v:8h to facilitate access by the large specialist vehicles for both construction and transport of the turbine components. The maximum acceptable gradients are usually defined by the turbine manufacturer.

7.3 Cable Routes

The general principles regarding the construction of the cable routes in peat that minimises the risk of instability and environmental effects are discussed below.

In order to maintain the current level or improve the stability of the peat mass on the slopes around the cable route, it is necessary to ensure that the construction methods do not seriously disrupt the established drainage and that no areas are surcharged, either by water discharge or spoil.

The majority of the cable route will be located on or close to bedrock, with only limited sections crossing peat. The cable route is planned to follow the line of the proposed access track to the substation at Dallangwell, at Strathy North. The construction of the cable route will minimise disturbance to drainage by taking cable route alongside existing access track and around the turbines adjacent to new tracks. Much of the cable routes are over shallow peaty soils where complete re-use of the materials on site is envisaged.

If the cable route is on rock, the site may require excavation of rock or laying cable in an upfilled area to minimise the amount of excavation of rock; this is unlikely on this site.

7.3.1 Crossing Watercourses

The access tracks will have to cross a number of watercourses and particular care is required to ensure conformity in the settlement characteristics between the crossing structure and the approaches.

The preferred option for the stream crossings will be with the use of culverts and bridges. These are discussed at length in the Chapter A14: Soil and Water of the ES Addendum and in a Technical Appendix A14.2: Watercourse Crossing Assessment. The larger watercourse crossings will not be influenced by peat. Watercourse crossing designs will be subject to the approval of the Scottish Environmental Protection Agency (SEPA).

7.4 Substation

The position of the substation has been identified close to the proposed site entrance of Strathy North and close to Dallangwell. There are no peat issues associated with the substation site.

7.5 Switching Station and Temporary Construction Compound

Both the switching station and temporary construction compound are located on areas of or thin peat on relatively flat ground and will require minimal construction management.

7.6 Borrow Pits

The borrow pits will be required to comply with appropriate construction and quarrying regulations. They have been deliberately sited to avoid excavating peat and no significant construction mitigation will be required.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The Strathy South wind farm site has been assessed for potential hazards associated with peat instability; the assessment has been based on:

- a thorough inspection of the digital terrain map at a scale of 1:25,000;
- a detailed geotechnical probing exercise at over 2400 locations in areas of identified peat to determine the thickness thereof, and
- a walk-over survey by a geologist of 28 years experience.

The overall conclusion regarding peat stability is that there is a negligible to low risk of peat instability over most of the site although some limited areas of medium risk were identified. For the medium risk areas, a hazard impact assessment was completed which concluded that, subject to the employment of appropriate mitigation measures, all these areas can be considered as an insignificant risk. Additional mitigation measures have been identified in areas where hazards are already considered insignificant to further reduce the risk of potential hazards occurring.

The entire site can be considered to be extensively covered in peat with a maximum recorded thickness of 5.0m on the flatter areas. The locally thicker areas of peat have been avoided through layout design.

This report has highlighted the complicated inter-relationship between all the aspects that have an effect on the stability of peat. Consequently the discussion has also addressed areas of construction and drainage in order to avoid a stability problem rather than attempt to put it right after the event.

This assessment has been undertaken with respect to the recommendations in the SE guidance[2] document and is considered to fulfil the requirements set out in that document.

8.2 Recommendations

A summary of recommendations is provided in the following sections.

8.2.1 Stability

The complexity of peat stability has been discussed in some detail in this report and at great length by Lindsay and Bragg[3], amongst others. Following a review of published work and the observation and analysis undertaken for this project, it is believed that there will be a negligible hazard from peat instability if the recommendations contained in this report are adopted.

Suitable guidance and documentation in the form of a construction method statement will be established before work commences to ensure poor construction practices do not precipitate instability.

Due to the complex inter-reactions affecting peat stability it is proposed that the recommendations given below are used as a set of guidelines to generate a design concept. The concept should include the range of potential risks discussed in this report and the design should be sufficiently flexible to allow for continual modification and up-dating as construction progresses.

8.2.2 Turbines

It is the objective of this assessment to consider the potential risk from, or to initiate, peat instability and to recommend solutions and mitigation measures to eliminate, or at least reduce the risk to a manageable level. Risk reduction can be best achieved by minimising the effect of any construction works and an appropriate construction method statement is believed to be an integral element in ensuring that all parties understand and acknowledge the potential consequences of a peat slide.

The preferred foundation solution for areas of thick peat would be a gravity pad foundation bearing on a sound stratum. The side slopes of the excavation in the peat should be maintained in a stable condition throughout the construction process; consideration should be given to constructing a rock retaining bund (rock doughnut) prior to excavation of the peat or alternatively micrositing to reduce peat thickness.

8.2.3 Access Track

The main recommendations for the design and construction of typical site access tracks over peat are listed below:

- Identify and mark all existing drainage features within track corridors; these drainage features should be maintained (not enhanced) during the construction and operational phases of the wind farm;
- Install cross drains at regular intervals to maintain interstitial groundwater flow through the peat mass below the tracks where track settlement could reduce the natural permeability
- Install additional drainage in areas up-slope to any access track to prevent ponding and possible instability;
- Install small dams at regular intervals along the track side drains to prevent significant water velocities in the side drains causing deep erosion in the peat;
- Where construction is required over peat areas in excess of 1m deep, this should be undertaken with a floating track construction, where the integrity of the peat allows;
- Longitudinal gradients to be consistent with limitations of the heavy lift and large transport vehicles, probably no steeper than 1V:8H;
- Crossfalls on the track surface to shed water to the up-slope drainage ditches;
- Cut and fill should be avoided in peat greater than 1.0 m deep if possible; if not, the following requirements on side long ground should be adopted;
    - Excavate to a sound stratum;
    - Construction surface to be essentially horizontal with a slight fall to aid drainage;
    - Where the depth of cut is deemed unstable, employ a stepped or benched surface with the intention of minimising the exposed surface of the up-slope cut face;
    - Protect all exposed peat surfaces from erosion and desiccation, by ensuring the integrity and moisture content of the peat is maintained;
    - The top of cut slopes should be provided with a small bund to retain the peat to prevent desiccation and maintain the local stability of the peat.

8.2.4 Watercourse Crossings

The major river crossings are likely to be a more substantial bridge or bottom less arch structures due to the difference in elevation of the river banks. There is likely to be an approach embankment to give access onto the river crossing and this should be designed to accommodate the likely differential settlement and the need to maintain adequate drainage.

It is recommended that flexible, corrugated, galvanised steel or plastic culverts are used for all minor crossings in the peat areas as they have a number of advantages over concrete box culverts and bridges, these being:

- Light weight sections that can be man-handled
- Crossing can be constructed from one side of the bank
- Can accommodate total and differential settlement without significant loss of performance.

Details regarding watercourse crossings are included in the Chapter A14: Soil and Water.

8.2.5 Temporary Construction Compound and Switching Station

The position of these sites are, by design, in an area of negligible risk, the peat thickness below the temporary construction compound is up to 0.8m.

8.2.6 Substation

This is located in an area with no peat near Dallangwell.

8.2.7 Cabling Route

The cabling route from the site to the sub-station is located partly on peaty soils over glacial soils and in peat. The cable route poses a negligible risk as most of the route is not impacting peat.

8.3 Further Work

This report should be considered as the first stage in the development of a fundamental understanding of the various inter-relationships that govern and control the peat lands at Strathy South.

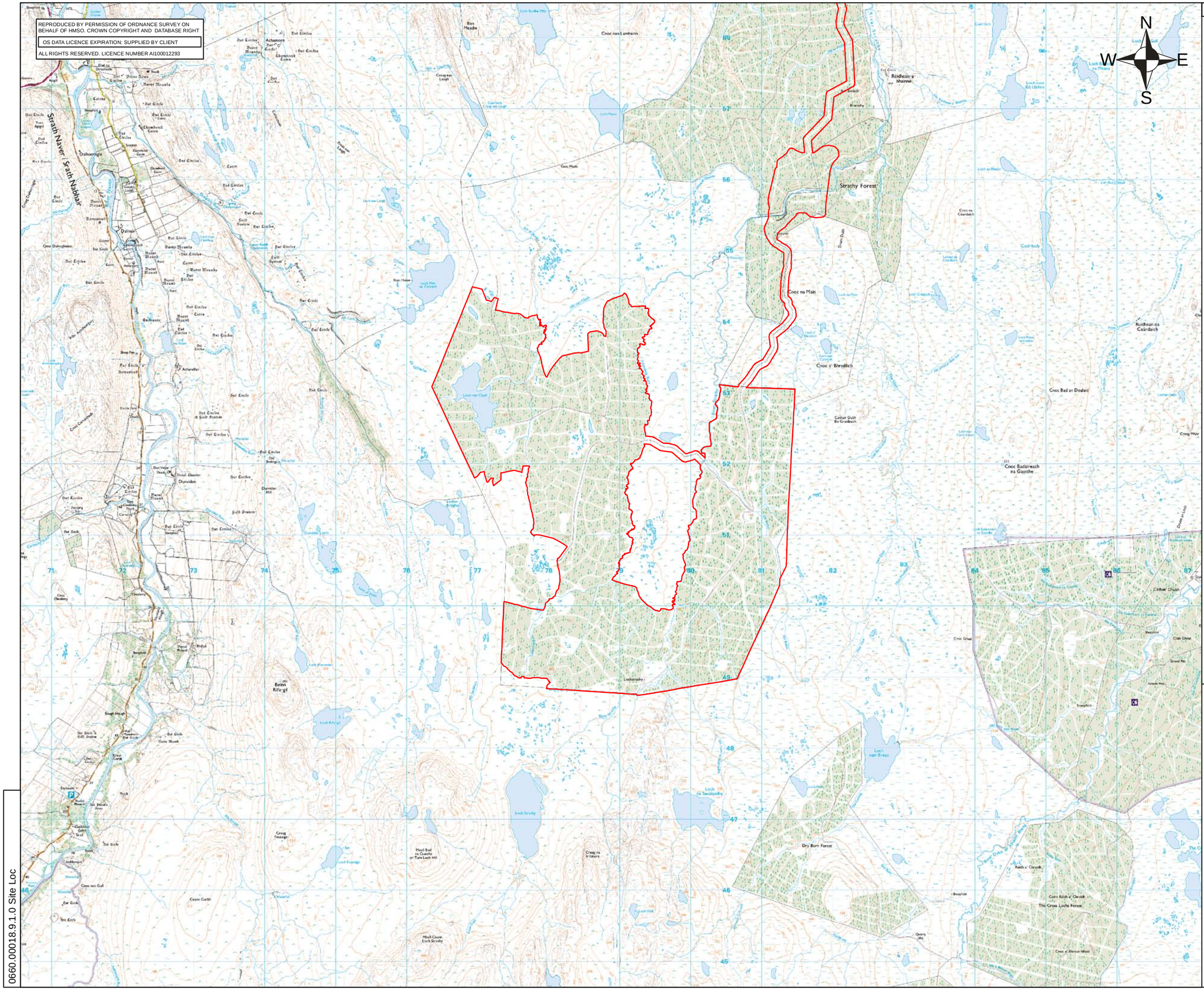
The commissioned assessment has purposefully kept the extent of physical intrusion into the sensitive peat areas to an absolute minimum. The results are considered appropriate for the planning application.

More detailed ground investigations will be required to facilitate the geotechnical design of the various foundations and access track, particularly the vertical and horizontal alignment and the design of the river/stream crossings. These will be incorporated into the Construction Method Statement which will be submitted to the Planning Authority for approval as part of the condition compliance prior to any site works commencing.

It is not the purpose of this report to provide a detailed scope for the investigation; however, it is believed that the strength and stiffness parameters are needed for turbine design and regular probes along access tracks to determine bearing capacity for either excavated or floated track design.

DRAWINGS

Drawing No. 1 Site Location



LEGEND

SITE BOUNDARY

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

SITE LOCATION

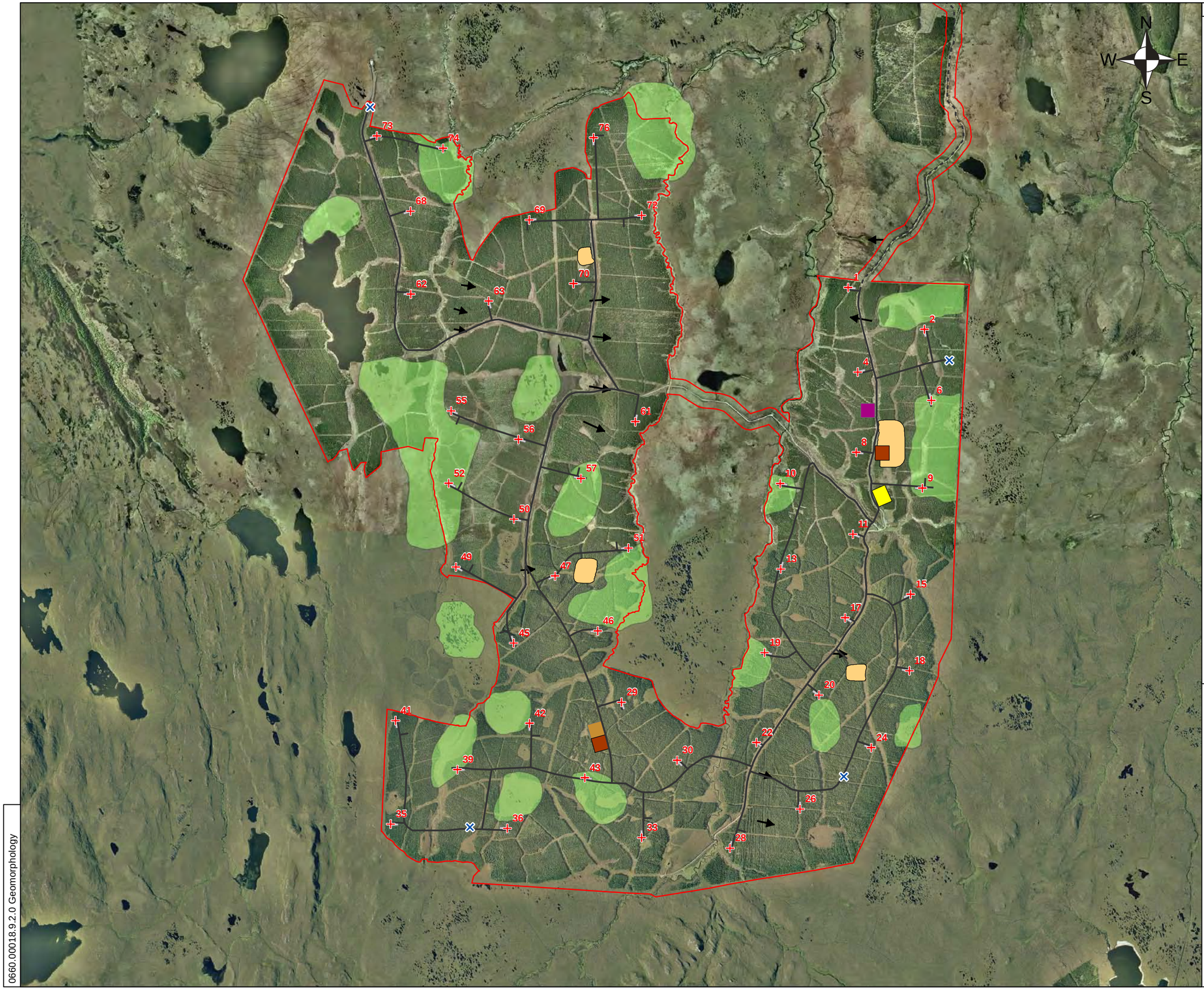
1

Scale 1:50,000 @ A3

Date MAY 2013

0660.00018.9.1.0 Site Loc

Drawing No. 2 Geomorphological Features overlying Aerial Photograph



LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- THICK PEAT / POND AREAS
- STEEP SLOPE

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

GEOMORPHOLOGY

2

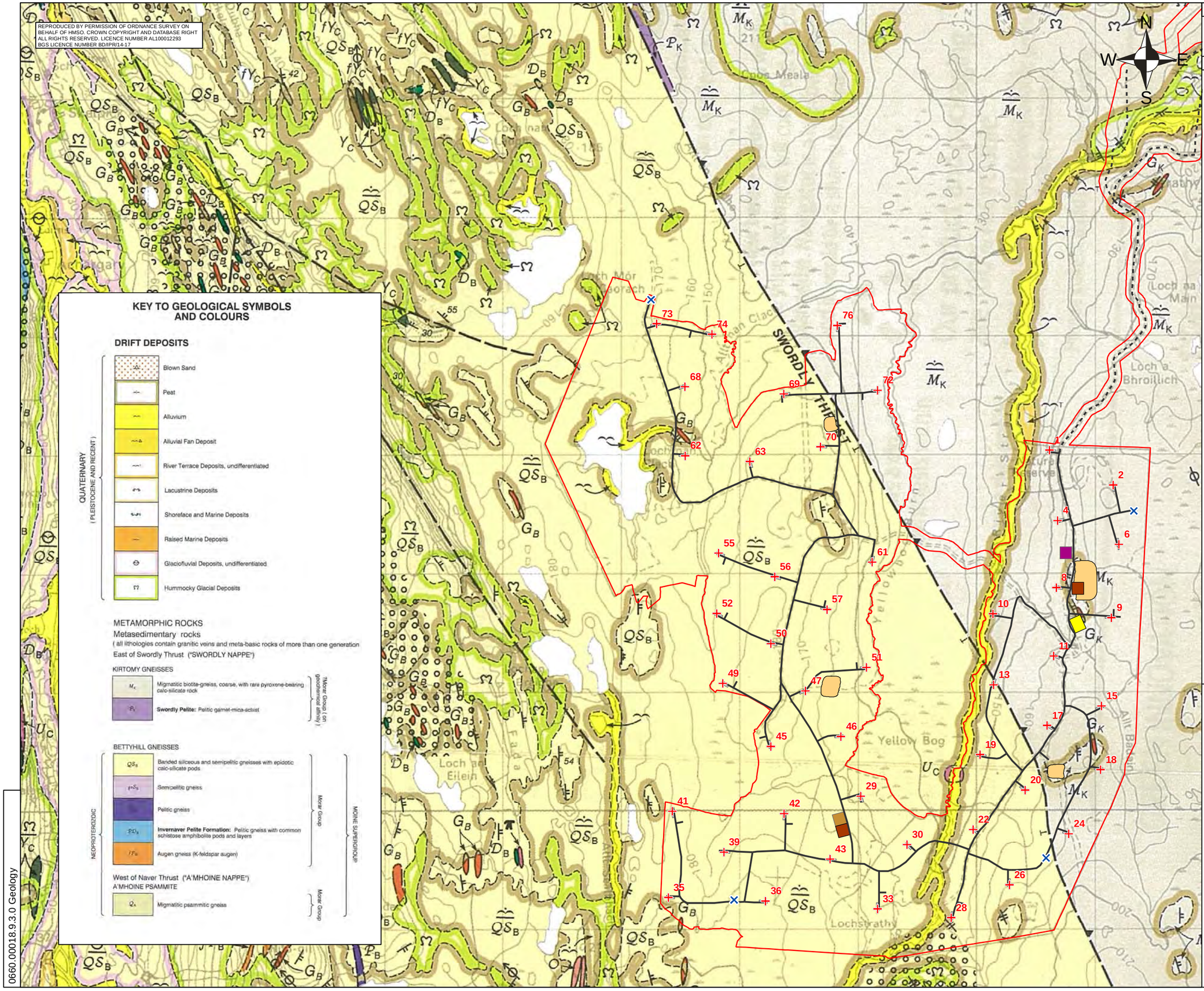
Scale 1:25,000 @ A3

Date MAY 2013

0660.00018.9.2.0 Geomorphology

Drawing No. 3 Superficial and Bedrock Geology Plan

REPRODUCED BY PERMISSION OF ORDNANCE SURVEY ON BEHALF OF HMSO. CROWN COPYRIGHT AND DATABASE RIGHT ALL RIGHTS RESERVED. LICENCE NUMBER AL100012293
BGS LICENCE NUMBER BDI/PR/14-17



NOTES

1. MAP EXTRACT FROM SCOTLAND SHEET 115W - STRATHY POINT. SOLID AND DRIFT EDITION

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

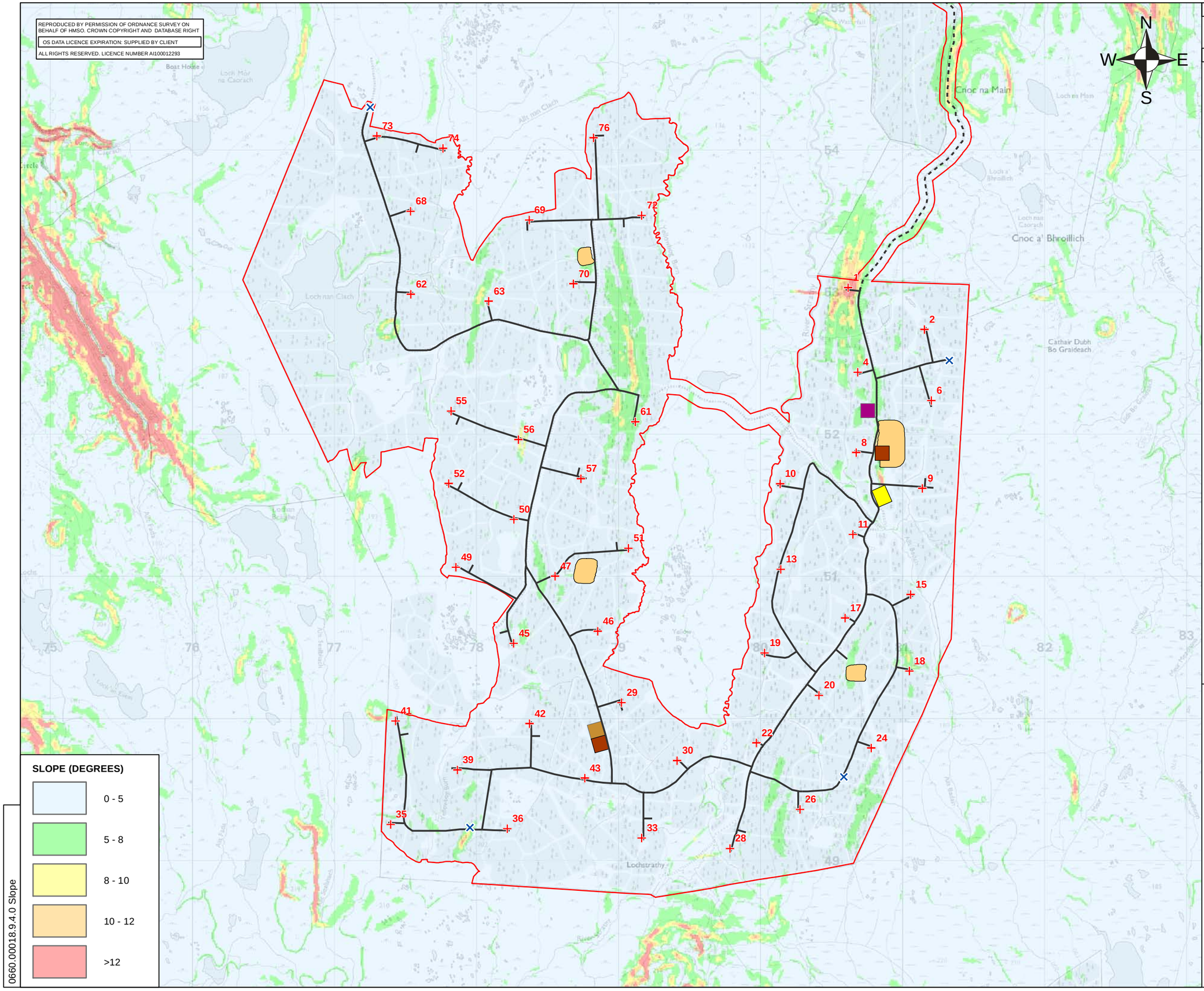
SUPERFICIAL AND BEDROCK GEOLOGY

3

Scale	Date
1:30,000 @ A3	MAY 2013

0660.00018.9.3.0 Geology

Drawing No. 4 Slope Plan



NOTES

1. SLOPE CALCULATED USING OS PROFILE DTM

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

SLOPE PLAN

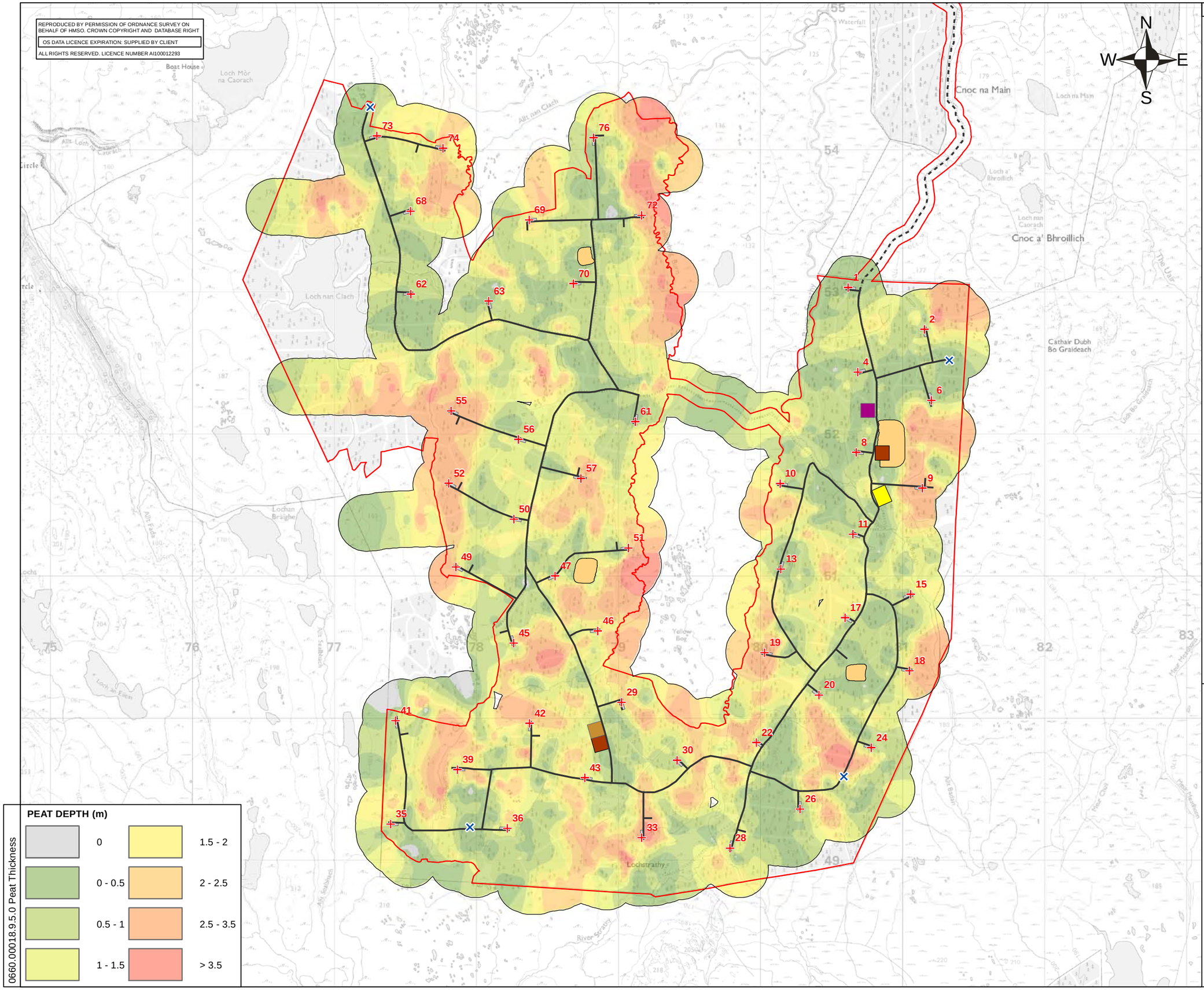
4

Scale 1:25,000 @ A3

Date MAY 2013

0660.00018.9.4.0 Slope

Drawing No. 5 Interpreted Peat Thickness



LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

ITERPRETED PEAT THICKNESS

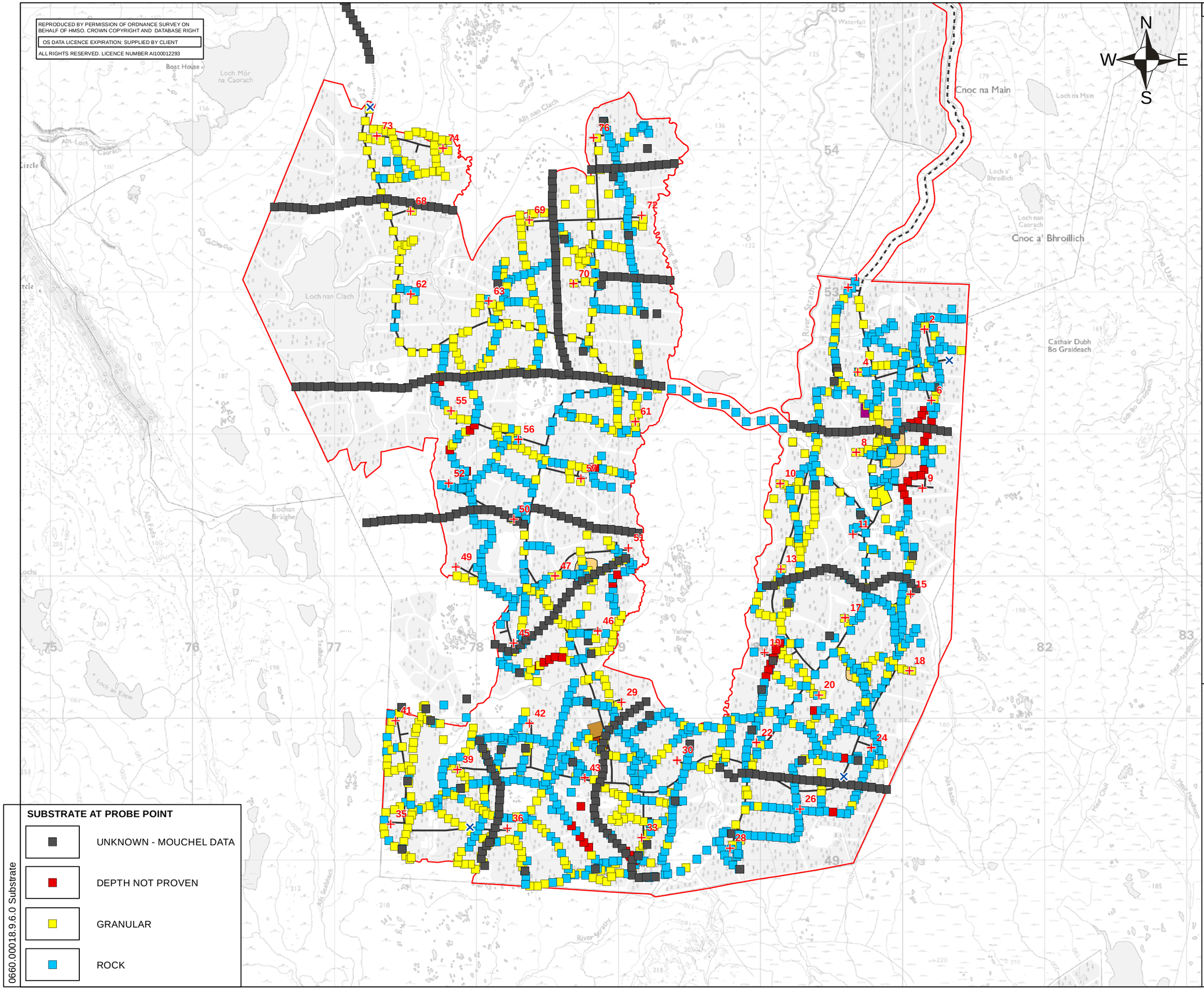
5

Scale 1:25,000 @ A3

Date MAY 2013

Drawing No. 6 Interpreted Substrate

REPRODUCED BY PERMISSION OF ORDNANCE SURVEY ON BEHALF OF HMSO. CROWN COPYRIGHT AND DATABASE RIGHT
OS DATA LICENCE EXPIRATION: SUPPLIED BY CLIENT
ALL RIGHTS RESERVED. LICENCE NUMBER AI100012293



LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT

SUBSTRATE AT PROBE POINT

- UNKNOWN - MOUCHEL DATA
- DEPTH NOT PROVEN
- GRANULAR
- ROCK

0660.00018.9.6.0 Substrate

SSE Renewables

SLR

4 THE ROUNDAL
RODDINGLAW BUSINESS PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

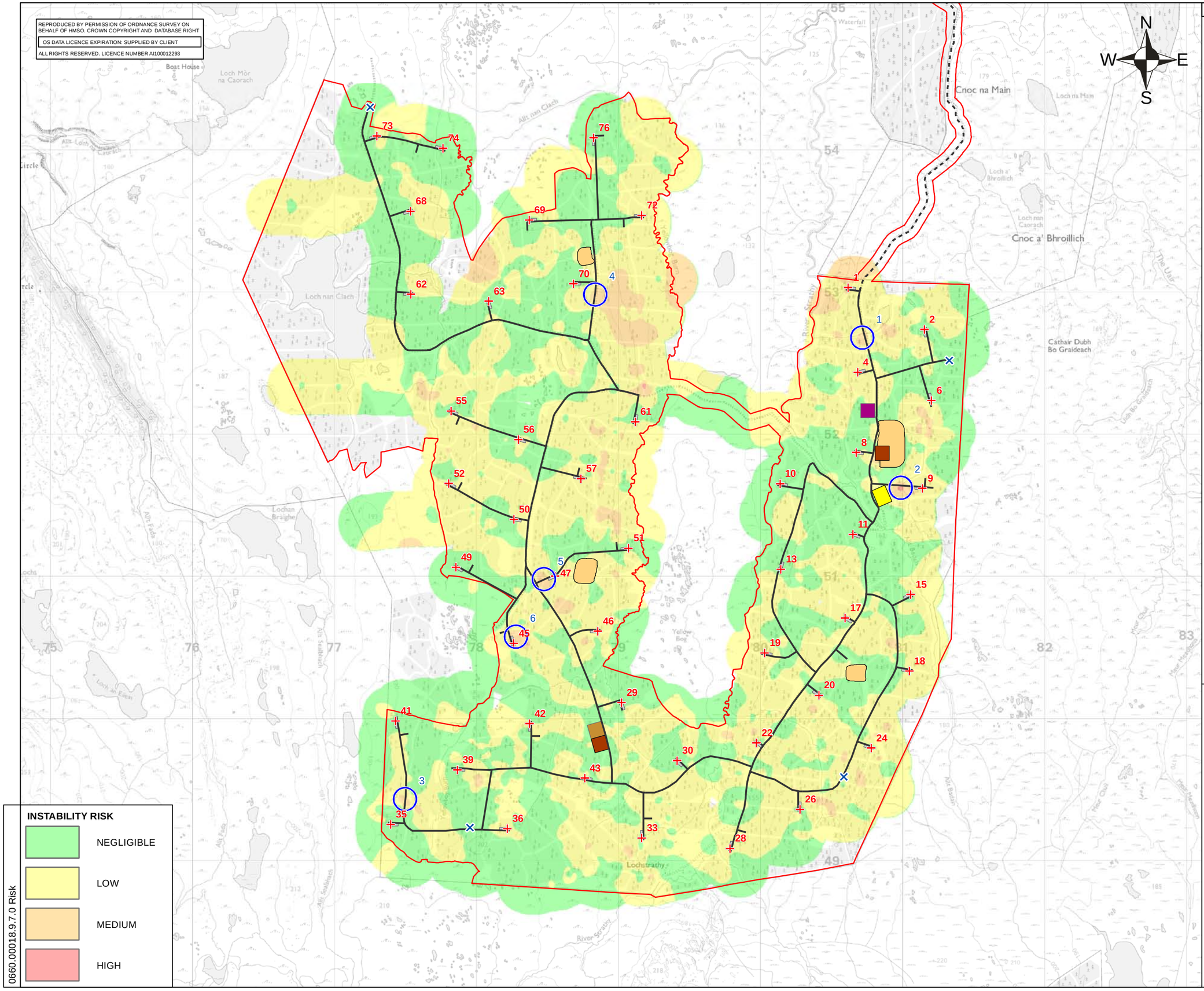
INTERPRETED SUBSTRATE

6

Scale 1:25,000 @ A3

Date MAY 2013

Drawing No. 7 Stability Risk Rating



LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- MEDIUM RISK SITES CLOSE TO INFRASTRUCTURE

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

STABILITY RISK RATING

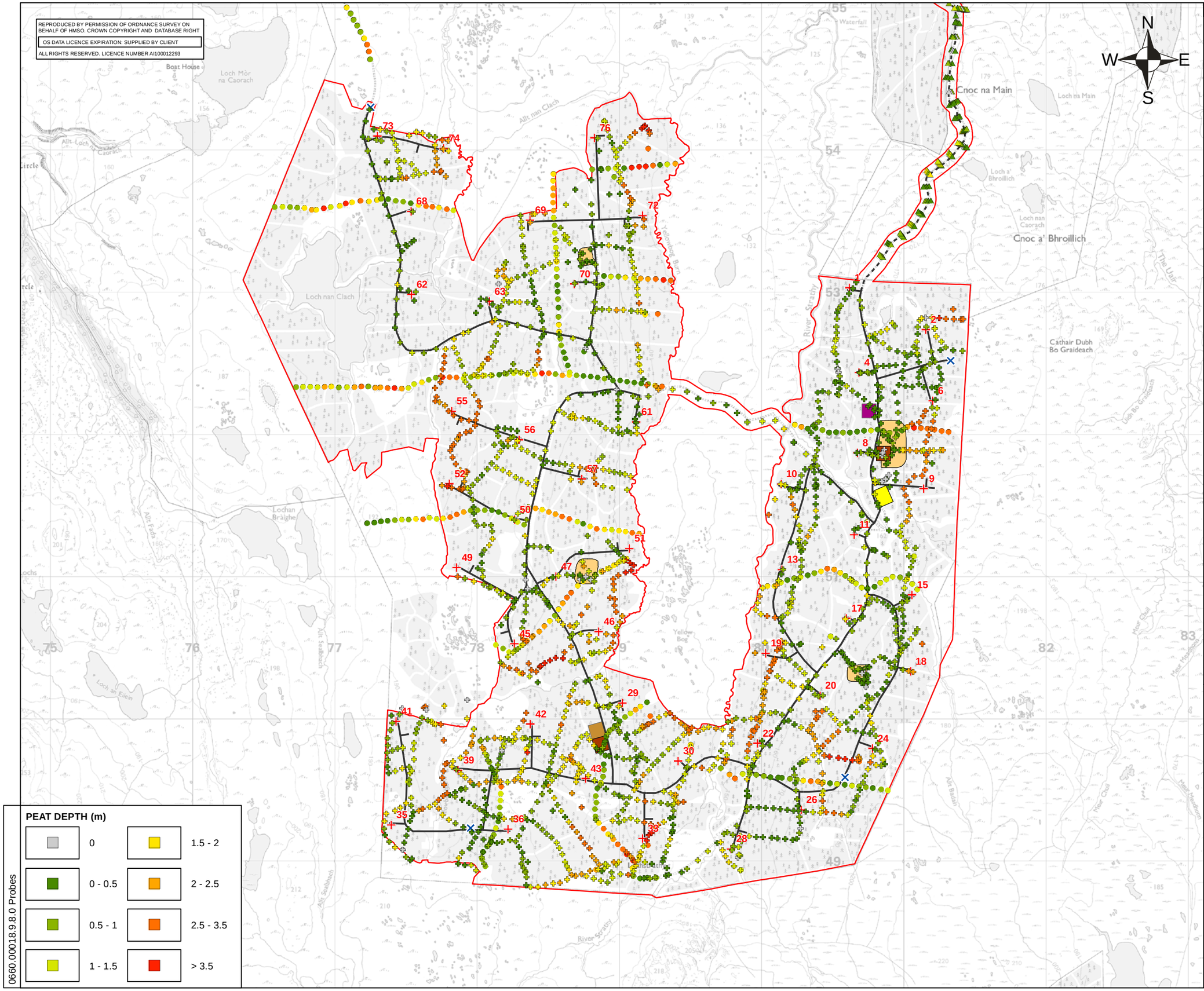
7

Scale 1:25,000 @ A3

Date MAY 2013

Drawing No. 8 Peat Probing Locations

REPRODUCED BY PERMISSION OF ORDNANCE SURVEY ON BEHALF OF HMSO. CROWN COPYRIGHT AND DATABASE RIGHT
OS DATA LICENCE EXPIRATION: SUPPLIED BY CLIENT
ALL RIGHTS RESERVED. LICENCE NUMBER AI100012293



LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT

PEAT PROBE SOURCE

- SLR
- MOUCHEL
- RPS

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS PARK, GOGAR
EDINBURGH, EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

PEAT LANDSLIDE AND HAZARD RISK ASSESSMENT

PEAT PROBING LOCATIONS

8

Scale 1:25,000 @ A3

Date MAY 2013

Appendix A
PROBE LOCATIONS, PEAT THICKNESS AND RISK RATING

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
1	Probehole	280666.84	953070.49	0.20	12.75	8	ROCK	Peaty soil	1	2	16	Medium
2	Probehole	280642.72	953026.47	0.20	11.82	6	ROCK	Peaty soil	1	2	12	Low
3	Probehole	280616.31	952990.33	0.50	13.23	8	ROCK	Peaty soil	1	2	16	Medium
4	Probehole	280589.04	952951.61	0.50	9.55	6	SAND OR GRAVEL	Peaty soil	1	1	6	Low
5	Probehole	280559.45	952906.83	0.70	7.50	4	ROCK	Thin Peat	2	2	16	Medium
6	Probehole	280540.56	952877.88	0.60	8.14	6	ROCK	Thin Peat	2	2	24	Medium
7	Probehole	280532.86	952858.43	0.30	7.20	4	ROCK	Peaty soil	1	2	8	Low
8	Probehole	280530.92	952813.93	0.60	6.58	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
9	Probehole	280527.24	952757.22	0.80	6.80	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
10	Probehole	280529.35	952714.63	0.80	5.63	4	ROCK	Thin Peat	2	2	16	Medium
11	Probehole	280527.82	952677.17	1.50	5.11	4	ROCK	Thin Peat	2	2	16	Medium
12	Probehole	280520.61	952660.86	1.20	4.99	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
13	Probehole	280511.49	952613.97	1.30	5.14	4	ROCK	Thin Peat	2	2	16	Medium
14	Probehole	280507.35	952583.83	1.20	4.68	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
15	Probehole	280526.03	952567.29	0.80	3.89	2	ROCK	Thin Peat	2	2	8	Low
16	Probehole	280532.13	952511.96	0.30	4.35	4	ROCK	Peaty soil	1	2	8	Low
17	Probehole	280535.80	952466.17	0.40	3.73	2	ROCK	Peaty soil	1	2	4	Negligible
18	Probehole	280536.75	952462.42	0.00	3.38	2	ROCK	No Peat	0	2	0	Negligible
19	Probehole	280541.93	952437.38	0.00	4.52	4	ROCK	No Peat	0	2	0	Negligible
20	Probehole	280550.94	952410.56	0.70	5.77	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
21	Probehole	280521.52	952365.22	0.30	3.59	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
22	Probehole	280533.14	952286.50	0.50	3.26	2	ROCK	Peaty soil	1	2	4	Negligible
23	Probehole	280547.35	952324.51	0.50	3.91	2	ROCK	Peaty soil	1	2	4	Negligible
24	Probehole	280550.12	952374.00	0.40	5.66	4	ROCK	Peaty soil	1	2	8	Low
25	Probehole	280564.68	952362.97	0.20	5.46	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
26	Probehole	280598.96	952340.95	1.20	5.32	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
27	Probehole	280639.89	952310.18	0.90	4.61	4	ROCK	Thin Peat	2	2	16	Medium
28	Probehole	280678.44	952281.33	0.40	5.71	4	ROCK	Peaty soil	1	2	8	Low
29	Probehole	280721.87	952249.56	0.50	5.16	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
30	Probehole	280761.79	952211.21	0.40	4.57	4	ROCK	Peaty soil	1	2	8	Low
31	Probehole	280798.01	952188.75	0.30	5.50	4	ROCK	Peaty soil	1	2	8	Low
32	Probehole	280829.05	952169.05	0.50	6.74	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
33	Probehole	280841.68	952260.96	0.40	5.51	4	ROCK	Peaty soil	1	2	8	Low
34	Probehole	280845.30	952335.12	0.60	5.02	4	ROCK	Thin Peat	2	2	16	Medium
35	Probehole	280825.71	952136.10	0.50	5.34	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
36	Probehole	280840.82	952079.01	0.20	6.35	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
37	Probehole	280860.89	952018.42	0.60	8.14	6	SAND OR GRAVEL	Thin Peat	2	1	12	Low
38	Probehole	280888.45	951989.92	0.50	1.09	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
39	Probehole	280893.85	951962.46	0.50	3.78	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
40	Probehole	280824.53	951943.58	0.50	10.62	6	SAND OR GRAVEL	Peaty soil	1	1	6	Low
41	Probehole	280759.51	951893.01	0.40	2.86	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
42	Probehole	280782.21	951854.99	0.60	3.51	2	ROCK	Thin Peat	2	2	8	Low
43	Probehole	280820.65	951847.88	0.60	8.18	6	ROCK	Thin Peat	2	2	24	Medium
44	Probehole	280848.25	951852.61	0.00	6.05	4	ROCK	No Peat	0	2	0	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
45	Probehole	280852.33	951871.25	0.00	6.95	4	ROCK	No Peat	0	2	0	Negligible
46	Probehole	281153.09	952166.27	3.00	3.41	2	ROCK	Thick Peat	3	2	12	Low
47	Probehole	281137.12	952131.10	3.00	3.15	2	ROCK	Thick Peat	3	2	12	Low
48	Probehole	281109.39	952086.64	3.00	1.89	1	ROCK	Thick Peat	3	2	6	Low
49	Probehole	281059.33	952076.46	3.00	1.35	1	ROCK	Thick Peat	3	2	6	Low
50	Probehole	281004.84	952042.46	0.70	5.05	4	ROCK	Thin Peat	2	2	16	Medium
51	Probehole	280945.13	951980.58	0.80	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
52	Probehole	280934.94	951891.95	0.50	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
53	Probehole	280996.00	951889.16	1.80	0.20	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
54	Probehole	281090.12	951884.64	2.50	0.82	1	ROCK	Thick Peat	3	2	6	Low
55	Probehole	281141.19	951889.59	1.10	0.52	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
56	Probehole	281155.28	951949.69	2.70	0.77	1	ROCK	Thick Peat	3	2	6	Low
57	Probehole	281176.91	951995.09	2.70	2.79	2	ROCK	Thick Peat	3	2	12	Low
58	Probehole	281196.80	952040.91	2.70	4.88	4	ROCK	Thick Peat	3	2	24	Medium
59	Probehole	281206.74	952092.60	2.70	3.17	2	ROCK	Thick Peat	3	2	12	Low
60	Probehole	281216.41	952138.73	1.30	2.14	2	ROCK	Thin Peat	2	2	8	Low
61	Probehole	281233.90	952185.55	1.50	2.22	2	ROCK	Thin Peat	2	2	8	Low
62	Probehole	281182.98	951886.84	2.20	0.29	1	ROCK	Thick Peat	3	2	6	Low
63	Probehole	281210.36	951887.68	2.00	0.29	1	ROCK	Thick Peat	3	2	6	Low
64	Probehole	281260.06	951888.96	1.90	0.23	1	ROCK	Thick Peat	3	2	6	Low
65	Probehole	281277.43	951890.29	2.10	0.57	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
66	Probehole	281159.97	951857.08	2.70	1.01	1	ROCK	Thick Peat	3	2	6	Low
67	Probehole	281158.42	951857.31	2.70	1.01	1	ROCK	Thick Peat	3	2	6	Low
68	Probehole	281159.09	951808.64	2.40	0.00	1	ROCK	Thick Peat	3	2	6	Low
69	Probehole	281152.58	951751.28	2.70	0.00	1	ROCK	Thick Peat	3	2	6	Low
70	Probehole	281201.31	951797.89	0.40	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
71	Probehole	281130.22	951710.73	2.70	0.00	1	ROCK	Thick Peat	3	2	6	Low
72	Probehole	281074.86	951705.91	2.70	0.00	1	ROCK	Thick Peat	3	2	6	Low
73	Probehole	281038.28	951668.21	2.70	0.00	1	ROCK	Thick Peat	3	2	6	Low
74	Probehole	281001.12	951621.43	2.70	4.37	4	ROCK	Thick Peat	3	2	24	Medium
75	Probehole	281015.12	951572.54	2.70	2.49	2	ROCK	Thick Peat	3	2	12	Low
76	Probehole	281036.51	951526.59	2.70	1.32	1	ROCK	Thick Peat	3	2	6	Low
77	Probehole	281036.41	951474.97	1.60	1.09	1	ROCK	Thick Peat	3	2	6	Low
78	Probehole	281041.37	951429.88	2.30	1.43	1	ROCK	Thick Peat	3	2	6	Low
79	Probehole	281020.62	951391.15	2.30	1.99	1	ROCK	Thick Peat	3	2	6	Low
80	Probehole	280986.54	951359.31	1.30	1.32	1	ROCK	Thin Peat	2	2	4	Negligible
81	Probehole	280974.11	951315.50	1.10	4.95	4	ROCK	Thin Peat	2	2	16	Medium
82	Probehole	280372.24	951735.46	0.50	2.86	2	ROCK	Peaty soil	1	2	4	Negligible
83	Probehole	280380.39	951683.59	0.50	4.01	4	ROCK	Peaty soil	1	2	8	Low
84	Probehole	280380.71	951639.75	0.40	3.14	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
85	Probehole	280374.51	951640.69	0.40	2.90	2	ROCK	Peaty soil	1	2	4	Negligible
86	Probehole	280369.51	951773.61	0.40	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
87	Probehole	280349.31	951769.02	0.60	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
88	Probehole	280306.05	951755.30	0.30	0.00	1	ROCK	Peaty soil	1	2	2	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
89	Probehole	280281.96	951712.59	0.60	1.58	1	ROCK	Thin Peat	2	2	4	Negligible
90	Probehole	280271.38	951662.77	0.50	1.68	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
91	Probehole	280311.96	951607.69	0.60	2.53	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
92	Probehole	280247.68	951610.58	0.40	1.55	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
93	Probehole	280210.68	951604.28	0.60	1.00	1	ROCK	Thin Peat	2	2	4	Negligible
94	Probehole	280210.00	951562.89	2.20	1.45	1	ROCK	Thick Peat	3	2	6	Low
95	Probehole	280221.31	951509.07	2.60	2.05	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
96	Probehole	280235.96	951472.23	2.30	2.69	2	ROCK	Thick Peat	3	2	12	Low
97	Probehole	280245.83	951422.35	1.80	3.08	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
98	Probehole	280264.17	951359.77	1.30	3.29	2	ROCK	Thin Peat	2	2	8	Low
99	Probehole	280270.94	951322.98	0.90	3.08	2	ROCK	Thin Peat	2	2	8	Low
100	Probehole	280266.42	951264.44	1.50	2.45	2	ROCK	Thin Peat	2	2	8	Low
101	Probehole	280268.56	951226.12	0.60	2.75	2	ROCK	Thin Peat	2	2	8	Low
102	Probehole	280271.14	951205.25	0.60	1.77	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
103	Probehole	280279.78	951175.64	0.40	2.45	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
104	Probehole	280282.28	951120.23	0.70	2.01	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
105	Probehole	280282.22	951073.63	0.60	2.08	2	ROCK	Thin Peat	2	2	8	Low
106	Probehole	280275.39	951031.87	0.60	2.09	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
107	Probehole	280253.93	950979.60	0.80	1.94	1	ROCK	Thin Peat	2	2	4	Negligible
108	Probehole	280222.14	950927.28	0.40	2.26	2	ROCK	Peaty soil	1	2	4	Negligible
109	Probehole	280211.51	950888.80	0.60	2.33	2	ROCK	Thin Peat	2	2	8	Low
110	Probehole	280218.04	950844.03	1.50	2.04	2	ROCK	Thin Peat	2	2	8	Low
111	Probehole	280208.50	950812.57	1.60	1.86	1	ROCK	Thick Peat	3	2	6	Low
112	Probehole	280188.28	950816.72	0.90	1.73	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
113	Probehole	280203.49	950785.61	1.40	1.79	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
114	Probehole	280185.09	950744.21	1.30	1.94	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
115	Probehole	280150.25	950719.83	1.00	1.66	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
116	Probehole	280139.64	950675.22	0.40	1.60	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
117	Probehole	280150.34	950620.67	0.50	1.83	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
118	Probehole	280140.58	950550.04	2.30	1.60	1	ROCK	Thick Peat	3	2	6	Low
119	Probehole	280525.02	950565.61	0.90	2.19	2	ROCK	Thin Peat	2	2	8	Low
120	Probehole	280742.98	951304.51	0.80	0.23	1	ROCK	Thin Peat	2	2	4	Negligible
121	Probehole	280723.58	951207.98	1.20	1.60	1	ROCK	Thin Peat	2	2	4	Negligible
122	Probehole	280777.05	951188.90	0.10	1.55	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
123	Probehole	280801.20	951185.57	0.20	1.69	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
124	Probehole	280653.67	951333.22	0.50	1.83	1	ROCK	Peaty soil	1	2	2	Negligible
125	Probehole	280681.66	951344.07	0.50	1.75	1	ROCK	Peaty soil	1	2	2	Negligible
126	Probehole	280569.65	950466.95	0.50	4.01	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
127	Probehole	280600.73	950419.21	0.10	3.93	2	ROCK	Peaty soil	1	2	4	Negligible
128	Probehole	280638.81	950387.04	0.10	6.10	4	ROCK	Peaty soil	1	2	8	Low
129	Probehole	280680.40	950351.79	0.60	3.26	2	ROCK	Thin Peat	2	2	8	Low
130	Probehole	280707.46	950322.19	0.00	2.31	2	ROCK	No Peat	0	2	0	Negligible
131	Probehole	280721.42	950281.65	0.40	2.31	2	ROCK	Peaty soil	1	2	4	Negligible
132	Probehole	280733.68	950226.69	0.00	2.02	2	ROCK	No Peat	0	2	0	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
133	Probehole	280742.20	950164.22	0.40	1.72	1	ROCK	Peaty soil	1	2	2	Negligible
134	Probehole	280751.12	950134.06	1.00	1.94	1	ROCK	Thin Peat	2	2	4	Negligible
135	Probehole	280778.44	950145.11	0.80	2.09	2	ROCK	Thin Peat	2	2	8	Low
136	Probehole	280814.88	950174.27	0.30	2.59	2	ROCK	Peaty soil	1	2	4	Negligible
137	Probehole	280854.23	950212.63	0.40	2.99	2	ROCK	Peaty soil	1	2	4	Negligible
138	Probehole	280879.91	950262.73	0.40	2.45	2	ROCK	Peaty soil	1	2	4	Negligible
139	Probehole	280895.92	950311.82	1.10	1.32	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
140	Probehole	280914.32	950359.54	0.60	0.20	1	ROCK	Thin Peat	2	2	4	Negligible
141	Probehole	280938.76	950404.29	0.70	4.75	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
142	Probehole	280960.94	950441.87	0.50	1.81	1	ROCK	Peaty soil	1	2	2	Negligible
143	Probehole	280977.49	950467.36	1.10	3.98	2	ROCK	Thin Peat	2	2	8	Low
144	Probehole	280751.75	950074.43	0.80	2.45	2	ROCK	Thin Peat	2	2	8	Low
145	Probehole	280764.11	950022.81	1.70	2.01	2	ROCK	Thick Peat	3	2	12	Low
146	Probehole	280773.68	949972.38	1.60	2.58	2	ROCK	Thick Peat	3	2	12	Low
147	Probehole	280786.74	949927.79	0.80	3.14	2	ROCK	Thin Peat	2	2	8	Low
148	Probehole	280804.10	949880.10	0.60	4.09	4	ROCK	Thin Peat	2	2	16	Medium
149	Probehole	280821.31	949830.93	0.80	3.58	2	ROCK	Thin Peat	2	2	8	Low
150	Probehole	280800.83	949785.31	0.30	2.58	2	ROCK	Peaty soil	1	2	4	Negligible
151	Probehole	280783.17	949739.61	1.80	3.01	2	ROCK	Thick Peat	3	2	12	Low
152	Probehole	280767.10	949694.79	2.60	3.49	2	ROCK	Thick Peat	3	2	12	Low
153	Probehole	280748.98	949646.88	2.00	3.01	2	ROCK	Thick Peat	3	2	12	Low
154	Probehole	280729.11	949598.83	1.00	4.17	4	ROCK	Thin Peat	2	2	16	Medium
155	Probehole	280714.65	949552.67	0.70	4.72	4	ROCK	Thin Peat	2	2	16	Medium
156	Probehole	280692.49	949503.20	0.50	5.06	4	ROCK	Peaty soil	1	2	8	Low
157	Probehole	280675.22	949457.68	0.70	5.05	4	ROCK	Thin Peat	2	2	16	Medium
158	Probehole	280662.90	949427.23	0.30	4.70	4	ROCK	Peaty soil	1	2	8	Low
159	Probehole	280646.60	949384.83	0.90	3.85	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
160	Probehole	280631.87	949348.88	0.40	2.86	2	ROCK	Peaty soil	1	2	4	Negligible
161	Probehole	280608.19	949326.39	1.10	3.06	2	ROCK	Thin Peat	2	2	8	Low
162	Probehole	280562.61	949330.01	2.10	3.12	2	ROCK	Thick Peat	3	2	12	Low
163	Probehole	280510.79	949340.13	2.60	3.15	2	ROCK	Thick Peat	3	2	12	Low
164	Probehole	280456.09	949345.14	2.80	2.33	2	ROCK	Thick Peat	3	2	12	Low
165	Probehole	280415.36	949342.11	1.80	2.34	2	ROCK	Thick Peat	3	2	12	Low
166	Probehole	280362.30	949346.51	1.20	2.86	2	ROCK	Thin Peat	2	2	8	Low
167	Probehole	280311.85	949350.28	0.40	2.37	2	ROCK	Peaty soil	1	2	4	Negligible
168	Probehole	280261.44	949355.53	0.50	0.30	1	ROCK	Peaty soil	1	2	2	Negligible
169	Probehole	280226.09	949356.05	0.10	4.92	4	ROCK	Peaty soil	1	2	8	Low
170	Probehole	280182.05	949362.59	0.30	5.44	4	ROCK	Peaty soil	1	2	8	Low
171	Probehole	280132.61	949367.45	0.30	4.53	4	ROCK	Peaty soil	1	2	8	Low
172	Probehole	280085.30	949372.23	0.30	4.21	4	ROCK	Peaty soil	1	2	8	Low
173	Probehole	280029.55	949374.68	0.40	5.30	4	ROCK	Peaty soil	1	2	8	Low
174	Probehole	279980.60	949379.71	0.30	3.46	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
175	Probehole	279926.89	949382.28	0.50	2.86	2	ROCK	Peaty soil	1	2	4	Negligible
176	Probehole	279898.22	949381.48	0.80	3.46	2	ROCK	Thin Peat	2	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
177	Probehole	279895.22	949353.35	0.80	3.59	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
178	Probehole	279826.49	949250.35	1.00	3.99	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
179	Probehole	279761.53	949203.51	1.00	2.34	2	ROCK	Thin Peat	2	2	8	Low
180	Probehole	279737.61	949192.36	0.80	2.63	2	ROCK	Thin Peat	2	2	8	Low
181	Probehole	279799.19	949186.20	0.70	3.33	2	ROCK	Thin Peat	2	2	8	Low
182	Probehole	279852.50	949180.11	1.10	3.21	2	ROCK	Thin Peat	2	2	8	Low
183	Probehole	279913.25	949175.28	1.10	3.58	2	ROCK	Thin Peat	2	2	8	Low
184	Probehole	279963.52	949171.70	0.40	4.29	4	ROCK	Peaty soil	1	2	8	Low
185	Probehole	280010.07	949170.83	0.50	4.09	4	ROCK	Peaty soil	1	2	8	Low
186	Probehole	280071.10	949165.63	0.40	4.57	4	ROCK	Peaty soil	1	2	8	Low
187	Probehole	280112.66	949161.01	0.50	5.57	4	ROCK	Peaty soil	1	2	8	Low
188	Probehole	280167.39	949156.93	0.40	3.37	2	ROCK	Peaty soil	1	2	4	Negligible
189	Probehole	280221.20	949151.38	0.40	1.24	1	ROCK	Peaty soil	1	2	2	Negligible
190	Probehole	280247.63	949158.56	0.50	2.88	2	ROCK	Peaty soil	1	2	4	Negligible
191	Probehole	280267.11	949199.75	0.80	2.31	2	ROCK	Thin Peat	2	2	8	Low
192	Probehole	280274.80	949231.27	0.00	2.29	2	ROCK	No Peat	0	2	0	Negligible
193	Probehole	280271.19	949269.44	0.50	2.24	2	ROCK	Peaty soil	1	2	4	Negligible
194	Probehole	280266.04	949314.72	0.70	2.19	2	ROCK	Thin Peat	2	2	8	Low
195	Probehole	280256.24	949389.67	0.50	4.38	4	ROCK	Peaty soil	1	2	8	Low
196	Probehole	280251.66	949437.53	0.60	2.95	2	ROCK	Thin Peat	2	2	8	Low
197	Probehole	280244.27	949498.66	0.60	4.44	4	ROCK	Thin Peat	2	2	16	Medium
198	Probehole	280238.87	949548.40	0.50	4.35	4	ROCK	Peaty soil	1	2	8	Low
199	Probehole	280233.04	949606.15	0.60	3.14	2	ROCK	Thin Peat	2	2	8	Low
200	Probehole	280228.22	949649.37	0.40	2.64	2	ROCK	Peaty soil	1	2	4	Negligible
201	Probehole	280270.43	949685.41	0.50	2.15	2	ROCK	Peaty soil	1	2	4	Negligible
202	Probehole	280316.10	949713.17	1.90	2.08	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
203	Probehole	280365.38	949744.90	1.70	2.58	2	ROCK	Thick Peat	3	2	12	Low
204	Probehole	280403.37	949773.45	1.90	1.92	1	ROCK	Thick Peat	3	2	6	Low
205	Probehole	280394.49	949808.08	2.30	0.00	1	ROCK	Thick Peat	3	2	6	Low
206	Probehole	280375.71	949859.71	2.30	1.97	1	ROCK	Thick Peat	3	2	6	Low
207	Probehole	280359.13	949894.39	2.20	2.43	2	ROCK	Thick Peat	3	2	12	Low
208	Probehole	280330.92	949918.09	2.00	2.72	2	ROCK	Thick Peat	3	2	12	Low
209	Probehole	280516.60	950458.72	0.40	2.95	2	ROCK	Peaty soil	1	2	4	Negligible
210	Probehole	280447.04	950381.37	1.10	2.90	2	ROCK	Thin Peat	2	2	8	Low
211	Probehole	280384.88	950307.50	0.80	2.14	2	ROCK	Thin Peat	2	2	8	Low
212	Probehole	280324.63	950225.96	0.50	0.87	1	ROCK	Peaty soil	1	2	2	Negligible
213	Probehole	280263.67	950143.71	1.60	0.84	1	ROCK	Thick Peat	3	2	6	Low
214	Probehole	280204.87	950065.28	0.80	2.75	2	ROCK	Thin Peat	2	2	8	Low
215	Probehole	280157.94	949982.97	0.50	3.61	2	ROCK	Peaty soil	1	2	4	Negligible
216	Probehole	280190.82	949988.10	0.30	2.56	2	ROCK	Peaty soil	1	2	4	Negligible
217	Probehole	280232.22	949962.32	0.50	2.43	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
218	Probehole	280280.26	949940.43	1.20	2.98	2	ROCK	Thin Peat	2	2	8	Low
219	Probehole	280329.35	949920.92	2.20	2.72	2	ROCK	Thick Peat	3	2	12	Low
220	Probehole	280353.50	949955.65	2.30	3.01	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
221	Probehole	280384.61	950001.49	2.70	2.54	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
222	Probehole	280396.85	950019.69	2.80	2.43	2	ROCK	Thick Peat	3	2	12	Low
223	Probehole	280381.53	950053.95	2.80	2.50	2	ROCK	Thick Peat	3	2	12	Low
224	Probehole	280424.59	950054.12	2.80	2.63	2	ROCK	Thick Peat	3	2	12	Low
225	Probehole	280456.66	950070.60	1.50	2.34	2	ROCK	Thin Peat	2	2	8	Low
226	Probehole	280488.74	950033.42	1.50	2.44	2	ROCK	Thin Peat	2	2	8	Low
227	Probehole	280518.99	949996.66	2.00	2.48	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
228	Probehole	280553.35	949960.51	1.50	2.67	2	ROCK	Thin Peat	2	2	8	Low
229	Probehole	280597.85	949975.69	0.40	2.46	2	ROCK	Peaty soil	1	2	4	Negligible
230	Probehole	280634.25	950013.20	0.40	3.38	2	ROCK	Peaty soil	1	2	4	Negligible
231	Probehole	280668.77	950049.47	1.30	2.59	2	ROCK	Thin Peat	2	2	8	Low
232	Probehole	280704.75	950085.89	0.50	2.00	2	ROCK	Peaty soil	1	2	4	Negligible
233	Probehole	280741.17	950114.12	1.10	1.86	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
234	Probehole	279690.05	949128.64	0.10	2.38	2	ROCK	Peaty soil	1	2	4	Negligible
235	Probehole	279622.58	949070.17	1.40	1.63	1	ROCK	Thin Peat	2	2	4	Negligible
236	Probehole	279554.40	949007.46	1.10	2.53	2	ROCK	Thin Peat	2	2	8	Low
237	Probehole	279477.65	948948.35	0.80	0.91	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
238	Probehole	279438.78	948923.18	0.50	1.50	1	ROCK	Peaty soil	1	2	2	Negligible
239	Probehole	279329.97	948899.04	0.20	0.91	1	ROCK	Peaty soil	1	2	2	Negligible
240	Probehole	279347.92	948906.29	0.40	3.64	2	ROCK	Peaty soil	1	2	4	Negligible
241	Probehole	279334.43	948952.38	0.10	1.58	1	ROCK	Peaty soil	1	2	2	Negligible
242	Probehole	279217.27	948878.55	0.80	4.21	4	ROCK	Thin Peat	2	2	16	Medium
243	Probehole	279174.16	948880.25	0.40	3.14	2	ROCK	Peaty soil	1	2	4	Negligible
244	Probehole	279091.41	948901.92	0.80	2.22	2	ROCK	Thin Peat	2	2	8	Low
245	Probehole	279100.79	948931.16	1.20	2.44	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
246	Probehole	279118.01	948968.14	1.60	2.66	2	ROCK	Thick Peat	3	2	12	Low
247	Probehole	279111.45	948995.64	2.80	2.63	2	ROCK	Thick Peat	3	2	12	Low
248	Probehole	279087.78	949024.41	2.80	2.02	2	ROCK	Thick Peat	3	2	12	Low
249	Probehole	279080.09	949037.46	2.50	2.13	2	ROCK	Thick Peat	3	2	12	Low
250	Probehole	279134.31	949007.00	1.90	0.64	1	ROCK	Thick Peat	3	2	6	Low
251	Probehole	279145.64	949036.37	1.90	2.31	2	ROCK	Thick Peat	3	2	12	Low
252	Probehole	279180.33	948995.19	1.30	2.58	2	ROCK	Thin Peat	2	2	8	Low
253	Probehole	279228.71	948980.89	0.40	3.43	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
254	Probehole	279305.83	948998.38	0.20	3.16	2	ROCK	Peaty soil	1	2	4	Negligible
255	Probehole	279311.15	949022.36	0.40	2.45	2	ROCK	Peaty soil	1	2	4	Negligible
256	Probehole	279326.20	949064.98	0.60	3.58	2	ROCK	Thin Peat	2	2	8	Low
257	Probehole	279343.66	949109.93	1.20	0.91	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
258	Probehole	279358.18	949154.24	2.00	0.00	1	ROCK	Thick Peat	3	2	6	Low
259	Probehole	279372.34	949199.67	0.10	2.58	2	ROCK	Peaty soil	1	2	4	Negligible
260	Probehole	279375.57	949215.91	0.40	2.58	2	ROCK	Peaty soil	1	2	4	Negligible
261	Probehole	279379.62	949255.71	0.50	4.56	4	ROCK	Peaty soil	1	2	8	Low
262	Probehole	279379.36	949310.68	0.50	4.29	4	ROCK	Peaty soil	1	2	8	Low
263	Probehole	279381.52	949355.74	0.90	4.47	4	ROCK	Thin Peat	2	2	16	Medium
264	Probehole	279386.16	949405.36	1.50	2.64	2	ROCK	Thin Peat	2	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
265	Probehole	279416.30	949412.60	2.30	2.67	2	ROCK	Thick Peat	3	2	12	Low
266	Probehole	279452.27	949416.51	3.00	2.95	2	ROCK	Thick Peat	3	2	12	Low
267	Probehole	279396.78	949468.54	2.10	2.40	2	ROCK	Thick Peat	3	2	12	Low
268	Probehole	279420.72	949521.65	1.90	2.58	2	ROCK	Thick Peat	3	2	12	Low
269	Probehole	279449.62	949568.12	1.20	2.02	2	ROCK	Thin Peat	2	2	8	Low
270	Probehole	279461.44	949613.25	1.40	2.13	2	ROCK	Thin Peat	2	2	8	Low
271	Probehole	279480.05	949664.11	0.80	1.91	1	ROCK	Thin Peat	2	2	4	Negligible
272	Probehole	279488.47	949709.90	1.20	1.51	1	ROCK	Thin Peat	2	2	4	Negligible
273	Probehole	279498.10	949757.14	1.80	1.43	1	ROCK	Thick Peat	3	2	6	Low
274	Probehole	279503.51	949803.21	2.00	1.38	1	ROCK	Thick Peat	3	2	6	Low
275	Probehole	279491.40	949900.33	2.20	0.91	1	ROCK	Thick Peat	3	2	6	Low
276	Probehole	279481.44	949925.15	2.30	0.87	1	ROCK	Thick Peat	3	2	6	Low
277	Probehole	279454.46	949890.51	1.60	1.11	1	ROCK	Thick Peat	3	2	6	Low
278	Probehole	279416.63	949854.53	1.20	1.11	1	ROCK	Thin Peat	2	2	4	Negligible
279	Probehole	279384.47	949825.81	0.60	1.51	1	ROCK	Thin Peat	2	2	4	Negligible
280	Probehole	279347.56	949787.95	1.10	1.63	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
281	Probehole	279306.07	949747.26	0.90	1.86	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
282	Probehole	279268.83	949708.49	0.70	2.19	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
283	Probehole	279238.20	949678.79	1.00	1.63	1	ROCK	Thin Peat	2	2	4	Negligible
284	Probehole	280745.13	950920.44	0.40	2.33	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
285	Probehole	280739.41	951011.04	1.40	1.97	1	ROCK	Thin Peat	2	2	4	Negligible
286	Probehole	280743.79	951097.44	0.60	1.52	1	ROCK	Thin Peat	2	2	4	Negligible
287	Probehole	279252.07	948885.28	0.70	4.77	4	ROCK	Thin Peat	2	2	16	Medium
288	Probehole	278896.29	948951.39	1.20	1.86	1	ROCK	Thin Peat	2	2	4	Negligible
289	Probehole	278918.46	948968.91	1.40	1.77	1	ROCK	Thin Peat	2	2	4	Negligible
290	Probehole	278979.93	948977.59	1.50	1.86	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
291	Probehole	278996.66	948995.65	1.70	1.90	1	ROCK	Thick Peat	3	2	6	Low
292	Probehole	278962.67	948993.17	2.10	1.77	1	ROCK	Thick Peat	3	2	6	Low
293	Probehole	278903.48	948982.37	1.30	1.77	1	ROCK	Thin Peat	2	2	4	Negligible
294	Probehole	278860.45	948977.38	2.10	1.86	1	ROCK	Thick Peat	3	2	6	Low
295	Probehole	278838.68	949007.58	2.40	1.99	1	ROCK	Thick Peat	3	2	6	Low
296	Probehole	278811.33	949037.02	2.50	2.43	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
297	Probehole	278791.40	949092.23	2.60	2.95	2	ROCK	Thick Peat	3	2	12	Low
298	Probehole	278758.33	949125.74	2.60	1.19	1	ROCK	Thick Peat	3	2	6	Low
299	Probehole	278731.03	949166.14	2.60	1.58	1	ROCK	Thick Peat	3	2	6	Low
300	Probehole	278701.68	949206.60	2.50	1.58	1	ROCK	Thick Peat	3	2	6	Low
301	Probehole	278670.25	949242.48	2.60	1.58	1	ROCK	Thick Peat	3	2	6	Low
302	Probehole	278644.77	949278.74	2.00	1.38	1	ROCK	Thick Peat	3	2	6	Low
303	Probehole	278619.47	949311.46	0.50	1.58	1	ROCK	Peaty soil	1	2	2	Negligible
304	Probehole	278592.42	949353.33	1.10	1.38	1	ROCK	Thin Peat	2	2	4	Negligible
305	Probehole	278533.56	949356.27	0.50	1.38	1	ROCK	Peaty soil	1	2	2	Negligible
306	Probehole	278566.55	949395.91	0.80	1.92	1	ROCK	Thin Peat	2	2	4	Negligible
307	Probehole	278543.43	949445.46	1.80	1.72	1	ROCK	Thick Peat	3	2	6	Low
308	Probehole	278514.32	949493.53	0.80	1.72	1	ROCK	Thin Peat	2	2	4	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
309	Probehole	278499.76	949535.95	2.20	1.92	1	ROCK	Thick Peat	3	2	6	Low
310	Probehole	278526.65	949567.43	1.10	1.82	1	ROCK	Thin Peat	2	2	4	Negligible
311	Probehole	278555.04	949600.34	0.80	2.63	2	ROCK	Thin Peat	2	2	8	Low
312	Probehole	278584.44	949631.00	2.00	1.92	1	ROCK	Thick Peat	3	2	6	Low
313	Probehole	278610.03	949664.56	2.00	1.38	1	ROCK	Thick Peat	3	2	6	Low
314	Probehole	278678.00	949698.11	2.10	1.92	1	ROCK	Thick Peat	3	2	6	Low
315	Probehole	278656.38	949720.32	2.60	1.86	1	ROCK	Thick Peat	3	2	6	Low
316	Probehole	278663.13	949743.14	2.40	1.57	1	ROCK	Thick Peat	3	2	6	Low
317	Probehole	278693.15	949800.33	1.80	1.77	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
318	Probehole	278711.58	949829.29	1.40	1.93	1	ROCK	Thin Peat	2	2	4	Negligible
319	Probehole	278735.40	949874.97	1.10	2.95	2	ROCK	Thin Peat	2	2	8	Low
320	Probehole	278771.35	949890.76	1.20	1.63	1	ROCK	Thin Peat	2	2	4	Negligible
321	Probehole	278792.18	949855.39	1.60	1.96	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
322	Probehole	278822.83	949813.22	1.90	1.43	1	ROCK	Thick Peat	3	2	6	Low
323	Probehole	278841.69	949793.14	0.50	1.58	1	ROCK	Peaty soil	1	2	2	Negligible
324	Probehole	278869.27	949764.81	0.50	1.38	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
325	Probehole	278885.58	949797.92	0.60	0.65	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
326	Probehole	278902.01	949844.02	0.40	1.72	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
327	Probehole	278918.73	949896.42	0.60	2.38	2	ROCK	Thin Peat	2	2	8	Low
328	Probehole	278958.07	949936.80	0.70	2.63	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
329	Probehole	278964.80	950047.82	0.10	1.70	1	ROCK	Peaty soil	1	2	2	Negligible
330	Probehole	278925.16	950082.66	0.70	2.31	2	ROCK	Thin Peat	2	2	8	Low
331	Probehole	278890.42	950087.07	1.20	1.63	1	ROCK	Thin Peat	2	2	4	Negligible
332	Probehole	278841.65	950101.02	1.30	2.23	2	ROCK	Thin Peat	2	2	8	Low
333	Probehole	278775.42	950114.02	1.80	1.62	1	ROCK	Thick Peat	3	2	6	Low
334	Probehole	278737.88	950122.24	2.40	1.73	1	ROCK	Thick Peat	3	2	6	Low
335	Probehole	278700.92	950117.81	2.20	1.83	1	ROCK	Thick Peat	3	2	6	Low
336	Probehole	278649.70	950106.02	2.40	1.79	1	ROCK	Thick Peat	3	2	6	Low
337	Probehole	278673.92	950202.39	1.10	2.50	2	ROCK	Thin Peat	2	2	8	Low
338	Probehole	278690.94	950248.66	0.70	1.97	1	ROCK	Thin Peat	2	2	4	Negligible
339	Probehole	278651.00	950160.58	2.50	2.13	2	ROCK	Thick Peat	3	2	12	Low
340	Probehole	278638.78	950111.93	2.00	1.83	1	ROCK	Thick Peat	3	2	6	Low
341	Probehole	278627.02	950059.19	1.20	1.52	1	ROCK	Thin Peat	2	2	4	Negligible
342	Probehole	278610.95	950012.15	2.00	0.82	1	ROCK	Thick Peat	3	2	6	Low
343	Probehole	278592.65	949959.05	2.60	1.79	1	ROCK	Thick Peat	3	2	6	Low
344	Probehole	278582.13	949918.15	2.00	1.42	1	ROCK	Thick Peat	3	2	6	Low
345	Probehole	278567.54	949868.84	1.10	1.92	1	ROCK	Thin Peat	2	2	4	Negligible
346	Probehole	278555.52	949817.22	0.80	1.72	1	ROCK	Thin Peat	2	2	4	Negligible
347	Probehole	278512.27	949820.41	0.70	1.92	1	ROCK	Thin Peat	2	2	4	Negligible
348	Probehole	278470.91	949837.66	1.50	1.86	1	ROCK	Thin Peat	2	2	4	Negligible
349	Probehole	278424.33	949853.22	1.90	1.95	1	ROCK	Thick Peat	3	2	6	Low
350	Probehole	278373.75	949858.69	0.70	1.54	1	ROCK	Thin Peat	2	2	4	Negligible
351	Probehole	278321.87	949863.45	1.10	1.81	1	ROCK	Thin Peat	2	2	4	Negligible
352	Probehole	278271.38	949859.63	1.80	1.87	1	ROCK	Thick Peat	3	2	6	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
353	Probehole	278225.09	949856.05	1.00	1.63	1	ROCK	Thin Peat	2	2	4	Negligible
354	Probehole	278251.79	949840.37	1.40	1.91	1	ROCK	Thin Peat	2	2	4	Negligible
355	Probehole	278195.24	949857.91	0.80	1.46	1	ROCK	Thin Peat	2	2	4	Negligible
356	Probehole	278188.37	949824.88	1.20	1.44	1	ROCK	Thin Peat	2	2	4	Negligible
357	Probehole	278180.44	949795.42	1.10	0.45	1	ROCK	Thin Peat	2	2	4	Negligible
358	Probehole	278175.51	949777.75	0.00	0.57	1	ROCK	No Peat	0	2	0	Negligible
359	Probehole	278166.30	949864.01	1.70	2.73	2	ROCK	Thick Peat	3	2	12	Low
360	Probehole	278123.61	949866.63	2.30	1.43	1	ROCK	Thick Peat	3	2	6	Low
361	Probehole	278073.82	949860.01	0.80	1.01	1	ROCK	Thin Peat	2	2	4	Negligible
362	Probehole	278026.49	949851.27	0.70	1.30	1	ROCK	Thin Peat	2	2	4	Negligible
363	Probehole	278037.59	949800.79	2.40	0.00	1	ROCK	Thick Peat	3	2	6	Low
364	Probehole	278056.81	949757.85	1.10	0.00	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
365	Probehole	278077.94	949710.59	0.90	1.58	1	ROCK	Thin Peat	2	2	4	Negligible
366	Probehole	278100.94	949657.32	0.40	2.23	2	ROCK	Peaty soil	1	2	4	Negligible
367	Probehole	278121.05	949614.91	0.10	3.18	2	ROCK	Peaty soil	1	2	4	Negligible
368	Probehole	278066.90	949559.03	2.50	2.58	2	ROCK	Thick Peat	3	2	12	Low
369	Probehole	278117.26	949558.77	0.70	2.65	2	ROCK	Thin Peat	2	2	8	Low
370	Probehole	278167.67	949559.80	2.20	1.87	1	ROCK	Thick Peat	3	2	6	Low
371	Probehole	278216.54	949555.50	1.40	1.38	1	ROCK	Thin Peat	2	2	4	Negligible
372	Probehole	278264.59	949568.31	2.40	1.92	1	ROCK	Thick Peat	3	2	6	Low
373	Probehole	278316.12	949561.69	2.20	1.28	1	ROCK	Thick Peat	3	2	6	Low
374	Probehole	278361.65	949553.23	1.50	1.72	1	ROCK	Thin Peat	2	2	4	Negligible
375	Probehole	278410.75	949540.56	0.60	1.82	1	ROCK	Thin Peat	2	2	4	Negligible
376	Probehole	278472.68	949526.76	0.70	1.38	1	ROCK	Thin Peat	2	2	4	Negligible
377	Probehole	278486.36	949553.26	0.40	1.92	1	ROCK	Peaty soil	1	2	2	Negligible
378	Probehole	278498.54	949594.29	1.40	1.33	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
379	Probehole	278510.41	949647.03	0.40	0.81	1	ROCK	Peaty soil	1	2	2	Negligible
380	Probehole	278522.21	949694.76	0.70	1.92	1	ROCK	Thin Peat	2	2	4	Negligible
381	Probehole	278533.70	949741.76	0.60	1.70	1	ROCK	Thin Peat	2	2	4	Negligible
382	Probehole	278541.28	949772.72	0.40	1.95	1	ROCK	Peaty soil	1	2	2	Negligible
383	Probehole	278601.30	949731.68	1.60	1.92	1	ROCK	Thick Peat	3	2	6	Low
384	Probehole	278630.32	949712.40	2.00	1.79	1	ROCK	Thick Peat	3	2	6	Low
385	Probehole	278731.28	949663.04	1.90	1.58	1	ROCK	Thick Peat	3	2	6	Low
386	Probehole	278715.69	949612.27	1.90	1.87	1	ROCK	Thick Peat	3	2	6	Low
387	Probehole	278697.74	949558.05	1.70	1.24	1	ROCK	Thick Peat	3	2	6	Low
388	Probehole	278669.54	949477.96	2.30	0.91	1	ROCK	Thick Peat	3	2	6	Low
389	Probehole	278737.25	949379.86	2.60	0.00	1	ROCK	Thick Peat	3	2	6	Low
390	Probehole	278835.41	949292.90	1.00	3.24	2	ROCK	Thin Peat	2	2	8	Low
391	Probehole	278945.32	949179.39	1.90	2.05	2	ROCK	Thick Peat	3	2	12	Low
392	Probehole	279052.82	949063.18	2.60	2.41	2	ROCK	Thick Peat	3	2	12	Low
393	Probehole	278413.70	950921.09	0.40	2.76	2	ROCK	Peaty soil	1	2	4	Negligible
394	Probehole	278313.38	950893.01	0.70	3.24	2	ROCK	Thin Peat	2	2	8	Low
395	Probehole	278272.56	950839.31	0.50	0.82	1	ROCK	Peaty soil	1	2	2	Negligible
396	Probehole	278257.78	950827.70	0.40	1.03	1	ROCK	Peaty soil	1	2	2	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
397	Probehole	278219.70	950855.80	0.60	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
398	Probehole	278182.37	950886.49	1.10	0.45	1	ROCK	Thin Peat	2	2	4	Negligible
399	Probehole	278140.89	950905.60	1.50	1.32	1	ROCK	Thin Peat	2	2	4	Negligible
400	Probehole	278098.49	950926.61	1.00	0.91	1	ROCK	Thin Peat	2	2	4	Negligible
401	Probehole	278047.95	950945.63	0.60	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
402	Probehole	278042.78	951001.69	1.10	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
403	Probehole	278037.22	951045.50	0.60	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
404	Probehole	278005.33	951059.67	0.20	1.99	1	ROCK	Peaty soil	1	2	2	Negligible
405	Probehole	278032.56	951099.12	0.30	3.15	2	ROCK	Peaty soil	1	2	4	Negligible
406	Probehole	278033.77	951156.83	0.50	2.86	2	ROCK	Peaty soil	1	2	4	Negligible
407	Probehole	278051.94	951189.88	0.80	3.34	2	ROCK	Thin Peat	2	2	8	Low
408	Probehole	278086.09	951223.36	1.80	0.00	1	ROCK	Thick Peat	3	2	6	Low
409	Probehole	278110.64	951267.35	1.80	0.00	1	ROCK	Thick Peat	3	2	6	Low
410	Probehole	278108.12	951321.09	1.00	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
411	Probehole	278098.82	951363.34	1.00	3.01	2	ROCK	Thin Peat	2	2	8	Low
412	Probehole	278050.74	951364.28	0.90	1.28	1	ROCK	Thin Peat	2	2	4	Negligible
413	Probehole	278004.00	951361.28	0.80	2.35	2	ROCK	Thin Peat	2	2	8	Low
414	Probehole	277982.78	951392.77	0.80	2.86	2	ROCK	Thin Peat	2	2	8	Low
415	Probehole	277977.67	951444.55	0.40	2.44	2	ROCK	Peaty soil	1	2	4	Negligible
416	Probehole	277977.22	951492.66	0.50	2.50	2	ROCK	Peaty soil	1	2	4	Negligible
417	Probehole	277969.35	951543.41	0.70	3.04	2	ROCK	Thin Peat	2	2	8	Low
418	Probehole	277954.88	951591.58	0.90	2.41	2	ROCK	Thin Peat	2	2	8	Low
419	Probehole	277894.74	951611.65	2.60	1.58	1	ROCK	Thick Peat	3	2	6	Low
420	Probehole	277913.83	951627.40	2.30	1.27	1	ROCK	Thick Peat	3	2	6	Low
421	Probehole	277909.86	951668.93	2.30	1.15	1	ROCK	Thick Peat	3	2	6	Low
422	Probehole	277938.51	951625.89	1.30	2.06	2	ROCK	Thin Peat	2	2	8	Low
423	Probehole	277915.59	951712.21	2.00	1.23	1	ROCK	Thick Peat	3	2	6	Low
424	Probehole	277931.56	951737.15	2.60	0.57	1	ROCK	Thick Peat	3	2	6	Low
425	Probehole	277921.81	951739.87	2.70	3.01	2	ROCK	Thick Peat	3	2	12	Low
426	Probehole	277882.31	951750.38	2.50	0.92	1	ROCK	Thick Peat	3	2	6	Low
427	Probehole	277850.81	951792.59	2.70	1.51	1	ROCK	Thick Peat	3	2	6	Low
428	Probehole	277828.92	951840.06	3.00	1.85	1	ROCK	Thick Peat	3	2	6	Low
429	Probehole	277813.24	951887.16	2.60	2.03	2	ROCK	Thick Peat	3	2	12	Low
430	Probehole	277826.06	951917.22	3.10	2.24	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
431	Probehole	277836.59	951930.26	3.20	2.54	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
432	Probehole	277864.47	951965.60	1.80	2.64	2	ROCK	Thick Peat	3	2	12	Low
433	Probehole	277861.66	951969.03	2.30	2.64	2	ROCK	Thick Peat	3	2	12	Low
434	Probehole	277878.97	951996.34	2.80	2.66	2	ROCK	Thick Peat	3	2	12	Low
435	Probehole	277924.17	952015.92	2.70	2.58	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
436	Probehole	277955.71	952024.97	2.60	1.72	1	ROCK	Thick Peat	3	2	6	Low
437	Probehole	277987.85	952062.77	2.70	2.37	2	ROCK	Thick Peat	3	2	12	Low
438	Probehole	278122.05	951928.80	0.80	1.28	1	ROCK	Thin Peat	2	2	4	Negligible
439	Probehole	278236.54	951975.38	0.90	0.77	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
440	Probehole	278216.70	951957.24	2.10	1.15	1	ROCK	Thick Peat	3	2	6	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
441	Probehole	278187.60	951919.89	0.50	1.52	1	ROCK	Peaty soil	1	2	2	Negligible
442	Probehole	278167.89	951881.14	1.20	1.77	1	ROCK	Thin Peat	2	2	4	Negligible
443	Probehole	278141.31	951840.37	1.30	2.06	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
444	Probehole	278103.35	951797.35	1.00	2.69	2	ROCK	Thin Peat	2	2	8	Low
445	Probehole	278074.71	951756.28	0.80	2.74	2	ROCK	Thin Peat	2	2	8	Low
446	Probehole	278034.87	951715.18	0.40	2.59	2	ROCK	Peaty soil	1	2	4	Negligible
447	Probehole	278003.17	951682.00	0.70	2.90	2	ROCK	Thin Peat	2	2	8	Low
448	Probehole	277970.61	951646.62	0.90	2.54	2	ROCK	Thin Peat	2	2	8	Low
449	Probehole	277935.02	951623.21	1.30	2.14	2	ROCK	Thin Peat	2	2	8	Low
450	Probehole	278136.86	951766.23	1.40	2.41	2	ROCK	Thin Peat	2	2	8	Low
451	Probehole	278181.23	951749.62	1.40	2.08	2	ROCK	Thin Peat	2	2	8	Low
452	Probehole	278228.71	951726.24	1.80	1.32	1	ROCK	Thick Peat	3	2	6	Low
453	Probehole	278273.66	951699.96	1.40	3.31	2	ROCK	Thin Peat	2	2	8	Low
454	Probehole	278313.68	951681.08	1.30	4.13	4	ROCK	Thin Peat	2	2	16	Medium
455	Probehole	278357.47	951657.99	1.60	2.73	2	ROCK	Thick Peat	3	2	12	Low
456	Probehole	278403.84	951636.50	1.60	3.26	2	ROCK	Thick Peat	3	2	12	Low
457	Probehole	278418.99	951679.30	1.30	2.50	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
458	Probehole	278391.43	951585.08	1.30	3.17	2	ROCK	Thin Peat	2	2	8	Low
459	Probehole	278360.98	951491.87	1.50	3.17	2	ROCK	Thin Peat	2	2	8	Low
460	Probehole	278322.27	951465.04	1.20	1.65	1	ROCK	Thin Peat	2	2	4	Negligible
461	Probehole	278287.17	951445.14	1.30	3.43	2	ROCK	Thin Peat	2	2	8	Low
462	Probehole	278348.11	951400.36	1.00	3.40	2	ROCK	Thin Peat	2	2	8	Low
463	Probehole	278337.38	951289.83	1.90	2.92	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
464	Probehole	278336.91	951177.50	0.60	4.04	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
465	Probehole	278333.20	951082.91	0.60	2.94	2	ROCK	Thin Peat	2	2	8	Low
466	Probehole	278336.41	951016.89	0.60	2.44	2	ROCK	Thin Peat	2	2	8	Low
467	Probehole	278343.46	950977.31	0.00	2.75	2	ROCK	No Peat	0	2	0	Negligible
468	Probehole	278255.66	950784.31	0.80	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
469	Probehole	278206.90	950713.40	0.80	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
470	Probehole	278170.77	950660.49	0.40	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
471	Probehole	278362.42	951214.78	0.50	2.64	2	ROCK	Peaty soil	1	2	4	Negligible
472	Probehole	278399.32	951214.56	0.70	4.91	4	ROCK	Thin Peat	2	2	16	Medium
473	Probehole	278445.74	951213.31	0.70	3.99	2	ROCK	Thin Peat	2	2	8	Low
474	Probehole	278496.26	951209.33	0.30	1.52	1	ROCK	Peaty soil	1	2	2	Negligible
475	Probehole	278521.33	951185.71	1.10	1.87	1	ROCK	Thin Peat	2	2	4	Negligible
476	Probehole	278463.04	951787.12	0.50	1.58	1	ROCK	Peaty soil	1	2	2	Negligible
477	Probehole	278519.52	952023.05	1.10	2.13	2	ROCK	Thin Peat	2	2	8	Low
478	Probehole	278483.23	951887.79	1.20	1.15	1	ROCK	Thin Peat	2	2	4	Negligible
479	Probehole	278536.81	952084.54	1.20	2.56	2	ROCK	Thin Peat	2	2	8	Low
480	Probehole	278579.13	952171.25	1.30	2.46	2	ROCK	Thin Peat	2	2	8	Low
481	Probehole	278641.36	952253.62	1.10	1.23	1	ROCK	Thin Peat	2	2	4	Negligible
482	Probehole	278730.34	952281.51	0.40	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
483	Probehole	278829.01	952282.91	0.30	5.12	4	ROCK	Peaty soil	1	2	8	Low
484	Probehole	278921.65	952303.26	0.30	5.91	4	ROCK	Peaty soil	1	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
485	Probehole	279012.17	952296.01	0.50	6.95	4	ROCK	Peaty soil	1	2	8	Low
486	Probehole	279098.32	952270.33	1.00	6.46	4	ROCK	Thin Peat	2	2	16	Medium
487	Probehole	279206.72	952268.29	0.80	5.25	4	ROCK	Thin Peat	2	2	16	Medium
488	Probehole	279376.49	952317.84	1.20	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
489	Probehole	279478.15	952302.46	0.90	2.94	2	ROCK	Thin Peat	2	2	8	Low
490	Probehole	279555.90	952253.64	0.40	1.03	1	ROCK	Peaty soil	1	2	2	Negligible
491	Probehole	279661.53	952221.62	0.60	1.15	1	ROCK	Thin Peat	2	2	4	Negligible
492	Probehole	279754.94	952207.05	0.10	1.91	1	ROCK	Peaty soil	1	2	2	Negligible
493	Probehole	279828.52	952152.43	0.10	1.50	1	ROCK	Peaty soil	1	2	2	Negligible
494	Probehole	279901.30	952087.25	0.90	1.55	1	ROCK	Thin Peat	2	2	4	Negligible
495	Probehole	280006.93	952093.12	1.40	3.51	2	ROCK	Thin Peat	2	2	8	Low
496	Probehole	280097.32	952100.56	1.10	2.05	2	ROCK	Thin Peat	2	2	8	Low
497	Probehole	280159.56	952040.73	1.70	2.92	2	ROCK	Thick Peat	3	2	12	Low
498	Probehole	279193.48	952347.24	2.70	7.62	4	ROCK	Thick Peat	3	2	24	Medium
499	Probehole	279259.26	952339.83	2.30	2.00	2	ROCK	Thick Peat	3	2	12	Low
500	Probehole	279275.19	952316.68	2.40	0.00	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
501	Probehole	279170.74	952389.91	0.40	7.16	4	ROCK	Peaty soil	1	2	8	Low
502	Probehole	279151.50	952444.72	1.80	5.10	4	ROCK	Thick Peat	3	2	24	Medium
503	Probehole	279137.12	952496.23	1.60	6.15	4	SAND OR GRAVEL	Thick Peat	3	1	12	Low
504	Probehole	279141.81	952544.18	1.20	5.29	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
505	Probehole	279134.90	952594.72	1.10	4.72	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
506	Probehole	279129.47	952633.14	2.10	5.59	4	ROCK	Thick Peat	3	2	24	Medium
507	Probehole	279084.59	952869.79	0.80	5.20	4	ROCK	Thin Peat	2	2	16	Medium
508	Probehole	279031.32	952875.52	1.70	5.21	4	SAND OR GRAVEL	Thick Peat	3	1	12	Low
509	Probehole	278981.82	952874.08	2.10	5.88	4	ROCK	Thick Peat	3	2	24	Medium
510	Probehole	278928.61	952878.51	1.10	4.57	4	ROCK	Thin Peat	2	2	16	Medium
511	Probehole	278879.91	952880.75	0.60	4.27	4	ROCK	Thin Peat	2	2	16	Medium
512	Probehole	278839.08	952882.57	0.70	3.89	2	ROCK	Thin Peat	2	2	8	Low
513	Probehole	279130.53	952866.52	1.10	6.14	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
514	Probehole	279181.12	952862.17	1.00	3.72	2	ROCK	Thin Peat	2	2	8	Low
515	Probehole	279155.34	952866.12	1.90	4.35	4	ROCK	Thick Peat	3	2	24	Medium
516	Probehole	279140.97	952923.95	2.60	4.54	4	ROCK	Thick Peat	3	2	24	Medium
517	Probehole	279129.95	952980.36	1.40	4.38	4	ROCK	Thin Peat	2	2	16	Medium
518	Probehole	279128.17	953026.66	1.60	3.30	2	ROCK	Thick Peat	3	2	12	Low
519	Probehole	279124.98	953071.69	1.40	3.62	2	ROCK	Thin Peat	2	2	8	Low
520	Probehole	279114.01	953126.25	1.70	3.13	2	ROCK	Thick Peat	3	2	12	Low
521	Probehole	279103.46	953172.26	1.50	3.13	2	ROCK	Thin Peat	2	2	8	Low
522	Probehole	279090.16	953217.79	1.20	2.92	2	ROCK	Thin Peat	2	2	8	Low
523	Probehole	279082.63	953263.89	0.80	3.30	2	ROCK	Thin Peat	2	2	8	Low
524	Probehole	279079.94	953299.81	1.00	3.15	2	ROCK	Thin Peat	2	2	8	Low
525	Probehole	279073.49	953362.03	0.60	3.20	2	ROCK	Thin Peat	2	2	8	Low
526	Probehole	279068.37	953410.47	0.70	3.20	2	ROCK	Thin Peat	2	2	8	Low
527	Probehole	279097.63	953424.98	0.90	3.43	2	ROCK	Thin Peat	2	2	8	Low
528	Probehole	279066.08	953468.85	0.80	3.35	2	ROCK	Thin Peat	2	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
529	Probehole	279064.65	953517.17	0.20	3.20	2	ROCK	Peaty soil	1	2	4	Negligible
530	Probehole	279067.76	953573.71	1.00	3.49	2	ROCK	Thin Peat	2	2	8	Low
531	Probehole	279078.34	953617.02	2.50	3.40	2	ROCK	Thick Peat	3	2	12	Low
532	Probehole	279080.21	953664.87	2.70	2.92	2	ROCK	Thick Peat	3	2	12	Low
533	Probehole	279058.31	953705.84	2.70	2.88	2	ROCK	Thick Peat	3	2	12	Low
534	Probehole	279032.40	953752.51	2.60	2.41	2	ROCK	Thick Peat	3	2	12	Low
535	Probehole	279003.30	953780.71	1.40	1.68	1	ROCK	Thin Peat	2	2	4	Negligible
536	Probehole	279014.53	953800.97	1.80	1.74	1	ROCK	Thick Peat	3	2	6	Low
537	Probehole	279002.34	953844.43	1.50	1.36	1	ROCK	Thin Peat	2	2	4	Negligible
538	Probehole	278989.79	953891.61	1.20	1.46	1	ROCK	Thin Peat	2	2	4	Negligible
539	Probehole	278979.51	953952.83	1.50	1.72	1	ROCK	Thin Peat	2	2	4	Negligible
540	Probehole	278978.74	953984.61	1.50	1.46	1	ROCK	Thin Peat	2	2	4	Negligible
541	Probehole	279010.25	954015.21	0.70	1.01	1	ROCK	Thin Peat	2	2	4	Negligible
542	Probehole	279042.79	954054.31	1.40	1.83	1	ROCK	Thin Peat	2	2	4	Negligible
543	Probehole	279076.75	954091.89	2.10	2.03	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
544	Probehole	279111.78	954123.49	2.90	1.87	1	ROCK	Thick Peat	3	2	6	Low
545	Probehole	279160.70	954153.92	3.70	2.15	2	ROCK	Thick Peat	3	2	12	Low
546	Probehole	279180.17	954173.00	3.70	1.41	1	ROCK	Thick Peat	3	2	6	Low
547	Probehole	279208.09	954138.16	3.70	2.03	2	ROCK	Thick Peat	3	2	12	Low
548	Probehole	278963.74	954009.21	1.50	1.15	1	ROCK	Thin Peat	2	2	4	Negligible
549	Probehole	278950.74	954048.43	0.50	0.86	1	ROCK	Peaty soil	1	2	2	Negligible
550	Probehole	278933.94	954093.70	1.00	1.41	1	ROCK	Thin Peat	2	2	4	Negligible
551	Probehole	278919.23	954140.57	1.50	0.93	1	ROCK	Thin Peat	2	2	4	Negligible
552	Probehole	278901.77	954189.58	1.60	1.19	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
553	Probehole	278897.71	954202.89	1.40	1.72	1	ROCK	Thin Peat	2	2	4	Negligible
554	Probehole	279004.50	953693.76	0.40	2.36	2	ROCK	Peaty soil	1	2	4	Negligible
555	Probehole	278931.48	953689.71	0.50	4.57	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
556	Probehole	278803.93	953619.00	0.60	2.14	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
557	Probehole	278807.75	953550.36	0.60	1.82	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
558	Probehole	278808.17	953463.45	0.50	2.78	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
559	Probehole	278821.63	953341.59	0.70	3.67	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
560	Probehole	278840.77	953333.94	0.50	3.58	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
561	Probehole	278879.09	953333.13	0.50	3.53	2	ROCK	Peaty soil	1	2	4	Negligible
562	Probehole	278926.51	953330.55	1.80	4.40	4	SAND OR GRAVEL	Thick Peat	3	1	12	Low
563	Probehole	278979.40	953318.88	0.40	5.63	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
564	Probehole	279023.98	953309.52	0.50	5.04	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
565	Probehole	278834.54	953195.42	0.60	5.07	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
566	Probehole	278840.59	953133.03	0.80	4.07	4	ROCK	Thin Peat	2	2	16	Medium
567	Probehole	278866.78	953044.94	0.70	4.61	4	ROCK	Thin Peat	2	2	16	Medium
568	Probehole	278854.35	953039.57	0.70	4.54	4	ROCK	Thin Peat	2	2	16	Medium
569	Probehole	278826.74	952930.68	0.70	4.04	4	ROCK	Thin Peat	2	2	16	Medium
570	Probehole	278816.42	952858.21	0.60	3.75	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
571	Probehole	278803.27	952747.57	0.70	5.06	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
572	Probehole	278791.40	952662.89	0.50	3.33	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
573	Probehole	278826.82	952570.99	0.40	3.40	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
574	Probehole	278888.84	952467.31	0.60	4.00	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
575	Probehole	278929.78	952405.88	0.40	6.27	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
576	Probehole	278983.85	952318.61	0.00	5.46	4	SAND OR GRAVEL	No Peat	0	1	0	Negligible
577	Probehole	278809.37	953215.70	0.40	5.07	4	ROCK	Peaty soil	1	2	8	Low
578	Probehole	278772.41	953222.97	0.40	9.76	6	SAND OR GRAVEL	Peaty soil	1	1	6	Low
579	Probehole	278690.63	953294.76	0.20	4.90	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
580	Probehole	278745.62	953275.14	0.20	6.27	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
581	Probehole	278651.14	953346.12	1.40	3.59	2	ROCK	Thin Peat	2	2	8	Low
582	Probehole	278634.46	953388.79	1.20	2.78	2	ROCK	Thin Peat	2	2	8	Low
583	Probehole	278616.59	953402.90	1.30	2.26	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
584	Probehole	278587.89	953453.37	0.60	1.99	1	ROCK	Thin Peat	2	2	4	Negligible
585	Probehole	278556.87	953372.81	1.20	3.20	2	ROCK	Thin Peat	2	2	8	Low
586	Probehole	278560.07	953278.19	1.30	2.72	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
587	Probehole	278558.44	953225.51	1.80	2.66	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
588	Probehole	278512.74	953205.20	1.10	2.00	2	ROCK	Thin Peat	2	2	8	Low
589	Probehole	278465.85	953181.02	0.70	1.97	1	ROCK	Thin Peat	2	2	4	Negligible
590	Probehole	278411.67	953150.77	1.30	2.80	2	ROCK	Thin Peat	2	2	8	Low
591	Probehole	278378.68	953135.45	1.30	2.31	2	ROCK	Thin Peat	2	2	8	Low
592	Probehole	278350.67	953189.43	1.00	2.14	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
593	Probehole	278333.29	953247.35	0.80	2.13	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
594	Probehole	278326.67	953291.37	0.60	2.50	2	ROCK	Thin Peat	2	2	8	Low
595	Probehole	278325.00	953315.75	0.80	2.24	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
596	Probehole	278334.86	953122.32	0.30	2.54	2	ROCK	Peaty soil	1	2	4	Negligible
597	Probehole	278285.70	953106.58	1.00	2.34	2	ROCK	Thin Peat	2	2	8	Low
598	Probehole	278242.28	953087.69	1.90	2.21	2	ROCK	Thick Peat	3	2	12	Low
599	Probehole	278206.50	953092.14	1.70	1.36	1	ROCK	Thick Peat	3	2	6	Low
600	Probehole	278188.47	953116.66	2.50	0.00	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
601	Probehole	278189.48	953164.72	2.30	2.66	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
602	Probehole	278192.94	953194.70	1.30	3.73	2	ROCK	Thin Peat	2	2	8	Low
603	Probehole	278202.65	953215.94	0.90	4.01	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
604	Probehole	278146.52	953154.36	2.40	5.05	4	ROCK	Thick Peat	3	2	24	Medium
605	Probehole	278141.19	953114.41	1.90	4.24	4	ROCK	Thick Peat	3	2	24	Medium
606	Probehole	278223.09	953068.42	1.70	2.28	2	ROCK	Thick Peat	3	2	12	Low
607	Probehole	278215.57	953036.34	1.10	2.38	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
608	Probehole	278204.26	952991.94	1.10	2.66	2	ROCK	Thin Peat	2	2	8	Low
609	Probehole	278189.26	952944.87	1.10	1.85	1	ROCK	Thin Peat	2	2	4	Negligible
610	Probehole	278433.93	952886.21	0.50	5.43	4	ROCK	Peaty soil	1	2	8	Low
611	Probehole	278452.65	952843.29	0.40	0.00	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
612	Probehole	278771.84	952631.74	0.40	5.52	4	ROCK	Peaty soil	1	2	8	Low
613	Probehole	278763.72	952605.25	0.00	6.25	4	ROCK	No Peat	0	2	0	Negligible
614	Probehole	278995.61	952286.31	0.30	8.23	6	SAND OR GRAVEL	Peaty soil	1	1	6	Low
615	Probehole	278994.91	952241.58	0.60	10.28	6	SAND OR GRAVEL	Thin Peat	2	1	12	Low
616	Probehole	278995.35	952202.20	0.50	11.43	6	SAND OR GRAVEL	Peaty soil	1	1	6	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
617	Probehole	278994.37	952158.04	0.40	10.03	6	ROCK	Peaty soil	1	2	12	Low
618	Probehole	278991.94	952110.76	0.30	5.56	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
619	Probehole	278995.91	952053.26	1.10	7.06	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
620	Probehole	278994.38	952010.04	0.50	5.24	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
621	Probehole	279021.32	952005.86	0.90	4.54	4	ROCK	Thin Peat	2	2	16	Medium
622	Probehole	279055.78	952027.46	0.50	5.61	4	ROCK	Peaty soil	1	2	8	Low
623	Probehole	278952.44	952026.56	0.80	4.95	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
624	Probehole	278904.72	952045.30	1.10	4.25	4	ROCK	Thin Peat	2	2	16	Medium
625	Probehole	278867.67	952075.23	0.60	4.98	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
626	Probehole	278831.93	952096.95	1.10	4.13	4	ROCK	Thin Peat	2	2	16	Medium
627	Probehole	278785.97	952109.32	0.80	4.01	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
628	Probehole	278744.11	952116.00	1.60	5.16	4	SAND OR GRAVEL	Thick Peat	3	1	12	Low
629	Probehole	278692.88	952115.54	1.60	3.34	2	SAND OR GRAVEL	Thick Peat	3	1	6	Low
630	Probehole	278675.04	952143.21	1.70	3.55	2	ROCK	Thick Peat	3	2	12	Low
631	Probehole	278651.89	952121.83	1.40	3.27	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
632	Probehole	278611.11	952147.60	1.50	2.56	2	ROCK	Thin Peat	2	2	8	Low
633	Probehole	279172.94	954162.64	3.80	2.08	2	ROCK	Thick Peat	3	2	12	Low
634	Probehole	279214.62	954116.23	3.50	2.03	2	ROCK	Thick Peat	3	2	12	Low
635	Probehole	277900.53	951619.46	3.00	1.51	1	ROCK	Thick Peat	3	2	6	Low
636	Probehole	278666.76	952121.18	1.70	3.88	2	ROCK	Thick Peat	3	2	12	Low
637	Probehole	280693.06	952943.80	0.60	4.97	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
638	Probehole	280705.09	952891.25	0.80	5.73	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
639	Probehole	280725.16	952773.47	1.50	4.95	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
640	Probehole	280762.90	952692.66	1.40	4.17	4	ROCK	Thin Peat	2	2	16	Medium
641	Probehole	280799.03	952705.68	1.30	3.40	2	ROCK	Thin Peat	2	2	8	Low
642	Probehole	280841.12	952719.62	1.30	3.34	2	ROCK	Thin Peat	2	2	8	Low
643	Probehole	280882.46	952741.21	1.80	5.06	4	ROCK	Thick Peat	3	2	24	Medium
644	Probehole	280921.12	952783.30	1.10	3.88	2	ROCK	Thin Peat	2	2	8	Low
645	Probehole	280938.37	952761.42	0.70	4.17	4	ROCK	Thin Peat	2	2	16	Medium
646	Probehole	280786.40	952684.15	0.40	3.81	2	ROCK	Peaty soil	1	2	4	Negligible
647	Probehole	280809.68	952662.27	0.70	2.98	2	ROCK	Thin Peat	2	2	8	Low
648	Probehole	280855.93	952643.23	1.10	3.06	2	ROCK	Thin Peat	2	2	8	Low
649	Probehole	280899.86	952605.68	0.80	3.49	2	ROCK	Thin Peat	2	2	8	Low
650	Probehole	280955.91	952585.60	0.40	5.16	4	ROCK	Peaty soil	1	2	8	Low
651	Probehole	281006.17	952573.86	0.80	3.38	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
652	Probehole	281054.99	952568.66	0.30	1.96	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
653	Probehole	281097.97	952557.52	0.50	4.32	4	ROCK	Peaty soil	1	2	8	Low
654	Probehole	281094.75	952573.21	1.10	5.37	4	ROCK	Thin Peat	2	2	16	Medium
655	Probehole	281090.72	952607.50	0.60	0.65	1	ROCK	Thin Peat	2	2	4	Negligible
656	Probehole	281092.04	952654.07	1.20	4.21	4	ROCK	Thin Peat	2	2	16	Medium
657	Probehole	281098.71	952707.16	0.40	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
658	Probehole	281099.34	952756.72	1.00	1.52	1	ROCK	Thin Peat	2	2	4	Negligible
659	Probehole	281114.17	952802.87	1.50	2.11	2	ROCK	Thin Peat	2	2	8	Low
660	Probehole	281153.08	952821.19	0.00	2.01	2	ROCK	No Peat	0	2	0	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
661	Probehole	281126.93	952816.44	1.60	2.05	2	ROCK	Thick Peat	3	2	12	Low
662	Probehole	281200.73	952822.53	1.60	2.50	2	ROCK	Thick Peat	3	2	12	Low
663	Probehole	281251.17	952819.89	5.00	2.95	2	ROCK	Thick Peat	3	2	12	Low
664	Probehole	281298.75	952812.88	2.70	2.37	2	ROCK	Thick Peat	3	2	12	Low
665	Probehole	281351.93	952810.71	2.70	2.14	2	ROCK	Thick Peat	3	2	12	Low
666	Probehole	281403.30	952809.71	2.70	1.57	1	ROCK	Thick Peat	3	2	6	Low
667	Probehole	281417.55	952810.77	2.70	1.83	1	ROCK	Thick Peat	3	2	6	Low
668	Probehole	281348.60	952880.63	2.70	1.79	1	ROCK	Thick Peat	3	2	6	Low
669	Probehole	281106.97	952511.01	0.30	2.94	2	ROCK	Peaty soil	1	2	4	Negligible
670	Probehole	281135.18	952461.87	0.50	1.62	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
671	Probehole	281151.91	952468.05	1.00	2.23	2	ROCK	Thin Peat	2	2	8	Low
672	Probehole	281183.38	952497.55	0.60	1.36	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
673	Probehole	281221.11	952512.19	0.70	3.09	2	ROCK	Thin Peat	2	2	8	Low
674	Probehole	281248.25	952472.93	0.40	0.55	1	ROCK	Peaty soil	1	2	2	Negligible
675	Probehole	281259.85	952428.38	0.40	3.52	2	ROCK	Peaty soil	1	2	4	Negligible
676	Probehole	281265.55	952388.29	0.40	0.30	1	ROCK	Peaty soil	1	2	2	Negligible
677	Probehole	281250.81	952338.79	0.50	0.79	1	ROCK	Peaty soil	1	2	2	Negligible
678	Probehole	281235.39	952299.14	0.30	1.41	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
679	Probehole	281224.51	952245.25	0.30	1.97	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
680	Probehole	281199.57	952190.12	0.70	2.66	2	ROCK	Thin Peat	2	2	8	Low
681	Probehole	280749.26	952644.24	1.00	4.41	4	ROCK	Thin Peat	2	2	16	Medium
682	Probehole	280771.42	952553.32	0.50	4.00	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
683	Probehole	280797.27	952446.32	0.50	5.77	4	ROCK	Peaty soil	1	2	8	Low
684	Probehole	280814.86	952349.05	0.20	6.24	4	ROCK	Peaty soil	1	2	8	Low
685	Probehole	280822.64	952297.56	0.50	5.65	4	ROCK	Peaty soil	1	2	8	Low
686	Probehole	280820.74	952238.38	0.40	5.92	4	ROCK	Peaty soil	1	2	8	Low
687	Probehole	280544.43	952276.69	0.70	3.17	2	ROCK	Thin Peat	2	2	8	Low
688	Probehole	280472.41	952296.71	0.70	2.75	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
689	Probehole	280430.53	952305.60	0.50	3.90	2	ROCK	Peaty soil	1	2	4	Negligible
690	Probehole	280396.26	952296.25	0.50	4.37	4	ROCK	Peaty soil	1	2	8	Low
691	Probehole	280398.38	952234.90	0.70	4.63	4	ROCK	Thin Peat	2	2	16	Medium
692	Probehole	280408.70	952187.05	0.50	3.99	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
693	Probehole	280417.36	952142.22	0.80	3.40	2	ROCK	Thin Peat	2	2	8	Low
694	Probehole	280402.18	952091.25	0.60	3.04	2	ROCK	Thin Peat	2	2	8	Low
695	Probehole	280371.80	952068.78	0.80	3.26	2	ROCK	Thin Peat	2	2	8	Low
696	Probehole	280364.24	952060.47	0.50	3.40	2	ROCK	Peaty soil	1	2	4	Negligible
697	Probehole	280349.27	952013.39	0.50	4.22	4	SAND OR GRAVEL	Peaty soil	1	1	4	Negligible
698	Probehole	280388.92	951975.79	0.50	3.12	2	ROCK	Peaty soil	1	2	4	Negligible
699	Probehole	280404.93	951938.90	0.30	0.32	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
700	Probehole	280392.04	951889.90	0.80	1.60	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
701	Probehole	280380.89	951846.61	0.90	1.80	1	ROCK	Thin Peat	2	2	4	Negligible
702	Probehole	280372.00	951820.32	0.80	1.63	1	ROCK	Thin Peat	2	2	4	Negligible
703	Probehole	280390.76	951780.76	0.80	1.92	1	ROCK	Thin Peat	2	2	4	Negligible
704	Probehole	280421.11	951735.27	0.40	2.72	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
705	Probehole	280485.58	951665.15	0.40	4.93	4	ROCK	Peaty soil	1	2	8	Low
706	Probehole	280560.36	951591.38	0.30	2.31	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
707	Probehole	280633.87	951527.13	0.60	1.93	1	ROCK	Thin Peat	2	2	4	Negligible
708	Probehole	280703.99	951447.37	0.80	1.82	1	ROCK	Thin Peat	2	2	4	Negligible
709	Probehole	280740.38	951388.89	1.10	1.62	1	ROCK	Thin Peat	2	2	4	Negligible
710	Probehole	280879.69	951403.41	0.30	0.74	1	SAND OR GRAVEL	Peaty soil	1	1	1	Negligible
711	Probehole	280824.21	951493.85	0.30	3.68	2	ROCK	Peaty soil	1	2	4	Negligible
712	Probehole	280814.73	951518.65	0.20	2.08	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
713	Probehole	280796.02	951581.98	1.50	3.27	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
714	Probehole	280799.52	951658.94	1.60	3.39	2	ROCK	Thick Peat	3	2	12	Low
715	Probehole	280830.39	951668.40	0.70	2.72	2	ROCK	Thin Peat	2	2	8	Low
716	Probehole	280848.32	951668.97	0.00	14.18	8	ROCK	No Peat	0	2	0	Negligible
717	Probehole	280875.25	951686.72	0.00	3.12	2	ROCK	No Peat	0	2	0	Negligible
718	Probehole	280895.83	951713.57	0.00	2.00	2	ROCK	No Peat	0	2	0	Negligible
719	Probehole	280795.59	951680.23	1.10	2.96	2	ROCK	Thin Peat	2	2	8	Low
720	Probehole	280784.56	951755.95	0.40	3.76	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
721	Probehole	280897.99	951326.35	0.10	1.42	1	ROCK	Peaty soil	1	2	2	Negligible
722	Probehole	280947.23	951318.73	0.70	1.79	1	ROCK	Thin Peat	2	2	4	Negligible
723	Probehole	280980.35	951286.71	1.20	2.23	2	SAND OR GRAVEL	Thin Peat	2	1	4	Negligible
724	Probehole	281011.50	951247.89	1.40	1.83	1	ROCK	Thin Peat	2	2	4	Negligible
725	Probehole	281018.44	951203.85	1.40	1.52	1	ROCK	Thin Peat	2	2	4	Negligible
726	Probehole	281040.29	951144.14	0.60	1.52	1	ROCK	Thin Peat	2	2	4	Negligible
727	Probehole	281064.44	951111.66	0.60	1.62	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
728	Probehole	281051.82	951068.03	0.90	0.74	1	SAND OR GRAVEL	Thin Peat	2	1	2	Negligible
729	Probehole	281035.81	951015.41	0.10	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
730	Probehole	281013.29	950973.20	1.20	3.58	2	ROCK	Thin Peat	2	2	8	Low
731	Probehole	281005.48	950921.26	1.30	1.36	1	ROCK	Thin Peat	2	2	4	Negligible
732	Probehole	280997.10	950869.71	0.20	1.43	1	ROCK	Peaty soil	1	2	2	Negligible
733	Probehole	280990.34	950816.81	1.00	2.11	2	ROCK	Thin Peat	2	2	8	Low
734	Probehole	280991.76	950767.37	0.90	2.15	2	ROCK	Thin Peat	2	2	8	Low
735	Probehole	280997.46	950720.96	0.40	2.84	2	ROCK	Peaty soil	1	2	4	Negligible
736	Probehole	281000.63	950671.47	0.40	1.77	1	ROCK	Peaty soil	1	2	2	Negligible
737	Probehole	280996.27	950617.57	0.40	0.00	1	ROCK	Peaty soil	1	2	2	Negligible
738	Probehole	280983.49	950572.09	0.50	3.45	2	ROCK	Peaty soil	1	2	4	Negligible
739	Probehole	280974.28	950531.52	0.60	4.58	4	ROCK	Thin Peat	2	2	16	Medium
740	Probehole	280981.20	950486.93	0.60	4.79	4	ROCK	Thin Peat	2	2	16	Medium
741	Probehole	280999.08	950501.62	0.70	5.65	4	SAND OR GRAVEL	Thin Peat	2	1	8	Low
742	Probehole	281020.34	950521.58	0.40	4.89	4	ROCK	Peaty soil	1	2	8	Low
743	Probehole	281049.42	950562.11	1.20	3.61	2	ROCK	Thin Peat	2	2	8	Low
744	Probehole	281080.87	950603.31	1.00	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
745	Probehole	281096.60	950630.68	0.60	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
746	Probehole	281130.63	950529.01	2.60	1.30	1	ROCK	Thick Peat	3	2	6	Low
747	Probehole	280951.23	950555.25	0.80	4.25	4	ROCK	Thin Peat	2	2	16	Medium
748	Probehole	280944.89	950606.32	0.60	2.95	2	ROCK	Thin Peat	2	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
749	Probehole	280947.60	950653.96	0.70	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
750	Probehole	280942.30	950707.22	0.40	2.54	2	ROCK	Peaty soil	1	2	4	Negligible
751	Probehole	280922.73	950755.35	0.10	2.26	2	ROCK	Peaty soil	1	2	4	Negligible
752	Probehole	280892.27	950794.72	0.40	2.18	2	ROCK	Peaty soil	1	2	4	Negligible
753	Probehole	280858.44	950819.14	0.40	2.44	2	ROCK	Peaty soil	1	2	4	Negligible
754	Probehole	280813.77	950836.47	0.60	2.24	2	ROCK	Thin Peat	2	2	8	Low
755	Probehole	280776.86	950846.13	1.00	0.45	1	ROCK	Thin Peat	2	2	4	Negligible
756	Probehole	280758.28	950811.79	0.60	1.99	1	ROCK	Thin Peat	2	2	4	Negligible
757	Probehole	280710.42	950720.58	0.40	3.24	2	ROCK	Peaty soil	1	2	4	Negligible
758	Probehole	280793.02	951188.60	0.10	1.69	1	ROCK	Peaty soil	1	2	2	Negligible
759	Probehole	280859.60	951162.07	0.10	1.83	1	ROCK	Peaty soil	1	2	2	Negligible
760	Probehole	280886.18	951145.66	1.00	1.73	1	ROCK	Thin Peat	2	2	4	Negligible
761	Probehole	281083.89	951204.10	0.90	1.87	1	ROCK	Thin Peat	2	2	4	Negligible
762	Probehole	280427.55	950506.00	1.80	2.29	2	ROCK	Thick Peat	3	2	12	Low
763	Probehole	280276.53	950529.92	0.50	2.51	2	ROCK	Peaty soil	1	2	4	Negligible
764	Probehole	280136.66	950526.76	2.70	1.72	1	ROCK	Thick Peat	3	2	6	Low
765	Probehole	280110.88	950483.17	2.70	1.36	1	ROCK	Thick Peat	3	2	6	Low
766	Probehole	280092.78	950423.19	2.70	1.22	1	ROCK	Thick Peat	3	2	6	Low
767	Probehole	280071.20	950380.21	2.70	1.09	1	ROCK	Thick Peat	3	2	6	Low
768	Probehole	280056.36	950337.58	2.70	1.18	1	ROCK	Thick Peat	3	2	6	Low
769	Probehole	280039.89	950292.78	2.70	1.01	1	ROCK	Thick Peat	3	2	6	Low
770	Probehole	280027.95	950249.69	1.80	1.67	1	ROCK	Thick Peat	3	2	6	Low
771	Probehole	280022.05	950200.11	2.30	2.51	2	ROCK	Thick Peat	3	2	12	Low
772	Probehole	280012.50	950174.41	2.50	0.10	1	ROCK	Thick Peat	3	2	6	Low
773	Probehole	280014.90	950150.94	2.50	0.51	1	ROCK	Thick Peat	3	2	6	Low
774	Probehole	280009.24	950096.52	2.40	1.74	1	ROCK	Thick Peat	3	2	6	Low
775	Probehole	280009.58	950053.43	1.00	5.51	4	ROCK	Thin Peat	2	2	16	Medium
776	Probehole	280004.21	950040.22	2.30	3.26	2	ROCK	Thick Peat	3	2	12	Low
777	Probehole	279982.19	950014.71	2.50	1.63	1	ROCK	Thick Peat	3	2	6	Low
778	Probehole	279960.61	950003.30	2.60	0.29	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
779	Probehole	279927.49	950003.39	1.60	1.54	1	ROCK	Thick Peat	3	2	6	Low
780	Probehole	279876.50	949995.66	1.00	2.90	2	ROCK	Thin Peat	2	2	8	Low
781	Probehole	279822.39	950006.98	1.00	1.24	1	ROCK	Thin Peat	2	2	4	Negligible
782	Probehole	279793.68	949985.95	2.30	0.00	1	SAND OR GRAVEL	Thick Peat	3	1	3	Negligible
783	Probehole	279766.06	949980.85	0.70	0.00	1	ROCK	Thin Peat	2	2	4	Negligible
784	Probehole	279797.22	949926.42	3.00	0.93	1	ROCK	Thick Peat	3	2	6	Low
785	Probehole	279782.63	949882.67	2.30	5.05	4	ROCK	Thick Peat	3	2	24	Medium
786	Probehole	279788.80	949826.40	1.20	0.64	1	ROCK	Thin Peat	2	2	4	Negligible
787	Probehole	279989.59	949985.89	2.50	2.55	2	ROCK	Thick Peat	3	2	12	Low
788	Probehole	279968.09	949945.32	2.60	0.65	1	ROCK	Thick Peat	3	2	6	Low
789	Probehole	279948.74	949914.91	2.60	4.17	4	ROCK	Thick Peat	3	2	24	Medium
790	Probehole	279926.18	949874.75	2.60	2.46	2	ROCK	Thick Peat	3	2	12	Low
791	Probehole	279912.26	949821.14	2.60	2.73	2	ROCK	Thick Peat	3	2	12	Low
792	Probehole	279903.04	949774.44	2.60	3.08	2	ROCK	Thick Peat	3	2	12	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
793	Probehole	279898.17	949726.87	1.30	1.95	1	ROCK	Thin Peat	2	2	4	Negligible
794	Probehole	279900.46	949664.59	1.60	2.50	2	ROCK	Thick Peat	3	2	12	Low
795	Probehole	279918.46	949631.92	0.90	2.53	2	ROCK	Thin Peat	2	2	8	Low
796	Probehole	279897.66	949576.47	2.00	2.50	2	ROCK	Thick Peat	3	2	12	Low
797	Probehole	279899.49	949496.20	0.20	2.58	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
798	Probehole	279898.36	949459.10	0.20	2.31	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
799	Probehole	279910.55	949459.65	0.50	2.40	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
800	Probehole	279943.19	949666.44	0.20	3.14	2	SAND OR GRAVEL	Peaty soil	1	1	2	Negligible
801	Probehole	279976.72	949743.59	1.20	3.56	2	ROCK	Thin Peat	2	2	8	Low
802	Probehole	280057.64	949815.57	0.40	4.28	4	ROCK	Peaty soil	1	2	8	Low
803	Probehole	280118.45	949934.23	0.20	3.22	2	ROCK	Peaty soil	1	2	4	Negligible
804	Probehole	280683.77	949732.42	2.30	2.13	2	ROCK	Thick Peat	3	2	12	Low
805	Probehole	280688.38	949717.24	2.40	1.96	1	ROCK	Thick Peat	3	2	6	Low
806	Probehole	280674.82	949710.41	2.60	2.44	2	ROCK	Thick Peat	3	2	12	Low
807	Probehole	280145.89	950031.99	0.70	4.01	4	ROCK	Thin Peat	2	2	16	Medium

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
1	Probehole	279151.7	949065.0	2.00	2.3	2	GRANULAR	Thick Peat	3	1	6	Low
2	Probehole	279171.8	949106.5	1.30	2.9	2	GRANULAR	Thin Peat	2	1	4	Negligible
3	Probehole	279193.8	949145.9	3.70	2.7	2	GRANULAR	Thick Peat	3	1	6	Low
4	Probehole	279209.3	949185.4	4.00	3.1	2	GRANULAR	Thick Peat	3	1	6	Low
5	Probehole	279226.7	949198.8	3.70	2.6	2	ROCK	Thick Peat	3	2	12	Low
6	Probehole	279249.9	949240.4	3.50	2.1	2	GRANULAR	Thick Peat	3	1	6	Low
7	Probehole	279222.8	949260.3	3.50	2.4	2	ROCK	Thick Peat	3	2	12	Low
8	Probehole	279176.3	949273.3	3.30	2.4	2	GRANULAR	Thick Peat	3	1	6	Low
9	Probehole	279128.0	949287.2	1.40	2.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
10	Probehole	279081.9	949302.9	1.20	2.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
11	Probehole	279037.3	949290.0	1.20	2.1	2	GRANULAR	Thin Peat	2	1	4	Negligible
12	Probehole	278998.5	949274.1	0.90	2.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
13	Probehole	278954.1	949285.5	1.60	2.7	2	GRANULAR	Thick Peat	3	1	6	Low
14	Probehole	278991.4	949318.5	0.90	2.9	2	GRANULAR	Thin Peat	2	1	4	Negligible
15	Probehole	279025.5	949360.8	0.70	1.5	1	GRANULAR	Thin Peat	2	1	2	Negligible
16	Probehole	279052.2	949405.4	1.00	2.9	2	GRANULAR	Thin Peat	2	1	4	Negligible
17	Probehole	279073.8	949449.9	0.90	2.2	2	ROCK	Thin Peat	2	2	8	Low
18	Probehole	279106.8	949502.3	1.70	2.1	2	GRANULAR	Thick Peat	3	1	6	Low
19	Probehole	279127.2	949530.5	1.60	2.2	2	ROCK	Thick Peat	3	2	12	Low
20	Probehole	279120.8	949730.1	0.40	3.6	2	GRANULAR	Peaty soil	1	1	2	Negligible
21	Probehole	279077.4	949722.7	0.60	3.5	2	GRANULAR	Thin Peat	2	1	4	Negligible
22	Probehole	279033.1	949717.4	0.60	3.0	2	ROCK	Thin Peat	2	2	8	Low
23	Probehole	278983.1	949732.5	0.50	3.3	2	GRANULAR	Peaty soil	1	1	2	Negligible
24	Probehole	278931.8	949740.2	0.20	2.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
25	Probehole	278508.2	949608.9	0.90	2.1	2	GRANULAR	Thin Peat	2	1	4	Negligible
26	Probehole	278289.8	949588.3	1.90	1.9	1	GRANULAR	Thick Peat	3	1	3	Negligible
27	Probehole	278308.1	949626.6	1.80	1.5	1	ROCK	Thick Peat	3	2	6	Low
28	Probehole	278321.6	949651.8	1.60	1.5	1	ROCK	Thick Peat	3	2	6	Low
29	Probehole	278336.6	949705.0	1.80	1.4	1	ROCK	Thick Peat	3	2	6	Low
30	Probehole	278354.5	949765.0	3.80	1.2	1	GRANULAR	Thick Peat	3	1	3	Negligible
31	Probehole	278367.8	949816.0	0.90	1.6	1	GRANULAR	Thin Peat	2	1	2	Negligible
32	Probehole	278340.5	949867.3	1.00	1.6	1	GRANULAR	Thin Peat	2	1	2	Negligible
33	Probehole	278261.2	949894.9	1.70	1.8	1	ROCK	Thick Peat	3	2	6	Low
34	Probehole	278294.7	949933.6	1.60	1.9	1	ROCK	Thick Peat	3	2	6	Low
35	Probehole	278326.9	949989.8	2.70	1.7	1	ROCK	Thick Peat	3	2	6	Low
36	Probehole	278347.2	950043.2	3.50	1.6	1	GRANULAR	Thick Peat	3	1	3	Negligible
37	Probehole	278172.7	949755.6	0.40	1.4	1	GRANULAR	Peaty soil	1	1	1	Negligible
38	Probehole	278159.4	949723.3	0.40	1.1	1	ROCK	Peaty soil	1	2	2	Negligible
39	Probehole	278147.5	949678.3	0.80	2.0	2	ROCK	Thin Peat	2	2	8	Low
40	Probehole	278139.5	949638.5	0.60	2.5	2	GRANULAR	Thin Peat	2	1	4	Negligible
41	Probehole	278130.3	949587.9	0.60	2.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
42	Probehole	277952.3	949559.6	2.10	3.6	2	GRANULAR	Thick Peat	3	1	6	Low
43	Probehole	277919.7	949588.5	1.90	2.7	2	GRANULAR	Thick Peat	3	1	6	Low
44	Probehole	277888.4	949614.2	1.90	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
45	Probehole	277855.0	949645.8	1.00	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
46	Probehole	277824.3	949664.3	1.70	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
47	Probehole	277790.3	949689.3	2.70	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
48	Probehole	277766.2	949848.4	2.60	0.6	1	GRANULAR	Thick Peat	3	1	3	Negligible
49	Probehole	277455.6	950034.5	1.00	1.3	1	GRANULAR	Thin Peat	2	1	2	Negligible
50	Probehole	277397.7	950024.4	0.20	5.1	4	ROCK	Peaty soil	1	2	8	Low
51	Probehole	277404.1	949973.2	0.70	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
52	Probehole	277391.3	949920.8	0.60	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
53	Probehole	277370.6	949864.1	0.60	0.0	1	ROCK	Thin Peat	2	2	4	Negligible
54	Probehole	277372.1	949814.1	0.80	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
55	Probehole	277369.6	949761.8	0.70	0.0	1	ROCK	Thin Peat	2	2	4	Negligible
56	Probehole	277404.8	949777.8	0.70	3.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
57	Probehole	277443.2	949792.2	0.90	4.0	4	ROCK	Thin Peat	2	2	16	Medium
58	Probehole	277479.7	949799.4	1.40	5.9	4	GRANULAR	Thin Peat	2	1	8	Low
59	Probehole	277373.2	949714.5	0.70	1.1	1	GRANULAR	Thin Peat	2	1	2	Negligible
60	Probehole	277372.0	949662.6	0.40	3.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
61	Probehole	277379.3	949618.5	0.50	0.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
62	Probehole	277426.6	949632.5	1.50	3.9	2	GRANULAR	Thin Peat	2	1	4	Negligible
63	Probehole	277474.8	949653.1	1.80	5.3	4	GRANULAR	Thick Peat	3	1	12	Low
64	Probehole	277523.3	949663.8	1.00	2.9	2	GRANULAR	Thin Peat	2	1	4	Negligible
65	Probehole	277529.2	949617.7	1.50	2.3	2	GRANULAR	Thin Peat	2	1	4	Negligible
66	Probehole	277522.7	949572.5	0.90	3.0	2	ROCK	Thin Peat	2	2	8	Low
67	Probehole	277502.7	949409.7	1.70	4.2	4	ROCK	Thick Peat	3	2	24	Medium
68	Probehole	277461.7	949377.9	1.80	1.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
69	Probehole	277423.9	949357.2	2.00	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
70	Probehole	277363.0	949335.1	1.80	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
71	Probehole	277349.6	949281.5	2.00	0.0	1	ROCK	Thick Peat	3	2	6	Low
72	Probehole	277348.4	949230.1	0.80	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
73	Probehole	277355.0	949184.0	0.30	0.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
74	Probehole	277384.5	949138.0	0.90	1.9	1	ROCK	Thin Peat	2	2	4	Negligible
75	Probehole	277424.7	949098.5	1.80	2.1	2	GRANULAR	Thick Peat	3	1	6	Low
76	Probehole	277730.3	949371.7	2.50	0.0	1	ROCK	Thick Peat	3	2	6	Low
77	Probehole	277757.7	949326.0	1.70	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
78	Probehole	277803.3	949292.4	1.80	3.4	2	GRANULAR	Thick Peat	3	1	6	Low
79	Probehole	277849.4	949266.8	1.00	4.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
80	Probehole	277904.2	949239.1	0.20	3.6	2	GRANULAR	Peaty soil	1	1	2	Negligible
81	Probehole	277963.6	949204.8	0.30	7.4	4	GRANULAR	Peaty soil	1	1	4	Negligible
82	Probehole	278047.0	949153.7	0.40	1.8	1	GRANULAR	Peaty soil	1	1	1	Negligible
83	Probehole	278103.7	949166.1	0.70	1.6	1	GRANULAR	Thin Peat	2	1	2	Negligible
84	Probehole	278295.6	949177.4	0.90	2.2	2	ROCK	Thin Peat	2	2	8	Low
85	Probehole	278321.6	949231.6	0.40	1.9	1	GRANULAR	Peaty soil	1	1	1	Negligible
86	Probehole	278352.8	949290.0	0.50	1.1	1	ROCK	Peaty soil	1	2	2	Negligible
87	Probehole	278385.0	949352.7	1.00	1.4	1	GRANULAR	Thin Peat	2	1	2	Negligible
88	Probehole	278426.0	949416.6	1.00	1.6	1	GRANULAR	Thin Peat	2	1	2	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
89	Probehole	278459.1	949473.0	1.00	1.6	1	GRANULAR	Thin Peat	2	1	2	Negligible
90	Probehole	278715.0	949679.1	2.00	1.5	1	ROCK	Thick Peat	3	2	6	Low
91	Probehole	278717.0	949632.8	1.70	1.6	1	ROCK	Thick Peat	3	2	6	Low
92	Probehole	278701.0	949587.5	1.80	1.3	1	GRANULAR	Thick Peat	3	1	3	Negligible
93	Probehole	278749.1	949637.1	1.20	1.1	1	ROCK	Thin Peat	2	2	4	Negligible
94	Probehole	278783.4	949602.9	1.70	1.7	1	ROCK	Thick Peat	3	2	6	Low
95	Probehole	278827.7	949568.9	1.10	1.5	1	GRANULAR	Thin Peat	2	1	2	Negligible
96	Probehole	278869.9	949535.5	0.70	2.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
97	Probehole	278907.0	949508.7	0.40	3.3	2	GRANULAR	Peaty soil	1	1	2	Negligible
98	Probehole	278966.0	949475.5	0.90	4.4	4	GRANULAR	Thin Peat	2	1	8	Low
99	Probehole	279001.1	949461.8	0.50	3.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
100	Probehole	279030.4	949450.1	0.70	2.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
101	Probehole	279127.9	949431.3	1.70	2.0	2	ROCK	Thick Peat	3	2	12	Low
102	Probehole	279182.5	949422.0	2.70	1.4	1	ROCK	Thick Peat	3	2	6	Low
103	Probehole	279239.6	949419.2	1.60	1.8	1	ROCK	Thick Peat	3	2	6	Low
104	Probehole	279293.2	949412.1	0.90	2.1	2	GRANULAR	Thin Peat	2	1	4	Negligible
105	Probehole	279341.5	949402.6	0.70	4.9	4	GRANULAR	Thin Peat	2	1	8	Low
106	Probehole	279372.8	949393.7	0.90	2.4	2	GRANULAR	Thin Peat	2	1	4	Negligible
107	Probehole	279388.6	949449.8	2.00	2.6	2	ROCK	Thick Peat	3	2	12	Low
108	Probehole	279362.6	949479.1	1.70	2.0	2	GRANULAR	Thick Peat	3	1	6	Low
109	Probehole	279313.7	949490.8	1.50	3.0	2	ROCK	Thin Peat	2	2	8	Low
110	Probehole	279470.0	949653.7	1.00	1.9	1	GRANULAR	Thin Peat	2	1	2	Negligible
111	Probehole	279527.2	949667.5	2.00	1.1	1	ROCK	Thick Peat	3	2	6	Low
112	Probehole	279581.3	949656.4	3.00	0.7	1	GRANULAR	Thick Peat	3	1	3	Negligible
113	Probehole	279635.1	949640.6	1.80	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
114	Probehole	279665.1	949673.5	1.50	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
115	Probehole	279693.9	949725.3	1.60	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
116	Probehole	279716.7	949775.1	0.90	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
117	Probehole	279731.0	949826.5	1.70	0.0	1	ROCK	Thick Peat	3	2	6	Low
118	Probehole	279359.0	949302.6	0.50	0.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
119	Probehole	279313.9	949277.0	2.00	2.0	2	ROCK	Thick Peat	3	2	12	Low
120	Probehole	279274.5	949256.2	2.70	1.9	1	GRANULAR	Thick Peat	3	1	3	Negligible
121	Probehole	280425.0	949545.7	2.40	2.9	2	ROCK	Thick Peat	3	2	12	Low
122	Probehole	280434.2	949493.1	1.40	2.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
123	Probehole	280427.8	949468.0	1.80	2.0	2	GRANULAR	Thick Peat	3	1	6	Low
124	Probehole	280430.1	949424.1	2.60	5.1	4	ROCK	Thick Peat	3	2	24	Medium
125	Probehole	280430.3	949374.5	1.80	2.6	2	ROCK	Thick Peat	3	2	12	Low
126	Probehole	280429.3	949615.8	2.50	2.4	2	GRANULAR	Thick Peat	3	1	6	Low
127	Probehole	280403.0	949701.0	1.40	1.9	1	GRANULAR	Thin Peat	2	1	2	Negligible
128	Probehole	280407.7	949775.7	0.80	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
129	Probehole	280434.6	949811.5	3.30	1.9	1	GRANULAR	Thick Peat	3	1	3	Negligible
130	Probehole	280468.7	949845.9	2.90	1.4	1	ROCK	Thick Peat	3	2	6	Low
131	Probehole	280501.5	949878.5	2.50	2.1	2	ROCK	Thick Peat	3	2	12	Low
132	Probehole	280540.2	949909.9	2.70	2.0	2	ROCK	Thick Peat	3	2	12	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
133	Probehole	280609.2	949924.8	0.90	2.4	2	ROCK	Thin Peat	2	2	8	Low
134	Probehole	280663.3	949914.1	0.20	2.0	2	ROCK	Peaty soil	1	2	4	Negligible
135	Probehole	280713.2	949904.4	0.30	3.8	2	ROCK	Peaty soil	1	2	4	Negligible
136	Probehole	280762.1	949897.5	0.30	2.4	2	ROCK	Peaty soil	1	2	4	Negligible
137	Probehole	280837.2	949772.5	0.70	4.0	2	ROCK	Thin Peat	2	2	8	Low
138	Probehole	280854.9	949712.6	1.50	4.7	4	ROCK	Thin Peat	2	2	16	Medium
139	Probehole	280868.6	949682.2	0.30	2.8	2	GRANULAR	Peaty soil	1	1	2	Negligible
140	Probehole	280842.4	949671.0	0.90	4.6	4	GRANULAR	Thin Peat	2	1	8	Low
141	Probehole	280806.5	949676.1	1.60	5.8	4	GRANULAR	Thick Peat	3	1	12	Low
142	Probehole	280638.7	949708.9	4.50	2.4	2	ROCK	Thick Peat	3	2	12	Low
143	Probehole	280588.3	949717.9	4.70	2.0	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
144	Probehole	280542.3	949725.8	4.70	1.3	1	ROCK	Thick Peat	3	2	6	Low
145	Probehole	280478.0	949735.5	3.60	1.9	1	ROCK	Thick Peat	3	2	6	Low
146	Probehole	280442.4	949743.9	3.40	2.4	2	ROCK	Thick Peat	3	2	12	Low
147	Probehole	280004.6	949845.6	0.50	3.3	2	ROCK	Peaty soil	1	2	4	Negligible
148	Probehole	280008.3	949812.1	0.90	3.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
149	Probehole	279974.1	949763.0	1.80	3.2	2	ROCK	Thick Peat	3	2	12	Low
150	Probehole	279948.8	949716.4	1.10	3.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
151	Probehole	279932.9	949676.8	0.80	2.7	2	GRANULAR	Thin Peat	2	1	4	Negligible
152	Probehole	279739.4	949691.1	1.80	0.0	1	ROCK	Thick Peat	3	2	6	Low
153	Probehole	279740.5	949695.5	2.10	0.0	1	ROCK	Thick Peat	3	2	6	Low
154	Probehole	279754.1	949720.7	2.70	0.5	1	GRANULAR	Thick Peat	3	1	3	Negligible
155	Probehole	279756.8	949745.5	1.50	0.5	1	GRANULAR	Thin Peat	2	1	2	Negligible
156	Probehole	280290.1	950228.1	1.80	2.2	2	ROCK	Thick Peat	3	2	12	Low
157	Probehole	280223.7	950233.5	1.80	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
158	Probehole	280198.7	950256.0	1.80	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
159	Probehole	280146.7	950272.1	1.60	2.2	2	ROCK	Thick Peat	3	2	12	Low
160	Probehole	280113.3	950302.2	1.50	1.5	1	GRANULAR	Thin Peat	2	1	2	Negligible
161	Probehole	280063.3	950337.6	3.00	1.2	1	ROCK	Thick Peat	3	2	6	Low
162	Probehole	279956.3	950465.6	2.50	0.2	1	ROCK	Thick Peat	3	2	6	Low
163	Probehole	280025.7	950536.5	2.00	1.0	1	ROCK	Thick Peat	3	2	6	Low
164	Probehole	280170.2	950538.2	1.80	2.1	2	ROCK	Thick Peat	3	2	12	Low
165	Probehole	280213.4	950524.8	0.40	2.9	2	GRANULAR	Peaty soil	1	1	2	Negligible
166	Probehole	280266.3	950523.9	0.50	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
167	Probehole	280126.5	950504.0	2.70	1.8	1	GRANULAR	Thick Peat	3	1	3	Negligible
168	Probehole	280155.1	950482.9	1.10	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
169	Probehole	280156.6	950446.1	0.60	2.5	2	GRANULAR	Thin Peat	2	1	4	Negligible
170	Probehole	280197.2	950417.8	0.80	2.4	2	GRANULAR	Thin Peat	2	1	4	Negligible
171	Probehole	280240.3	950382.8	0.90	2.8	2	GRANULAR	Thin Peat	2	1	4	Negligible
172	Probehole	280271.0	950353.9	1.10	2.2	2	ROCK	Thin Peat	2	2	8	Low
173	Probehole	280303.5	950321.3	1.30	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
174	Probehole	280330.4	950265.5	0.90	1.9	1	GRANULAR	Thin Peat	2	1	2	Negligible
175	Probehole	279860.1	949141.3	1.00	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
176	Probehole	279839.3	949099.7	1.10	2.8	2	ROCK	Thin Peat	2	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
177	Probehole	279803.0	949106.6	0.90	2.3	2	GRANULAR	Thin Peat	2	1	4	Negligible
178	Probehole	279791.7	949079.8	0.70	2.4	2	ROCK	Thin Peat	2	2	8	Low
179	Probehole	280352.4	950211.2	0.60	2.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
180	Probehole	280377.7	950172.9	1.00	2.8	2	GRANULAR	Thin Peat	2	1	4	Negligible
181	Probehole	280401.5	950160.1	1.00	2.5	2	ROCK	Thin Peat	2	2	8	Low
182	Probehole	280431.1	950167.6	0.80	3.1	2	GRANULAR	Thin Peat	2	1	4	Negligible
183	Probehole	280643.8	950385.8	0.30	6.1	4	GRANULAR	Peaty soil	1	1	4	Negligible
184	Probehole	280709.5	950344.6	0.50	2.1	2	ROCK	Peaty soil	1	2	4	Negligible
185	Probehole	280756.5	950369.0	0.20	3.1	2	GRANULAR	Peaty soil	1	1	2	Negligible
186	Probehole	280791.6	950407.1	0.90	3.5	2	GRANULAR	Thin Peat	2	1	4	Negligible
187	Probehole	280837.0	950437.8	0.70	4.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
188	Probehole	280866.0	950429.3	0.20	3.3	2	ROCK	Peaty soil	1	2	4	Negligible
189	Probehole	280902.0	950397.8	0.20	2.5	2	GRANULAR	Peaty soil	1	1	2	Negligible
190	Probehole	280936.8	950362.9	0.30	1.1	1	GRANULAR	Peaty soil	1	1	1	Negligible
191	Probehole	280995.1	950347.2	0.90	2.3	2	GRANULAR	Thin Peat	2	1	4	Negligible
192	Probehole	281036.3	950337.8	2.50	2.3	2	GRANULAR	Thick Peat	3	1	6	Low
193	Probehole	281066.4	950332.5	2.40	4.8	4	GRANULAR	Thick Peat	3	1	12	Low
194	Probehole	280620.6	950671.0	0.20	2.8	2	GRANULAR	Peaty soil	1	1	2	Negligible
195	Probehole	280590.4	950701.6	1.60	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
196	Probehole	280656.4	950687.5	0.90	2.5	2	ROCK	Thin Peat	2	2	8	Low
197	Probehole	280696.4	950707.3	0.80	3.2	2	ROCK	Thin Peat	2	2	8	Low
198	Probehole	280712.3	950775.3	0.90	2.5	2	ROCK	Thin Peat	2	2	8	Low
199	Probehole	280744.7	950812.0	1.00	1.8	1	GRANULAR	Thin Peat	2	1	2	Negligible
200	Probehole	280743.8	950866.1	2.00	2.0	1	ROCK	Thick Peat	3	2	6	Low
201	Probehole	280928.5	950775.0	0.30	2.1	2	GRANULAR	Peaty soil	1	1	2	Negligible
202	Probehole	280969.0	950774.9	0.60	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
203	Probehole	280990.7	950820.7	0.90	2.1	2	GRANULAR	Thin Peat	2	1	4	Negligible
204	Probehole	281023.2	950853.7	0.20	1.8	1	GRANULAR	Peaty soil	1	1	1	Negligible
205	Probehole	281023.6	950832.5	0.90	2.5	2	GRANULAR	Thin Peat	2	1	4	Negligible
206	Probehole	280257.0	951630.3	0.30	1.8	1	GRANULAR	Peaty soil	1	1	1	Negligible
207	Probehole	280201.9	951616.2	0.30	3.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
208	Probehole	280166.9	951642.4	1.10	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
209	Probehole	280138.5	951650.3	1.70	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
210	Probehole	280095.7	951546.0	2.00	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
211	Probehole	280051.2	951436.8	2.70	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
212	Probehole	280206.6	951243.2	0.50	4.0	4	GRANULAR	Peaty soil	1	1	4	Negligible
213	Probehole	280257.8	951234.8	0.40	4.9	4	GRANULAR	Peaty soil	1	1	4	Negligible
214	Probehole	280105.3	950939.8	2.20	4.0	2	GRANULAR	Thick Peat	3	1	6	Low
215	Probehole	280119.7	950973.7	1.10	4.0	4	GRANULAR	Thin Peat	2	1	8	Low
216	Probehole	280140.5	951018.9	0.20	3.6	2	ROCK	Peaty soil	1	2	4	Negligible
217	Probehole	280153.1	951051.0	0.60	3.3	2	GRANULAR	Thin Peat	2	1	4	Negligible
218	Probehole	280008.9	950921.0	1.90	1.3	1	ROCK	Thick Peat	3	2	6	Low
219	Probehole	279987.8	950861.5	2.10	0.5	1	GRANULAR	Thick Peat	3	1	3	Negligible
220	Probehole	279973.4	950816.4	1.80	1.6	1	GRANULAR	Thick Peat	3	1	3	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
221	Probehole	279960.7	950767.4	2.00	1.9	1	ROCK	Thick Peat	3	2	6	Low
222	Probehole	279996.5	950735.7	2.00	2.4	2	GRANULAR	Thick Peat	3	1	6	Low
223	Probehole	280039.6	950723.0	2.70	2.9	2	GRANULAR	Thick Peat	3	1	6	Low
224	Probehole	280096.3	950713.3	2.70	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
225	Probehole	280139.1	950713.9	0.90	1.5	1	ROCK	Thin Peat	2	2	4	Negligible
226	Probehole	280291.6	951192.9	0.70	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
227	Probehole	280307.5	951240.0	0.90	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
228	Probehole	280325.1	951285.5	2.50	2.2	2	GRANULAR	Thick Peat	3	1	6	Low
229	Probehole	280346.2	951326.6	1.80	1.9	1	GRANULAR	Thick Peat	3	1	3	Negligible
230	Probehole	280376.1	951366.0	0.60	2.4	2	GRANULAR	Thin Peat	2	1	4	Negligible
231	Probehole	280387.2	951417.8	0.30	1.5	1	GRANULAR	Peaty soil	1	1	1	Negligible
232	Probehole	280382.7	951467.4	1.70	1.8	1	GRANULAR	Thick Peat	3	1	3	Negligible
233	Probehole	280382.2	951511.6	0.50	2.6	2	GRANULAR	Peaty soil	1	1	2	Negligible
234	Probehole	280382.3	951564.7	0.20	3.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
235	Probehole	280381.5	951621.5	0.20	2.7	2	GRANULAR	Peaty soil	1	1	2	Negligible
236	Probehole	278447.6	951832.9	0.70	1.3	1	GRANULAR	Thin Peat	2	1	2	Negligible
237	Probehole	278400.0	951854.4	0.70	1.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
238	Probehole	278355.2	951881.6	1.20	0.6	1	GRANULAR	Thin Peat	2	1	2	Negligible
239	Probehole	278313.4	951901.5	1.10	8.3	6	GRANULAR	Thin Peat	2	1	12	Low
240	Probehole	278267.6	951920.8	1.20	0.8	1	GRANULAR	Thin Peat	2	1	2	Negligible
241	Probehole	278218.0	951920.6	0.80	1.1	1	GRANULAR	Thin Peat	2	1	2	Negligible
242	Probehole	278256.0	951983.1	0.90	1.1	1	GRANULAR	Thin Peat	2	1	2	Negligible
243	Probehole	278286.4	951955.6	1.60	0.5	1	ROCK	Thick Peat	3	2	6	Low
244	Probehole	278283.5	952025.4	0.40	1.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
245	Probehole	278239.1	952037.1	0.40	1.3	1	ROCK	Peaty soil	1	2	2	Negligible
246	Probehole	278197.0	952041.8	0.40	1.3	1	GRANULAR	Peaty soil	1	1	1	Negligible
247	Probehole	278146.1	952049.3	0.40	0.8	1	GRANULAR	Peaty soil	1	1	1	Negligible
248	Probehole	278137.2	952026.2	0.90	1.2	1	GRANULAR	Thin Peat	2	1	2	Negligible
249	Probehole	278150.8	951989.2	0.90	1.1	1	GRANULAR	Thin Peat	2	1	2	Negligible
250	Probehole	278169.0	951943.1	0.90	1.6	1	GRANULAR	Thin Peat	2	1	2	Negligible
251	Probehole	277876.8	951618.9	3.00	1.4	1	ROCK	Thick Peat	3	2	6	Low
252	Probehole	277822.2	951627.8	3.00	0.0	1	ROCK	Thick Peat	3	2	6	Low
253	Probehole	277791.7	951636.2	3.60	0.0	1	ROCK	Thick Peat	3	2	6	Low
254	Probehole	277753.2	951641.7	2.50	0.0	1	ROCK	Thick Peat	3	2	6	Low
255	Probehole	278259.2	950821.3	0.20	0.4	1	GRANULAR	Peaty soil	1	1	1	Negligible
256	Probehole	278214.0	950857.8	0.30	0.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
257	Probehole	278168.7	950876.9	0.90	0.2	1	ROCK	Thin Peat	2	2	4	Negligible
258	Probehole	278083.5	950925.6	0.60	0.0	1	ROCK	Thin Peat	2	2	4	Negligible
259	Probehole	277978.4	950967.7	1.80	4.0	2	GRANULAR	Thick Peat	3	1	6	Low
260	Probehole	277914.9	950987.7	0.90	1.3	1	GRANULAR	Thin Peat	2	1	2	Negligible
261	Probehole	277864.8	951000.7	2.70	0.7	1	GRANULAR	Thick Peat	3	1	3	Negligible
262	Probehole	278261.2	951400.5	1.00	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
263	Probehole	279083.7	952010.3	0.70	6.7	4	GRANULAR	Thin Peat	2	1	8	Low
264	Probehole	279126.7	952008.9	1.80	3.8	2	ROCK	Thick Peat	3	2	12	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
265	Probehole	279122.2	952048.6	1.10	5.9	4	GRANULAR	Thin Peat	2	1	8	Low
266	Probehole	279118.6	952085.7	0.20	6.8	4	GRANULAR	Peaty soil	1	1	4	Negligible
267	Probehole	279111.4	952111.0	0.40	5.9	4	GRANULAR	Peaty soil	1	1	4	Negligible
268	Probehole	279141.8	952141.8	0.40	5.0	4	GRANULAR	Peaty soil	1	1	4	Negligible
269	Probehole	279125.6	952197.3	0.40	5.3	4	GRANULAR	Peaty soil	1	1	4	Negligible
270	Probehole	279137.0	952253.0	0.70	4.3	4	GRANULAR	Thin Peat	2	1	8	Low
271	Probehole	280776.8	951856.8	0.70	3.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
272	Probehole	280748.7	951867.9	0.60	3.2	2	ROCK	Thin Peat	2	2	8	Low
273	Probehole	280698.8	951873.3	0.60	2.7	2	GRANULAR	Thin Peat	2	1	4	Negligible
274	Probehole	280670.9	951870.1	0.40	2.7	2	GRANULAR	Peaty soil	1	1	2	Negligible
275	Probehole	280780.0	952435.5	0.20	4.8	4	GRANULAR	Peaty soil	1	1	4	Negligible
276	Probehole	280753.4	952431.7	0.80	5.0	4	ROCK	Thin Peat	2	2	16	Medium
277	Probehole	280701.8	952436.0	0.20	4.2	4	ROCK	Peaty soil	1	2	8	Low
278	Probehole	280690.7	952438.4	0.40	4.3	4	ROCK	Peaty soil	1	2	8	Low
279	Probehole	280697.0	952433.6	0.60	4.2	4	GRANULAR	Thin Peat	2	1	8	Low
280	Probehole	280745.8	952440.3	0.70	5.4	4	ROCK	Thin Peat	2	2	16	Medium
281	Probehole	280561.8	950470.0	0.10	2.9	2	GRANULAR	Peaty soil	1	1	2	Negligible
282	Probehole	280586.8	950436.3	0.20	3.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
283	Probehole	280614.5	950398.2	0.30	4.9	4	GRANULAR	Peaty soil	1	1	4	Negligible
284	Probehole	280636.4	950364.8	0.60	6.4	4	GRANULAR	Thin Peat	2	1	8	Low
285	Probehole	280660.2	950337.6	0.20	4.9	4	ROCK	Peaty soil	1	2	8	Low
286	Probehole	280692.1	950351.6	0.40	2.4	2	ROCK	Peaty soil	1	2	4	Negligible
287	Probehole	280737.8	950363.0	0.30	2.9	2	GRANULAR	Peaty soil	1	1	2	Negligible
288	Probehole	280757.5	950364.7	0.30	3.2	2	GRANULAR	Peaty soil	1	1	2	Negligible
289	Probehole	280725.5	950324.1	0.00	2.9	2	ROCK	No Peat	0	2	0	Negligible
290	Probehole	280734.5	950312.6	0.20	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
291	Probehole	280749.0	950306.3	0.20	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
292	Probehole	280739.3	950286.3	0.40	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
293	Probehole	280749.7	950257.4	0.30	2.7	2	GRANULAR	Peaty soil	1	1	2	Negligible
294	Probehole	280726.3	950240.5	0.20	2.1	2	GRANULAR	Peaty soil	1	1	2	Negligible
295	Probehole	280704.6	950253.9	0.30	2.0	1	ROCK	Peaty soil	1	2	2	Negligible
296	Probehole	280687.7	950279.9	0.20	2.5	2	GRANULAR	Peaty soil	1	1	2	Negligible
297	Probehole	280675.7	950285.1	0.30	3.3	2	GRANULAR	Peaty soil	1	1	2	Negligible
298	Probehole	280790.9	952171.9	0.20	4.6	4	ROCK	Peaty soil	1	2	8	Low
299	Probehole	280752.4	952199.4	0.40	4.5	4	GRANULAR	Peaty soil	1	1	4	Negligible
300	Probehole	280796.0	952122.3	0.30	4.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
301	Probehole	280803.5	951882.9	0.10	5.1	4	GRANULAR	Peaty soil	1	1	4	Negligible
302	Probehole	280823.2	951868.6	0.30	8.7	6	GRANULAR	Peaty soil	1	1	6	Low
303	Probehole	280847.3	951868.1	0.00	7.0	4	ROCK	No Peat	0	2	0	Negligible
304	Probehole	280863.8	951894.5	0.00	5.8	4	ROCK	No Peat	0	2	0	Negligible
305	Probehole	280871.5	951840.0	0.80	5.6	4	ROCK	Thin Peat	2	2	16	Medium
306	Probehole	280876.8	951791.2	0.30	4.4	4	ROCK	Peaty soil	1	2	8	Low
307	Probehole	280879.2	951689.2	0.10	3.1	2	ROCK	Peaty soil	1	2	4	Negligible
308	Probehole	280902.1	951631.9	0.30	4.0	4	ROCK	Peaty soil	1	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
309	Probehole	280941.7	951677.5	0.40	0.0	1	ROCK	Peaty soil	1	2	2	Negligible
310	Probehole	280948.8	951727.7	0.40	0.0	1	ROCK	Peaty soil	1	2	2	Negligible
311	Probehole	280890.1	951801.0	0.30	2.2	2	GRANULAR	Peaty soil	1	1	2	Negligible
312	Probehole	280917.7	951853.3	0.30	0.9	1	GRANULAR	Peaty soil	1	1	1	Negligible
313	Probehole	280932.1	951890.7	0.50	0.0	1	ROCK	Peaty soil	1	2	2	Negligible
314	Probehole	280972.1	951890.3	0.40	2.0	2	GRANULAR	Peaty soil	1	1	2	Negligible
315	Probehole	281011.1	951889.8	2.10	0.7	1	ROCK	Thick Peat	3	2	6	Low
316	Probehole	281043.3	951889.6	2.30	1.4	1	GRANULAR	Thick Peat	3	1	3	Negligible
317	Probehole	281126.3	951883.0	1.90	0.7	1	GRANULAR	Thick Peat	3	1	3	Negligible
318	Probehole	280928.7	951905.1	0.10	1.0	1	ROCK	Peaty soil	1	2	2	Negligible
319	Probehole	280922.7	951940.4	0.90	5.1	4	ROCK	Thin Peat	2	2	16	Medium
320	Probehole	280903.7	951957.5	0.10	5.3	4	ROCK	Peaty soil	1	2	8	Low
321	Probehole	280857.5	951996.4	0.20	8.2	6	GRANULAR	Peaty soil	1	1	6	Low
322	Probehole	278809.4	953212.9	0.10	5.7	4	GRANULAR	Peaty soil	1	1	4	Negligible
323	Probehole	278774.3	953214.4	0.30	9.4	6	GRANULAR	Peaty soil	1	1	6	Low
324	Probehole	278743.7	953205.3	0.20	9.3	6	GRANULAR	Peaty soil	1	1	6	Low
325	Probehole	278729.7	953183.1	0.40	4.2	4	GRANULAR	Peaty soil	1	1	4	Negligible
326	Probehole	278723.2	953234.3	0.70	7.5	4	GRANULAR	Thin Peat	2	1	8	Low
327	Probehole	278730.6	953274.2	0.60	5.9	4	GRANULAR	Thin Peat	2	1	8	Low
328	Probehole	278799.9	953304.4	0.20	4.0	4	GRANULAR	Peaty soil	1	1	4	Negligible
329	Probehole	278927.1	953404.2	0.60	3.7	2	ROCK	Thin Peat	2	2	8	Low
330	Probehole	278639.5	953213.9	0.20	0.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
331	Probehole	278410.0	952940.8	0.20	1.8	1	GRANULAR	Peaty soil	1	1	1	Negligible
332	Probehole	278401.0	952996.8	0.10	2.0	1	ROCK	Peaty soil	1	2	2	Negligible
333	Probehole	278388.6	953038.8	0.30	2.5	2	GRANULAR	Peaty soil	1	1	2	Negligible
334	Probehole	278381.3	953082.6	0.20	2.3	2	GRANULAR	Peaty soil	1	1	2	Negligible
335	Probehole	278324.1	953328.6	0.80	2.5	2	GRANULAR	Thin Peat	2	1	4	Negligible
336	Probehole	278318.5	953399.3	1.50	2.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
337	Probehole	278315.9	953453.8	1.10	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
338	Probehole	278309.9	953497.8	1.10	2.7	2	GRANULAR	Thin Peat	2	1	4	Negligible
339	Probehole	278306.7	953540.1	0.70	3.1	2	GRANULAR	Thin Peat	2	1	4	Negligible
340	Probehole	278390.1	953550.3	2.10	2.6	2	GRANULAR	Thick Peat	3	1	6	Low
341	Probehole	278373.8	953492.5	2.10	1.7	1	GRANULAR	Thick Peat	3	1	3	Negligible
342	Probehole	278407.1	953552.0	1.80	2.0	2	GRANULAR	Thick Peat	3	1	6	Low
343	Probehole	278477.2	953556.0	2.50	2.3	2	GRANULAR	Thick Peat	3	1	6	Low
344	Probehole	278625.6	953616.7	1.40	1.2	1	GRANULAR	Thin Peat	2	1	2	Negligible
345	Probehole	278691.2	953722.4	0.20	1.1	1	GRANULAR	Peaty soil	1	1	1	Negligible
346	Probehole	278803.5	953788.9	0.40	2.3	2	GRANULAR	Peaty soil	1	1	2	Negligible
347	Probehole	278874.1	953861.6	0.20	4.0	4	GRANULAR	Peaty soil	1	1	4	Negligible
348	Probehole	278859.4	953993.9	0.30	2.9	2	GRANULAR	Peaty soil	1	1	2	Negligible
349	Probehole	278848.9	954083.9	0.80	2.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
350	Probehole	279094.4	953647.7	2.20	2.9	2	GRANULAR	Thick Peat	3	1	6	Low
351	Probehole	279068.7	953469.3	0.30	3.3	2	GRANULAR	Peaty soil	1	1	2	Negligible
352	Probehole	279114.0	953470.7	2.20	3.7	2	GRANULAR	Thick Peat	3	1	6	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
353	Probehole	279171.9	953463.7	2.50	3.0	2	GRANULAR	Thick Peat	3	1	6	Low
354	Probehole	279175.2	953514.5	2.80	2.6	2	GRANULAR	Thick Peat	3	1	6	Low
355	Probehole	279046.6	953469.4	0.90	3.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
356	Probehole	278827.7	953069.2	0.90	3.9	2	GRANULAR	Thin Peat	2	1	4	Negligible
357	Probehole	278766.1	953072.4	0.50	3.8	2	GRANULAR	Peaty soil	1	1	2	Negligible
358	Probehole	278687.8	953063.3	0.60	3.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
359	Probehole	278725.1	951003.6	0.30	4.1	4	GRANULAR	Peaty soil	1	1	4	Negligible
360	Probehole	278723.7	950980.9	0.00	1.7	1	ROCK	No Peat	0	2	0	Negligible
361	Probehole	278746.0	950980.4	0.50	2.5	2	ROCK	Peaty soil	1	2	4	Negligible
362	Probehole	278803.0	950978.7	0.00	2.4	2	ROCK	No Peat	0	2	0	Negligible
363	Probehole	278825.8	950967.4	0.70	2.8	2	GRANULAR	Thin Peat	2	1	4	Negligible
364	Probehole	278830.8	951011.8	0.80	3.0	2	ROCK	Thin Peat	2	2	8	Low
365	Probehole	278786.4	951038.2	1.30	2.4	2	GRANULAR	Thin Peat	2	1	4	Negligible
366	Probehole	278750.7	951075.4	2.20	2.6	2	ROCK	Thick Peat	3	2	12	Low
367	Probehole	278742.2	951107.8	1.10	2.8	2	GRANULAR	Thin Peat	2	1	4	Negligible
368	Probehole	278735.1	951174.8	0.50	2.3	2	GRANULAR	Peaty soil	1	1	2	Negligible
369	Probehole	278654.8	950655.7	2.10	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
370	Probehole	278604.1	950663.6	2.00	2.4	2	GRANULAR	Thick Peat	3	1	6	Low
371	Probehole	278573.5	950695.9	1.70	3.1	2	GRANULAR	Thick Peat	3	1	6	Low
372	Probehole	278655.1	950572.7	0.60	1.7	1	GRANULAR	Thin Peat	2	1	2	Negligible
373	Probehole	278661.9	950508.8	2.20	1.8	1	ROCK	Thick Peat	3	2	6	Low
374	Probehole	278616.4	950469.0	2.80	1.5	1	GRANULAR	Thick Peat	3	1	3	Negligible
375	Probehole	278763.6	950264.1	0.30	1.6	1	GRANULAR	Peaty soil	1	1	1	Negligible
376	Probehole	278791.6	950274.7	0.30	1.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
377	Probehole	278842.2	950296.0	1.70	0.9	1	ROCK	Thick Peat	3	2	6	Low
378	Probehole	278865.5	950304.0	1.30	1.7	1	GRANULAR	Thin Peat	2	1	2	Negligible
379	Probehole	278904.1	950269.7	1.90	1.5	1	GRANULAR	Thick Peat	3	1	3	Negligible
380	Probehole	278915.0	950223.9	1.90	0.6	1	GRANULAR	Thick Peat	3	1	3	Negligible
381	Probehole	278932.3	950172.7	1.00	0.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
382	Probehole	278935.3	950100.7	0.80	4.2	4	GRANULAR	Thin Peat	2	1	8	Low
383	Probehole	278995.8	950089.2	2.00	0.5	1	GRANULAR	Thick Peat	3	1	3	Negligible
384	Probehole	278843.1	950092.6	1.20	2.7	2	GRANULAR	Thin Peat	2	1	4	Negligible
385	Probehole	278426.6	950258.1	0.20	0.0	1	GRANULAR	Peaty soil	1	1	1	Negligible
386	Probehole	278654.9	951742.7	0.60	4.0	4	GRANULAR	Thin Peat	2	1	8	Low
387	Probehole	278660.7	951684.1	1.60	2.3	2	GRANULAR	Thick Peat	3	1	6	Low
388	Probehole	278733.5	951665.8	2.50	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
389	Probehole	277235.2	954078.0	0.80	3.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
390	Probehole	277292.9	954071.6	0.70	3.7	2	GRANULAR	Thin Peat	2	1	4	Negligible
391	Probehole	277326.1	954062.9	0.70	4.3	4	GRANULAR	Thin Peat	2	1	8	Low
392	Probehole	277320.9	954143.7	1.60	4.2	4	GRANULAR	Thick Peat	3	1	12	Low
393	Probehole	277364.6	954131.6	1.00	4.5	4	GRANULAR	Thin Peat	2	1	8	Low
394	Probehole	277402.0	954121.5	1.30	3.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
395	Probehole	277413.9	954076.3	1.20	1.3	1	GRANULAR	Thin Peat	2	1	2	Negligible
396	Probehole	277429.2	954037.8	1.20	1.3	1	GRANULAR	Thin Peat	2	1	2	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
397	Probehole	277440.0	953996.0	1.20	1.4	1	GRANULAR	Thin Peat	2	1	2	Negligible
398	Probehole	277451.6	953931.2	1.30	2.0	1	GRANULAR	Thin Peat	2	1	2	Negligible
399	Probehole	277490.0	953922.8	1.20	2.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
400	Probehole	277539.6	953900.1	1.30	2.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
401	Probehole	277568.9	953860.2	1.20	2.2	2	GRANULAR	Thin Peat	2	1	4	Negligible
402	Probehole	277719.0	953894.5	2.20	1.6	1	GRANULAR	Thick Peat	3	1	3	Negligible
403	Probehole	277715.6	953940.3	2.20	0.8	1	GRANULAR	Thick Peat	3	1	3	Negligible
404	Probehole	277704.5	953991.9	2.10	1.1	1	GRANULAR	Thick Peat	3	1	3	Negligible
405	Probehole	277705.9	954035.1	1.60	1.1	1	GRANULAR	Thick Peat	3	1	3	Negligible
406	Probehole	277763.4	954007.1	2.50	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
407	Probehole	277801.7	953994.8	1.80	0.4	1	GRANULAR	Thick Peat	3	1	3	Negligible
408	Probehole	277798.1	954065.3	2.20	0.8	1	GRANULAR	Thick Peat	3	1	3	Negligible
409	Probehole	277756.3	954070.7	2.90	0.0	1	GRANULAR	Thick Peat	3	1	3	Negligible
410	Probehole	277706.5	954090.6	0.70	1.9	1	GRANULAR	Thin Peat	2	1	2	Negligible
411	Probehole	277663.6	954101.8	0.70	2.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
412	Probehole	277615.5	954118.3	2.00	3.1	2	GRANULAR	Thick Peat	3	1	6	Low
413	Probehole	277573.5	954128.5	2.00	2.8	2	GRANULAR	Thick Peat	3	1	6	Low
414	Probehole	277522.9	954102.8	1.80	2.2	2	GRANULAR	Thick Peat	3	1	6	Low
415	Probehole	277274.2	954147.6	0.30	2.4	2	GRANULAR	Peaty soil	1	1	2	Negligible
416	Probehole	277548.4	953568.5	0.80	3.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
417	Probehole	280666.8	953070.5	0.20	12.8	8	ROCK	Peaty soil	1	2	16	Medium
418	Probehole	280642.7	953026.5	0.20	11.8	6	ROCK	Peaty soil	1	2	12	Low
419	Probehole	280616.3	952990.3	0.50	13.2	8	ROCK	Peaty soil	1	2	16	Medium
420	Probehole	280589.0	952951.6	0.50	9.6	6	GRANULAR	Peaty soil	1	1	6	Low
421	Probehole	280559.4	952906.8	0.70	7.5	4	ROCK	Thin Peat	2	2	16	Medium
422	Probehole	280540.6	952877.9	0.60	8.1	6	ROCK	Thin Peat	2	2	24	Medium
423	Probehole	280532.9	952858.4	0.30	7.2	4	ROCK	Peaty soil	1	2	8	Low
424	Probehole	280530.9	952813.9	0.60	6.6	4	GRANULAR	Thin Peat	2	1	8	Low
425	Probehole	280527.2	952757.2	0.80	6.8	4	GRANULAR	Thin Peat	2	1	8	Low
426	Probehole	280529.4	952714.6	0.80	5.6	4	ROCK	Thin Peat	2	2	16	Medium
427	Probehole	280527.8	952677.2	1.50	5.1	4	ROCK	Thin Peat	2	2	16	Medium
428	Probehole	280520.6	952660.9	1.20	5.0	4	GRANULAR	Thin Peat	2	1	8	Low
429	Probehole	280511.5	952614.0	1.30	5.1	4	ROCK	Thin Peat	2	2	16	Medium
430	Probehole	280507.4	952583.8	1.20	4.7	4	GRANULAR	Thin Peat	2	1	8	Low
431	Probehole	280526.0	952567.3	0.80	3.9	2	ROCK	Thin Peat	2	2	8	Low
432	Probehole	280532.1	952512.0	0.30	4.3	4	ROCK	Peaty soil	1	2	8	Low
433	Probehole	280535.8	952466.2	0.40	3.7	2	ROCK	Peaty soil	1	2	4	Negligible
434	Probehole	280536.8	952462.4	0.00	3.4	2		No Peat	0	3	0	Negligible
435	Probehole	280541.9	952437.4	0.00	4.5	4		No Peat	0	3	0	Negligible
436	Probehole	280550.9	952410.6	0.70	5.8	4	GRANULAR	Thin Peat	2	1	8	Low
437	Probehole	280521.5	952365.2	0.30	3.6	2	GRANULAR	Peaty soil	1	1	2	Negligible
438	Probehole	280533.1	952286.5	0.50	3.3	2	ROCK	Peaty soil	1	2	4	Negligible
439	Probehole	280547.3	952324.5	0.50	3.9	2	ROCK	Peaty soil	1	2	4	Negligible
440	Probehole	280550.1	952374.0	0.40	5.7	4	ROCK	Peaty soil	1	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
441	Probehole	280564.7	952363.0	0.20	5.5	4	GRANULAR	Peaty soil	1	1	4	Negligible
442	Probehole	280599.0	952340.9	1.20	5.3	4	GRANULAR	Thin Peat	2	1	8	Low
443	Probehole	280639.9	952310.2	0.90	4.6	4	ROCK	Thin Peat	2	2	16	Medium
444	Probehole	280678.4	952281.3	0.40	5.7	4	ROCK	Peaty soil	1	2	8	Low
445	Probehole	280721.9	952249.6	0.50	5.2	4	GRANULAR	Peaty soil	1	1	4	Negligible
446	Probehole	280761.8	952211.2	0.40	4.6	4	ROCK	Peaty soil	1	2	8	Low
447	Probehole	280798.0	952188.8	0.30	5.5	4	ROCK	Peaty soil	1	2	8	Low
448	Probehole	280829.1	952169.1	0.50	6.7	4	GRANULAR	Peaty soil	1	1	4	Negligible
449	Probehole	280841.7	952261.0	0.40	5.5	4	ROCK	Peaty soil	1	2	8	Low
450	Probehole	280845.3	952335.1	0.60	5.0	4	ROCK	Thin Peat	2	2	16	Medium
451	Probehole	280825.7	952136.1	0.50	5.3	4	GRANULAR	Peaty soil	1	1	4	Negligible
452	Probehole	280840.8	952079.0	0.20	6.3	4	GRANULAR	Peaty soil	1	1	4	Negligible
453	Probehole	280860.9	952018.4	0.60	8.1	6	GRANULAR	Thin Peat	2	1	12	Low
454	Probehole	280888.5	951989.9	0.50	1.1	1	GRANULAR	Peaty soil	1	1	1	Negligible
455	Probehole	280893.8	951962.5	0.50	3.8	2	GRANULAR	Peaty soil	1	1	2	Negligible
456	Probehole	280824.5	951943.6	0.50	10.6	6	GRANULAR	Peaty soil	1	1	6	Low
457	Probehole	280759.5	951893.0	0.40	2.9	2	GRANULAR	Peaty soil	1	1	2	Negligible
458	Probehole	280782.2	951855.0	0.60	3.5	2	ROCK	Thin Peat	2	2	8	Low
459	Probehole	280820.7	951847.9	0.60	8.2	6	ROCK	Thin Peat	2	2	24	Medium
460	Probehole	280848.3	951852.6	0.00	6.0	4	ROCK	No Peat	0	2	0	Negligible
461	Probehole	280852.3	951871.2	0.00	7.0	4	ROCK	No Peat	0	2	0	Negligible
462	Probehole	281153.1	952166.3	3.00	3.4	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
463	Probehole	281137.1	952131.1	3.00	3.2	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
464	Probehole	281109.4	952086.6	3.00	1.9	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
465	Probehole	281059.3	952076.5	3.00	1.4	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
466	Probehole	281004.8	952042.5	0.70	5.1	4	ROCK	Thin Peat	2	2	16	Medium
467	Probehole	280945.1	951980.6	0.80	0.0	1	ROCK	Thin Peat	2	2	4	Negligible
468	Probehole	280934.9	951891.9	0.50	0.0	1	ROCK	Peaty soil	1	2	2	Negligible
469	Probehole	280996.0	951889.2	1.80	0.2	1	GRANULAR	Thick Peat	3	1	3	Negligible
470	Probehole	281090.1	951884.6	2.50	0.8	1	ROCK	Thick Peat	3	2	6	Low
471	Probehole	281141.2	951889.6	1.10	0.5	1	GRANULAR	Thin Peat	2	1	2	Negligible
472	Probehole	281155.3	951949.7	2.70	0.8	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
473	Probehole	281176.9	951995.1	2.70	2.8	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
474	Probehole	281196.8	952040.9	2.70	4.9	4	DEPTH NOT PROVEN	Thick Peat	3	3	36	High
475	Probehole	281206.7	952092.6	2.70	3.2	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
476	Probehole	281216.4	952138.7	1.30	2.1	2	ROCK	Thin Peat	2	2	8	Low
477	Probehole	281233.9	952185.5	1.50	2.2	2	ROCK	Thin Peat	2	2	8	Low
478	Probehole	281183.0	951886.8	2.20	0.3	1	ROCK	Thick Peat	3	2	6	Low
479	Probehole	281210.4	951887.7	2.00	0.3	1	ROCK	Thick Peat	3	2	6	Low
480	Probehole	281260.1	951889.0	1.90	0.2	1	ROCK	Thick Peat	3	2	6	Low
481	Probehole	281277.4	951890.3	2.10	0.6	1	GRANULAR	Thick Peat	3	1	3	Negligible
482	Probehole	281160.0	951857.1	2.70	1.0	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
483	Probehole	281158.4	951857.3	2.70	1.0	1	ROCK	Thick Peat	3	2	6	Low
484	Probehole	281159.1	951808.6	2.40	0.0	1	ROCK	Thick Peat	3	2	6	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
485	Probehole	281152.6	951751.3	2.70	0.0	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
486	Probehole	281201.3	951797.9	0.40	0.0	1	ROCK	Peaty soil	1	2	2	Negligible
487	Probehole	281130.2	951710.7	2.70	0.0	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
488	Probehole	281074.9	951705.9	2.70	0.0	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
489	Probehole	281038.3	951668.2	2.70	0.0	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
490	Probehole	281001.1	951621.4	2.70	4.4	4	DEPTH NOT PROVEN	Thick Peat	3	3	36	High
491	Probehole	281015.1	951572.5	2.70	2.5	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
492	Probehole	281036.5	951526.6	2.70	1.3	1	DEPTH NOT PROVEN	Thick Peat	3	3	9	Low
493	Probehole	281036.4	951475.0	1.60	1.1	1	ROCK	Thick Peat	3	2	6	Low
494	Probehole	281041.4	951429.9	2.30	1.4	1	ROCK	Thick Peat	3	2	6	Low
495	Probehole	281020.6	951391.1	2.30	2.0	1	ROCK	Thick Peat	3	2	6	Low
496	Probehole	280986.5	951359.3	1.30	1.3	1	ROCK	Thin Peat	2	2	4	Negligible
497	Probehole	280974.1	951315.5	1.10	5.0	4	ROCK	Thin Peat	2	2	16	Medium
498	Probehole	280372.2	951735.5	0.50	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
499	Probehole	280380.4	951683.6	0.50	4.0	4	ROCK	Peaty soil	1	2	8	Low
500	Probehole	280380.7	951639.8	0.40	3.1	2	GRANULAR	Peaty soil	1	1	2	Negligible
501	Probehole	280374.5	951640.7	0.40	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
502	Probehole	280369.5	951773.6	0.40	0.0	1	ROCK	Peaty soil	1	2	2	Negligible
503	Probehole	280349.3	951769.0	0.60	0.0	1	ROCK	Thin Peat	2	2	4	Negligible
504	Probehole	280306.0	951755.3	0.30	0.0	1	ROCK	Peaty soil	1	2	2	Negligible
505	Probehole	280282.0	951712.6	0.60	1.6	1	ROCK	Thin Peat	2	2	4	Negligible
506	Probehole	280271.4	951662.8	0.50	1.7	1	GRANULAR	Peaty soil	1	1	1	Negligible
507	Probehole	280312.0	951607.7	0.60	2.5	2	GRANULAR	Thin Peat	2	1	4	Negligible
508	Probehole	280247.7	951610.6	0.40	1.5	1	GRANULAR	Peaty soil	1	1	1	Negligible
509	Probehole	280210.7	951604.3	0.60	1.0	1	ROCK	Thin Peat	2	2	4	Negligible
510	Probehole	280210.0	951562.9	2.20	1.4	1	ROCK	Thick Peat	3	2	6	Low
511	Probehole	280221.3	951509.1	2.60	2.0	2	GRANULAR	Thick Peat	3	1	6	Low
512	Probehole	280236.0	951472.2	2.30	2.7	2	ROCK	Thick Peat	3	2	12	Low
513	Probehole	280245.8	951422.3	1.80	3.1	2	GRANULAR	Thick Peat	3	1	6	Low
514	Probehole	280264.2	951359.8	1.30	3.3	2	ROCK	Thin Peat	2	2	8	Low
515	Probehole	280270.9	951323.0	0.90	3.1	2	ROCK	Thin Peat	2	2	8	Low
516	Probehole	280266.4	951264.4	1.50	2.4	2	ROCK	Thin Peat	2	2	8	Low
517	Probehole	280268.6	951226.1	0.60	2.8	2	ROCK	Thin Peat	2	2	8	Low
518	Probehole	280271.1	951205.2	0.60	1.8	1	GRANULAR	Thin Peat	2	1	2	Negligible
519	Probehole	280279.8	951175.6	0.40	2.4	2	GRANULAR	Peaty soil	1	1	2	Negligible
520	Probehole	280282.3	951120.2	0.70	2.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
521	Probehole	280282.2	951073.6	0.60	2.1	2	ROCK	Thin Peat	2	2	8	Low
522	Probehole	280275.4	951031.9	0.60	2.1	2	GRANULAR	Thin Peat	2	1	4	Negligible
523	Probehole	280253.9	950979.6	0.80	1.9	1	ROCK	Thin Peat	2	2	4	Negligible
524	Probehole	280222.1	950927.3	0.40	2.3	2	ROCK	Peaty soil	1	2	4	Negligible
525	Probehole	280211.5	950888.8	0.60	2.3	2	ROCK	Thin Peat	2	2	8	Low
526	Probehole	280218.0	950844.0	1.50	2.0	2	ROCK	Thin Peat	2	2	8	Low
527	Probehole	280208.5	950812.6	1.60	1.9	1	ROCK	Thick Peat	3	2	6	Low
528	Probehole	280188.3	950816.7	0.90	1.7	1	GRANULAR	Thin Peat	2	1	2	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
529	Probehole	280203.5	950785.6	1.40	1.8	1	GRANULAR	Thin Peat	2	1	2	Negligible
530	Probehole	280185.1	950744.2	1.30	1.9	1	GRANULAR	Thin Peat	2	1	2	Negligible
531	Probehole	280150.3	950719.8	1.00	1.7	1	GRANULAR	Thin Peat	2	1	2	Negligible
532	Probehole	280139.6	950675.2	0.40	1.6	1	GRANULAR	Peaty soil	1	1	1	Negligible
533	Probehole	280150.3	950620.7	0.50	1.8	1	GRANULAR	Peaty soil	1	1	1	Negligible
534	Probehole	280140.6	950550.0	2.30	1.6	1	ROCK	Thick Peat	3	2	6	Low
535	Probehole	280525.0	950565.6	0.90	2.2	2	ROCK	Thin Peat	2	2	8	Low
536	Probehole	280743.0	951304.5	0.80	0.2	1	ROCK	Thin Peat	2	2	4	Negligible
537	Probehole	280723.6	951208.0	1.20	1.6	1	ROCK	Thin Peat	2	2	4	Negligible
538	Probehole	280777.1	951188.9	0.10	1.5	1	GRANULAR	Peaty soil	1	1	1	Negligible
539	Probehole	280801.2	951185.6	0.20	1.7	1	GRANULAR	Peaty soil	1	1	1	Negligible
540	Probehole	280653.7	951333.2	0.50	1.8	1	ROCK	Peaty soil	1	2	2	Negligible
541	Probehole	280681.7	951344.1	0.50	1.7	1	ROCK	Peaty soil	1	2	2	Negligible
542	Probehole	280569.6	950466.9	0.50	4.0	4	GRANULAR	Peaty soil	1	1	4	Negligible
543	Probehole	280600.7	950419.2	0.10	3.9	2	ROCK	Peaty soil	1	2	4	Negligible
544	Probehole	280638.8	950387.0	0.10	6.1	4	ROCK	Peaty soil	1	2	8	Low
545	Probehole	280680.4	950351.8	0.60	3.3	2	ROCK	Thin Peat	2	2	8	Low
546	Probehole	280707.5	950322.2	0.00	2.3	2	ROCK	No Peat	0	2	0	Negligible
547	Probehole	280721.4	950281.7	0.40	2.3	2	ROCK	Peaty soil	1	2	4	Negligible
548	Probehole	280733.7	950226.7	0.00	2.0	2	ROCK	No Peat	0	2	0	Negligible
549	Probehole	280742.2	950164.2	0.40	1.7	1	ROCK	Peaty soil	1	2	2	Negligible
550	Probehole	280751.1	950134.1	1.00	1.9	1	ROCK	Thin Peat	2	2	4	Negligible
551	Probehole	280778.4	950145.1	0.80	2.1	2	ROCK	Thin Peat	2	2	8	Low
552	Probehole	280814.9	950174.3	0.30	2.6	2	ROCK	Peaty soil	1	2	4	Negligible
553	Probehole	280854.2	950212.6	0.40	3.0	2	ROCK	Peaty soil	1	2	4	Negligible
554	Probehole	280879.9	950262.7	0.40	2.4	2	ROCK	Peaty soil	1	2	4	Negligible
555	Probehole	280895.9	950311.8	1.10	1.3	1	GRANULAR	Thin Peat	2	1	2	Negligible
556	Probehole	280914.3	950359.5	0.60	0.2	1	ROCK	Thin Peat	2	2	4	Negligible
557	Probehole	280938.8	950404.3	0.70	4.8	4	GRANULAR	Thin Peat	2	1	8	Low
558	Probehole	280960.9	950441.9	0.50	1.8	1	ROCK	Peaty soil	1	2	2	Negligible
559	Probehole	280977.5	950467.4	1.10	4.0	2	ROCK	Thin Peat	2	2	8	Low
560	Probehole	280751.7	950074.4	0.80	2.5	2	ROCK	Thin Peat	2	2	8	Low
561	Probehole	280764.1	950022.8	1.70	2.0	2	ROCK	Thick Peat	3	2	12	Low
562	Probehole	280773.7	949972.4	1.60	2.6	2	ROCK	Thick Peat	3	2	12	Low
563	Probehole	280786.7	949927.8	0.80	3.1	2	ROCK	Thin Peat	2	2	8	Low
564	Probehole	280804.1	949880.1	0.60	4.1	4	ROCK	Thin Peat	2	2	16	Medium
565	Probehole	280821.3	949830.9	0.80	3.6	2	ROCK	Thin Peat	2	2	8	Low
566	Probehole	280800.8	949785.3	0.30	2.6	2	ROCK	Peaty soil	1	2	4	Negligible
567	Probehole	280783.2	949739.6	1.80	3.0	2	ROCK	Thick Peat	3	2	12	Low
568	Probehole	280767.1	949694.8	2.60	3.5	2	ROCK	Thick Peat	3	2	12	Low
569	Probehole	280749.0	949646.9	2.00	3.0	2	ROCK	Thick Peat	3	2	12	Low
570	Probehole	280729.1	949598.8	1.00	4.2	4	ROCK	Thin Peat	2	2	16	Medium
571	Probehole	280714.6	949552.7	0.70	4.7	4	ROCK	Thin Peat	2	2	16	Medium
572	Probehole	280692.5	949503.2	0.50	5.1	4	ROCK	Peaty soil	1	2	8	Low

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
573	Probehole	280675.2	949457.7	0.70	5.1	4	ROCK	Thin Peat	2	2	16	Medium
574	Probehole	280662.9	949427.2	0.30	4.7	4	ROCK	Peaty soil	1	2	8	Low
575	Probehole	280646.6	949384.8	0.90	3.8	2	GRANULAR	Thin Peat	2	1	4	Negligible
576	Probehole	280631.9	949348.9	0.40	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
577	Probehole	280608.2	949326.4	1.10	3.1	2	ROCK	Thin Peat	2	2	8	Low
578	Probehole	280562.6	949330.0	2.10	3.1	2	ROCK	Thick Peat	3	2	12	Low
579	Probehole	280510.8	949340.1	2.60	3.2	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
580	Probehole	280456.1	949345.1	2.80	2.3	2	ROCK	Thick Peat	3	2	12	Low
581	Probehole	280415.4	949342.1	1.80	2.3	2	ROCK	Thick Peat	3	2	12	Low
582	Probehole	280362.3	949346.5	1.20	2.9	2	ROCK	Thin Peat	2	2	8	Low
583	Probehole	280311.8	949350.3	0.40	2.4	2	ROCK	Peaty soil	1	2	4	Negligible
584	Probehole	280261.4	949355.5	0.50	0.3	1	ROCK	Peaty soil	1	2	2	Negligible
585	Probehole	280226.1	949356.0	0.10	4.9	4	ROCK	Peaty soil	1	2	8	Low
586	Probehole	280182.1	949362.6	0.30	5.4	4	ROCK	Peaty soil	1	2	8	Low
587	Probehole	280132.6	949367.4	0.30	4.5	4	ROCK	Peaty soil	1	2	8	Low
588	Probehole	280085.3	949372.2	0.30	4.2	4	ROCK	Peaty soil	1	2	8	Low
589	Probehole	280029.5	949374.7	0.40	5.3	4	ROCK	Peaty soil	1	2	8	Low
590	Probehole	279980.6	949379.7	0.30	3.5	2	GRANULAR	Peaty soil	1	1	2	Negligible
591	Probehole	279926.9	949382.3	0.50	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
592	Probehole	279898.2	949381.5	0.80	3.5	2	ROCK	Thin Peat	2	2	8	Low
593	Probehole	279895.2	949353.4	0.80	3.6	2	GRANULAR	Thin Peat	2	1	4	Negligible
594	Probehole	279826.5	949250.4	1.00	4.0	2	GRANULAR	Thin Peat	2	1	4	Negligible
595	Probehole	279761.5	949203.5	1.00	2.3	2	ROCK	Thin Peat	2	2	8	Low
596	Probehole	279737.6	949192.4	0.80	2.6	2	ROCK	Thin Peat	2	2	8	Low
597	Probehole	279799.2	949186.2	0.70	3.3	2		Thin Peat	2	3	12	Low
598	Probehole	279852.5	949180.1	1.10	3.2	2	ROCK	Thin Peat	2	2	8	Low
599	Probehole	279913.3	949175.3	1.10	3.6	2	ROCK	Thin Peat	2	2	8	Low
600	Probehole	279963.5	949171.7	0.40	4.3	4	ROCK	Peaty soil	1	2	8	Low
601	Probehole	280010.1	949170.8	0.50	4.1	4	ROCK	Peaty soil	1	2	8	Low
602	Probehole	280071.1	949165.6	0.40	4.6	4	ROCK	Peaty soil	1	2	8	Low
603	Probehole	280112.7	949161.0	0.50	5.6	4	ROCK	Peaty soil	1	2	8	Low
604	Probehole	280167.4	949156.9	0.40	3.4	2	ROCK	Peaty soil	1	2	4	Negligible
605	Probehole	280221.2	949151.4	0.40	1.2	1	ROCK	Peaty soil	1	2	2	Negligible
606	Probehole	280247.6	949158.6	0.50	2.9	2	ROCK	Peaty soil	1	2	4	Negligible
607	Probehole	280267.1	949199.7	0.80	2.3	2	ROCK	Thin Peat	2	2	8	Low
608	Probehole	280274.8	949231.3	0.00	2.3	2	ROCK	No Peat	0	2	0	Negligible
609	Probehole	280271.2	949269.4	0.50	2.2	2	ROCK	Peaty soil	1	2	4	Negligible
610	Probehole	280266.0	949314.7	0.70	2.2	2	ROCK	Thin Peat	2	2	8	Low
611	Probehole	280256.2	949389.7	0.50	4.4	4	ROCK	Peaty soil	1	2	8	Low
612	Probehole	280251.7	949437.5	0.60	3.0	2	ROCK	Thin Peat	2	2	8	Low
613	Probehole	280244.3	949498.7	0.60	4.4	4	ROCK	Thin Peat	2	2	16	Medium
614	Probehole	280238.9	949548.4	0.50	4.3	4	ROCK	Peaty soil	1	2	8	Low
615	Probehole	280233.0	949606.1	0.60	3.1	2	ROCK	Thin Peat	2	2	8	Low
616	Probehole	280228.2	949649.4	0.40	2.6	2	ROCK	Peaty soil	1	2	4	Negligible

ID	Position	E	N	PEAT DEPTH	SLOPE	Slope Coefficient	SUBSTRATE	Ground Conditions Coefficient	Peat Coefficient	Substrate Coeff	Risk Coeff	Potential Instability
617	Probehole	280270.4	949685.4	0.50	2.1	2	ROCK	Peaty soil	1	2	4	Negligible
618	Probehole	280316.1	949713.2	1.90	2.1	2	GRANULAR	Thick Peat	3	1	6	Low
619	Probehole	280365.4	949744.9	1.70	2.6	2	ROCK	Thick Peat	3	2	12	Low
620	Probehole	280403.4	949773.5	1.90	1.9	1	ROCK	Thick Peat	3	2	6	Low
621	Probehole	280394.5	949808.1	2.30	0.0	1	ROCK	Thick Peat	3	2	6	Low
622	Probehole	280375.7	949859.7	2.30	2.0	1	ROCK	Thick Peat	3	2	6	Low
623	Probehole	280359.1	949894.4	2.20	2.4	2	ROCK	Thick Peat	3	2	12	Low
624	Probehole	280330.9	949918.1	2.00	2.7	2	ROCK	Thick Peat	3	2	12	Low
625	Probehole	280516.6	950458.7	0.40	3.0	2	ROCK	Peaty soil	1	2	4	Negligible
626	Probehole	280447.0	950381.4	1.10	2.9	2	ROCK	Thin Peat	2	2	8	Low
627	Probehole	280384.9	950307.5	0.80	2.1	2	ROCK	Thin Peat	2	2	8	Low
628	Probehole	280324.6	950226.0	0.50	0.9	1	ROCK	Peaty soil	1	2	2	Negligible
629	Probehole	280263.7	950143.7	1.60	0.8	1	ROCK	Thick Peat	3	2	6	Low
630	Probehole	280204.9	950065.3	0.80	2.8	2	ROCK	Thin Peat	2	2	8	Low
631	Probehole	280157.9	949983.0	0.50	3.6	2	ROCK	Peaty soil	1	2	4	Negligible
632	Probehole	280190.8	949988.1	0.30	2.6	2	ROCK	Peaty soil	1	2	4	Negligible
633	Probehole	280232.2	949962.3	0.50	2.4	2	GRANULAR	Peaty soil	1	1	2	Negligible
634	Probehole	280280.3	949940.4	1.20	3.0	2	ROCK	Thin Peat	2	2	8	Low
635	Probehole	280329.3	949920.9	2.20	2.7	2	ROCK	Thick Peat	3	2	12	Low
636	Probehole	280353.5	949955.6	2.30	3.0	2	GRANULAR	Thick Peat	3	1	6	Low
637	Probehole	280384.6	950001.5	2.70	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
638	Probehole	280396.9	950019.7	2.80	2.4	2	ROCK	Thick Peat	3	2	12	Low
639	Probehole	280381.5	950054.0	2.80	2.5	2	DEPTH NOT PROVEN	Thick Peat	3	3	18	Medium
640	Probehole	280424.6	950054.1	2.80	2.6	2	ROCK	Thick Peat	3	2	12	Low
641	Probehole	280456.7	950070.6	1.50	2.3	2	ROCK	Thin Peat	2	2	8	Low
642	Probehole	280488.7	950033.4	1.50	2.4	2	ROCK	Thin Peat	2	2	8	Low
643	Probehole	280519.0	949996.7	2.00	2.5	2	GRANULAR	Thick Peat	3	1	6	Low
644	Probehole	280553.4	949960.5	1.50	2.7	2	ROCK	Thin Peat	2	2	8	Low
645	Probehole	280597.8	949975.7	0.40	2.5	2	ROCK	Peaty soil	1	2	4	Negligible
646	Probehole	280634.3	950013.2	0.40	3.4	2	ROCK	Peaty soil	1	2	4	Negligible
647	Probehole	280668.8	950049.5	1.30	2.6	2	ROCK	Thin Peat	2	2	8	Low
648	Probehole	280704.8	950085.9	0.50	2.0	2	ROCK	Peaty soil	1	2	4	Negligible
649	Probehole	280741.2	950114.1	1.10	1.9	1	GRANULAR	Thin Peat	2	1	2	Negligible
650	Probehole	279690.1	949128.6	0.10	2.4	2	ROCK	Peaty soil	1	2	4	Negligible
651	Probehole	279622.6	949070.2	1.40	1.6	1	ROCK	Thin Peat	2	2	4	Negligible
652	Probehole	279554.4	949007.5	1.10	2.5	2	ROCK	Thin Peat	2	2	8	Low
653	Probehole	279477.6	948948.4	0.80	0.9	1	GRANULAR	Thin Peat	2	1	2	Negligible
654	Probehole	279438.8	948923.2	0.50	1.5	1	ROCK	Peaty soil	1	2	2	Negligible
655	Probehole	279330.0	948899.0	0.20	0.9	1	ROCK	Peaty soil	1	2	2	Negligible
656	Probehole	279347.9	948906.3	0.40	3.6	2	ROCK	Peaty soil	1	2	4	Negligible
657	Probehole	279334.4	948952.4	0.10	1.6	1	ROCK	Peaty soil	1	2	2	Negligible
658	Probehole	279217.3	948878.6	0.80	4.2	4	ROCK	Thin Peat	2	2	16	Medium

global environmental solutions

Strathy South Wind Farm

Watercourse Crossing Assessment

SLR Ref : 405-00660-00018

May 2013

Version:1

CONTENTS

1.0 INTRODUCTION 3
1.1 General 3
1.2 Legislation 3
2.0 METHODOLOGY 4
2.1 General 4
2.2 Site Visit 4
2.3 Summary of Watercourse Crossing Assessment 4
3.0 WATERCOURSE CROSSING ASSESSMENT 6
4.0 WATERCOURSE CROSSING REQUIREMENTS 8
4.1 Methodology 8
4.2 Construction 8

FIGURES

Figure 1 Site Infrastructure Layout and Water Crossing Locations

APPENDICES

Appendix A Water Crossings

1.0 INTRODUCTION

1.1 General

SLR Consulting Ltd (SLR) was commissioned by Scottish and Southern Energy Renewables (SSER) to carry out an assessment of the watercourse crossings required as part of the proposed road construction for the Modified 2013 Scheme at Strathy South.

The Modified 2013 Scheme is located within the Strathy South forest block, approximately 15 km south of Strathy village and 30-35 km west of Thurso. Strathy South forest is a commercial conifer plantation of which the site occupies most of the forest between Loch Nam Breac Mor and the River Strathy. The surrounding area is open and undulating and is characterised by lochs, pools and blanket bog.

In order to construct the Modified 2013 Scheme, watercourse crossings would be necessary. The watercourses range from ditches, small natural streams / surface watercourses and the River Strathy.

1.2 Legislation

The Water Framework Directive (2000/60/EC) (WFD) represents a significant piece of environmental legislation which has implications for the Modified 2013 Scheme. The WFD has been transposed into Scottish legislation as the Water Environment and Water Services (Scotland) Act 2003 (or WEWS) and has given Scottish ministers powers to introduce regulatory controls over activities in order to protect and improve Scotland's water environment. The water environment includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater. These regulatory controls, known as the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) which came into force in 2005 and have just recently been amended in 2011.

With respect to watercourse crossings required for the Modified 2013 Scheme, CAR requires that all *engineering works in inland surface waters and wetlands* are subject to authorisation and allow for proportionate risk-based regulation. The authorisation process operates at three levels:

- General Binding Rules (GBR);
- Registration; and
- License (Simple/Complex).

These levels cover activities with increasing levels of potential impact upon the hydrological environment. The Scottish Environment Protection Agency (SEPA) will only be required to provide authorisation for watercourse crossings shown on the 1:50,000 scale Ordnance Survey (OS) maps (Landranger Series). All other watercourses are classed as a "minor watercourse" and are exempt under CAR. Where appropriate, likely authorisation levels for the proposed crossings are provided in this report.

The information presented in this document is only intended to act as a guide. The actual design, construction and/or improvements to the crossings throughout construction would be agreed with SEPA prior to any construction works commencing.

2.0 METHODOLOGY

2.1 General

The following section describes the methodology undertaken to carry out the watercourse crossing survey.

SLR has undertaken a watercourse crossing survey based on the proposed road layout for the Modified 2013 Scheme which is illustrated in Figure 1.

1:50,000 OS mapping and aerial photographs for the area were studied to identify the likely watercourse crossings required to be established for the proposed road layout. 18 watercourse crossings were identified and comprise both large river crossings and small surface watercourse crossings.

All watercourse crossings would be permanent and used to access the site for construction and maintenance purposes during the life of the Modified 2013 Scheme.

2.2 Site Visit

Following identification of the potential watercourse crossings, a site visit and inspection of each of the identified crossings was undertaken to obtain information specific to each watercourse. Photographs and detailed field notes were taken, reporting the dimensions of the watercourse channel and the existing crossing type (if applicable).

The inspection recorded upgradient and downgradient positions (photographs), channel width and depth. An assessment was undertaken on possible crossing solutions and drawings were prepared detailing the water crossing survey at each point.

In addition, the watercourses across the site have been assessed by ecologists for the suitability of the presence of otters and water voles, either via habitat and/or the presence of field signs for each species.

The original site survey was carried out as part of the peat assessment of the route between 14th May 2012 and 18th May 2012. During this site survey 17 water crossings were confirmed to be present along the proposed road layout route.

Following several surveys across the site the proposed road layout and number of turbines were amended from the original design. The Modified 2013 scheme was assessed for any significant differences thus affecting the number and location of watercourse crossings required. The revised layout requires 18 water crossings. The additional water crossings encountered as part of the Modified 2013 scheme were surveyed as part of the additional peat assessment in May 2013.

2.3 Summary of Watercourse Crossing Assessment

The locations for the assessed crossings are provided in Figure 1 with details and photographs of each watercourse crossing presented in Appendix A. This assessment provides an accurate indication of the likely number, scale and types of permanent watercourse crossings required as part of the Modified 2013 Scheme. It is anticipated that this data can be used as a supporting document during the CAR application process, if required.

With the final road layout design of the Modified 2013 Scheme there are a total of 18 crossings identified, all of which were identified on the OS 1:50,000 scale digital mapping

and are therefore CAR-applicable (known as regulated crossings). In addition, it is possible that other small and ephemeral streams and flushes would be encountered during the construction period. The locations of the watercourse crossings in relation to the proposed infrastructure of the Modified 2013 Scheme are provided in Figure 1.

3.0 WATERCOURSE CROSSING ASSESSMENT

As detailed within Section 1.2, the watercourse crossing assessment has been undertaken to meet the objectives of the Water Framework Directive.

Table 1 provides a summary of the surveyed watercourses. More detailed information on the watercourse crossings is provided in Appendix A, which includes the following:

- Watercourse crossing identification number;
- Grid reference;
- Hydromorphological information at watercourse crossing;
- Type of crossing required/crossing type characteristics; and
- The level of CAR authorisation required[1].

The assessment has determined that the required authorisations for this site could typically vary from General Binding Rules to Registrations to Simple Licenses. This is based on the following activities provided in pages 25 and 26 of SEPA's CAR practical guide[2]:

- General Binding Rules (GBR's)
    - Minor Bridges with no construction on bed or banks;
    - Temporary Bridges in rivers <5 m wide.
- Registration Activities:
    - Bridges across rivers and lochs where no part of the structure encroaches on the bed (e.g. no piers or in-channel supports). In addition, the total length of the structures on both banks should not be more than 20 m. This category includes bottomless arch culverts; and
    - Pipe and box culverts used for single-track roads, footpaths and/or cycle routes, where the affected river is not more than 2 m wide.
- Simple License Activities:
    - All other bridges, fords or causeways. This category would include bridges affecting more than 20 m total bank lengths, or bridges with in-stream supports.

[1] The engineering levels of authorisation can be found in Table 5 (Page 23) The Water Environment (Controlled Activities) (Scotland) Regulations 2005, A Practical Guide, SEPA, v6, August 2011

[2] The Water Environment (Controlled Activities) (Scotland) Regulations 2011, A Practical Guide, SEPA, v6, August 2011

Table 1: Summary of Watercourse Crossings

Water Crossing ID	Co-ordinates	Existing Crossing Type	Proposed Crossing Type	CAR Authorisation
1	281146 955508	None	Permanent Bridging	Registration or Simple licence depending on design of bridge
2	281304 953931	None	Arch Culvert	Registration
3	281878 955835	None	Permanent Bridging	Registration or Simple licence depending on design of bridge
4	280739 952708	Closed culvert	Upgrade existing culvert*	Registration
5	280178 952030	Bridge	Upgrade existing bridge*	Registration
6	280432 949494	None	Arch Culvert	Registration
7	280807 951395	Closed culvert	Upgrade existing culvert*	Registration
8	279176 949171	None	Arch Culvert	Registration
9	280171 950019	Closed culvert	Upgrade existing culvert*	Registration
10	279722 949723	None	Arch Culvert	Registration
11	279101 949512	None	Arch Culvert	Registration
12	278929 950103	None	Arch Culvert	Registration
13	278505 949620	None	Arch culvert	Registration
14	277693 949210	None	Arch Culvert	Registration
15	278763 950282	None	Arch Culvert	Registration
16	279354 952339	Closed culvert	Upgrade existing culvert*	Registration
17	277791 952663	Closed culvert	Upgrade existing culvert*	Registration
18	277459 953184	Closed culvert	Upgrade existing culvert*	Registration

*Subject to inspection

4.0 WATERCOURSE CROSSING REQUIREMENTS

4.1 Methodology

The purpose of this document is to provide an assessment of watercourse crossings rather than to comment on the detailed engineering design. The construction contractor would have overall responsibility for the undertaking of these watercourse crossings.

As part of the detailed site design, which would be completed prior to any construction commencing, the construction details for each proposed watercourse crossing would be agreed with SEPA, Scottish Natural Heritage and Northern District Salmon Fishery Board and with reference to SEPA guidance and potential fisheries, interests and protected species.

It is likely that the natural streams would show the greatest variety of sizes and cross-sectional profile. They are also, usually the most important ecologically as they are more likely to support the most valuable assemblages of flora and fauna and can have high individual nature conservation and fishery value. Channel bed and bank material can range from peat to soils, clays, gravels, cobbles and boulders and any combination of these is frequently encountered. An arch culvert structure would be the most suitable form of crossing for these watercourses. Several crossings already exist on the site and generally consist of closed culverts, there is potential for these to be upgraded in order to make them suitable as part of the permanent works, subject to an inspection.

It is recommended that all watercourse crossings are designed to maintain hydrology as well as allowing the free passage of mammals (otters and water voles).

4.2 Construction

It is proposed that each watercourse crossing would have sufficient capacity to pass the 1:200 year flood level, and include an allowance for potential partial blockage and / or potential effects of climate change.

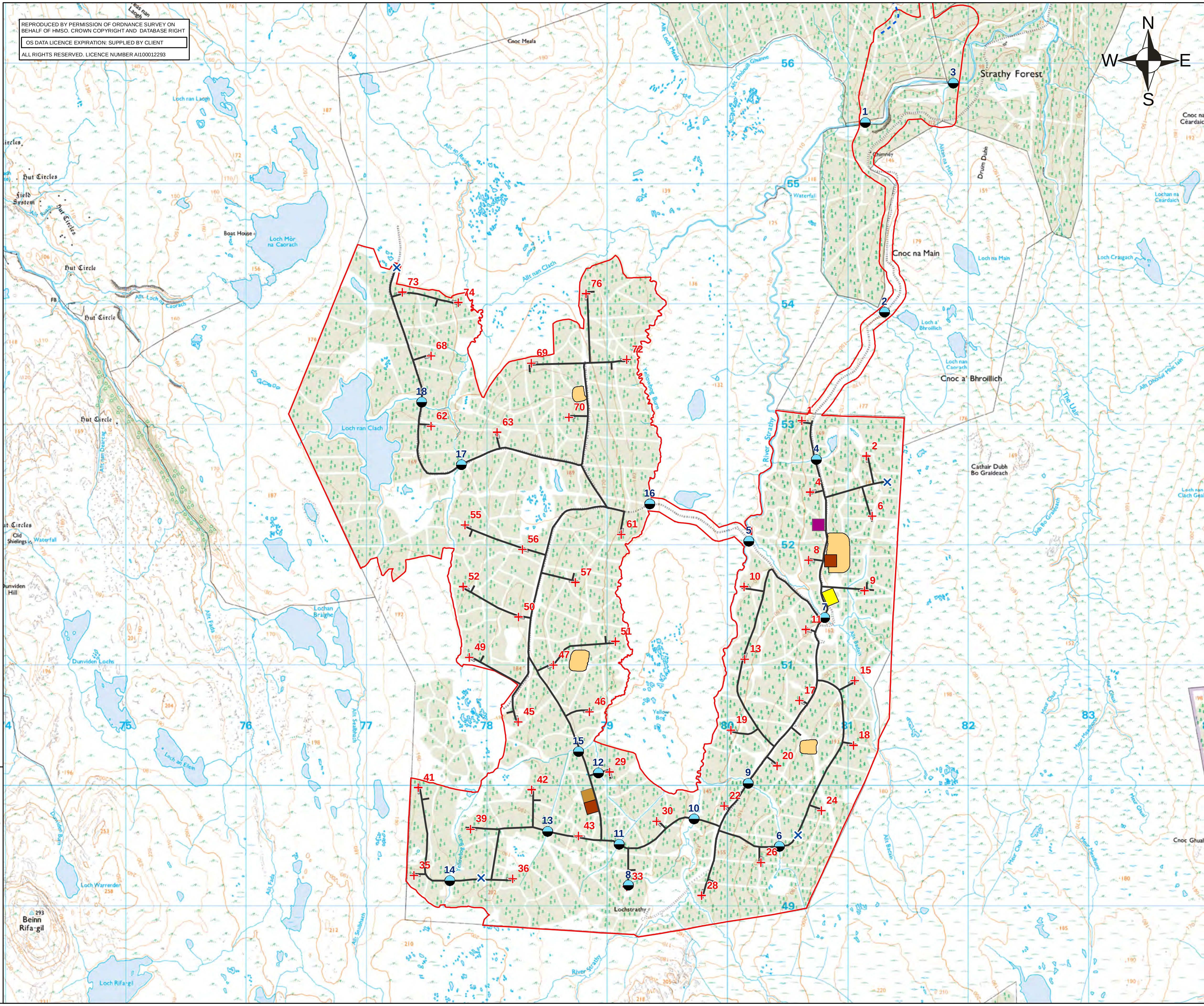
Suitability of crossing type is dependent upon ecological requirements, as well as hydrology.

In selecting a suitable crossing point the following is sought:

i) Narrowest and nearest location with either firm or low banks on either side – preferably both if possible;
ii) The route to and from the crossing point is relatively firm – necessary to cater for repeated crossing over a period of time; and
iii) No species of particular or special interest at the location or entry to or from the crossing.

Inevitably, there will be some disturbance in the vicinity of the crossing during the construction period. The Technical Appendix A4.1: Construction Environmental Management Plan (CEMP) would address risk minimisation and mitigation, particularly during the construction period. However, in addition to engineering, the reinstatement of vegetation must be integral to the design to provide ‘rest/cover’ areas.

FIGURES



0660.00018.9.1.0 Watercourse Crossings

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- ACCESS ROUTE
- WATER CROSSING
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT

SSE Renewables

SLR

4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATERCOURSE CROSSINGS

1

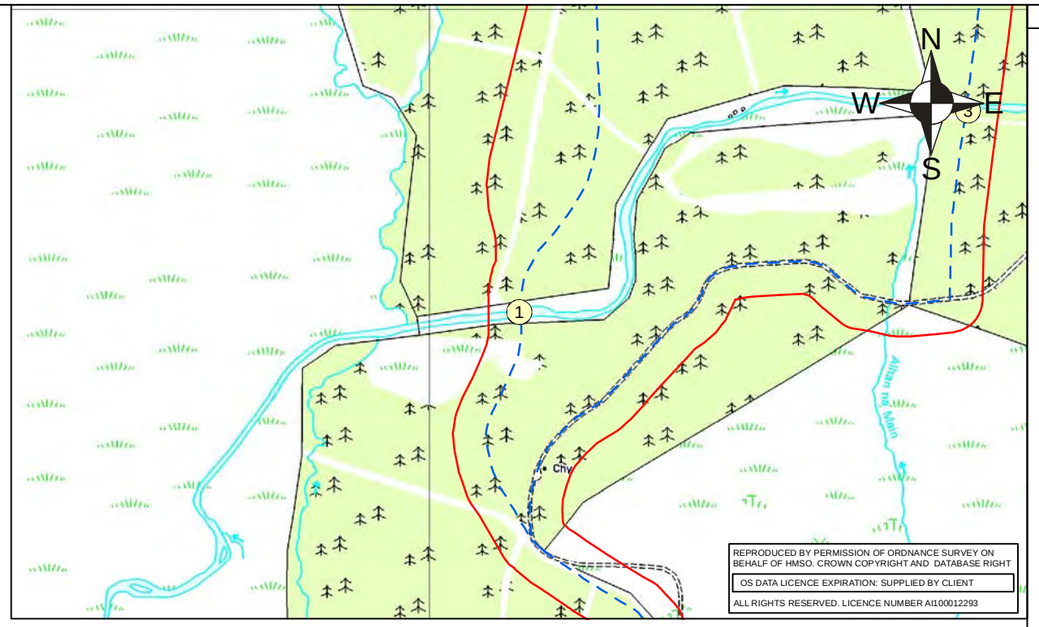
Scale	Date
1:30,000 @ A3	MAY 2013

APPENDICES

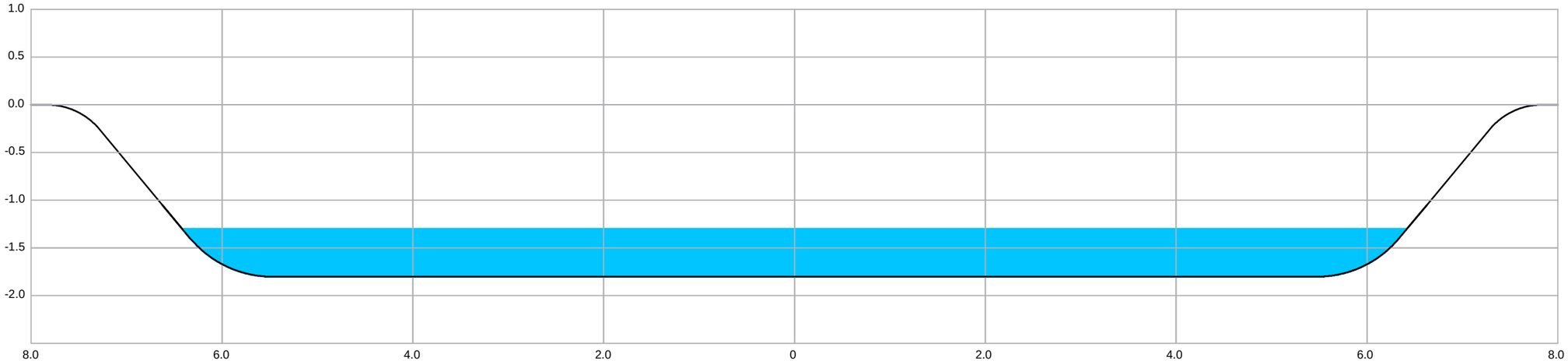
Appendix A Water Crossings

WATERCOURSE CROSSING 1 - VIEW UPSTREAM

WATERCOURSE CROSSING 1 - VIEW DOWNSTREAM



Water Crossing 1 (281146 955508)			
Watercourse Width:	12.00m	*Channel Width:*	15.00m
Watercourse Depth:	0.50m	*Channel Depth:*	1.80m
Context:	River Strathy		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Permanent Bridge*		Potential CAR Authorisation *Registration or Simple Licence required (dependant on type of bridge)*	



WATER CROSSING 1

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 1

1

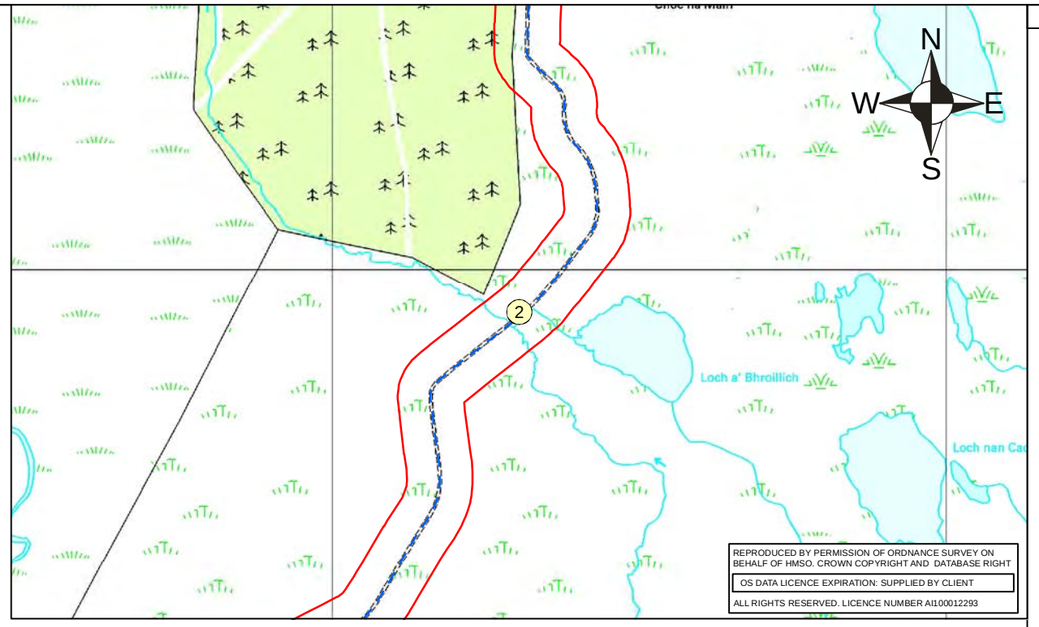
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.1.0 Watercourse Crossing 1

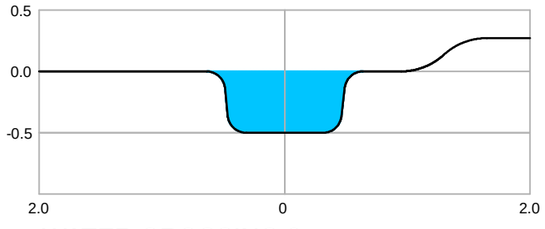
WATERCOURSE CROSSING 2
- VIEW UPSTREAM

WATERCOURSE CROSSING 2
- VIEW DOWNSTREAM



Water Crossing 2
(281304 953931)

Watercourse Width:	0.90m	*Channel Width:*	0.90m
Watercourse Depth:	0.50m	*Channel Depth:*	0.50m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type Arch Culvert		Potential CAR Authorisation *Registration*	



WATER CROSSING 2

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 2

2

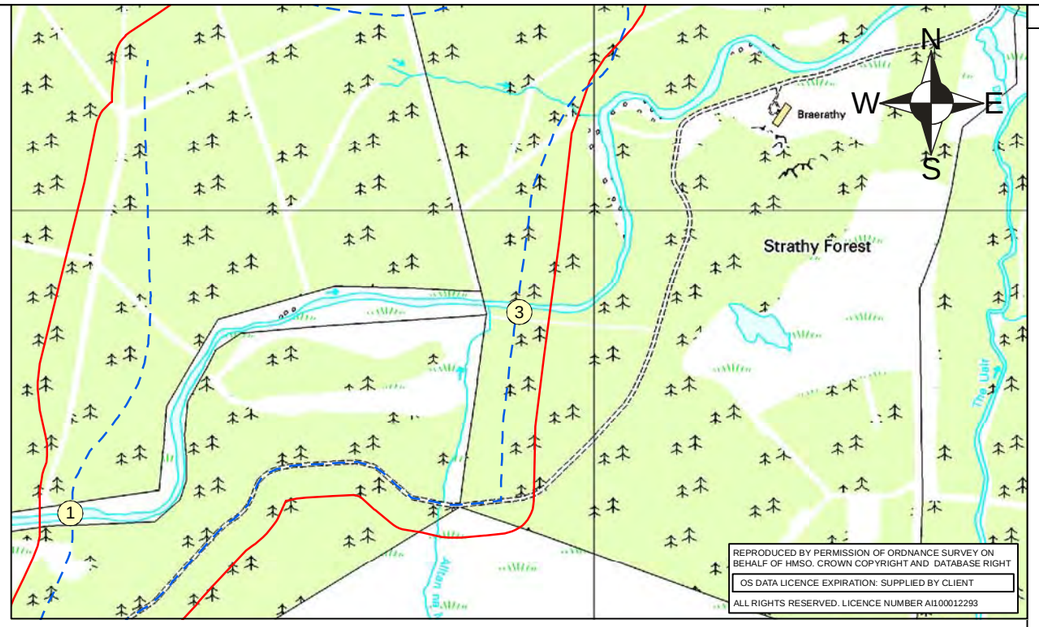
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.2.0 Watercourse Crossing 2

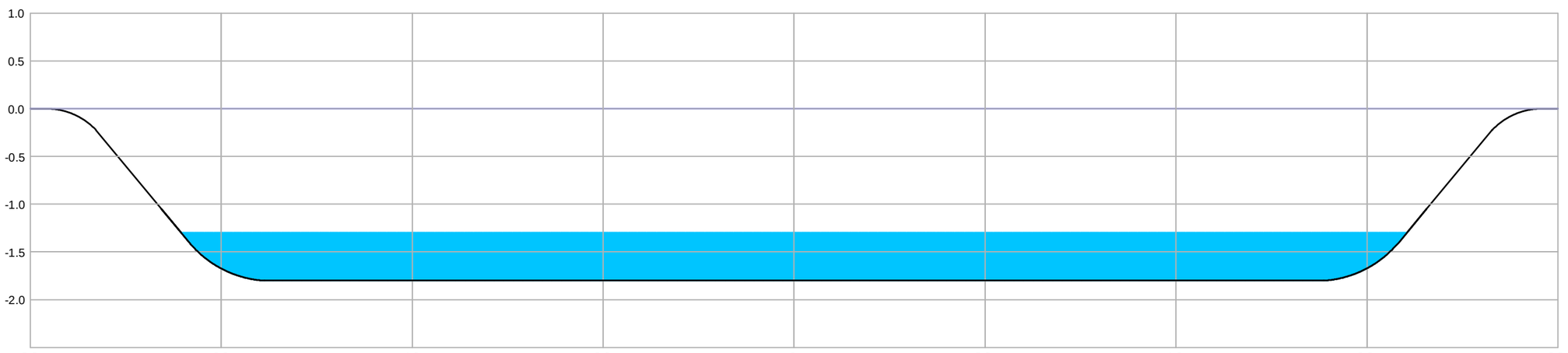
WATERCOURSE CROSSING 3 - VIEW UPSTREAM

WATERCOURSE CROSSING 3 - VIEW DOWNSTREAM



Water Crossing 3
(281878 955835)

Watercourse Width:	12.00m	*Channel Width:*	15.0m
Watercourse Depth:	0.5m	*Channel Depth:*	1.80m
Context:	River Strathy		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Permanent Bridge*		Potential CAR Authorisation *Registration or Simple Licence required (dependant on type of bridge)*	



WATER CROSSING 3

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 3

3

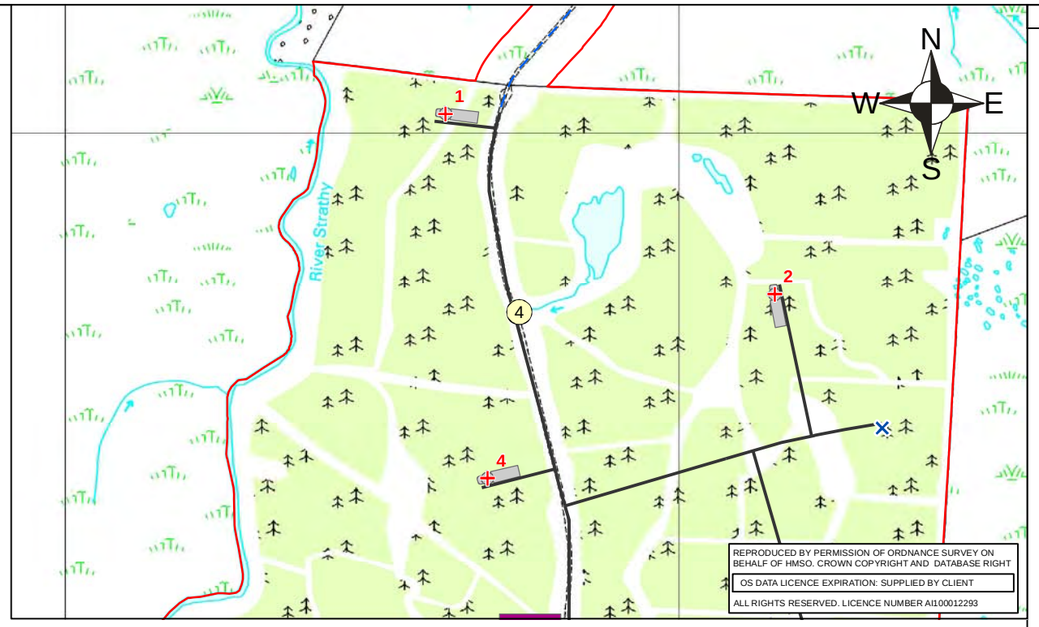
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.3.0 Watercourse Crossing 3

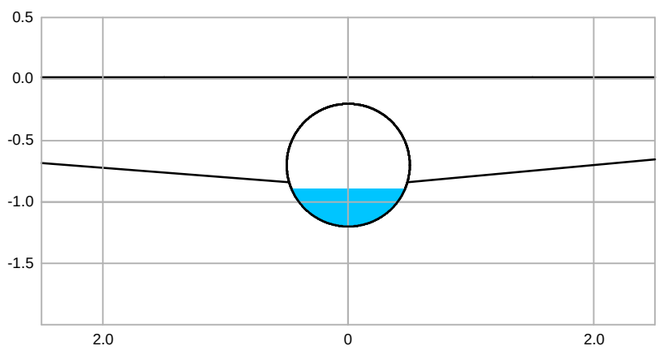
WATERCOURSE CROSSING 4
- VIEW UPSTREAM

WATERCOURSE CROSSING 4
- VIEW DOWNSTREAM



Water Crossing 4
(280739 952708)

Watercourse Width:	0.50m	*Channel Width:*	2.00m
Watercourse Depth:	0.30m	*Channel Depth:*	1.20m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Existing Culvert – Upgrade Existing Culvert subject to inspection*		Potential CAR Authorisation *Registration*	



WATER CROSSING 4

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 4

4

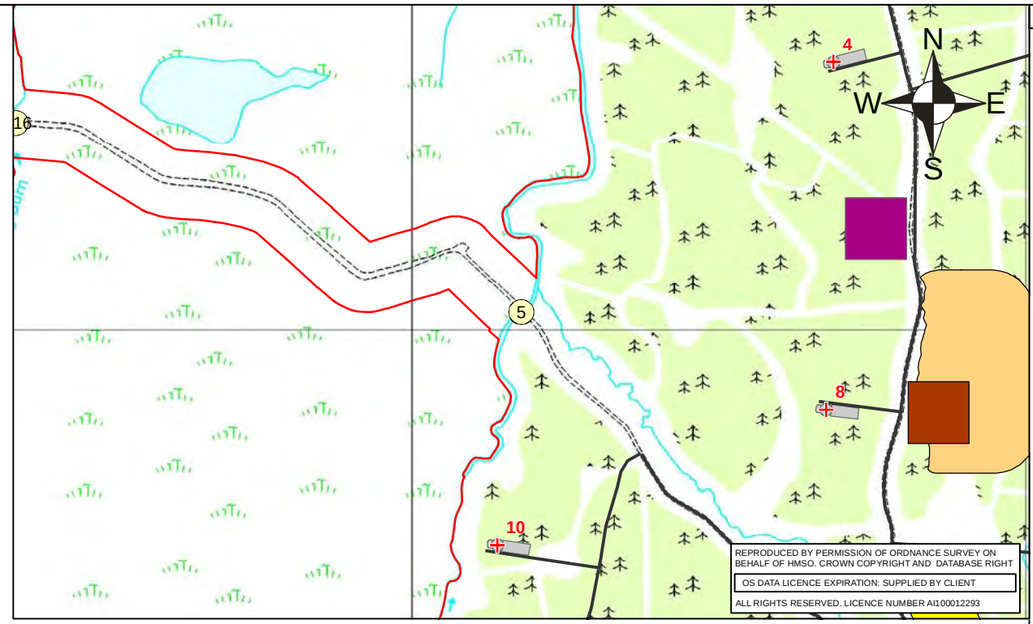
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.4.0 Watercourse Crossing 4

WATERCOURSE CROSSING 5 - VIEW UPSTREAM

WATERCOURSE CROSSING 5 - VIEW DOWNSTREAM

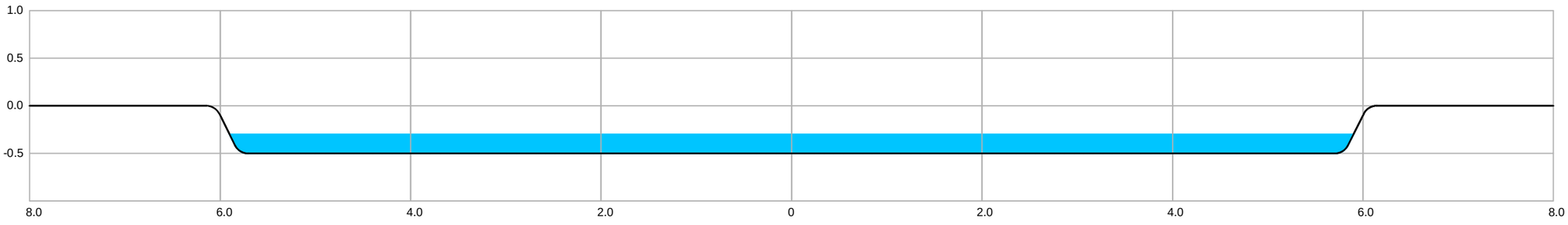


Water Crossing 5
(280178 952030)

Watercourse Width:	11.60m	*Channel Width:*	11.60m
Watercourse Depth:	0.20m	*Channel Depth:*	0.50m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Existing Bridge over River Strathy – Upgrade bridge subject to inspection*		Potential CAR Authorisation Registration	

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING



WATER CROSSING 5

1:50

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 5

5

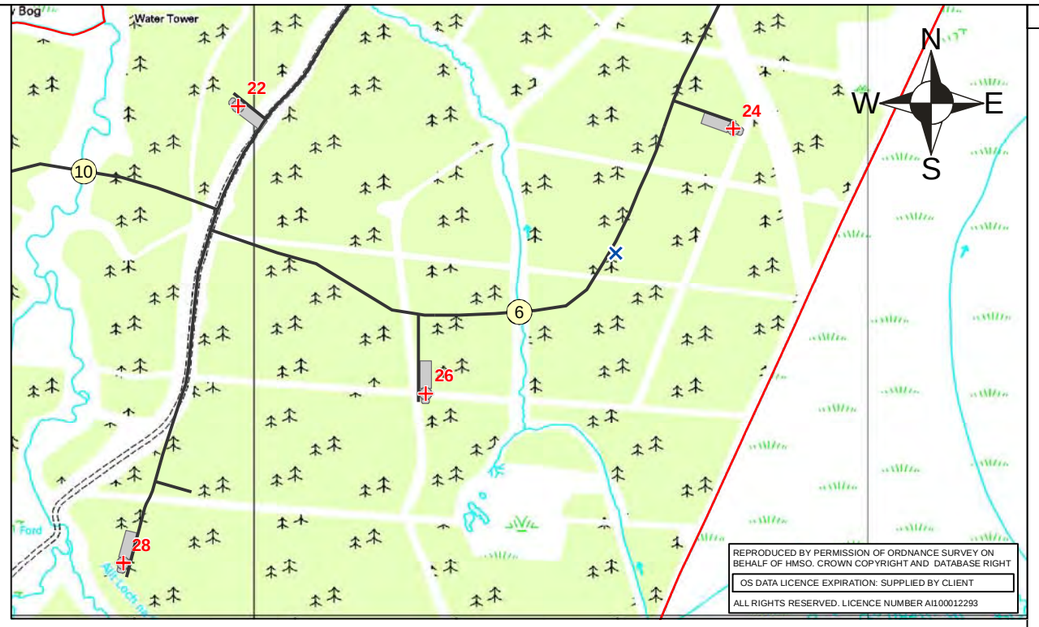
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.5.0 Watercourse Crossing 5

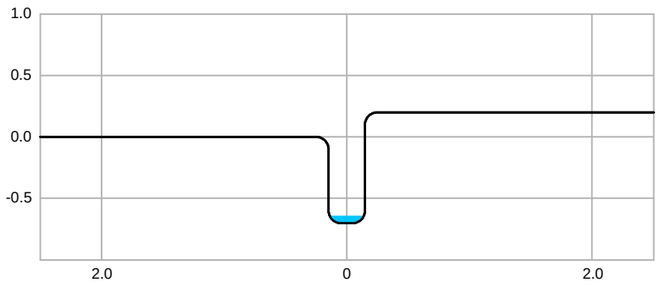
WATERCOURSE CROSSING 6 - VIEW UPSTREAM

WATERCOURSE CROSSING 6 - VIEW DOWNSTREAM



Water Crossing 6
(280432 949494)

Watercourse Width:	0.30m	*Channel Width:*	0.30m
Watercourse Depth:	0.05m	*Channel Depth:*	0.90m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type		Potential CAR Authorisation	
Arch Culvert		*Registration*	



WATER CROSSING 6

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 6

6

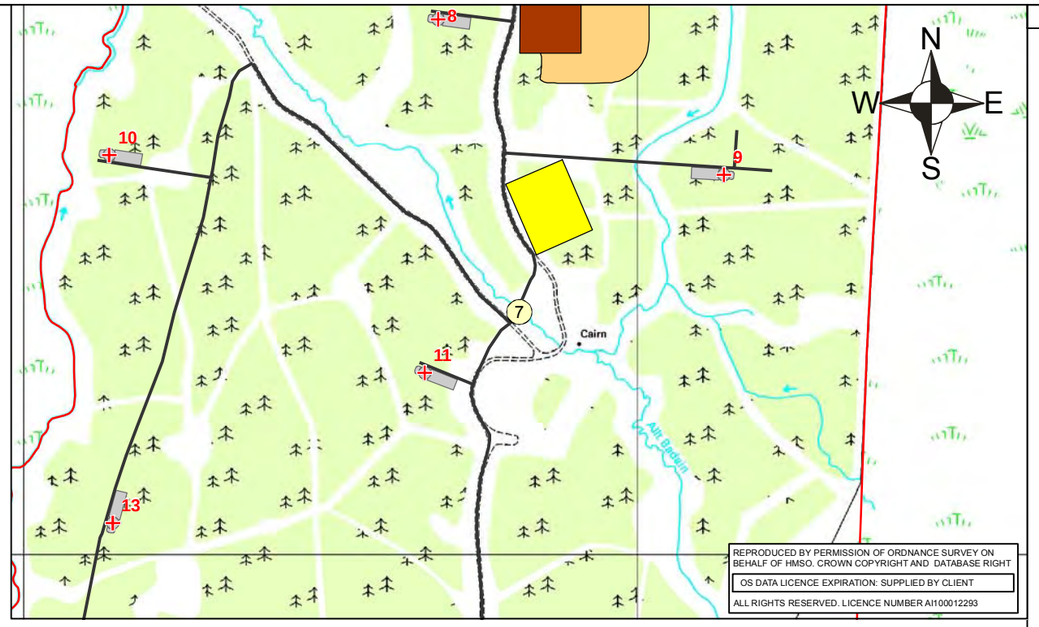
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.6.0 Watercourse Crossing 6

WATERCOURSE CROSSING 7
- VIEW UPSTREAM

WATERCOURSE CROSSING 7
- VIEW DOWNSTREAM



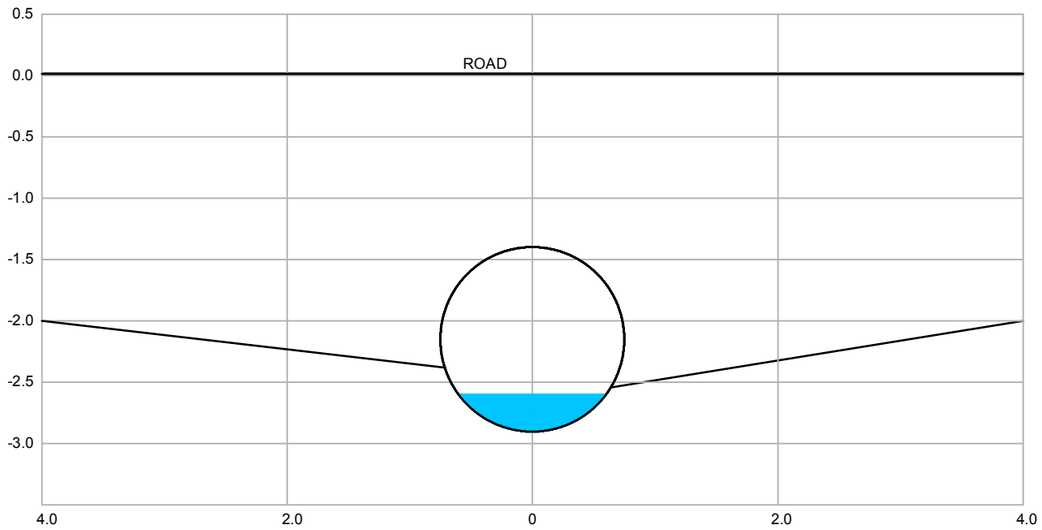
LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

WATERCOURSE CROSSING 7
- CULVERT

Water Crossing 7
(280807 951395)

Watercourse Width:	0.50 - 2.00m	*Channel Width:*	0.50 – 2.00m
Watercourse Depth:	0.20m	*Channel Depth:*	0.50m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Existing Culvert – Upgrade Existing Culvert subject to inspection*		Potential CAR Authorisation *Registration*	



WATER CROSSING 7

1:50

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 7

7

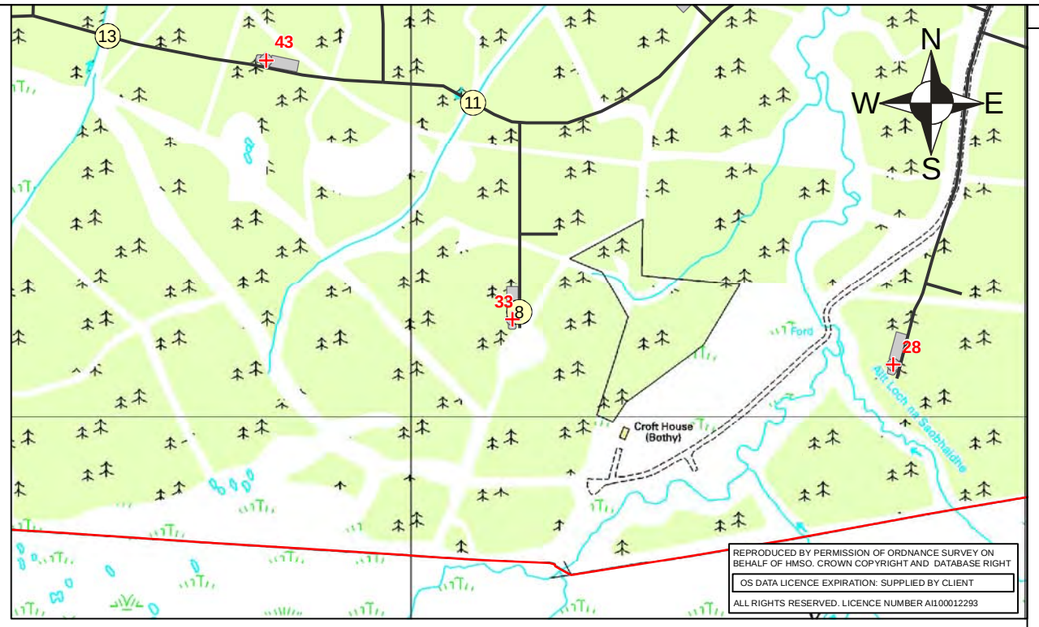
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.7.0 Watercourse Crossing 7

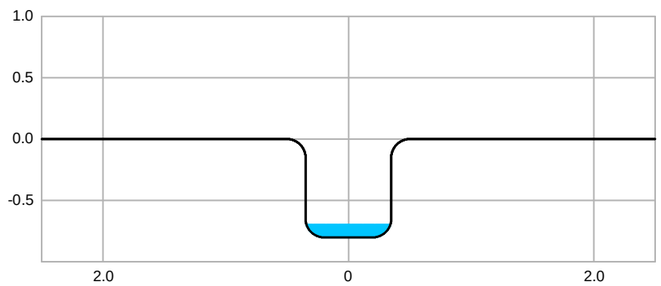
WATERCOURSE CROSSING 8 - VIEW UPSTREAM

WATERCOURSE CROSSING 8 - VIEW DOWNSTREAM



Water Crossing 8
(279176 949171)

Watercourse Width:	0.70m	*Channel Width:*	0.70m
Watercourse Depth:	0.10m	*Channel Depth:*	0.80m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type		Potential CAR Authorisation	
Arch Culvert		*Registration*	



WATER CROSSING 8

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 8

8

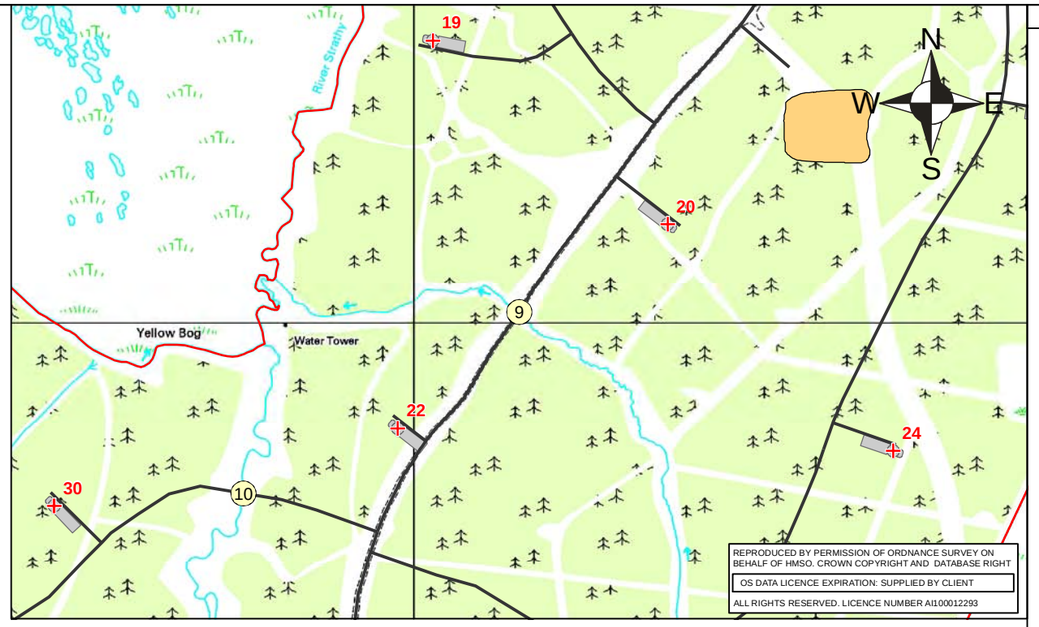
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.8.0 Watercourse Crossing 8

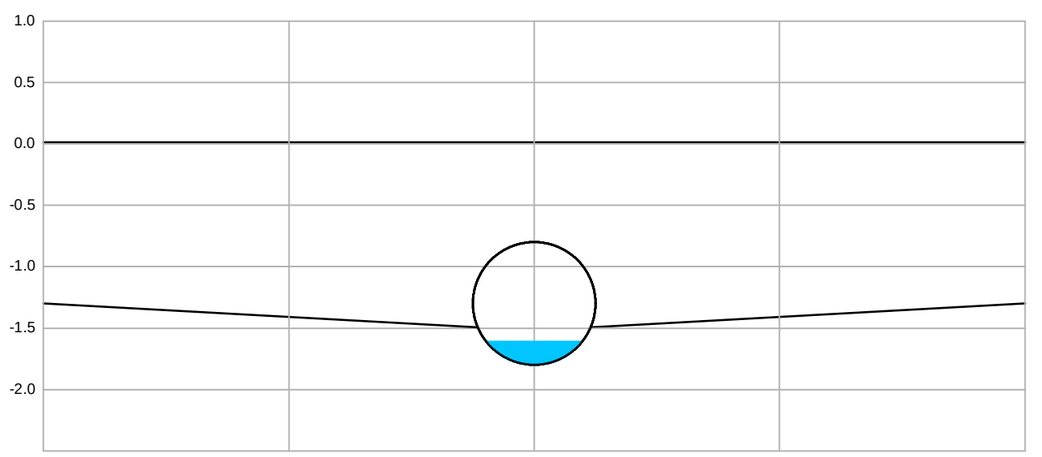
WATERCOURSE CROSSING 9 - VIEW UPSTREAM

WATERCOURSE CROSSING 9 - VIEW DOWNSTREAM



Water Crossing 9
(280171 950019)

Watercourse Width:	0.80m	*Channel Width:*	0.80m
Watercourse Depth:	0.20m	*Channel Depth:*	0.40m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Existing Culvert – Upgrade Existing Culvert subject to inspection*		Potential CAR Authorisation *Registration*	



WATER CROSSING 9

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 9

9

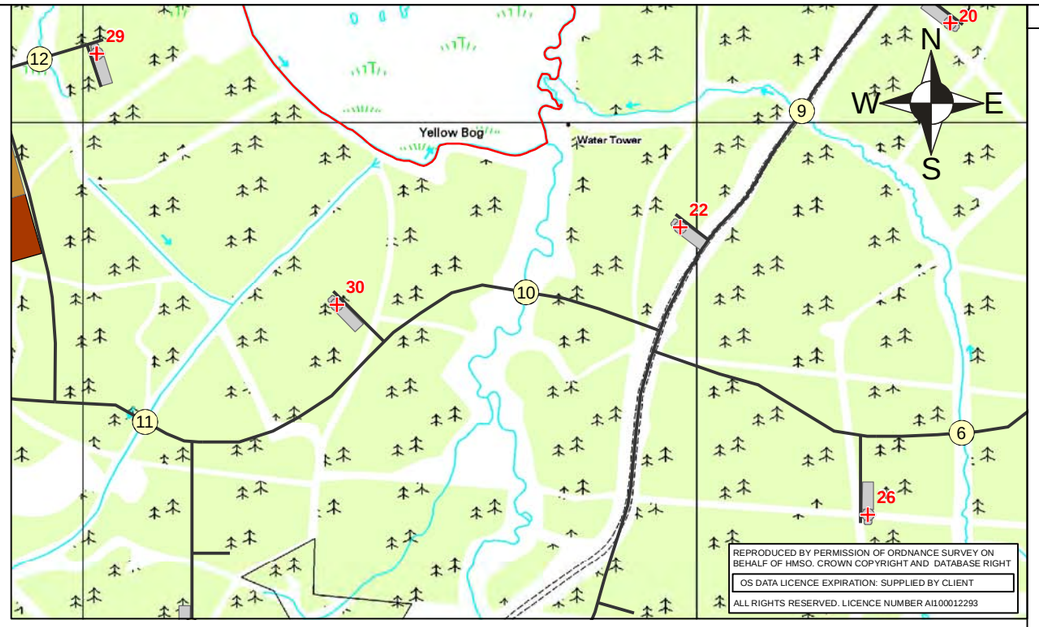
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.9.0 Watercourse Crossing 9

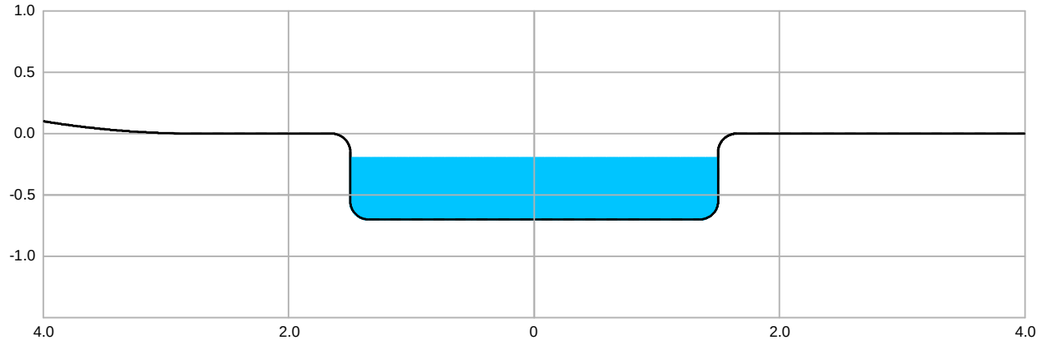
WATERCOURSE CROSSING 10 - VIEW UPSTREAM

WATERCOURSE CROSSING 10 - VIEW DOWNSTREAM



Water Crossing 10
(279722 949723)

Watercourse Width:	3.00m	*Channel Width:*	3.00m
Watercourse Depth:	0.50m	*Channel Depth:*	0.70m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Arch Culvert*		Potential CAR Authorisation *Registration*	



WATER CROSSING 10

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 10

10

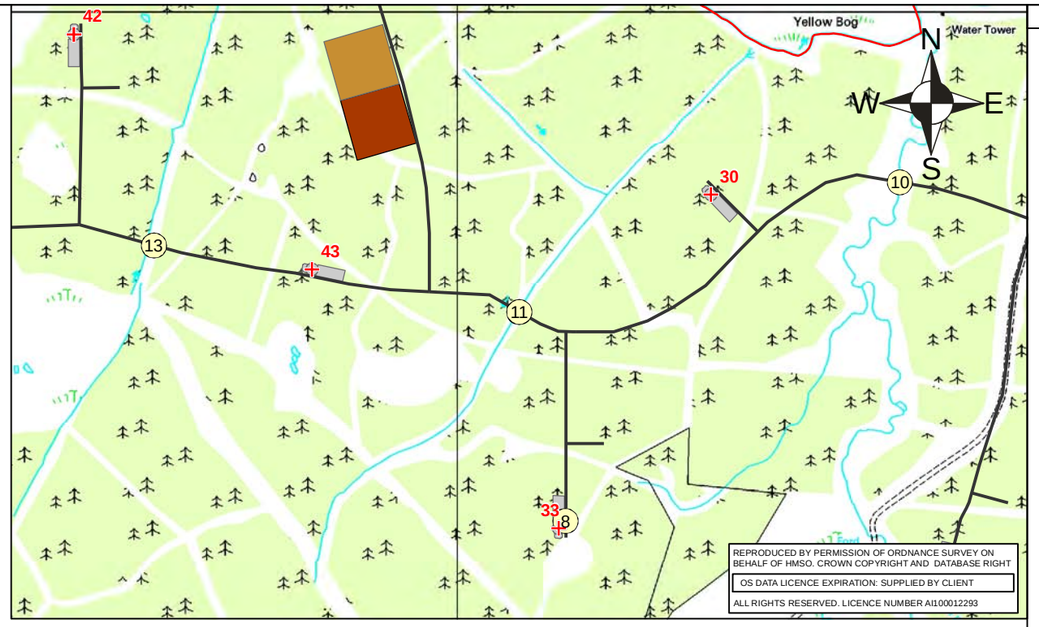
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.10.0 Watercourse Crossing 10

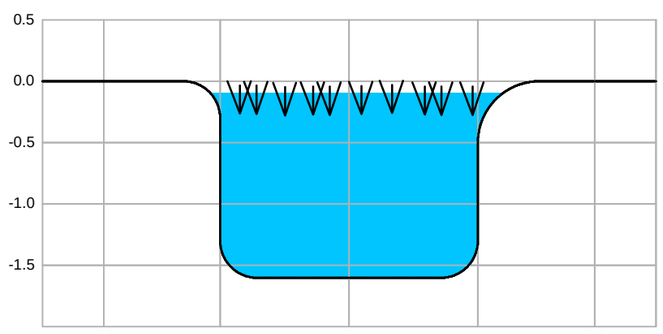
WATERCOURSE CROSSING 11 - VIEW UPSTREAM

WATERCOURSE CROSSING 11 - VIEW DOWNSTREAM



Water Crossing 11
(279101 949512)

Watercourse Width:	2.00m	*Channel Width:*	2.10m
Watercourse Depth:	1.50m	*Channel Depth:*	1.60m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Arch Culvert*		Potential CAR Authorisation *Registration*	



WATER CROSSING 11

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 11

11

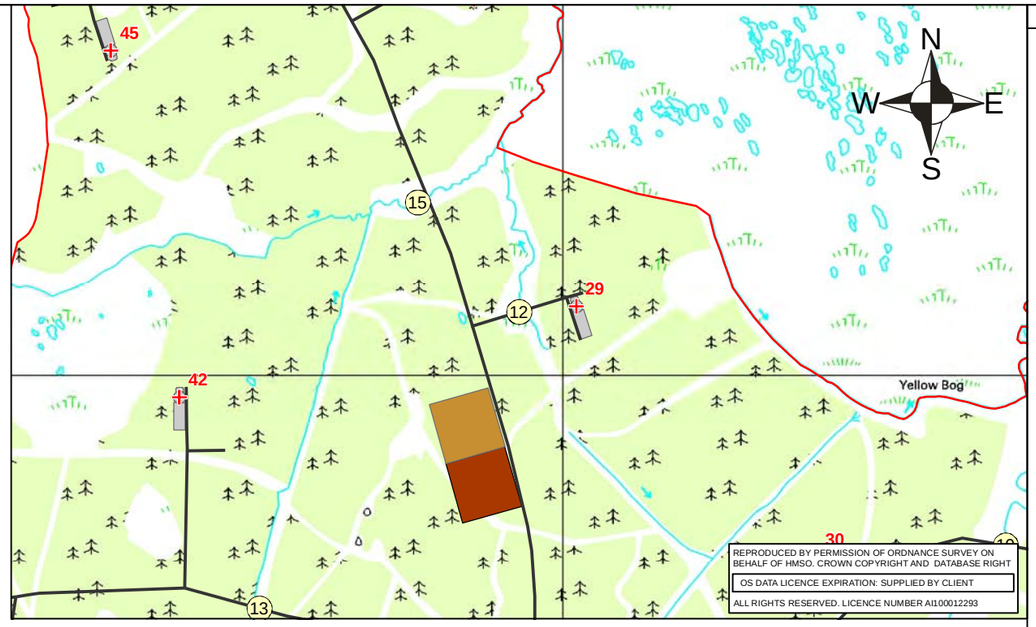
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.11.0 Watercourse Crossing 11

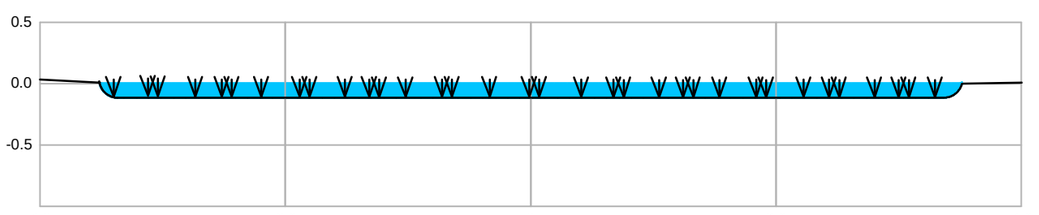
WATERCOURSE CROSSING 12 - VIEW UPSTREAM

WATERCOURSE CROSSING 12 - VIEW DOWNSTREAM



Water Crossing 12
(278929 950103)

Watercourse Width:	7.00m	*Channel Width:*	7.00m
Watercourse Depth:	0.10m	*Channel Depth:*	0.10m
Context:	Surface Watercourse (Flush)		
Bed Material:	Peat		
Gradient:	Gentle		
Proposed Crossing Type *Arch Culvert*		Potential CAR Authorisation *Registration*	



WATER CROSSING 12

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 12

12

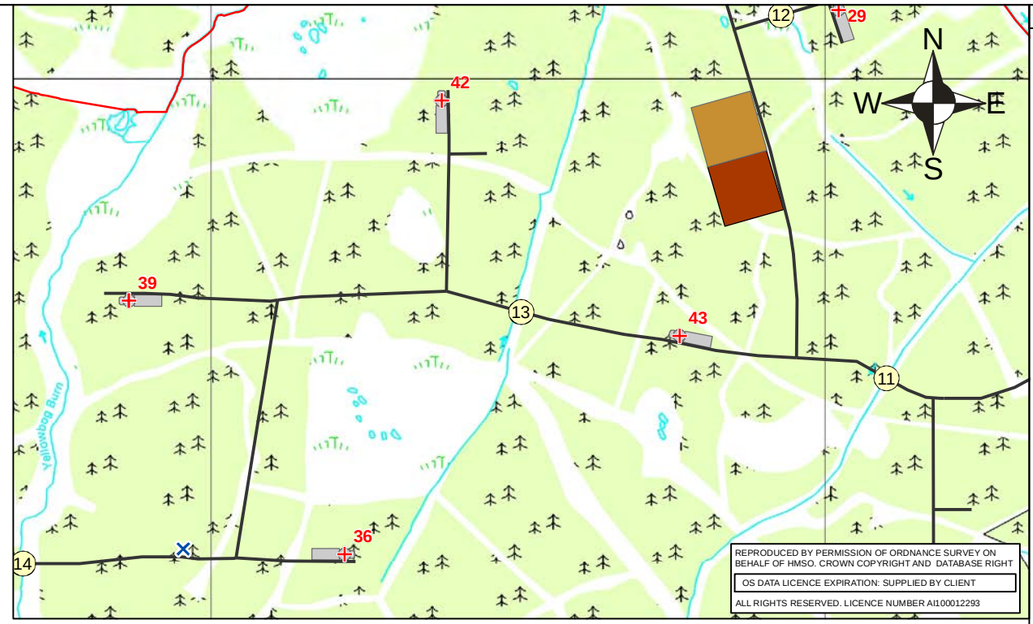
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.12.0 Watercourse Crossing 12

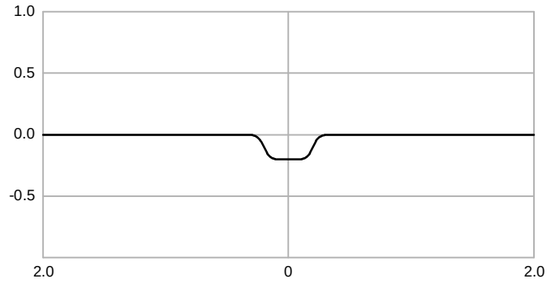
WATERCOURSE CROSSING 13 - VIEW UPSTREAM

WATERCOURSE CROSSING 13 - VIEW DOWNSTREAM



Water Crossing 13
(278505 949620)

Watercourse Width:	Dry at time of inspection	*Channel Width:*	0.50m
Watercourse Depth:	Dry at time of inspection	*Channel Depth:*	0.20m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type Arch Culvert		Potential CAR Authorisation *Registration*	



WATER CROSSING 13

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 13

13

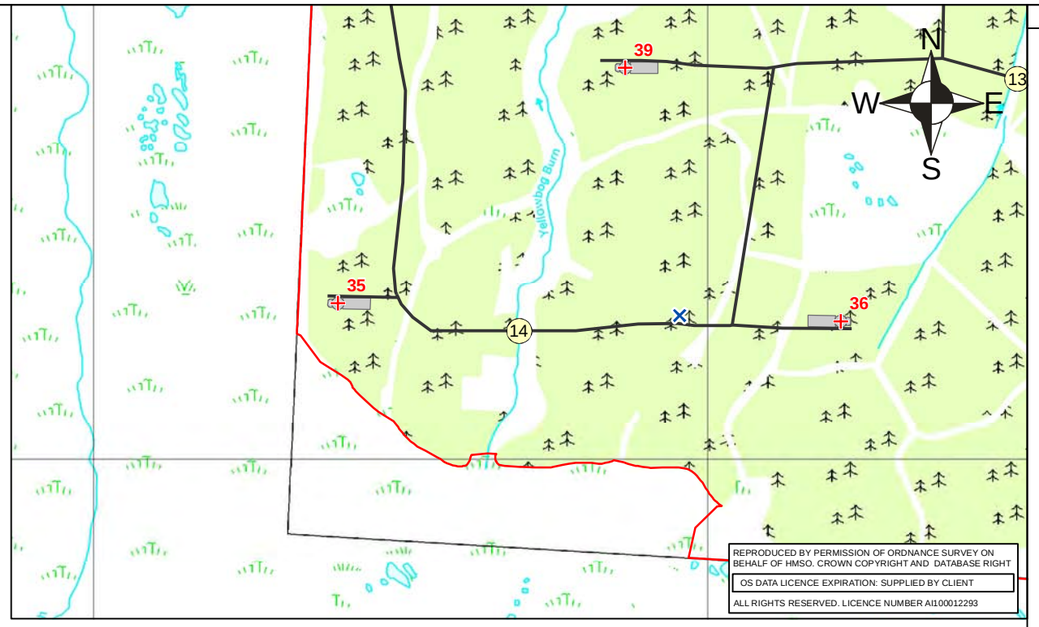
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.13.0 Watercourse Crossing 13

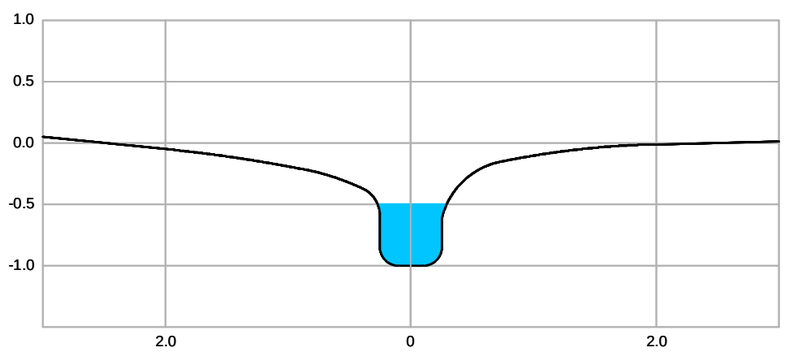
WATERCOURSE CROSSING 14
- VIEW UPSTREAM

WATERCOURSE CROSSING 14
- VIEW DOWNSTREAM



Water Crossing 14
(277693 949210)

Watercourse Width:	0.50m	*Channel Width:*	5.00m
Watercourse Depth:	0.50m	*Channel Depth:*	1.00m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type		Potential CAR Authorisation	
Arch Culvert		*Registration*	



WATER CROSSING 14
1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 14

14

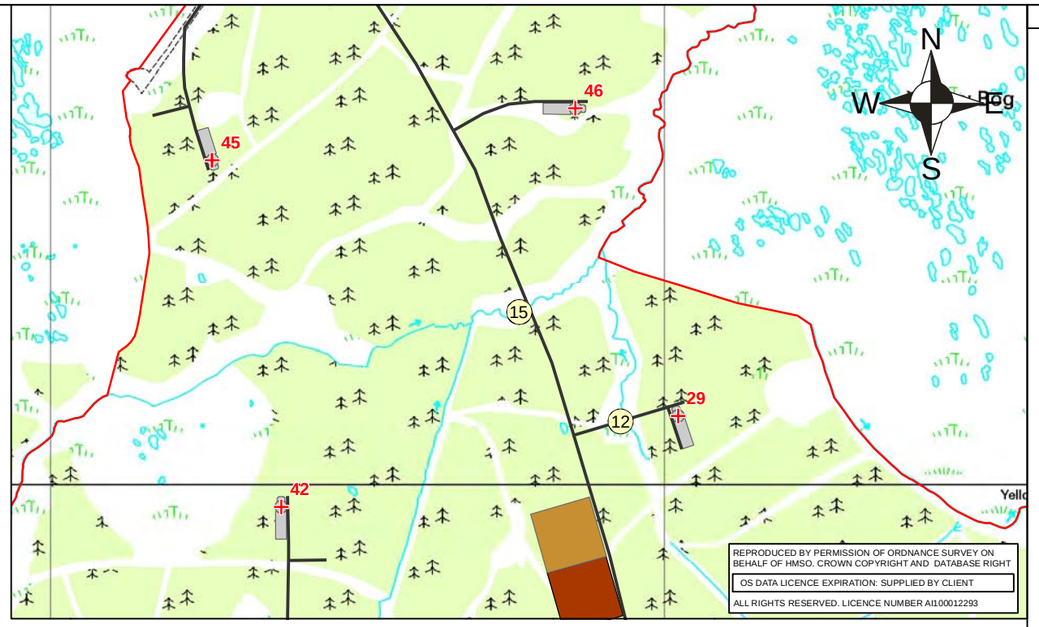
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.14.0 Watercourse Crossing 14

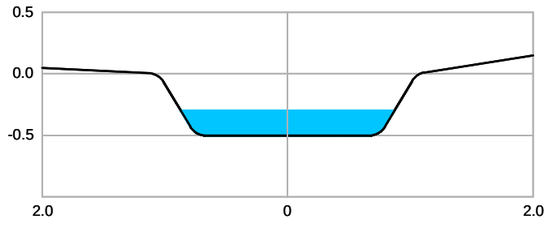
WATERCOURSE CROSSING 15 - VIEW UPSTREAM

WATERCOURSE CROSSING 15 - VIEW DOWNSTREAM



Water Crossing 15
(278763 950282)

Watercourse Width:	1.50m	*Channel Width:*	2.10m
Watercourse Depth:	0.20m	*Channel Depth:*	0.50m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type Arch Culvert		Potential CAR Authorisation Registration	



WATER CROSSING 15

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 15

15

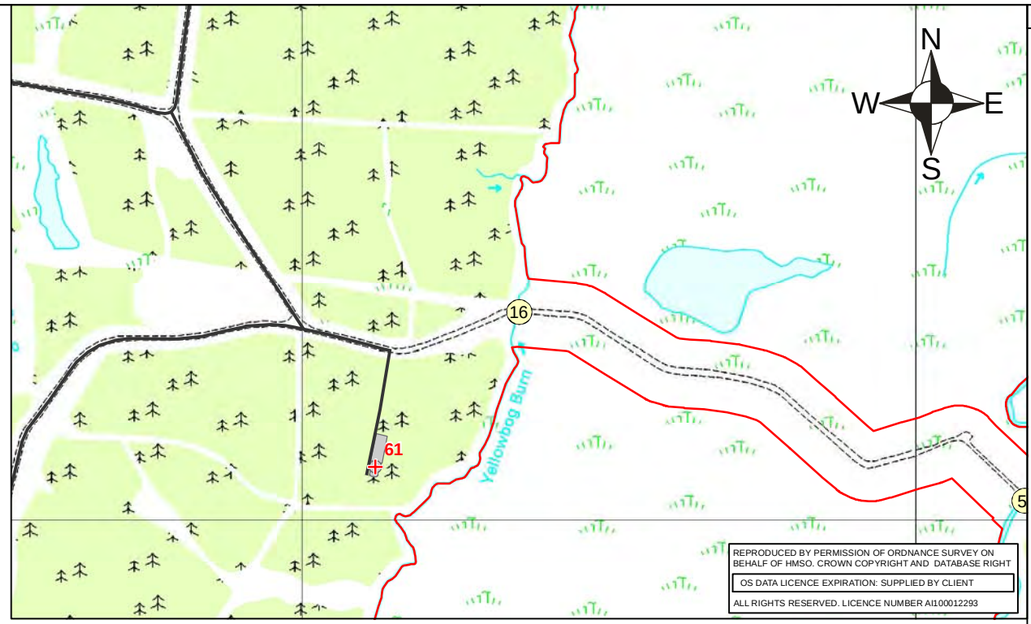
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.15.0 Watercourse Crossing 15

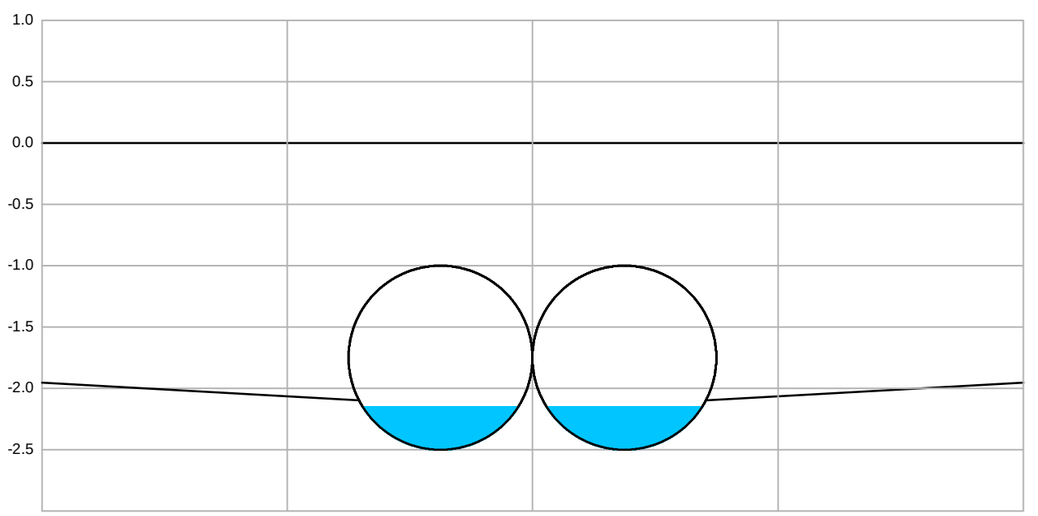
WATERCOURSE CROSSING 16 - VIEW UPSTREAM

WATERCOURSE CROSSING 16 - VIEW DOWNSTREAM



Water Crossing 16
(279354 952339)

Watercourse Width:	3.00m	*Channel Width:*	3.00m
Watercourse Depth:	0.20m	*Channel Depth:*	0.30m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Existing Culvert – Upgrade Existing Culvert subject to inspection*		Potential CAR Authorisation *Registration*	



WATER CROSSING 16

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 16

16

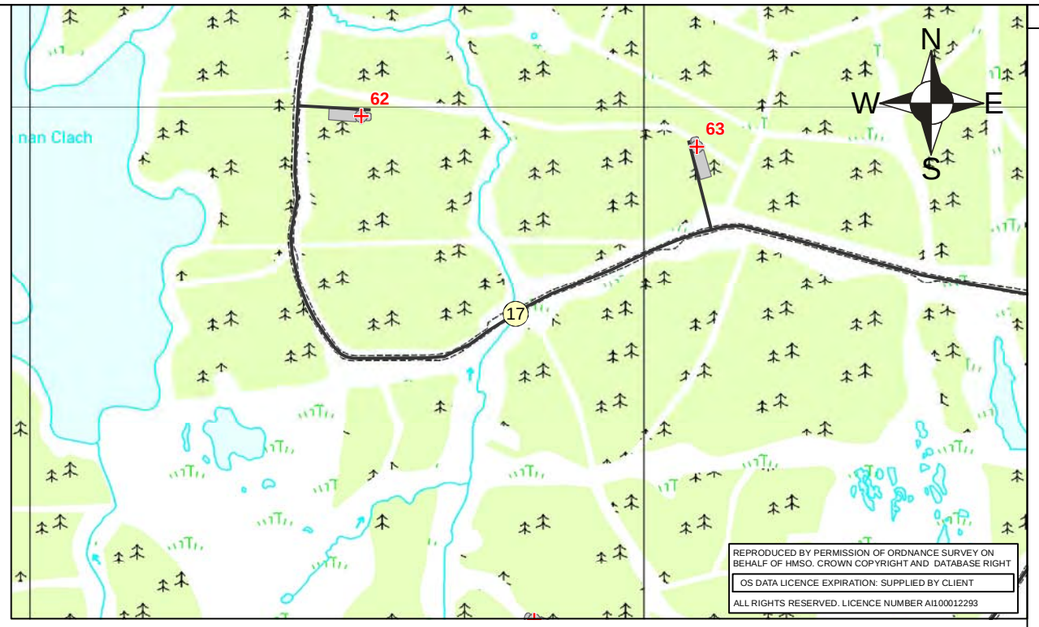
Scale 1:10,000 @ A3

Date MAY 2013

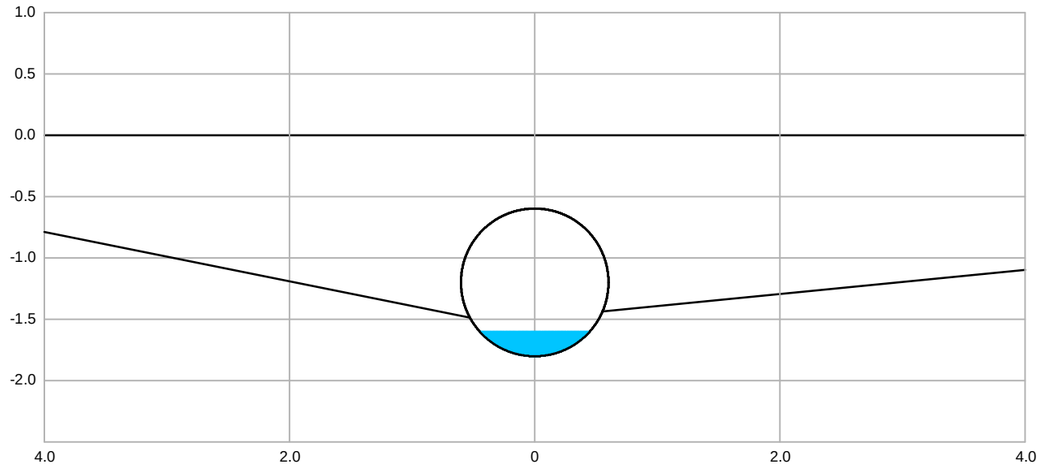
0660.00018.9.16.0 Watercourse Crossing 16

WATERCOURSE CROSSING 17 - VIEW UPSTREAM

WATERCOURSE CROSSING 17 - VIEW DOWNSTREAM



Water Crossing 17 (277791 952663)	
Watercourse Width: 1.00m *Watercourse Depth:* 0.20m *Context:* Surface Watercourse *Bed Material:* Not Proven *Gradient:* Gentle	*Channel Width:* 1.00m *Channel Depth:* 0.50m
Proposed Crossing Type *Existing Culvert – Upgrade Existing Culvert subject to inspection*	Potential CAR Authorisation *Registration*



WATER CROSSING 17

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 17

17

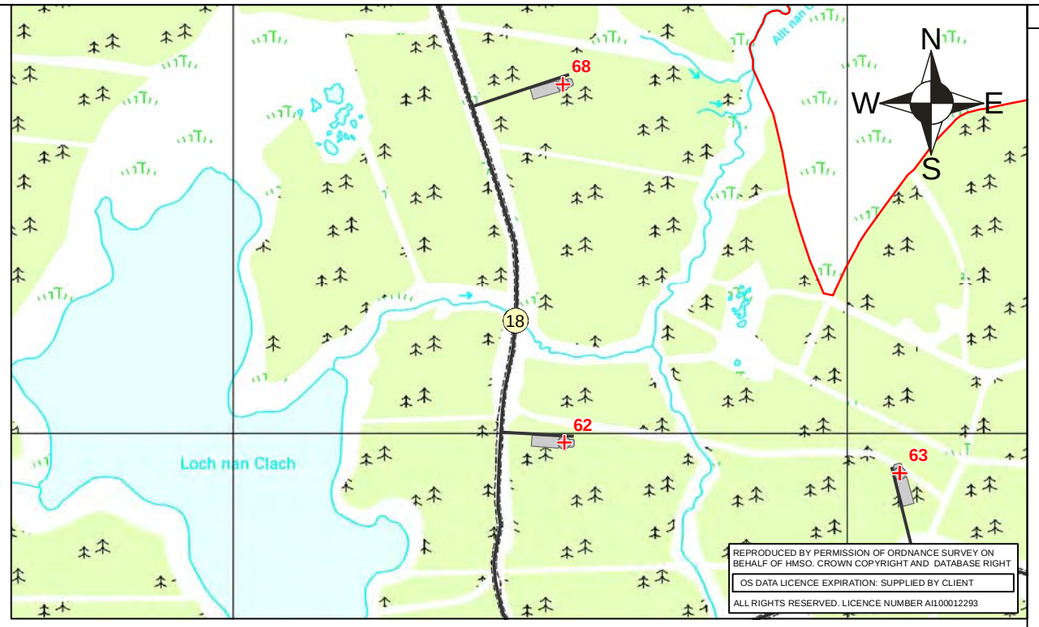
Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.17.0 Watercourse Crossing 17

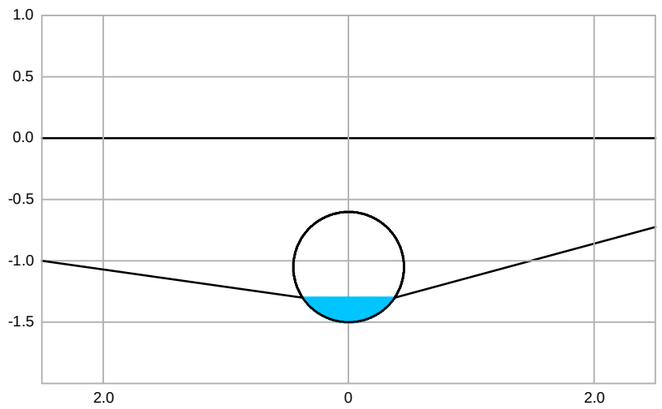
WATERCOURSE CROSSING 18 - VIEW UPSTREAM

WATERCOURSE CROSSING 18 - VIEW DOWNSTREAM



Water Crossing 18
(277459 953184)

Watercourse Width:	2.00m	*Channel Width:*	2.00m
Watercourse Depth:	0.10m	*Channel Depth:*	0.40m
Context:	Surface Watercourse		
Bed Material:	Not Proven		
Gradient:	Gentle		
Proposed Crossing Type *Existing Culvert – Upgrade Existing Culvert subject to inspection*		Potential CAR Authorisation *Registration*	



WATER CROSSING 18

1:50

LEGEND

- SITE BOUNDARY
- TURBINE
- PERMANENT MET MASTS
- PROPOSED TRACK
- POTENTIAL ACCESS
- HARDSTANDINGS
- CONCRETE BATCHING PLANT
- CONSTRUCTION COMPOUND
- SWITCHING STATION
- LAY DOWN AREA
- BORROW PIT
- WATERCOURSE CROSSING

SSE Renewables

SLR
4 THE ROUNDAL
RODDINGLAW BUSINESS
PARK, GOGAR
EDINBURGH. EH12 9DB
T: 0131 335 6830
F: 0131 335 6831
www.slrconsulting.com

STRATHY SOUTH WIND FARM

WATERCOURSE CROSSING REPORT

WATER CROSSING 18

18

Scale 1:10,000 @ A3

Date MAY 2013

0660.00018.9.18.0 Watercourse Crossing 18

SLR

global environmental solutions

AYLESBURY
7 Wornal Park, Menmarsh Road, Worminghall, Aylesbury, Buckinghamshire HP18 9PH
T: +44 (0)1844 337380

BELFAST
24 Ballynahinch Street, Hillsborough, Co. Down, BT26 6AW Northern Ireland
T: +44 (0)28 9268 9036

BRADFORD-ON-AVON
Treenwood House, Rowden Lane, Bradford-on-Avon, Wiltshire BA15 2AU
T: +44 (0)1225 309400

BRISTOL
Langford Lodge, 109 Pembroke Road, Clifton, Bristol BS8 3EU
T: +44 (0)117 9064280

CAMBRIDGE
8 Stow Court, Stow-cum-Quy, Cambridge CB25 9AS
T: + 44 (0)1223 813805

CARDIFF
Fulmar House, Beignon Close, Ocean Way, Cardiff CF24 5HF
T: +44 (0)29 20491010

CHELMSFORD
Unit 77, Waterhouse Business Centre, 2 Cromar Way, Chelmsford, Essex CM1 2QE
T: +44 (0)1245 392170

DUBLIN
7 Dundrum Business Park, Windy Arbour, Dundrum, Dublin 14 Ireland
T: + 353 (0)1 2964667

EDINBURGH
No. 4 The Roundal, Roddinglaw Business Park, Gogar, Edinburgh EH12 9DB
T: +44 (0)131 3356830

EXETER
69 Polsloe Road, Exeter EX1 2NF
T: + 44 (0)1392 490152

FARNBOROUGH
The Pavilion, 2 Sherborne Road, South Farnborough, Hampshire GU14 6JT
T: +44 (0)1252 515682

GLASGOW
4 Woodside Place, Charing Cross, Glasgow G3 7QF
T: +44 (0)141 3535037

HUDDERSFIELD
Westleigh House, Wakefield Road, Denby Dale, Huddersfield HD8 8QJ
T: +44 (0)1484 860521

LEEDS
Suite 1, Jason House, Kerry Hill, Horsforth, Leeds LS18 4JR
T: +44 (0)113 2580650

MAIDSTONE
19 Hollingworth Court, Turkey Mill, Maidstone, Kent ME14 5PP
T: +44 (0)1622 609242

NEWCASTLE UPON TYNE
Sailors Bethel, Horatio Street, Newcastle-upon-Tyne NE1 2PE
T: +44 (0)191 2611966

NOTTINGHAM
Aspect House, Aspect Business Park, Bennerley Road, Nottingham NG6 8WR
T: +44 (0)115 9647280

ST. ALBAN'S
White House Farm Barns, Gaddesden Row, Hertfordshire HP2 6HG
T: +44 (0)1582 840471

SHEFFIELD
STEP Business Centre, Wortley Road, Deepcar, Sheffield S36 2UH
T: +44 (0)114 2903628

SHREWSBURY
Mytton Mill, Forton Heath, Montford Bridge, Shrewsbury SY4 1HA
T: +44 (0)1743 850170

STAFFORD
8 Parker Court, Staffordshire Technology Park, Beaconside, Stafford ST18 0WP
T: +44 (0)1785 253331

WARRINGTON
Suite 9 Beech House, Padgate Business Park, Green Lane, Warrington WA1 4JN
T: +44 (0)1925 827218

WORCESTER
Suite 5, Brindley Court, Gresley Road, Shire Business Park, Worcester WR4 9FD
T: +44 (0)1905 751310

Energy | Waste Management | Planning & Development | Industry | Mining & Minerals | Infrastructure

Strathy South Wind Farm: Baseline Hydrochemical Monitoring

Report to Waterside Ecology

By: Dr Alistair Headley, MIEEM

Date: 17/10/2012

SUMMARY

Background

This report gives a summary of the results of the baseline monitoring of certain hydrochemical variables of the watercourses subject to possible impact from the proposed Strathy South Wind Farm development. The key objectives of the survey are to provide a baseline against which any potential changes in the hydrochemistry of the receiving waters can be assessed against. The monitoring of the hydrochemistry is not just an end itself, but has been designed to help identify any sources of impact on the biota within the watercourses that may arise from the construction of a wind farm. Therefore, wherever possible, sampling sites have been harmonised with macroinvertebrate and fish surveys, described elsewhere.

This report covers the results of the analysis on water samples collected from eleven locations within the Strathy catchment, one from the Armadale Burn catchment and one from the River Halladale at Forsinard that were collected mostly between 26th September 2011 and 27th September 2012. Some preliminary sampling of the Yellowbog Burn, Allt nan Clach tributaries as well as the River Strathy were carried out in 2007 and 2008. These samples were analysed for the following:

- pH (a measure of acidity)
- electrical conductivity (an indirect measure of the total quantity of dissolved salts)
- Gran alkalinity (a measure of the ability of the water to buffer acids)
- Dissolved organic carbon (important in potentially neutralising aluminium toxicity)
- Suspended solids (potentially could silt-up spawning areas for salmonid fish)
- Turbidity (an indirect measure of the quantity of suspended solids)
- Ammonium and nitrate nitrogen (contribute to nutrient enrichment)
- Soluble reactive phosphate (a major contributor to eutrophication)
- Total and dissolved calcium, aluminium and zinc (the latter two elements are potentially very toxic to fish)

The pH, electrical conductivity, temperature and turbidity of the watercourses were also measured in the field at the same sample locations at the same time as the collection of the water samples.

Main Findings

- The pH of all the watercourses are typically around 6 to 7 during low flows, but the pH falls rapidly with increasing discharge of the watercourses, such that the pH drops to below 5 at moderate flows and as far as 4 to 4.5 at moderately high flows.

- There are moderately high concentrations of dissolved organic carbon which comes from the surrounding bogs and peaty soils.

- Concentrations of major plant nutrients (ammonium and nitrate nitrogen and soluble reactive phosphate) in all the waters are very low (oligotrophic) and are typical for a river system with a catchment dominated by peatlands.

- The median concentration of total zinc at all the sampling locations exceeds the Imperative standards for the protection of salmonid rivers under the EC Freshwater Fisheries Directive.

- The concentrations of dissolved aluminium rise rapidly during high flows and they regularly exceed 100 ppb in the River Strathy and Allt na Dubh-chlaise.

Concentrations of 100 ppb of free monomeric aluminium are considered to be lethal to fish, but the high concentrations of DOC are thought to result in the aluminium being made unavailable as organo-aluminium complexes.

- The calculated ANC levels are always positive, but close to zero during periods of high flow.

- The present suite of determinands is considered to be adequate to satisfy the water quality standards covered by the EC Freshwater Fisheries Directive and SEPA's monitoring requirements.

Table of Contents

1. BACKGROUND 1
2. SCOPE OF THE REPORT 2
3. METHODS 3
3.1 Site Description 3
3.2 Sample locations 3
3.1 Sampling Frequency 3
3.3 Sample collection 3
3.4 Field measurements 3
3.5 Field observations 4
3.6 Sample transport and storage 4
3.7 Laboratory Analyses 4
3.8 Data analysis and Assessment 5
4. RESULTS 6
4.1 Acidity (pH), alkalinity, dissolved organic carbon (DOC) and acid neutralising capacity (ANC) 6
4.2 Electrical Conductivity 7
4.3 Suspended solids, turbidity 7
4.4 Nutrients (ammonium, oxidised nitrogen, phosphate) 7
4.5 Aluminium, Zinc and Calcium 8
5. DISCUSSION 9
5.1 pH and ANC 9
5.2 Field and Laboratory measurements of pH and electrical conductivity 9
5.3 Nutrients 10
5.4 Aluminium 10
5.5 Zinc 10
5.6 Monitoring suspended solids 11
5.7 Control sites 11
5.8 Monitoring frequency 11
5.9 Determination of aluminium toxicity 11
6. CONCLUSIONS 13
7. RECOMMENDATIONS 14
8. REFERENCES 15
9. TABLES 16

10. FIGURES.....31

STRATHY SOUTH WIND FARM:
BASELINE HYDROCHEMICAL MONITORING

1. BACKGROUND

As part of the proposed Strathy South wind farm development in Sutherland, Scotland a series of fishery and water quality monitoring programmes have been commissioned by SSE Renewables (UK) Limited (SSER). These monitoring programmes have been designed to assess the conditions of potentially ecologically sensitive receptors in the various watercourses that could be impacted during the development. To achieve this a year of monitoring of a wide range of physico-chemical variables has been carried out to establish the baseline conditions of these variables or determinands. This report describes the results of an initial set of samples taken from the area of the proposed Strathy South Wind Farm and combining this with the full complete year's programme of monitoring of the specified hydrochemical variables that were described in the Strathy North Water Quality Monitoring Plan.

The suite of physico-chemical variables or determinands monitored are chosen on the basis of those that could potentially be affected by the proposed development within the catchment and that may have direct or indirect impacts on the sensitive ecological receptors within the rivers and streams draining the River Strathy catchment. The identified sensitive ecological receptors within the drainage system are the fish and aquatic invertebrates which are reported on separately. The suite of determinands and sampling locations were agreed by SEPA on 23rd September 2009.

2. SCOPE OF THE REPORT

This report describes the results of the analysis of a range of physico-chemical parameters in water samples taken from a total of 12 sampling locations from the Strathy catchment, including the River Strathy, Yellowbog Burn, Allt nan Clach, Allt Dhònuill Ghuinne, Allt na Dubh-chlaise, Allt nan Sac and the Uair. Some initial sampling was carried out in 2007 and 2008 of the Yellowbog Burn, Allt nan Clach as well as the River Strathy as an initial screening of likely hydrochemical issues for both the Strathy North and Strathy South Windfarm developments. The majority of the data presented here is a product of the baseline monitoring for the Strathy North wind farm development. Sampling from the River Halladale, which is outside of the Strathy catchment, was included to provide a control that was unlikely to be affected by any forestry operations. There is a comprehensive set of baseline data on the hydrochemistry of the River Strathy upstream of any potential impact from the Strathy North development which is presented in this report.

3. METHODS

3.1 Site Description

The Strathy South development site is in an area of conifer plantation at the headwaters of the River Strathy that was planted during the 1980s on an area of former blanket bog and wet heath (Figure 1). The vast majority of the Strathy catchment has a covering of peat of varying depths, except for mineral soils in the flood-plains of the River Strathy, Yellowbog Burn and Allt nan Clach, and around the few exposures of bedrock on rocky knolls. The area is extensively grazed by red deer.

3.2 Sample locations

The locations where water samples were taken are shown in Figure 2 and the grid references are shown in Table 1. The sample from The Uair (U1) and the River Halladale (HAL1) at Forsinard were chosen as controls to assist in the assessment of water quality over time from the main sample locations that may or may not be affected by the felling of the forestry and construction of the wind farm. Sample locations were chosen on the following basis:

- at a sufficient distance downstream of confluences from major tributaries coming off the development area to allow for adequate mixing;
- safe access points where the river is sufficiently shallow to allow sampling in mid-stream at times of low to moderate flows;
- ease of access.

3.1 Sampling Frequency

Samples from most watercourses were first collected on 12th September, 3rd and 10th November 2007 to represent low, medium and high river flows, respectively. Samples were also collected from these same locations in April 2008 for the analysis of major plant nutrients. A full set of samples were taken from all locations, except for the Yellowbog Burn (YB1) and Allt nan Clach (ANC1), on a fortnightly basis between 26th September 2011 and 27th September 2012 (Table 1). This was done as part of the baseline monitoring for the Strathy North Wind Farm development. It was not possible to gain access to sites U1 and RSM6 to collect samples between 6th May and 17th July 2012, due to a landowner access permission issue, which was subsequently resolved.

3.3 Sample collection

Whole water samples were collected wherever possible in mid-stream, but during periods of moderate or high flows samples could only be collected from the bank of the River Strathy. Bottles and syringes were rinsed three times with the stream water before filling the sample in the bottle. Whole water samples were collected in 1 litre LDPE bottles. Fifty millilitre syringes were used to collect either 50 ml or 25 ml samples of water that were filtered through 0.45 µm filters into 60 ml or 30 ml polypropylene bottles. Clean/new syringes were used for each separate sample location and visit.

3.4 Field measurements

The pH of the stream or river water was measured *in situ* in the field with a combined pH and conductivity with temperature correction (either a Hanna HI 991300 or an Aqua Probe). The pH meter/conductivity meters were calibrated on the day with pH (7.01 and 4.01) and conductivity buffer solutions according to the manufacturer's instructions. These meters

have built in temperature compensation. The temperature of the water was also recorded at the time.

A check on the results from the Aqua Probe revealed consistently lower pH and conductivities than the laboratory analysis and the data from this probe were removed in the resultant analysis which meant that the pH from a total of 19 determinations on four sampling occasions between 11th October and 22nd November 2011 are not available.

3.5 Field observations

Any visible evidence of the presence of suspended solids, oil, smell of pollutants (e.g. phenol) or any other observations was recorded at the time of sample collection. If there was any detectable odour this was noted.

3.6 Sample transport and storage

Samples were placed in a refrigerated coolbox immediately on the return to the vehicle. At the end of the days sampling a 0.5 ml aliquot of Aristar concentrated nitric acid was added to each of the filtered 25 ml samples of water for metal analysis to preserve the sample and prevent precipitation of any metals with any potential flocculates or colloids that may form during transportation. Samples were transported to the laboratory the day after collection in the refrigerated coolbox. Samples were stored in a refrigerator at 4ºC in the laboratory prior to analysis.

3.7 Laboratory Analyses

The samples collected in 2007 were analysed by the Environment Agency's laboratories in Nottingham, whilst the samples collected in April 2008 were analysed by the Centre for Ecology and Hydrology (CeH) at their laboratories in Lancaster. Full details of the methods and detection limits are given in earlier reports (Grontmij 2007, Headley 2008).

The samples collected between 2011 and 2012 were analysed by the Institute of Aquaculture laboratories at the University of Stirling for the following physico-chemical variables or determinands:

- pH
- electrical conductivity
- alkalinity by Gran titration
- dissolved organic carbon (DOC)
- suspended solids (SS)
- turbidity
- ammonium-nitrogen (total)
- nitrate + nitrite nitrogen (TON)
- soluble reactive phosphate (SRP)
- dissolved and total calcium
- dissolved and total aluminium
- dissolved and total zinc

The pH, electrical conductivity, SS, DOC, ANC and turbidity were measured on the whole water samples within one or two days of delivery to the laboratory. The pH of the water was measured in the laboratory using a Mettler Toledo FE20 pH meter. The alkalinity was measured by Gran titration to a final pH of 3.5.

Ammonium-nitrogen was measured in the filtered water samples using the Berthelot reaction and the salicylate reagent variant on a Bran Luebbe autoanalyser. Sodium nitroprusside is used to enhance the sensitivity and the blue-green coloured complex was measured at a wavelength of 660 nm.

Nitrate and nitrite (oxidised-nitrogen) were measured together on a Bran Luebbe autoanalyser using a copper-cadmium redactor column to reduce the nitrate to nitrite and the combined quantities of nitrite reacted with sulphanilamide before complexing it with the azo-dye N-1 naphthylethylenediamine dihydrochloride.

The concentrations of dissolved orthophosphate were measured using the antimony-molybdate reaction with ascorbic acid as the reductant. The resultant colour was measured on a Cecil Aquarius 7000 Series spectrophotometer at a wavelength of 690 nm. The detection limit for this method is 1 µg P dm^{-3}.

Calcium, zinc and aluminium were measured on a Thermo Scientific X-series 2 ICP-MS on filtered acidified water samples (dissolved) and on whole water samples (total).

Acid Neutralising Capacity (ANC) of each sample of water was calculated from the Gran alkalinity, concentrations of total aluminium and DOC using the method of Neal *et al*. (1999). Calculating the ANC on the basis of charge balance from the major cations and anions was rejected as dissolved organic carbon is the predominant control on acidity and it has been shown to be more important in determining ANC in Finnish lakes where organic acids have a predominant effect on ANC (Mattsson *et al*. 1995).

3.8 Data analysis and Assessment

Standardised descriptive statistical analysis was used to calculate means, standard deviations, medians and percentiles. Conventional two-way (without replication) ANOVA was performed on the data if it is normally distributed. As appropriate, logarithmic transformations were carried out on data that was not normally distributed before any statistical tests were performed.

The quality of the water will be evaluated against the SEPA river classification criteria and the Water Quality Standards (statutory and guideline standards) for compliance with the EC Freshwater Fisheries Directive (Table 2).

4. RESULTS

4.1 Acidity (pH), alkalinity, dissolved organic carbon (DOC) and acid neutralising capacity (ANC)

The pH of the streams and rivers within the Strathy catchment are very variable between different sample dates (Table 18 and Figure 3), but there is little difference between sample locations in the range of the pH measured in the laboratory (Figure 5). The discharge in the streams and rivers exert a very significant influence on pH, but the relationship between the height of River Strathy at Strathy Bridge and pH of the particular watercourse within the Strathy catchment is of varying strength (Figure 4). The three control sample locations, RSM7, U1 and HAL1 have pH values in a very similar range to those from within the development area and have similar levels of variability (Figure 5).

The Imperative Standards for the protection of the most sensitive taxa within rivers (5th percentile) is not achieved for all of the sample locations within the Strathy catchment whether laboratory or field measurements of pH are used (Table 4). Except for sample location DCM1 on the Allt na Dubh-chlaise and the River Halladale, all of the other sample sites have Fair or Poor water quality based on the SEPA river classification using the 5th and 10th percentiles of pH (Tables 2 and 4). Given all of these watercourses are located within acidic catchments dominated by bog peat these low pH levels are not unexpected and are almost certainly naturally low.

The measurement of pH in the field is on average 0.31 units higher than the laboratory measurements and this difference is also statistically highly significant using a paired t-test (Table 5). The field measurements of pH recorded a much wider range of pH values and the inter-quartile range of the difference in the recorded values varied from 2.14 pH units lower in the field to 2.24 pH units higher in the field. For all but the Allt nan Sac samples, the field measurements of pH were on average higher than the laboratory measurements and this difference was statistically significant at seven of the eleven sample locations (Table 5).

As with pH, there is very little discernable difference in the alkalinity between sample locations, but the significant differences between sample dates is due to the variation in discharge of the watercourse which has a strong influence on titratable alkalinity (Tables 6 and 18). The acid neutralising capacity (ANC) of the watercourses is strongly linked to the titratable alkalinity of the samples as this is the most important determinant in the formula used to calculate ANC using the method of Neal *et al*. (1999). Therefore the ANC is strongly influenced by the discharge of the watercourse concerned (Figure 6 and Table 18). When there are high flows in the streams or rivers the ANC is always low, but it may be high or low during low or moderate flows (Figure 6). At low flows there appears to be two populations of data, one with ANC values below 0.5 meq L^{-1} and one where ANC values rise above 1 meq L^{-1} when the water level in the River Strathy at Strathy Bridge drops below about 0.3 metres (Figure 6). This suggests that there are probably two different sources of water to the streams and rivers at moderate to low flows irrespective of sample location.

The concentrations of dissolved organic carbon (DOC) also vary significantly between sample dates, but sample location has no statistically significant effect (Table 18). The highest concentrations were found in the samples collected in September and October 2011 and July 2012, whilst the lowest concentrations were found in January 2012. The highest average concentrations of DOC were in the samples from the Allt Dhònuill Ghuinne and the lowest average concentrations were found in the Halladale and also River Strathy at sample

location RSM7 (Table 8). The average concentrations are slightly higher than those observed in the nearby River Thurso (Anderson *et al*. 2010).

The acid neutralising capacity (ANC) was calculated to be above zero in all of the water samples collected (Table 17). The ANC approached zero during the highest flows in late December 2011 and early January 2012. During high flows the ANC remained above zero largely due to the high concentrations of DOC in the samples.

4.2 Electrical Conductivity

The electrical conductivities of the various watercourses measured are low and typical for those in an upland setting dominated by peaty soils with an underlying geology of hard igneous bedrock. Conductivities are typically between 66 and 169 µS cm^{-1} (Table 7). The Allt na Dubh-chlaise has the highest conductivities, suggesting that there is a greater supply of water from mineral enriched groundwaters in this burn than for the other watercourses (Figure 7).

4.3 Suspended solids, turbidity

The concentrations of suspended solids are low with concentrations being below 20 mg L^{-1} for at least 95% of the time (Table 3). Even at moderately high flows when the level of the River Strathy at Strathy Bridge was over 0.9 metres in mid-winter the mean concentration of suspended solids in the watercourses was on average 0.8 to 1.1 mg L^{-1} (Figure 8). On only two occasions did the concentrations of suspended solids rise significantly and this was at moderate to low flows when the level of the River Strathy at Strathy Bridge was around 0.38 to 0.44 metres (Figure 8). The concentrations of suspended solids were below the guideline maximum of 25 mg L^{-1} for the protection of salmonid rivers under the Freshwater Fisheries Directive in all but five of the 296 samples collected.

The field measurement of turbidity shows a highly significant correlation with the laboratory measurements of suspended solids (Figure 9). This suggests that the field measurement of turbidity can provide an early warning when concentrations of suspended solids start to rise above 10 mg L^{-1}.

4.4 Nutrients (ammonium, oxidised nitrogen, phosphate)

The mean concentrations of ammonium-nitrogen are all low and one to two orders of magnitude below the Imperative standard of 1 mg L^{-1} for the protection of salmonids under the Freshwater Fisheries Directive (Tables 2 and 11). These concentrations would mean that all watercourses sampled are of class A1 quality based on SEPA's criteria (Table 2).

The concentrations of oxidised-inorganic nitrogen, all most all being nitrate, are also low (Table 12) and are at the bottom end of the range of concentrations found in watercourses from Northern Scotland. These are some of the lowest concentrations of nitrate in rivers for the whole of Scotland (Anderson *et al*. 2010).

Concentrations of dissolved ortho-phosphate (SRP) were below the detection limit of 1 µg P L^{-1} in all but 14 samples (Table 13). Four of these samples were collected on 6th January 2012 when there were high flows in all the burns and rivers. These exceedingly low concentrations are to be expected as inorganic phosphate is rapidly taken-up by micro-organisms and plants. They are also all below the upper value for the highest water quality (A1 or Excellent) for rivers (Table 2).

4.5 Aluminium, Zinc and Calcium

The concentrations of dissolved aluminium were above the former EQS of 10 µg L^{-1} for this determinand in all samples that were taken from all locations (Table 15a). The mean concentrations were also above 100 µg L^{-1} at two of the sample locations and these were both on the Allt na Dubh-chlaise and they are significantly higher than those from any other sample locations (Table 15a and Figure 11).

The Imperative standard of 200 µg L^{-1} of zinc for the protection of salmonid rivers under the Freshwater Fisheries Directive was used because the hardness of the watercourses is between 10 and 50 mg $CaCO_3$ L^{-1} in over 50% of samples (Tables 2 and 3). The mean concentrations of total zinc are below this threshold at all sample locations (Table 16b). However, all of the sample locations, including the Halladale, had concentrations of dissolved zinc above 100 µg L^{-1} on at least one occasion (Table 16a). The concentrations of dissolved and total zinc vary very significantly between sample dates, but not between locations (Table 18). Peak concentrations occurred during high flows when the proportion of zinc in the particulate form (i.e. particles greater than 0.45 µm in diameter) was highest at 49 to 91% in early January 2012.

In contrast to zinc the concentrations of dissolved and total calcium were highest when flows in the River Strathy and the other watercourses were low, particularly in early November 2011, and early June and late August 2012. The concentrations of dissolved and total calcium do vary significantly between sample locations as well as between sampling dates (Table 18). The highest concentrations were found in the Allt na Dubh-chlaise and the lowest concentrations were in the Allt Dhònuill Ghuinne samples (Table 14). The concentrations of calcium correlate well with titratable alkalinity and electrical conductivity in the River Strathy and Halladale, but not in the Allt na Dubh-chlaise.

5. DISCUSSION

The results of the baseline monitoring cover at least a year for all but two sample locations. The maximum of 30 sampling occasions cover a wide range of flow conditions in the River Strathy and its tributaries when river levels were very low to being at the top end of Moderate flows according to the SEPA monitoring station at Strathy Bridge. As a consequence of these variations in flows there are a wide range of physico-chemical conditions. The most outstanding features of the hydrochemistry of the various watercourses are:

- the pH is highly variable between sample dates (4.5 to 6.9 on Allt na Dubh-chlaise) depending on the flow;
- there are naturally high concentrations of dissolved and total aluminium in all the watercourses sampled, but they are particularly high in the Allt na Dubh-chlaise where they often exceed 100 µg L^{-1};
- as with the aluminium there are significant levels of dissolved and total zinc in the rivers which increase during high flows; and
- the concentrations of major nutrients are very low or undetectable.

5.1 pH and ANC

The pH of the River Strathy and its tributaries are between 6.4 and 7.0 during low flows but they become more acidic as flows increase. This is not surprising as the more mineral rich and consequently higher pH water coming from the underlying bedrock will be quickly diluted and overwhelmed by surface runoff from the dominant highly acidic peats and peaty gleys of the catchment when there is any significant quantity of rain. Although much of the upper part of the catchment of the River Strathy drains from or through the Strathy South conifer plantation the pH of the waters in this watercourse is not significantly different from its tributaries. The few measurements taken from the Yellowbog Burn and Allt nan Clach show that the pH of these watercourses is in the same range as that of the River Strathy and its other tributaries (Table 4).

Despite the pH of the River Strathy falling below 5.0 on at least four out of the 29 sampling occasions there are healthy population of salmon and trout in these water courses. Even though there is very little ANC present in the water on these occasions when flows are relatively high in the River Strathy there is no evidence to suggest that the fish populations are severely affected by these conditions. This is possibly due to the moderately high concentrations of dissolved organic matter in the waters neutralising any toxins that are associated with acidic waters.

5.2 Field and Laboratory measurements of pH and electrical conductivity

The measurement of the pH of stream waters *in situ* gives a wider range of values than those measured in the laboratory. The laboratory measurements of pH are on average 0.32 of a pH unit lower, but the differences between the field and laboratory measurements of pH are highly variable. The maximum difference between the field and laboratory measurements of pH is 2.2 units. This large discrepancy is not likely to be due to poor calibration of the meter as the differences vary by different amounts and in different directions on the same day. On several occasions the differences in pH occurred when there were higher levels of turbidity measured in the laboratory than in the field and this was associated with higher levels of suspended solids than would normally have been expected. This might suggest that there was some change in chemistry of the samples during storage and transportation that resulted in some material precipitating out.

The laboratory measurements of electrical conductivity are on average 19 µS cm^{-1} higher than the field measurements. This again suggests that there has been some release of electrolytes between sample collection and analysis in the laboratories. This is despite all the samples being refrigerated between collection in the field and transportation to the laboratory there has probably been some decomposition of organic matter by psychrophilic micro-organisms or lysis of cells in the samples and consequent release of electrically charged ions (Gounot 1996). This would result in some cases a reduction in pH through the production of organic acids and the release of electrolytes resulting in a small increase in electrical conductivity. It is therefore suggested that field measurements of pH and conductivity are taken in conjunction with laboratory measurements of these same parameters.

5.3 Nutrients

The concentrations of all the nutrients are very low and in the majority of cases for SRP they are below the level of detection. On the basis of the concentration of nutrients the water quality in all the watercourses should be regarded as Excellent using SEPA's criteria. Unfortunately the naturally low pH values would reduce the classification of the watercourses to Fair. Although the measurement of total phosphorus is more likely to give detectable concentrations on each sampling occasion than the measurement of SRP it has been shown that the measurement of SRP is a better predictor than total phosphorus of carbon export from catchments affected by the Whitelee wind farm development near Glasgow (Waldron *et al*. 2009).

5.4 Aluminium

Although the concentrations of dissolved aluminium went above 100 µg L^{-1} on four occasions on the lower stretch of the River Strathy and were above this level on 18 of the 26 samples at location DCM2 on the Allt na Dubh-chlaise, it does not appear to have an adverse impact on breeding salmon and trout populations that are present in these same watercourses. This is almost certainly due to the aluminium being bound up as organo-aluminium complexes, even at pH values of less than 5.0 (Lien *et al*. 1996; Roy & Campbell 1997). Humic acids typically have cation exchange capacities of 1 meq g^{-1} whilst for *Sphagnum* peat they can be as high as 3 meq g^{-1}. This means that there is plenty of capacity in the DOC present in the waters to adsorb all of the dissolved aluminium measured in the samples by about 5 to 16 times. It therefore seems that in this river system that adsorption of aluminium to the high concentrations of organic acids coming from the surrounding peatlands is the most likely explanation for there being healthy populations of salmon and trout in the River Strathy and some of its tributaries despite there being moderately high concentrations of aluminium.

5.5 Zinc

Concentrations of total zinc exceeded the imperative standards for salmonid rivers (30 µg L^{-1}) at all sample locations in at least 25% of the samples that were taken (Table 16b). Some of the samples had concentrations well over 100 µg L^{-1}, but as with aluminium, much of this zinc may be in an unavailable form, i.e. forming organo-zinc chelates. Concentrations of zinc increased during periods of high flow which is when the acidity of the streams increased. This could be a result of an increased solubilisation of zinc from bedrocks enriched with zinc, such as granites which do occur in this catchment, as well as washing in of DOC with zinc attached or particulates containing zinc from the catchment (Aubert & Pinta 1977). Again the presence of healthy macroinvertebrate populations and breeding populations of trout and salmon suggest that the zinc is not having an adverse effect.

5.6 Monitoring suspended solids

The concentrations of suspended solids in the water courses remained low, even at moderately high flows and only exceeded the guideline standard of 25 mg l^{-1} in five out of the 296 samples analysed. On one of the occasions when there were particularly elevated concentrations of suspended solids it appears to be linked to the first heavy frosts and snow of the autumn. The other occasion was in late July and early August.

The measurement of turbidity in the field shows a positive and strong correlation with the laboratory measurements of suspended solids above concentrations of 5 mg l^{-1} (Figure 9) and it can therefore provide a rapid confirmation of potentially high concentrations of suspended solids in receiving waters at this remote location long before the results of laboratory analysis can be produced.

5.7 Control sites

This baseline monitoring demonstrates the comparability of the control sampling locations against which the other sampling locations can be compared. The control site on the Uair (U1) is the most similar in chemistry, especially for pH, to the Yellowbog Burn and Allt Dhònuill Ghuinne and where possible this control should also be retained for monitoring any potential changes in these watercourses. The control site on the River Halladale is the closest in composition to the Allt na Dubh-chlaise and should therefore be retained as a control for the Allt na Dubh-chlaise.

5.8 Monitoring frequency

The frequency of monitoring to date has been once every two weeks. It has included samples taken when flows were low to occasions when flows were moderately high. However, using the depth of the River Strathy at Strathy Bridge at the time of sampling as a guide to flows, the depth of the River Strathy varied between 0.21 and 0.93 m throughout the whole of the monitoring period. According to the SEPA website this covers the lower half of Moderate flows for this river.

From an examination of the data for individual determinands the samples appear to cover the full range of pH conditions one would normally expect to occur, with laboratory measurements ranging from 4.5 to 7.1 and field measurements varying from 3.9 to 7.9. It therefore seems plausible to suggest that an adequate range of conditions within the watercourses has largely been characterised by this baseline set of data. The Freshwater Fisheries Directive only requires the calculation of mean concentrations or other statistics on samples taken monthly over a year. Given this the baseline has more than adequately characterised the baseline hydrochemical conditions of the River Strathy against which any potential changes in chemistry that could arise from the proposed Strathy South Windfarm. Although there has been minimal sampling of the waters of the Allt nan Clach and Yellowbog Burn in the upper part of the Strathy catchment, they are not anticipated to differ much in their hydrochemistry from the other tributaries of the River Strathy.

5.9 Determination of aluminium toxicity

Assuming that the current populations of fish and macroinvertebrate in these watercourses are largely stable, and then the observed ranges of dissolved and total aluminium and zinc in the water samples are typical for the River Strathy and its tributaries and can therefore not be in a toxic form. The monitoring of the species of aluminium present in the waters will not prevent an acid flush from killing the populations of fish and macroinvertebrate populations and can

only provide a *post hoc* diagnosis of such an event. Therefore, appropriate felling and construction activities to prevent acidification events coupled with on site monitoring of pH to provide an early warning of such an event will provide the best approach to protecting the biota in the watercourses draining from the development site and into the River Strathy.

6. CONCLUSIONS

- There are very large fluctuations in pH between sampling occasions, which are almost certainly natural, reflecting the changes in the main source of water entering the watercourses.
- There are moderately high concentrations of DOC in all the watercourses.
- The majority of the significant quantities of aluminium and zinc in nearly all of the samples must be bound to the dissolved and/or particulate organic matter in the water.
- There are very low concentrations of inorganic nitrogen and SRP in all the samples.
- The calculated ANC levels are always positive, but close to zero during periods of high flow.
- The baseline set of data is considered to be more than adequate to characterise the hydrochemistry of the River Strathy that drains the whole of the proposed Strathy South Wind Farm site.
- The present suite of determinands is considered to be adequate to satisfy the water quality standards covered by the EC Freshwater Fisheries Directive and SEPAs monitoring requirements.

7. RECOMMENDATIONS

1. It is recommended that the control sampling location on the Uair is retained as it provides a more similar control for the Yellowbog Burn and Allt nan Clach for certain determinands than any of the other controls that are available.
2. The monitoring of pH, electrical conductivity and turbidity in the field should be continued as there are suspicions that some changes in the first two of these parameters occurs between sample collection and laboratory measurement despite the samples being refrigerated.
3. The measurement of turbidity in the field should also be continued as this provides an early warning of significant inputs of suspended solids into any of the receiving waters.
4. Sampling frequency should be reduced to once a month as the current set of data already provides a clear indication of the range in each of the physico-chemical variables in the River Strathy. Monthly sampling is also the recommended frequency under the EC Freshwater Fisheries Directive.

8. REFERENCES

Anderson, H., Futter, M., Oliver, I., Redshaw, J. & Harper, A. 2010. Trends in Scottish river water quality. Scottish Environment Protection Agency.

Aubert H. & Pinta M. 1977. Trace elements in soils. Elsevier, Amsterdam.

Gounot, A.-M. 1996. Psychrophilic and psychrotrophic microorganisms. *Cellular and Molecular Life Sciences* **42**: 1192-1197.

Headley, A.D. (2007). *Strathy Windfarm: Hydrochemical Interpretation and Recommendations*. Grontmij, Leeds.

Headley, A.D. (2008). *Proposed Windfarm at Strathy: Hydrochemical Interpretation and Recommendations for future Baseline Monitoring*. PlantEcol, Steeton.

Lien, L., Raddum, G.G., Fjellheim, A. & Henriksen, A.A. 1996. Critical limit for neutralising capacity in Norwegian surface waters, based on new analyses of fish and invertebrate responses. *Science of the Total Environment* **177**: 173 –193.

Mattsson, T., Kortelainen & David, M.B. 1995. Acid neutralizing capacity of solutions containing organic acids isolated from Finnish Lakes. *Water, Air and Soil Pollution* **85**: 505-510.

Neal, C., Reynolds, B. & Robson, A.J. (1999). Acid neutralisation capacity measurements within natural waters: towards a standardised approach. *The Science of the Total Environment* **243/244**: 233-241.

Roy, R.L. & Campbell, P.G.C. 1997. Decreased toxicity of aluminium to juvenile Atlantic salmon (*Salmo salar*) in acidic soft water containing natural organic matter: a test of the free-ion model. *Environmental Toxicology and Chemistry* **16**: 1962 –1969.

Waldron S., Flowers H., Arlaud C., Bryant C., and McFarlane S. 2009. The significance of organic carbon and nutrient export from peatland-dominated landscapes subject to disturbance, a stoichiometric perspective. *Biogeosciences* **6**: 363-374.

9. TABLES

Table 1. Grid references for the different sample locations and dates when samples were collected.

Watercourse	Code	Grid reference	Dates
River Strathy	RSM2	NC 83101 62414	12/09/07, 03/11/07, 10/11/07, 08/04/08, 25/04/08, 26/09/11, 11/10/11, 25/10/11, 08/11/11, 22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 09/05/12, 22/05/12, 06/05/12, 27/06/12, 17/06/12, 17/07/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
	RSM4	NC 82496 59528	
	RSM5	NC 82529 58149	26/09/11, 11/10/11, 25/10/11, 08/11/11, 22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 09/05/12, 22/05/12, 06/05/12, 27/06/12, 17/06/12, 17/07/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
	RSM6	NC 82040 56070	26/09/11, 11/10/11, 25/10/11, 08/11/11, 22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
	RSM7	NC 80951 55458	26/09/11, 11/10/11, 25/10/11, 08/11/11, 22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 09/05/12, 22/05/12, 06/05/12, 27/06/12, 17/06/12, 17/07/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
Allt Dhònuill Ghuinne	ADGM1	NC 80961 55499	
Allt na Dubh-chlaise	DCM1	NC 82458 60941	
	DCM2	NC 81387 59576	12/09/07, 03/11/07, 10/11/07, 08/04/08, 25/04/08, 26/09/11, 11/10/11, 25/10/11, 08/11/11,

Watercourse	Code	Grid reference	Dates
			22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 09/05/12, 22/05/12, 06/05/12, 27/06/12, 17/06/12, 17/07/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
Allt nan Sac	ANS1	NC 80329 58188	26/09/11, 11/10/11, 25/10/11, 08/11/11, 22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 09/05/12, 22/05/12, 06/05/12, 27/06/12, 17/06/12, 17/07/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
The Uair	U1	NC 82670 55970	12/09/07, 03/11/07, 10/11/07, 08/04/08, 25/04/08, 26/09/11, 11/10/11, 25/10/11, 08/11/11, 22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
River Halladale	HAL1	NC 89408 43496	26/09/11, 11/10/11, 25/10/11, 08/11/11, 22/11/11, 06/12/11, 20/12/11, 05/01/12, 17/01/12, 31/01/12, 16/02/12, 29/02/12, 13/03/12, 27/03/12, 11/04/12, 24/04/12, 09/05/12, 22/05/12, 06/05/12, 27/06/12, 17/06/12, 17/07/12, 31/07/12, 14/08/12, 29/08/12, 12/09/12, 27/09/12
Allt nan Clach	ANC1		12/09/07, 03/11/07, 10/11/07, 08/04/08, 25/04/08
YellowBog Burn	YB1		

Table 2. Relevant Imperative (I) and Guideline (G) water quality standards for the EU Freshwater Fisheries Directive and the Scottish Environment Protection Agencies (SEPA) classification of water quality in river ecosystems.

Parameter	EC Freshwater Fisheries Directive	SEPA river classification	
		Class	Threshold
Ammonium (total) (I)	For salmonid rivers ≤ 1 mg N l^{-1}	A1	90th %tile ≤ 0.25 mg N L^{-1}
		A2	90th %tile ≤ 0.6 mg N L^{-1}
		B	90th %tile ≤ 1.3 mg N l^{-1}
		C	90th %tile ≤ 9.0 mg N l^{-1}
		D	90th %tile > 9.0 mg N l^{-1}
Biochemical Oxygen Demand (BOD)		A1	90th %tile ≤ 2.5 mg l^{-1}
		A2	90th %tile ≤ 4 mg l^{-1}
		B	90th %tile ≤ 6 mg l^{-1}
		C	90th %tile ≤ 15 mg l^{-1}
		D	90th %tile > 15 mg l^{-1}
Dissolved Oxygen (DO) (I)	For salmonid rivers 50th percentile >9 mg l^{-1}	A1	10th %tile ≥ 80 mg l^{-1}
		A2	10th %tile ≥ 70 mg l^{-1}
		B	10th %tile ≥ 60 mg l^{-1}
		C	10th %tile ≥ 20 mg l^{-1}
		D	10th %tile < 20 mg l^{-1}
Iron		A1 & A2	Mean ≤ 1 mg l^{-1}
		B	Mean ≤ 2 mg l^{-1}
		C & D	Mean > 2 mg l^{-1}
Nitrate			≤ 6.8 mg N l^{-1}
pH (I)	5th percentile ≥ 6.0 and 95th percentile ≤ 9.0	A1	5th percentile ≥ 6.0
		A2	10th percentile ≥ 5.2
		B	10th percentile < 5.2
Soluble reactive phosphate		A1	≤ 20 µg P l^{-1}
		A2	≤ 100 µg P l^{-1}
		B, C & D	> 100 µg P l^{-1}
Suspended solids (G)	Maximum 25 mg l^{-1}		
Temperature (I)	Maximum 21.5 ºC at monitoring site (salmonid rivers)		
	Maximum 10.0 ºC during breeding season (salmonid rivers)		
Zinc (total) (I)	≤ 30 µg l^{-1} for water hardness 0 to 10 mg $CaCO_3$ L^{-1} ≤ 200 µg l^{-1} for water hardness 10 to 50 mg $CaCO_3$ L^{-1}		

Table 3. Summary statistics for the various determinands measured in all the water samples taken between 26th September 2011 and 27th September 2012. Cells highlighted in pink exceed Imperative or Guideline standards for protection of Salmonid rivers of particular concern. Cells highlighted in green are within the limits used by SEPA for rivers with class A1 (Excellent) water quality.

Determinand	units	Location/ Fraction	Number of samples analysed		Statistic								
			Total	below detection limit	minimum	5%tile	25%tile	median	mean	s.d.	75%tile	95%tile	maximum
Temperature	ºC	Field	272	0	0.2	0.8	6.1	8.2	8.0	4.2	10.8	14.4	20.1
Acidity	pH	Field	254	0	3.93	4.26	5.81	6.64	6.32	0.96	6.91	7.45	7.94
		Laboratory	296	0	4.15	4.66	5.5	6.14	5.9	0.69	6.41	6.92	7.22
Conductivity	µS cm^{-1}	Field	254	0	6	32	67	86	92	43	118	164	253
		Laboratory	296	0	49	62	85	99	110	37	130	183	240
Gran Alkalinity	meq L^{-1}	Laboratory	277	0	0.01	0.03	0.10	0.33	0.7	0.95	1.00	2.64	6.00
	mg $CaCO_3$ L^{-1}	Laboratory	281	0	0.5	1.5	5.0	16.5	35.4	46.6	47.0	131.1	367.7
Dissolved Organic Carbon	mg L^{-1}	Laboratory	285	0	4.01	6.32	9.10	12.96	14.00	6.22	18.37	25.96	36.39
Turbidity	FTU/NTU	Field	263	158	below detection limit				1.10	3.55	0.70	5.09	31.83
		Laboratory	264	0	0.20	0.64	1.04	1.43	2.90	4.80	2.71	8.71	43.49
Suspended solids	mg L^{-1}	Laboratory	281	0	0.2	0.4	1.0	2.0	3.5	5.3	3.6	13.2	44.2

Table 3. continued.

Determinand	Units	Location/ Fraction	Number of samples analysed		Statistic							
			Total	below detection limit	minimum	25%tile	median	mean	s.d.	75%tile	95%tile	maximum
Ammonium-Nitrogen	µg L^{-1}	Laboratory	282	0	1.0	2.5	8.9	25.6	47.2	22.6	111.1	287.3
Oxidised inorganic-Nitrogen	µg L^{-1}	Laboratory	289	0	1.1	10.6	16.6	23.1	18.5	29.0	63.8	85.4
Total Inorganic - N	µg L^{-1}	Laboratory	275	0	4.4	19.2	29.3	48.7	58.6	50.7	157.5	363.1
Soluble Reactive Phosphate	µg L^{-1}	Laboratory	290	276	below detection limit				NA	below detection limit		27
Calcium	mg L^{-1}	Dissolved	276	0	0.683	1.69	2.295	2.6	1.217	3.344	4.885	6.584
		Particulate	268	0	0.001	0.092	0.166	0.244	0.232	0.303	0.738	1.208
		Total	295	0	0.805	1.876	2.558	2.8	1.302	3.676	5.193	6.927
Aluminium	µg L^{-1}	Dissolved	276	0	11.0	44.1	60.1	75.6	56.6	87.2	189.9	358.6
		Particulate	266	0	0.3	4.9	8.1	13.3	16.3	14.8	40.8	128.1
		Total	309	0	12.9	48.3	73.8	88.1	64.4	104	226.8	380.3
Zinc	µg L^{-1}	Dissolved	276	0	1.1	4.4	7.0	17.2	23.4	23.4	71.9	147.5
		Particulate	263	0	0.03	1.7	4.1	10.6	13.9	13.0	42.3	67.3
		Total	294	0	1.1	6.8	11.1	25.9	32.6	37.7	91.6	188.9

Table 4. Descriptive statistics of the results of laboratory analysis (a) and field determination (b) of pH by sample location. Values highlighted in pink are below the A1 Environmental Quality Standard (EQS). Sample locations highlighted in yellow are control sites.

(a)

Location	minimum	5%tile	10%tile	median	mean	s.d.	75%tile	maximum
YB1	4.15				5.38			7.06
ANC1	4.30				5.52			6.73
ADGM1	4.61	4.63	4.74	6.00	5.75	0.67	6.19	6.94
ANS1	4.60	4.86	5.49	6.23	6.18	0.65	6.65	7.11
DCM1	4.87	5.00	4.88	6.20	6.10	0.52	6.38	6.98
DCM2	4.53	4.70	4.83	6.06	5.87	0.68	6.39	6.91
RSM2	4.61	4.70	4.76	6.14	5.99	0.71	6.48	7.22
RSM4	4.49	4.81	4.84	6.12	5.94	0.68	6.41	7.07
RSM5	4.69	4.83	4.89	6.13	5.95	0.62	6.40	6.98
RSM6	4.51	4.86	4.73	6.12	5.95	0.70	6.40	7.00
RSM7	4.66	4.72	4.77	6.18	5.96	0.70	6.44	7.04
U1	4.32	4.63	4.73	6.00	5.79	0.79	6.35	6.93
HAL1	4.66	5.03	4.95	6.21	6.07	0.59	6.47	6.86

(b)

Location	Minimum	5%tile	10%tile	median	mean	s.d.	75%tile	maximum
ADGM1	4.04	4.13	4.49	6.41	6.02	0.99	6.82	7.18
ANS1	4.08	4.11	4.34	6.37	6.15	1.01	6.87	7.31
DCM1	4.10	4.37	5.43	6.64	6.32	0.83	6.86	7.25
DCM2	3.93	4.00	4.32	6.23	5.94	1.04	6.79	7.29
RSM2	4.22	4.33	4.92	6.83	6.37	0.96	6.91	7.80
RSM4	4.28	4.65	5.02	6.73	6.38	0.91	6.97	7.50
RSM5	4.14	4.33	4.67	6.35	6.11	0.97	6.89	7.34
RSM6	4.25	4.50	5.21	6.87	6.50	0.97	7.22	7.60
RSM7	4.23	4.49	4.87	6.59	6.38	0.99	7.10	7.64
U1	3.93	4.28	4.76	6.87	6.43	1.01	6.99	7.47
HAL1	4.69	5.38	5.94	6.92	6.88	0.74	7.36	7.94

Table 5. Differences in pH between field and laboratory on the same samples. Negative values indicate pH values measured in the field are lower than laboratory measurements, whilst positive values indicate that field measurements are higher than laboratory measurements.

Location	Number (n)	Mean difference	s.d. of difference	Range in difference		Paired t-test	
				minimum	Maximum	Z	P
ADGM1	26	0.20	0.64	-1.14	1.61	1.553	0.133
ANS1	26	-0.04	0.87	-2.14	2.05	0.222	0.826
DCM1	26	0.27	0.44	-0.77	1.20	3.152	0.004
DCM2	26	0.05	0.57	-1.22	0.99	0.467	0.645
RSM2	26	0.39	0.67	-0.82	1.93	2.952	0.007
RSM4	26	0.43	0.59	-0.55	2.05	3.710	0.001
RSM5	26	0.13	0.60	-1.70	0.91	1.076	0.292
RSM6	20	0.47	0.65	-0.52	2.03	3.261	0.004
RSM7	26	0.37	0.72	-0.88	2.24	2.596	0.016
U1	20	0.49	0.89	-1.14	2.09	2.455	0.024
HAL1	26	0.81	0.55	0.00	1.87	7.546	<0.001
All samples	274	0.32	0.69	-0.10	0.72	7.631	<0.001

Table 6. Descriptive statistics of the results of laboratory measurement of Gran alkalinity (mg $CaCO_3$ L^{-1}) arranged by sample location. Sample locations highlighted in yellow are control sites.

Location	number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	3	<15		<15				19.3
ANC1	3	<15		<15				17.7
ADGM1	26	0.6	2.9	7.9	22.8	28.7	27.5	104.1
ANS1	26	1.0	6.7	19.8	41.8	50.9	56.8	196.7
DCM1	26	2.5	6.3	16.0	36.2	39.1	60.3	126.1
DCM2	26	1.1	5.4	16.8	37.1	45.2	55.4	170.6
RSM2	27	1.5	6.2	18.0	32.4	37.9	44.5	136.1
RSM4	26	0.9	5.1	14.7	30.8	39.3	35.3	141.1
RSM5	26	1.0	5.1	13.6	29.2	36.3	38.0	131.1
RSM6	20	1.0	8.0	17.5	36.4	41.7	44.2	144.1
RSM7	26	0.5	6.0	18.0	35.1	42.8	40.0	162.6
U1	23	0.6	3.6	16.5	35.5	44.2	50.3	156.6
HAL1	26	2.0	5.1	20.5	58.4	86.1	88.5	367.7

Table 7. Descriptive statistics of the results of laboratory measurement of electrical conductivity (µS cm^{-1}) arranged by sample location. Sample locations highlighted in yellow are control sites.

Location	number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	3	77.3		109				224
ANC1	3	84.2		111				194
ADGM1	26	51.1	89.0	97.9	101.3	21.5	111.6	150.3
ANS1	26	66.2	95.1	128.9	122.6	31.4	142.1	183.3
DCM1	26	55.5	138.5	160.1	154.2	32.5	168.0	222.0
DCM2	28	70.9	130.6	160.3	155.0	36.2	169.3	240.0
RSM2	29	54.4	87.5	99.4	104.0	30.3	116.2	200.0
RSM4	29	56.4	83.6	89.9	98.3	28.6	112.5	204.0
RSM5	26	55.3	84.6	94.2	94.9	21.1	104.6	143.9
RSM6	20	68.7	87.8	95.9	97.7	16.7	105.4	139.3
RSM7	26	59.8	87.2	94.4	95.4	20.8	104.0	144.6
U1	23	59.6	76.9	88.3	94.5	30.8	102.2	204.0
HAL1	26	49.1	66.1	83.1	83.6	21.7	96.5	122.0

Table 8. Descriptive statistics of the dissolved organic carbon (DOC) concentrations (mg l^{-1}) at each sample location. Sample locations highlighted in yellow are control sites.

Location	n	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	3	11.3		19.9				23.1
ANC1	3	9.58		15.4				16.6
ADGM1	25	7.81	10.03	16.15	16.01	6.96	19.71	36.39
ANS1	25	4.48	8.79	14.88	14.94	6.76	19.99	27.65
DCM1	25	5.69	9.97	12.57	13.47	5.18	16.46	27.29
DCM2	27	5.14	9.85	16.58	16.10	7.37	20.40	31.04
RSM2	28	6.32	9.12	12.70	13.28	5.45	17.20	25.00
RSM4	28	7.13	8.96	13.02	13.67	5.44	17.76	24.72
RSM5	25	6.89	8.47	12.90	13.33	5.27	17.23	22.95
RSM6	19	6.34	8.56	12.92	12.41	5.13	14.52	28.38
RSM7	25	5.68	8.66	12.74	12.66	4.72	15.51	24.18
U1	22	5.96	9.14	13.2	13.76	7.01	15.46	28.84
HAL1	25	4.01	7.03	10.97	12.58	6.69	15.60	27.26

Table 9. Descriptive statistics of the concentrations of suspended solids (mg l^{-1}) arranged by sampling date and sample location. Sample locations highlighted in yellow are control sites.

Location	n	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	3	<3		<3				6
ANC1	3	<3		<3				6
ADGM1	26	0.6	1.5	2.2	3.6	3.9	3.5	15.6
ANS1	26	0.4	1.2	2.8	3.6	2.9	5.5	11.0
DCM1	26	0.4	1.1	2.1	3.2	4.5	2.4	22.4
DCM2	27	0.4	0.8	2.2	4.5	7.4	4.5	44.2
RSM2	28	0.4	1.4	2.3	3.5	4.5	3.8	23.0
RSM4	26	0.4	1.0	2.0	3.6	5.6	2.7	25.4
RSM5	26	0.6	1.4	2.1	3.8	5.7	2.9	24.5
RSM6	20	0.8	1.0	1.8	4.0	6.4	3.2	27.0
RSM7	26	0.2	1.1	1.6	3.2	6.3	2.2	32.6
U1	23	0.5	0.8	2.0	4.1	6.4	4.0	27.5
HAL1	26	0.2	0.6	1.0	1.7	2.0	1.6	10.0

Table 10. Descriptive statistics of the results of laboratory measurement of turbidity (NTU/FTU) arranged by sampling date and sample location. Sample locations highlighted in yellow are control sites.

Location	n	minimum	25%tile	median	mean	s.d.	75%tile	maximum
ADGM1	25	0.47	1.01	2.00	3.00	3.79	3.18	19.52
ANS1	25	0.47	1.10	1.69	3.53	2.85	5.56	9.71
DCM1	24	0.85	1.02	1.42	2.35	2.58	2.26	11.87
DCM2	25	0.47	1.08	1.69	3.95	6.52	4.16	26.97
RSM2	25	0.67	0.95	1.20	2.31	3.71	1.69	18.84
RSM4	25	0.64	1.14	1.34	2.78	4.66	1.94	22.99
RSM5	25	0.50	1.04	1.35	2.57	4.33	1.98	22.17
RSM6	19	0.79	1.07	1.66	3.41	5.81	2.92	26.50
RSM7	25	0.67	1.17	1.50	3.44	8.39	2.42	43.49
U1	19	0.43	1.04	1.79	3.90	5.71	3.99	24.16
HAL1	25	0.20	0.70	1.03	1.17	0.74	1.30	3.72

Table 11. Descriptive statistics of the ammonium-nitrogen concentrations (µg N l^{-1}) arranged by sampling date and sample location. Sample locations highlighted in yellow are control sites.

Location	number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	2	<10						16
ANC1	2	<10						40
ADGM1	26	1.0	6.6	13.8	37.2	69.2	27.0	277.7
ANS1	26	1.9	4.2	9.3	16.9	19.3	23.3	71.7
DCM1	26	2.1	7.1	9.2	25.9	56.6	15.7	287.3
DCM2	27	2.0	3.9	9.2	25.1	43.0	22.4	212.2
RSM2	27	1.7	3.1	5.2	20.5	38.3	14.8	178.3
RSM4	27	2.0	3.7	6.0	26.6	57.7	18.0	258.8
RSM5	26	2.7	4.0	8.6	27.8	53.9	19.6	241.0
RSM6	20	1.8	4.3	6.6	19.4	31.4	18.9	111.5
RSM7	26	2.5	4.4	8.0	25.8	39.1	26.2	151.2
U1	22	2.0	5.3	12.9	18.8	16.6	23.7	50.6
HAL1	26	2.5	4.2	8.0	35.3	63.8	27.0	240.7

Table 12. Descriptive statistics of the oxidised-nitrogen (nitrate + nitrite) concentrations (µg N L^{-1}) arranged by sample location. Sample locations highlighted in yellow are control sites.

Location	number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	2	4						14
ANC1	2	27						39
ADGM1	26	2.0	11.6	16.8	23.4	20.2	24.5	85.4
ANS1	26	4.2	12.3	21.0	25.6	18.4	33.3	70.6
DCM1	26	1.1	14.2	39.0	35.6	23.6	54.7	83.7
DCM2	28	2.9	13.5	20.6	28.4	21.9	34.5	80.3
RSM2	28	2.7	10.6	19.3	23.4	19.2	26.9	84.1
RSM4	28	2.0	8.3	13.8	19.3	16.1	24.1	66.1
RSM5	26	1.5	8.3	14.3	18.3	14.6	25.1	60.0
RSM6	20	2.4	9.7	15.4	17.5	12.5	24.0	46.9
RSM7	26	3.1	10.8	13.3	22.9	19.1	30.3	72.2
U1	22	2.0	9.0	15.5	20.1	16.6	27.2	70.5
HAL1	26	1.1	9.3	17.0	18.2	12.9	24.0	51.9

Table 13. Descriptive statistics of the soluble reactive orthophosphate (SRP) concentrations (µg P L^{-1}) in all samples. Sample locations highlighted in yellow are control sites.

Location	Number of samples below detection limit	Dates when SRP concentrations were above detection limit	Concentration/s
YB1	0	8/4/08 25/4/08	19, 27
ANC1	0	8/4/08 25/4/08	6, 7
ADGM1	25	6/1/12	12.7
ANS1	23	17/1/12 27/3/12 11/4/12	5.04, 3.76, 5.0
DCM1	26	none	
DCM2	28	25/04/08	6.0
RSM2	28	25/04/08	6.0
RSM4	28	none	
RSM5	26	none	
RSM6	19	6/1/12	4.4
RSM7	25	6/1/12	3.1
U1	20	6/1/12 25/04/08	13.3, 6.0
HAL1	26	none	

Table 14. Descriptive statistics of the dissolved (a) and total (b) calcium concentrations (mg L^{-1}) arranged by sample location. Sample locations highlighted in yellow are control sites.

(a)

Location	Number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
ADGM1	26	0.922	1.362	1.770	1.878	0.700	2.165	3.650
ANS1	26	1.141	2.001	2.819	3.012	1.442	3.757	6.169
DCM1	26	1.938	2.629	3.219	3.317	0.902	4.017	5.322
DCM2	26	1.693	2.534	3.727	3.734	1.350	4.589	6.377
RSM2	26	0.972	1.648	2.271	2.438	1.014	2.934	5.031
RSM4	26	1.162	1.757	2.101	2.293	0.821	2.704	4.162
RSM5	26	0.910	1.534	2.073	2.191	0.901	2.600	4.521
RSM6	20	1.054	1.732	2.070	2.520	1.067	3.096	4.880
RSM7	26	1.003	1.595	2.234	2.553	1.312	3.233	6.584
U1	20	0.683	1.130	1.878	2.100	1.219	2.473	5.608
HAL1	26	0.906	1.474	2.295	2.516	1.246	3.212	5.279

(b)

Location	Number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	3	1.44		3.10				6.00
ANC1	3	2.21		2.88				5.53
ADGM1	26	1.03	1.51	1.88	2.06	0.75	2.29	4.12
ANS1	26	1.33	2.21	3.05	3.29	1.44	3.98	6.43
DCM1	26	2.27	2.94	3.57	3.63	0.92	4.14	5.68
DCM2	28	1.80	2.77	3.85	3.95	1.45	4.97	6.74
RSM2	29	0.98	2.00	2.50	2.74	1.14	3.30	5.14
RSM4	29	1.20	1.88	2.23	2.51	1.00	2.88	5.09
RSM5	26	1.09	1.71	2.13	2.36	0.96	2.71	4.60
RSM6	20	1.10	1.75	2.33	2.69	1.11	3.31	4.99
RSM7	26	1.03	1.70	2.43	2.77	1.42	3.32	6.93
U1	23	0.81	1.33	2.30	2.36	1.27	2.65	5.80
HAL1	26	1.08	1.68	2.50	2.76	1.34	3.42	5.75

Table 15. Descriptive statistics of the dissolved (a) and total (b) aluminium concentrations (µg L^{-1}) arranged by sample location. Sample locations highlighted in yellow are control sites.

(a)

Location	Number	minimum	25%tile	median	mean	s.d.	75%tile	Maximum
ADGM1	26	18.4	37.6	46.3	46.9	13.9	56.6	70.9
ANS1	26	11.6	35.3	51.3	47.8	19.7	60.3	87.4
DCM1	26	33.3	70.9	117.2	133.0	81.2	171.1	349.5
DCM2	26	29.0	82.4	139.5	156.4	93.9	234.1	358.6
RSM2	26	26.0	52.0	64.8	68.3	26.0	85.2	130.3
RSM4	26	25.3	51.4	53.9	68.3	29.0	83.6	137.8
RSM5	26	21.9	48.4	56.9	58.6	20.5	68.8	107.4
RSM6	20	17.2	36.5	47.9	52.0	22.7	64.2	115.3
RSM7	26	11.0	28.2	48.4	49.3	23.8	69.4	98.2
U1	20	20.0	33.0	49.2	51.3	23.6	66.8	116.0
HAL1	26	16.5	49.1	87.7	86.6	42.5	103.9	176.2

(b)

Location	Number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	5	22.4	77.1	94.7	89.0	43.7	112	139
ANC1	5	20.3	48.1	59.4	67.2	38.5	87.1	121
ADGM1	26	22.5	41.1	55.8	55.2	20.1	66.8	108.3
ANS1	26	12.9	43.1	61.2	56.9	23.0	75.2	96.4
DCM1	26	38.7	84.0	138.8	156.4	95.7	196.2	380.3
DCM2	30	36.0	89.7	181.2	178.0	103.7	250.0	370.0
RSM2	30	15.4	61.8	77.9	81.6	37.4	107.0	187.1
RSM4	31	26.1	58.8	77.7	77.1	30.7	98.9	145.2
RSM5	26	29.6	52.7	66.8	68.5	25.7	84.6	132.4
RSM6	20	19.1	42.3	55.8	59.7	25.3	75.8	122.9
RSM7	26	16.4	32.8	64.2	60.4	30.4	79.9	138.8
U1	25	22.5	35.7	53.1	63.2	30.9	79.8	127.0
HAL1	26	19.1	54.9	97.5	98.2	47.8	136.0	192.0

Table 16. Descriptive statistics of the dissolved (a) and total (b) zinc concentrations (µg l^{-1}) arranged by sample location. Sample locations highlighted in yellow are control sites.

(a)

Location	number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
ADGM1	26	2.22	6.41	12.77	25.82	32.04	34.28	150.62
ANS1	26	3.79	7.81	10.69	24.27	27.66	34.50	108.52
DCM1	26	3.24	8.34	10.61	29.75	39.35	38.55	160.77
DCM2	26	1.24	7.03	11.39	27.37	38.62	37.23	188.94
RSM2	26	3.14	9.41	11.41	27.33	34.99	37.81	174.66
RSM4	26	1.44	9.83	11.87	29.39	34.94	33.85	120.80
RSM5	26	2.99	7.25	10.79	26.06	28.38	44.10	119.00
RSM6	20	1.90	5.96	13.05	31.17	38.18	44.42	158.88
RSM7	26	1.88	6.75	11.49	26.34	33.48	37.12	150.06
U1	20	3.05	8.12	15.56	29.57	34.75	40.82	147.41
HAL1	26	2.50	7.58	11.00	24.92	28.46	36.46	130.52

(b)

Location	Number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
YB1	5	<5	<5	1.1			5.7	6.09
ANC1	5	<5	<5	1.7			5.47	6.7
ADGM1	26	2.22	6.41	12.77	25.82	32.04	34.28	150.62
ANS1	26	3.79	7.81	10.69	24.27	27.66	34.50	108.52
DCM1	26	3.24	8.34	10.61	29.75	39.35	38.55	160.77
DCM2	28	1.24	7.01	11.39	26.02	37.51	34.88	188.94
RSM2	28	3.14	8.01	11.24	25.94	34.05	37.60	174.66
RSM4	29	1.44	6.35	10.61	26.84	33.91	33.70	120.80
RSM5	26	2.99	7.25	10.79	26.06	28.38	44.10	119.00
RSM6	20	1.90	5.96	13.05	31.17	38.18	44.42	158.88
RSM7	26	1.88	6.75	11.49	26.34	33.48	37.12	150.06
U1	23	3.05	6.96	13.94	27.50	33.73	39.65	147.41
HAL1	26	2.50	7.58	11.00	24.92	28.46	36.46	130.52

Table 17. The summary statistics describing the results of calculating the Acid Neutralising Capacity (mequivalents L^{-1}) using the method of Neal *et al*. (1999) for water samples taken from each site.

Location	Number	minimum	25%tile	median	mean	s.d.	75%tile	maximum
ADGM1	25	0.08	0.17	0.25	0.54	0.56	0.59	2.09
ANS1	25	0.11	0.25	0.50	0.92	0.99	1.20	3.89
DCM1	25	0.09	0.20	0.36	0.78	0.77	1.31	2.50
DCM2	25	0.10	0.21	0.41	0.81	0.88	1.17	3.38
RSM2	25	0.08	0.20	0.38	0.72	0.75	0.95	2.72
RSM4	25	0.07	0.19	0.39	0.69	0.77	0.73	2.82
RSM5	25	0.07	0.19	0.34	0.65	0.71	0.79	2.62
RSM6	19	0.07	0.30	0.39	0.80	0.82	1.04	2.87
RSM7	25	0.08	0.21	0.42	0.77	0.84	0.82	3.22
U1	19	0.07	0.24	0.40	0.79	0.87	1.10	3.12
HAL1	25	0.08	0.23	0.47	1.16	1.43	1.78	5.27

Table 18. The results of one-way analyses of variance on the effect of sample location or date on each of the determinands. Abbreviations: Fvar = variance ratio; d.f. = degrees of freedom; P = probability. Cells highlighted in yellow indicate statistically significant results.

Determinand	Sample location			Sampling Date		
	Fvar	d.f.	P	Fvar	d.f.	P
pH	0.864	10/263	0.567	6.309	25/251	<0.001
Conductivity	19.322	10/263	<0.001	6.208	25/251	<0.001
Alkalinity	0.934	10/263	0.502	39.911	25/251	<0.001
Suspended Solids	1.380	10/263	0.189	27.826	25/251	<0.001
Dissolved Organic Carbon	0.822	10/252	0.608	12.982	25/240	<0.001
Turbidity	2.110	10/252	0.024	22.636	25/239	<0.001
Ammoniacal-nitrogen	0.515	10/262	0.879	24.351	25/250	<0.001
Nitrate-nitrogen	1.579	10/262	0.113	7.841	25/250	<0.001
Dissolved Reactive Phosphate	Not applicable as too few results above detection limit					
Dissolved aluminium	13.531	10/263	<0.001	3.030	25/251	<0.001
Total aluminium	11.846	10/263	<0.001	3.569	25/251	<0.001
Dissolved calcium	6.191	10/263	<0.001	18.009	25/251	<0.001
Total calcium	6.652	10/263	<0.001	18.100	25/251	<0.001
Dissolved zinc	0.178	10/263	0.998	62.644	25/251	<0.001
Total zinc	0.082	10/263	1.000	91.875	25/251	<0.001
Acid Neutralising Capacity	0.791	10/263	0.637	50.877	25/240	<0.001

10. FIGURES

Figure 1. Map showing the location of the Strathy South Wind Farm development in northern Scotland.

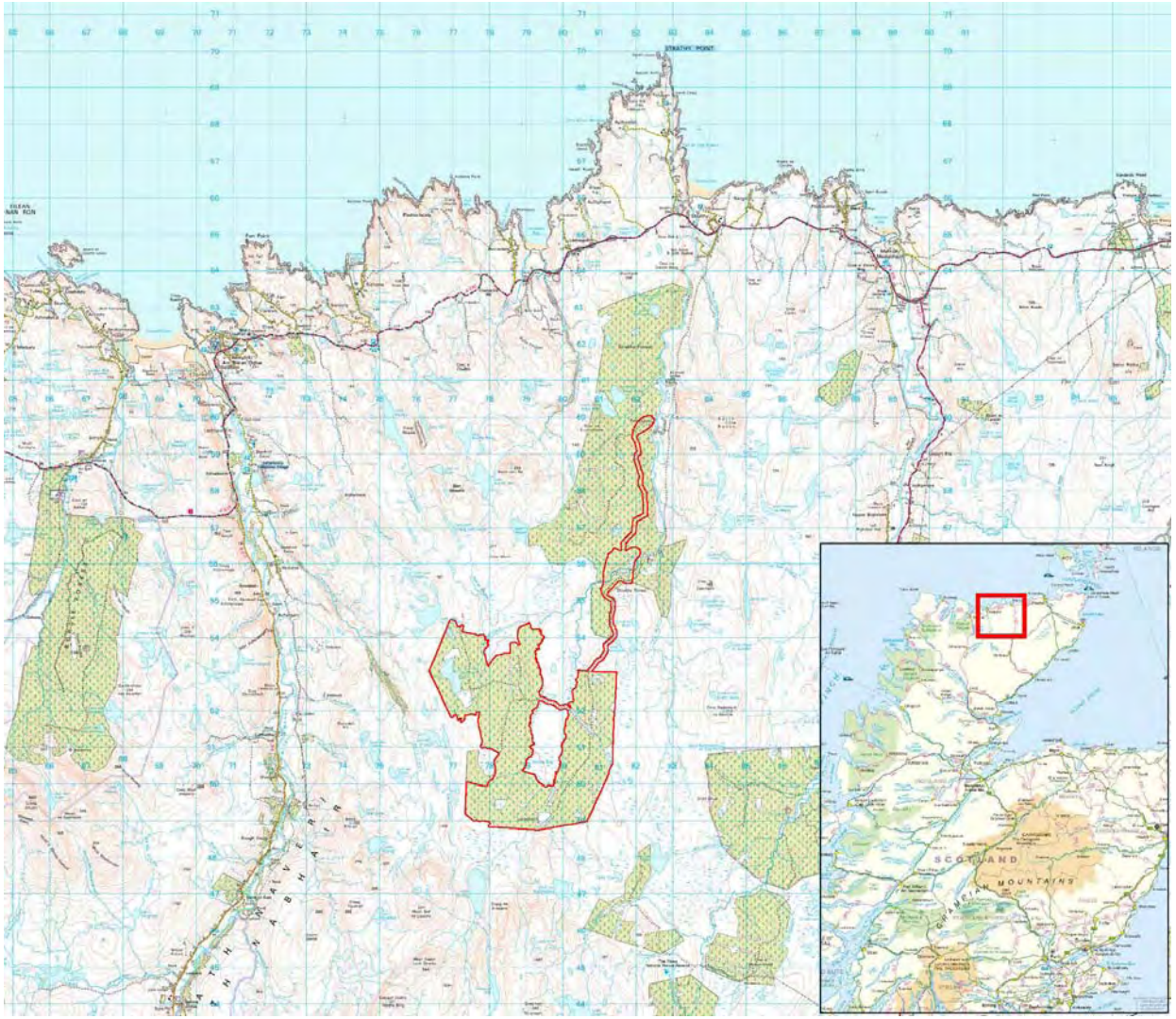
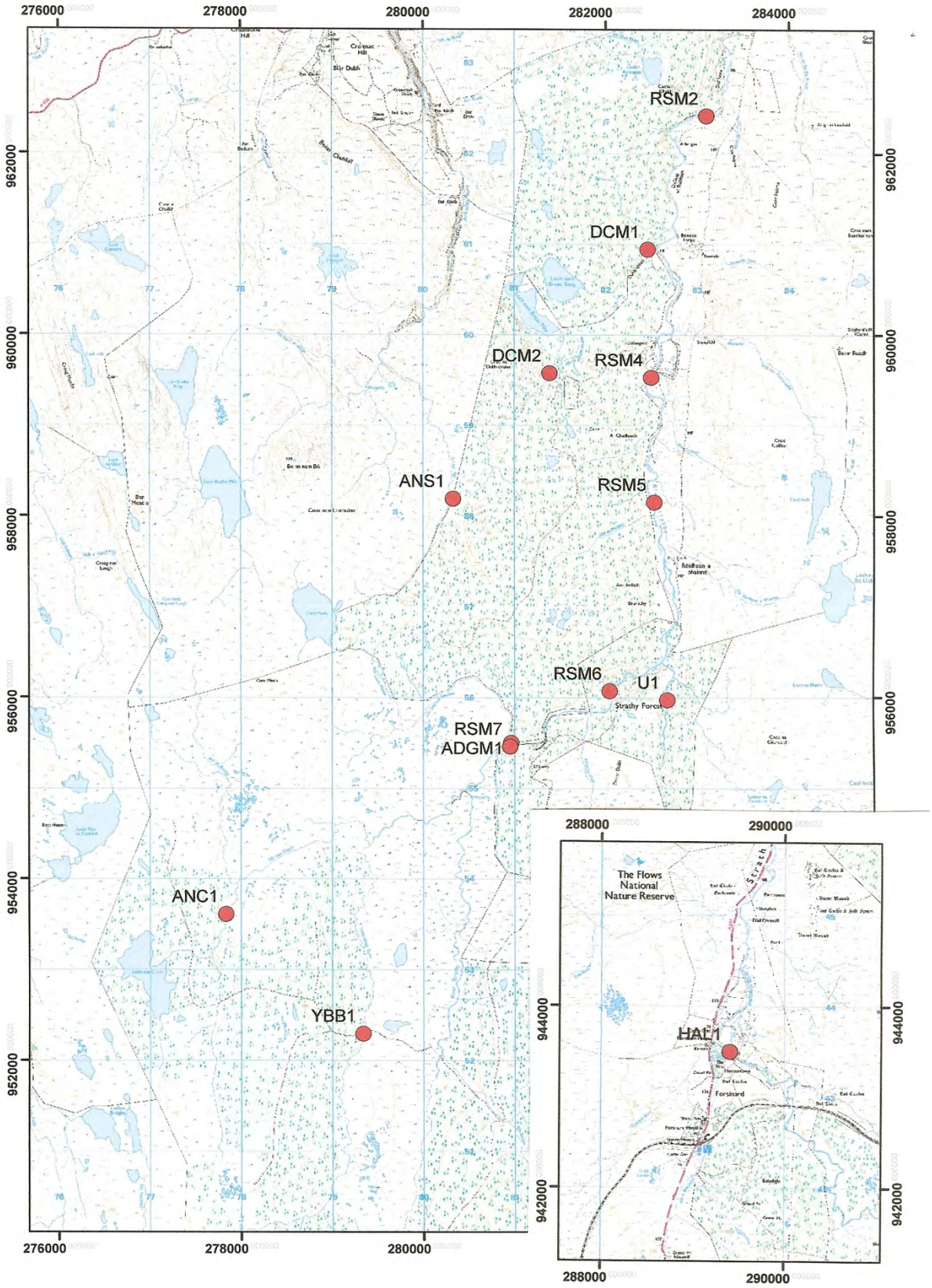


Figure 2. Map showing the location of the sampling locations described in this report.



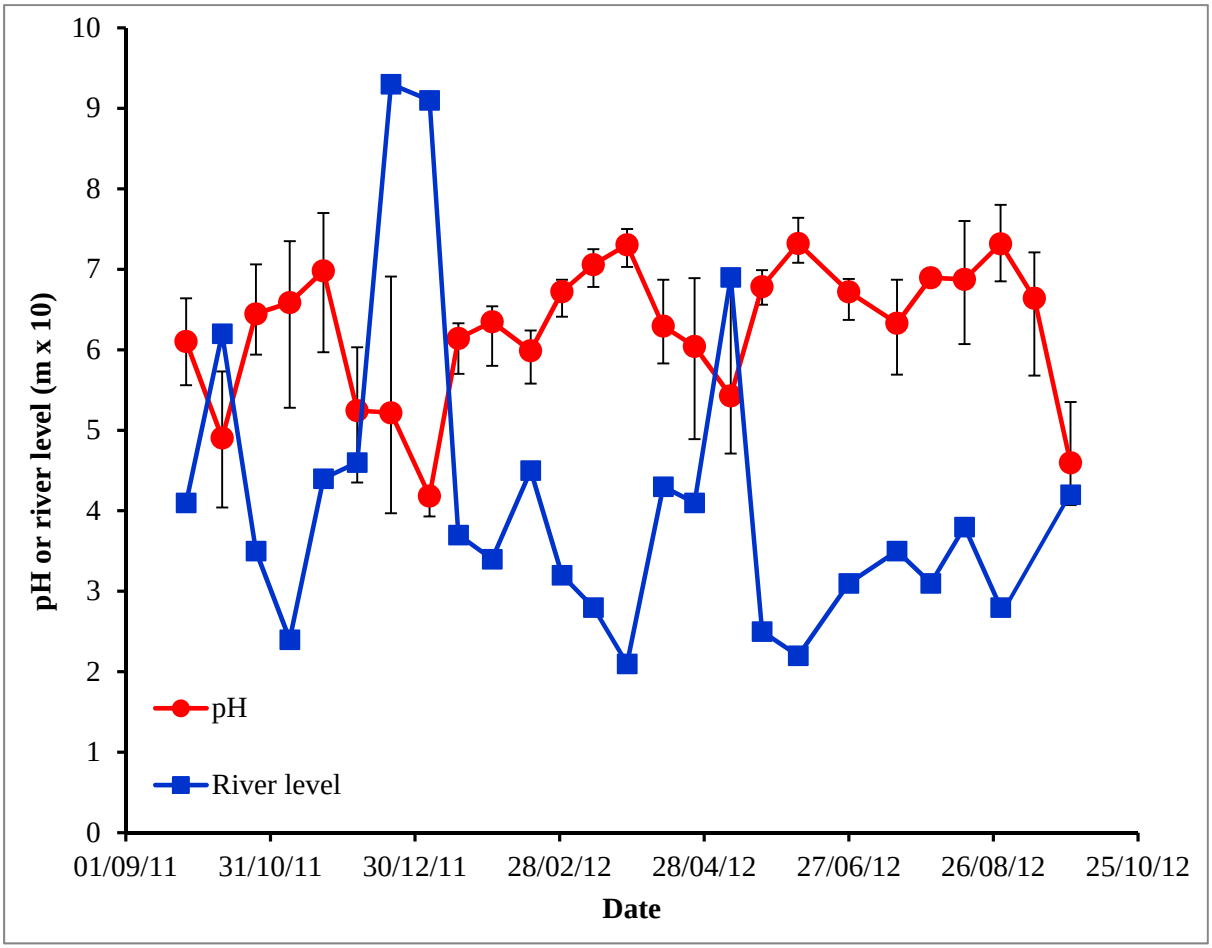


Figure 3. The mean pH (field measurement) of all the samples taken from the Strathy catchment through a full year and the level of the River Strathy at Strathy Bridge at mid-day on the day of sampling. Whiskers represent the ranges in pH.

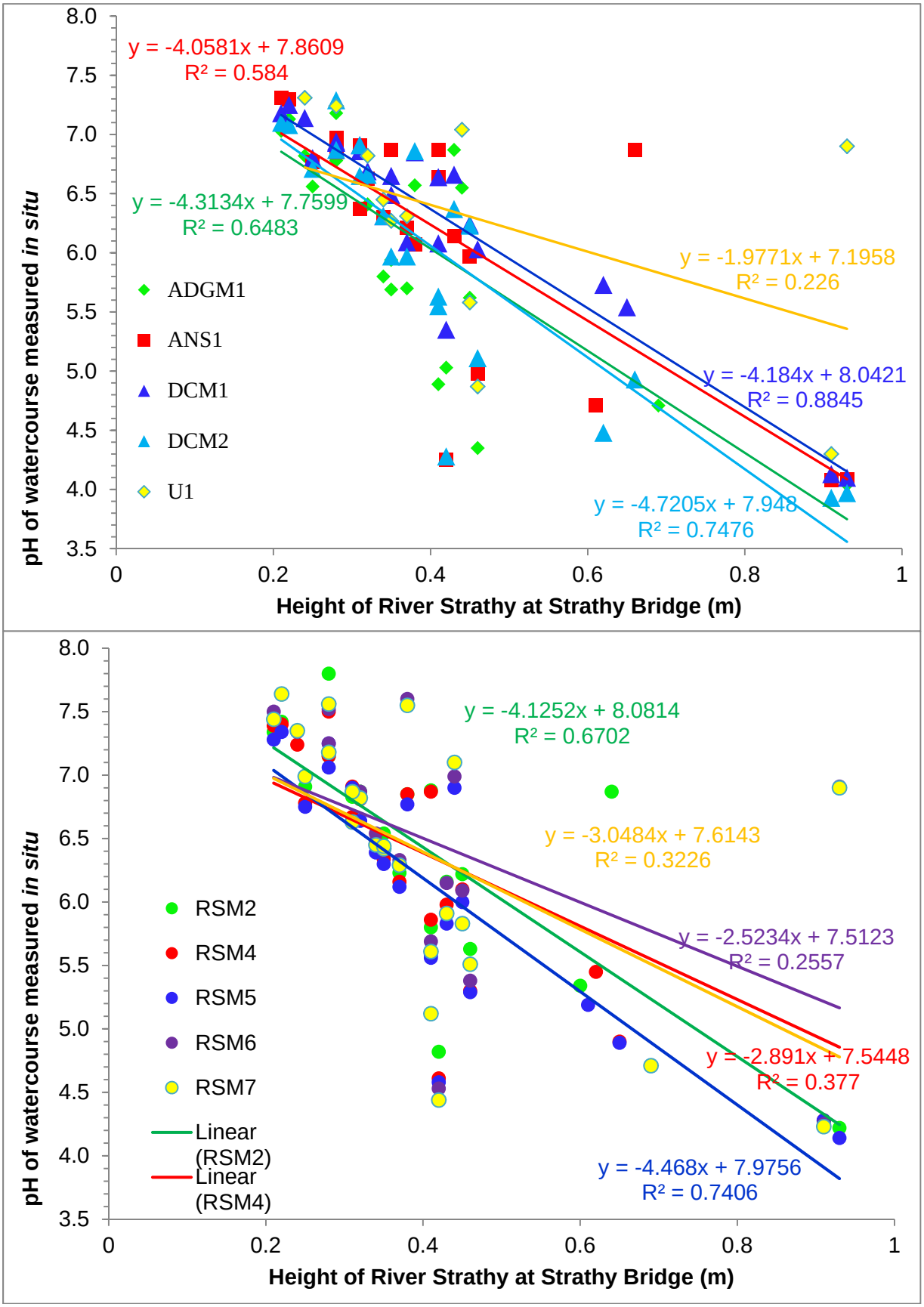


Figure 4. The relationship between the pH of the watercourses within the Strathy catchment and the depth of the River Strathy at Strathy Bridge on the same day.

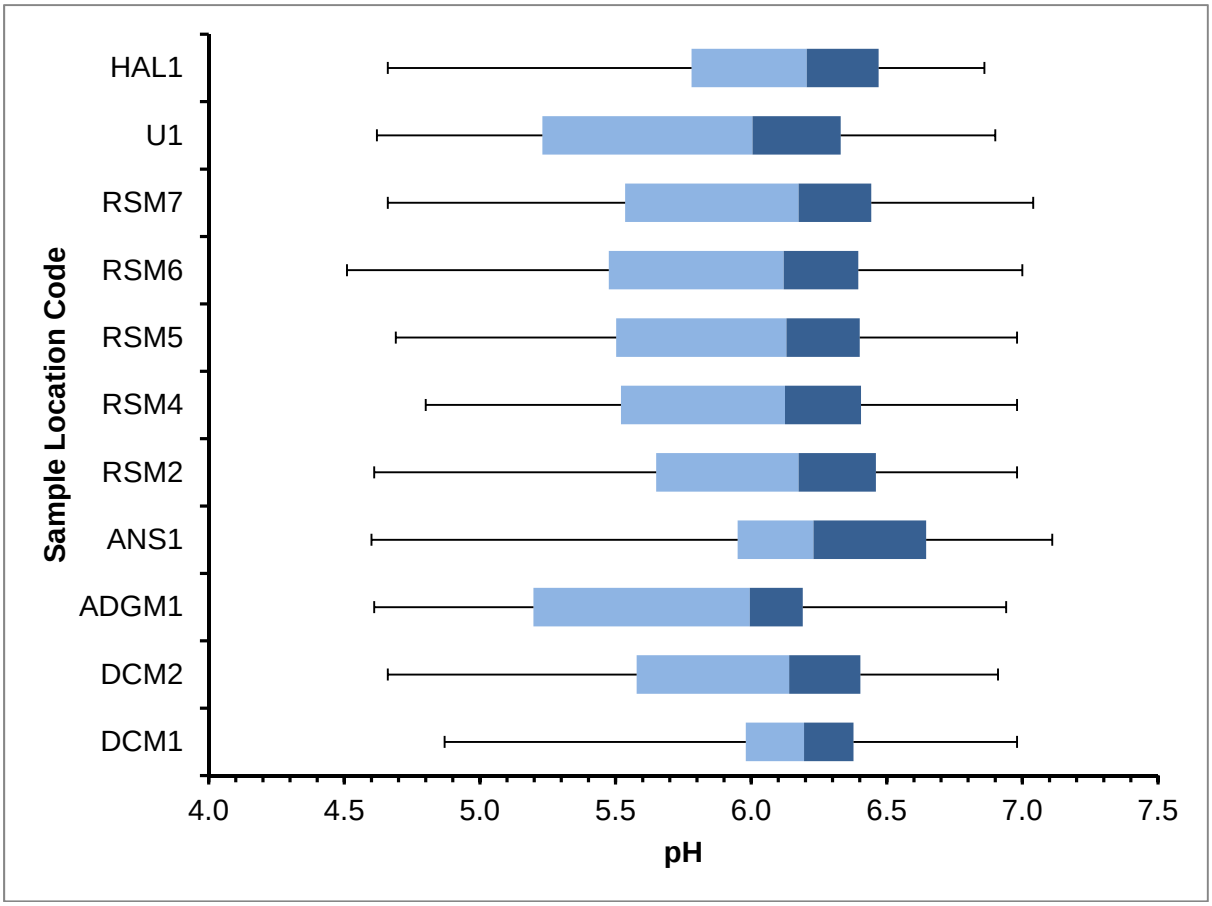


Figure 5. The lower (light blue) and upper quartile (dark blue) ranges in pH (laboratory determination) of the watercourses taken within the Strathy catchment along with the control site in the Halladale catchment (HAL1). Whiskers represent the minimum and maximum values recorded.

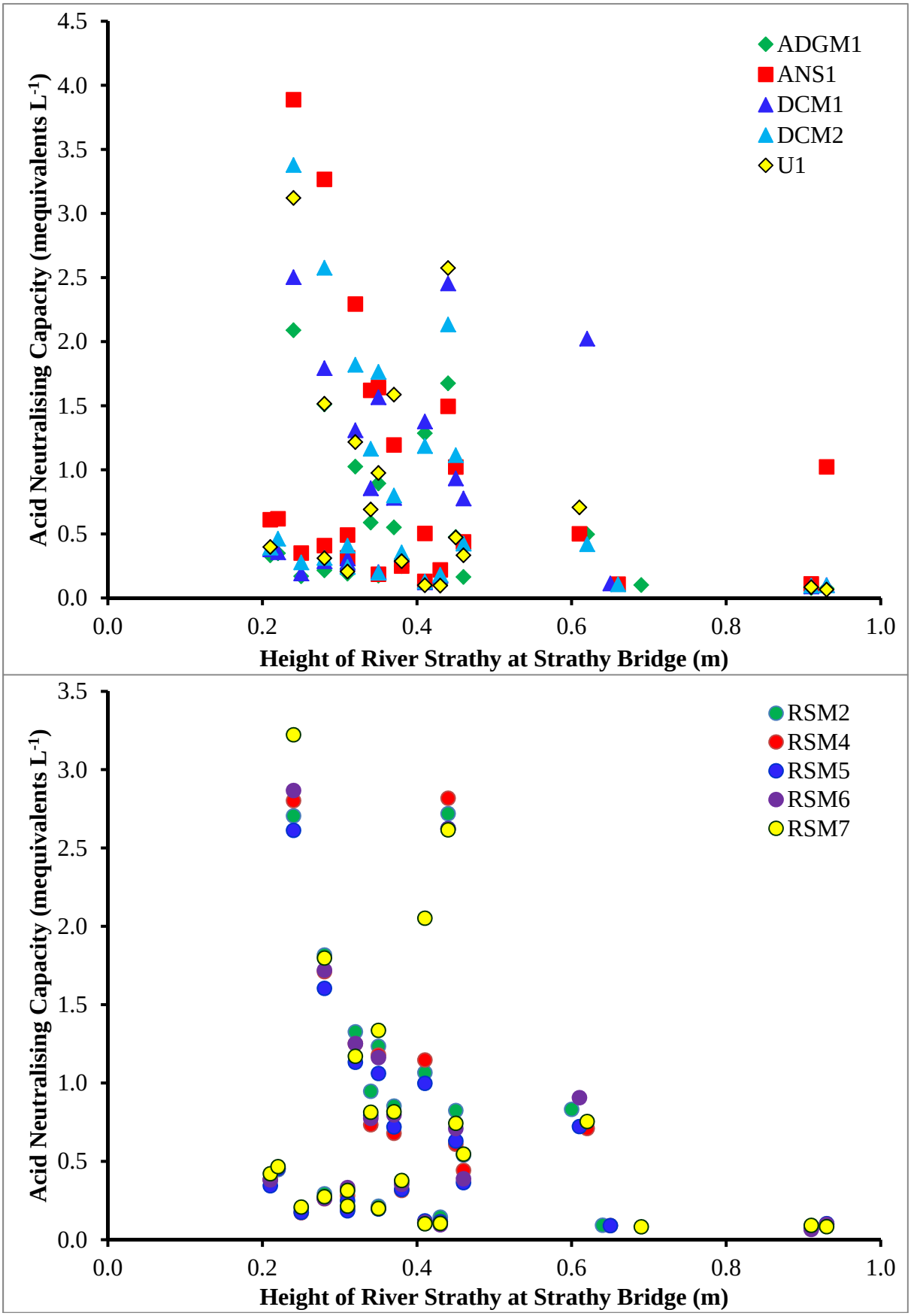


Figure 6. The relationship between the acid neutralising capacity of the water samples and the depth of the River Strathy at Strathy Bridge on the same day.

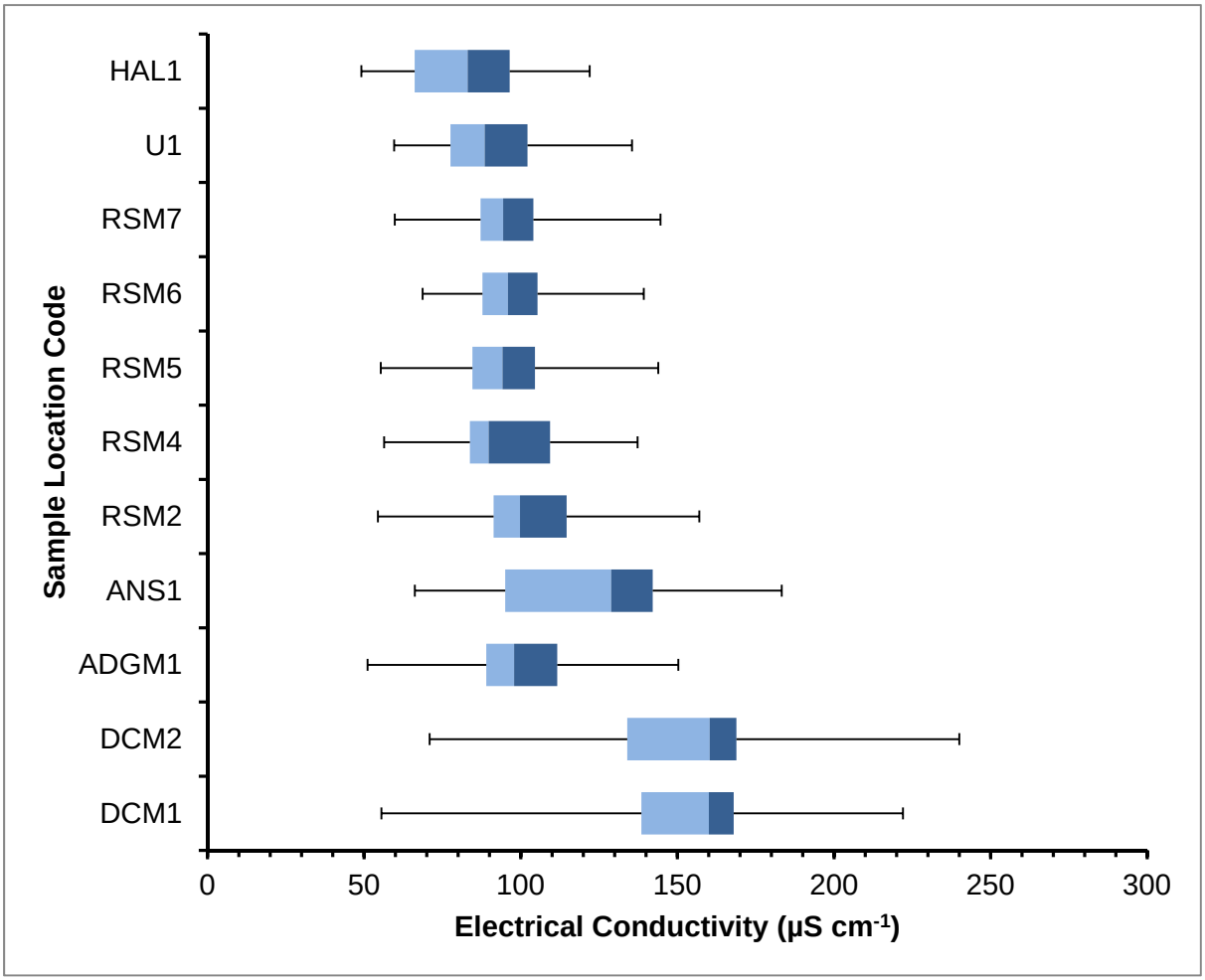


Figure 7. The lower (light blue) and upper quartile (dark blue) ranges in electrical conductivity of the stream and river samples taken within the Strathy and Halladale catchments. Whiskers represent the minimum and maximum values recorded.

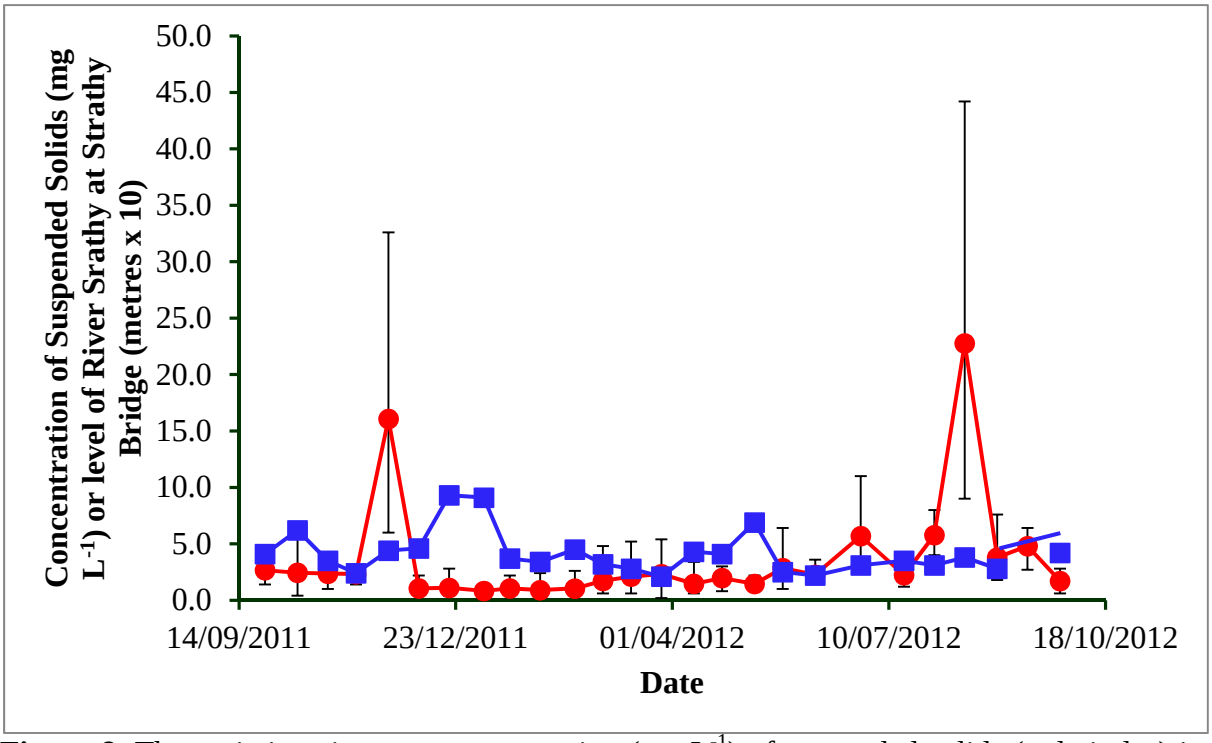


Figure 8. The variations in mean concentration (mg L^{-1}) of suspended solids (red circles) in the River Strathy and its depth (x10 metres) at Strathy Bridge (blue squares) through a year of monitoring. Whiskers represent the minimum and maximum values recorded.

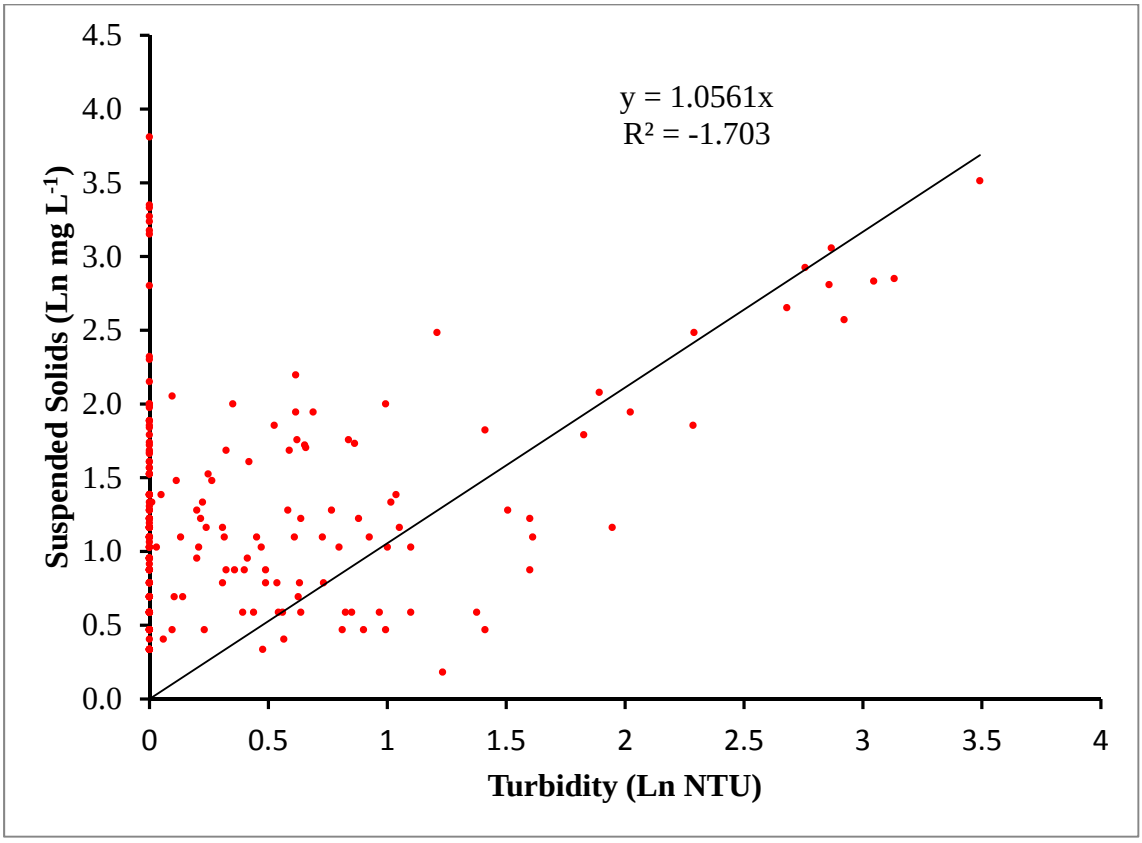


Figure 9. The relationship between logarithm of turbidity measured in the field and the logarithm concentration of suspended solids (mg L^{-1}) in all the surface water samples collected between September 2011 and September 2012 within the Strathy catchment.

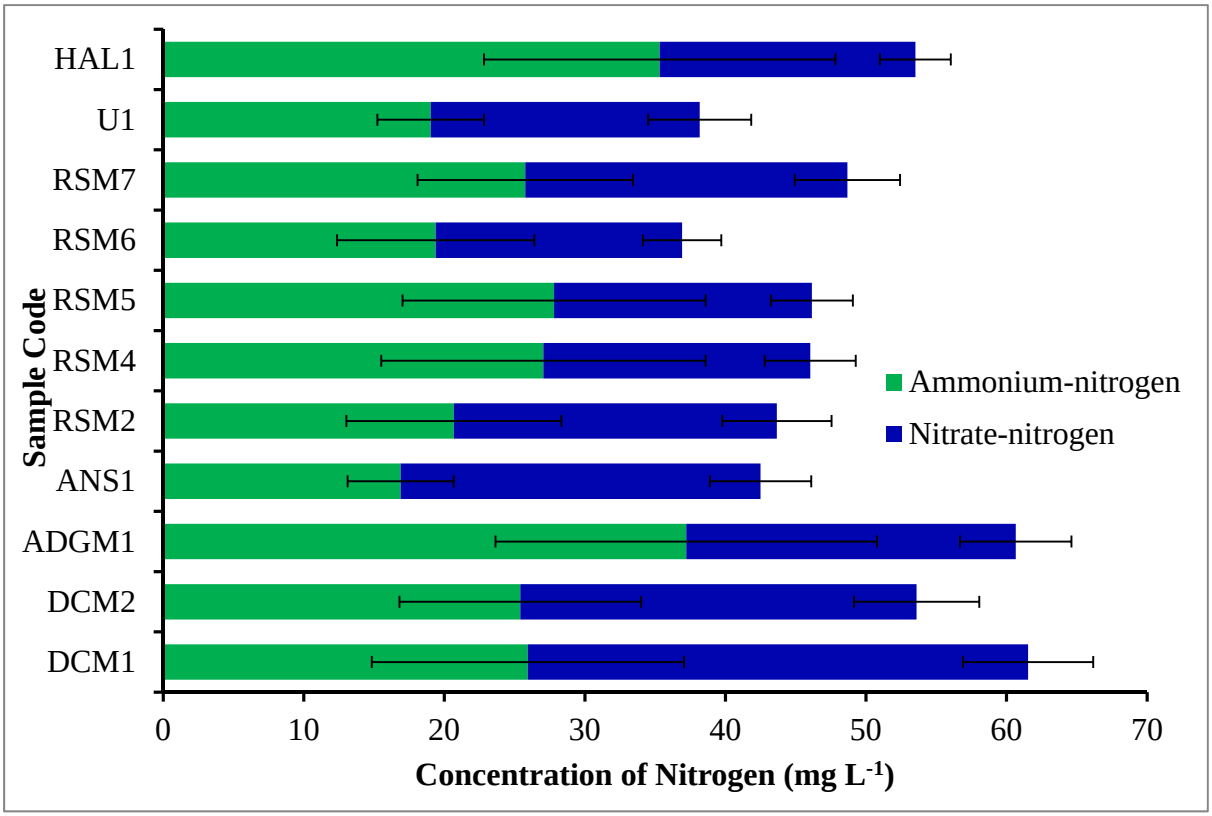


Figure 10. The mean concentration of ammonium-nitrogen (blue bars) and nitrate + nitrite-nitrogen (green bars) in the water samples collected from the Strathy and Halladale catchments. Whiskers represent one standard error of the mean.

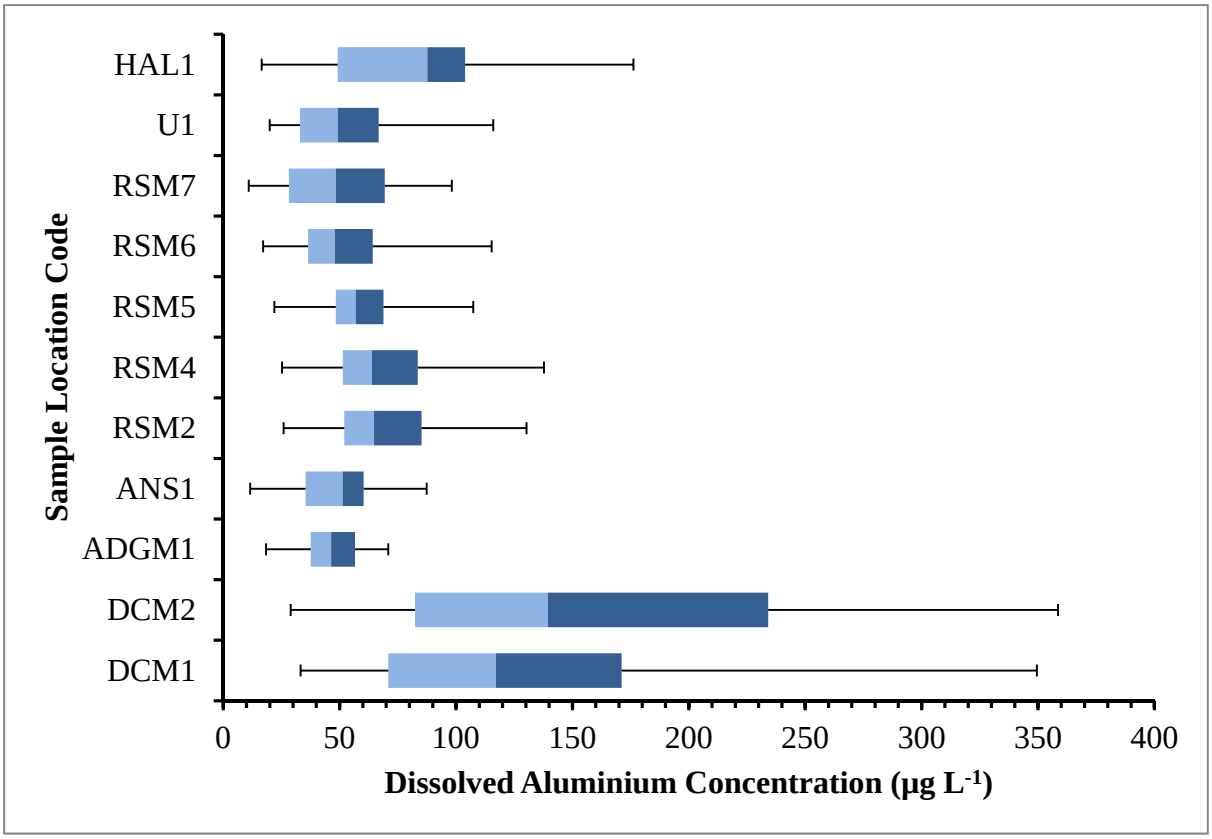


Figure 11. The lower (dark blue) and upper quartile (light blue) ranges in dissolved aluminium concentration of the water samples taken within the Strathy and Halladale catchments. Whiskers represent the minimum and maximum values recorded.

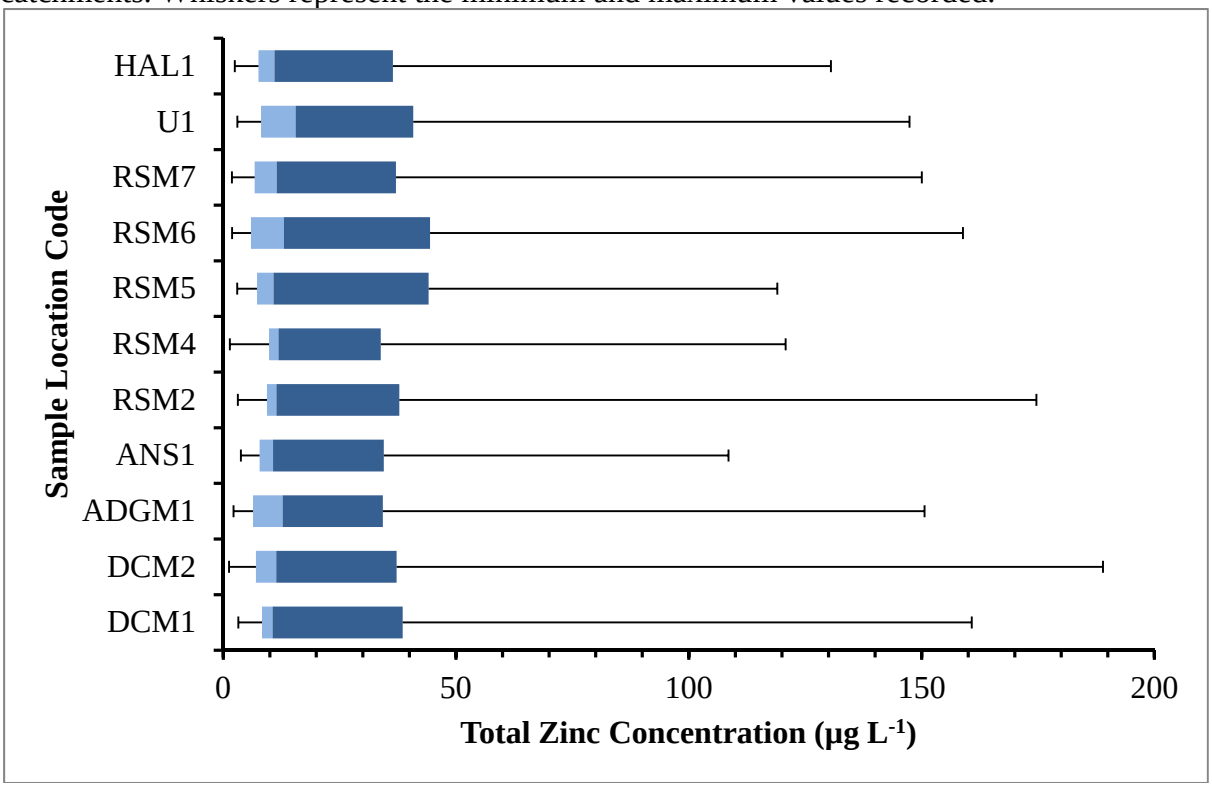


Figure 12. The lower (light blue) and upper quartile (dark blue) ranges in total zinc concentrations of the water samples taken within the Strathy and Halladale catchments. Whiskers represent the minimum and maximum values recorded.

Transport Statement

Strathy South Wind Farm

SSE Renewables Developments (UK) Ltd

05 July 2013

Halcrow
A CH2M HILL COMPANY

Transport Statement

Strathy South Wind Farm

SSE Renewables Developments (UK) Ltd

05 July 2013

Halcrow Group Limited
16 Abercromby Place, Edinburgh EH3 6LB
tel 0131 272 3300 fax 0131 272 3301
halcrow.com

Halcrow Group Limited, a CH2M HILL Company, has prepared this report in accordance with the instructions of client SSE Renewables Developments (UK) Ltd for the client's sole and specific use.
Any other persons who use any information contained herein do so at their own risk.

© Halcrow Group Limited 2013

Halcrow
A CH2M HILL COMPANY

Document history

Transport Statement

Strathy South Wind Farm

SSE Renewables Development (UK) Ltd

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
001	20.06.13		Alan Kerr	Alan Kerr	Jon Plant
002	05.07.13	Addition of stone import movements	Alan Kerr	Alan Kerr	Jon Plant

CONTENTS

1. INTRODUCTION 3
   1.1 BACKGROUND 3
   1.2 LIMITATIONS 3
   1.3 SCOPE 3
   1.4 REPORT STRUCTURE 4
2. TRAFFIC MOVEMENTS 5
   2.1 PLANT AND EQUIPMENT 5
   2.2 stone import 5
   2.3 FORESTRY MOVEMENTS 6
   2.4 CONCRETE 6
   2.5 CABLING SAND 6
   2.6 BALANCE OF DELIVERIES 7
   2.7 TURBINE COMPONENTS 7
   2.8 SUBSTATION TRANSFORMER 8
   2.9 CONSTRUCTION TRAFFIC MOVEMENTS SUMMARY 8
3. ROUTING 11
   3.1 INTRODUCTION 11
   3.2 POINTS OF ORIGIN 11
   3.3 ROUTING CONSIDERATIONS 12
   3.4 ROUTE OPTIONS – LARGE CONSTRUCTION PLANT / HGV's 12
   3.5 ROUTE OPTIONS – TURBINE EQUIPMENT 13
4. ROUTE IMPROVEMENTS 15
   4.1 INTRODUCTION 15
   4.2 SPECIFIC IMPROVEMENTS REQUIRED FOR ALL TRAFFIC 15
   4.3 IMPROVEMENTS REQUIRED FOR TURBINE COMPONENTS 15
   4.4 MODIFICATIONS REQUIRED FOR TURBINE COMPONENTS 15
5. TRAFFIC MANAGEMENT 16
   5.1 INTRODUCTION 16
   5.2 PRACTICAL MEASURES 16
   5.3 COMMUNICATION 17
6. MAINTENANCE 18
7. SUMMARY 19
   7.1 OVERVIEW 19

7.2 PREFERRED ROUTES 19
7.3 NUMBER OF VEHICLES (CONSTRUCTION TRAFFIC) 19
7.4 NUMBER OF VEHICLES (TURBINE COMPONENTS) 19
7.5 MITIGATION AND MAINTENANCE 19

1. INTRODUCTION

1.1 BACKGROUND

The principal traffic elements associated with the construction of the proposed Strathy South wind farm (Modified 2013 Scheme) are delivery of turbine components and materials for the concrete mix used in turbine foundations. Stone is required to construct site tracks, the intention is to source this from borrow pits located at the site, to minimise road transport. Aggregate/Stone for concrete will also be sourced on-site if suitable. During the wind farm construction phase forestry clearance will need to take place.

The purpose of this transport statement is to provide information about the proposed transport arrangements.

1.2 LIMITATIONS

The main limitation of this report arises because, in line with standard procurement practice, a contractor and supply-chain for materials will not be selected until later in the process.

In due course, the construction of the wind farm would be put out to tender. There are four key elements:

- forestry clearance
- supply and erection of wind turbines
- civil works
- electrical works

Contracts may be let on a multi-contract basis (i.e. separate contracts let for each element), or on a turnkey basis, in which a single contract is let for the construction of the wind farm, and the main turnkey contractor then lets sub-contracts for the other elements.

Consequently, the information presented in the Transport Statement should be considered as indicative only with the proposed routes, vehicles and other arrangements presented as examples.

In preparing this Transport Statement, consideration has been restricted to how construction related vehicles would reach the Modified 2013 Scheme from the nearest point(s) on the Trunk Road network, and how turbine equipment would reach the site from the proposed port of entry.

1.3 SCOPE

The report is restricted to forestry clearance plant and machinery, construction traffic, specifically construction plant, turbine equipment and materials. It does not

consider operational traffic (which will be minimal), or the transport of construction workers.

A minimum forestry clearance phase will need to commence prior to the arrival of construction related plant and equipment, and this phase will involve the felling and on-site mulching of trees to widen existing tracks and to create routes for new tracks.

1.4 REPORT STRUCTURE

Section 2 identifies:

- probable construction plant requirements
- probable concrete / aggregate requirements
- probable turbine components and their quantities, weights and dimensions
- probable balance of construction requirements
- for each of the above, probable vehicle requirements, quantities, weights and dimensions

Section 3 identifies the proposed routes to the site.

Section 4 identifies the proposed road improvements likely to be necessary to accommodate abnormal loads.

Section 5 identifies proposed traffic management measures, including Police supervision, and community liaison.

Section 6 identifies proposed arrangements to address potential abnormal wear and tear of public roads.

Section 7 provides a summary of this Transport Statement.

2. TRAFFIC MOVEMENTS

2.1 PLANT AND EQUIPMENT

Table 2.1 identifies an indicative construction plant inventory, and indicates the likely mode for transporting this to the site.

Table 2.1: Indicative Construction Plant Inventory

Item	No. Loads	Mode of Transport
Site offices	10	Articulated(1)
360° excavators	8	Low Loader
Dumpers	6 to 8	Low Loader
Crusher	2	Mobile(2)
JCB	2	Low Loader
Bowsers	2	Low Loader
Concrete batcher	3	Mobile
Mobile shovels + rollers	2	Low Loader
800 te crane	1	Mobile
Ballast truck	1 to 2	Articulated
250 te crane	1 or 2	Mobile
Ballast truck	1 to 2	Articulated
Total Loads	**44**	-

(1) - Standard articulated tractor/trailer

(2) - The plant is wheeled and can be towed

2.2 STONE IMPORT

It has been determined that stone may have to be imported to site for the initial enabling works[1]. Once the critical location is reached the stone required for construction will be won on-site. The estimated requirement is summarised in Table 2.2.

Table 2.2: Stone Import Requirements

Purpose	Quantity	Notes
Temporary Construction Compound	2,500m^3	
Strathy North to Strathy South Access Track	10,000m^3	
Total Stone Volume	12,500m^3	
Total Stone Weight	27,500 te	Assumed 2,200kg/m^3
Lorry Capacity	17.5 te	Assumed half 15.0 te and half 20.0 te
Total Number of Lorries	**1,572**	Tippers

[1] These initial enabling works consist of the construction of the new access track linking the consented Strathy North Wind Farm to the Strathy South Wind Farm and the associated new bridge across the River Strathy and the establishment of a temporary construction compound. Once the bridge crossing is in place the remainder of the access track to Strathy South will be formed from imported material until it is suitable for the trafficking of Plant and material for the main preparatory works. There are two conceivable routes between Strathy North and Strathy South. The route that would require the greater quantity of imported stone has been chosen.

2.3 FORESTRY MOVEMENTS

Forestry clearance will be undertaken by felling and a mixture of mulching and timber extraction. A summary of the estimated movements is provided in Table 2.3, from information supplied by the applicant (SSE).

Table 2.3: Indicative Forestry Movements

Area to be Harvested	Volume to be Harvested	Weight to be Harvested	Loads
231.5ha	29,860m³	23,888 tonnes	1,086

Whilst forestry traffic has been assumed to occur throughout the 24 month construction period, to allow for a worst case assessment, the applicant may delay the removal of wood from the site if drying becomes a requirement for subsequent biomass opportunities. Therefore final timing of forestry traffic would be confirmed as part of the Traffic Management Plan.

2.4 CONCRETE

The concrete works on this site will be carried out by installing a batching plant on-site. It is anticipated that aggregate and water will be sourced on-site however the aggregate has been assumed to be delivered to site in the calculations in order to present a worst-case scenario lest the quality of material required is not available. The estimated concrete requirement is summarised in Table 2.4.

Table 2.4: Concrete Requirements

Activity/Purpose	Quantity	Notes
Number of turbine foundations	47	
Foundation volume	400m^3	
Total foundation volume	18,800m^3	
Other concrete (substation, anemometer foundations, buildings)	200m^3	
Total concrete	**19,000m^3**	
Aggregate Requirement	15,200 te	0.8te/m^3 concrete
Sand Requirement	15,200 te	0.8te/m^3 concrete
Cement Requirement	7,600 te	0.4te/m^3 concrete
Water requirement	3,800 te	0.2te/m^3 concrete
Aggregate Lorry Capacity	17.5 te	Assumed half 15.0 te and half 20.0 te
Sand Lorry Capacity	17.5 te	Assumed half 15.0 te and half 20.0 te
Cement Tanker Capacity	29 .0 te	
Water Tanker Capacity	29 .0 te	Water sourced on-site
Number of Aggregate Lorries	869	Tipper
Number of Sand Lorries	869	Tipper
Number of Cement Lorries	263	Articulated Tanker
Number of Water Lorries	0	Water sourced on-site
Total Number of Lorries	**2,001**	

2.5 CABLING SAND

Electrical cables will be ploughed wherever possible but where this is not the case , laid in trenches and, according to local site conditions, bedded either in sand brought

onto the site, or in locally derived materials. The bedding sand has two purposes: firstly, to protect the cables from damage by stones, boulders, and other backfilled material; secondly to ensure adequate heat transfer away from the cable. Sand is required at approximately 0.375 te per linear metre of cable trench. Assuming a worst case of all cables being laid in imported sand, approximately 17,175te of sand would be required for the 41,800m of cable trench as summarised in Table 2.5.

Table 2.5: Cabling Sand Requirement

Inter-Turbine trench length	Weight of sand required per linear metre of trench (te))	Total weight of sand required (te)	Number of Tipper Loads @ 17.5te per load
41,800	0.375	15,675	**896**

2.6 BALANCE OF DELIVERIES

In addition to the transport requirements of the Construction Plant and Equipment, Concrete Aggregates and Cabling Sand, there are further items which will require transporting to the site during the construction phase. These are detailed in Table 2.6.

Table 2.6: Balance of Deliveries

Item	Number	Vehicle Type	Number of Loads
Cabling	84 cable drums(1)	Regular artic/rigid truck	21
Control Room Equipment	-	Regular artic/rigid truck	5
Reinforcing Steel	3.5 loads per turbine(2)	Regular artic truck	165
Plant Fuel	1 tanker per 10 days	Regular rigid truck	57
Balance of Switching Station Plant	-	Regular artic/rigid truck	20
Other: culvert pipes, geotextile membrane and transformers	-	Regular artic truck	129
Total Loads			**397**

(1) – 500m cable per drum and 4 drums per vehicle

(2) – 70.0 tonne per turbine and 20 tonne load per vehicle

2.7 TURBINE COMPONENTS

Information regarding the movement of turbine equipment and components is based on relevant recent experience and information on the manufacturer's requirements provided by SSE.

Table 2.7: Turbine Components

Component	Number per turbine	Total Component Deliveries	Notes
Foundation ring	1	47	Already included as a part of balance of deliveries
1st tower section	1	47	
2nd tower section	1	47	
3rd tower section	1	47	

Nacelle	1	47	Including transport frame
Blade	3	141	1 per load
Hub	1	47	
Total	**9**	**423**	

2.8 SUBSTATION TRANSFORMER

The delivery of the transformer components normally associated with the development of a wind farm is not required in this instance considering the development of a substation at the neighbouring Strathy North wind farm. The construction of a Switching Station will be required and loads associated with this are allowed for within Section 2.6.

2.9 CONSTRUCTION TRAFFIC MOVEMENTS SUMMARY

Table 2.8 summarises the estimated traffic movements of construction traffic.

Table 2.8: Estimated Traffic Deliveries

Movement	Total number	Delivery days	Average per day
Forestry equipment (in)	8	7	2
Forestry equipment (out)	8	7	2
Construction plant (in)	44	7	7
Construction plant (out)	44	7	7
Stone Import Movements	1,572	52	31
Forestry Movements	1,086	624	2
Concrete - Aggregate	869	234	4
Concrete - Cement	263	234	2
Concrete - Sand	869	234	4
Concrete - Water	0	0	0
Cabling Sand	896	130	7
Balance of Deliveries	397	624	1
Turbine Components	423	156	3
Total Vehicles	**6,479**	**624**	**11**

The tables presented above contain details of how the various plant and materials will arrive on-site during the Construction Phase. For the effort required to construct 47 turbines at Strathy South, a total of 6,482 vehicle loads of plant, equipment and materials will be required. With a phased construction programme, this equates to an average of 11 construction related vehicle arrivals on each working day during the lifetime of the construction phase (i.e. 22 movements per day across 24 months).

Not all materials require to be delivered on-site at the same time, therefore a phased programme of delivery and removal will be planned. The forestry clearance equipment will arrive early in Month 1 and leave site at the end of Month 24. An example of a phased delivery programme, based on the actual quantities and loads required for the Strathy South site is shown in Table 2.9.

In addition to Construction Traffic, staff will arrive in non-HGV vehicles. The workforce on-site will depend on the activities being undertaken. It has been assumed that an average of 50 vehicles will arrive, and 50 will depart each day

carrying construction staff, although it is considered that this is an over-estimate and is being used to represent a worst-case scenario.

Table 2.9: Construction Deliveries Phasing (HGV and Abnormal Loads)

	Month											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Forestry Plant	6	2										
Construction Plant	5	3	5	28	3							
Forestry Clearance	45	45	45	45	45	45	45	45	45	45	45	45
Stone Import	786	786										
Concrete Materials					177	221	230	235	257	257	257	195
Cabling Sand												180
Other	1	1	1	1	1	19	44	23	23	23	21	19
Turbine Delivery												
Totals	843	837	51	74	226	285	319	303	325	325	323	439
Working Days	26	26	26	26	26	26	26	26	26	26	26	26
Daily Average	33	33	2	3	9	11	13	12	13	13	13	17

Month												**Total**
13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	
										4	4	8
						1	5	5	18	10	5	44
45	45	45	45	45	45	45	45	45	45	45	45	1086
												1572
178												2001
180	180	180	176									896
19	19	23	23	23	25	21	20	19	13	9	6	397
	71	71	71	71	71	71						423
422	315	319	315	139	141	138	70	69	76	68	60	6482
26	26	26	26	26	26	26	26	26	26	26	26	624
17	13	13	13	6	6	6	3	3	3	3	3	11

3. ROUTING

3.1 INTRODUCTION

This section identifies the routing options considered, and explains how the likely preferred route has been identified. (Section 4 identifies the main modifications likely to be necessary to allow passage of the larger construction related loads which will use the same route agreed for the passage of the turbine and blade equipment).

To put this in context, the likely points of origin of the components and materials, and the principles informing route selection are outlined.

3.2 POINTS OF ORIGIN

3.2.1 Construction Plant and Forestry Equipment

A civil contractor has not been appointed, so the origin of civil plant and craneage is unknown at this stage. However, it can be assumed that there will be reasonable access to a trunk road from the point of origin (the equipment being moved around from contract to contract), and that access can be gained to Scrabster Harbour or the nearby A9(T)/A836 junction.

3.2.2 Concrete / Aggregates and Cement

The design specification for the Modified 2013 Scheme will be to use a concrete batching plant on site with the contractor being responsible for sourcing materials that cannot be sourced on-site. It is likely to be most economical to use local suppliers.

Aggregate for concrete and track construction is expected to be provided by using on-site borrow pits. However, the aggregate for the concrete has been assumed to be delivered to site in the calculations in Chapter 2 in order to present a worst-case scenario lest the quality of material required is not available. Material for concrete will be sourced from local, as yet unidentified quarries. The nearest known site is the existing concrete batching plant immediately east of Melvich, which currently supplies the requirements of Dounreay.

As with the construction plant it is assumed that there will be suitable access to a trunk road from the point of origin (materials being transported from the site frequently), and that access can be gained the nearby A9(T)/A836 junction.

3.2.3 Turbine Components

In accordance with Transport Scotland requirements that Special Order loads are shipped to the nearest available port, it is considered that the transportation of turbine equipment and components will originate from the port at Scrabster.

The arrival of smaller components, which would be moved under Special Types General Orders (STGO) Class 3 or less, have also been considered from the port of

Wick, but Highland Constabulary have raised concerns about such loads passing through Thurso town centre.

For the purposes of this Transport Statement, it has been assumed that all turbine equipment would be delivered through the port of Scrabster.

3.3 ROUTING CONSIDERATIONS

The following factors will influence the choice of route:

- travel time, effected by
  - distance
  - speed
  - congestion
- minimising loading / unloading points
- physical constraints including
  - road width
  - corners, bends, junctions
  - height restrictions
  - buildings and structures
  - street furniture
  - gradients
- structural strength of bridges and culverts
- advice of highways authority and police

The key issue, in particular for the long loads, is the feasibility of overcoming physical constraints.

3.4 ROUTE OPTIONS – LARGE CONSTRUCTION PLANT / HGV'S

3.4.1 Introduction

Four routes have been identified which allow access to the site from the A9 Trunk Road or port facility, one of which only applies to Turbine Equipment. The preferred route is Route 1, which is considered feasible for large construction and heavy goods vehicles. Route 2 from the west offers no advantage, having no suitable port facility, and being almost exclusively single track road. Route 3 may also provide lighter vehicles with a route to the site from the south although it is not recommended for frequent use by HGVs. These routes are shown in Figure 15-1.

3.4.2 Route 1 – A9(T) Scrabster – A836 to Strathy and Site Access

The A9(T) out of Scrabster Harbour joins the A836 within Thurso at a wide priority junction. The A836 is generally of good alignment and runs from east to west,

through Forss, past Dounreay and through Isauld and Reay. Near Melvich the A897 from Helmsdale joins the A836, before passing through Melvich and on to Strathy. The proposed Site Access is approximately 1km east of the entry to Strathy Village, leading south from the point where there exists a junction with an unclassified road leading north to Baligill.

3.4.3 Route 2 – A836 from Tongue to Site Access

This route runs from west to east along the A836. The road is predominantly single track with passing places, but otherwise of acceptable alignment. The road widens when passing through the dispersed settlement of Bettyhill before reaching Strathy village. There is a double bend on an uphill gradient as the road passes through Strathy, and then the road becomes rural in character again. The Site Access is approximately 1km east of Strathy Village, leading south from the point where there exists a junction with an unclassified road leading north to Baligill.

3.4.4 Route 3 – A897 from Helmsdale – A836 Melvich to Site Access

From Helmsdale on the A9(T) on the east coast, this route follows the River Helmsdale northwards, and over the watershed around Forsinard to follow the Halladale Water towards the north coast and the A836. Outwith Helmsdale the road is single track with passing places, is generally of good alignment and gradient, but is unfenced. The route passes through the village of Kinbrace, then crosses the Inverness – Wick/Thurso railway line by level crossing at Forsinard. At the northern end, approximately 800m south of the junction with the A836 there is a tight bend across a bridge which would require a structural assessment. From the junction with the A836 Route 3 follows Route 1 to the Site Access.

3.5 ROUTE OPTIONS – TURBINE EQUIPMENT

3.5.1 Introduction

Earlier work had identified one route from the port at Scrabster, and offered a secondary route from Wick which would be suitable for the movement of smaller components.

3.5.2 Route 1 – A9(T) Scrabster – A836 to Site Access

This route leaves the port area on the A9(T) to join the A836 at the existing priority junction. The route progresses westbound through Reay and Isauld. After passing the A897 the route passes through the settlement of Melvich. The route would turn left onto a new section of access road south of Baligill, and pass south east of Strathy, joining an existing track to Bowside Lodge and on to the edge of Strathy Forest at Dallangwell.

3.5.3 Route 4 - Wick to A9(T) at Scrabster via A822 or A99

This route is from the port of Wick to Strathy, using either the A822 or the A99 to reach the A9(T). This route would pass through Thurso town centre before approaching the A9(T)/A836 junction close to the port of Scrabster. This route would only be appropriate for loads being moved under STGO and not the largest

items, which are moved under Special Order (which must use the nearest available port facility). These route options have been assessed and are considered negotiable but Northern Constabulary have stated that “routes through Thurso town centre should only be considered as a last resort”

Route 1 from Scrabster using the A9(T) to the A836 westbound to the A897 then south to the Site Access is the preferred route for all construction, plant and turbine equipment deliveries.

4. ROUTE IMPROVEMENTS

4.1 INTRODUCTION

This section considers any areas or locations where improvements to the existing roads network or infrastructure will be required to allow the safe passage of the vehicles involved in the construction phase of the Modified 2013 Scheme. This is based upon the Baseline Review of the roads network, and consideration of the type and number of vehicles involved during the construction period.

4.2 SPECIFIC IMPROVEMENTS REQUIRED FOR ALL TRAFFIC

It is considered that a new access junction from A836 at Baligill is necessary, however this is to be constructed as part of the Strathy North development. In conjunction with the new access there is to be a new route constructed, bypassing Strathy, to develop the Strathy North site. This route will also be used as part of the transport route to Strathy South.

These improvements will be required for Construction Traffic using any of the potential routes to reach the Site Access.

4.3 IMPROVEMENTS REQUIRED FOR TURBINE COMPONENTS

As part of the planning application an assessment has been undertaken identifying the improvements required to permit the safe passage of the turbine components along Route 1.

4.4 MODIFICATIONS REQUIRED FOR TURBINE COMPONENTS

4.4.1 Street Furniture

It may be necessary, at least temporarily, to remove or relocate street signs, street lights, and utility poles and services. The relevant areas would be identified by more detailed studies, and utilities consulted.

4.4.2 Structural Checks

A further review of maximum axle loading on structures along the proposed route in consultation with the relevant roads agencies is recommended. Should structural assessment indicate that the structure cannot accept the proposed loadings, then solutions may include replacement, propping or spanning, as appropriate. However, it should be noted that structural checks are being undertaken for the Strathy North wind farm development.

5. TRAFFIC MANAGEMENT

5.1 INTRODUCTION

This section proposes traffic management measures to ensure the efficient transport of components and materials to the site, whilst minimising disruption to other road users and ensuring the safety of contractor personnel and the public.

5.2 PRACTICAL MEASURES

5.2.1 Management Co-ordination

It is proposed that, in addition to pre-application consultation, a management co-ordination group is established to facilitate communication and co-ordination by the relevant authorities regarding the abnormal loads. This group may include:

- The Highland Council
- BEAR Scotland
- Northern Constabulary
- the Haulage Contractor

5.2.2 Police Escort

It is expected that the Police would escort all abnormal loads from the docks to the site. Generally, the preference would be to have a convoy of several vehicles, in order to minimise disruption to other road users. The escorting vehicles would warn oncoming vehicles of the approaching loads, pulling the vehicles in where necessary. The escort would also pull the convoy over to allow any build-up of following traffic to pass, at pre-identified suitable locations.

5.2.3 Timing

It is likely that escorted loads would travel during daylight hours, for safety reasons. Other traffic would, in general, coincide with site working hours, generally 7am to 6pm, although it may occasionally be necessary to extend beyond this.

5.2.4 Driver Induction

The drivers' induction would likely include:

- a safety briefing
- the need for appropriate care and speed control
- identification of specific sensitive areas
- identification of the specified route
- the requirement not to deviate from the specified route

5.2.5 Signage

Where appropriate, additional warning and speed control signs can be installed temporarily, or otherwise, with the agreement of the roads authority.

5.3 COMMUNICATION

It is proposed that a construction liaison committee be established to ensure the smooth management of the project/public interface. Traffic management is likely to be an issue considered by the liaison committee. It is proposed that representatives of SSE, the construction contractors, the local community and, if appropriate, the Police, form the committee. This committee will form a means of communicating, updating on forthcoming activities and dealing with any issues arising.

There will be an opportunity for interested parties to identify themselves, and be updated of plans by means of email communication, post or telephone. In addition, the Police may be able to arrange notice of abnormal loads on local radio or in the press.

6. MAINTENANCE

The Highland Council have indicated that they will require an agreement under section 96 of *The Roads (Scotland) Act 1989*. In essence, this agreement provides for a developer to cover the cost of abnormal wear and tear on roads not designed for that purpose. This would relate to the A836 from its junction with the A9(T) at Scrabster to the site access junction. This would require a roads condition survey to be undertaken before the commencement of any works on-site, and a repeat survey to be undertaken on completion of the construction period.

The detail of this agreement would be agreed subsequent to planning permission, but the requirement to enter into such an agreement may form a suspensive planning condition.

7. SUMMARY

7.1 OVERVIEW

This Transport Statement provides a clear statement of how Construction Plant, Equipment and Materials and Turbine Components will be delivered to the Modified 2013 Scheme at Strathy South. It has considered the various route options to reach the site and examined the construction methodology to be adopted to derive generated traffic flows.

7.2 PREFERRED ROUTES

The preferred route for general construction traffic and turbine components from the A9(T) is Route 1 from Scrabster, following the A836 through Reay/Iasuld and Melvich to a new road junction east of Strathy village, bypassing the settlement and heading south.

7.3 NUMBER OF VEHICLES (CONSTRUCTION TRAFFIC)

The average number of construction vehicle trips per day to and from the site is 22 (11 in and 11 out). There may be short term peaks during Months 1 and 2, when the stone is being imported for the initial section of the track between Strathy North and Strathy South (estimated as 66 HGV trips per day (33 in and 33 out).

7.4 NUMBER OF VEHICLES (TURBINE COMPONENTS)

The number of vehicle movements involved in transporting turbine equipment for 47 turbine installations is expected to be 846 trips (423 loads in, returning unladen – excluding escort vehicles or vehicles associated with the temporary removal of street furniture which might accompany the loads). The impact of these movements can be reduced by transporting several loads at the same time in convoy operation; however a delivery profile has not yet been established for these movements.

7.5 MITIGATION AND MAINTENANCE

Mitigation measures to help minimise the impact of Construction Traffic have been proposed, and it is understood that The Highland Council will require a roads condition surveys as part of a Section 96 Agreement relating to the condition of the A836 from its junction with the A9(T) at Scrabster to the Site Access junction.

Appendix 15.1.1: Load Calculation Spreadsheet

CONSTRUCTION TRAFFIC MOVEMENTS

Concrete batching			
Total volume	**19,000**	**m3**	
Aggregate requirement	15,200	te	0.8 te/m3 concrete
Sand requirement	15,200	te	0.8 te/m3 concrete
Cement requirement	7,600	te	0.4 te/m3 concrete
Water requirement	3,800	te	0.2 te/m3 concrete
Aggregate lorry capacity	17.5	te	assumed half 15te half 20te
Sand lorry capacity	17.5	te	assumed half 15te half 20te
Cement tanker capacity	29	te	
Water tanker capacity	29	te	Water sourced on-site
No aggregate lorries	869		Tipper
No sand lorries	869		Tipper
No cement lorries	263		Articulated Tanker
No water lorries	0		Water sourced on-site
Total no lorries	**2,001**		
Available time	234	days	
Lorries per day	9		
Cable Sand			
Total Cable Length	41,800	m	At 0.375te per linear metre
Cable Sand Required	15,675	m3	
Total no lorries	**896**		
Forestry Movements			
Weight to be Harvested	23,888	tonnes	At 22 tonne per load
Total no lorries	**1,086**		
Stone Import			
Stone lorry capacity	17.5	te	assumed half 15te half 20te
Weight to be Imported	27,500	tonnes	
Total no lorries	**1,572**		Tipper
Plant and Equipment	**44**	**Vehicle loads in/out**	
Forestry Equipment	**8**	**Vehicle loads in/out**	
Balance of Deliveries	**397**	**Vehicle loads**	
TOTAL VEHICLE LOADS	**6,056**		

TURBINE COMPONENT MOVEMENTS

Item	Number	Number of Loads	Mode of transport
Foundation ring	47	47 [1]	Flat bed
1st tower section	47	47	Extendable stepframe
2nd tower section	47	47	Extendable stepframe
3rd tower section	47	47	Extendable stepframe
Nacelle	47	47	Hydraulic platform *or* hydraulic low loader
Blade	141	141 (@ 1per load)	Extendable flat bed
Hub	47	47	Flat bed
TOTAL VEHICLE LOADS		**423 [1]**	

[1] Foundation Ring loads are accounted for in Balance of Deliveries in Construction Traffic Movement Table (above)

Abnormal Load Route Survey Report

Strathy South Wind Farm

SSE Renewables Developments (UK) Ltd

20 June 2013

Halcrow Group Limited
16 Abercromby Place, Edinburgh EH3 6LB
tel 0131 272 3300 fax 0131 272 3301
halcrow.com

Halcrow Group Limited, a CH2M HILL Company, has prepared this report in accordance with the instructions of client SSE Renewables Developments (UK) Ltd for the client's sole and specific use.
Any other persons who use any information contained herein do so at their own risk.

© Halcrow Group Limited 2013

Halcrow
A CH2M HILL COMPANY

Document history

Abnormal Load Route Survey Report

Strathy South Wind Farm

SSE Renewables Development (UK) Ltd

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
001	27.06.12	Draft	Alan Kerr		
002	24.10.12	Draft following Environ comments	Alan Kerr		
003	29.03.13	Draft following changes to proposed turbine	Alan Kerr	Alan Kerr	Jon Plant
004	31.05.13	Draft following changes to part of proposed route to site	Alan Kerr/ Bryan Tighe	Alan Kerr	Jon Plant
005	06.06.13	Following Internal Review	Alan Kerr/ Bryan Tighe	Alan Kerr	Jon Plant
006	06.06.13	Change to include 'Preferred Route'	Alan Kerr/ Bryan Tighe	Alan Kerr	Jon Plant
007	20.06.13	Final following additional comments	Alan Kerr/ Bryan Tighe	Alan Kerr	Jon Plant

Contents

1 Introduction 1

1.1 Introduction 1
1.2 Background 1
1.3 Report Structure 2

2 Proposed Wind Farm 3

2.1 Site Description and Location 3
2.2 Proposed Turbine Details 3
2.3 Crane Details 4

3 Access Route Review 7

3.1 Route Review 7
3.2 Port of Entry 7
3.3 ESDAL Review 7
3.4 Swept Path Assessment Results 8
3.5 Swept Path Comments 9
3.6 Height Restrictions 10
3.7 To Review Prior to Delivery 10

4 Site Entrance Location and Details 38

4.1 Proposed Site Entrance Location 38
4.2 Design Manual for Roads and Bridges (DMRB) Guidance 38
4.3 Access Provision and Future Construction Method 39

5 Recommendations for Abnormal Load Route 40

5.1 Proposed Management Measures 40
5.2 Convoy System 40
5.3 Advance Warning Signage 40
5.4 Public Information 41

6 Utility Impact 42

6.1 Utility Contacts 42

7 Summary 43

7.1 Background 43
7.2 Route Review 43
7.3 Further Work 43

1 Introduction

1.1 Introduction

Halcrow Group Limited (hereinafter referred to as Halcrow) have been commissioned by SSE Renewables Development (UK) Ltd (hereinafter referred to as SSE) to undertake a route review for the delivery of abnormal loads associated with the proposed development of the Strathy South Wind Farm, Caithness. Halcrow have been requested to review the route for abnormal loads from the Port of Entry (POE) to the proposed site access from the A836 and to review the proposed route between the Strathy North wind farm development and the proposed Strathy South wind farm development.

This report has been prepared in accordance with instructions from SSE. No liability is accepted for the use of all or part of this report by third parties. This report is copyright of SSE and Halcrow. No section of this report may be reproduced without prior written approval.

To assist the wind farm developer to fulfil their responsibilities Halcrow have been commissioned to prepare this route strategy as an indicative initial source of guidance only. The report identifies the key points and issues associated with the route that may require remedial works to accommodate the predicted loads. The designs of these remedial works, however, are beyond the agreed scope of works. This route strategy identifies necessary further work and consultations and it is the responsibility of the wind farm developer to ensure that the access route from the POE to the site is fit for purpose and that appropriate consideration for all road users has been made in accordance with the relevant health and safety legislation and ruling transport requirements.

1.2 Background

Prior to the commissioning of this report Halcrow had been commissioned to undertake a route review for the delivery of abnormal loads associated with the proposed development of the neighbouring Strathy North Wind Farm, Caithness, reviewing the route for abnormal loads from POE to the proposed site access from the A836. The public road route and the proposed access from the A836 is the same for both proposed development sites.

The first draft of this report considered the impact of transporting the GE Energy 2.75 Series turbine components and formed the basis of the majority of tracking assessments considered in the second draft, which included revised tracking assessments undertaken at POI 16 considering the then nominated Siemens 2.3-93 turbine, based on a rotor diameter of 93m and a hub height of 90m A separate assessment was also commissioned to review the route between the Strathy North wind farm development and the Strathy South wind farm development and was included in the second draft of this report as an Appendix.

The Strathy North route survey considered the same Siemens 2.3-93 turbine but with a shorter hub height of 68m, with subsequent assessments being undertaken at POI 2, the junction between the A9 and A836, to determine the impact of delivering various sized turbine blades.

The third draft of the report was composed of a revised assessment of the route, considering the impacts of transporting the components associated with the nominated REpower 3.4M104 turbine, and combined the assessments of the public road route and the route between the Strathy North wind farm development and the Strathy South wind farm development.

The fourth, fifth, sixth and seventh drafts of the report have taken account of the revised route (preferred and alternative) between the Strathy North wind farm development and the Strathy South wind farm development and comments received.

1.3 Report Structure

Following this introductory Chapter the report is structured as follows:

- the proposed wind farm development is described in Chapter 2, along with details of the proposed abnormal loads
- the route review, the POE facilities and a summary of the swept path assessment results for the access route, based upon data provided by SSE, is described in Chapter 3
- an abnormal loads management plan is outlined in Chapter 4
- the potential impact on underground or overhead services is summarised in Chapter 5 ascertaining if the maximum height and axle loading would have a detrimental impact that may require mitigation
- the report is summarised and concluded in Chapter 6

2 Proposed Wind Farm

2.1 Site Description and Location

The proposals are for the development of a wind farm at Strathy South in Caithness. The site is located to the south of the A836 as shown in Figure 2-1.

2.2 Proposed Turbine Details

SSE requested that the impacts of transporting the REpower 3.4M104 turbine, with a rotor diameter of up to 104m and a hub height of up to 83m (to stay within a tip height of 135m), were assessed. This succeeds the candidate turbines considered in earlier drafts of this report, the GE Energy 2.75 Series turbine and the Siemens 2.3-93 turbine. The component details of the nominated REpower 3.4M104 turbine, relevant to undertaking a horizontal tracking assessment, are summarised in Table 2-1, based on a bespoke maximum hub height of 83m (the standard height is 80m).

Table 2-1: REpower 3.4M104 Component Details

Component	Approx. Length (m)	Approx. Width Bottom (m)	Approx. Width Top (mm)	Approx. Height (m)	Approx. Weight (t)
Blade	50.80	-	-	3.80	12.00
Tower Section 1 (Base)	13.00	4.300	4.300	-	59.00
Tower Section 2 (Mid 1)	20.00	4.300	3.628	-	-
Tower Section 3 (Mid 2)	20.00	3.628	3.002	-	-
Tower Section 4 (Top)	24.70[1]	3.002	3.002	-	-

As introduced above, the first draft of this report considered the impact of transporting the GE Energy 2.75 Series turbine components. Additional tracking assessments were then undertaken at POI 16 considering the then nominated Siemens 2.3-93 turbine with a rotor diameter of 93m and a hub height of 90m. These have now been superseded by the REpower 3.4M104 turbine tracking assessments.

As stated in Chapter 1, a route review for the delivery of abnormal loads associated with the proposed Strathy North Wind Farm development was also undertaken by Halcrow. This considered the same route for transporting abnormal loads from POE to the proposed site access from the A836.

[1] This is a bespoke length considering a bespoke hub height of 83m, (21.70m when based on a standard hub height of 80m)

2.3 Crane Details

It is anticipated that a 9-axle 1200 tonne Liebherr LTM11200 telescopic crane (with a 100m telescopic boom), or similar, will be used to erect the proposed turbines. Figure 2-2 below illustrates the general layout of the crane (sourced from a Liebherr brochure). The crane can be broken down to ensure that the axle loadings are no greater than 12 tonnes.

Halcrow Group Limited, A CH2M HILL COMPANY
16 Abercromby Place, Edinburgh, EH3 6LB
Tel +44 (0)131 272 3300 Fax +44 (0)131 272 3301
www.halcrow.com

Client

STRATHY SOUTH WIND FARM

Notes

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

Drawing

Site Location

Drawn by: AK	Date: 25/06/12
Checked by: -	Date: -
Approved by: -	Date: -

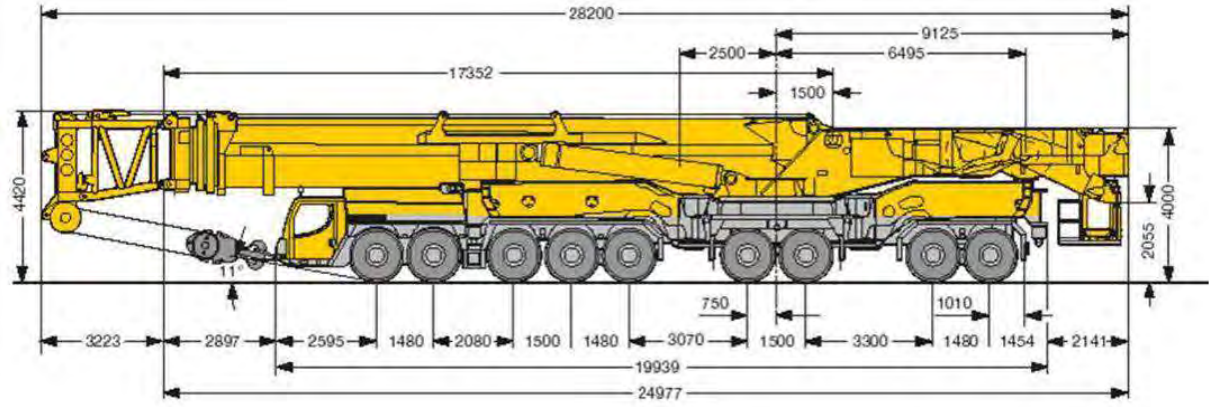
Figure 2-1

Revision -

Drawing Scale: NTS

Drawing file path & name
Xreference file path
User and Plot Date

Figure 2-2: 1200 tonne Liebherr Crane



3 Access Route Review

3.1 Route Review

An Access Route Review (Ref: UK12-17180, 2013) was undertaken by ENVIRON with the aim of identifying the optimal access route taking into account environmental, engineering and planning constraints. Halcrow provided input on the potential constraints in relation to the existing road network. The outcome of this assessment identified that the preferred site access would use the consented bypass proposed for the Strathy North Wind Farm which leaves the A836 at NGR 285247, 965160 (illustrated on Figure 3-1).

3.2 Port of Entry

Scrabster Harbour is considered the optimum Port of Entry (POE). It is located in the district of Caithness and is the sole harbour on the north coast mainland of Scotland with easy access to the A9 and A836.

The abnormal route review was undertaken from Scrabster Harbour to the site access at NGR 285247, 965160 on 01 September 2011, by video survey. This method allows a full record of the route to be undertaken, with notes recorded during and following completion of the survey. Not only is this process efficient, it also provides a much safer working environment for staff. The video survey also allows a full record of the route to be kept for future reference.

3.3 ESDAL Review

Halcrow has undertaken an ESDAL (Electronic Service Delivery for Abnormal Loads) review for the proposed loads using details from the Highways Agency website, www.esdal.com. The review identified the key organisations among the various highways agencies and authorities along the proposed route. Halcrow contacted these key organisations stating that the proposed development 'would require the transportation of wind turbine blades, tower sections and nacelle components on the proposed route from Scrabster Harbour'. Details of the proposed route and the key component dimensions and weights, associated with the GE Energy 2.75 Series turbine components, were provided (a 48.7m blade; a hub height of 85 metres; a maximum axle weight in the order of 14 tonnes; vehicles and cranes with a total weight of maximum 140t; and a maximum height of the loads to be in the order of 4.5 metres). Although the nominated turbine has changed since the original correspondence this does not prejudice the ESDAL assessment responses received. It was also confirmed that as the project is currently at the pre-planning stage, Halcrow was unable to provide a proposed date for transport movements or any detailed load tables. The organisations and their responses are summarised in Table 3-1. The full responses are attached as Appendix A.

Table 3-1: ESDAL Contacts and Responses

Organisation	Consultee Response Summary	Comment
Northern Constabulary	No response as of date of report.	-

Organisation	Consultee Response Summary	Comment
Scotland Transerv	The A9 part of the route is relatively predictable in that most long and heavy abnormal loads configured on long step-frame/ extendable beam trailers or low loaders are acceptable even at 140t gross train weight because the axles are arranged in distinct groups. Vehicles with axle loads up to 14t would however need to be analysed to check suitability. The cranes can be problematic, especially if they may approach 140t as the axles are concentrated together with short gaps between. A crane at this weight may be problematic when crossing the Thurso river bridge as this has a 32HB capacity and a heavy crane such as this may be at a point of overloading this bridge. The alternatives for some cranes would be to strip them down to reduce axle loads. Without accurate vehicle data, no further advice can be given and therefore when vehicle configurations are known a full route analysis, to check structure suitability, can be undertaken.	As stated by Scotland Transerv many cranes can be stripped down to reduce axle loads to allow them to cross bridges, or other structures, that have lower loading capacities. It may be that the crane does not have to cross this bridge but this is dependent on where the crane is being delivered from i.e. by road from the east of Thurso or by sea to Scrabster Harbour.
The Highland Council	A spreadsheet was provided containing details of structures along the proposed route. The comments provided are indicative only, and will require more detailed consideration. It was indicated that, depending on the exact departure point from the A836, the last two structures may or may not be relevant. The summary indicated that all of the A836 bridge structures are either likely or possibly able to carry the proposed abnormal loads. The bridge structures on the public road section of the Lochstrathy track (Strathy West) were determined as being unlikely to be able to carry the prospective abnormal loads.	-

3.4 Swept Path Assessment Results

During the public road route survey it was determined that a detailed swept path assessment was required at a number of the recorded Points of Interest (POI), illustrated on Figure 3-2, (described in Table 3-2 as 'tracking required'). Additionally, a swept path assessment of the entire length of the preferred and alternative routes between the Strathy North development and the Strathy South development has been undertaken (the routes are illustrated on Figure 3-1).

As introduced in section 2.2 this report considers tracking assessments that have been undertaken to determine the impact of transporting the nominated turbine components

associated with the Strathy South development. Summaries of the assessment results are provided in Table 3-2 and the illustrated outputs are provided in Appendix B for review. Where mitigation works are required, these are illustrated on the swept path drawings. The works required are also summarised in Table 3-2. The risk index that follows has been used to quantify the significance of any required improvements and land take at all POI listed in Table 3-2:

- 0: No risk
- 1 – 3: Low risk, some highways land take with limited modifications to street furniture
- 4 – 6: Medium risk with some limited third party land and further investigation required on bridges and other structures
- 7 – 9: High risk with extensive third party land, single track roads or major investigation required on structures
- 10: Route not feasible

It should be noted that manual rear wheel steer has been used at certain locations to minimise widening requirements along the route. Where mitigation works are required, these are illustrated on the swept path drawings.

It should be noted that both sides of the carriageway on the public road network and the whole width of the Access Track would be required along a significant proportion of the proposed delivery route due to the load and vehicle dimensions and the configuration of the loads on the vehicles. This would be particularly true at bends in the road. Therefore, appropriate traffic management would be required.

The drawings in Appendix B, illustrate both the blade and base tower sections. The drawings are for information only and should not be scaled from. The colours provided on the swept paths are as follows:

- blue: vehicle/trailer outline (body swept path)
- red: wheel tracked pathway (wheel swept path)
- green: load over-sail tracked path (load swept path)

Please note that any alterations to the load or vehicle details considered as part of this assessment will invalidate the assessment results.

3.5 Swept Path Comments

It is important to note that the swept path assessments undertaken have been based on OS mastermap data and indicative data supplied by SSE on the proposed route between Strathy North and Strathy South. There is likely to be measurement errors associated with the use of the OS mastermap data and therefore, to define the exact swept path, site specific topographical survey data must be recorded and the swept path must be reassessed.

The swept path assessment builds in a degree of safety margin that tends to provide a conservative estimate of the required area. Consequently, Halcrow recommends that a

trial run must be undertaken before the delivery of actual components to confirm the findings of this and any future model based study.

3.5.1 Public Roads

The future Works Contactor would present the final detailed design drawings to The Highland Council highways department for approval prior to the development commencing. All appropriate permits and consents for temporary works would be the responsibility of the Contractor. Prior to any highway works commencing the areas should be checked for underground utilities equipment.

All works would be carried out to the approval of The Highland Council highways authority and all modifications carried out to the public highway are to be reinstated to their satisfaction.

Reinstatement on any temporary works or signage should be carried out at the end of the turbine delivery and erection period. This would also prevent the new junctions from being used as lay-bys by road users.

3.6 Height Restrictions

With regard to height restrictions, it is worth noting that 'The Electrical Safety, Quality and Continuity Regulations 2002' states that the 'height above ground of any wire or cable which is attached to a support carrying any overhead line shall not be less than 5.8 metres at any point where it is over a road accessible to vehicular traffic'. Also, the bridges straddling the proposed route are able to accommodate heights greater than the vehicle/load combinations proposed. The Transport Scotland website contains advisory routes, which are either 18' (5.48 m) or 20' (6.09 m), for extremely high loads. High vehicles are those which cannot pass safely under a bridge of 16'-6" (5.03 m) minimum headroom; or have a vehicle/load combination greater than 16'-3" (4.95 m) high – allowing for the minimum safety margin of 0.275 m.

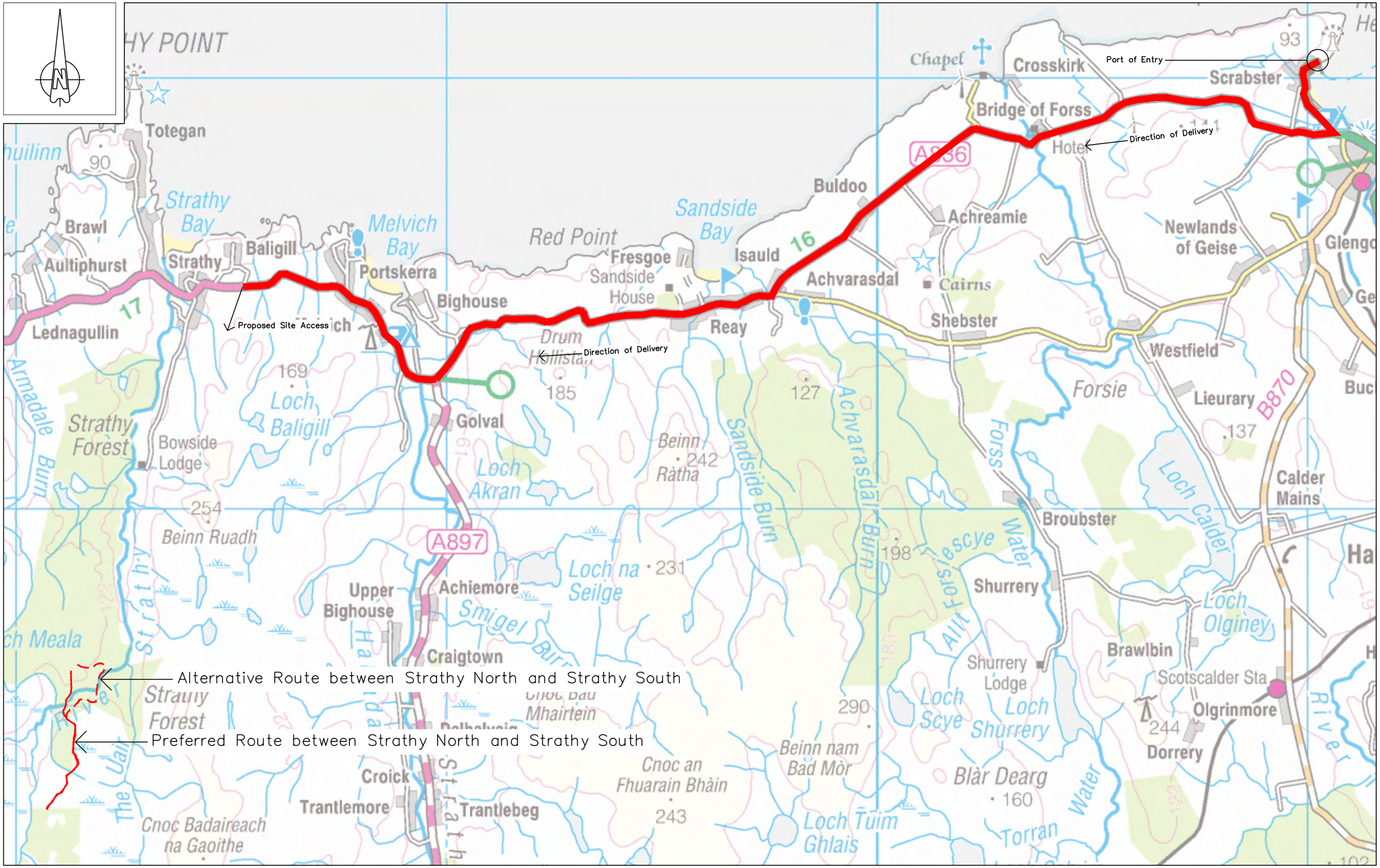
With regard to adjacent landscaping, the Highland Council's 'Roads and Transport Guidelines for New Developments' refers to the potential requirement to remove or cut back trees or vegetation along abnormal load delivery routes. Within these guidelines, reference is made to the location of trees stating that 'trees should be sited to permit full branch growth and spread. Trees that are too close to the kerb may come into regular contact with high vehicles, affecting their growth. Where this could happen, trees should be sited such that their branches will not be within 450 mm of the kerbline for their first 5.3 m height.' Although the Highland Council's guidelines regarding the location of trees is specifically for the locating of new trees, this provides a good basis for informing the necessary trimming of overhanging tree branches or side vegetation.

Table 3-2 includes a catalogue of the tree canopy and any other overhead issues cited during the September 2011 survey.

3.7 To Review Prior to Delivery

Halcrow has undertaken a high level review of the access route from the POE to the proposed access from the A836. The following need to be undertaken prior to the delivery of the abnormal loads, to ensure load and road user safety:

- record site specific topographical survey data and reassess the swept path assessments, including on the chosen route between Strathy North and Strathy South
- a further review of maximum axle loading on structures along the proposed route in consultation with the relevant roads agencies;
- a review of clear heights with utility providers and the transport agencies along the route;
- undertake a trial run before the delivery of actual components to confirm the findings of this and any future model based study;
- final detailed design drawings will need to be presented to The Highland Council highways department for approval prior to the development commencing with all appropriate permits and consents for temporary works the responsibility of the Contractor;
- all works must be carried out to the approval of The Highland Council highways authority and all modifications carried out to the public highway must be reinstated to their satisfaction;
- ensure any vegetation which may foul the loads is trimmed back to allow passage (this is of concern once the load is on the local road network and should be assessed for summer conditions);
- confirm there are no roadworks or closures that could affect the passage of the loads;
- check no new or diverted underground services on the proposed route are at risk from the abnormal loads;
- confirm the various police constabularies are satisfied with the route being used and the local roads authorities have been contacted regarding the proposed loads and suggested route;
- undertake a condition survey to determine the extents of any existing highway defects and agree this in advance of any load movements with the roads agencies to protect the client group from unrelated damage claims; and
- the developer contacts the appropriate agencies to ensure that the above points are reviewed before the transport of the components commences.



Halcrow Group Limited, A CH2M HILL COMPANY
16 Abercromby Place, Edinburgh, EH3 6LB
Tel +44 (0)131 272 3300 Fax +44 (0)131 272 3301
www.halcrow.com

Client

Notes

STRATHY SOUTH WIND FARM

Rev	By	Chkd	Approvd	Date	Description
A	AK	AK	JP	31/05/13	Change to Proposed Strathy North to Strathy South Route

Drawing

Proposed Delivery Route

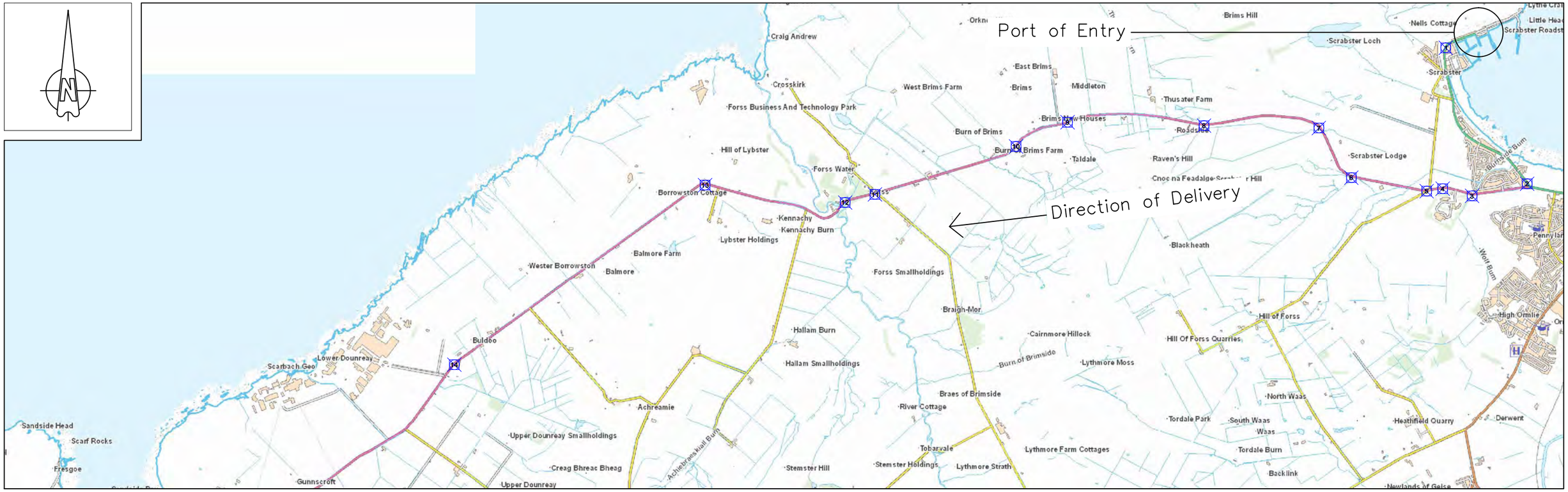
Drawn by: AK Date: 23/10/12
Checked by: - Date: -
Approved by: - Date: -

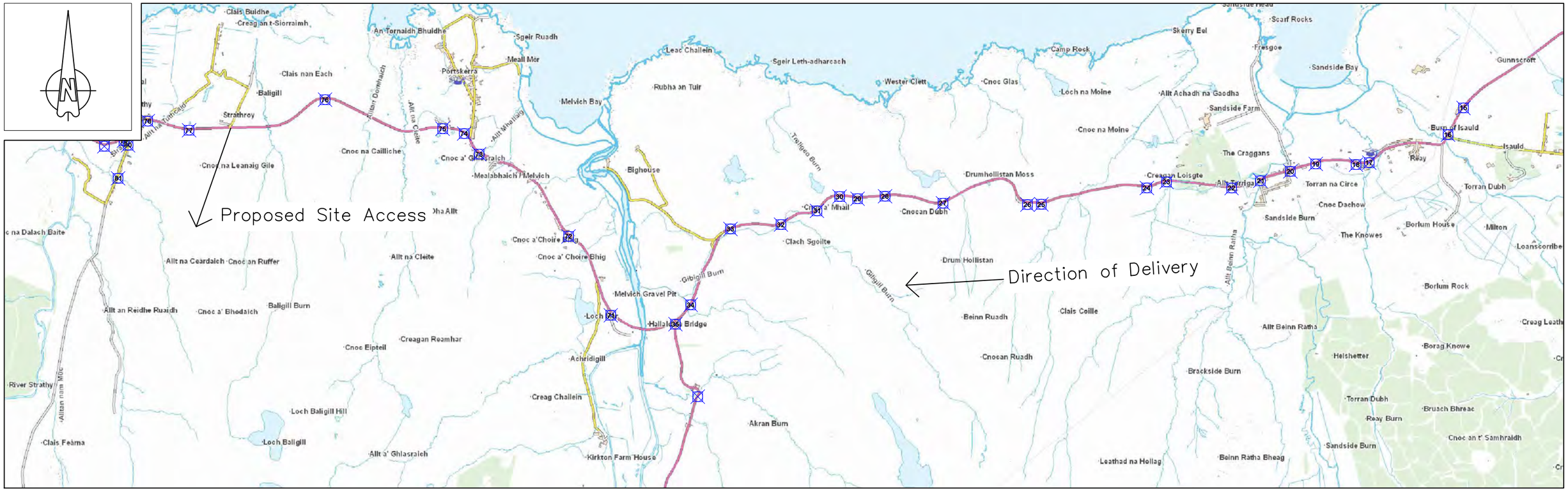
Figure 3-1

Revision A

Drawing Scale: NTS

Drawing file path & name:
Xreference file path:
User and Plot Date





Halcrow Group Limited, A CH2M HILL COMPANY
16 Abercromby Place, Edinburgh, EH3 6LB
Tel +44 (0)131 272 3300 Fax +44 (0)131 272 3301
www.halcrow.com

Halcrow
A CH2M HILL COMPANY

Client: SSE Renewables

STRATHY SOUTH WIND FARM

Notes

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

Drawing: Surveyed Points of Interest

Drawn by: AK — Date: 25/06/12
Checked by: - — Date: -
Approved by: - — Date: -

Figure 3-2

Revision: -

Drawing Scale: NTS

Drawing file path & name: Xreference file path: User and Plot Date

Table 3-2: POI Summary of Public Road Route (please note comments in Section 3.5)

POI 1	POI 2	POI 2
OSGR: 309902,970271	OSGR: 310733,968886	OSGR: 310733,968886
straddle	horizontal tracking	horizontal tracking
Loads are anticipated to straddle the centre line. Falling rocks waning signs were also noted.	The tracking assessment highlights there would be a significant amount of over-run required to accommodate the movements, mainly to the south of the A836. This over-run would require the removal/relocation of adjacent street furniture and boundary fences/walls. There would also be associated over-sail extending beyond the over-run areas. The over-run areas to the south of the A836 extend beyond the highway boundary and encroaches third-party land, while the over-sail area to the east of the A9 is within the adjacent highway boundary. See Drawing GGRSSE003/9001.	The tracking assessment evaluates the turbine components at this location excluding the use of manual rear wheel steer, providing a conservative estimate of the mitigation required.
Risk = 0, No Risk	Risk = 7, High Risk	-

POI 3	POI 4	POI 5
OSGR: 310171,968763	OSGR: 309871,968836	OSGR: 309708,968811
straddle	straddle	straddle
Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.
Risk = 0, No Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI 6	POI 7	POI 8
OSGR: 308939,968948	OSGR: 308607,969454	OSGR: 307435,969478
straddle	straddle	straddle
Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.
Risk = 0, No Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI 9	POI 9	POI 10
OSGR: 306042,969513	OSGR: 306042,969513	OSGR: 305516,969266
straddle	straddle	straddle
Loads are anticipated to straddle the centre line.	-	Loads are anticipated to straddle the centre line.
Risk = 0, No Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI 11	POI 12	POI 12
OSGR: 304076,968778	OSGR: 303772,968695	OSGR: 303772,968695
tree canopy/side vegetation	horizontal tracking	horizontal tracking
It will be necessary to ensure that all tree canopies and side vegetation are trimmed along the route in order to avoid fouling the loads. A clear head height of 5.3m, as specified in the Highland Council's 'Roads and Transport Guidelines for New Developments', is considered adequate for all the turbine loads under consideration.	The tracking assessment evaluates the turbine components at this location, which highlights that the proposed tower loads can negotiate this left-hand bend and subsequent right-hand bend with no impact beyond the road edge. However the proposed blade loads will require minor vehicle and load over-sail within the highway boundary. See Drawing GGRSSE003/9002.	The photograph above is a second view of POI 12 at the right-hand bend. See Drawing GGRSSE003/9003.
Risk = 0, No Risk	Risk = 2, Low Risk	-

POI 13	POI 14	POI 15
OSGR: 302342,968872	OSGR: 299783,967043	OSGR: 297838,965366
horizontal tracking	straddle	straddle
The tracking assessment highlights that the proposed tower loads can negotiate this left-hand bend and subsequent right-hand bend with no impact beyond the road edge. However the proposed blade loads will require minor vehicle and load over-sail within the highway boundary. See Drawing GGRSSE003/9004.	Loads are anticipated to straddle the centre line avoiding the telegraph poles and signage close to the carriageway edge.	Loads are anticipated to straddle the centre line.
Risk = ,2, Low Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI 16	POI 17	POI 18
OSGR: 297680,965093	OSGR: 296876,964807	OSGR: 296741,964787
horizontal tracking	straddle	straddle
The assessment evaluated the impacts of the nominated turbine worst-case components which highlighted that third-party land and the bridge structure can be avoided using manual rear wheel steer, although there would be over-run beyond the carriageway edge into highways land. This, and associated over-sail, is concentrated to the south of the A836. The over-run/over-sail combination would require the removal/relocation of adjacent street furniture. See Drawing GGRSSE003/9005.	Loads are anticipated to straddle the centre line avoiding the telegraph poles, street lighting and signage close to the carriageway edge.	Loads are anticipated to straddle the centre line.
Risk = 5, Medium Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI 19	POI 20	POI 21
OSGR: 296330,964794	OSGR: 296071,964718	OSGR: 295765,964622
straddle	vertical tracking	horizontal tracking
Loads are anticipated to straddle the centre line.	Humped section of road. A swept path assessment (vertical tracking) required at this location to confirm movement and the extent of any required works. This will require a topographical survey to be completed.	The tracking assessment evaluated the nominated turbine components at this location, highlighting that the proposed abnormal loads can negotiate this bridge/right-hand bend combination with minor over-sail impact beyond the road edge, but within the highway boundary. See Drawing GGRSSE003/9006.
Risk = 0, No Risk	-	Risk = 1, Low Risk

POI 22	POI 23	POI 24
OSGR: 295471,964548	OSGR: 294807,964610	OSGR: 294606,964549
straddle	horizontal tracking	straddle
Loads are anticipated to straddle the centre line.	The tracking assessment evaluated the nominated turbine components at this location, highlighting that the proposed abnormal loads can negotiate this left-hand bend/right-hand bend combination with nominal over-sail beyond the road edge with no impact anticipated. See Drawing GGRSSE003/9007.	Loads are anticipated to straddle the centre line.
Risk = 0, No Risk	Risk = 1, Low Risk	Risk = 0, No Risk

POI 25	POI 26	POI 27
OSGR: 293529,964382	OSGR: 293387,964379	OSGR: 292525,964393
straddle	horizontal tracking	straddle
Loads are anticipated to straddle the centre line.	The tracking assessment evaluated the nominated turbine components at this location, highlighting that the proposed abnormal loads can negotiate this right-hand bend/left-hand bend combination with minor vehicle and load over-sail beyond the road edge with the only potential impact being on a road sign located on the eastern side of the A836 north of the lay-by. See Drawings GGRSSE003/9008 and GGRSSE003/9009.	Loads are anticipated to straddle the centre line.
Risk = 0, No Risk	Risk = 2, Low Risk	Risk = 0, No Risk

POI 28	POI 29	POI 30
OSGR: 291934,964464	OSGR: 291653,964439	OSGR: 291470,964461
straddle	straddle	straddle
Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.
Risk = 0, No Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI 31	POI 32	POI 33
OSGR: 291239,964315	OSGR: 290871,964175	OSGR: 290356,964130
horizontal tracking	horizontal tracking	straddle
The tracking assessment evaluated the nominated turbine components at this location, highlighting that the proposed abnormal loads can negotiate this right-hand bend/left-hand bend combination with minor vehicle and load over-sail beyond the road edge with the only potential impact being on adjacent marker posts on the southern side of the A836. See Drawing GGRSSE003/9010.	The tracking assessment evaluated the nominated turbine components at this location, highlighting that the proposed abnormal loads can negotiate this right-hand bend/left-hand bend combination with nominal over-sail beyond the road edge with no impact anticipated. See Drawing GGRSSE003/9011.	Loads are anticipated to straddle the centre line.
Risk = 2, Low Risk	Risk = 1, Low Risk	Risk = 0, No Risk

POI 34	POI 71	POI 72
OSGR: 289950,963356	OSGR: 289134,963249	OSGR: 288703,964054
straddle	straddle	straddle
Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.
Risk = 0, No Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI 73	POI 74	POI 75
OSGR: 287791,964894	OSGR: 287638,965104	OSGR: 287418,965154
straddle	straddle	care point
Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.	Cattle grid on road. This will require reinforcement to allow loads to pass safely.
Risk = 0, No Risk	Risk = 0, No Risk	Risk = 1, Low Risk

POI 76	POI 77	Access from A836 between POI 76 and POI 77
OSGR: 286218,965450	OSGR: 284830,965138	OSGR: 285247,965160
straddle	straddle	horizontal tracking
Loads are anticipated to straddle the centre line.	Loads are anticipated to straddle the centre line.	At the proposed access, the tracking assessment highlights there would be significant over-run and associated over-sail to support the movements on the land south of the A836. This would require significant works due to the adjacent drainage ditch and level differences between the land to be traversed and the A836 and track (that the new haul road would be based on). This option is also considered for the neighbouring Strathy North Wind Farm and likely to have been constructed prior to the development movements, hence the lower risk applied below. The impact on the bus stop will have to be considered, and may be best to relocate this. See Drawing GGRSSE003/9012.
Risk = 0, No Risk	Risk = 0, No Risk	Risk = 0, No Risk

POI Summary of Preferred Section of Route between Strathy North and Strathy South (please note comments in Section 3.5)

-	-	-
Right-hand Bend	Left-hand Bend	Successive Bends
The assessment estimates some minor over-sail beyond the track edge for both components assessed.	The assessment estimates some over-run beyond the track edge for the blade component movements considered. Load and vehicle over-sail are anticipated for all component movements.	The assessment estimates minor over-run beyond the track edge for the blade component movements considered. Load and vehicle over-sail are anticipated for all component movements.
See Drawing GGRSSE003/9016	See Drawing GGRSSE003/9017	See Drawing GGRSSE003/9018

-
Successive Left-hand Bends
The assessment estimates minor over-run beyond the track edge for the blade component movements considered. Load and vehicle over-sail are anticipated for all component movements.
See Drawing GGRSSE003/9019

POI Summary of Alternative Section of Route between Strathy North and Strathy South (please note comments in Section 3.5)

-	-	-
Successive Right-hand Bends	Right-hand Bend	Successive Left-hand Bends
The assessment estimates some minor over-run beyond the track edge. Load and vehicle over-sail are anticipated beyond the carriageway edge for all components considered in the assessment.	The assessment estimates some over-run beyond the track edge. Load and vehicle over-sail are anticipated beyond the carriageway edge for all components considered in the assessment.	The assessment estimates some minor over-run beyond the track edge. Load and vehicle over-sail are anticipated beyond the carriageway edge for all components considered in the assessment.
See Drawing GGRSSE003/9021	See Drawing GGRSSE003/9022	See Drawing GGRSSE003/9023

-	-	-
Sharp Right-hand Bend and Subsequent Right-hand Bend	Successive Bends	Successive Bends
The assessment estimates significant over-run beyond the track edge for all component movements considered most significantly with the movement of the blade component. Load and vehicle over-sail are anticipated beyond this. It is recommended that the track is realigned at this location.	The assessment estimates some over-run beyond the track edge for the blade component movements considered. Load and vehicle over-sail are anticipated for all component movements.	The assessment estimates that load and vehicle over-sail are anticipated beyond the track edge for all component movements.
See Drawing GGRSSE003/9025	See Drawing GGRSSE003/9026	See Drawing GGRSSE003/9027

-
Left-hand Bend
The assessment estimates over-run beyond the track edge for the blade component movements considered. Load and vehicle over-sail are anticipated for all components considered.
See Drawing GGRSSE003/9028

POI Summary of Common Section of Route between Strathy North and Strathy South (please note comments in Section 3.5)

-	-	-
Right-hand Bend	Successive Bends	Left-hand Bend
The assessment estimates some over-run beyond the track edge for all component movements considered most significantly with the movement of the blade component. Load and vehicle over-sail are anticipated beyond this.	The assessment estimates minor over-run beyond the track edge for some component movements considered in the assessment. Load and vehicle over-sail are anticipated beyond the track edge for all component movements.	The assessment estimates over-run beyond the track edge for all component movements considered in the assessment. Load and vehicle over-sail are also anticipated beyond the estimated over-run.
See Drawing GGRSSE003/9029	See Drawing GGRSSE003/9029 and GGRSSE003/9030	See Drawing GGRSSE003/9031

-	-	-
Right/Left S-Bend	Right-hand Bend	Left-hand Bend
The assessment estimates over-run beyond the track edge for all component movements considered in the assessment. Load and vehicle over-sail are also anticipated beyond the estimated over-run.	The assessment estimates that load and vehicle over-sail are anticipated beyond the track edge for all component movements.	The assessment estimates over-run beyond the track edge for all component movements considered in the assessment. Load and vehicle over-sail are also anticipated beyond the estimated over-run.
See Drawing GGRSSE003/9031 and GGRSSE003/9032	See Drawing GGRSSE003/9032	See Drawing GGRSSE003/9034

-	-	-
Right-hand Bend	Right-hand Bend	Left-hand Bend
The assessment estimates over-sail beyond the track edge for all component movements considered in the assessment.	The assessment estimates minor over-run and over-sail beyond the track edge for all component movements considered in the assessment.	The assessment estimates over-sail beyond the track edge for all tower component movements considered in the assessment.
See Drawing GGRSSE003/9034	See Drawing GGRSSE003/9035	See Drawing GGRSSE003/9035 and GGRSSE003/9036

-
Left-hand Bend
The assessment estimates over-sail beyond the track edge for all tower component movements considered in the assessment.
See Drawing GGRSSE003/9037

4 Site Entrance Location and Details

4.1 Proposed Site Entrance Location

Egress from the A836 for construction vehicles, including abnormal load delivery vehicles, is proposed, by the developer, to be taken via a single priority junction arrangement from the Baligill/Strathroy junction on the A836, prior to reaching the town of Strathy. The proposed site entrance is proposed to be located at OSGR 285247,965160.

4.2 Design Manual for Roads and Bridges (DMRB) Guidance

4.2.1 Visibility

It is anticipated that the proposed A836 junction take the form of a simple priority junction, designed to accommodate the movement of all development related traffic, including the abnormal load vehicles. It is essential that drivers approaching the priority junction, from both the major road and the minor road, should have unobstructed visibility to permit them to make their manoeuvre safely.

Drivers approaching the junction along the major road should be able to see the entry from a distance corresponding to the desirable minimum stopping sight distance (SSD) for the design speed of the major road. The speed limit on the A836 is 60 mph (96 kph), which corresponds to a design speed of 100 kph. Therefore, an SSD of 215 m is required, as defined in DMRB. This visibility allows drivers on the major road to be aware of traffic entering from the minor road in time for them to be able to slow down and stop safely if necessary.

The distance back along the minor road from which the full visibility is measured is desirably 9.0 m. However, a relaxation from 9.0 m to 4.5 m for lightly trafficked simple junctions can be made. The distance from which the full visibility distance is provided, should not be more than 9.0 m, as this induces high minor road approach speeds into the junction and leads to excessive land take. A distance of 4.5 m has been assumed in this case.

Drivers approaching the priority junction along the minor road should have unobstructed visibility of the junction from a distance corresponding to the SSD for the design speed of the minor road. A speed limit on the minor road of 30 mph (48 kph) has been assumed, which corresponds to a design speed of 60 kph. As defined in DMRB, a SSD of 90 m is required allowing drivers time to slow down safely at the junction, or stop, if necessary.

From a point 15 m back along the centreline of the minor road measured from the continuation of the line of the nearside edge of the running carriageway of the major road an approaching driver should be able to see clearly the junction form, and those peripheral elements of the junction layout. This provides the driver with an idea of the junction form, possible movements and conflicts, and possible required action before reaching the major road.

4.3 Access Provision and Future Construction Method

The specific details of any improvements or new 'public' road sections created i.e. the public road junction for the access route, or where improvements are required for the proposed public access section of the A836 road, must be agreed with The Highland Council. Issues that these approvals may require include:

- The first 15-20 metres of the haul road may have be constructed in full road construction and surfaced in 75 mm thick single course macadam, as per the Road Authority's desired specification;
- The visibility requirements of the junction, described above in Section 4.2.1, between the public road and the site access road would be agreed with the Council. Any verge side slopes would be graded, to provide the required visibility splays in both directions;
- The existing drainage ditch adjacent to the A836 would likely to have to be piped using a minimum 500 mm diameter piping in a concrete surround. The size of the pipe should be determined following a required assessment; If drains are required, these would be located on each side at the beginning of the access track to ensure that water would not discharge from the haul road onto the public road. These would drain into the 500 mm drainage piping; and
- An application for a road opening permit could be required before works commence on the road opening.

However, it should be noted that the proposed access for Strathy South from the A386 is the same for the consented Strathy North wind farm. Therefore, it is considered likely that the issues highlighted above, would have already been addressed as part of the construction for the Strathy North site entrance.

5 Recommendations for Abnormal Load Route

5.1 Proposed Management Measures

This chapter introduces a number of traffic management measures that could help reduce the impact of the abnormal load convoys. These measures are currently presented as indicative, to be confirmed with the various highways agencies and constabularies closer to the construction date.

5.2 Convoy System

A police escort would be required to facilitate the delivery of the predicted loads. The police escort would be further supplemented by a civilian pilot car to assist with the escort duty. It is proposed that an advanced escort would warn oncoming vehicles ahead of the convoy, with one escort staying with the convoy at all times. The escorts and convoy would remain in radio contact at all times where possible.

The abnormal load convoys should be no more than three HGVs long, to permit safe transit along the delivery route and to allow limited overtaking opportunities for following traffic where it is safe to do so. Where designated passing bays are provided to allow oncoming vehicles to pass the convoy, these would be controlled by one of the escort vehicles. The passing bays would also be marked to discourage people parking in them. The passing bays are predominantly required for the delivery of turbine tower and nacelle components.

The times at which the convoys would travel would need to be agreed with the local constabularies. Typical delivery times for similar projects has seen the early morning periods used in constrained sections, as traffic levels are generally lighter than those found in the afternoon.

A full convoy operation plan would be developed in consultation with the various highways and constabulary agencies along the route and agreed before deliveries commence to the site.

5.3 Advance Warning Signage

Advance warning signs would be installed on the approaches to the affected roads network. Temporary signage advising drivers that abnormal loads would be operating could be erected on the route to help assist drivers, such as the example shown in Figure 5-1.

The purpose of the advance warning signage would be to help improve driver information and allow drivers of oncoming traffic to consider proceeding to the nearest convenient passing bay, or breaking their journey until the convoy has moved on.

To further improve driver information, it is suggested that Variable Message Signs (VMS), operated by Transport Scotland (located on the approach to Wick from the south), are used to warn drivers of abnormal loads operating on the trunk road sections of the route. This would display information warning of possible delays and would allow drivers to consider alternative routes, if possible.

Figure 5-1: Indicative Information Sign

5.4 Public Information

Information on the movement of abnormal load convoys should be provided to local media outlets to help assist the public. Information could be provided to local newspapers and radio stations, which may include:

- The Press and Journal newspaper
- John O'Groats Journal (newspaper)
- Caithness Courier
- Caithness Community Website
- Caithness FM
- BBC Radio Scotland
- BBC Radio nan Gaidheal

Information would relate to expected vehicle movements from the POE through to the site accesses. It is hoped that this level of information would make residents aware of convoy movements and help reduce any potential conflicts.

Halcrow also suggests that the developer considers producing a local newsletter for distribution to properties along the most affected sections of the proposed access route, advising of convoy movements and the measures put in place to ensure the safe and efficient operation of the road network.

6 Utility Impact

6.1 Utility Contacts

In order to review any impact on underground or overhead services, contact should be made with the following utility firms to ascertain if the maximum height and axle loading would have a detrimental impact that may require mitigation:

- Verizon UK Limited
- Scottish Power Data Management
- British Telecom
- Scottish & Southern Energy
- Geo Networks Limited
- Scotland Gas Networks (SGN)
- Cable & Wireless
- Thus PLC
- Virgin Media
- National Grid

Halcrow has not undertaken any service impact assessments and these remain the responsibility of the wind farm developer.

7 Summary

7.1 Background

Halcrow was commissioned by SSE to undertake an initial route review for the delivery of abnormal loads associated with the proposed Strathy South Wind Farm. Halcrow has undertaken a route review for abnormal loads from the POE through to the proposed location where abnormal loads would exit the public road network (A836) and of the routes between the Strathy North development and the Strathy South development.

This report identifies the key points and issues associated with the route. It is the responsibility of the wind farm developer to ensure that the access route from the POE to the site is fit for purpose and that appropriate consideration for all road users has been made in accordance with the relevant health and safety legislation and ruling transport requirements.

7.2 Route Review

The access review has been undertaken from the POE through to the proposed location where abnormal loads would exit the public road network (A836) and on the routes between the Strathy North development and the Strathy South development, and consultation with the statutory authorities has been undertaken. Based on this initial indicative review only, it appears that the route could be suitable for the movement of the anticipated loads, although careful manoeuvring would be required at several key locations with mitigation required to accommodate the anticipated abnormal load movements at some. However, as noted in section 3.5 there is likely to be measurement errors associated with the use of the OS mastermap data and the data supplied by SSE relating to the route between Strathy North and Strathy South, and therefore, to define the exact swept path, site specific topographical survey data should be recorded and the swept path must be reassessed. The public road section of the proposed route is the same as the route to be used to deliver the turbine components for the Strathy North wind farm.

Halcrow has identified the extent of the required improvement works based on horizontal tracking assessments and these are provided for guidance for the client group's civil engineers and quantity surveyors to review for engineering feasibility and cost review.

7.3 Further Work

The following work is recommended to SSE:

- The work outlined in Section 3.7;
- Review the A836 constraint locations using a topographical base plan to confirm the extents of mitigation works and requirement for land beyond the highway boundary;
- Undertake a land registry review at the constraint points (assumed to be undertaken in house by SSE); and
- A detailed Traffic Management Plan (TMP) would be essential for this project.

Appendix A – ESDAL Responses

Kerr, Alan

From: Norman Smart [Norman.Smart@highland.gov.uk]
Sent: 07 June 2012 12:00
To: Kerr, Alan
Cc: Iain Moncrieff; David MacKenzie - Structures; Abnormal Loads; Marsela McLeod
Subject: RE: Abnormal Loads Review - Wind Farm
Attachments: Proposed Strathy.xls

Your enquiry regarding abnormal loads travelling to proposed wind farm near Strathy has been passed to me for consideration.

I attach spreadsheet which contains details of structures along the proposed route as indication. The comments in column J are indicative only, and will require more detailed consideration. Depending on exact departure point of the A836 the last two structures may or may not be relevant.

At this stage in your proposed development, you should liaise directly with either myself or David Mackenzie in Structures Section, and Iain Moncrieff in The Council's Area Office in Wick.

Regards,

Norman

Norman D Smart

Principal Engineer (Structures)
The Highland Council
TEC Services
Osprey House
Alness Point Business Park
ALNESS
IV17 0UP

Tel 01349 886754
Fax 01349 886749
E-mail norman.smart@highland.gov.uk

PROPOSED STRATHY WIND FARM

Item Type	Bridge Code	Bridge Name	Easting	Northing	No Of Spans	Overall Length of Structure (m)	Structural Form	Superstructure Type	Notes and likelihood of being able to safely carry proposed abnormal indivisible loads (AIL) - viz. 148Te gross and 14/13.5 Te axles at c. 1.5m centres.
BRIDGE	A08360409	SMITHY	309521	968843	1	4	New structure	Concrete Slab	**DESIGN LOADING - FULL HA & 37.5 UNITS HB. Able to carry proposed AIL.**
BRIDGE	A08360400C29	BRIMS	305240	969135	1	2.88	Simply Supported Deck,	Concrete Slab	**Likely to be able to carry proposed AIL**
BRIDGE	A08360400C01	UNNAMED	303790	968720	1	2.5	Simply Supported Deck, Arch Fixed Ends	Masonry Arch widened with Concrete Slab	SINGLE SPAN MASONRY ARCH, WIDENED IN RC AND WITH MASONRY FLAGS. **Likely to be able to carry proposed AIL. AVOID MASONRY FLAG SECTION ON UPSTREAM SIDE.**
BRIDGE	A08360400	FORSS	303723	968665	2	16	Arch Fixed Ends	Masonry Arch widened in concrete	**Category B Listed . Possibly able to carry proposed AIL.**
BRIDGE	A08360390	ISAULD	297650	965035	2	8	Arch Fixed Ends	Masonry Arch	**Possibly able to carry proposed AIL**
BRIDGE	A08360380	OLD REAY	296980	964902	1	4.02	Arch Fixed Ends	Masonry Arch	**Possibly able to carry proposed AIL**
BRIDGE	A08360370	NEW REAY	295730	964613	2	18.4	Arch Fixed Ends	Masonry Arch	**Possibly able to carry proposed AIL**
BRIDGE	A08360360C73	DRUMHOLLINSTON NC	293880	964490	1	2.85	Simply Supported Deck	Concrete Slab	**Possibly able to carry proposed AIL**
BRIDGE	A08360360	HALLADALE	289470	963180	2	48.8	Simply Supported Deck	Pre stressedConcrete Beams/Slab	**Likely to be able to carry proposed AIL**
BRIDGE	A08360349	ALLT NA CLEITE	287000	965100	1	3	New structure		**DESIGN LOADING - FULL HA & 37.5 UNITS HB. Able to carry proposed AIL.**
BRIDGE	A08360339	BALIGILL	285600	965300	1	5	New structure		**DESIGN LOADING - FULL HA & 37.5 UNITS HB. Able to carry proposed AIL.**
BRIDGE	U17960000C11	TUTHCAID	284205	965000	1	2.7	Simply Supported Deck	Concrete Slab	**Assessment required. UNLIKELY to be able to carry proposed AIL.**
BRIDGE	U17960010	CEARDAICH	284100	964640	1	3.7	Arch Fixed Ends	Masonry Arch	**Assessment required. UNLIKELY to be able to carry proposed AIL.**

Kerr, Alan

From: Wigley, Keith [keith.wigley@scotland.transerv.co.uk]
Sent: 07 June 2012 16:43
To: Kerr, Alan
Subject: RE: Abnormal Loads Review - Wind Farm

Movement of wind farm associated abnormal loads from Scrabster to Strathy.

The A9 part of the route is relatively predictable in that most long and heavy abnormal loads configured on long step-frame/extendable beam trailers or low loaders are acceptable even at 140t gross train weight because the axles are arranged in distinct groups. Vehicles with axle loads up to 14t would however need to be analysed to check suitability.

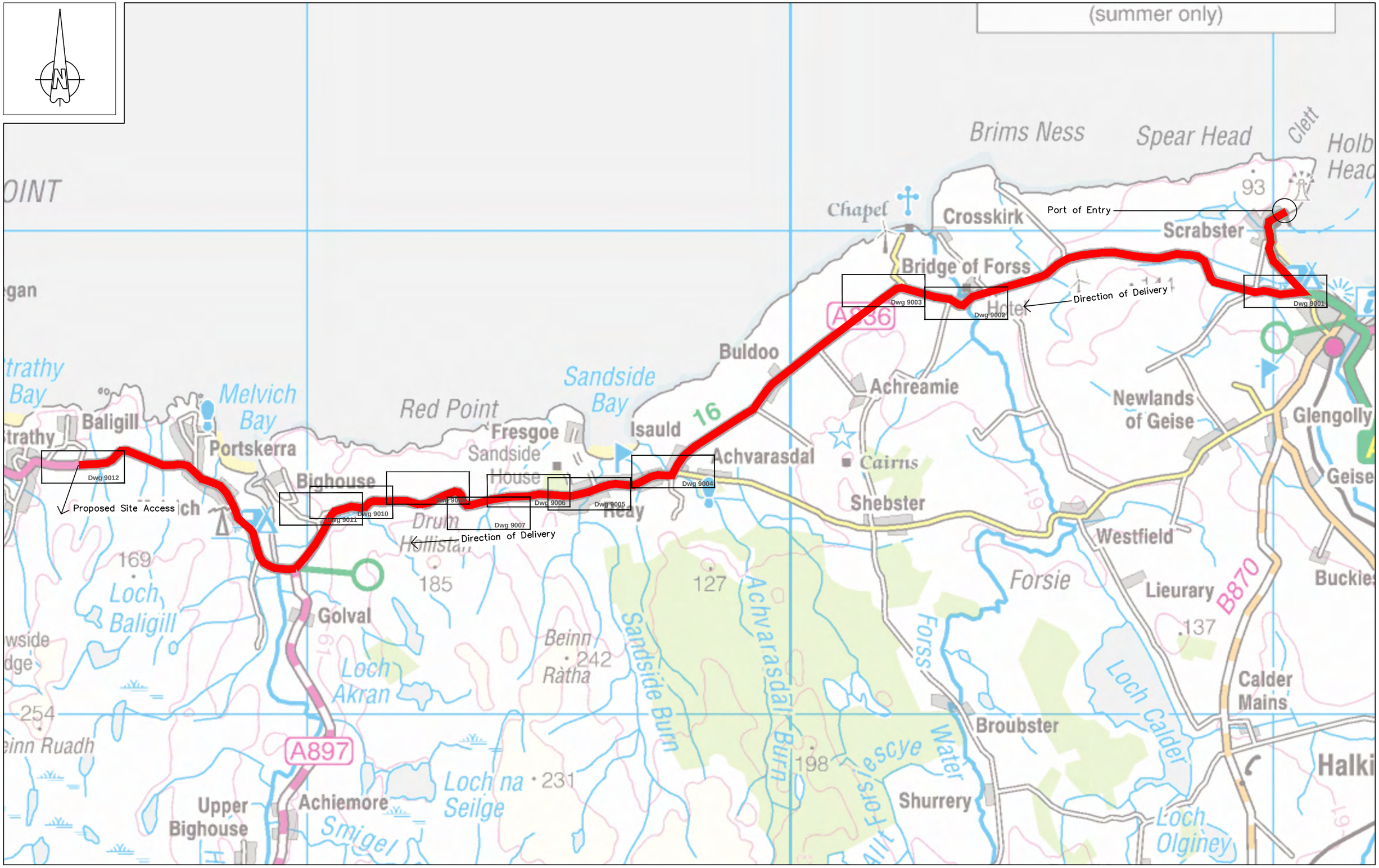
The cranes can be problematic, especially if as you say they may approach 140t as the axles are concentrated together with short gaps between. A crane at this weight may be problematic when crossing the Thurso river bridge as this has a 32HB capacity and a heavy crane such as this may be at a point of overloading this bridge. When the vehicle configuration is known, I can do a route analysis to check the bridges suitability. The alternatives for some cranes would be to strip them down a bit to reduce axle loads. If you have the crane configuration which can be obtained from most of the manufacturers, I can run the vehicle through out analysis software however without accurate vehicle data, I can't really give any further advice at the moment.

Feel free to call me on the number listed below if you require clarification on any issues regarding the A9.

Regards

Keith Wigley
Bridge Engineer
Scotland*TranServ*
Tel: +44 01738 455380
Fax: +44 01738 455301
Email: keith.wigley@scotland.transerv.co.uk

Appendix B – Swept Path Assessment Drawings



Halcrow Group Limited, A CH2M HILL COMPANY
16 Abercromby Place, Edinburgh, EH3 6LB
Tel +44 (0)131 272 3300 Fax +44 (0)131 272 3301
www.halcrow.com

Halcrow
A CH2M HILL COMPANY

Client

SSE Renewables

STRATHY SOUTH WIND FARM

Notes

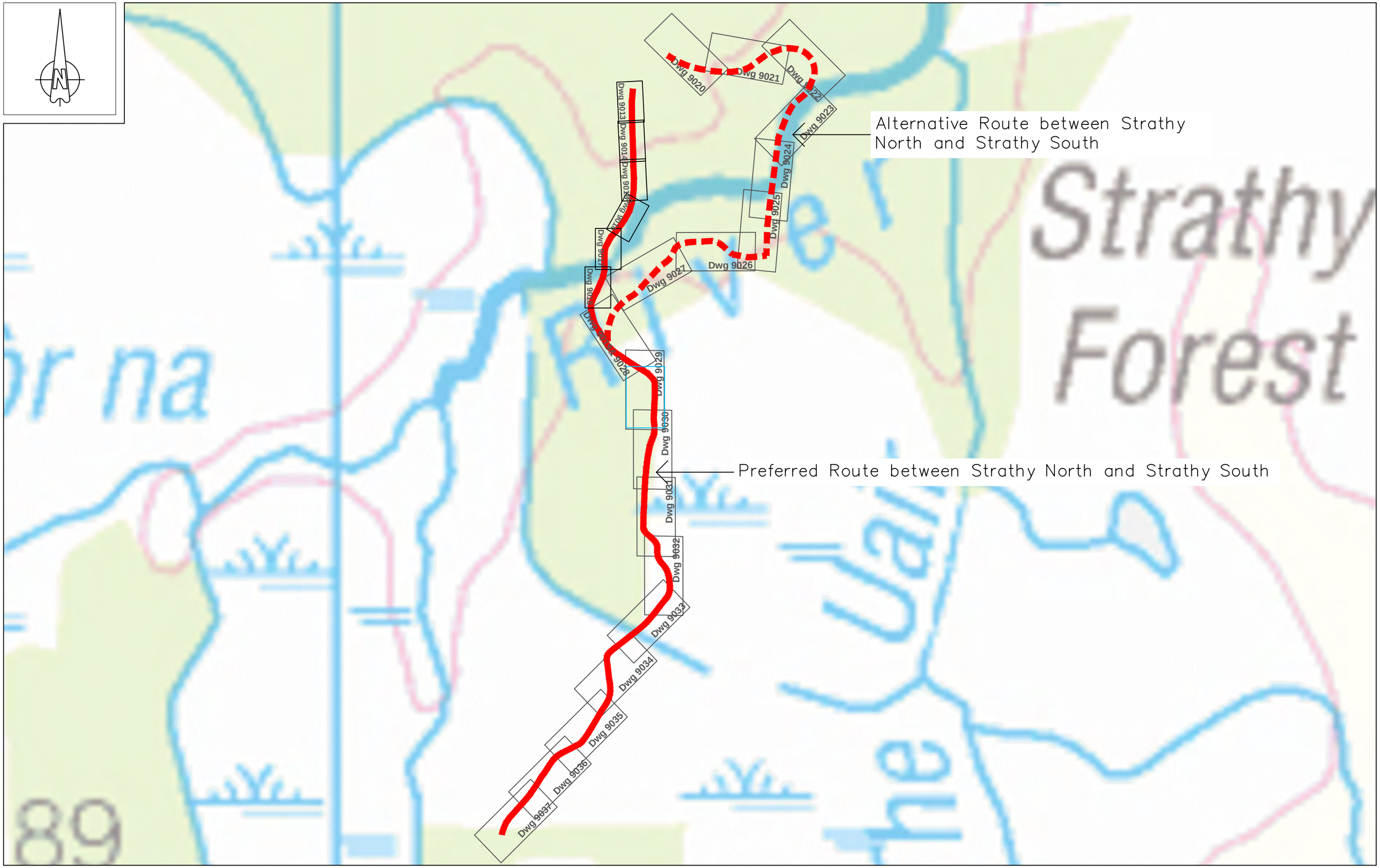
Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

Drawing

Abnormal Loads
Assessment Overview
Public Road Route

Drawn by: AK	Date: 29/05/2013
Checked by: -	Date: -
Approved by: -	Date: -
GGRSSE003/9000a	Revision -
Drawing Scale: NTS	

Drawing file path & name:
Xreference file path
User and Plot Date



Halcrow Group Limited, A CH2M HILL COMPANY
16 Abercromby Place, Edinburgh, EH3 6LB
Tel +44 (0)131 272 3300 Fax +44 (0)131 272 3301
www.halcrow.com

Halcrow
A CH2M HILL COMPANY

Client
SSE Renewables

STRATHY SOUTH WIND FARM

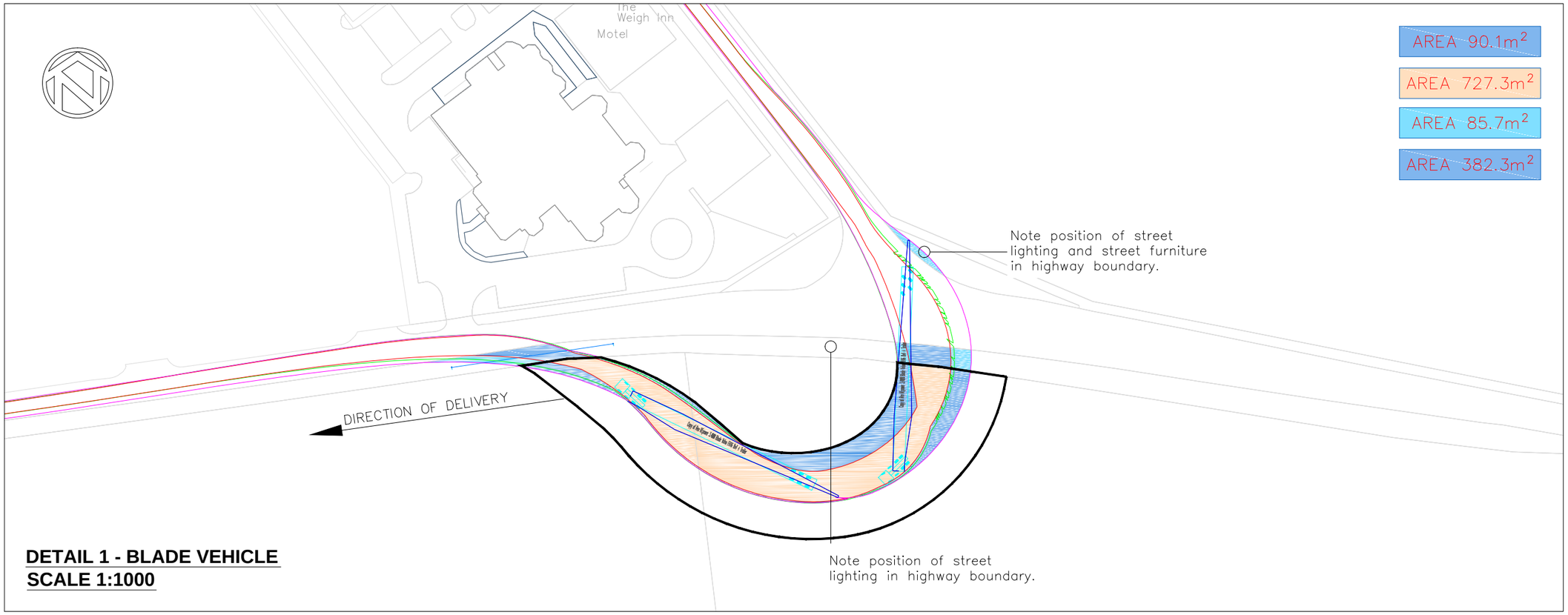
Notes

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

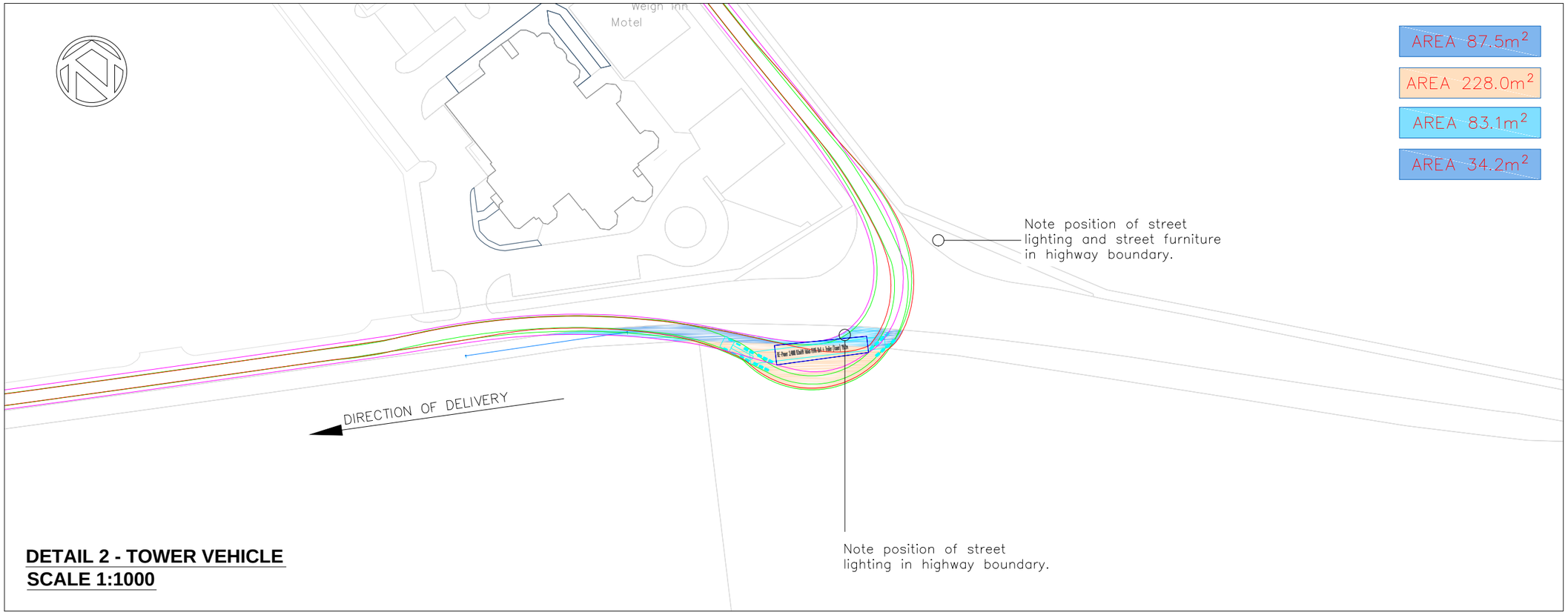
Drawing
Abnormal Loads
Assessment Overview
Strathy North to Strathy South

Drawn by: AK	Date: 29/05/2013
Checked by: -	Date: -
Approved by: -	Date: -
GGRSSE003/9000b	Revision -
Drawing Scale: NTS	

Drawing file path & name :
Xreference file path
User and Plot Date



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

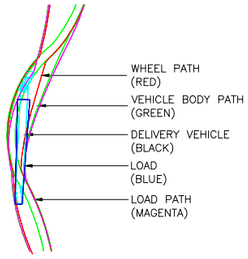


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
A	BT	AK	AK	9/5/13	Red line boundary showing third party land area available, added.

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

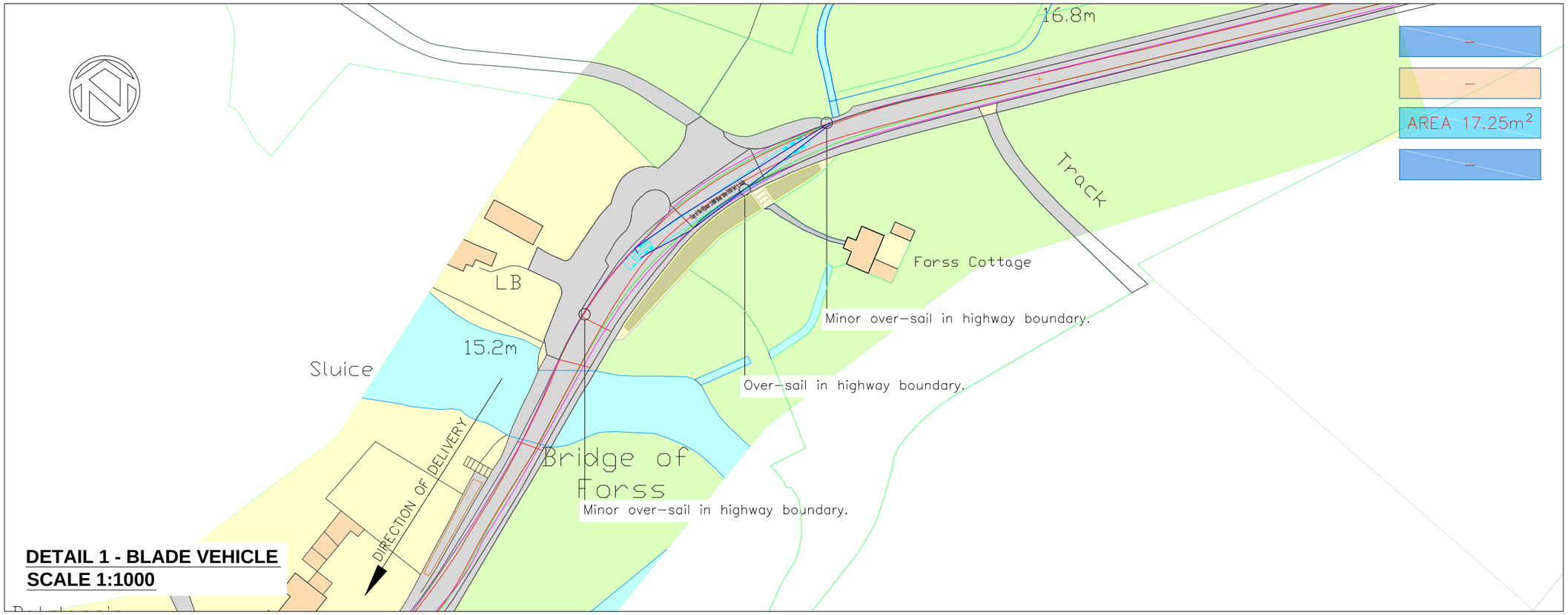
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 02
DETAILED JUNCTION ANALYSIS

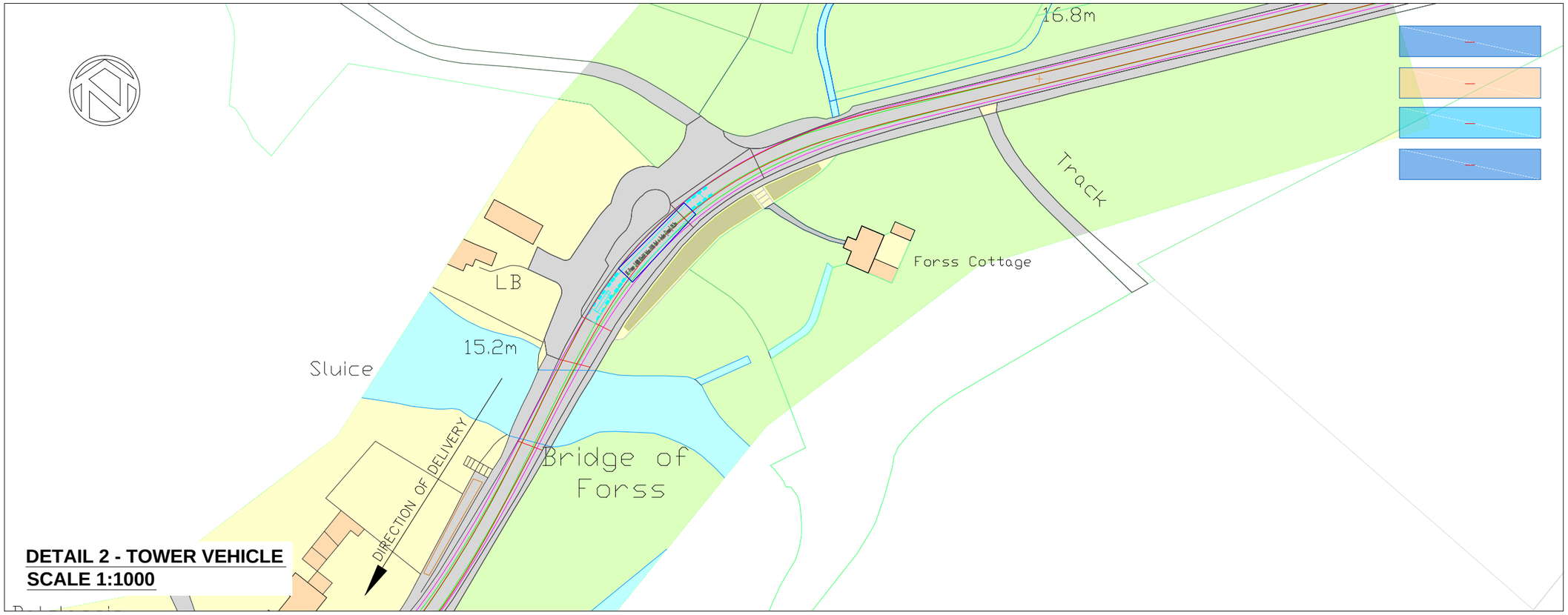
Drawn by BT	Date: 22/03/2013
Checked by	Date:
Authorised by AK	Date: 22/03/2013

Drawing No.	Revision
GGRSSE003/9001	A

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

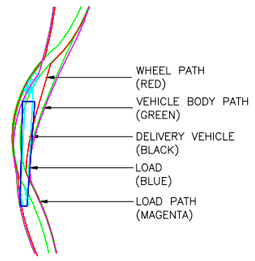


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

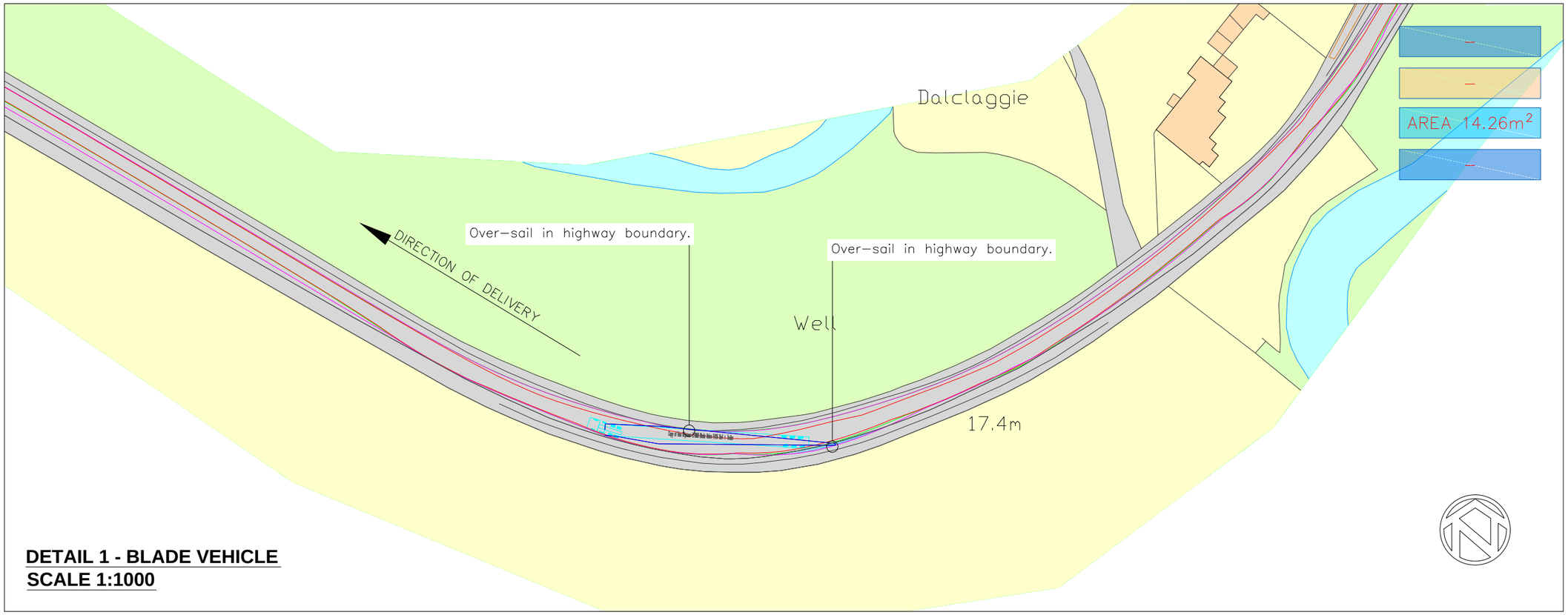
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 12
DETAILED JUNCTION ANALYSIS

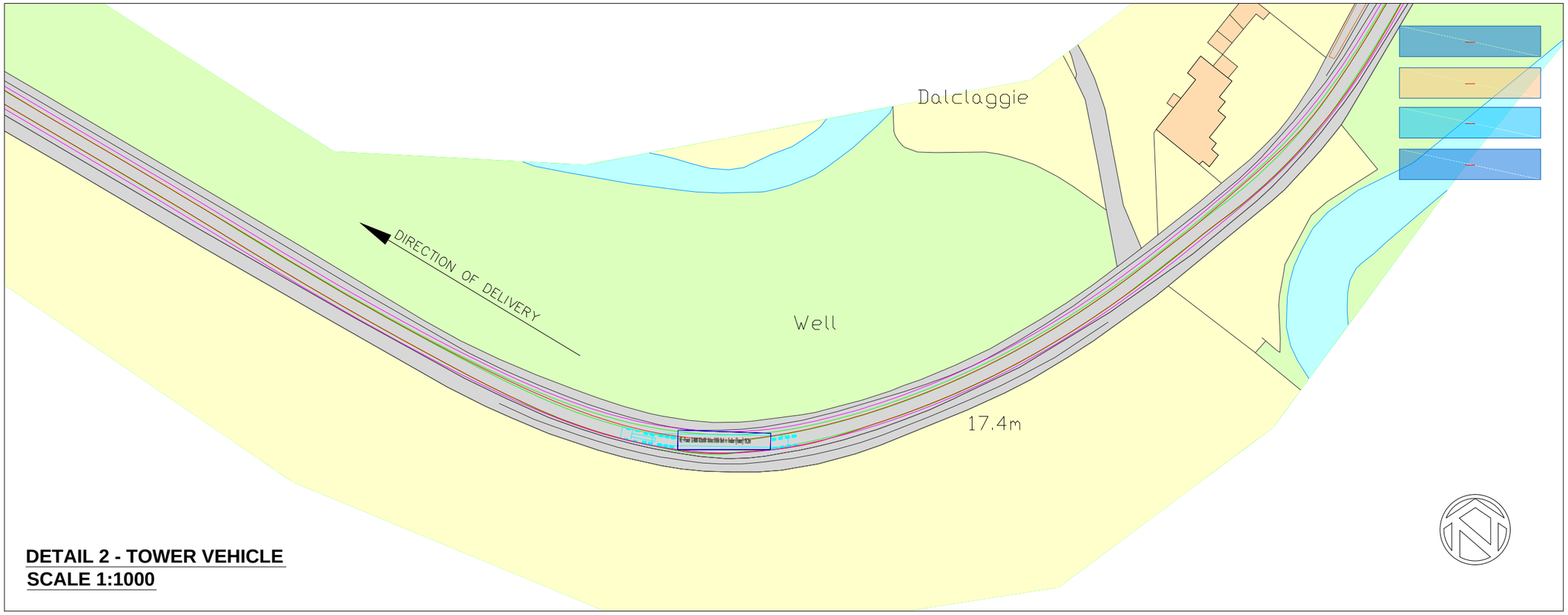
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9002	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

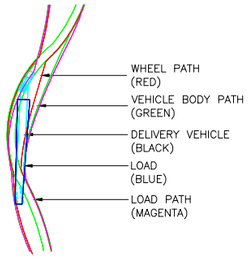


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

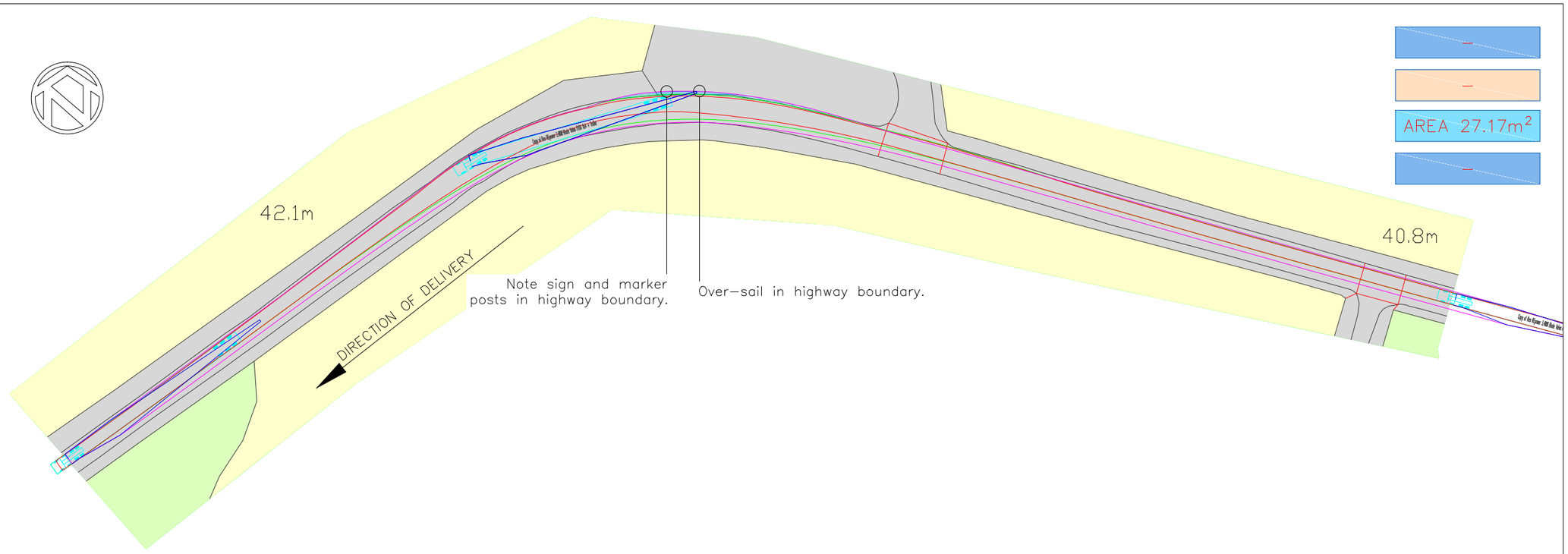
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 12
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

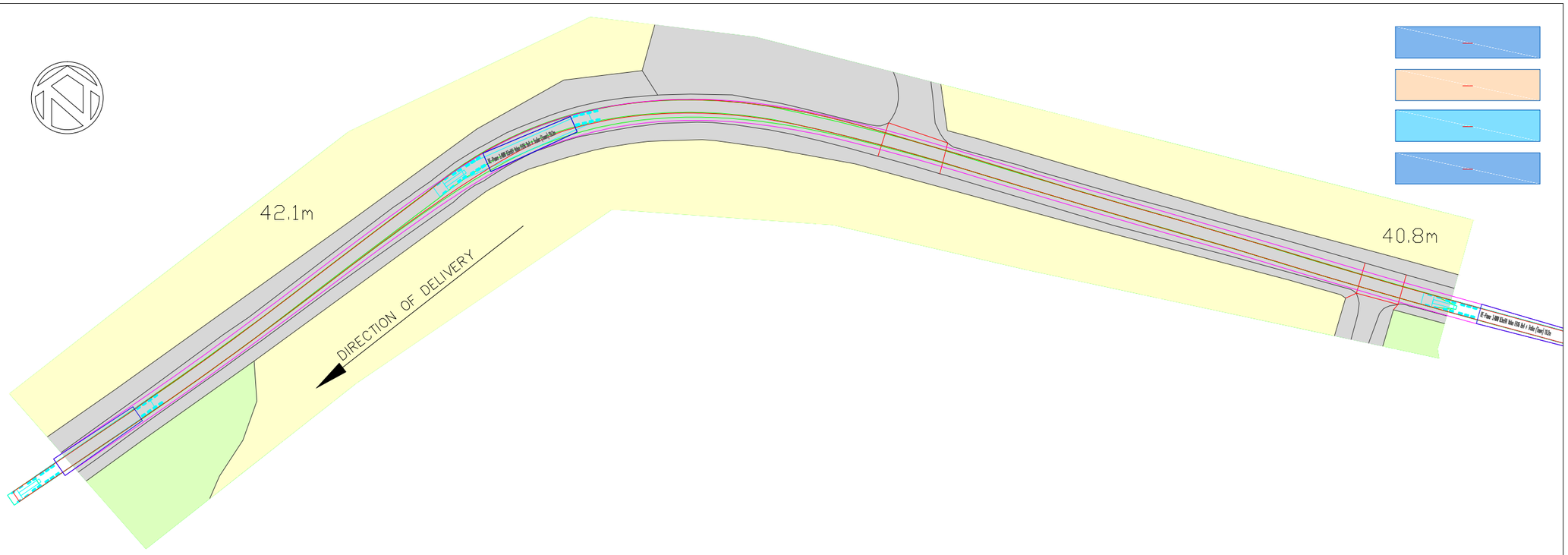
Drawing No.	Revision
GGRSSE003/9003	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

opyright 2012. All rights reserved. Licence number 100020449



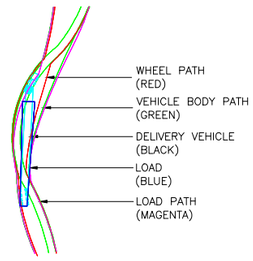
DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

opyright 2012. All rights reserved. Licence number 100020449

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

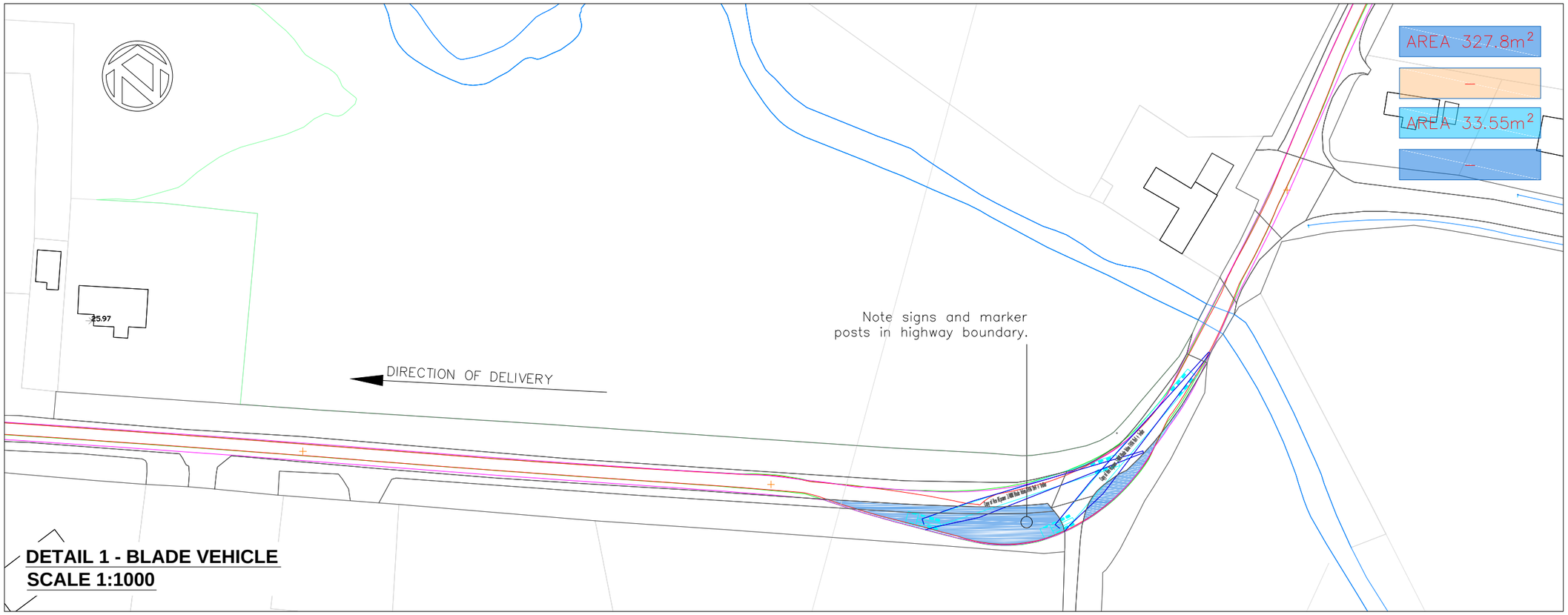
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 13
DETAILED JUNCTION ANALYSIS

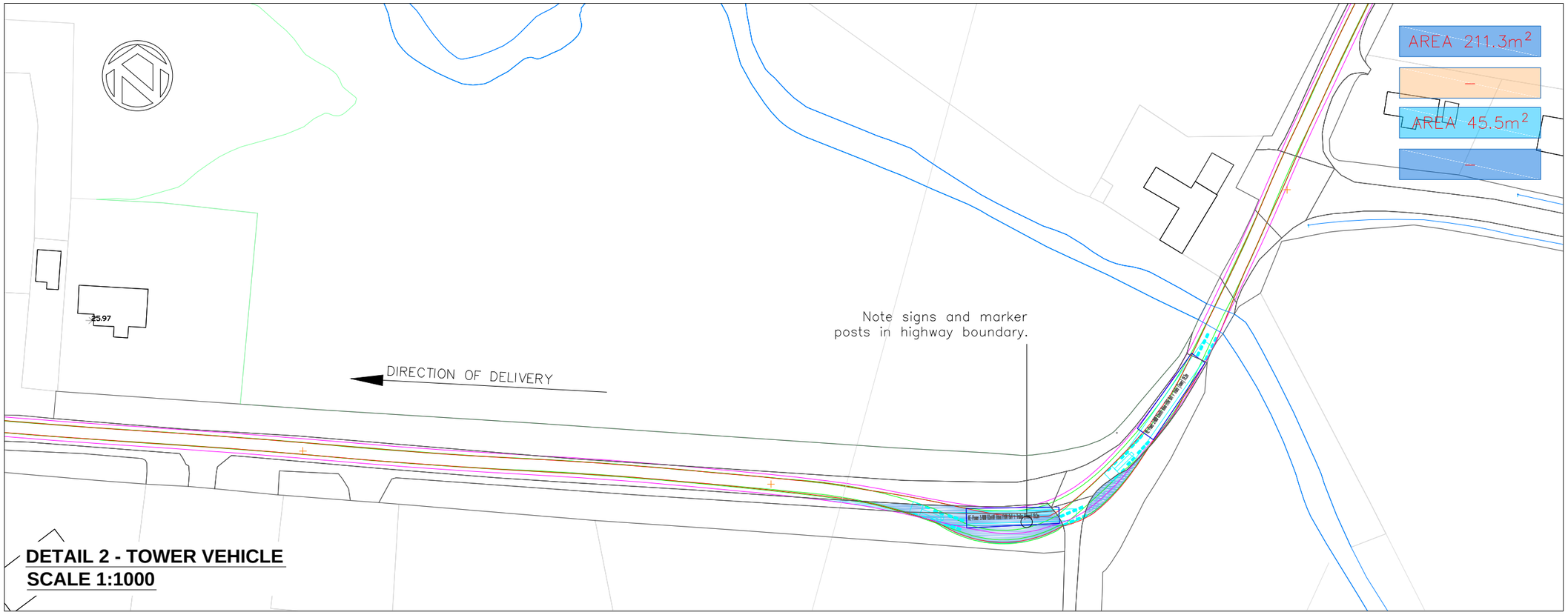
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9004	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB - 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

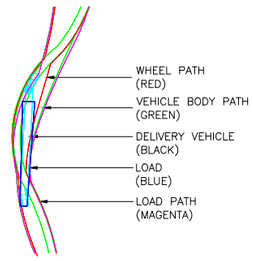


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

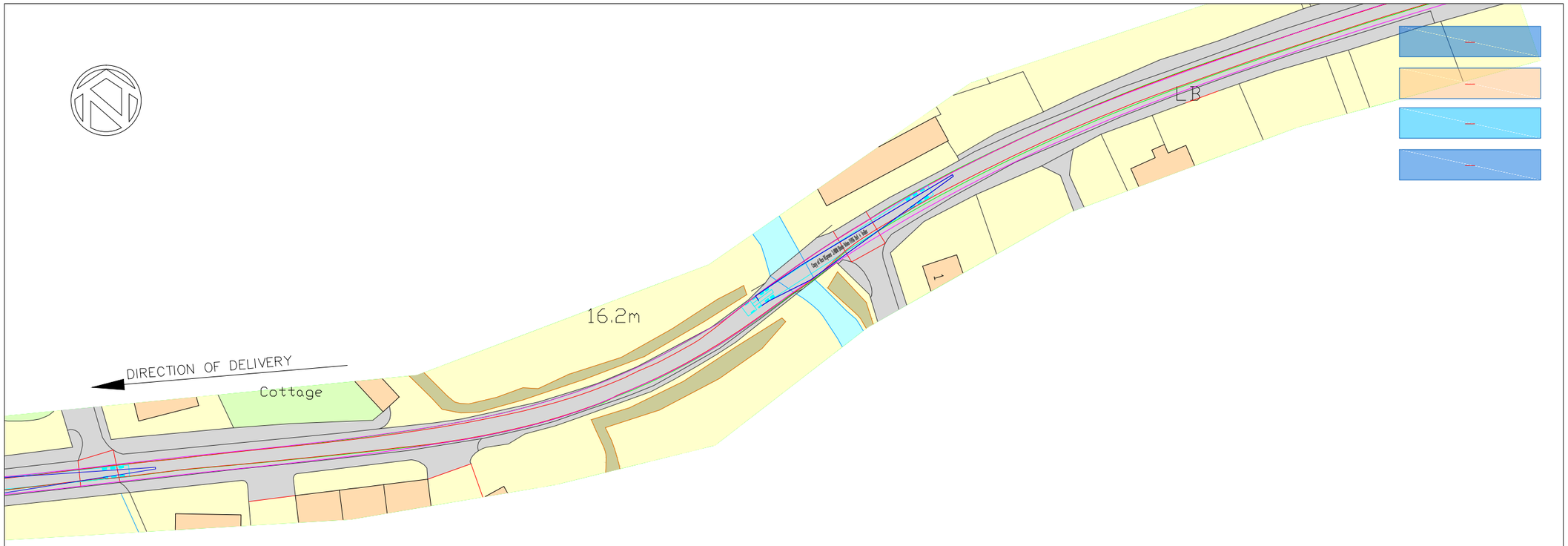
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 16
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

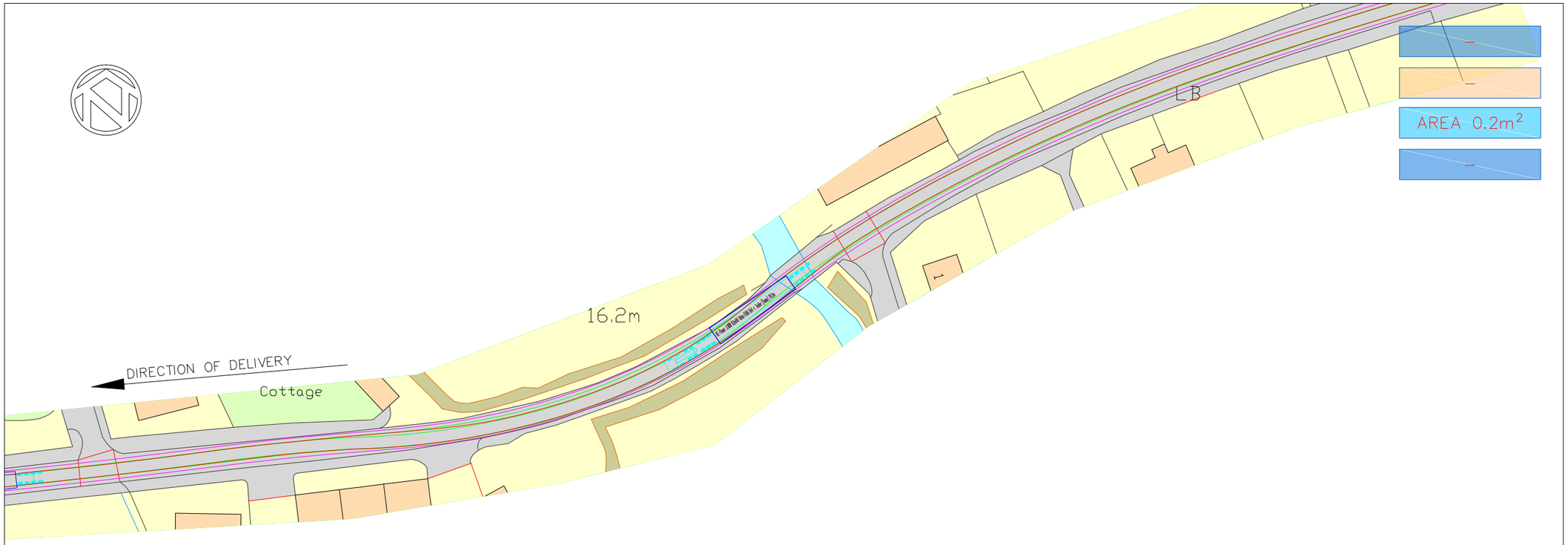
Drawing No.	Revision
GGRSSE003/9005	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

012. All rights reserved. Licence number 100020449



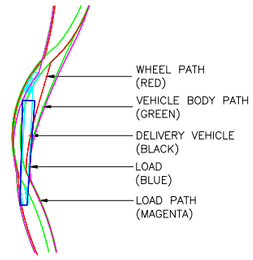
DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

12. All rights reserved. Licence number 100020449

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

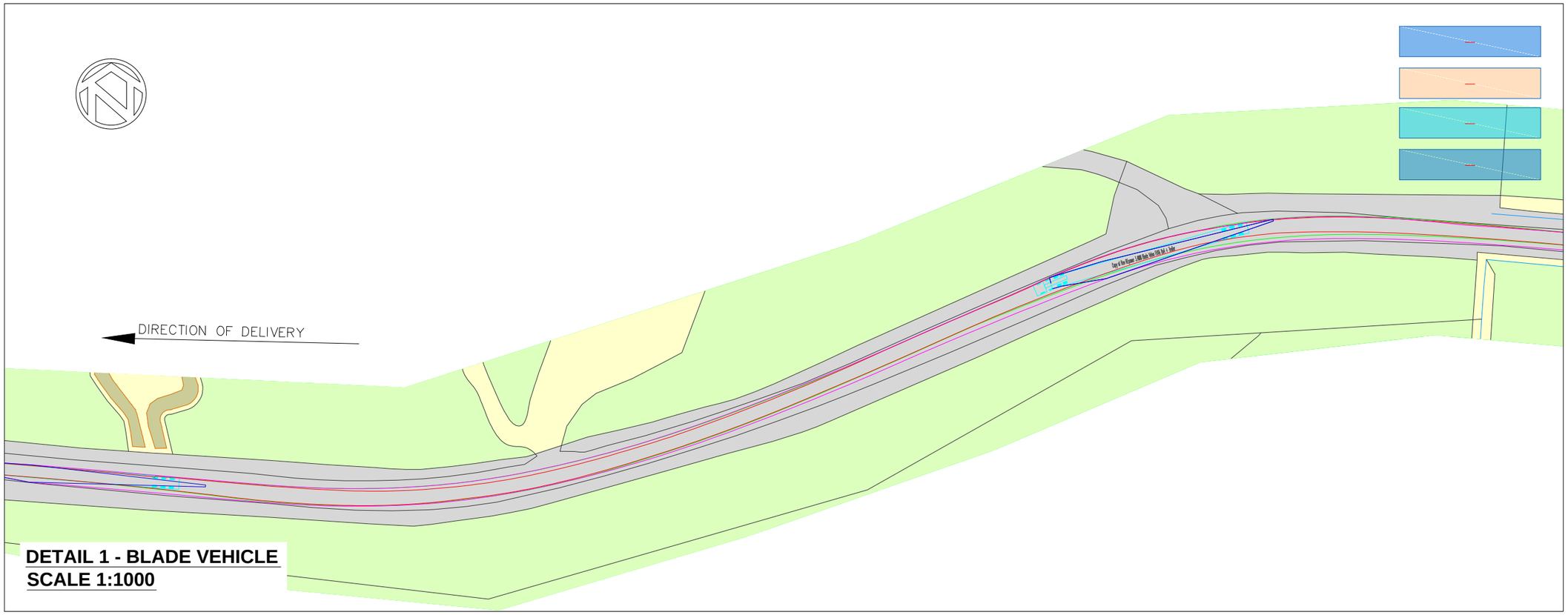
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 21
DETAILED JUNCTION ANALYSIS

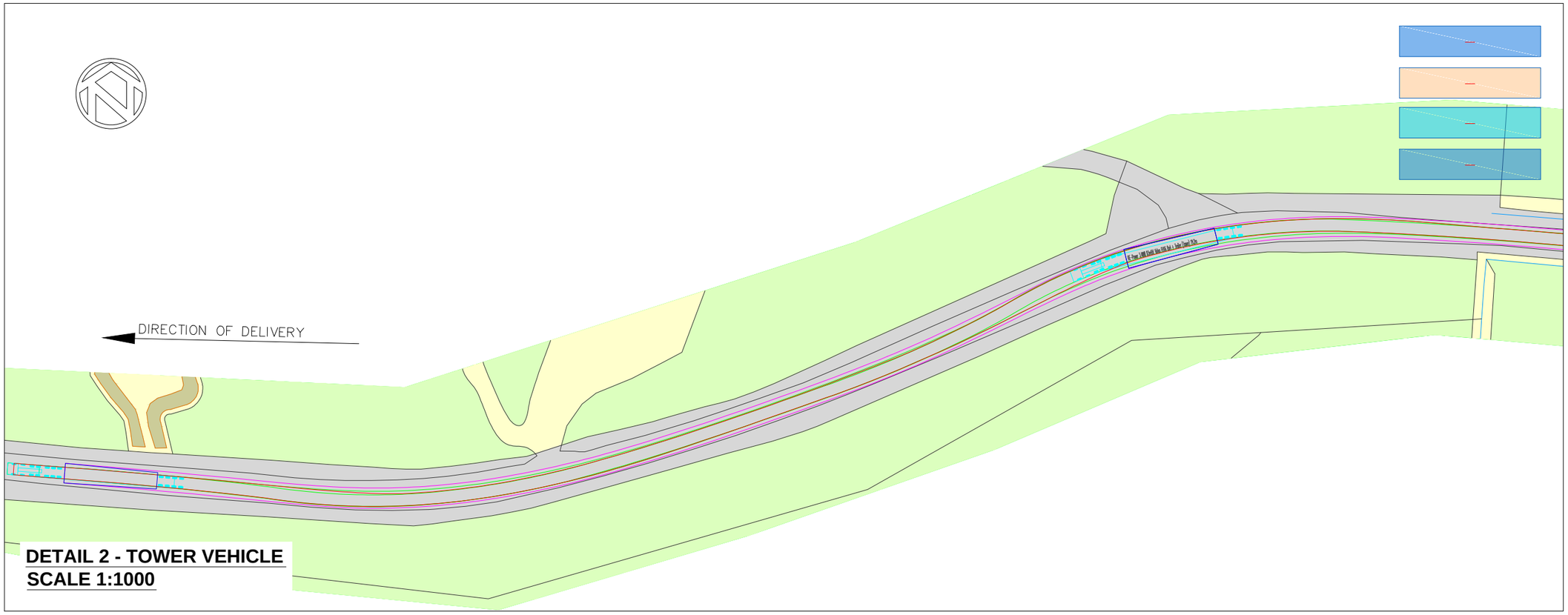
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9006	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB - 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

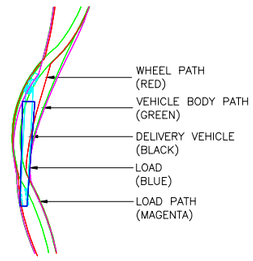


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

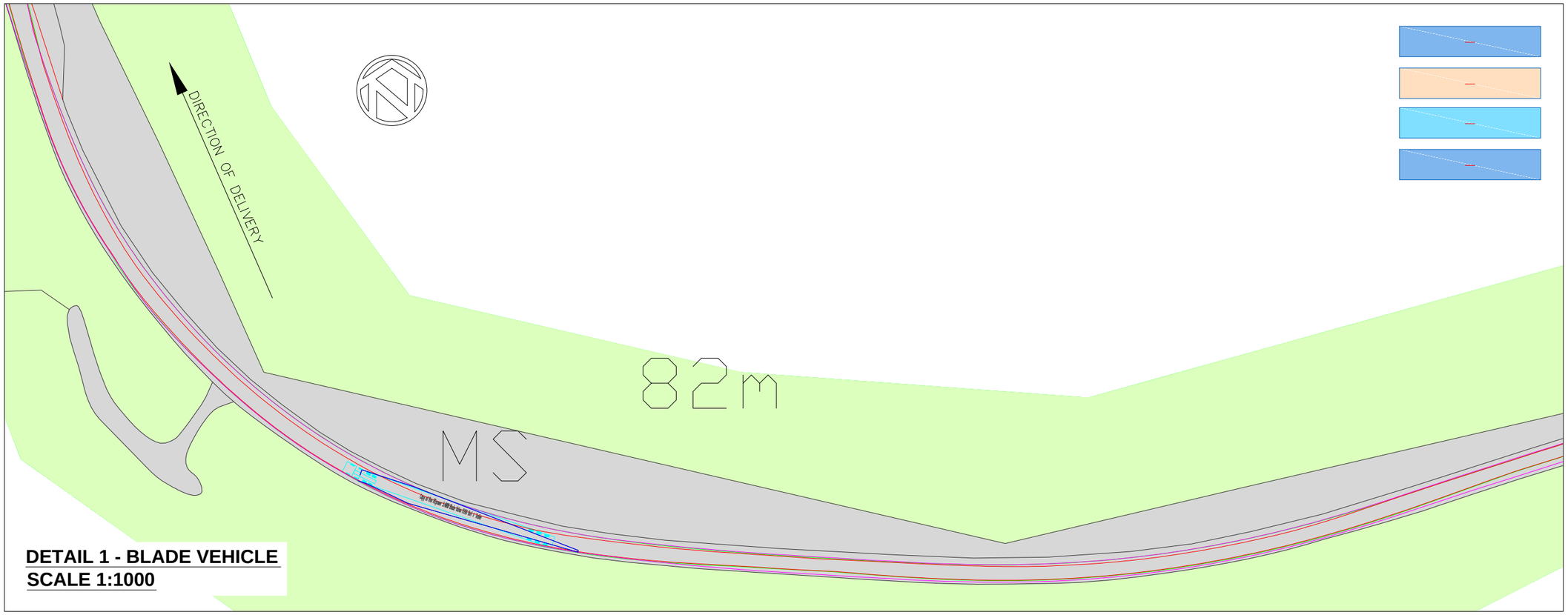
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 23
DETAILED JUNCTION ANALYSIS

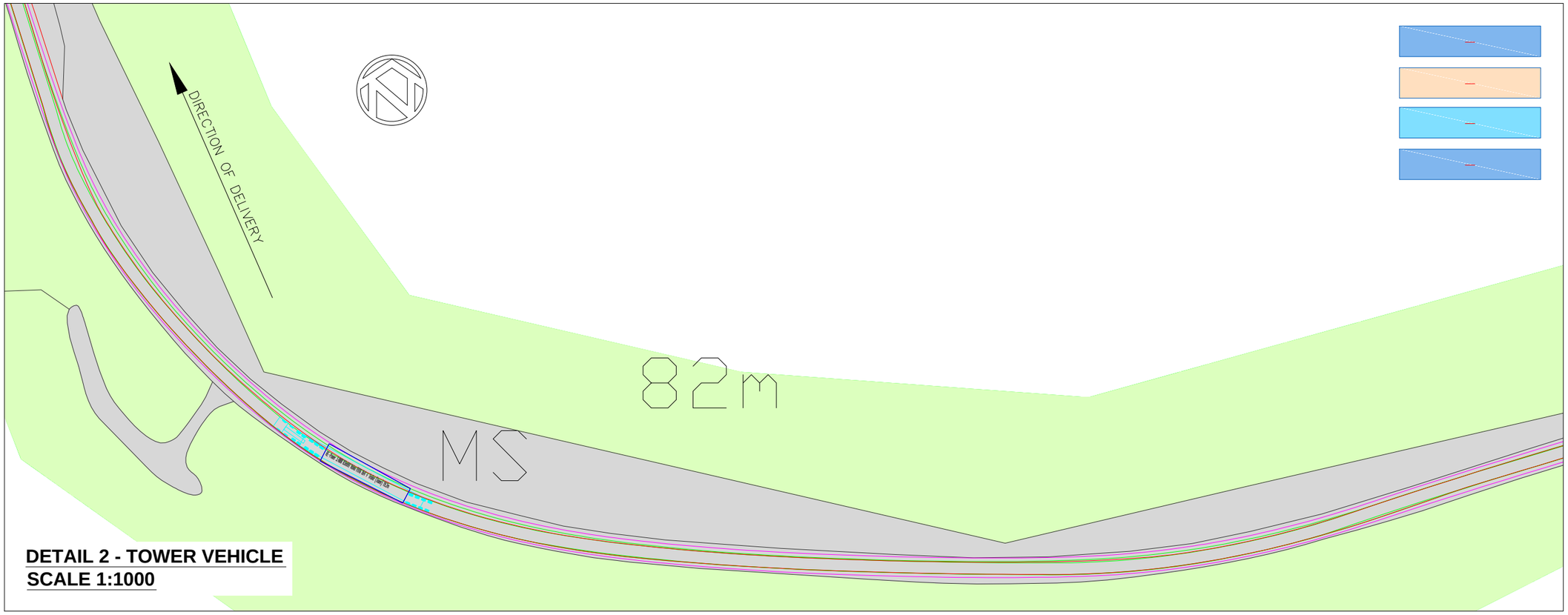
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9007	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

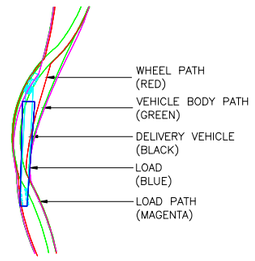


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

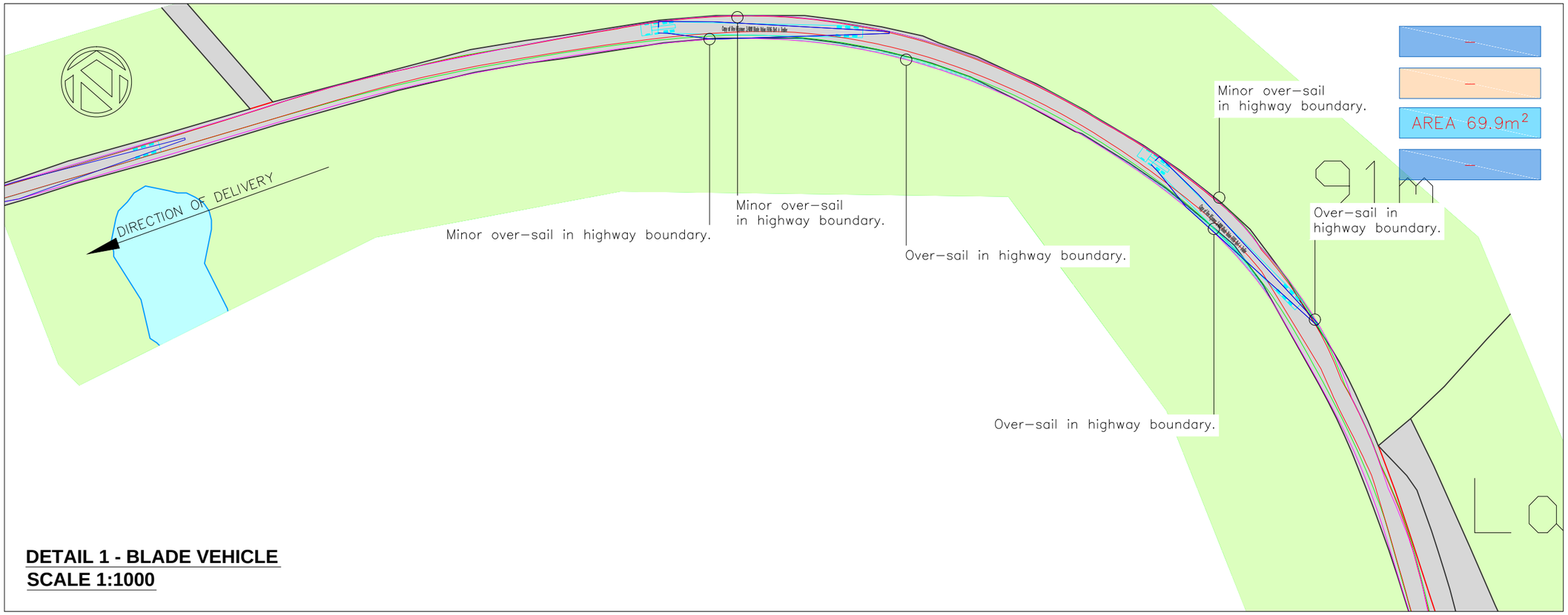
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 26
DETAILED JUNCTION ANALYSIS

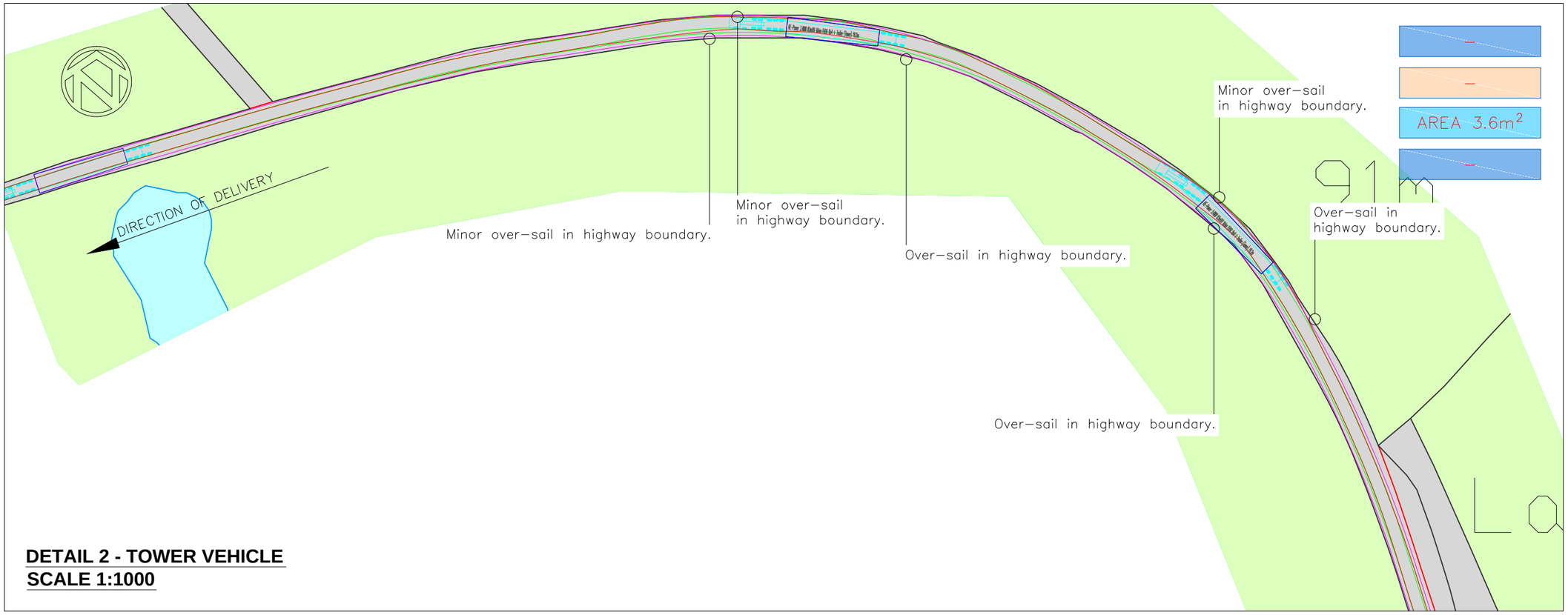
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9008	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

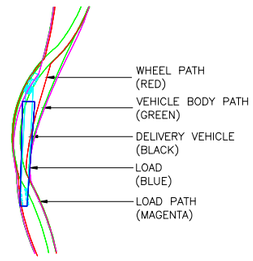


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

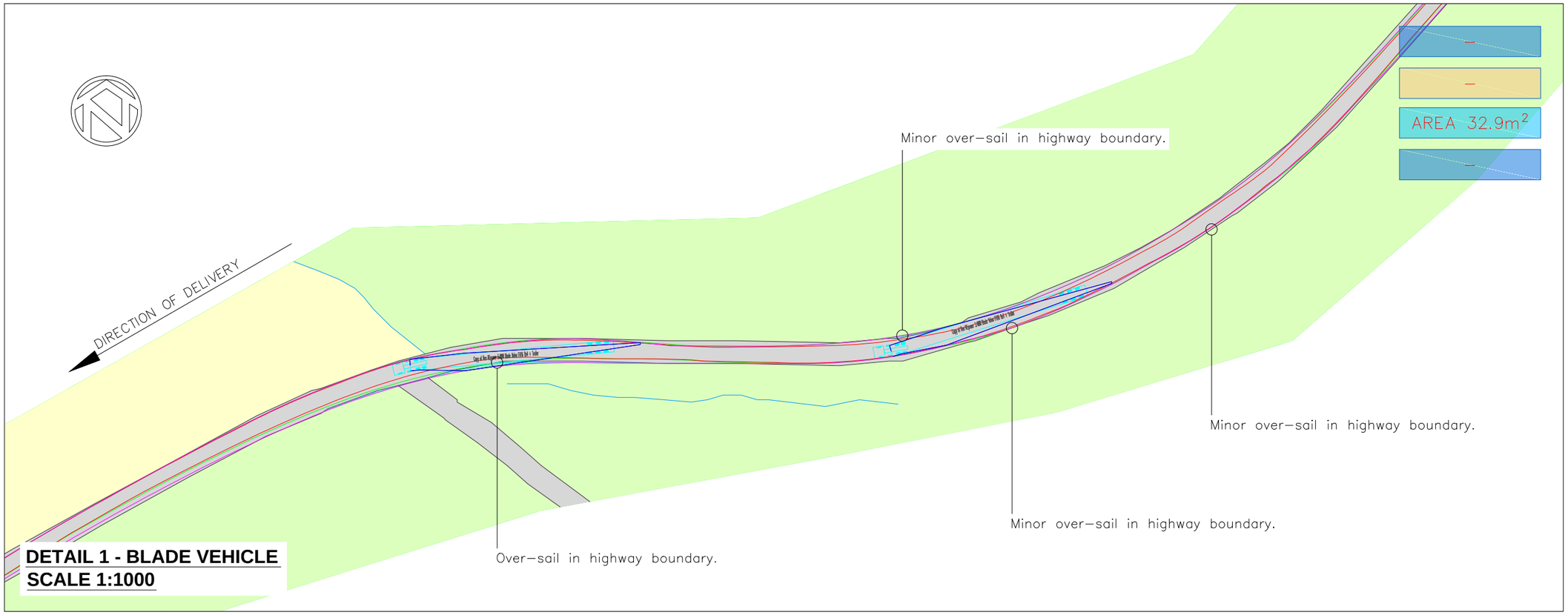
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 26
DETAILED JUNCTION ANALYSIS

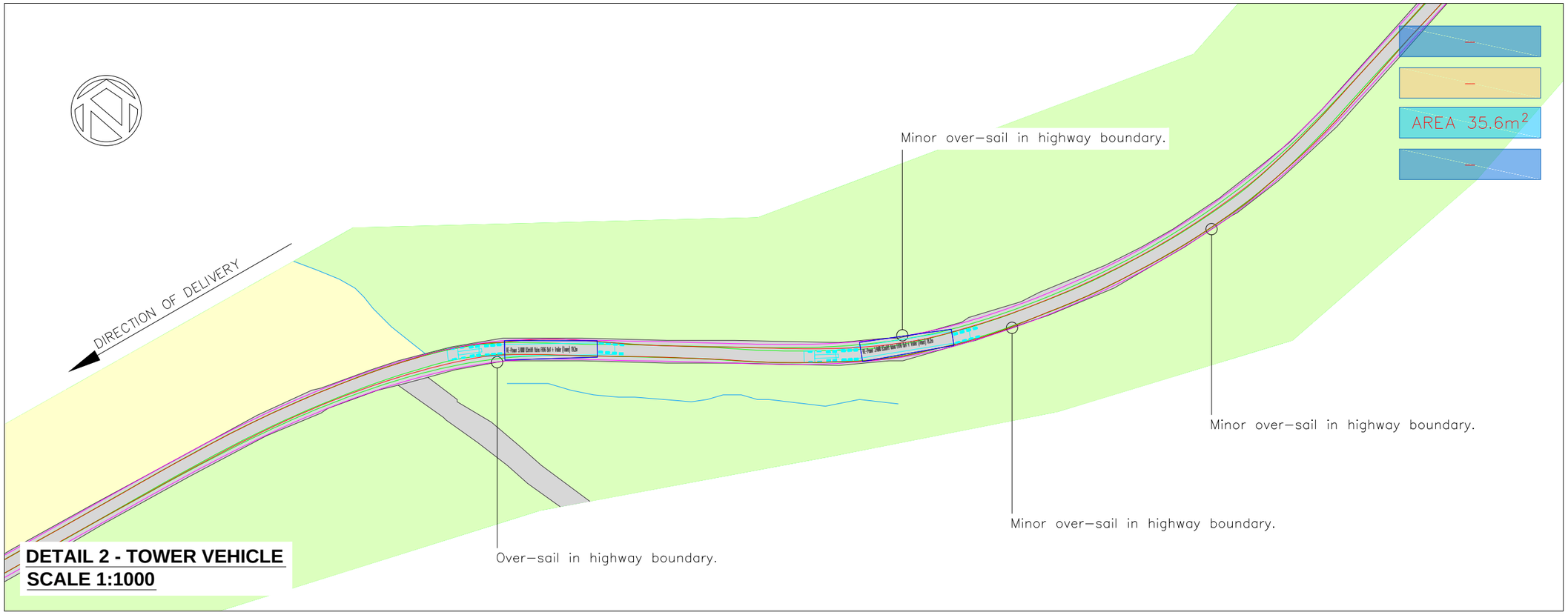
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9009	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

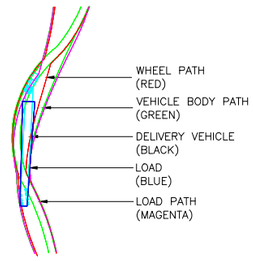


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

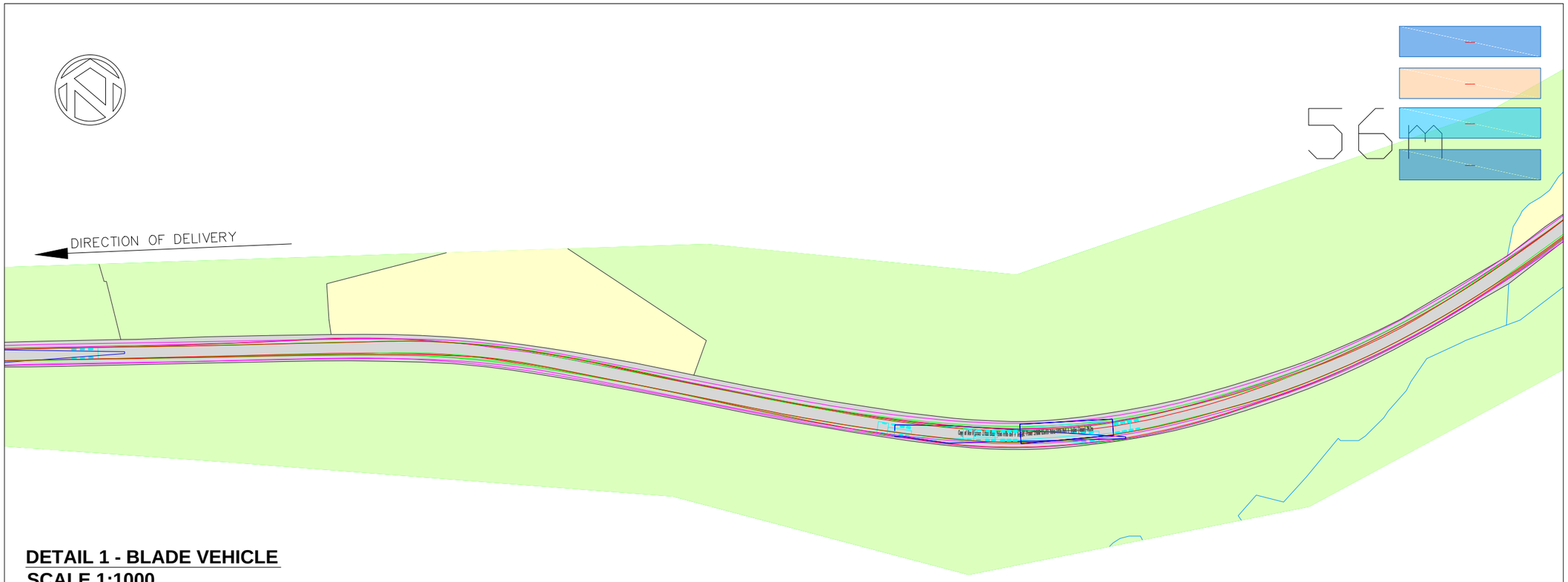
Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 31
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

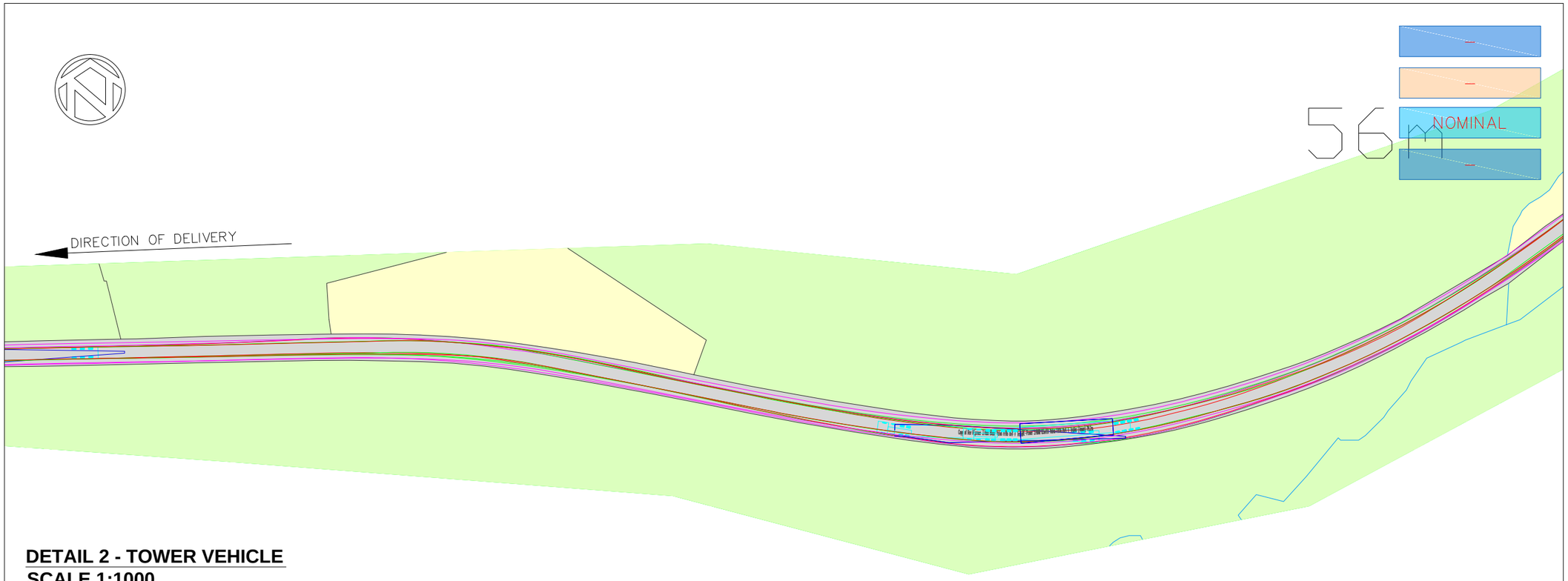
Drawing No.	Revision
GGRSSE003/9010	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

y, ... ghts reserved. Licence number 100020449



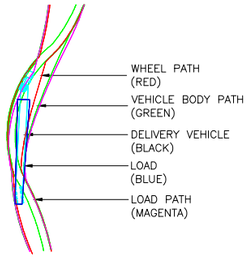
DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

y, ... ghts reserved. Licence number 100020449

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
POI 32
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9011	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm

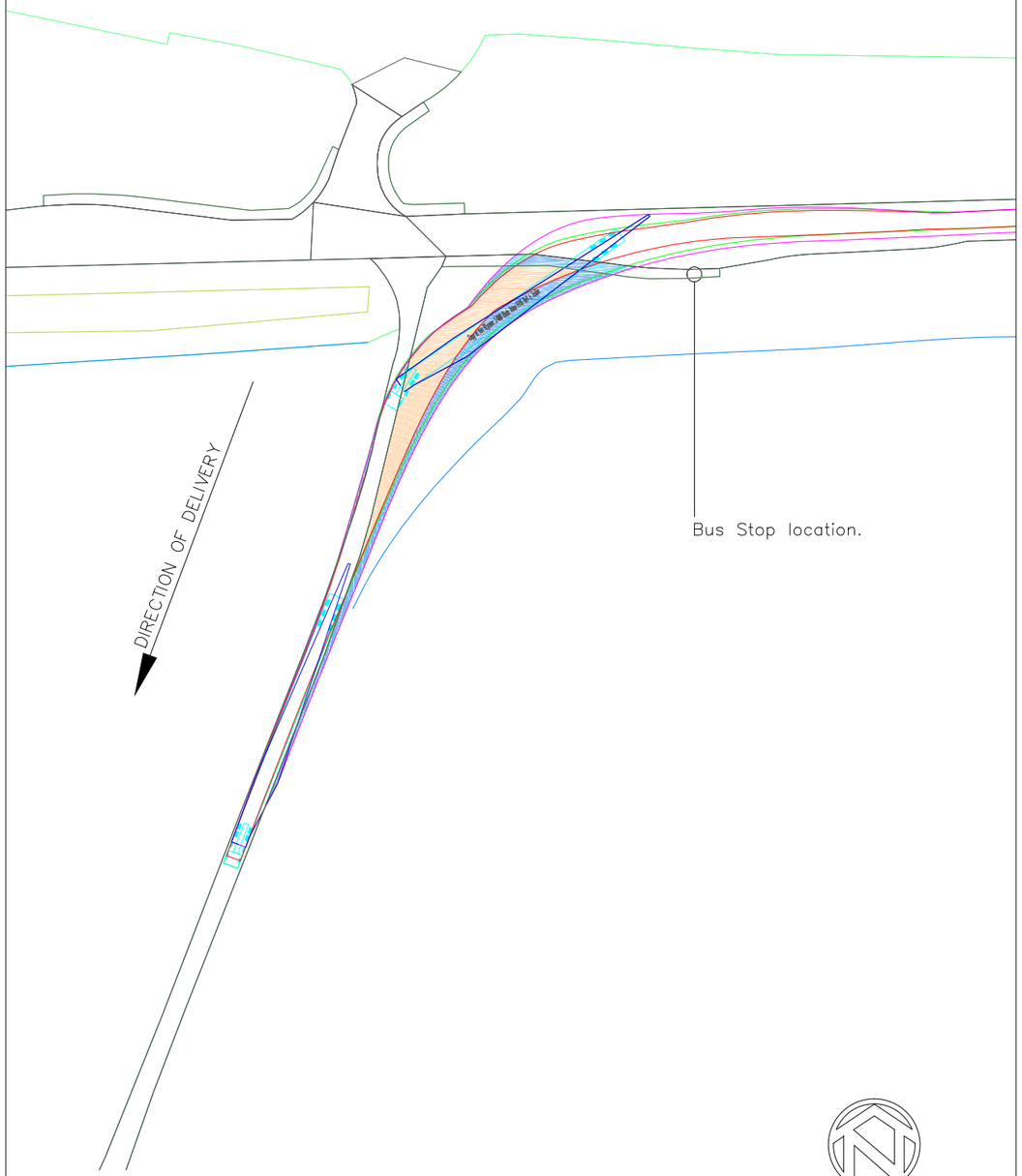
The land required for the access arrangements may be irrelevant considering that this junction may already be constructed as part of the neighbouring Strathy North Wind Farm.

AREA 19.1m^2

AREA 224.5m^2

AREA 15.4m^2

AREA 173.8m^2



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

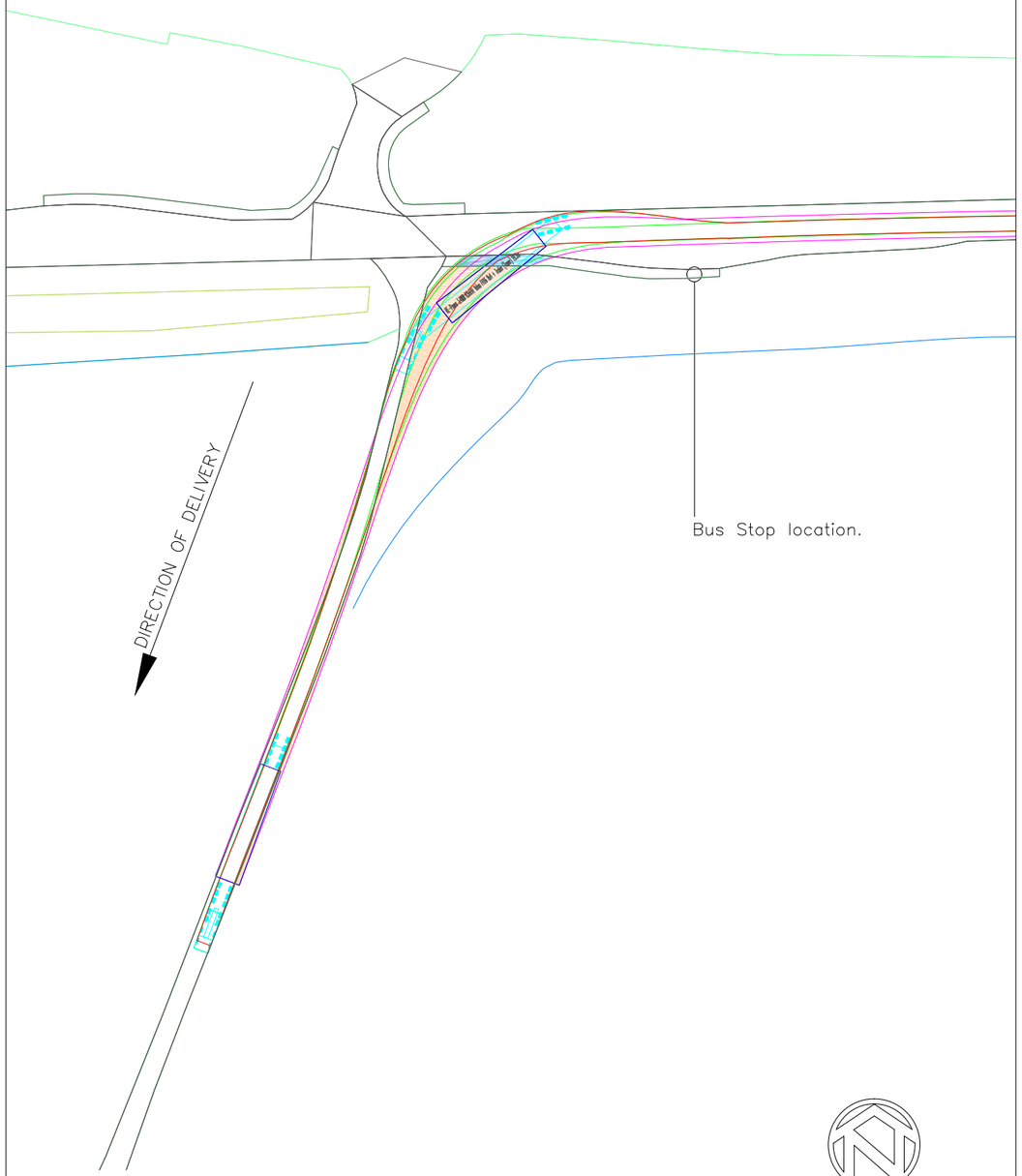
The land required for the access arrangements may be irrelevant considering that this junction may already be constructed as part of the neighbouring Strathy North Wind Farm.

AREA 11.9m^2

AREA 111.7m^2

AREA 14.5m^2

AREA 147.6m^2

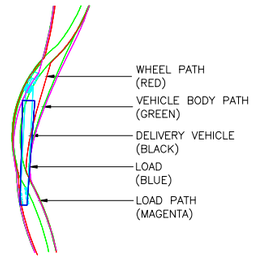


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING WITHIN HIGHWAYS
- AREA OF WIDENING WITHIN 3rd PARTY LAND INCLUDING CIVILS WORKS
- AREA OF OVER-SAIL WITHIN HIGHWAYS
- AREA OF OVER-SAIL WITHIN 3rd PARTY LAND
- EXISTING ROAD/TRACK SURFACE
- EXISTING PHYSICAL BOUNDARY
- APPROXIMATE THIRD PARTY LAND AREA AVAILABLE AS DETAILED AND AGREED BY SSE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

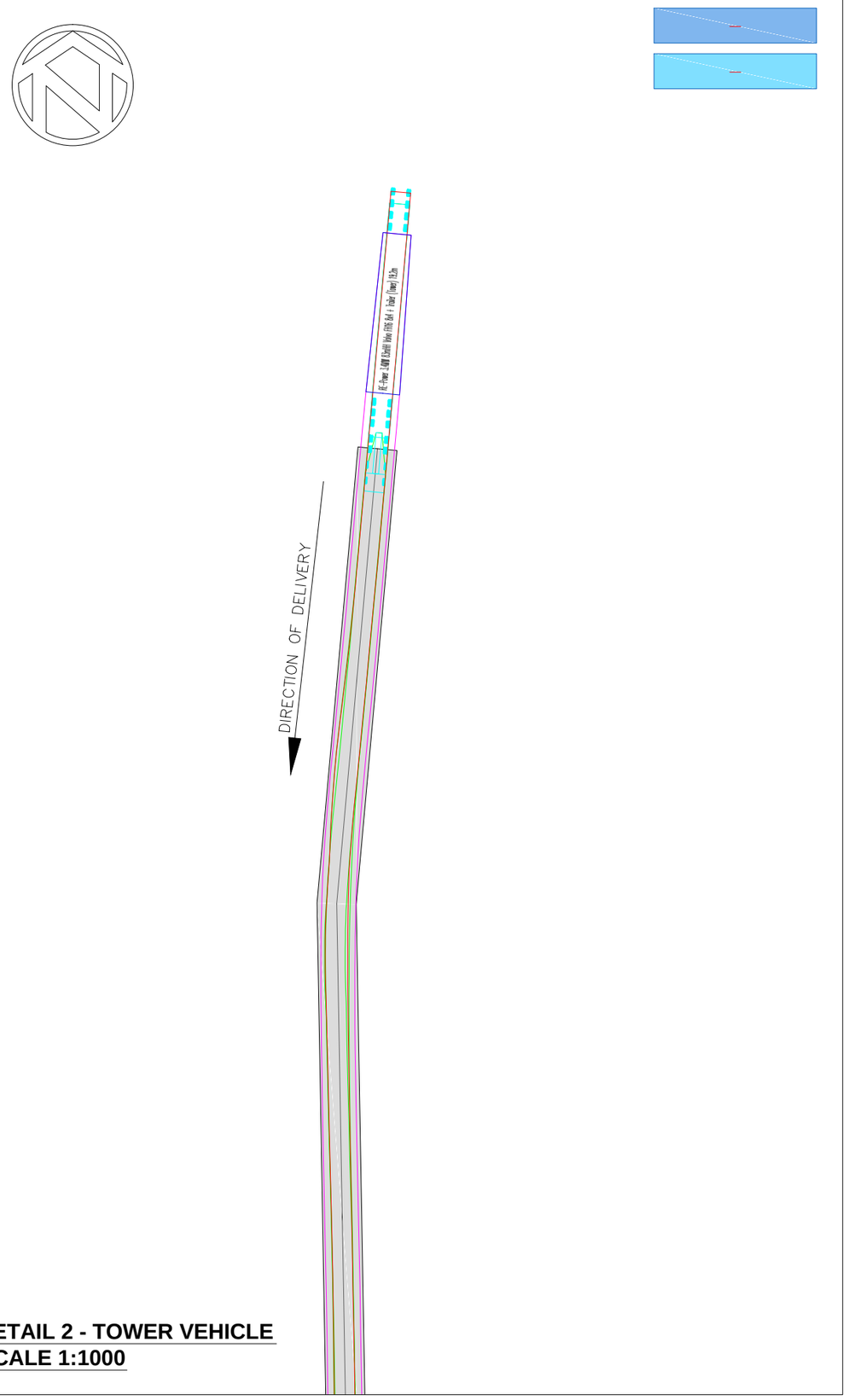
ABNORMAL LOADS ASSESSMENT
PROPOSED SITE ACCESS
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9012	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm

DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

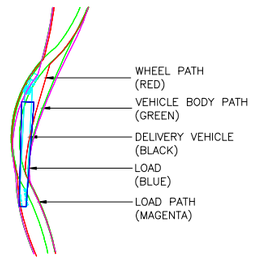


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

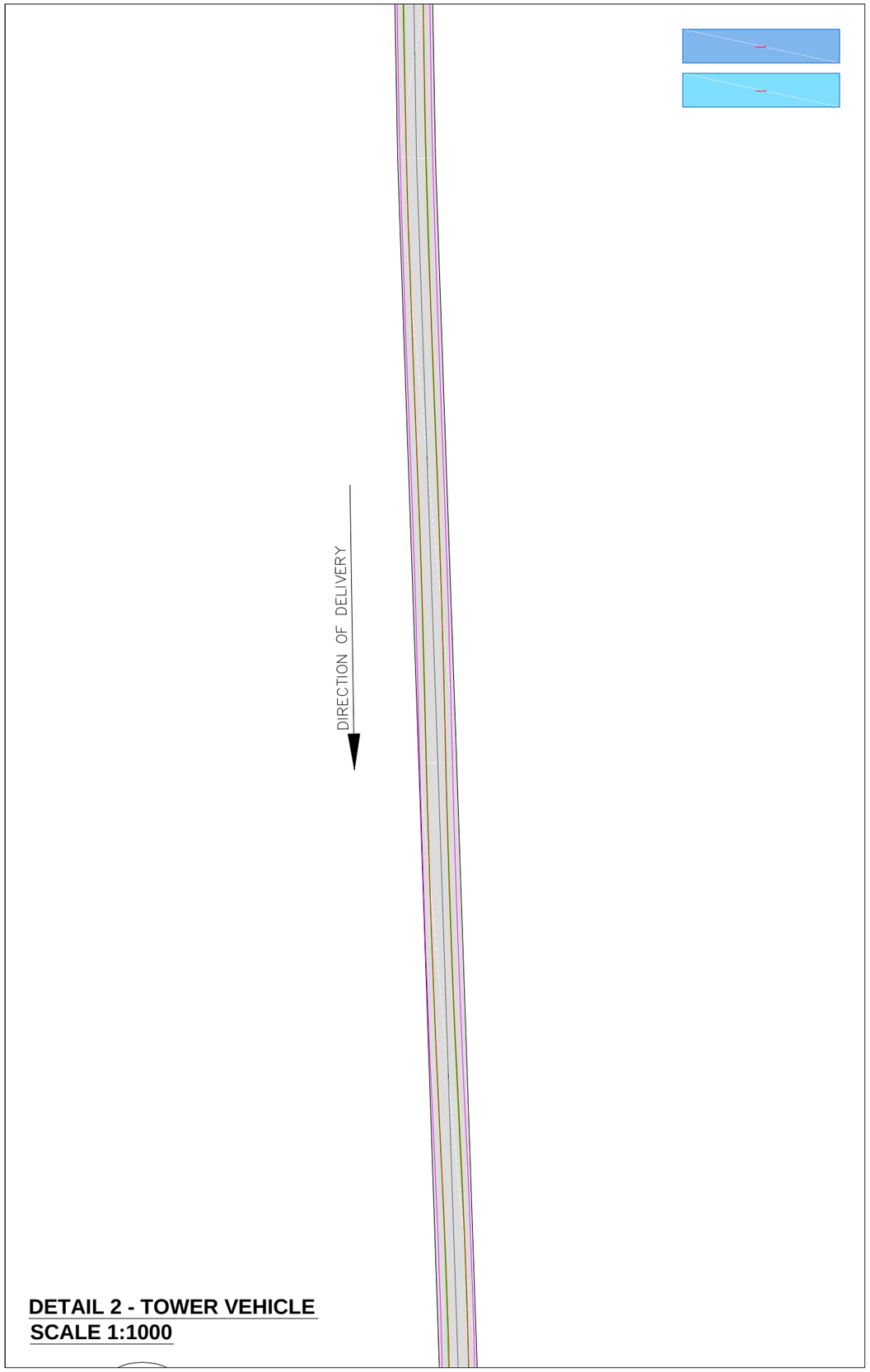
ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9013	-

Drawing file path & name : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRSS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513-Revised tracks.dwg
Xreference file path : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRSS\Outgoing\Re
User and Plot Date : TightMB 6:6:2013 - 4:6 pm

DETAIL 1 - BLADE VEHICLE
SCALE 1:1000



DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

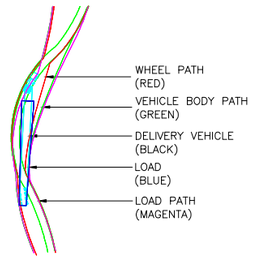
Key:

AREA OF WIDENING

AREA OF OVER-SAIL

EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

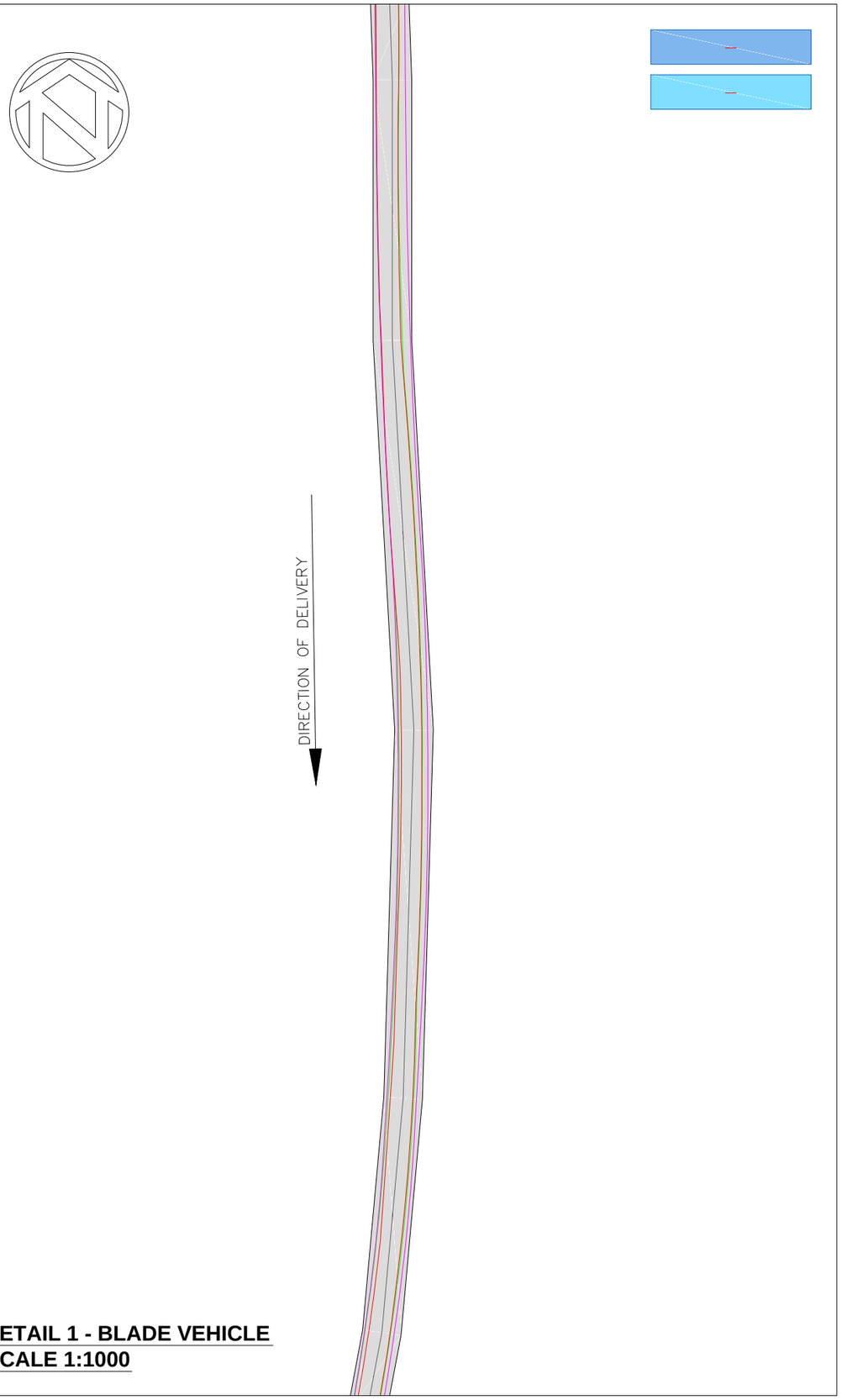
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

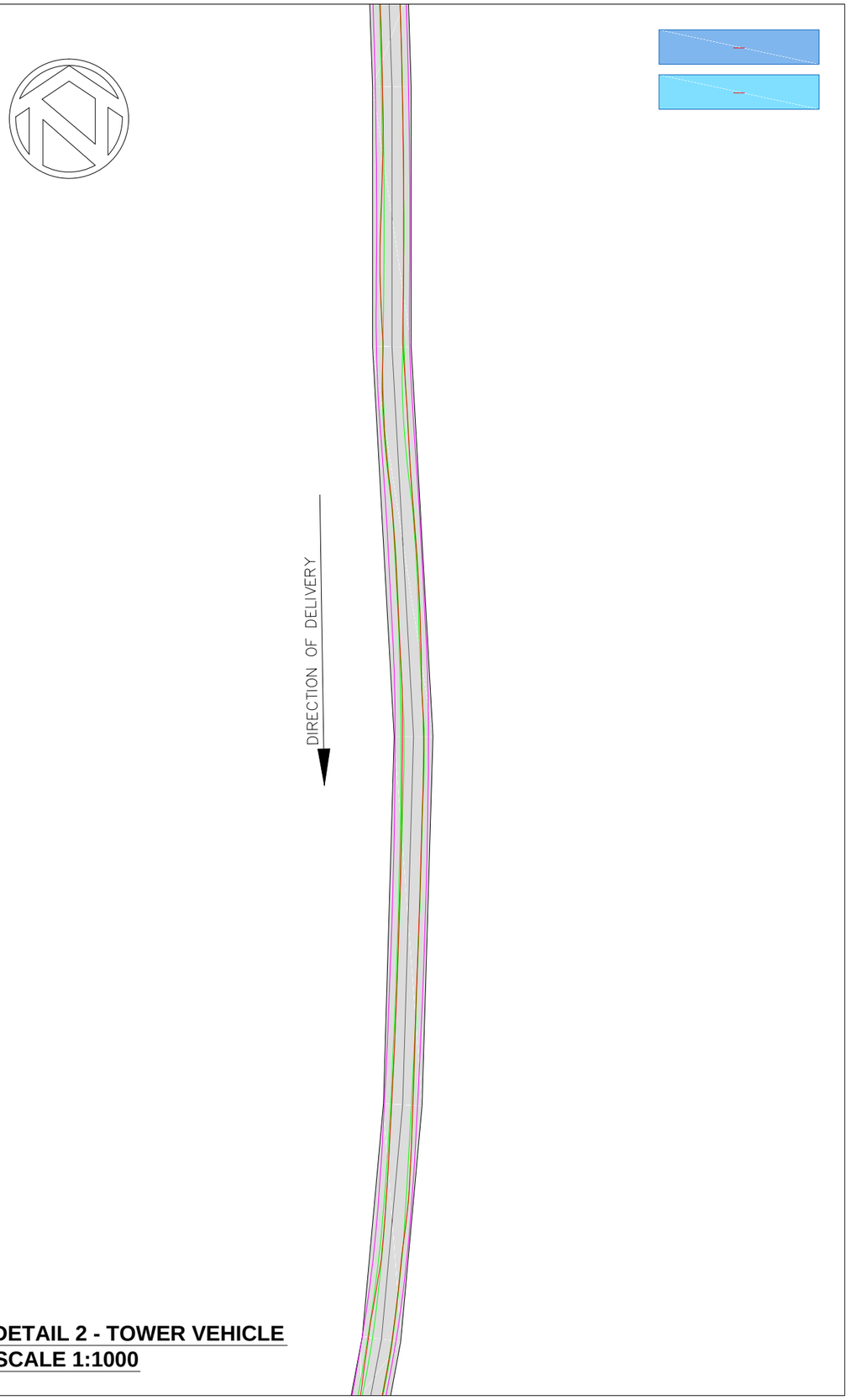
Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9014	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Rev Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB - 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000



DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

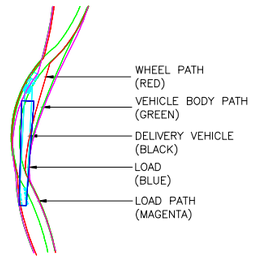
Key:

AREA OF WIDENING

AREA OF OVER-SAIL

EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

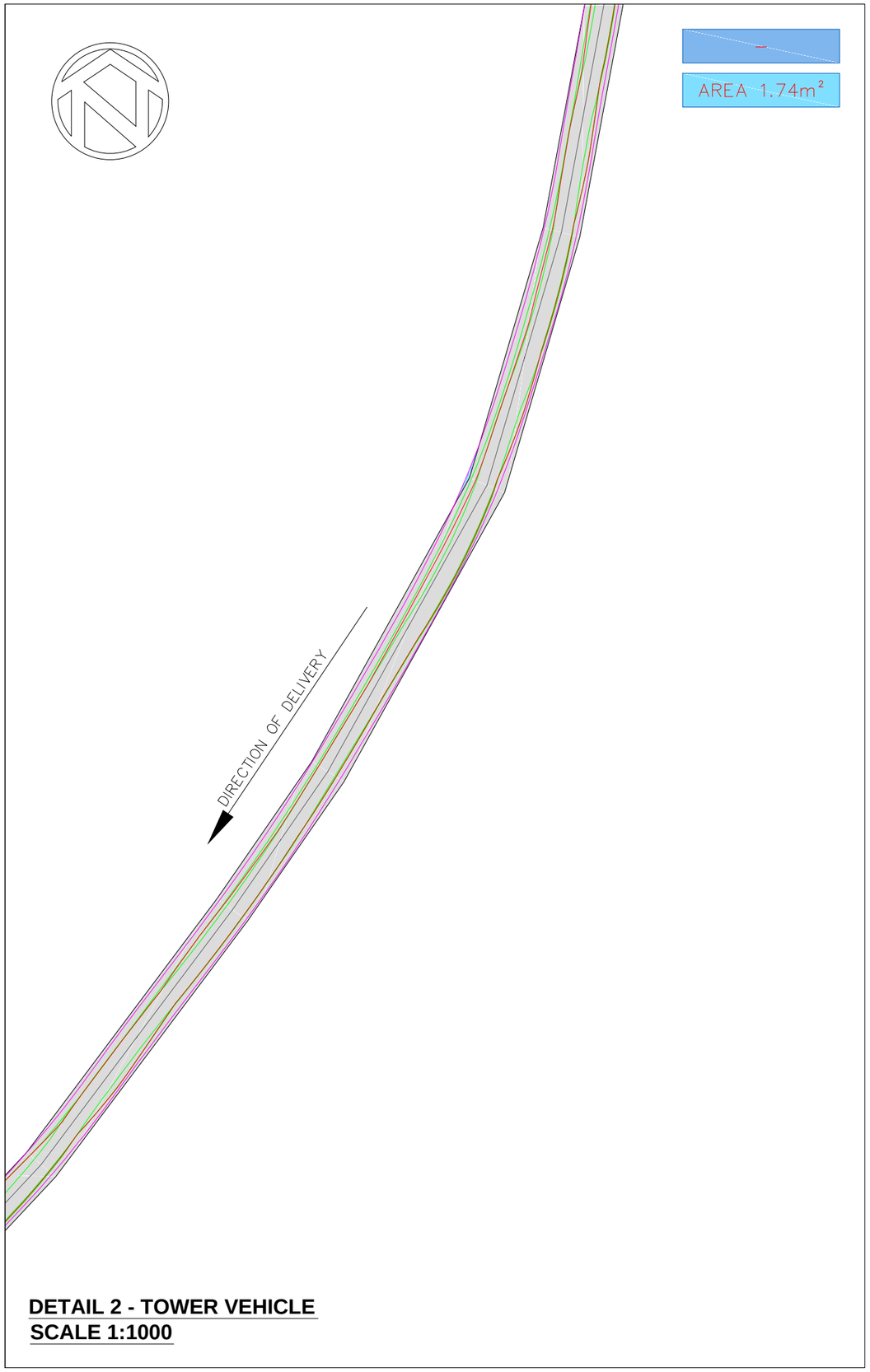
ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9015	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC-00.04 - Strathy South\DRGS\Outgoing\Rev Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC-00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB - 6/6/2013 - 4:6 pm

DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

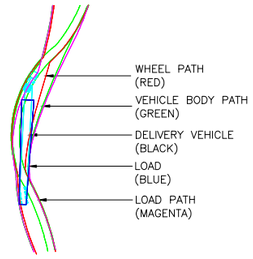


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9016	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm

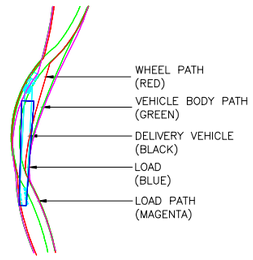
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9017	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : Tigheb 6/6/2013 - 4:6 pm

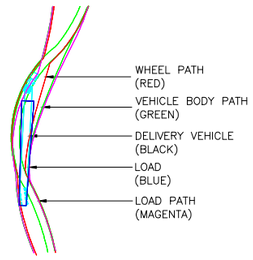
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9018	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm

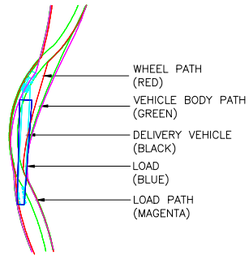
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9019	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm

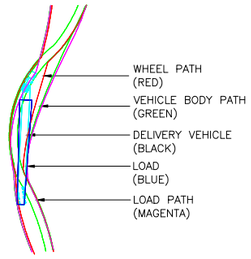
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

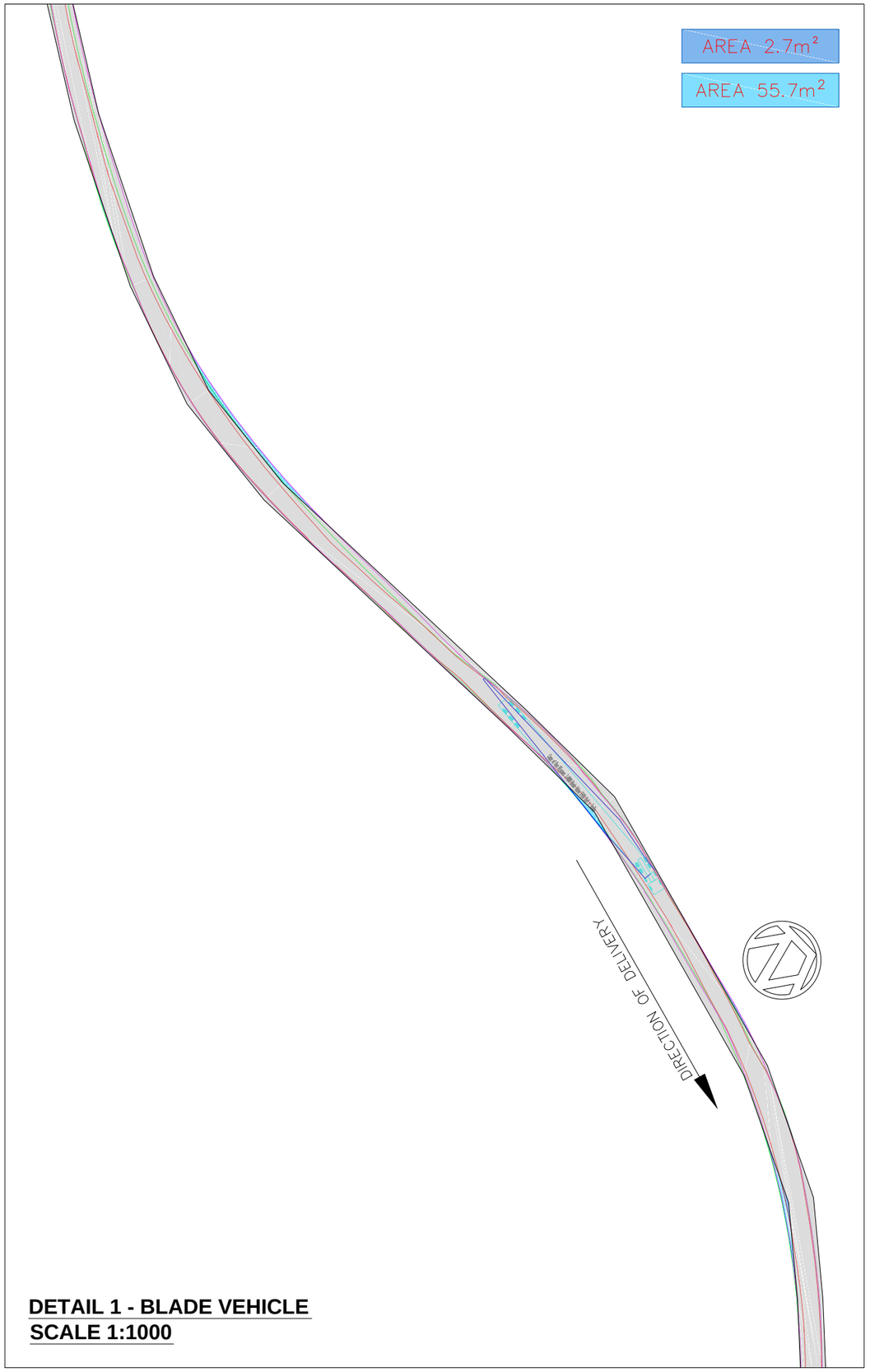
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

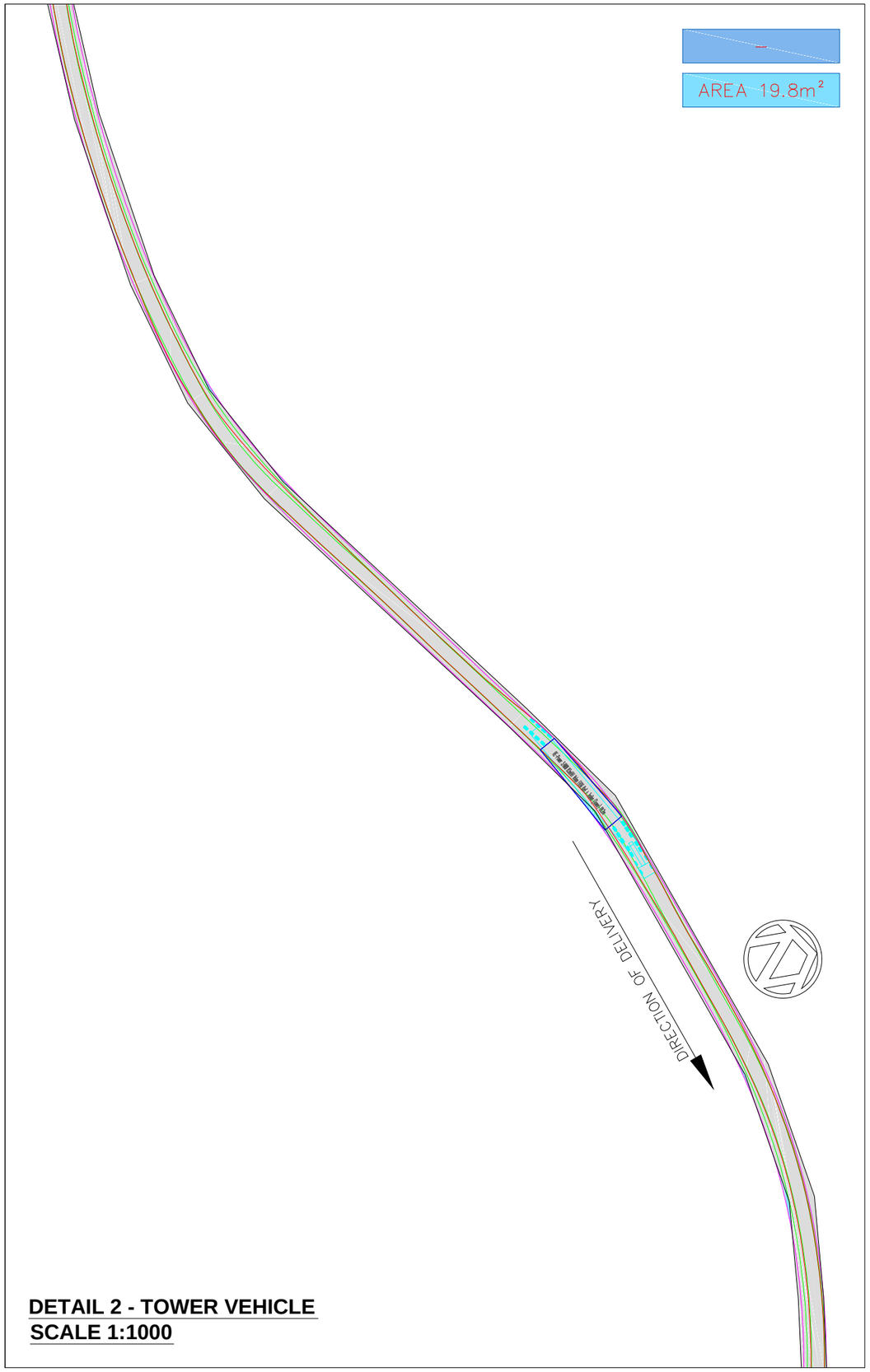
Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9020	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

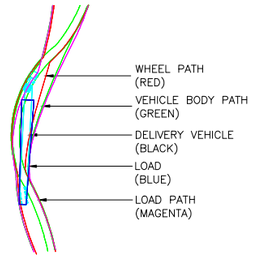


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	I	I	I	I	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

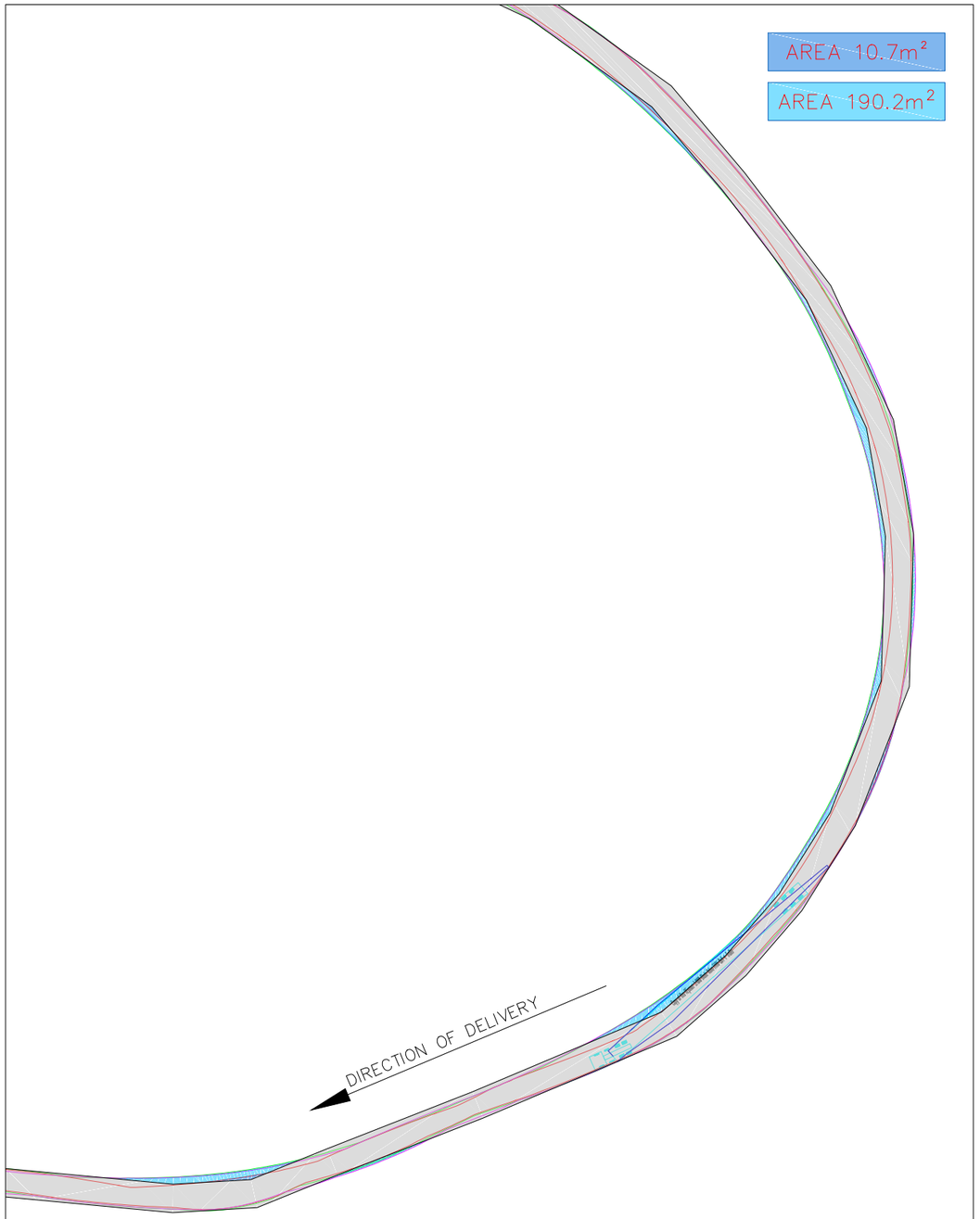
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9021	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB - 6/6/2013 - 4:6 pm



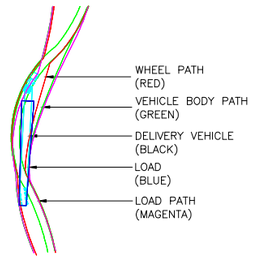
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

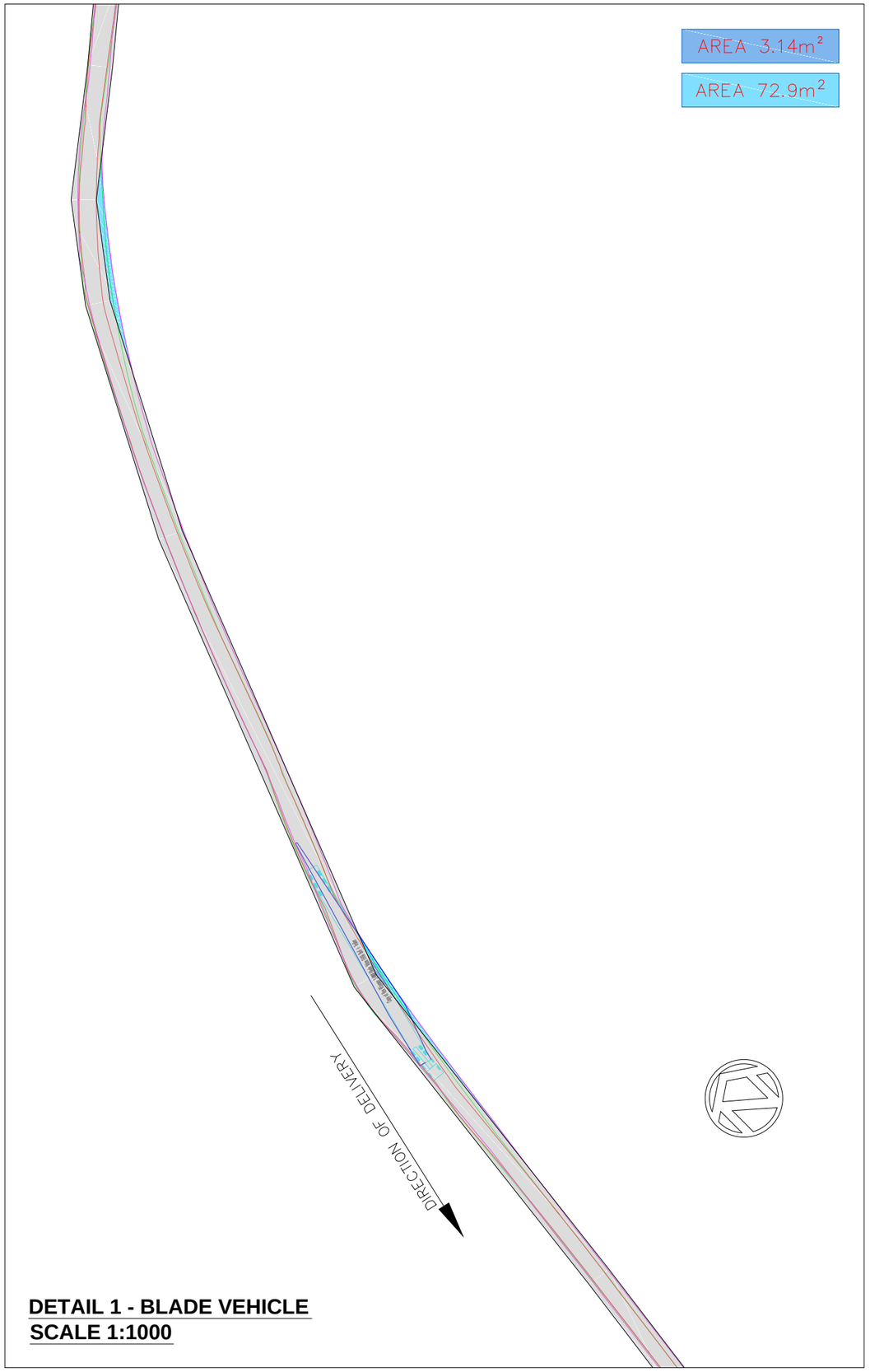
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

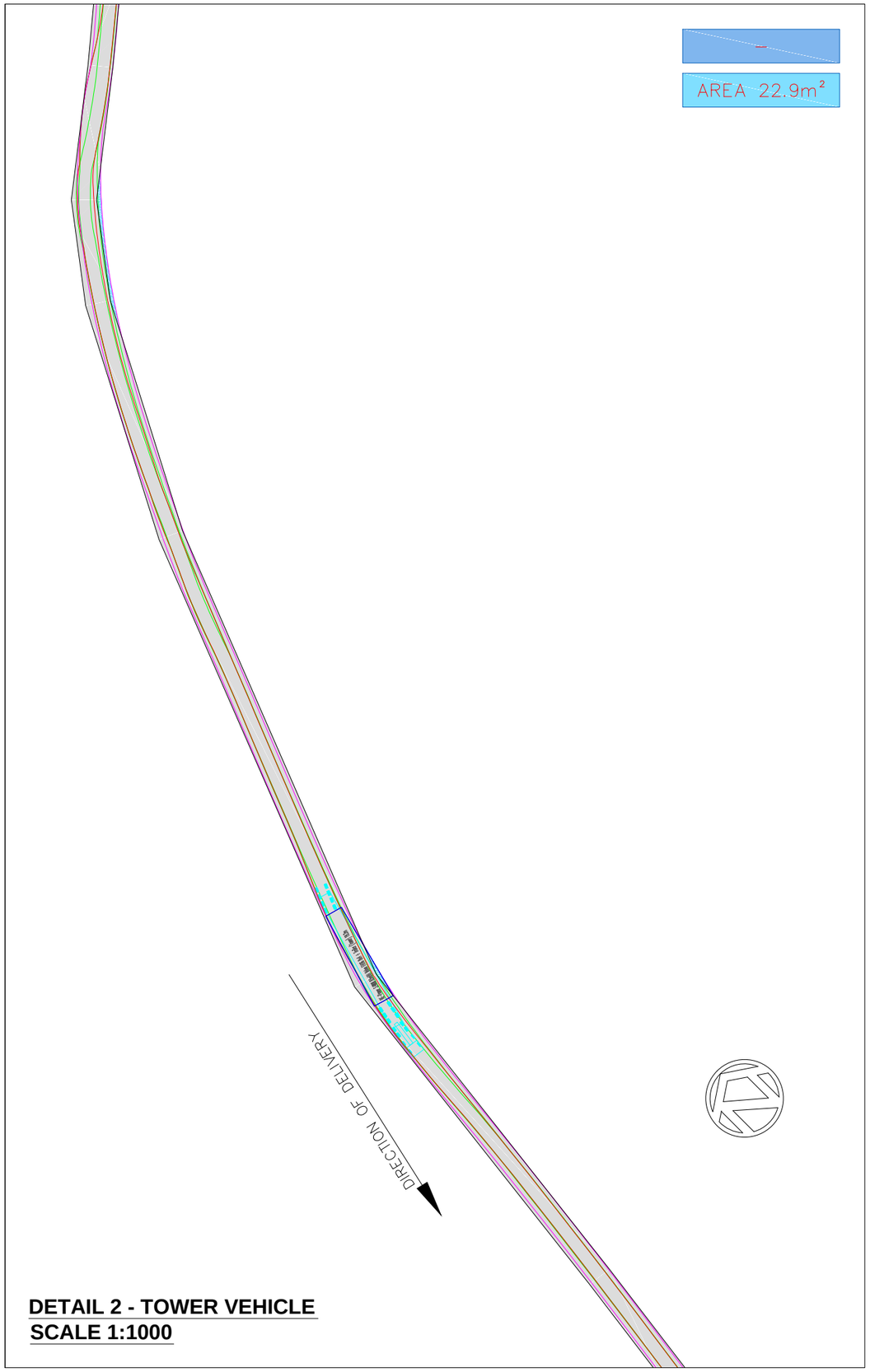
Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9022	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB - 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

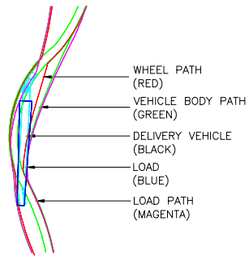


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

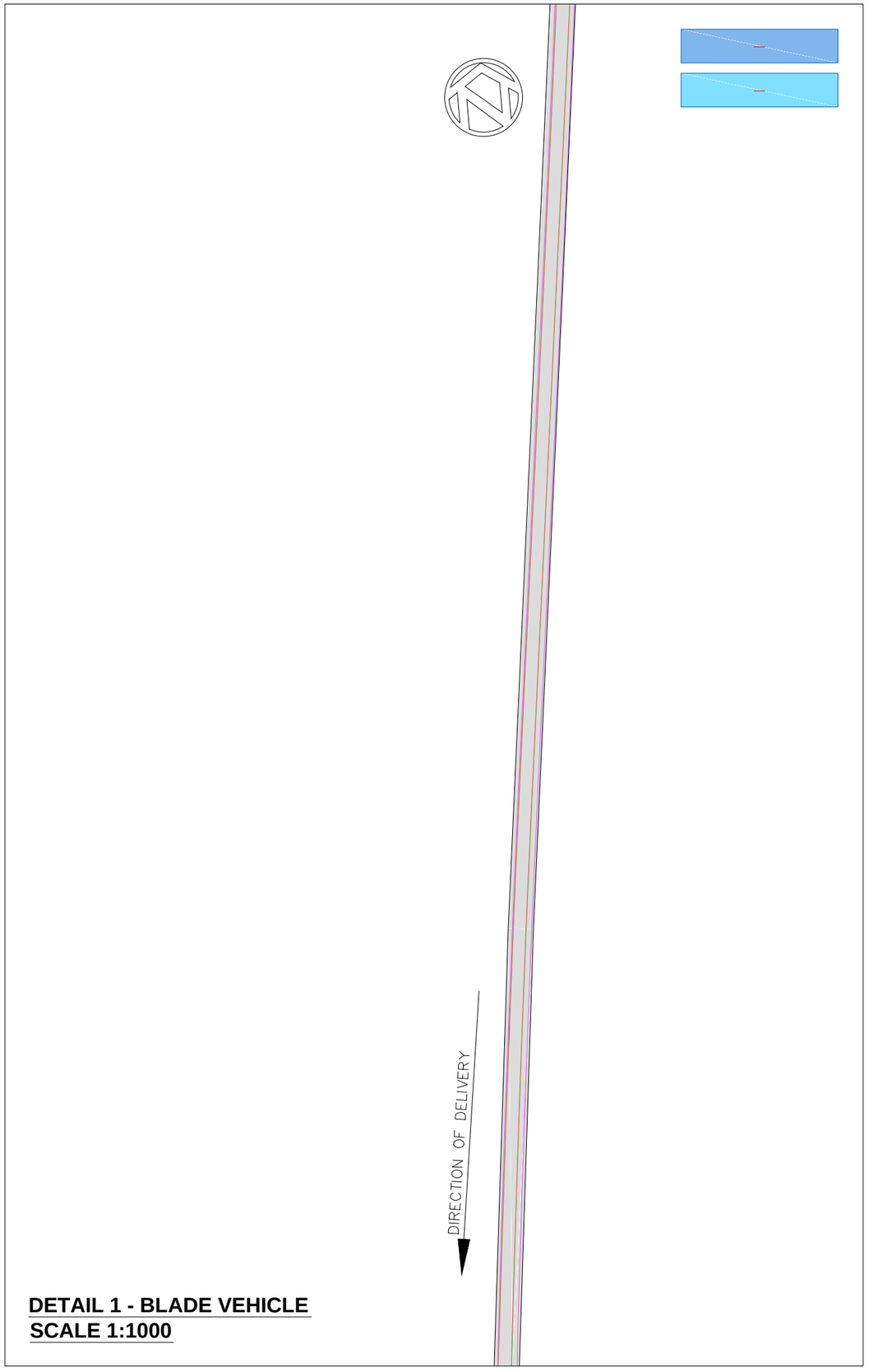
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

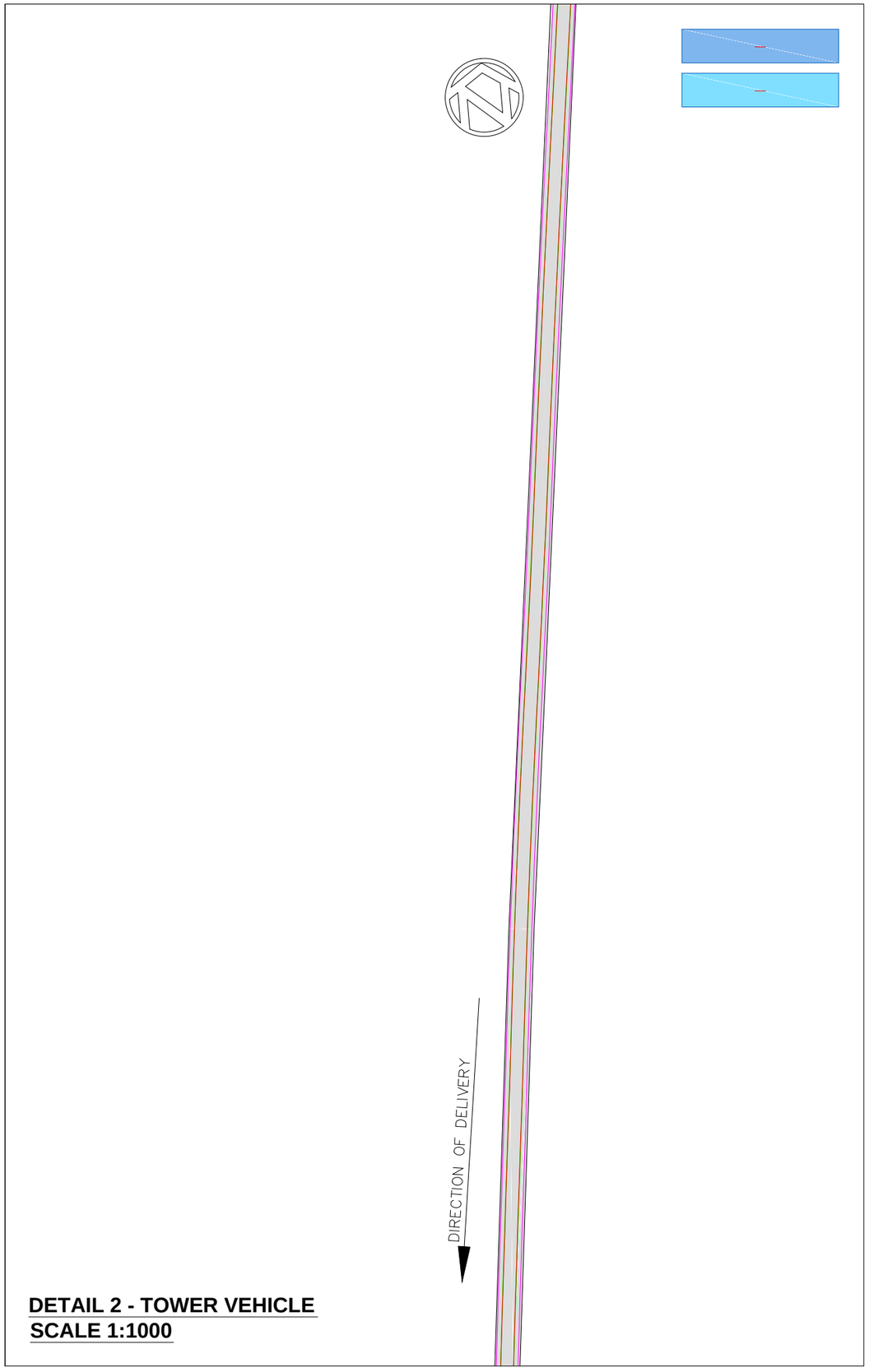
Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9023	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

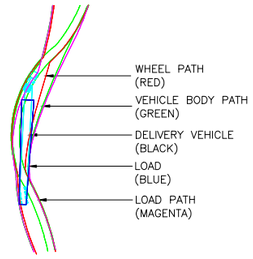


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

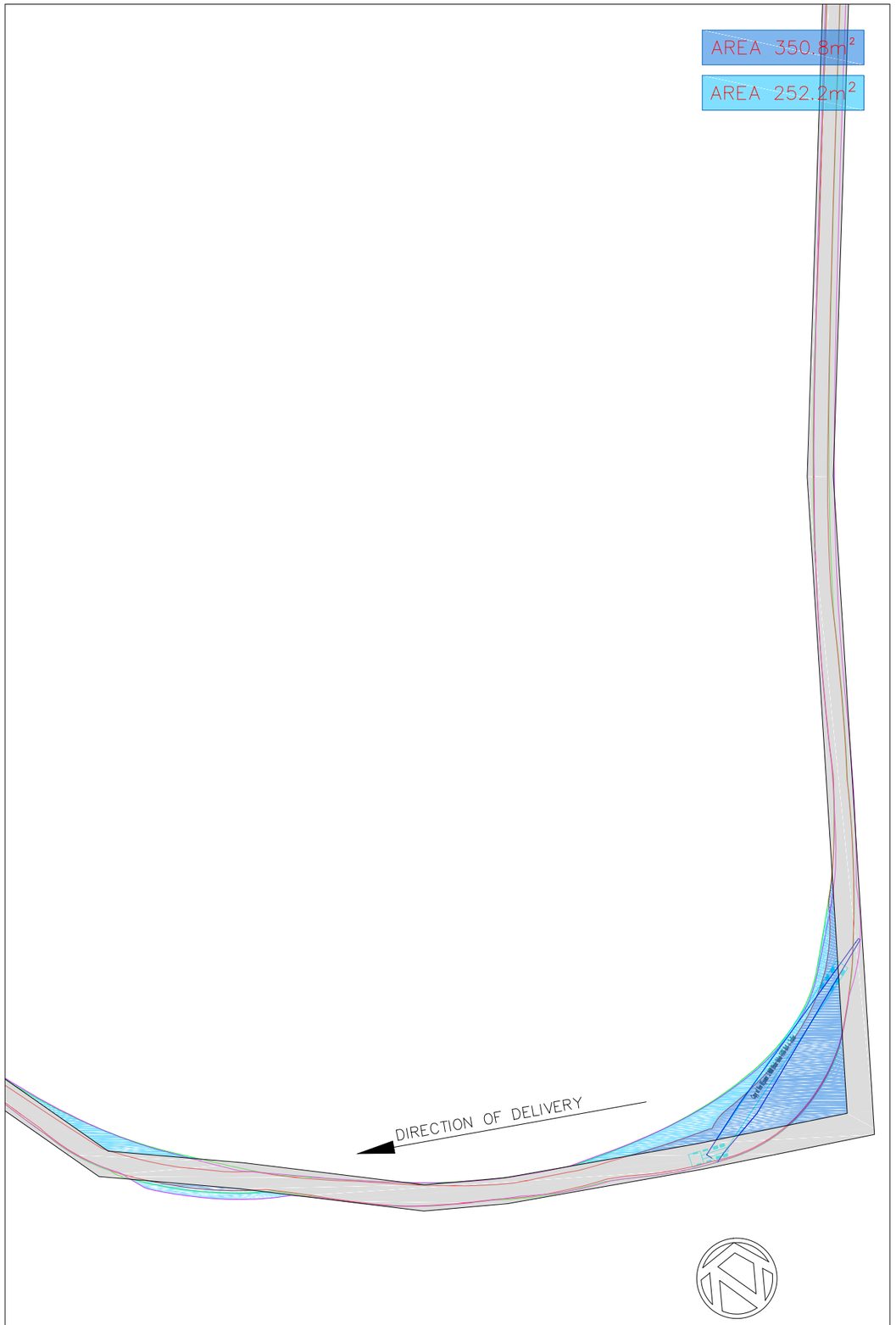
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

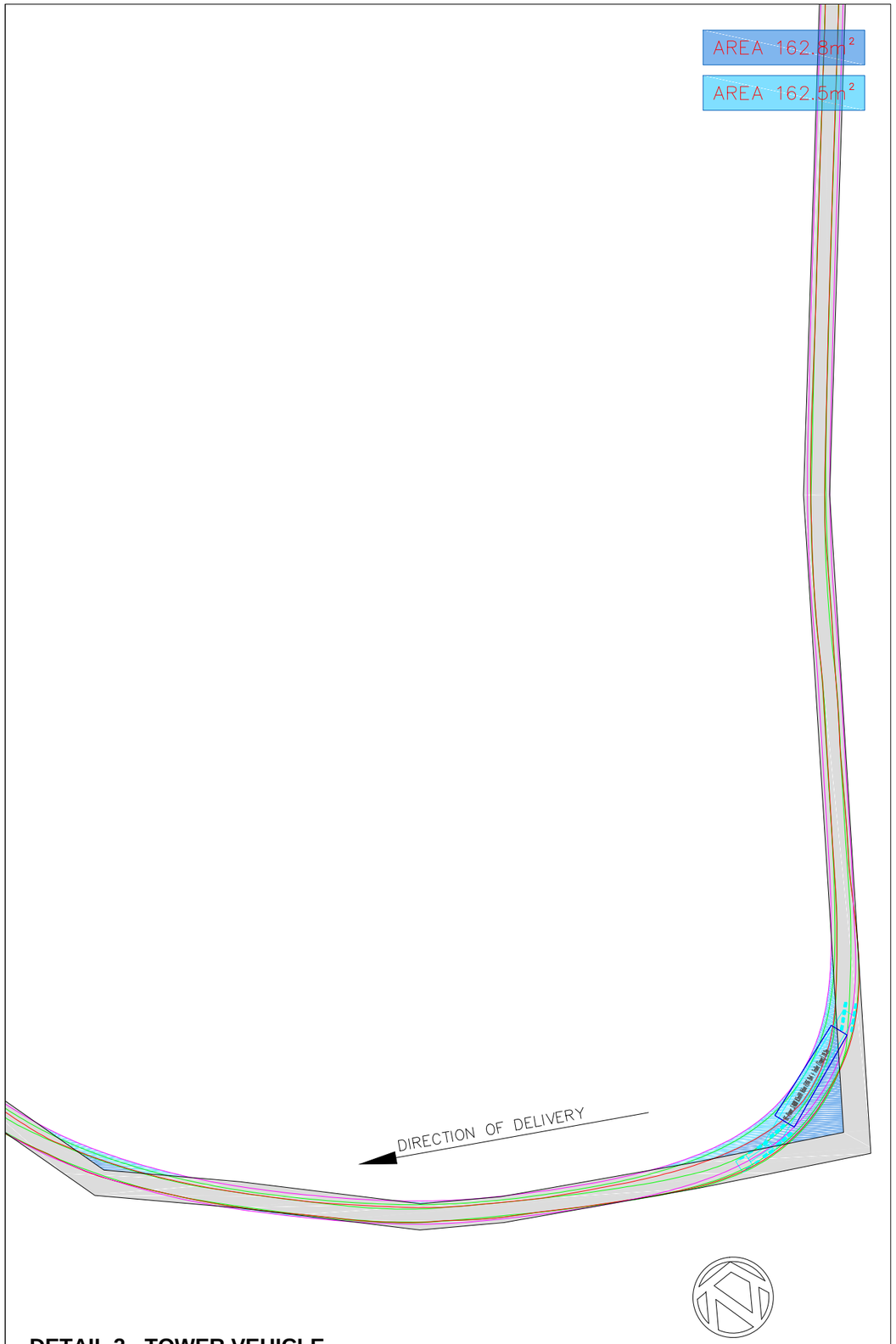
Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9024	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

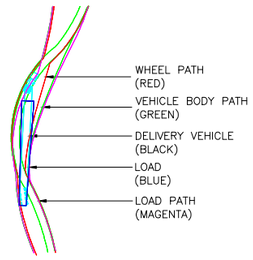


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

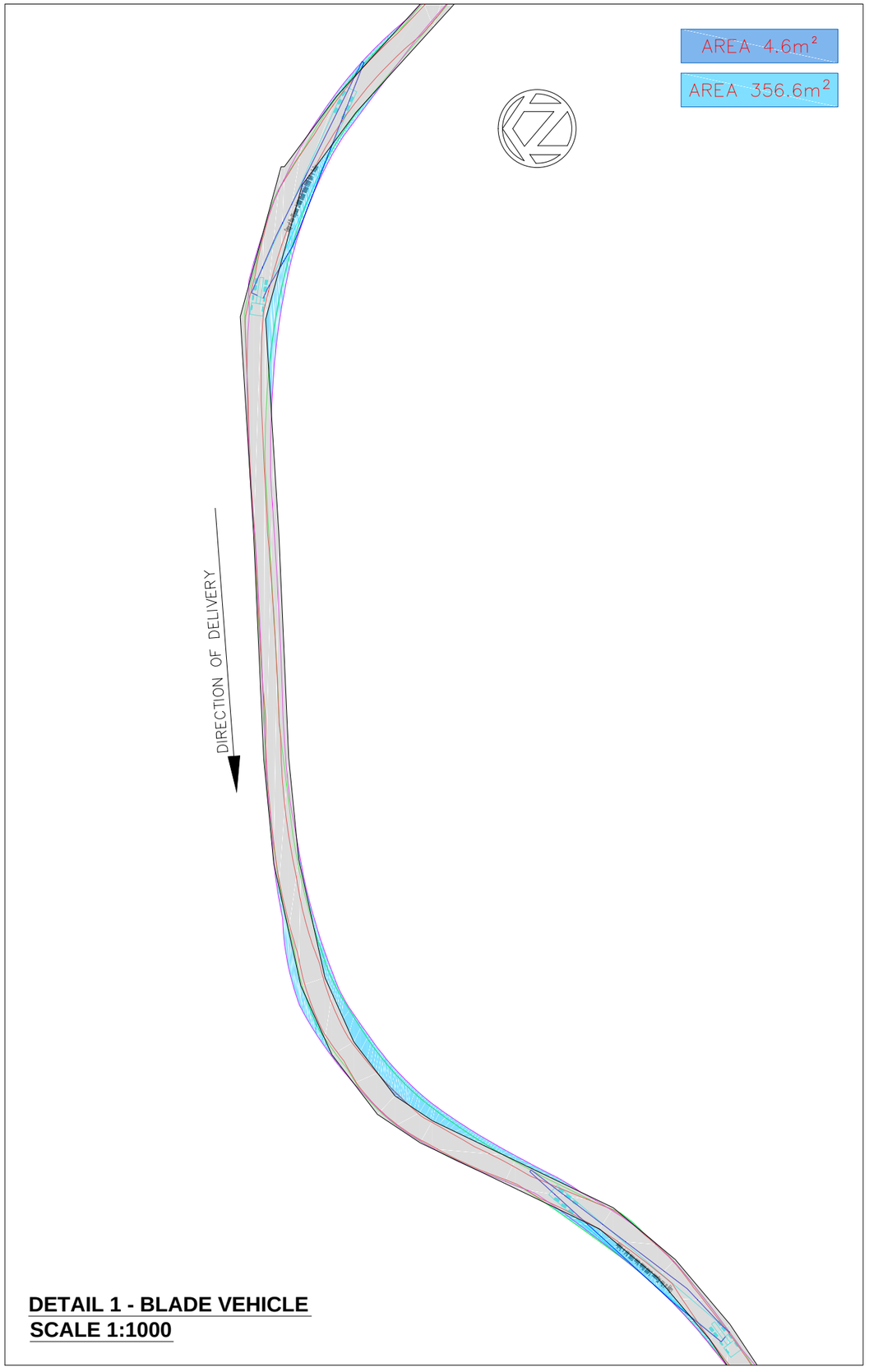
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9025	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



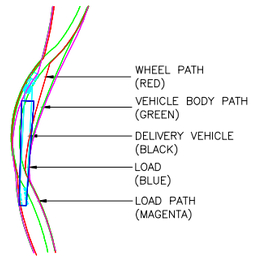
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9026	-

Drawing file path & name : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_29\0513 Revised tracks.dwg
Xreference file path : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigrNeB 6\6\2013 - 4:6 pm

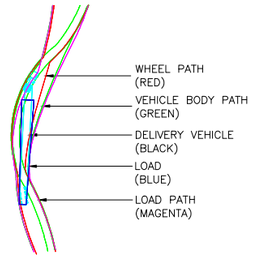
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9027	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB 6/6/2013 - 4:6 pm

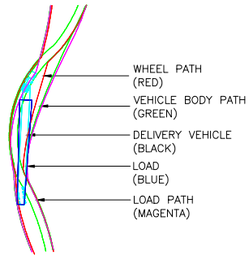
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009. All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 29/05/2013
Checked by	Date:
Authorised by AK	Date: 29/05/2013

Drawing No.	Revision
GGRSSE003/9028	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm

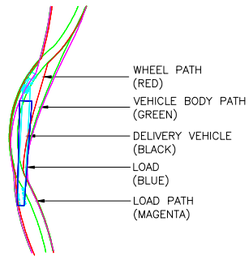
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

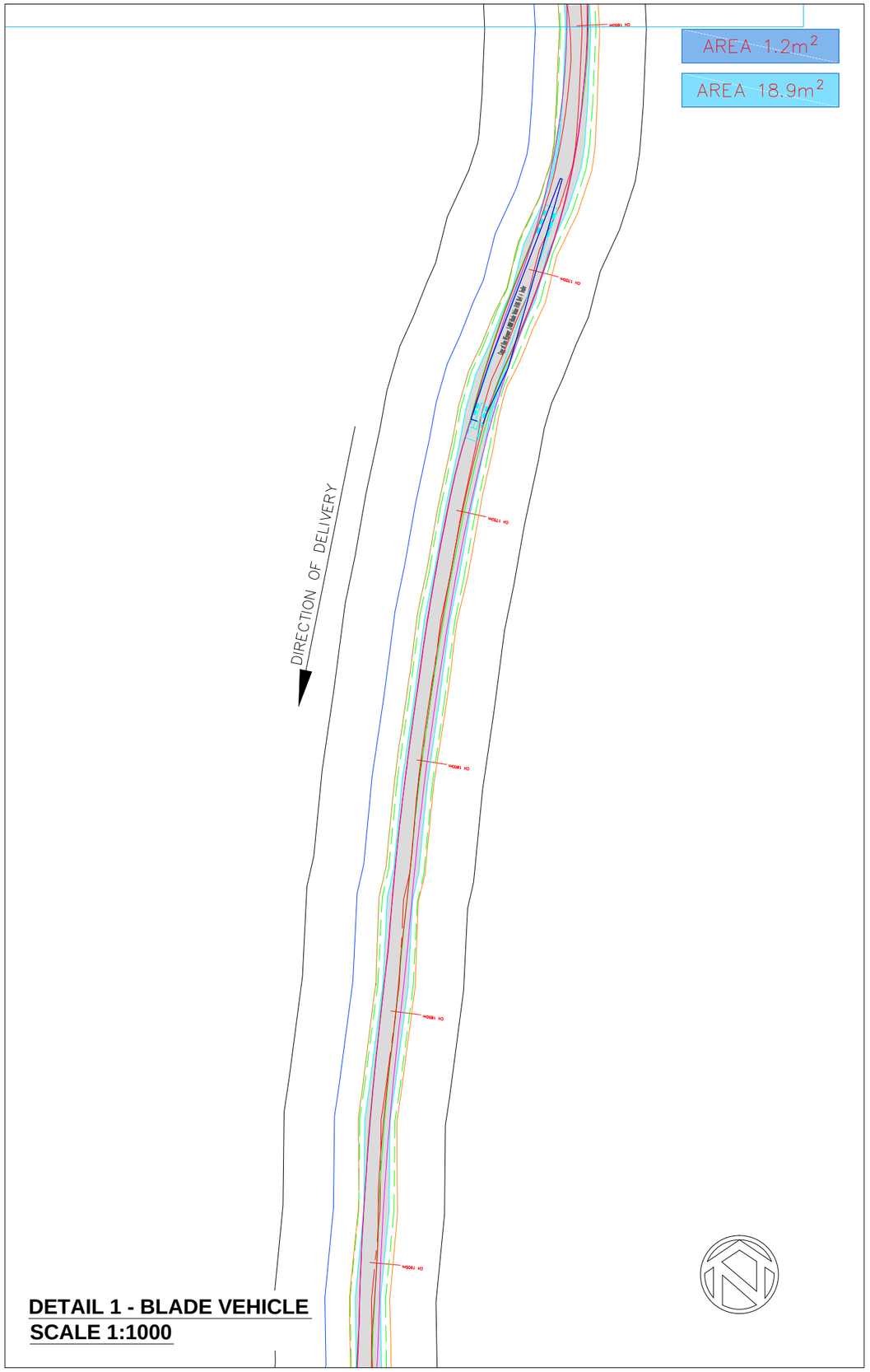
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

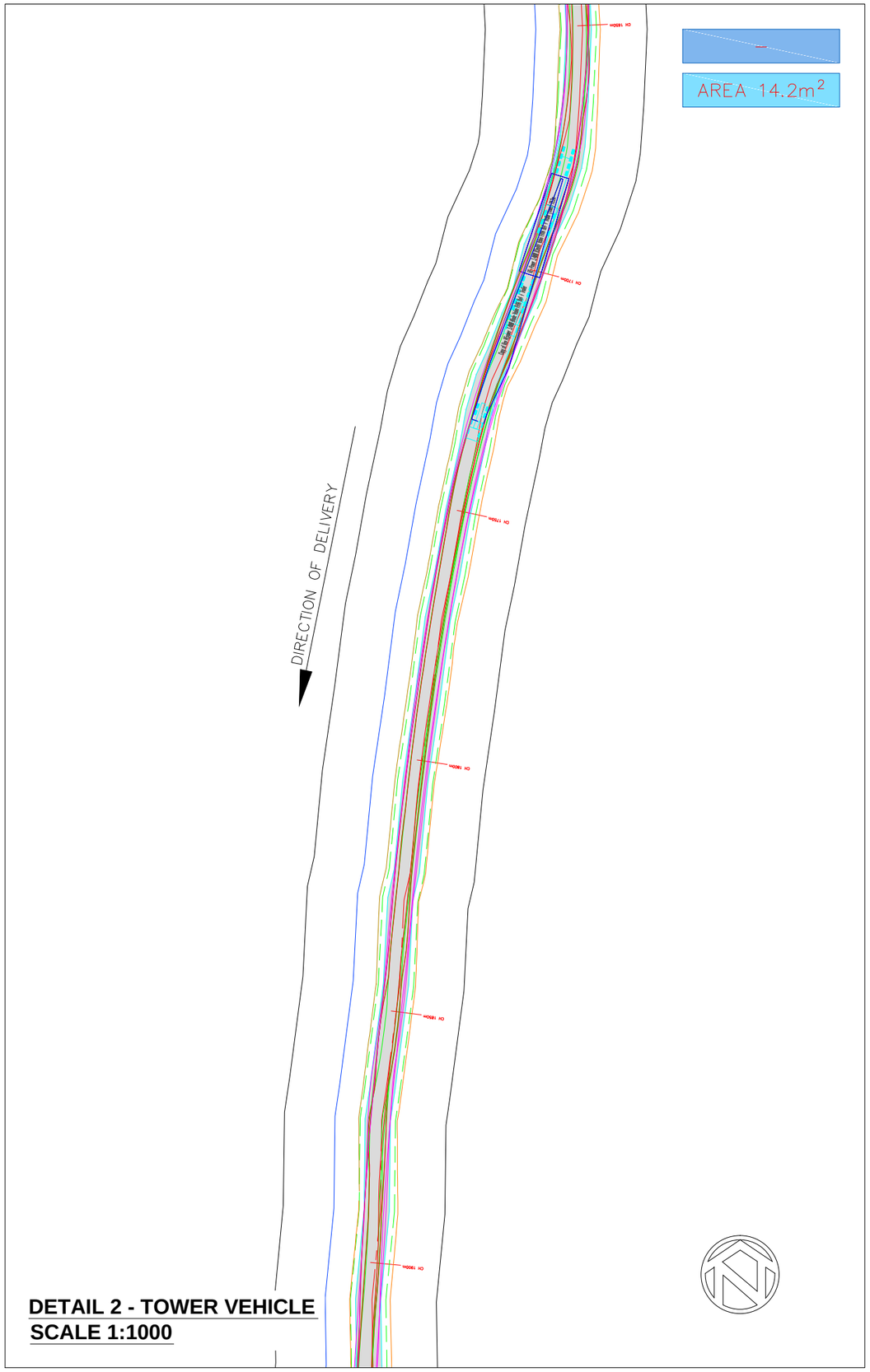
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9029	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

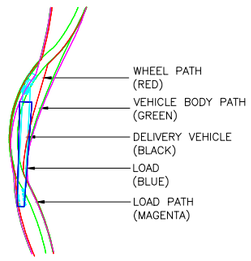


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9030	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB 6/6/2013 - 4:6 pm

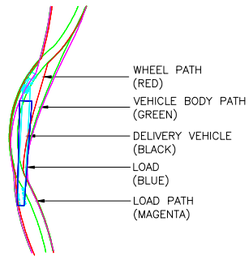
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

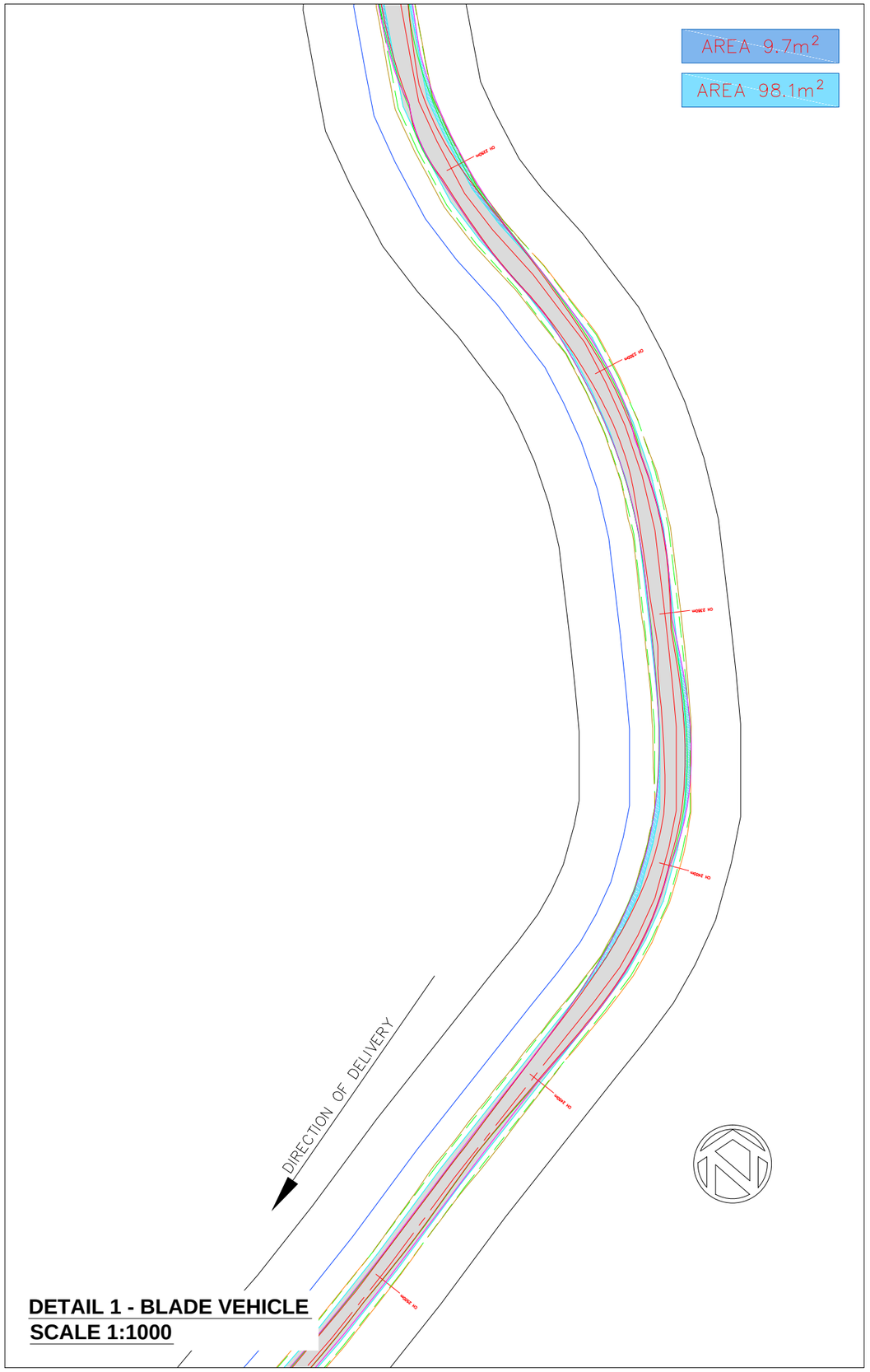
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

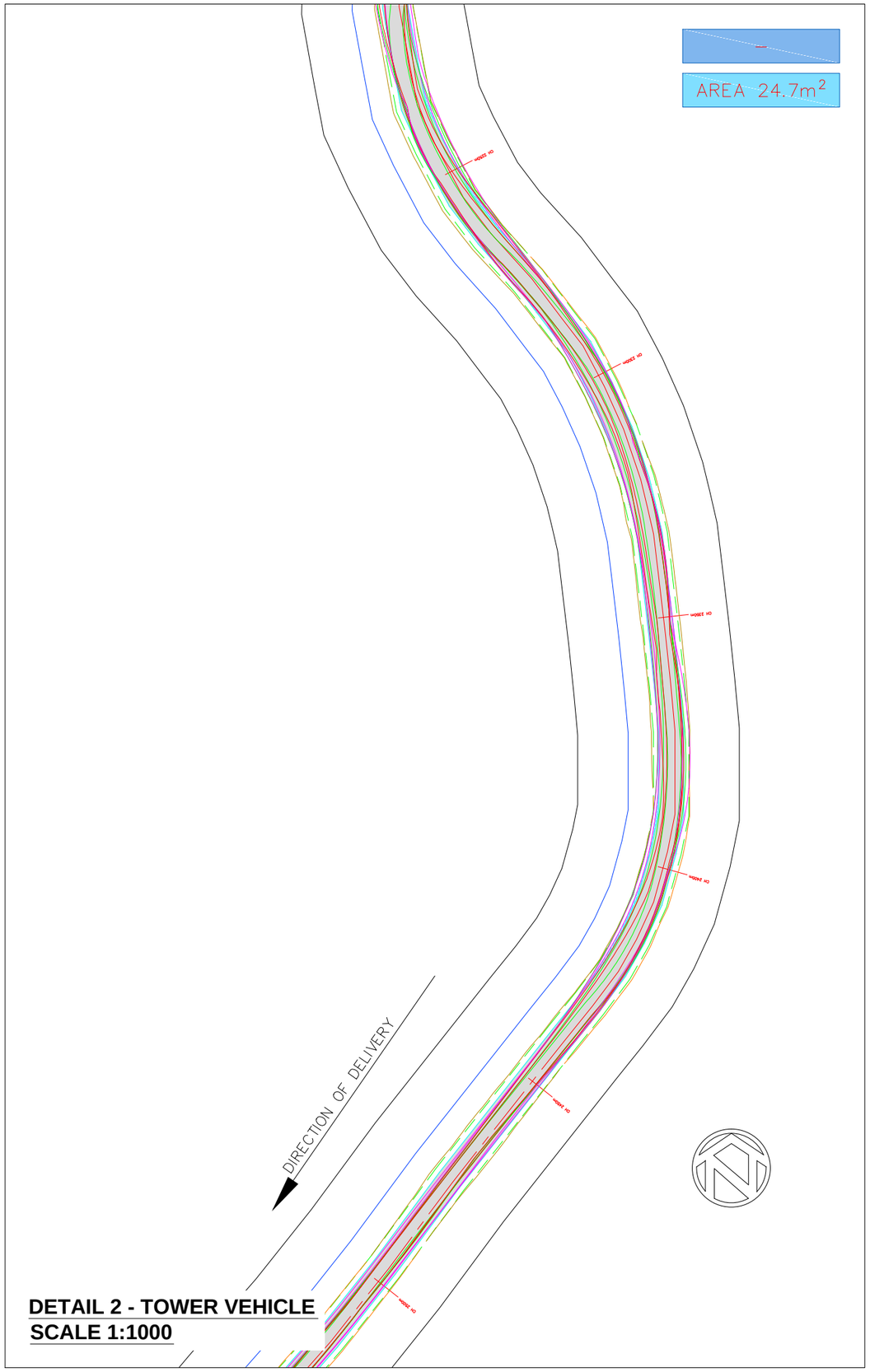
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9031	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

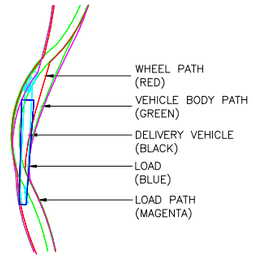


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

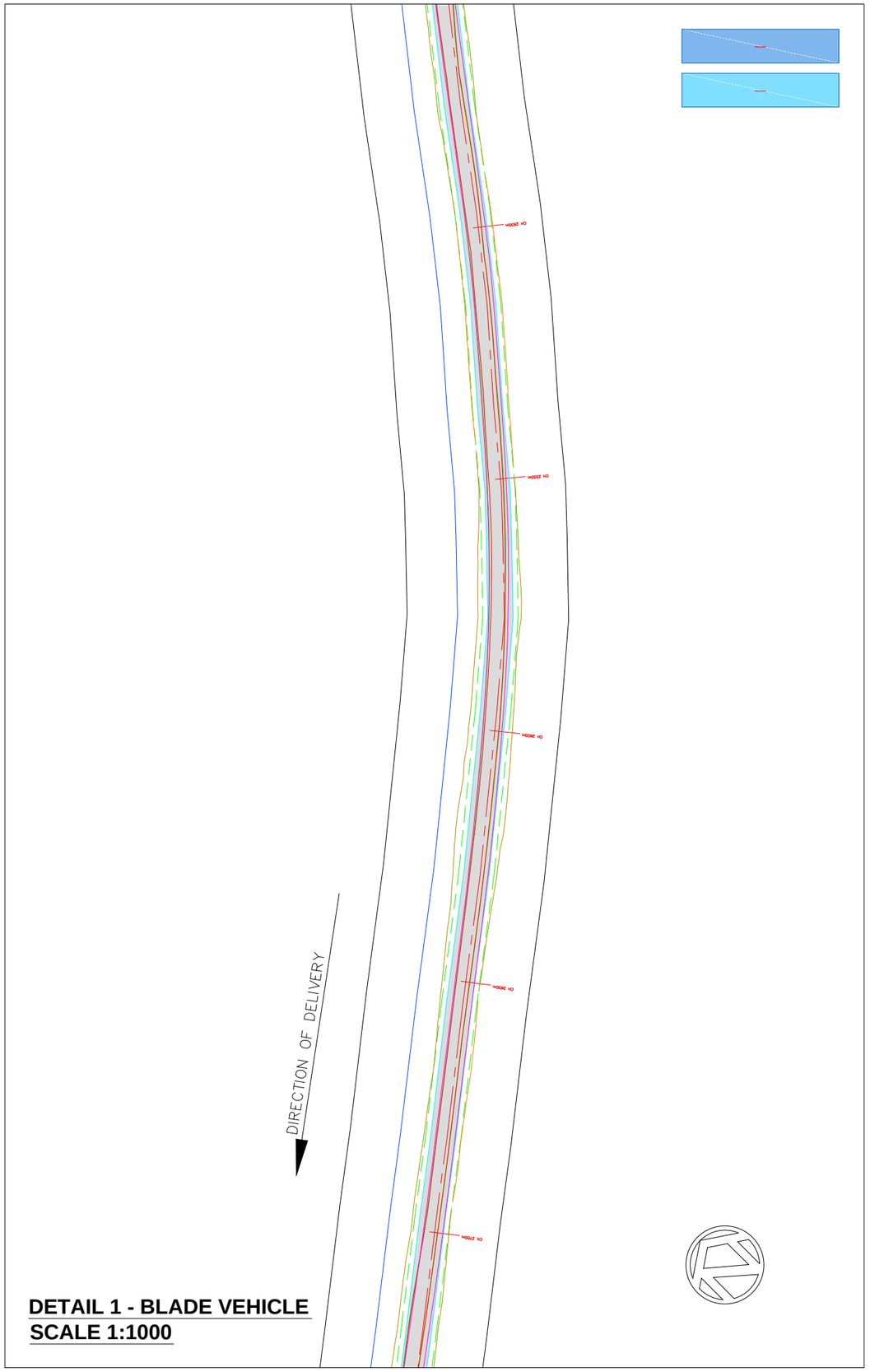
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

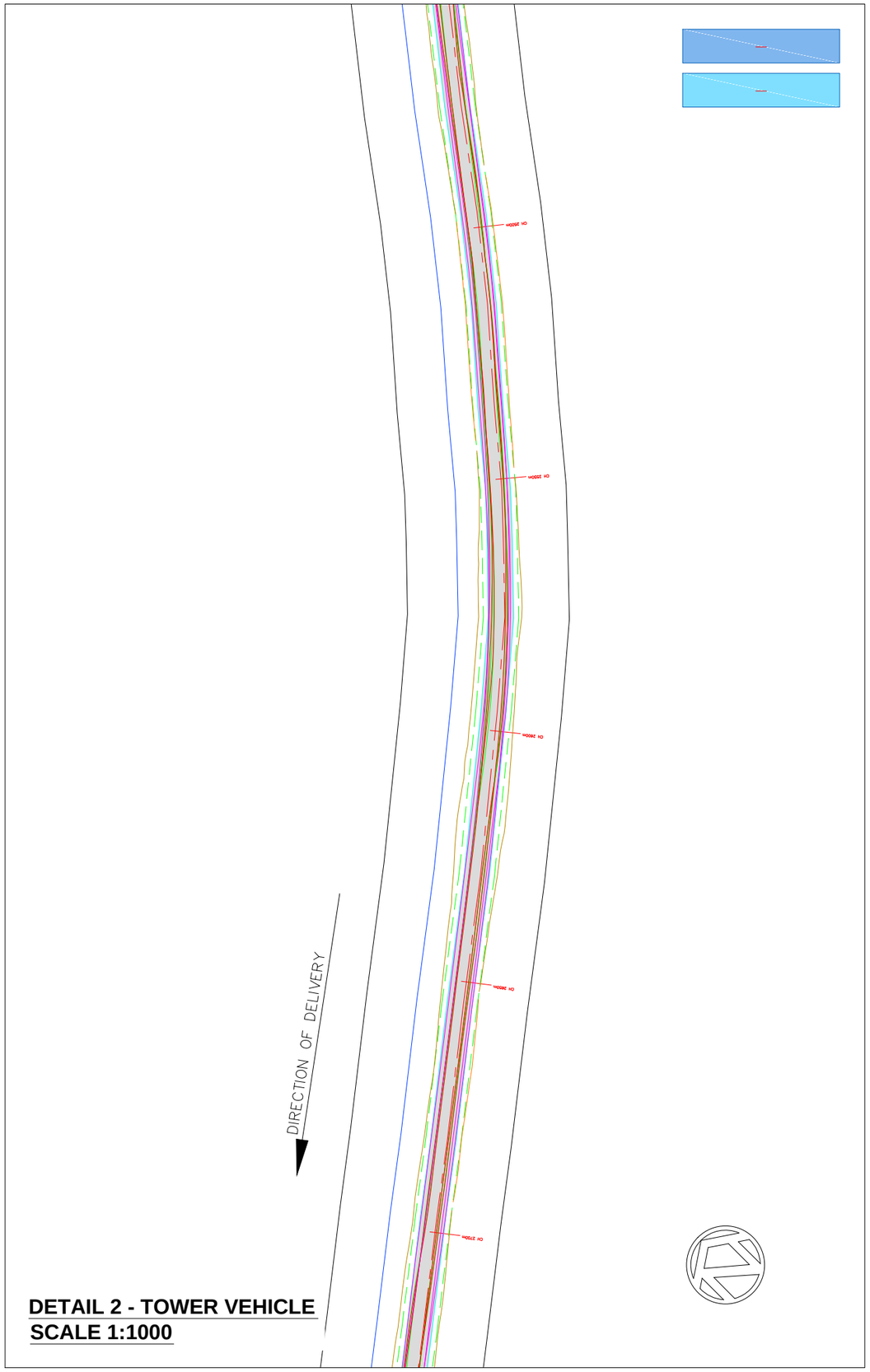
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9032	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000



DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

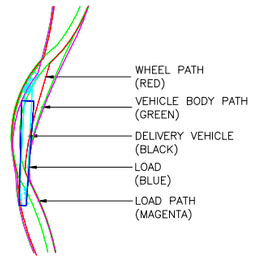
Key:

AREA OF WIDENING

AREA OF OVER-SAIL

EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

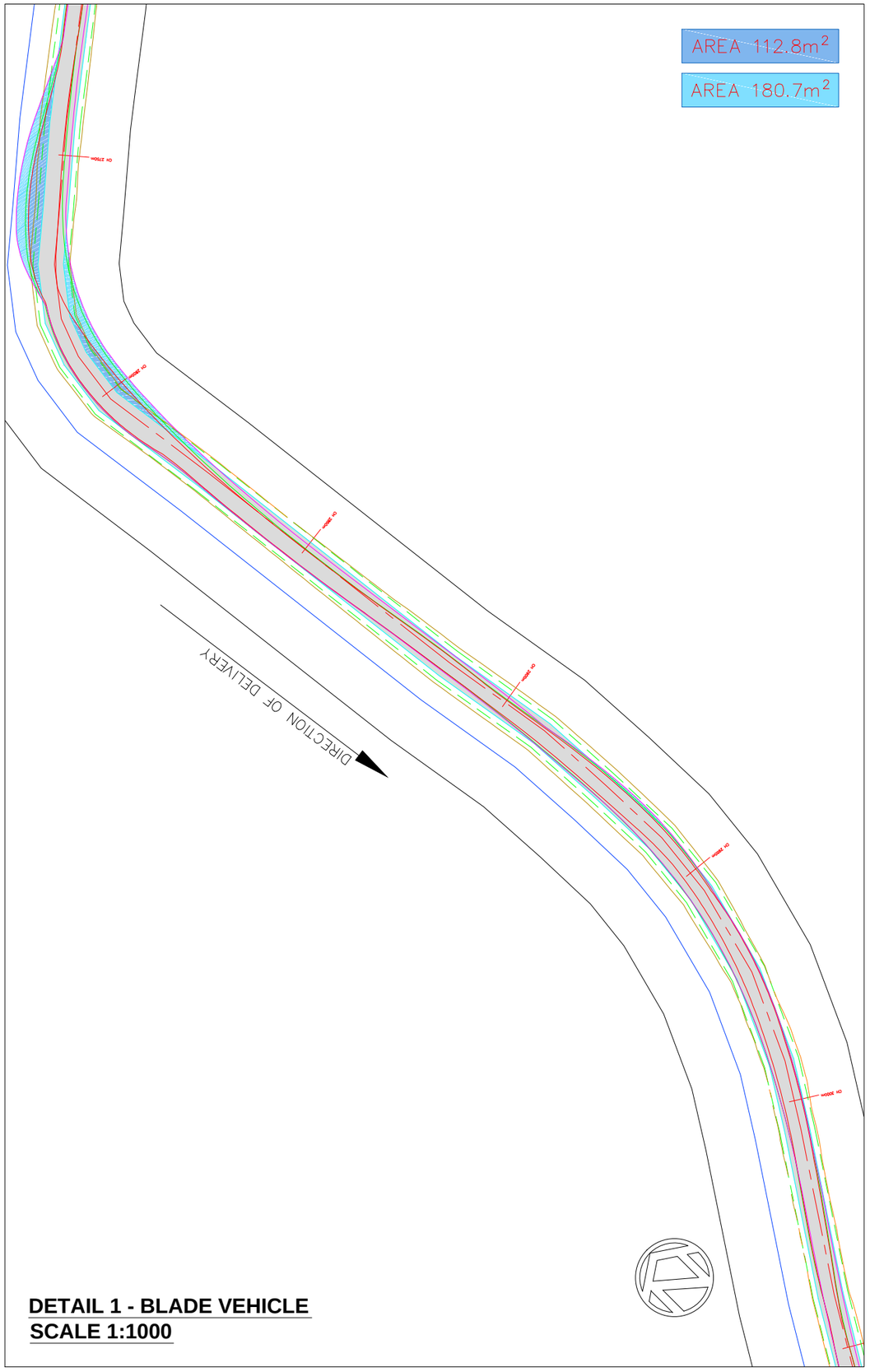
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

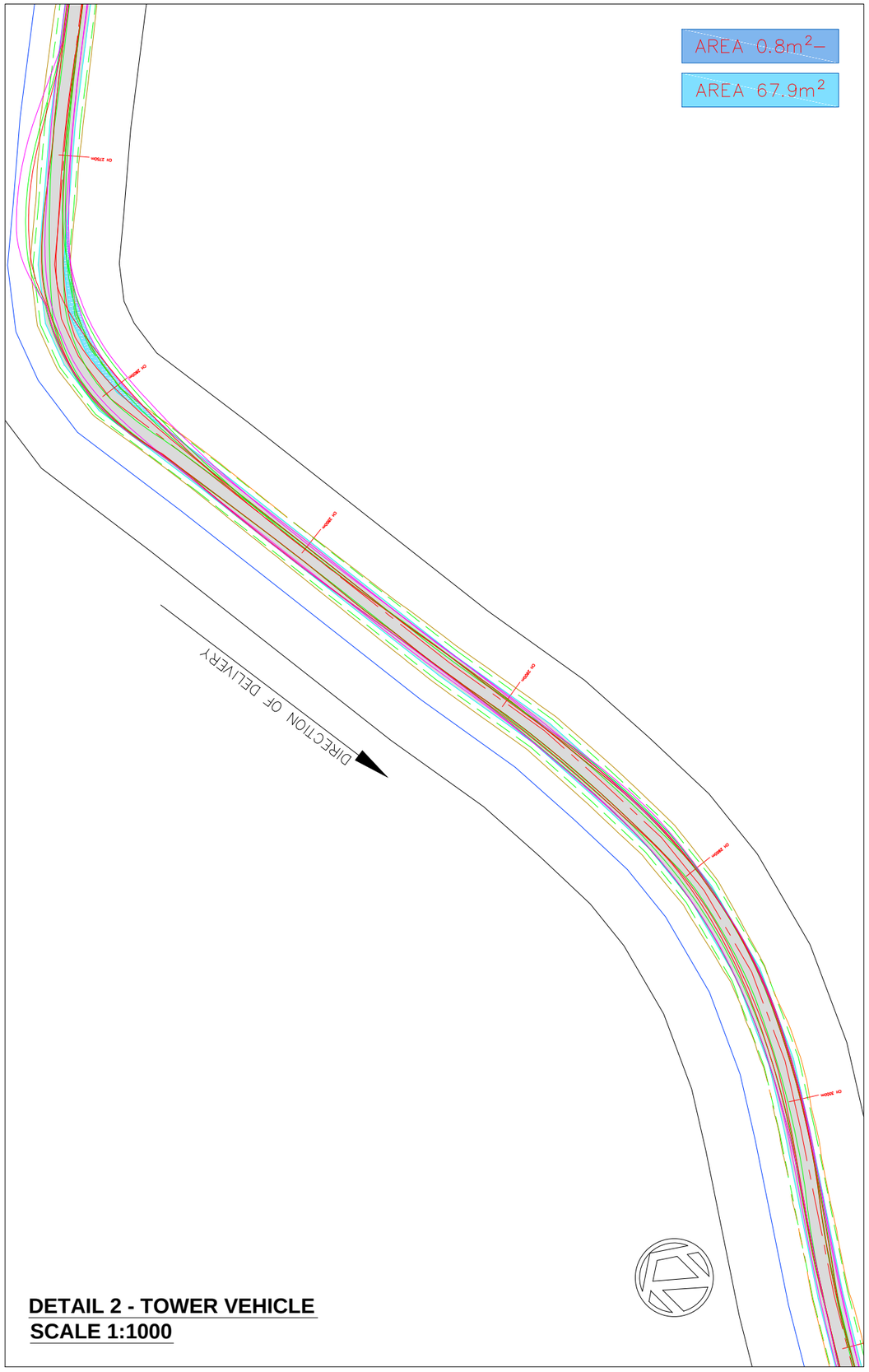
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9033	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Rev Strathy South - Revised Turbine Assessment_290313 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB - 6/6/2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

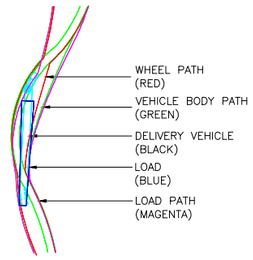


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	I	I	I	I	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

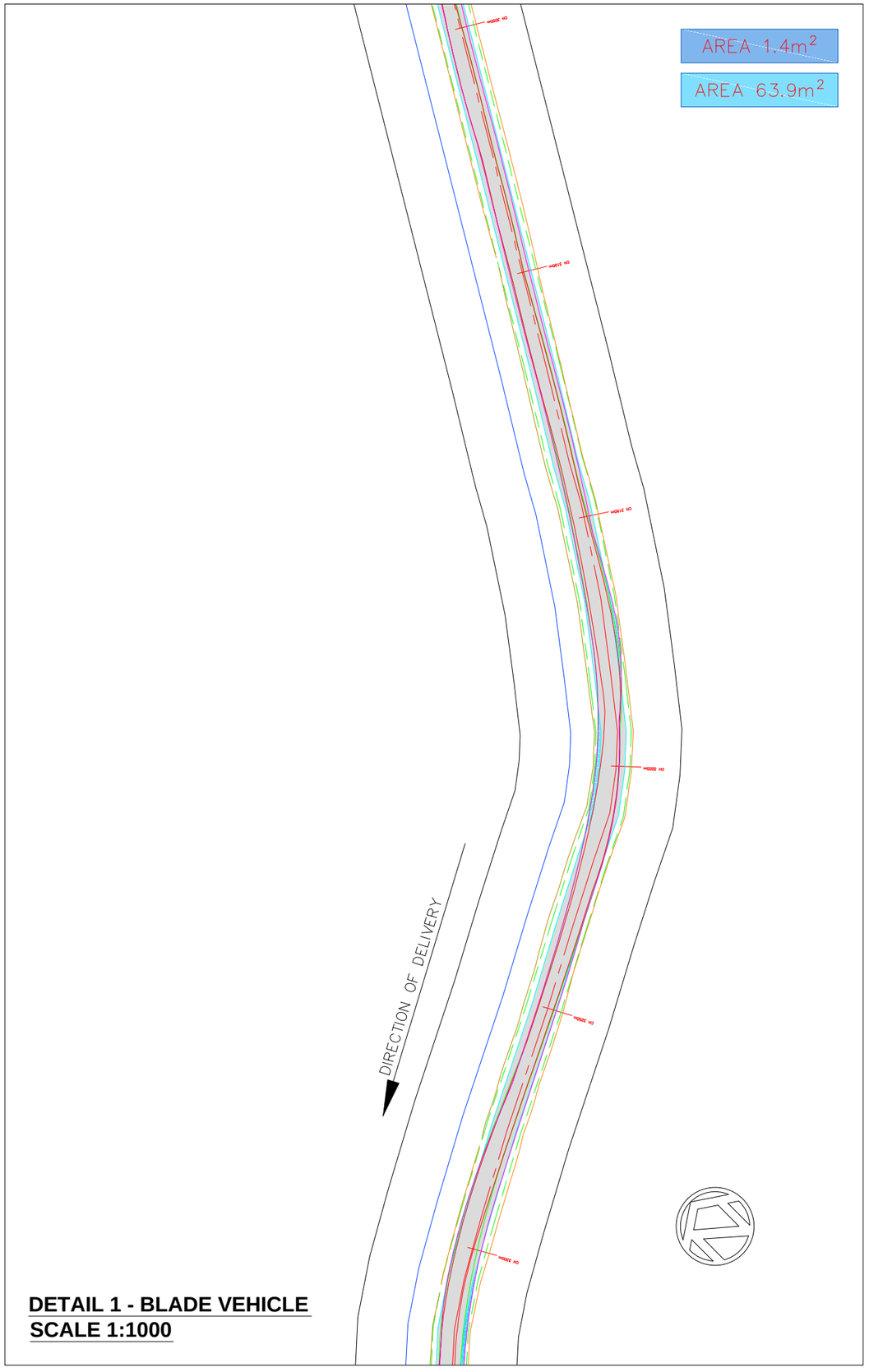
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

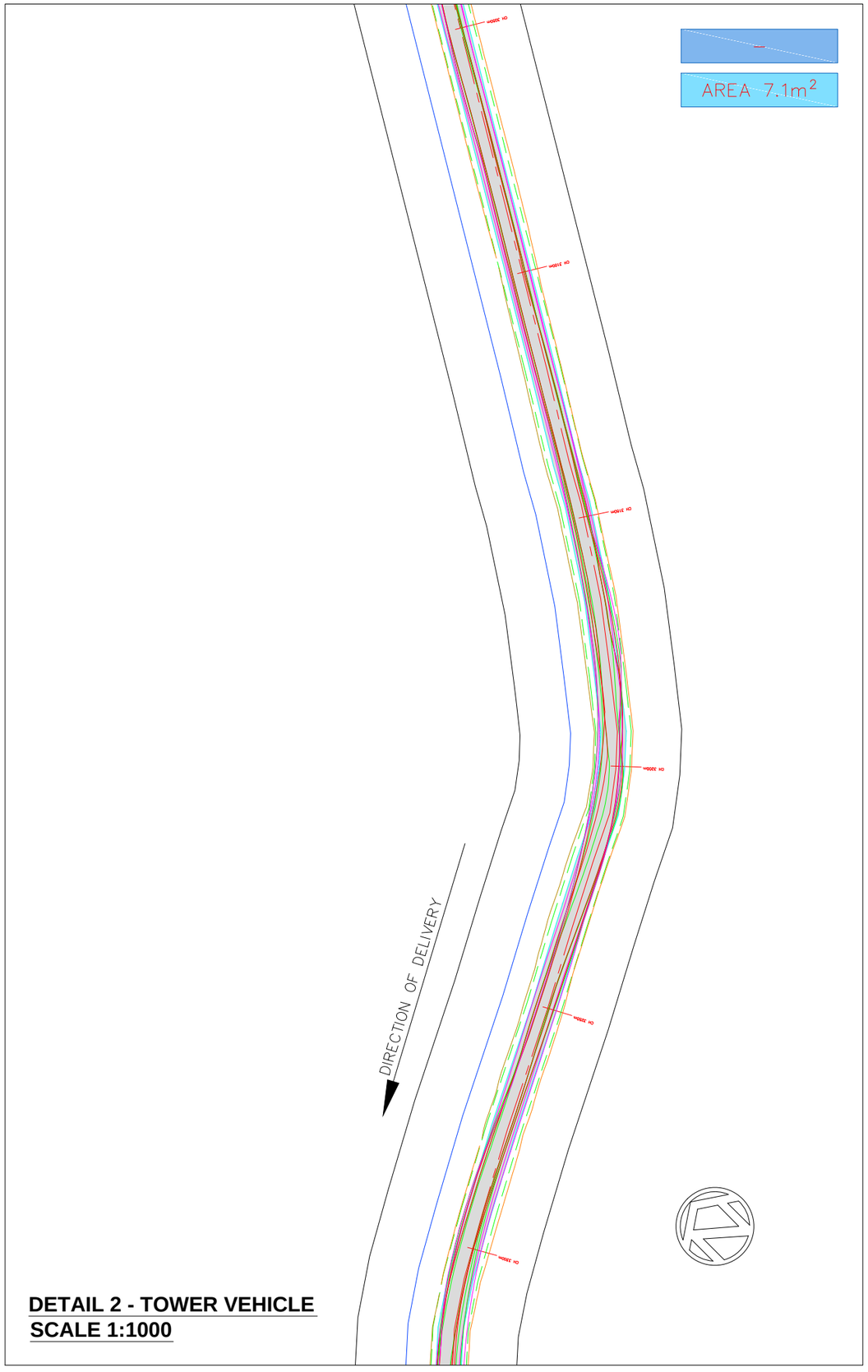
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9034	-

Drawing file path & name : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513-Revised tracks.dwg
Xreference file path : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TightMB 6:6:2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

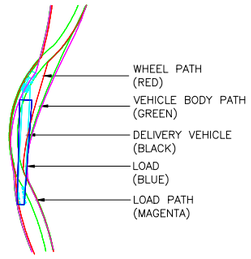


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office, © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9035	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_290513 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigheB : 6/6/2013 - 4:6 pm

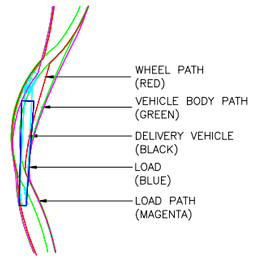
DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

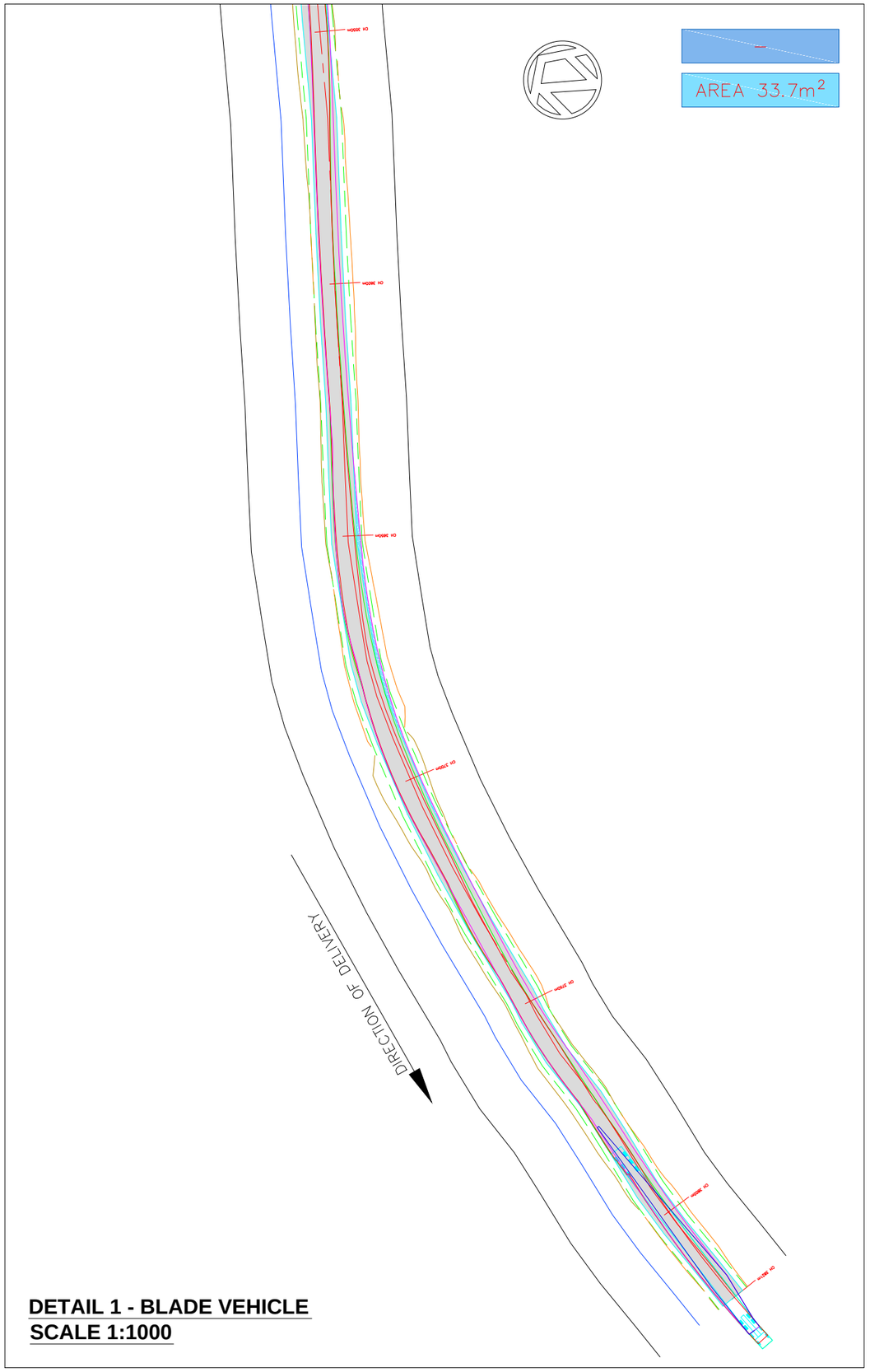
Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

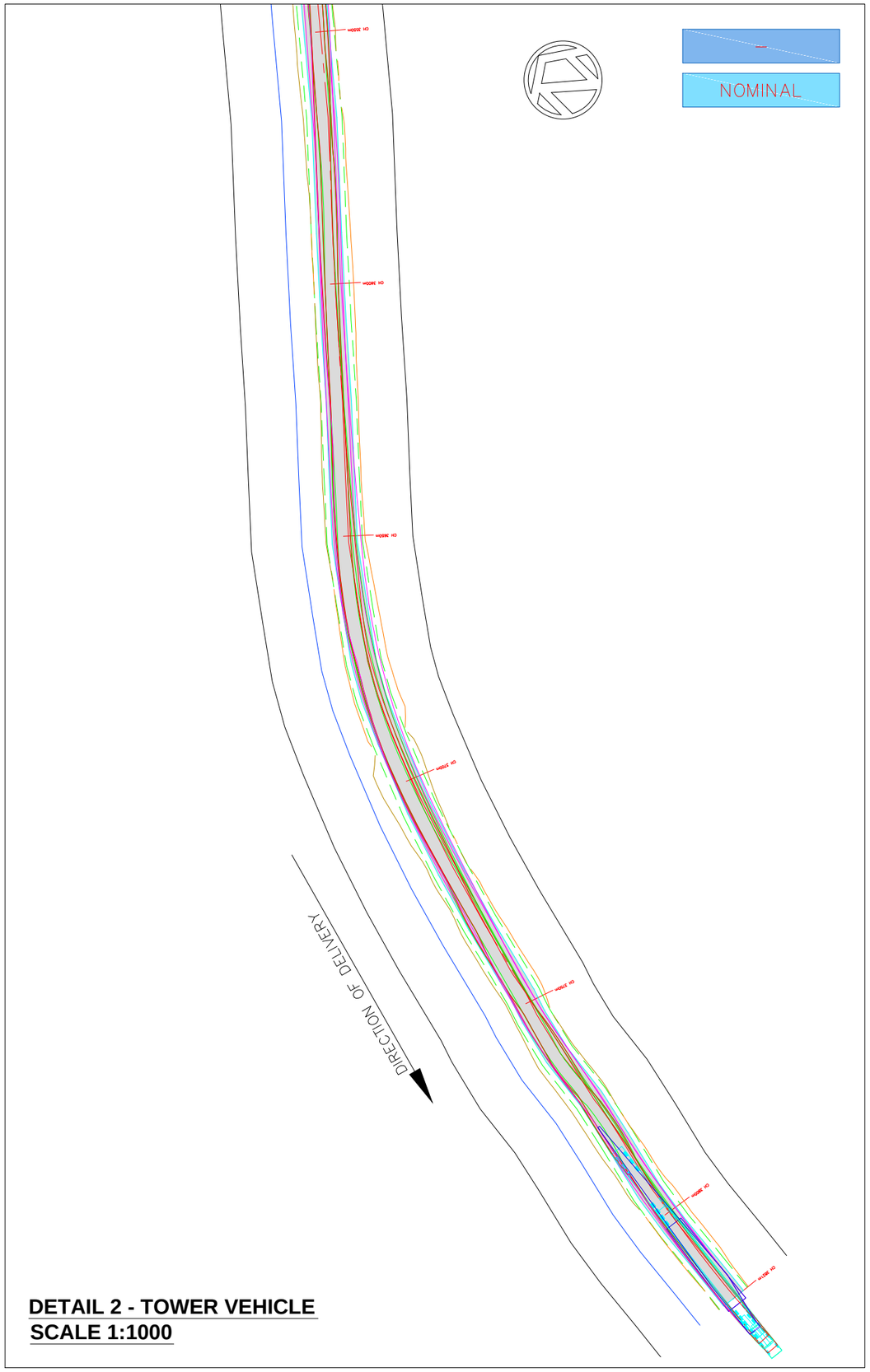
Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9036	-

Drawing file path & name : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re Strathy South - Revised Turbine Assessment_29\0313 Revised tracks.dwg
Xreference file path : U:\4_Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRGS\Outgoing\Re
User and Plot Date : TigrNeB 6\6\2013 - 4:6 pm



DETAIL 1 - BLADE VEHICLE
SCALE 1:1000

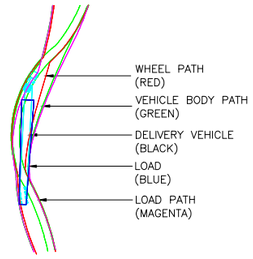


DETAIL 2 - TOWER VEHICLE
SCALE 1:1000

Key:

- AREA OF WIDENING
- AREA OF OVER-SAIL
- EXISTING ROAD/TRACK SURFACE

VEHICLE PATH



ANALYSIS CARRIED OUT FOR:

BASED ON REPOWER 3.4MW TURBINE 50.8m BLADE and 20.0m MID 1 TOWER SECTION. ALL VEHICLES USED ARE FOR INDICATION ONLY AND SUBJECT TO CONFIRMATION FOLLOWING TURBINE AND HAULAGE COMPANY SELECTION.

Revision	By	Checked	Approved	Date	Description
-	-	-	-	-	-

Reproduced by permis sion of Ordnance Survey on behalf of Her Majesty's Stationery Office. © Crown copyright and database right 2009.
All rights reserved. Ordnance SurveyLicence Number: 100023379

Client

SSE Renewables

Halcrow Group Limited
City Park 368 Alexandra Parade Glasgow G31 3AU
Tel +44 (0)141 552 2000 Fax +44 (0)141 552 2525
www.halcrow.com

Halcrow

Project

STRATHY SOUTH
WIND FARM

Drawing Title

ABNORMAL LOADS ASSESSMENT
STRATHY NORTH TO STRATHY SOUTH
DETAILED JUNCTION ANALYSIS

Drawn by BT	Date: 25/03/2013
Checked by	Date:
Authorised by AK	Date: 25/03/2013

Drawing No.	Revision
GGRSSE003/9037	-

Drawing file path & name : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRSS\Outgoing\Re Strathy South - Revised Turbine Assessment_290313 Revised tracks.dwg
Xreference file path : U:\4. Transport Planning\Projects\Live Projects\GGRSSE - SSE Wind Farm Framework (201227)\AC.00.04 - Strathy South\DRSS\Outgoing\Re
User and Plot Date : TrgHeB 6/6/2013 - 4:6 pm

SSE Renewables

Delivering Social and Economic Benefits

Gordonbush Wind Farm Case Study

A wind turbine blade makes its way to the Gordonbush wind farm

SSE Renewables is part of the SSE Group, Scotland's leading energy business. We develop renewable energy projects across the UK and Ireland. You may know us as 'Scottish Hydro'.

We have a long history in the Highlands with our hydro stations, and as Scotland moves to a low-carbon economy with more renewable energy needing to be developed, SSE aims to ensure that the lasting legacy of our developments is a positive one for the communities within which we live and work. Our objectives are to deliver green energy, local economic benefits, jobs, training, community development and social and environmental responsibility.

To illustrate our commitment this document demonstrates the local and regional, social and economic benefits of one of our previous renewable energy projects, and touches on some other examples. There may not be the local supply chain for some aspects of a particular project, this is always the case, but we will do our utmost to ensure that the lasting legacy of our developments is one that maximises local social and economic benefits. These are the kind of things you can expect from an SSE Renewables development.

Case Study: Gordonbush Wind Farm

Gordonbush is a 35 turbine wind farm near Brora in Sutherland. It has an installed capacity of 70 megawatts (MW). Work on preparing the site started in Autumn 2009, the turbine installation started in August 2011 and the wind farm was completed and commissioned in May 2012.

The Environmental Statement that was submitted as part of the planning process for this onshore wind farm project included a review of the potential socio-economic impacts of the proposed development. This case study summarises the actual impacts that Gordonbush wind farm has had during its development and construction, as well as the impacts that are expected over its 25-year operating lifetime.

SSE aims to ensure that the lasting legacy of our developments is a positive one for the communities within which we live and work.

Key Points

- The construction of Gordonbush wind farm has delivered real and significant economic and social benefits to Brora, the Highlands and Scotland; an estimated 237 construction job years in Scotland, including 166 in the Highland Council area and 52 in the local Sutherland economy;
- Gordonbush will continue to deliver economic, social and environmental benefits during its 25-year operating lifetime, providing 32 jobs in the Scottish economy;
- SSE Renewables invested over £100m in the development of Gordonbush wind farm;
- Local firms in Brora and other towns benefitted by providing a wide range of materials, services and labour;
- Local accommodation and service providers have housed and supplied those working on site from outwith the local area;
- Gordonbush and other investments have provided sustainable construction jobs in companies including Highland company RJ McLeod, at a time where the construction sector has suffered a deep and lengthy recession;
- Environmental benefits include estimated carbon dioxide emission savings of around 100,000 tonnes each year;
- Investment in local transport infrastructure, circa £2m, such as an upgraded road and planned bridge upgrade will provide legacy benefits to the local community and economy;
- Gordonbush wind farm will, as part of its Estate Management, continue to employ ornithological surveyors, deer management and forestry management from local suppliers from Aboyne, Brora and Inverness respectively, to maintain the estate to the standard specified in the Planning Application's Environmental Statement. Estate Management is required every year of the 25-year consent.
- Community investment funding is delivering both social and economic benefits, therefore supporting the local economy;
- SSE takes its responsibilities and contribution to the Scottish and local economy seriously; SSE is the biggest Scotland headquartered energy company and a leading private sector employer in the Highlands; and
- SSE is demonstrating its commitment to maximising Scottish economic impacts by investing in the Scottish supply chain (for example Wind Towers Ltd in Argyll) and by investing in research and development in Scotland.

Direct and Supply Chain Economic Impacts

SSE Renewables invested over £100m in the Gordonbush wind farm. Many of the larger contracts were awarded to Scottish businesses and several local firms worked on the project.

During the development and construction phase (to May 2012), the project supported an estimated 237 job years in Scotland (i.e. the equivalent of 237 jobs for a year) across a wide range of sectors, including, planning, legal and environmental impact assessment services, civil engineering and infrastructure development and grid connection. The supply chain for these services included everything from electrical services to plant hire to ecological clerk of works. Of these impacts an estimated 166 job years were supported in the Highland economy (i.e. within the Highland Council area), including 52 job years in the local Sutherland economy.

Employment will also be supported directly and indirectly during the operational phase of the wind farm including on turbine maintenance, site maintenance and other asset management services. This will vary both seasonally and over the lifetime of the project with service schedules etc. On average, it is estimated that 32 full-time equivalent jobs will the supported directly and indirectly in the Scottish economy, of which 23 will be in the Highlands and 15 in the local Sutherland economy.

SSE Renewables invested over £100m in the Gordonbush wind farm. Many of the larger contracts were awarded to Scottish businesses and several local firms worked on the project.

Local Suppliers

Local suppliers of materials to the project included:

- fuel from Highland Fuels;
- drainage supplies from Alpha Drainage in Dingwall, Keyline in Tain and WT Burden in Muir of Ord;
- traffic signs from Ansco Signs in Muir of Ord;
- aggregates from Dornoch Quarry and Edward Mackay Ltd in Brora;
- concrete from Pat Munro in Alness and Achley Concrete in Dornoch;
- general site supplies from MacGregor Industrial Supplies in Inverness;
- office supplies from Grants Office Supplies in Alness;
- timber products from G & R Sutherland in Brora;
- grass seed from WA Geddes in Brora; and
- building stone from Sutherland Estates.

Local staff employed included vehicle servicing, joiners, electricians, plumbers, fencers, stonemasons and general construction labour from Brora and the surrounding area.

A number of plant and tool hire businesses benefitted from the project including Edward Mackay Ltd of Brora, Waverley Engineering of Golspie, JA MacDougall of Ardross, KV Shepherd of Contin, Duncan Mackay of Rogart, James Jack of Invergordon, Campbell Plant Hire of Inverness, MacDonald Scaffolding of Invergordon and Fraser MacLennan of Dornoch.

Suppliers have also included Highland-based specialist wind energy companies such as Chillwind, which has provided wind monitoring services for Gordonbush as well as SSE's other proposed and operating wind farms in the region. Chillwind is based in Glenelg in Wester Ross and has a depot in Inverness. The company manufactures, supplies and installs guyed meteorological masts and associated instrumentation.

Local staff employed included vehicle servicing, joiners, electricians, plumbers, fencers, stonemasons and general construction labour from Brora and the surrounding area.

Spending on Accommodation and Local Businesses

The wider economic impacts of the Gordonbush wind farm have included the use of local accommodation and services in the Brora area, including outside the normal tourism season. Examples include lunches from Harry Gows in Brora main street; rental of around 12 houses in the area for periods ranging from one to two years; use of hotels, including the Marine Hotel in Brora and the Trentham Hotel in Dornoch; and food and groceries purchased by visiting employees from the Co-op and Spar Shops in Brora and Golspie.

There will also be a positive legacy impact for the local tourism sector in the Brora area. SSE is refurbishing the old schoolhouse building next to the access to Gordonbush wind farm, on the key A9 tourist route, which will then be gifted to Brora Heritage Trust for use as a heritage visitor centre. This is expected to generate income to support the work of the Trust as well as providing a facility that will attract and retain visitors in the locality.

Environmental Benefits

The installed capacity of Gordonbush wind farm is 70MW. Using government approved methods, it is estimated that the wind farm will provide energy for around 70,000 homes, based on an average demand per home of 3,300 kilowatt hours (KWh), the standard unit of measurement for domestic electricity.

Each year the wind farm is estimated to generate around 233,000MWh (or 233 million kWh) of electricity, although it could generate more or less than this, depending on wind conditions. Every kWh of electricity produced by Gordonbush wind farm and consumed in the UK will displace a unit of electricity, which would otherwise have been produced by a power station burning fossil fuel. The industry standard for calculating the positive environmental impact of wind power is based on 430 grams of carbon dioxide emissions saved by each kWh of wind power generated. Gordonbush could result in carbon dioxide emission savings of around 100,000 tonnes each year.

RJ McLeod

RJ McLeod, formed by Roderick John MacLeod from the north west of Scotland, has operated as a Scottish business for over 60 years. In this time, it has had a proven track record of creating employment, either directly or by employing local plant/labour/services, for generations of families from all over Scotland, including the Highlands and Islands and retains a big Highland presence with a large northern office in Dingwall.

The firm undertakes a wide range of construction contracts, has a turnover of almost £80m and around 400 employees. In its early days in the 1950s, energy projects were a key element of the business, particularly the construction of hydro schemes for The North of Scotland Hydro-Electric Board. Civil and balance of plant contracts on wind farm projects, as well as new hydro schemes and grid infrastructure projects, represents a return to its roots for RJ McLeod. It has established expertise in heavy civil engineering in harsh and challenging environments.

The total contracts at Gordonbush were worth more than £13m, with work undertaken over a period of just over a year. The work undertaken at Gordonbush included 22.2km of access roads, the upgrade of a 12km section of the C6 road, 35 wind turbine bases, 48,000 square metres of hard standings, a welfare building and two met masts.

The portfolio of energy projects undertaken by RJ McLeod in the Highlands, for SSE Renewables (including Fairburn wind farm in Strathconnon, Ross-shire; Achany near Lairg, Sutherland; and Spurness, Orkney) and other developers, has allowed the firm to provide sustainable construction employment in the Highlands, at a time when the construction sector as a whole has suffered a serious downturn.

"The last few years have seen markets such as infrastructure for housing/offices/etc. in decline, which could have meant a significant reduction in our employee numbers, as well as reduce our ability to employ site specific local workers and services. The renewable energy industry, including wind farms such as Gordonbush, has therefore contributed to us maintaining a sustainable business model, and allowed us to continue to provide much needed employment in the Highlands and Islands of Scotland."
Jamie Corser, Business Development Manager at RJ McLeod

RJ McLeod preparing one of the turbine bases

Investment in Transport Infrastructure

As well as on the site itself, the investment in the Gordonbush wind farm includes more than £2m on the local transport infrastructure, including upgrading the Gordonbush Bridge and upgrading of 12km of the Clyne C6 road by Loch Brora. This investment provided local construction employment (for example, the surfacing contractor was Pat Munro) and the improvement to the local infrastructure will be a legacy of the project.

Although the turbines were made in Germany, transporting them to the site creates jobs in local ports and haulage companies. The parts for the turbines required 280 return lorry journeys between Invergordon Harbour and the site, which were timed to minimise disruption to local communities. The transport operations were important to Collett Transport, specialist transport contractors and to the Cromarty Firth Port Authority at Invergordon. For all future wind farm developments, SSE intends to procure the towers from Wind Towers Limited in Machrahanish, Argyll, which SSE acquired in 2010. WTL also sources some of its supplies from Highland companies.

Working with the Community

SSE worked closely with the local community during the construction of Gordonbush wind farm to maximise economic opportunities and minimise disruption for businesses and residents. On the day that Gordonbush first generated power Brora Community Council chairperson, Kathleen Cunningham, said:

"This is an important day for the community as it signifies that Gordonbush is nearing completion. We have worked closely with SSE since the start of the project to ensure that the community is kept up to date and considered properly during the construction works and we have been delighted with the efficient, regular engagement and communication demonstrated throughout the entire process. The liaison has been excellent and SSE's team has gone the extra mile in responding to local questions and concerns. The turbine deliveries have gone much smoother than anticipated and we look forward to Gordonbush being fully up and running next year."

Community Benefits

The Scottish Hydro Gordonbush Community Fund has been established for the benefit of residents in the geographic areas represented by the Community Councils of Brora, Golspie, Rogart and Helmsdale. SSE contributes at least £144,000 per year, index linked for 25 years, and an additional variable amount linked to the output of the wind farm.

The Fund provides grants to support charitable activities that enhance quality of life for local residents; contribute to vibrant, healthy, successful and sustainable communities and promote community spirit and encourage community activity. As well as these important social impacts, the Fund also has an economic impact where facilities are built or refurbished and as a result of supporting staff and seasonal workers in community projects.

In April 2012, ahead of the commissioning of the wind farm, it was announced that 33 community organisations in Brora, Golspie, Helmsdale and Rogart have benefited from the second round of awards from the Scottish Hydro Gordonbush Community Fund, receiving more than £100,000. Awards included the purchase of essential equipment for sporting facilities such as funding towards replacing Helmsdale Community Golf Clubs' 100 year old golf greens; sports equipment to help talented young athletes and cyclists; a new play park facilities in Rogart; vital funds to upgrade Kinbrace village hall; an upgrade to the kitchen in the Royal British Legion, Golspie; and new links and pathways in Rovie Woods.

In April 2012, ahead of the commissioning of the wind farm, it was announced that 33 community organisations in Brora, Golspie, Helmsdale and Rogart have benefited from the second round of awards from the Scottish Hydro Gordonbush Community Fund, receiving more than £100,000.

SSE has revised its community investment approach for all new onshore wind farms. This maintains the local community element of £2,500 per MW per year, but has now doubled the benefit to £5,000 per MW. The additional funds will be aimed at supporting skills and training initiatives, community energy schemes and environmental and built environment across the Highland region, and is also of course open to the local community.

This new policy will allow a wider range of activities to be supported. There are good examples of community investment funded projects that could be applied elsewhere in the country. In the Fort Augustus area, community investment funds have been used to assist many local residences to purchase energy efficient household appliances, improving quality of life and reducing demand for electricity.

Community at Heart

In addition to the community investment fund, members of the Gordonbush construction team also helped restore local footpaths which ran past Brora's old Ice House. The work was made possible as part of SSE's 'Community at Heart' scheme, which gives every member of staff a day away from their normal work duties to do voluntary work for a local organisation or charity. Kathleen Cunningham, Secretary for 'A Brighter Brora' said:

"We're delighted with the excellent job that the Gordonbush team has done. They've given this popular local walk, which is also a section of the 'Brora Heritage Village Trail' such a facelift and all in time for Easter visitors too! The path runs past the Ice House which was used heavily back in the day when Brora exported a lot of salmon to London; the crofters used to cut the ice from the river in winter and store it in the Ice House for use during the summer to keep the salmon fresh. 'A Brighter Brora' and dedicated local volunteers work hard at maintaining the Ice House's semi wild garden area and pathways but it would have taken us weeks to achieve what 'Community at Heart' accomplished in just one day. Once again, we've benefited from our positive working relationship with the Gordonbush wind farm team and are very grateful to them for investing their time in the local community of Brora."

SSE staff help restore local footpaths as part of SSE's Community at Heart scheme

SSE: Scotland's leading energy company

SSE is one of Scotland's biggest companies, with headquarters in Perth and 20,000 staff located in over 100 offices throughout the UK, and around 1,800 staff and contractors currently employed in the Highland Region. SSE has its origins as a supplier of electricity in the north of Scotland (Scottish Hydro) and in southern England. The company has firm roots in renewable energy with hydro power in the Highlands and is the UK's largest generator of renewable energy with existing capacity of over 1,450MW of hydro and over 1,300MW of wind capacity in the UK and Ireland and further onshore and offshore wind farms under development.

SSE in the Highlands

SSE supports 1,800 jobs in the Highlands and Islands, making the company one of the largest private sector employers in the region. This includes direct employees and jobs supported in contractors. In 2012 SSE announced significant expansion plans across the business in our Highland headquarters at Henderson Road, Inverness, creating 50 new roles.

SSE has made commitments in 2012 to deliver a pilot training initiative for young people with the University of Highlands and Islands (Inverness College) with a view to significantly scaling up recruitment and training between now and 2020.

On announcing these commitments SSE's Managing Director for Group Services, Jim McPhillimy, said:

> *"The Highland region has always been very important to us since the early 'Hydro' days and we have significant development opportunities in the region planned for the future. We are determined to leave a lasting legacy and our move to significantly expand our presence in the Highlands is a signal of our intent."*

Welcoming the news of SSE's commitment to the Highland region in early 2012 the then Highland Council Convener Sandy Park said:

"The Highland Council welcomes this news of expansion by SSE at its main Inverness office. This represents a significant boost to the local economy in tough economic times. We are also very pleased to be working with SSE on training opportunities for young people as the Council has identified youth employability as a top priority."

In June 2012 SSE is to launch a new web portal for the Highlands supply chain, so that we can maximise the opportunity and input of local businesses to our projects. In addition to this we will normally hold open days for local businesses well in advance of any construction works getting underway.

SSE and Wind Towers Limited

SSE is committed to increasing the value of the Scottish supply chain.

This has included a significant investment in a joint venture, Wind Towers Limited, which secured the future of the wind turbine tower manufacturing plant near Campbeltown in Argyll. The facility is currently working on orders for towers for onshore wind farms across the UK and its management team is planning to exploit the longer-term opportunities from offshore wind farm development. WTL provided all the towers for SSE's Clyde wind farm in South Lanarkshire, where an estimated £118m of contracts were awarded to Scottish companies, or companies with significant Scottish headquarters.

SSE intends to procure all of its towers for future wind farms from Wind Towers Limited.

SSE and Investment in R&D

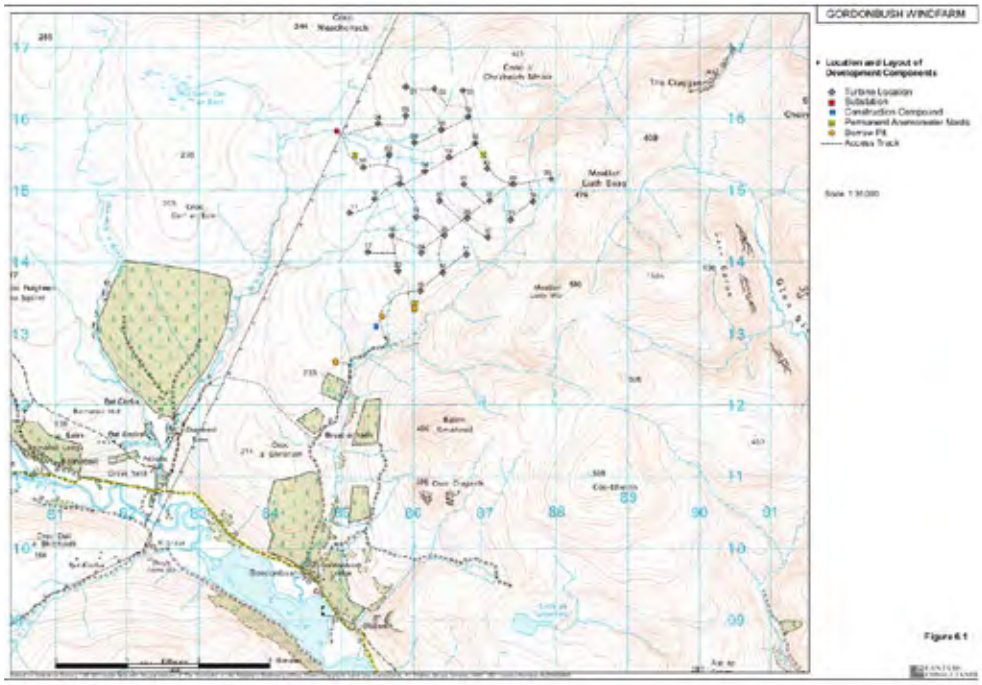
SSE is also investing heavily in research and development, which will help to ensure that the Scottish economy increasingly benefits from the growth of the renewable energy sector, both as a result of capacity installed in Scotland and as an exporter of renewable energy technologies and expertise.

In addition, SSE is supporting a major RSPB research project on the effect of wind farm construction on Golden Plover at Gordonbush, which involves monitoring before, during and after construction.

Summary

This document sets out a picture of how a typical SSE wind farm is developed, the benefits to the local community and to the wider economy in the Highlands. It is by no means exhaustive but it does point to significant positive impacts. SSE is committed to going even further where we can. For example in June 2012 SSE will launch a new Highlands supply chain web portal to help companies in the Highlands engage with SSE and bid for work. In addition we have upgraded our community benefit package for all new projects with £5,000 per MW going to both the local community and also for wider skills development, community energy and environmental restoration projects. SSE is also developing significant plans for investment in young people and skills to ensure that the number of people working on energy projects in the Highlands, come from the Highlands.

This case study was produced with research carried out by independent consultancy Biggar Economics.



Please contact us for more information,
or to feed back your views on how we can do better.

SSE Renewables, 10 Henderson Road, Inverness IV1 1SN

www.sse.com

GordonbushWindFarm@sserenewables.com

Produced June 2012

SSE plc
Registered Office: Inveralmond House 200 Dunkeld Road Perth PH1 3AQ
Registered in Scotland No. SC117119